INTERNATIONAL ENERGY AGENCY

UKRAINE

ENERGY POLICY REVIEW 2006

OECD

INTERNATIONAL ENERGY AGENCY

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- To operate a permanent information system on the international oil market.
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The OECD is a unique forum where the governments of thirty democracies work together to address the economic, social and environmental challenges of globalisation. The OECD is also at the forefront of efforts to understand and to help governments respond to new developments and concerns, such as corporate governance, the information economy and the challenges of an ageing population. The Organisation provides a setting where governments can compare policy experiences, seek answers to common problems, identify good practice and work to co-ordinate domestic and international policies.

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This book is dedicated to Gordon Duffus, a leader, mentor and friend.
Gordon joined the IEA as Head of Division
for the Office of Non-member Countries in 2002.
He passed away on 28 February 2006.
We will miss his good humour, his wise counsel and his courage.

FOREWORD

Ukraine is crucial to providing energy supplies to Europe because of its natural geographic position as a transit country: 80% of Russian gas supplies to Europe transit through Ukraine. Ukrainian energy policy is driven by the country's strong desire to improve domestic energy security and reduce natural gas imports. Today, the majority of its energy supply comes from or through Russia.

Ukraine now stands at a threshold as it confronts both dramatically higher energy prices and significant changes in government. This Review highlights three key priority areas where the government could reduce its energy dependence and improve policy: energy efficiency, cost-reflective pricing and transparency. Ukraine has one of the most energy intensive economies in the industrialised world, thus energy efficiency represents Ukraine's single best opportunity to improve energy security. Improved efficiency is essential for Ukraine's growth and development, and for protecting its environment.

Ukraine can considerably improve its energy efficiency both through targeted policies and through market-oriented energy pricing. Today, most energy prices only cover operational costs, which has created a pressing need to invest in upgrading the infrastructure. Cost-reflective prices are necessary to attract adequate investment and to provide incentives for needed reform across many areas of the energy sector. Ukraine could strengthen its energy policy by improving the transparency of energy data and clarifying market rules.

The Review examines the energy sector from many angles, including the policy framework, environmental impact and developments in subsectors such as energy efficiency, oil, gas, coal, electricity, district heating and renewables.

The Review was an interactive process building upon a constructive dialogue between Ukraine and IEA. The Ukrainian government has worked very hard to make this Review a success; the process has enhanced cooperation between various branches of the government that address energy issues. Moreover, Ukraine has already made progress on the Review Team's top priority recommendations. We congratulate the government on these achievements. At the same time, much remains to be done. We hope the Review and its recommendations can provide a useful input to Ukraine's energy policy formulation and we look forward to working with the government as it continues its energy sector reforms.

Claude Mandil

Executive Director, International Energy Agency

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ORGANISATION OF THE REVIEW AND ACKNOWLEDGEMENTS

The 2006 IEA Energy Policy Review of Ukraine was undertaken by a team of energy specialists from International Energy Agency (IEA) member countries and from international organisations. The team visited Kyiv from 14-22 November 2005 to hold discussions with government officials, energy companies, parliamentary committees, non-governmental organisations and other stakeholders. The IEA Secretariat and review team members drafted this report based on those discussions, as well as the Government of Ukraine's official response to the IEA policy questionnaire and other information provided by the government. When information from official Ukrainian sources was not available, the team relied on alternative sources. This report is primarily based on information available as of July 2006.

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1. *MOL is the acronym for Magyar Olaj-és Gázipari Rt., the Hungarian Oil and Gas Company.*

Organisations Visited

- **Ukrainian Government Institutions**
  - Ministry of Fuel and Energy
  - Ministry of Construction, Architecture, Housing and Communal Services
  - Ministry of Environmental Protection and Climate Change Centre
  - Ministry of Foreign Affairs
  - Ministry of Emergency Situations and Protecting the Population from the Consequences of the Chornobyl Accident
  - Verkhovna Rada (Ukrainian parliament)
  - National Electricity Regulation Commission
  - State Nuclear Regulatory Committee
  - State Committee for Energy Conservation (has been restructured into National Agency on Efficient Energy Use)
  - State Statistics Committee
  - Energy-efficiency Inspectorate
- **Companies**
  - Naftogaz of Ukraine (state oil and gas company) and its affiliate companies Ukrtransgaz, Ukrtransnafta, Gas of Ukraine and Gaz-Teplo
  - Energoatom (state nuclear energy company)
  - Energorynok (national wholesale electricity market operator)
  - Kyivenergo (electricity and heat utility)
  - UkrEnergo (national electricity grid company)
  - UkrESCO (Ukrainian energy service company)
  - AES (operator of two regional utilities Kyivoblenergo and Rivneenergo)
  - Kazmunaigaz (Kazakh national oil and gas company)
  - Ernst and Young (international accounting and consulting company)
- **Other Public Institutions**
  - Agency for Rational Energy Use and Ecology (ARENA-ECO)
  - District Heating Association of Ukraine
  - Institute of Economic Forecasting
  - PointCarbon (environmental non-governmental organisation)
  - Centre for Economic and Political Studies named after Olexander Razumkov (Razumkov Centre)
  - Renewable Energy Agency
  - Scientific and Technical Centre Biomass

- **International Organisations and IEA Member Countries**
  - European Bank for Reconstruction and Development (EBRD)
  - The World Bank
  - IEA member country embassies and representatives (Canada, European Commission, the Netherlands, the United Kingdom, the United States)

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EXECUTIVE SUMMARY AND RECOMMENDATIONS

Ukrainian energy policy is driven by the country's strong desire to improve energy security and reduce natural gas imports. The majority of its energy supply comes from or through Russia. Since it gained political independence in 1991, Ukraine has made some progress in reducing its dependence on energy imports, primarily by improving energy efficiency. At present, Ukrainian energy policy remains mainly focused on energy production, thus there is much opportunity to achieve greater gains through energy efficiency. However, domestic energy prices have typically been well below international levels; this limits investment in infrastructure, as well as incentives for efficiency. In addition, the government maintains a strong role in owning and regulating energy assets; this is often done in a way which minimises competition and, hence, reduces efficiency.

Ukraine must contend with tremendous change in the international energy scene as energy prices are growing globally. The rate of price increases is particularly fast in Ukraine because the country must adjust to new terms from Russia at the same time. Today, most of Ukraine's oil and gas – and all of its nuclear fuel – comes from or through Russia. This will not change quickly. Tension between Ukraine and its main energy supplier has grown in recent years. Because of its geographic position, Ukraine does not have many affordable and accessible supply alternatives.

Priority Setting: Efficiency, Prices and Transparency

The Review Team identified three key priority areas in its recommendations: energy efficiency, cost-reflective pricing and transparency. Ukraine is distinct from other industrialised countries in its economy's intensive use of energy. This is detrimental to the economy: it makes Ukraine less competitive and highly vulnerable to price shifts. Improving energy efficiency represents a major opportunity to increase energy security, reduce imports, improve economic growth and lower its environmental footprint. Greater energy efficiency will be much easier to achieve if domestic prices reflect the full, long-term costs. Today, most energy prices in Ukraine only cover operational costs. Because of these low prices, the energy sector has had little or no money for investment, which has ultimately had a negative effect on reliability, efficiency and long-term, economic sustainability. To attract investment, Ukraine must allow investors to cover their costs and make a reasonable return. Finally, Ukraine could strengthen its energy policy by improving the transparency of its energy data and market rules.

Energy efficiency represents Ukraine's single best opportunity to improve energy security. It will also reduce the economic burden of energy use, making Ukraine less vulnerable to rising energy prices and disruptions. Moreover, efficiency is essential for Ukraine's growth and development. Today, Ukraine uses energy about three times less efficiently than EU countries on average; even neighbouring Russia and Belarus are less energy intensive. The government's own projections for energy efficiency and expanded domestic energy supply show that energy efficiency is less expensive and has a bigger impact on reducing imports than projected new domestic supply. Ukraine put an energy-efficiency policy in place in 1994. However, insufficient funding was allocated to this goal so the policy could not be fully implemented. In 2005, a government decree closed the State Committee for Energy Conservation. This Committee was responsible for developing and implementing energy-efficiency programmes nationwide; it also worked to encourage energy efficiency through standards, public information campaigns and mechanisms to promote financing. Recognising the void left by the closure of the State Committee for Energy Conservation, the government has now opened a new National Agency on Efficient Energy Use. Investment in energy efficiency is growing, reflecting the economic benefits of such investments. Ukraine also has many energy-efficiency experts in the private sector and academia, providing needed intellectual capacity to develop effective strategies.

Several factors contribute to Ukraine's inefficiency. Low energy prices are one of the more important ones. Only oil and oil product prices are at international levels. Despite recent increases in import prices, retail natural gas prices remain several times lower than prices in Western Europe and they are also lower than prices in neighbours like Russia. Coal prices do not cover production costs; thus, coal mines are in dire financial straits. Electricity prices cover operating costs, but not investment costs. This is most pronounced for nuclear energy, where the nuclear tariff effectively does not cover capital expenditures and decommissioning. Likewise, the tariff does not fully fund nuclear safety or waste disposal. District heat is also priced below long-term costs, which leaves no money for investment and ultimately leads to dangerous outages and inefficiency. The National Electricity Regulatory Commission (NERC) and the government have developed a plan to raise electricity and gas tariffs; consistent follow through is vital to improving energy efficiency and energy security.

Greater transparency in energy data and market rules could boost investment and thereby enhance competition and service quality. High-quality energy statistics and well-founded energy projections are foundations of effective policy making. Ukraine has good energy-production data, but very little data on energy consumption. This can distort policy because it complicates the task of assessing demand trends. The Ukrainian government recognises that its policy would benefit from demand-driven energy projections, as well as from using more sophisticated economic modelling tools and approaches. A second element of transparency needed is clear market rules that are enforced uniformly. Such rules would stimulate investment and enhance fair competition in Ukraine. Ukrainian citizens will also benefit from a more transparent marketplace because competition typically brings better services.

Supply Scene

Ukraine depends on imports for most of its energy supply. The country is particularly reliant on natural gas in its energy balance. Domestic gas production meets about 25% of total demand. The rest is imported, and all of that through Russian pipes. International gas purchases, domestic production, transmission and wholesale sales are primarily in the hands of the state-owned firm Naftogaz of Ukraine. Regional gas companies, most of which are private, are responsible for distribution and related retail sales. RosUkrEnergo, the controversial Swiss-based gas trading company, is playing a growing and persistently opaque role in the Ukrainian gas sector. In early 2006, it became the sole supplier of imported gas and has a growing role in the retail sector as well. Its ownership structure is murky, and the company appears to make significant profit simply because it signs contracts to transit gas from Central Asia to Ukraine. To reduce its reliance on gas imports, Ukraine plans to increase domestic production. Achieving this goal will require improving the upstream investment climate.

The private sector has a more predominant role in Ukraine's oil sector than in the gas sector: private companies, primarily Russian, own most of the refineries and filling stations. State-owned companies do control most oil production and transportation. The government has expressed concern about the potential for market manipulation because relatively few companies sell oil products domestically. In 2005 and 2006, several refineries reduced output for extended modernisation upgrades. Ukrainian refineries tend to produce heavier products than demand currently warrants:

too much fuel oil, too little gasoline. Thus there is a need to modernise, although the government is concerned about the timing of the closures.

Transit is very important to Ukraine. It is the largest gas transit country in the world by volume and also hosts major oil transit routes because of its location between Russia and Europe. The Ukrainian government views transit as a partial guarantee of secure energy supplies, as energy suppliers in the East cannot easily shut off Ukraine without harming customers farther downstream. The gas dispute in early January 2006 showed that simply providing transit routes does not make Ukraine immune from supply disruption. This has become even more evident in recent years as Russia has made concerted efforts to diversify its supply routes for gas and oil. Three pipelines – the North European Gas Pipeline, Yamal and Bluestream – are or will be serious alternatives to transit through Ukraine, which means that Ukraine's transit business and energy security will depend increasingly on relations with Russia. Likewise, European buyers are relying more on sea routes for oil and gas supply, which could affect the geopolitical importance of Ukraine's transit business. The volumes of oil transited have dropped gradually in recent years, though gas transit volumes are more or less stable. Given the many options on the table, greater transparency in the transit sector would build the credibility of Ukraine as a route for transit. Likewise, permitting private operating licences could attract investments needed for system upgrading, international competitiveness and reliability.

For much of the 20th century, coal fuelled Ukraine's industrial growth. However, the coal industry has been in decline for several decades: coal output dropped steadily, particularly since the fall of the Soviet Union. Production has stabilised today, although the sector still faces major problems – many of which can be attributed to poor governance. For example, industrial groups control the sale of coal from many mines while also supplying the same mines with expensive equipment and materials. This makes for profitable steel production, but keeps the coal mines operating at a loss. In addition, the government provides significant production and investment subsidies. The government has a plan to close unprofitable mines; most of the mines slated for closure have already been shut down. Still, the remaining mines are, by and large, not yet profitable. The government has also been privatising mines, though most mines are still in state hands. Private Ukrainian mines are, on average, more profitable and have higher productivity levels. The coal sector also needs to address significant environmental and worker safety issues: Ukrainian coal mines are the second most dangerous in the world, after China's.

The power sector has undergone liberalisation and privatisation, but the reforms are not yet complete. Ukraine has a wholesale power market with a single buyer, called Energorynok. In theory, regional thermal power companies compete to sell their power, however, because of frequent fuel shortages and emergencies, the government plays a large role in allocating fuel. Nuclear, hydro and wind stations also sell to the wholesale market, but at regulated prices. Nuclear energy accounts for about half of total power production, and the government would like to see the share of nuclear energy in the energy balance grow further. Only one of the major power supply companies is majority privately held. In the mid-1990s, the government unbundled transmission and distribution from supply. However, in 2004, the government created a new company, Energy Company of Ukraine, which took over the state power assets (both supply and distribution). The grid company and nuclear operator are also state owned, although in separate companies. Several of the regional distribution companies are in private hands and are not part of Energy Company of Ukraine. The power sector is significantly more stable than it was several years ago, with fewer outages, more stable grid frequency and higher levels of payment. At the same time, the sector needs significant new investment and would benefit from a more vibrant market with greater incentives for efficiency. The nuclear sector sees some of the largest distortions because wholesale tariffs fail to cover a large share of the cost of nuclear energy.

The district heating sector is at an earlier stage of reform, although the government has recently done significant work to outline a new sectoral strategy and has adopted a Law on Heat Supply. Most Ukrainian families rely on district heating, and district heating accounts for a large share of total energy use. At the same time, district heating companies have not been able to make significant capital investments for years because of the low tariffs. This means that many systems are not only in financial trouble, but are also at high risk for outages and technical failures. For example, the district heating system of Alchevsk, a town of 120 000, suffered a severe outage in the cold winter of 2006. The pipes throughout the system cracked when the heat stopped flowing, creating a national emergency. Ultimately, almost the entire system had to be replaced. Clearly, avoiding such problems in the future is important, but this requires systematic reform and follow through. The district heating sector is also a prime candidate for energy-efficiency improvements, in all parts of the energy chain, from production to distribution and consumption. The need for better government co-ordination is possibly most clear in this sector. In order to limit gas demand, the Ministry of Fuel and Energy plans to shift away from district heating toward electric heating.

At the same time, the Ministry of Construction wants to reform the district heating sector and make it more efficient. Investing in completely new heating systems would be very expensive, and electricity is an inefficient way of providing heat. Likewise, district heating's low tariffs often serve as a substitute for social support for the poor; stronger co-ordination might help in identifying welfare solutions that do not tax district heating systems.

Renewable energy has a small but growing share in Ukraine's energy balance. The bulk of this comes from large hydro power plants. The government has also invested in wind farms. Use of biomass, mainly for heat, is relatively common in rural areas and many agricultural villages have been switching to biomass-fired boilers for their small district heating systems. The country also has the potential to expand bio-fuel production. Ukraine has adopted several targets and sectoral programmes to increase the use of renewables, but implementation has been slower than promised. Underpriced conventional fuels are a major barrier to expanding renewables.

Ukraine's energy sector has high pollution levels. Two main reasons for this are Ukraine's high energy intensity and the obsolete technology used in energy transformation. Power and heat plants are old and have few pollution controls. In addition, government energy policy has not traditionally placed high priority on environmental concerns, although the situation is changing gradually. The government now has programmes to promote energy efficiency and modernisation at power plants. One could see this shift occurring even as the government developed the *Energy Strategy of Ukraine to 2030*, which ultimately did address environmental protection in each sectoral chapter. Ukraine has major opportunities through the Kyoto Protocol to finance energy efficiency and renewable energy, and associated emission reductions. To date, the government has been slow to pursue those opportunities: it approved rules for one of the Kyoto mechanisms, joint implementation, only in 2006.

In conclusion, Ukraine has taken important steps in meeting key goals of energy policy related to energy security, economic efficiency and environmental protection. However, it has many opportunities to further expand reforms by improving energy efficiency, adopting cost-reflective pricing and enhancing transparency. These steps, while difficult, will position Ukraine to meet new challenges, such as import price increases and global competition, while increasing its energy autonomy.

Recommendations

As part of the review process, the IEA Review Team developed recommendations for energy policy as a whole and for each sub-sector. The recommendations are designed to provide concrete advice on improving Ukrainian energy policy in line with stated government goals and the "Shared Goals" of IEA member countries (Annex II). While Ukraine is not a member of IEA, IEA believes that applying the "Shared Goals" is broadly beneficial to most countries in improving their energy security, promoting economic growth and protecting the environment.

Based on this review, the government of Ukraine should take action in the following areas:

Cross-Cutting

Recommendations in this section cover issues such as pricing that are not unique to a single energy sub-sector, but rather cut across many types of energy or energy policies.

- Concentrate on improving energy efficiency.
- Eliminate subsidies and cross-subsidies in the energy sector and ensure that tariffs cover costs, including capital investment. Simultaneously introduce targeted social measures to protect the most vulnerable households against price increases.
- Increase the independence of the National Electricity Regulatory Commission.
- Enhance co-operation between government institutions working on energy and related environmental, social and macroeconomic issues.
- Enhance competition and improve transparency in the energy sector to promote corporate efficiency.
- Develop transparent and competitive mechanisms to attract private investors to purchase or operate energy assets.
- Promote policies that allow for well-defined ownership and management of buildings.
- Ensure that the Ukrainian energy strategy is based on solid energy data, economic models and demand projections.

- Shift the analytical focus from energy supply to demand to improve the *Energy Strategy of Ukraine to 2030* and other energy sector programmes.
- Improve statistics, particularly on energy consumption, by providing technical and economic support for the offices engaged in data collection and publication and by adopting international statistical methodologies.

Energy and Environment

- Ensure that environmental assessments and issues are more thoroughly incorporated into energy policy.
- Take full advantage of opportunities offered by the Kyoto Protocol. Develop a credible greenhouse inventory and registry.
- Focus on the most polluted areas where the population is directly affected by the poor air quality.
- Form working groups with government and power sector representatives to jointly develop effective strategies on modernising and improving the efficiency of energy production.
- Facilitate emissions reductions where it is most cost effective, for example, in energy efficiency, district heating, coalbed methane and renewable energy.
- Use environmental audits of large power plants as a means of encouraging companies to capture cost-effective opportunities to improve efficiency and reduce emissions.
- Internalise a larger portion of the environmental costs of energy production into energy prices.

Energy Efficiency

- Ensure that prices cover the full, long-term cost of energy supply. Help ease the pain of rising energy prices by investing in energy-efficiency measures in low-income households.
- Make it mandatory for all buildings and other energy consumers to have heat, electricity and gas meters.
- Provide ample staff and funding for the new National Agency on Efficient Energy Use. Ensure that this Agency has continued high-level support that reflects the importance of its mission.
- Develop and implement energy-efficiency standards for equipment and buildings rather than relying on normative use of energy per unit of output and its associated penalties.
- Strengthen and improve enforcement of building energy codes.

- Use tax policy to promote energy efficiency.
- Proceed with creating the planned energy-efficiency fund.
- Create incentives for efficient energy use at state-owned enterprises through performance-based contracts for enterprise management.
- Enhance dialogue between the government and major energy consumers through voluntary agreements.
- Realise the full potential of the energy-efficiency capacity that exists in Ukraine, particularly in non-governmental organisations, energy service companies and academic institutions.
- Expand existing public awareness campaigns and training programmes.
- Use monitoring and evaluation as tools to understand the benefits and impacts of energy-efficiency policies and programmes, and to expand and replicate the most successful programmes.

Natural Gas and Oil

- Based on the lessons learned from government interventions on the oil product market, commit to more market-based approach; use regulation to enhance competition and efficiency.
- Clearly separate business and political functions in running Naftogaz of Ukraine and other state companies.
- Streamline licensing and permit processes to make them more predictable. Use transparent, competitive tender procedures for exploration licences. Create a mechanism whereby companies that make discoveries have the right to acquire production licences without a new bidding procedure.
- Implement and enforce the rules for production-sharing agreements.
- Improve taxation and other revenue-sharing terms and conditions.
- Allow ownership of product by operators and investors at the wellhead.
- Discontinue the practice of setting gas prices based on the source and end user of the gas.
- Develop a clear strategy for enhancing competition in the domestic gas market. In the meantime, continue regulating gas companies to avoid abuses of a monopoly position, accounting for the fact that import supply to the country is controlled by a single company (Gazprom and its affiliates).
- Clarify and simplify the rules and conditions for third-party access to pipelines.

- Enhance efforts to install gas meters.
- Provide incentives to increase the sophistication of refineries by adopting higher fuel standards.
- Develop a comprehensive plan for creating 90 days of oil stocks; consider the agency-type approach to stock-holding.
- Remove export restrictions and further liberalise the domestic oil and oil product markets.
- Abandon the plan to create a national vertically-integrated oil company.

Energy Transit

- Ensure that future investments in transit infrastructure involve commercial partners and are, thus, driven by economics and market demand.
- Develop a clear, unambiguous method of pricing gas imports and gas transit services: prices for both activities should reflect market fundamentals.
- Allow Ukrtransgaz and Ukrtransnafta to use the transit fees collected for investment in the systems.
- Reduce leakages and improve the efficiency of compressor stations to enhance sector performance and limit environmental impact.
- Reduce administrative and fiscal barriers in order to increase oil transit through Ukraine.
- Eliminate intermediary companies that do not add value to transit operations. As a transitional step, improve the transparency of intermediaries by requiring the publication of full ownership information and independent audit reports as a prerequisite for acquiring licences.
- Improve transparency of other operators to strengthen investors' confidence.
- Proceed with the restructuring of Naftogaz of Ukraine to completely separate supply from transportation. In the longer term, move to gas market liberalisation.
- Take steps to attract investors to gas transport and storage projects.
- Continue efforts to sell storage services and optimise use of excess storage capacity. Make sure that storage facilities have enough gas to meet domestic gas demand in winter.

Coal

- Enhance oversight of transactions at state-owned mines.
- Establish auctions for coal and coal products.
- Phase out subsidies for coal production and capital investments as quickly as possible; redirect some of the funds to address social and environmental consequences of mine closure.
- Reinforce efforts to quickly close unprofitable mines.
- Follow through with privatisation of coal mining enterprises.
- Establish clear labour safety regulations and consistently enforce them.
- Strengthen environmental regulations and enforcement. Consider using royalties to establish a fund to pay for environmental remediation after mine closure.
- Seek to improve management of coal reforms and of financial outlays related to the reforms.
- Assess whether plans to expand production are realistic.
- Promote coalbed methane with clearly defined and enforced rules to access natural gas pipelines, and licensing regimes that allow sales of the gas at competitive prices.

Electricity

- Consolidate efforts to develop a wholesale market for electricity.
- Remove barriers to competition; specifically, un-bundle power generation and distribution to allow the market to function as designed.
- Reassess whether current regulations, as implemented, adequately encourage – and fairly price – combined heat and power production and other efficient technologies.
- Stop allocating fuel to thermal power generators. Such allocations distort the market and add significantly to fuel use and costs.
- Consider reinvigorating a transparent and competitive privatisation process to encourage new investment and enhance sector efficiency.
- Ensure that the nuclear power industry can operate sustainably in the long term by requiring that nuclear power prices cover the full costs of nuclear

power, including capital, waste treatment, decommissioning and nuclear safety. Resolve outstanding legal issues related to the creation of funds for decommissioning and waste disposal.

- Reassess Ukraine's uranium reserves to ensure that their size and extraction cost match the extent to which policy makers plan to draw on them to support Ukraine's nuclear power production.

District Heating

- Create a level playing field for competitive heating options.
- Design and implement a national district heating development strategy in order to make the district heating sector competitive on a well-developed heat market.
- Improve and clarify heat tariff regulation; enhance the independence of the regulator and ensure that tariffs are not kept artificially low as a substitute for social support programmes.
- Require contracts between district heating providers and end users.
- Enhance efforts to install energy-metering equipment.
- Create incentives for investing in energy efficiency in district heating and buildings. Focus on improving efficiency throughout the energy chain, from production to end use.
- Make sure that national policies and measures to stimulate combined heat and power production are properly implemented.
- Establish systematic data collection on district heating.

Renewable Energy

- Conduct a comprehensive cost-benefit analysis of policy options in order to develop realistic policies to support renewable energy.
- Focus on facilitating renewable energy development in areas in which they have a competitive advantage (*e.g.* biomass) rather than subsidising more expensive options.
- Continue efforts to create a level playing field for renewable energy by removing subsidies and cross-subsidies for fossil fuels.
- Facilitate access to financing for potential developers and users of renewable energy sources.
- Adopt policies to facilitate the entry of renewable energy on the energy market through fiscal incentives, increased awareness, improved regulations for renewable energy planning and integration into energy systems, and other measures.

PART I:
SETTING THE SCENE

1. GENERAL ENERGY SCENE AND ENERGY POLICY

Political and Economic Overview

Country Overview

Ukraine, with Russia to its East and Europe to its West, has a territory of 603 700 km^2 (slightly larger than France), a population of some 47 million and GDP of USD 39 billion in 2004 (at purchasing power parity, USD 250 billion).[2] Most of Ukraine has a temperate continental climate and is covered by steppe and mixed forests; the Southern coast of Crimea has a sub-tropical climate. Administratively, Ukraine consists of 24 oblasts (regions), one autonomous republic (Crimea) and two cities with special status – Kyiv and Sevastopol. Ethnic Ukrainians represent 78% of the total population and ethnic Russians over 17%. Ukrainian is the official language but a large share of the population, especially in Eastern and Southern Ukraine, speaks Russian. One of Ukraine's assets is a highly qualified and hardworking labour force, but the population has been shrinking in recent years due to a low birth rate and emigration.

Because of its strategic geopolitical location Ukraine is one of the most important energy transit countries in the world: 80% of the gas and 14-17% of the oil that Europe acquires from Russia travels through Ukraine. However, the transit infrastructure requires investment in modernisation in order for Ukraine to maintain its strategic role in energy transit. Ukraine is highly dependent on Russia for energy supplies. In 2005, more than 85% of Ukraine's oil, about 75% of its gas and all of its nuclear fuel came from Russia or through Russia. Ukraine has some domestic resources of coal, gas and oil but they are not sufficient to meet the country's energy demand. Most of the country's hydro resources have been developed.

Political Developments

Ukraine proclaimed its independence on 24 August 1991 and elected its first president, Leonid Kravchuk, on 1 December 1991. Leonid Kuchma won the next presidential election in 1994 and was re-elected for a second term in 1999.

2. *Billion USD at 2000 exchange rates. Source: IEA statistics.*

The events around the 2004 presidential election became known as the Orange Revolution. On 26 December 2004, Viktor Yushchenko was elected Ukraine's president. Yulia Tymoshenko was the prime minister until September 2005; then she was replaced by Yuri Yekhanurov. Subsequently, the parliamentary elections of 26 March 2006 were very important because of the constitutional reforms, which Ukraine introduced in December 2004. These reforms have moved Ukraine away from a presidential system to a parliamentary one and have given greater authority to the Verkhovna Rada[3] (the parliament) and the prime minister. In the March election, Viktor Yanukovych's *Party of Regions* won the majority of votes (over 32%); the *Block of Yulia Tymoshenko* won 22% and Viktor Yushchenko's *Our Ukraine* won 14%. As of July 2006, the Verkhovna Rada had not yet confirmed a new government, but it had nominated Viktor Yanukovych as prime minister. The next presidential elections are set for 2009.

Ukraine's Economy

Ukraine has an industrialised economy, dependent on energy imports. Its main industries include ferrous and nonferrous metals, machinery and transport equipment, chemicals, coal, electricity and food processing. Ukraine has a large services sector accounting for nearly 50% of GDP. This includes electricity, gas and water supply, which provide 3.8% of GDP. Agriculture accounts for some 11% of GDP. Due to its fertile soil, Ukraine was long known as the "breadbasket of the Soviet Union". The country has good prospects for growing biomass for energy purposes. It is worth noting that the national flag of Ukraine has two colours: blue and yellow that represent the sky over a wheat field.

Following its independence in 1991, Ukraine's economy declined for nearly a decade. GDP shrank by almost 50% from 1992 to USD 29.5 billion (at purchasing power parity, USD 190 billion) in 1999. In 2000, GDP began to rise again and grew by an impressive 9.4% in 2003 and more than 12% in 2004 (Table 1.1). GDP growth dropped significantly in 2005 to 2.6% and then strengthened again in the first half of 2006. The "shadow" or underground economy, which flourished in the 1990s, is gradually decreasing but still represents a large share of economic activity.

Ukraine's currency, the hryvnia (UAH), has remained stable against the dollar,[4] and Ukraine has had a positive trade balance for several years. The

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3. As a general rule, this book uses the Ukrainian-language spelling of proper names, as transliterated into English. In some cases the Ukrainian spelling is simplified to make it more understandable to English readers.

4. Since 2000, the exchange rate has been approximately USD 1 to UAH 5-5.5. In the first half of 2006, USD 1 was worth approximately UAH 5. This book primarily uses average conversion rates for specific years or other periods of time.

Table 1.1

Main Economic Indicators in Ukraine, 1992-2005

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005e
Population (million)	52.2	52.2	51.9	51.5	51.1	50.6	50.1	49.7	49.2	48.7	48.2	47.8	47.5	47e
GDP (billion USD at 2000 prices and exchange rates)	59.5	51.0	39.3	34.5	31.1	30.2	29.6	29.5	31.3	34.1	35.9	39.3	44.0	
GDP PPP (billion USD at 2000 prices and purchasing power parities)	373.4	327.9	248.2	220.0	197.4	191.5	189.2	190.3	202.0	217.8	228.4	249.2	278.9	
GDP growth (%)		-14.2	-22.9	-12.2	-10.0	-3.0	-1.9	-0.2	5.9	9.2	5.2	9.4	12.1	2.6
Inflation* (%)	1 527.0	4 735.0	891.2	377.0	80.3	15.9	10.6	22.7	28.2	12.0	0.8	5.2	9.0	13.5

**Inflation: consumer price indices, year-to-year.*
e – estimated.
Sources: IEA Statistics; Derzhkomstat (Ukrainian State Statistics Committee).

government has incurred only a moderate fiscal deficit. While inflation and the shadow economy rightfully cause some concern, Ukraine's economy demonstrates significant resilience to external shocks. The World Bank estimated that the consequences of the January 2006 gas agreement (Chapter 6: Energy Transit) will reduce the economic growth by about 2% of GDP.[5] Thus far in 2006, economic growth has been strong.

Energy Policy Institutions

● President

The president of Ukraine is elected by a universal direct vote for a five-year term. The constitutional reforms that entered into force in 2006 have increased the power of the parliament, but the president's legislative and executive powers still remain quite strong. The president can propose new laws, issue decrees and orders, and veto laws adopted by the parliament. The president is responsible for the country's national security. The president also acts as the Commander-in-Chief of the Ukrainian Army and the Head of the National Security and Defense Council.

● Legislative Power: the Verkhovna Rada

The highest legislative body of Ukraine is the unicameral parliament, known as the Verkhovna Rada (Supreme Council). Its 450 members are elected by a national vote for a five-year term. The seats are allocated proportionally based on the parties that gain 3% or more in the national parliamentary elections. The Verkhovna Rada adopts laws and approves the state budget, national economic, social and environmental programmes, and the principles of domestic and foreign policy. It has several committees relevant to the energy sector, as highlighted below:

- The Committee for Fuel and Energy, Nuclear and Nuclear Safety prepares legislative proposals in the energy sector.
- The Committee for Environmental Policy, Nature Protection and Liquidation of Consequences of the Chornobyl Accident is responsible for developing legislation on the natural resources, environmental safety and pollution (including nuclear).

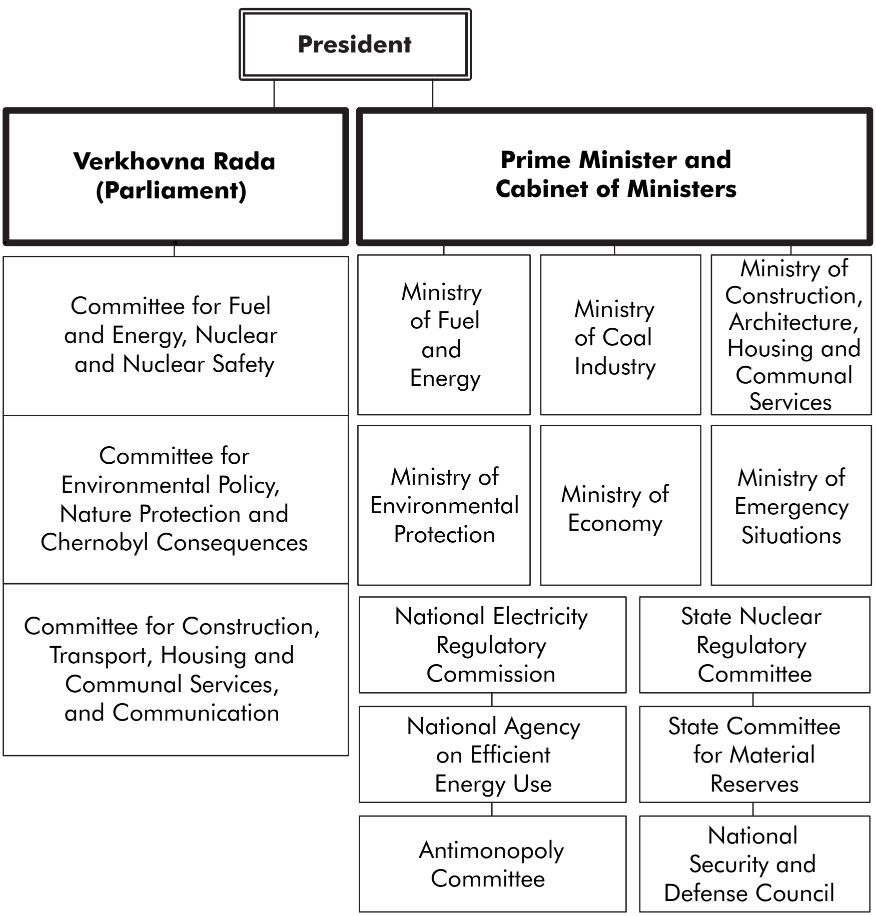
5. The World Bank had previously projected Ukrainian GDP growth at 3.5-5.5% in 2006; following the January 2006 Agreement, the estimate was reduced to 1.5-3.5%.

- The Committee for Construction, Transport, Housing and Communal Services, and Communication develops legislation on district heating and other residential services.

The constitutional reform that entered into force in 2006 gave the Verkhovna Rada the power to appoint the prime minister. The parliamentary majority coalition (*i.e.* at least 226 members of the parliament) nominates a prime minister candidate. Within 15 days, the president must present this candidate for the Verkhovna Rada's approval. The parliament also approves other members of the Cabinet, as well as heads of the Antimonopoly Committee and the State Property Fund.

Figure 1.1

Key Energy Policy Institutions of Ukraine



Note: Some of the names in this figure have been shortened for ease of presentation.

Executive Power

Executive bodies that deal with various aspects of the energy sector include several ministries and state committees (Figure 1.1). The structure of energy policy institutions in Ukraine reflects the legacy of the Soviet-style distinction between “large-scale energy” (large-scale fuel production and generation) and “small-scale energy” (residential energy services including district heating and distributed generation).

The **Ministry of Fuel and Energy** is the key administrative body for Ukraine’s energy sector. It develops the energy sector’s strategy and regulatory framework, and contributes to the development of the state budget and targeted economic and social programmes. It also plays a role in the development of local renewable energy sources. The Ministry is an important economic actor in the energy sector. It has authority over the state-owned companies Naftogaz of Ukraine and Energy Company of Ukraine and thus controls major assets in the oil, gas, electricity and district heating sectors. Until recently, it also controlled the coal sector. When there are fuel shortages, the Ministry also allocates fuel to thermal power stations. The Ministry of Fuel and Energy participates in preparing international contracts for fuel supply and international energy agreements, including on nuclear safety and civilian use of nuclear technologies. It also helps develop proposals to adapt Ukrainian energy legislation to EU directives.

The Ministry was founded by presidential decree on 14 April 2000 by merging the Ministry of Coal Industry, the Ministry of Energy, the State Committee for the Power Industry, the State Committee for Oil, Gas and Oil-refining Industries, and the State Committee for Nuclear Power.

The **Ministry of Coal Industry** is responsible for the on-going management, restructuring and privatisation of the coal industry, including closing unprofitable mines. It manages budget allocations directed to coal companies and implements social programmes related to mines closures. The Ministry of Coal Industry was re-established through the re-organisation of the Ministry of Fuel and Energy on 25 July 2005 by the presidential *Decree on Measures of Improving the State Management of Coal Industry.*

The **Ministry of Construction, Architecture, Housing and Communal Services** (Ministry of Construction) oversees the so-called “small-scale energy” sector. This Ministry is responsible, in particular, for developing and implementing policy on district heating and other residential services. The Ministry was created in July 2005 from the State Committee for Construction and Architecture and the State Committee for Housing and

Communal Services. The merging of the two committees into a single Ministry is intended to facilitate the implementation of energy-efficiency improvements in the housing stock.

The **Ministry of Emergency Situations and Protecting the Population from the Consequences of Chornobyl Accident** was established on 26 July 1996, a decade after the Chornobyl accident. The main tasks of the Ministry include developing and implementing measures to protect Ukrainian citizens from the consequences of the Chornobyl accident and other emergencies. Other responsibilities include national supervision and monitoring of civil defence and technological safety, as well as ensuring emergency preparedness.

The **Ministry of Environmental Protection** develops and implements state policy in the area of nature protection, rational use of natural resources, ecological, nuclear and radioactive safety. The Ministry was created in 1991 and has since undergone several restructurings. It is the main co-ordinator of climate change policy and programmes, although it is the Ministry of Fuel and Energy that determines priority actions to reduce greenhouse gas emissions in the energy sector. **Interagency Commission for Implementing the UN Framework Convention for Climate Change** controls Ukraine's carbon credits.

Following the adoption of the presidential *Decree on the Strategy for European Integration of Ukraine* in 1998, the **Ministry of Economy** has been the main co-ordinator of co-operation with the European Union, including the harmonisation of EU and Ukrainian energy policy. The Ministry formulates and implements economic and social policies of Ukraine, including those that have an impact on the opportunities for energy sector reforms. For example, the Ministry helps fund social programmes related to the closure of unprofitable coal mines.

The **National Electricity Regulatory Commission** (NERC) plays a very important role in the energy sector through licensing and price regulation. The Commission was founded on 8 December 1994 to regulate the electricity sector, but since then its authority and functions have been extended to other energy sub-sectors. NERC issues licences for the following activities:

- Power generation, transmission, wholesale sales, distribution and supply to end-users.
- Combined heat and power generation; heat generation from renewable energy sources.
- Oil and oil product transportation.
- Gas transportation, storage, distribution and supply.

NERC sets the wholesale price of electricity from nuclear, hydro, wind and cogeneration plants, and establishes retail electricity tariffs. In 2005, NERC also gained the authority to regulate tariffs for heat generated from cogeneration, nuclear energy, and renewable and non-conventional sources. These tariffs were previously regulated by municipalities. NERC sets natural gas price caps for all customers, establishes tariffs for transportation of natural gas via main pipelines and distribution networks, and determines tariffs for supply and storage of natural gas. In the oil sector, NERC sets tariffs for oil and oil product transportation.

NERC is independent from the Ministry of Fuel and Energy. However, the Ministry of Justice must approve and register NERC's decisions, which limits its independence. The Cabinet of Ministers appoints the chairman of NERC and its four commissioners for six-year terms that can be renewed only once. However, NERC has had three chairmen in the last four years.[6] NERC does not control its own budget. Initially it was funded from licence fees and could afford to offer competitive salaries to attract highly qualified staff. Since 2000, it has received its budget from the government and must follow civil servant regulations for salaries. This means that salaries are lower than in many of the companies it regulates (Gochenour, 2004). The Verkhovna Rada has prepared draft legislation that would grant NERC budgetary and administrative independence, and reduce the ability of the Verkhovna Rada or the government to overrule its decisions.

The **State Nuclear Regulatory Committee** (SNRC) was created by presidential decree on 5 December 2000. The Committee sets criteria, requirements and conditions for nuclear safety (*e.g.* normative documents, standards); issues permits and licences for activities in this area; and supervises implementation of legislation, norms, rules and standards on nuclear and radiation safety. It also oversees the Chornobyl decommissioning and the management and transport of nuclear waste. SNRC is an independent body, but like NERC, it receives its budget from the government.

A presidential decree of 31 December 2005 created the **National Agency on Questions of Providing Efficient Use of Energy Resources (National Agency on Efficient Energy Use).** The Agency replaced the State Committee for Energy Conservation, which operated from 1995 and was officially closed in April 2005 with a plan to transfer its functions to the Ministry of Fuel and Energy. A vigorous public debate followed this decision: many institutions and individual experts supported the idea of an independent

6. Yuri Prodan was appointed head of NERC in June 2002, Serhiy Tytenko in April 2004, and Valeriy Kalchenko in February 2005.

energy-efficiency body in Ukraine. The debate led to the creation of a new institution with wider authorities than those held by the previous committee. The responsibilities of the new Agency include state policy on energy use, energy efficiency, renewable and alternative energy sources, as well as energy metering and monitoring.

The **National Security and Defense Council** is a very powerful body made up of the heads of relevant military and civil institutions, including most ministers and the head of the Verkhovna Rada. The formal head of the Council is the president of Ukraine, but day-to-day management is in the hands of the Secretary of the National Security and Defense Council. The Council plays an important role in developing Ukraine's energy security policy.

The **State Committee on Material Reserves** (Derzhkomreserv) manages the formation, distribution, maintenance, use, replenishment and renovation of commodities in the state reserve. It may manage the strategic oil stocks as well, although Ukraine is considering an option to place these stocks under the control of the National Security and Defense Council.

The **Antimonopoly Committee**, established in November 1993, monitors implementation of antimonopoly legislation and limits the concentration of economic power, including that in the energy sector.

Regional and local authorities can influence energy companies by setting local taxes and levies (for example, environmental taxes) and by issuing certain licences or permits (such as site permits for oil and gas drilling). Local administrations continue to regulate district heating companies and tariffs for heat from local heat-only boilers. Most regional administrations have an energy-efficiency department that monitors energy consumption and manages energy-efficiency programmes in the region.

Various other bodies that hold executive power oversee a broad range of areas that are less directly related to the energy sector but still underpin elements important to the sector's structure or operation. The **State Statistics Committee** (Derzhkomstat) collects and publishes energy supply and consumption data. The **Ministry of Finance** is responsible for the state budget, taxation policy and public debt management. The **Ministry of Agriculture** co-ordinates the agricultural sector and influences policies related to biomass. The **State Property Fund** formally owns the State assets in the energy sector. Other institutions involved in the energy sector administration include the **Ministry of Industrial Policy**, the **State Committee for Technical Regulation and Consumption Policy**, and the **Ministry of Justice**.

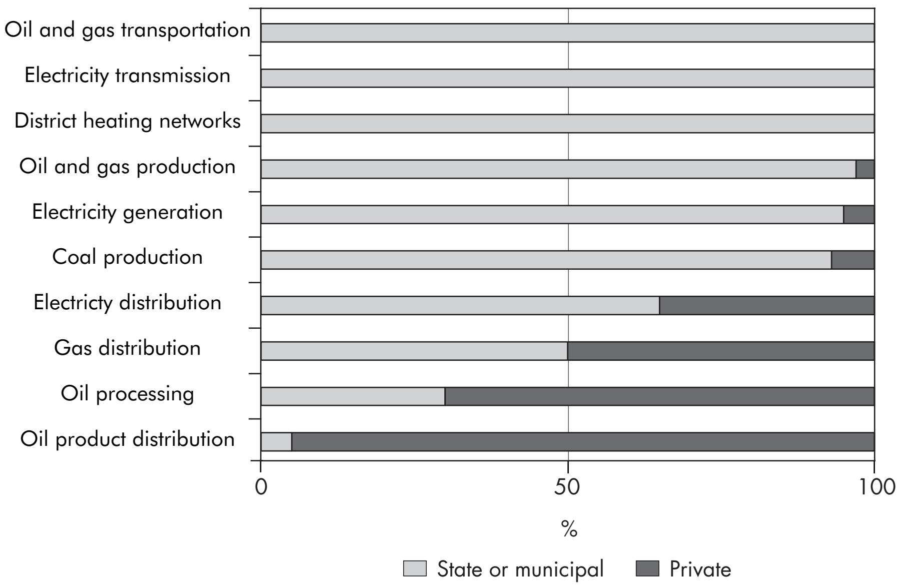
Energy Sector Ownership and Structure

• Privatisation versus Consolidation Policy

State-owned companies dominate the Ukrainian energy sector, even though the degree of state control varies from one sub-sector to another, and may change in the future following the policy trends discussed below. Private companies have the advantage of being able to raise financing on capital markets, and Ukraine's energy sector is in urgent need of capital investment.

Figure 1.2

Ownership Structure in the Ukrainian Energy Sector, Early 2006



Note: Most district heating networks are under municipal ownership. Gas distribution pipelines are state-owned but about 50% of companies that operate these pipelines are in private hands.

Source: IEA estimates based on information provided by the government and other sources.

Since the creation of the state holding company Naftogaz of Ukraine in 1998, the upstream hydrocarbon sector has been a virtual state monopoly, except for several relatively small projects led by private companies. Other energy sub-sectors have undergone several administrative changes over the last few years. The Kuchma government launched the first privatisations of coal mines (1996), electricity distribution companies (1998) and oil refineries (1999). The results of these privatisations were mixed. Majority shares in four out of six refineries were sold to foreign (mostly Russian) companies. In 2001-02, the oil processing level significantly increased and Ukraine became a net exporter of oil products. (However, the situation had much deteriorated by 2006). In the coal sector, the privatised mines attracted most investments and showed positive production results, but privatisation and restructuring slowed down by 2003. In electricity, only six distribution companies were privatised by 2001. The remaining 21 power distributors are partially privatised with a mix of free-floating shares and shares owned by the government or other shareholders. Ukraine has several private companies and organisations working on energy efficiency, as well as a state-owned energy service company, UkrESCO. In addition, several state research institutes focus on energy-efficiency issues.

In 2004, the government somewhat changed the policy direction and took new steps to increase state control in the energy sector. It reconsolidated the electricity and coal industries into large, vertically-integrated companies, similar to Naftogaz of Ukraine, which dominates the hydrocarbon sector. In the electricity sector, the government created the state holding Energy Company of Ukraine (ECU) in June 2004. The holding company Coal of Ukraine was created in the autumn of 2004 by consolidating state-owned assets, although it has since been abolished and its assets have been transferred to the Ministry of Coal Industry. In the same year, the government announced its plans to create a vertically integrated national oil company.

The government under President Yushchenko seems set to continue most of the policies on state ownership of energy assets started under the previous Kuchma government. The government supports the idea of a vertically integrated oil company and is considering several options for its structure and operation. In the electricity sector, state assets remain consolidated in the Energy Company of Ukraine and the government has not taken steps toward further privatisation. According to the *Concept for the Development of the Coal Industry*, adopted in July 2005, the government will continue to corporatise state-owned mines and then privatise them through competitive bids.

Government officials have been actively discussing the optimal approach to future privatisations: strategic investors or sale of shares on the stock market. The *Energy Strategy of Ukraine to 2030*, approved by the Cabinet of Ministers of Ukraine in March 2006 (Cabinet of Ministers, 2006a),[7] indicates that privatisation of energy sector facilities should be based on an individual approach towards each company. It also highlights the need to apply privatisation methods that would re-invest revenue from privatisation (in full or in part) in the company privatised. It is important to ensure that privatisation takes place in a transparent and competitive manner.

7. *For ease of reading this book uses a shortened version of the title:* Energy Stategy to 2030.

Oil and Gas

The state holding company Naftogaz of Ukraine ("oil and gas of Ukraine") plays a dominant role in many aspects of the oil and gas business in Ukraine, including oil and gas production, management of trunk pipelines, oil and gas transit, and natural gas processing and distribution in Ukraine. Until the beginning of 2006, Naftogaz of Ukraine also handled all gas imports into the country; a trading intermediary, RosUkrEnergo, has now taken over this function. Another state joint-stock company, Nadra of Ukraine ("subsoil of Ukraine"), deals with most of the exploration of hydrocarbon reserves. Several other private and public companies explore and produce hydrocarbons, but their collective share of total oil and gas production is less than 3% and 4%, respectively.

Naftogaz of Ukraine has several affiliate companies including Ukrtransnafta, Ukrtransgaz, Chornomornaftogaz and Gas of Ukraine. Ukrtransnafta operates all main oil pipelines in Ukraine. Ukrtransgaz is in charge of the gas transmission system (GTS) and gas storage in most of Ukraine, while Chornomornaftogaz operates transmission lines and a storage facility in Crimea. Gas of Ukraine is a wholesale gas company and, as such, sells gas to regional distribution companies (oblgaz). Most of the 42 gas distribution companies are partially privatised, but Naftogaz of Ukraine holds shares in most of them. UkrGaz-Energo, the new joint venture between Naftogaz of Ukraine and RosUkrEnergo, created in February 2006, also sells imported gas to Ukrainian consumers.

The government has liberalised the processing and distribution of petroleum products in Ukraine. Russian companies control four out of six Ukrainian refineries.[8] Several foreign (mostly Russian) companies operate filling stations in various parts of the country. Since 2003, Ukrnafta, an oil company affiliated to Naftogaz of Ukraine, has purchased many filling stations across the country.

Coal

The majority of Ukraine's 164 active mines are owned by 24 state enterprises that report to the Ministry of Coal Industry. Three private companies, Krasnodonvuhillya, Krasnoarmeiska-Zakhidna and Pavlohradvuhillya, own 25 mines, which are primarily coking coal mines. Only 7% of mines were private in 2005, but they produced 40% of the coal.

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8. The Kazakh state oil and gas company, Kazmunaigaz, owns the majority of shares in the Kherson refinery, but the Russian Alliance group, which owns 27.6%, operates it.

Electricity and Heat

The state holding company, Energy Company of Ukraine, owns most non-nuclear generation assets and has shares in most regional distribution companies. The state company, Energorynok ("energy market"), operates the wholesale electricity market. The thermal electricity generation companies (gencos) theoretically compete on the power market. Four gencos have mixed ownership; a fifth genco is privately held. Nuclear plants belonging to the state-owned company Energoatom also sell power to Energorynok, but at regulated prices. Another state company, Ukrenergo, operates Ukraine's national transmission grid and the external interconnections with the grids of Russia, Central Europe, Belarus and Romania.

Regional power distributors (oblenergos) are responsible for Ukraine's low-voltage networks and for retail electricity supply. Some of them also operate small district heating plants at the local level. Municipalities generally own local district heating networks. In general, the distribution companies buy power from Energorynok and sell it to final consumers, at regulated prices. There are 27 oblenergos, which include 24 regional companies, plus one company in the Autonomous Republic of Crimea and two city-based distribution companies (in Kyiv and in Sevastopol). In addition, in some regions portions of the electricity grid are held by other owners, who acquire licences for electricity distribution and supply at regulated tariffs.[9]

Building Sector and Communal Services

The building sector, represented in statistics as residential, and commercial and public services, accounts for more than 30% of domestic final energy consumption. The ownership structure in the building sector is rather ambiguous. More than 85% of residential apartments have been privatised, but responsibility for common areas within buildings (roofs, doors, lifts, and electricity, heat, water and sewage infrastructures) has not been properly assigned. Therefore, in most cases, there is no clear owner of the building as a whole. Common areas are generally the responsibility of municipal housing maintenance companies (so-called ZhEKs). Ownership of commercial and public buildings is much clearer, except when a commercial company or a public institution occupies part of a residential building. Co-operatives of apartment owners in multi-storey buildings (condominiums) are being established in Ukraine but their share is less than 5% of all residential buildings so far. In general, people are not interested in creating

9. *As of 1 April 2006, there were 49 distribution licence holders and 42 supply licence holders.*

condominiums because they could lose the right to obtain municipal subsidies for building maintenance.

The ambiguity of residential building ownership blurs responsibilities and complicates decision making for operation, maintenance, long-term planning and investments. Owners of individual apartments often find it difficult to agree on repairs of common parts of buildings such as the heating system. Even if there is a mutual agreement, financing becomes a problem. Private loans require guarantees, which are practically impossible without clear ownership. On the other hand, low income residents cannot afford to pay for even minor improvements. For these reasons even the most urgent maintenance needs are often neglected, and feasible and low-cost energy-efficiency measures are not implemented. This is a major barrier for modernisation and efficiency improvements in buildings.

Management of building services is also unclear. Housing (communal) services are the responsibility of local authorities. Municipal housing maintenance enterprises, known as ZhEKs, are responsible for providing heating, water, gas, electricity and sewage services to households, small commercial and service companies, and public institutions. ZhEKs act as intermediaries between supply companies (electricity, heat, gas and water) and end users; the ZhEKs handle billing and collection, as well as routine repairs and maintenance. However, the ZhEKs have neither the finances nor the staff to provide quality services. In some cases, municipalities delegate some building management responsibilities to other enterprises, but there is generally no clear or systematic way of managing these delegated activities.

Building management is a very demanding and important task, which should be carried out by professionals. It can be handled effectively by either a single individual or a company (private or municipal). The building manager must work on a contract basis, with clearly defined responsibilities and duties, and report to the building owner(s). The key element is to ensure that the manager has the necessary resources and competences, including knowledge of the building and its technologies, energy consumption and efficiency, basic skills in repair, and a solid understanding of costs and financial matters.

It is equally important to clearly define the responsibilities of companies supplying district heating, electricity, water and other services to the buildings. Based on international experience, the best approach is to create an open, competitive market for building management and residential services. President Yushchenko has officially announced that Ukraine must move to competition in the communal services sector. On 21 July 2005, the government approved the rules for organising tenders to provide housing and communal services.

Some cities have created what is known as a "single buyer services company" – *i.e.* a private company that supposedly signs contracts with providers of various communal services based on competitive bids, and collects payments from households. However, in the absence of alternative suppliers of district heating, water and electricity, the single buyer service company may have few options. More often than not, it has no choice but to sign a supply contract with the only existing provider. Another potential problem is that the single buyer services company itself is not necessarily selected on a competitive basis.

Energy Prices, Tariffs, Taxes and Subsidies

● Prices and Tariffs[10]

For many years, electricity, gas and district heating tariffs for residential consumers were very low in Ukraine; until recently, they were even lower than in neighbouring countries such as Russia. The increases in gas and electricity tariffs, implemented in 2006, are an important step toward sustainable pricing levels; however, electricity and natural gas (especially for households) are still priced below the long-run marginal cost. The problem seems even more serious in district heating and nuclear power. According to the Ministry of Construction, district heating tariffs, on average, cover about 80% of costs. Current electricity prices do not fully include the capital costs of power stations, which are particularly high for nuclear power. Although the tariff for nuclear electricity generation includes a small decommissioning charge, it has not been sufficient to accumulate necessary funds for nuclear plants decommissioning.

Despite some progress with price liberalisation in the early 1990s, real prices for energy actually declined from 2000-05. While inflation (the producer price index) grew by 47% from 2001-04, prices for electricity, natural gas and heating grew only by 22% over the same period. The sharp growth in price for gas imports in 2006 made an increase of domestic prices unavoidable. NERC raised gas prices for various consumer groups by 25% from May 2006, and by a further 80-85% from July 2006. NERC is also gradually

10. The term "prices" generally refers to non-regulated, market-based prices of a commodity; "tariffs" are regulated.

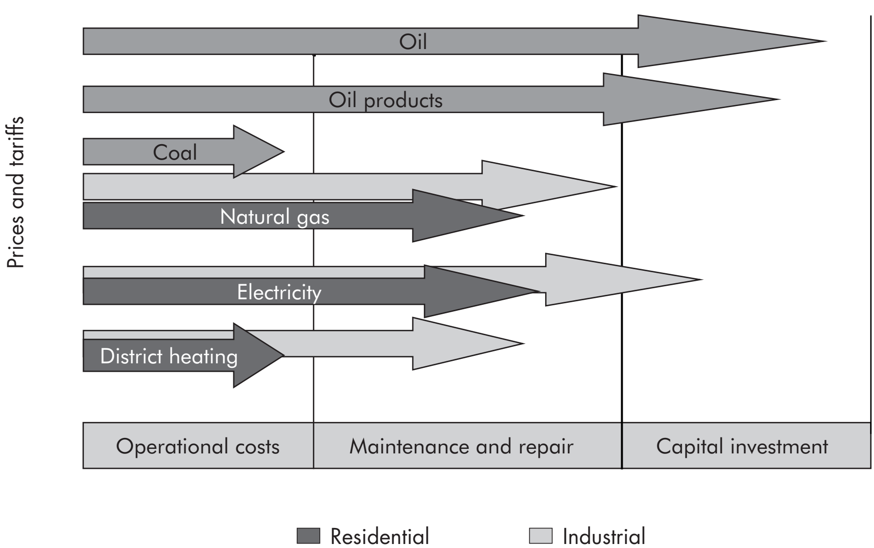
raising electricity tariffs with the intention of reaching cost-recovery levels by 2008. District heating prices are also expected to grow because of the higher fuel costs. Adjusting the economy and social support programmes to higher energy prices is painful and challenging, but it is a necessary step in the transition to a market economy.

Coal prices are formally set by the market. However, in practice, large industrial groups that own metallurgical plants have tremendous influence over the price of coal. As a result, Ukrainian coal is reportedly priced 20-40% below costs at the mines. Mines receive direct production subsidies and many mines also receive capital investments from the state budget, but even with subsidies most mines are loss-making.

Oil and oil product prices are not regulated and approximate world prices. Most of the oil is imported to Ukraine by foreign, vertically-integrated companies that also own or operate Ukrainian refineries. These companies set prices for imported crude oil based on their business considerations. Ukrainian companies with over 50% state ownership must sell domestically produced crude oil and gas condensate at auctions.

Figure 1.3

Energy Prices and Tariffs Compared to Costs, June 2006



Source: IEA estimates based on information provided by the government and mass media.

Subsidies

Ukraine does not have many explicit subsidies but the existing cross-subsidies and other distortions deflate prices for many energy products. Residential consumers, public institutions and agricultural users obtain energy at a relatively low, regulated rate. Electricity tariffs for households and natural gas prices for the residential and public sectors are lower than those for industrial users. Thus, industries bear the financial burden by cross-subsidising the residential and public sectors. On the other side, some industries are also subsidised, for example, through coal subsidies, and government-funded investments in coal mining and nuclear safety. Until the end of 2005 all Ukrainian consumers also paid relatively low natural gas prices, which were subsidised by Naftogaz of Ukraine through substantial revenues from transiting Russian gas to Europe.

The Ukrainian government recognises that it should raise energy prices to stimulate energy-efficiency improvements and attract the necessary investment to the sector. The *Energy Strategy to 2030* states that one of Ukraine's main tasks is assuring the coverage of production costs to create conditions for the sustainable development of energy companies. NERC began raising electricity and gas tariffs in May 2005, but tariffs for households and some other consumer groups have not yet reached cost recovery levels. Raising tariffs for households further is politically difficult. This highlights the necessity for strong co-ordination between energy policy and social and economic policy.

Taxation

Ukraine has made progress in reforming its tax system over the last several years. The European Business Association reports that Ukraine has resolved a number of problematic issues in taxation and made the whole system more transparent and simple (European Business Association, 2005). Nevertheless, the Ukrainian tax system still appears rather unpredictable "due to repeated changes in legislation, often retroactive, failure to proceed with declared intentions and schedules for tax reform, and many cases of one-sided fiscal interpretation of the law by the tax authorities" (European Business Association, 2005).

Ukraine has several nationwide taxes specific to the energy sector, which include:

- **Surcharge** on the effective tariff for electricity and heat, except for electricity produced by cogeneration plants.

- **Surcharge** on the approved tariff for natural gas for all consumer types.
- **Royalties** for producing oil, natural gas and gas condensate, for natural gas transit and for transportation of oil through main oil pipelines.
- **Fee for exploration activities.** This fee is intended to create an economic mechanism to compensate for exploration and prospecting costs financed by the state, and to collect funds for financing further exploration.

Ukraine also has several, more general, nationwide taxes, duties and levies that impact the energy sector, including a value-added tax (VAT) of 20%. Small companies, non-profit organisations and state institutions do not have to pay the VAT. Companies exporting goods, including energy products, must pay VAT on exports but the tax authorities ultimately reimburse it. Ukrainian refineries exporting their products have reported significant delays in VAT reimbursement, which has a negative effect on their finances. In addition, there are local taxes set by regional and city administrations. Ukraine also has environmental pollution fines.

Investment

A large share of assets in the Ukrainian energy sector have worked beyond their design life and need urgent replacement or modernisation. The *Energy Strategy to 2030* estimates the total investment requirements in the supply side of the energy sector at more than UAH 1 trillion (USD 200 billion) from 2005-30 (Table 1.2), which implies a substantial higher rate of investment than occurred in the last 15 years. In looking at the demand side, it estimates investments in energy-efficiency improvements at UAH 102.3 billion (USD 21 billion) over the same time period.

Currently, investment in the sector is insufficient to meet the needs of the ageing infrastructure. One reason for underinvestment is the sector's ownership structure: most assets belong to the state, which cannot make all the necessary investments because it faces other priorities for the state budget. Moreover, financing from the state budget is not always very efficient because social or political concerns often prevail over economics. Private investment has made inroads in the energy sector, but private companies could play an even greater role.

Two major barriers to private investment are artificially low energy prices and the complicated system of subsidies, cross-subsidies and other market distortions (see section Energy Prices, Tariffs, Taxes and Subsidies). Non-payment for electricity, gas and district heating was long another serious issue, which undermined the financial sustainability of those sectors and deterred investment. Payment discipline has significantly improved since 2000. The collection rate for energy services among final consumers was close to 100% in 2005, but many companies were overburdened with debt accumulated in previous years. A law passed in June 2005 introduced a mechanism to restructure the accumulated debt. The non-payment problem reappeared in 2006, following the sharp increase in the price of imported gas.

Table 1.2

Investment Needs of the Ukrainian Energy Sector (billion UAH and USD)

	2005-2010		2011-2020		2021-2030		2005-2030	
	UAH	USD	UAH	USD	UAH	USD	USD	USD
District heating and thermal power production	16.7	3.3	75.8	15.2	90.9	18.2	183.4	36.7
Hydropower	3.5	0.7	5.6	1.1	10.6	2.1	19.0	3.8
Electricity networks development	13.2	2.6	43.8	8.8	25.9	5.2	82.9	16.6
Nuclear power	11.6	2.3	79.0	15.8	117.6	23.5	208.2	41.6
Renewable power	1.1	0.2	3.0	0.6	3.0	0.6	7.1	1.4
Nuclear fuel cycle	4.0	0.8	13.3	2.7	4.4	0.9	21.7	4.3
Coal industry	42.4	8.5	87.9	17.6	91.4	18.3	221.7	44.3
Oil and gas complex	65.6	13.1	122.6	24.5	112.1	22.4	300.3	60.1
Total	**158.2**	**31.6**	**431.0**	**86.2**	**455.9**	**91.2**	**1045.0**	**209.0**

Note: USD numbers are the converted equivalent of the UAH numbers.

Source: Cabinet of Ministers, 2006a.

The actual terms of access to exploration and production of energy resources do not encourage investment. Administrative procedures are cumbersome, especially for foreign companies. Companies exploring new fields have no guarantee of acquiring a production licence if they discover oil or gas. Quotas restrict gas and oil exports, and obligatory sales of gas to domestic consumers – usually at the lowest regulated prices – do not provide production incentives.

The discrepancy between the letter of the law and its implementation in practice is a major systemic risk for investors in the energy sector and the economy at large. The official approval of a law does not always mean that it will be rigorously enforced; moreover, many conflicting laws and regulations are still in place. Quite often, there are significant delays in adopting secondary legislation (regulations, rules and instructions) required to implement a law; occasionally, the secondary legislation that does exist may contradict one or more laws. The court system in Ukraine has a poor record of enforcing creditor, property and contract rights, which often stems from shortcomings in procedure, organisation and resources (both material and human). These deficiencies may well lead to a perceived lack of objectiveness and to arbitrary or selective implementation of laws. On the positive side, all Ukrainian laws are publicly available on the website of the Verkhovna Rada.

Another barrier to investment is the complicated system of licensing and permitting, which lacks clear procedural rules and deadlines. This potentially encourages corruption and reduces investor confidence in the rights accorded by a licence or a permit.

Nevertheless, the government has made some progress in increasing transparency and improving the investment climate in Ukraine. Reducing the importance of barter payments and increasing cash collections are two positive examples. The effort to investigate possible corruption in Naftogaz of Ukraine is another. The *Law on Production Sharing Agreements* has encouraging provisions, although it has not been effectively implemented. Given all these changes, private capital has started making inroads into most energy sub-sectors. However, additional improvements are needed to ensure an adequate level of investment.

Main Energy Policy Directions

- **Energy Strategy of Ukraine to 2030**

Ukraine first developed its official energy strategy in the mid-1990s – the *National Energy Programme of Ukraine to 2010* – which the Verkhovna Rada adopted in 1996. Ukraine also adopted several so-called comprehensive state programmes that outlined the government medium-term policies in various sub-sectors: *Creation of a Nuclear Fuel Cycle* (1994); *Development of Hydrocarbon Resources in the Ukrainian Sector of the Black and Azov Seas* (1996); *Energy Conservation* (1997); *Construction of Wind Power Stations* (1997); *Oil and Gas of Ukraine until 2010* (2001) and *Thermal Power Plant Reconstruction* (2002). In 2001, the National Academy of Sciences developed a proposal for an *Energy Strategy to 2030 and over the Longer Term*, which it presented for approval to the Verkhovna Rada, the Cabinet of Ministers and the president.

By 2003-04 it became clear that the comprehensive energy programmes were not being implemented as expected. The government tasked the Ministry of Fuel and Energy with preparing an improved energy strategy. The Ministry adjusted the previous draft version, using the most recent statistical data and the state policy trends. In March 2006, the Cabinet of Ministers approved the *Energy Strategy to 2030*, the major objectives and tasks of which are outlined in Box 1.1.

Box 1.1 Strategic Objectives of the *Energy Strategy of Ukraine to 2030*

The *Energy Strategy of Ukraine to 2030* outlines strategic objectives for energy sub-sectors that aim to enhance the country's overall economic development and the people's well-being. The broad objectives focus on efforts to:

- Create favourable conditions for meeting energy demand in a sustainable way.
- Determine mechanisms for the safe, reliable and stable functioning of the energy system, and for its efficient development; create favourable conditions for implementing these mechanisms.
- Increase domestic energy security.
- Reduce the impact on the environment.
- Reduce the cost per unit of energy production and use, via the following measures: assuring efficient energy use, introducing energy-saving technologies, rationalising the structure of industry and reducing the share of energy-intensive technologies.
- Integrate Ukraine's energy system into the European energy system, with gradual growth of electricity exports; strengthen Ukraine's position as an oil and gas transit nation.

Source: Cabinet of Ministers, 2006a.

The *Energy Strategy to 2030* provides a comprehensive overview of the current situation in the energy sector. However its projections seem to be based not on detailed statistical data and models, but rather on political objectives without economic analysis of whether these objectives are feasible (Chapter 2: Energy Trends). As a result, the projected demand for energy may be significantly inflated. Overall, the *Energy Strategy to 2030* is very heavily focused on energy supply, while IEA believes energy efficiency should take greater precedence in policy development. Higher energy prices, for example, would naturally lead to lower consumption levels over time. In addition, the *Energy Strategy to 2030* would benefit from fuller consideration of fiscal, financial, social, environmental and employment issues related to the energy sector.

Most objectives of the *Energy Strategy to 2030* echo the key tasks and priorities of the government programme *Towards the People*, which was endorsed by the parliament in early 2005. According to this programme and the *Energy Strategy to 2030*, the key priorities for Ukraine include improving the country's energy security, strengthening its position on international energy markets and reducing the energy intensity of the economy. Another priority is integrating Ukraine's energy system into the European energy system, which is a component of Ukraine's general strategic goal of joining the EU. Fighting corruption, particularly in the energy sector, was also announced as one the government's top priorities. In this context, the following sections will look at two key policy directions: domestic energy security and the role of Ukraine on the international energy scene.

Energy Security

Given Ukraine's overdependence on energy imports, improving energy security has long been an important concern for the government. President Yushchenko has put energy security at the top of the policy agenda and emphasised his determination to reduce the country's dependence on Russia and Turkmenistan for energy supplies. This builds on concerted efforts pursued by both prime ministers Tymoshenko's and Yekhanurov's governments to further strengthen key policies initiated under the previous government, *i.e.* creating strategic oil stocks and a state reserve of nuclear fuel, building new nuclear generation capacities, developing some elements of the nuclear fuel cycle, and enhancing domestic hydrocarbon production.

The Ukrainian government expects to enhance energy security through at least four sets of measures:

- Reducing energy intensity (the energy use per unit of output).
- Diversifying energy supplies and transportation routes.
- Enhancing domestic production of fuels and increasing nuclear power generation.
- Shifting the fuel balance toward larger use of domestic resources like coal.

Reducing Energy Intensity

The government has declared that its key priority is a radical reduction in Ukrainian energy intensity, which is currently three times higher than the EU average. Since Ukraine declared independence, energy efficiency has consistently been a top government priority. Unfortunately, political declarations have not always been implemented in practice. Progress in improving efficiency has been slower than it could have been, largely due to low energy prices and insufficient attention to the issue at the highest government level. (That said, energy intensity has declined since independence.) The government under President Yushchenko seems to understand the vital importance of energy efficiency and the great potential that Ukraine has in this area, although this is not fully reflected in the *Energy Strategy to 2030.*

The government plans to increase energy efficiency by introducing new technologies, modern systems of control, management and metering in all parts of the value chain, including production, transportation and consumption of energy products. It is considering developing market mechanisms to stimulate energy-efficiency improvements in all sectors of economy, which is encouraging. On the other hand, the government seems willing to keep its outdated practice of establishing plant-specific norms of energy consumption per unit of industrial production. Worldwide, a more effective approach has been introducing market-based energy prices that cover costs, as well as mechanisms for financing energy-efficiency measures (more details in Chapter 2: Energy Trends and Chapter 4: Energy Efficiency).

Because past efforts to improve energy efficiency have often suffered from waning political commitment, underfunding and understaffing, consistent implementation is key to achieving the goals outlined in the *Energy Strategy to 2030.*

Diversification

Ukraine seeks to reduce its dependence on Russia by diversifying its supplies of gas, oil and nuclear fuel. Apart from trying to sign a long-term gas supply agreement with Turkmenistan, Naftogaz of Ukraine is studying the possibility of importing gas from Kazakhstan (through existing pipelines), as well as from Azerbaijan, Iran and Iraq (possibly through a branch of the proposed Nabucco pipeline). Norway has also been mentioned as a potential gas supplier.

Naftogaz of Ukraine is also assessing the feasibility of producing gas and oil in other countries such as Libya, the United Arab Emirates (UAE), Turkmenistan, Uzbekistan, Kazakhstan and Azerbaijan. It is not clear, however, how Naftogaz of Ukraine could bring these resources to Ukraine. Thus, these potential deals may be more about diversifying Naftogaz of Ukraine's business than about diversifying Ukraine's energy supply. The *Energy Strategy to 2030* includes oil and gas, which Naftogaz would presumably produce abroad, in its energy supply projections. This implies a potential supply gap if Naftogaz of Ukraine does not manage to bring these resources to Ukraine.

The national nuclear company Energoatom is planning to diversify nuclear fuel supplies to reduce its total dependence on the Russian TVEL Corporation. For example, it has particularly close contacts with Westinghouse Electric Company, Ltd. (USA). Ultimately, Ukraine hopes to conduct a tender for alternative suppliers of nuclear fuel. Ukraine also plans to develop domestic elements of the nuclear fuel cycle.

Domestic Energy Production and Changing the Fuel Supply Balance

The plan to increase the share of domestic coal and nuclear in the energy balance, while also decreasing the share of imported oil and gas, is a key aspect of Ukrainian energy policy. The government expects to reduce dependency on imported fuels from the actual 55% to just 12.4% in 2030. Such a sharp reduction in imports could prove unrealistic if the costs of increasing domestic production were thoroughly analysed. The Ministry of Fuel and Energy assumes that "forecasted growth in international prices for crude oil and natural gas will happen under conditions of rather stable prices for coal and nuclear fuel, which improves the competitiveness of hydro, nuclear and condensing power plants operating on coal" (Cabinet of Ministers, 2006a). While world coal prices, indeed, may grow more slowly than oil and gas prices, it does not mean that coal produced in Ukraine will be cheap. The cost of producing coal in Ukraine may be too high to make coal a competitive option for the volumes planned. At present, the Ukrainian coal industry receives huge subsidies and most mines are unprofitable. It is not obvious that in the future the coal industry will be able to produce the projected amount of coal profitably without a major improvement in productivity.

The government's plan to create elements of the nuclear cycle raises the same concern: would it be economically justified? Given Ukraine's relatively scarce reserves of uranium (most of its resources are associated with deep, low-grade deposits with relatively high extraction costs) and the high cost of uranium processing facilities, it is not entirely clear whether it would make economic sense for Ukraine to pursue this initiative. It may eventually prove economically justified but more precise cost-benefit analysis must be done before making the investment decision. This analysis could also take into consideration the possibility of importing uranium.

Ukraine is also seeking to enhance domestic production of oil and gas, particularly in the Black and Azov Seas, which presumably contain some of Ukraine's most significant reserves. To meet this goal, Ukraine would need to improve the upstream investment climate to attract private investors.

Ukraine's Role on the International Energy Scene

Ukraine is planning to enhance its role on the international energy scene mainly in three areas: increasing its role in energy transit; developing its electricity export potential; and taking active part in energy projects abroad.

One of Ukraine's strategic objectives is to sustain and increase the volumes of Russian oil and gas transited via its territory. Russia, on the contrary, is seeking to reduce its reliance on Ukraine and is developing alternative export routes. As a result, Russian oil transit via Ukraine has been decreasing; gas transit may also drop in the future with the construction of alternative routes such as the North European Gas Pipeline. At present, some 30% of Ukrainian gas transit capacity and about 50% of oil transit capacity are not being used (Cabinet of Ministers, 2006a). Moreover, after a brief disruption of gas supply in January 2006, which stemmed from a contract dispute between Russia and Ukraine, Western European countries started looking more seriously at diversifying their supplies. It is, therefore, in Ukraine's strategic interest to persuade both the supplier and the consumer states that it is a reliable and economically attractive transit country.

Ukraine is also exploring other transit opportunities. In 2005, Ukraine and Iran signed a Memorandum of Understanding on building a pipeline that would carry Iranian gas to Ukraine and onward to Europe. However, the economic prospects of this project are questionable.

The *Energy Strategy to 2030* identifies developing the export potential of the electricity sector as a policy priority. The government aims to attract investment into upgrading and re-equipping the generation facilities and power transmission infrastructure, including cross-border transmission lines.

The *Energy Strategy to 2030* also emphasises the importance of domestic manufacturing of power equipment, which, in the government's view, would make Ukrainian enterprises competitive in energy sector development at home and abroad. Ukrainian companies have already initiated projects to extract hydrocarbons in other countries (*e.g.* Kazakhstan, Turkmenistan, Libya, Iran and Iraq) and to construct electric power stations and electricity supply networks (*e.g.* Vietnam and Cuba). IEA believes that the *Energy Strategy to 2030* puts too much emphasis on Ukrainian activities abroad, rather than focusing more on reforming the domestic energy markets.

European Integration

Ukrainian aspirations for EU membership presume the adaptation of legislation, harmonisation of standards and the associated institutional reforms. Ukraine adopted a *Law on an All-National Programme for Adaptation of Ukrainian Legislation to European Union Legislation* in March 2004.

To adapt its energy legislation and institutional base to those of the EU, Ukraine would have to modify several of the key principles of governing the energy sector:

Current principle		**EU principle**
Monopoly	▶	Competition
State management	▶	State regulation
Central planning	▶	Liberalisation
State ownership	▶	Opportunities for the private sector

EU countries are obliged to introduce complete liberalisation of natural gas and electricity markets by July 2007. They must also create and maintain oil and oil product reserves sufficient to provide domestic consumption during at least 90 days, and set up an emergency preparedness plan for possible supply disruptions. In addition, EU countries must eliminate state subsidies to the coal industry and set transparent and competitive prices at the coal market. Ukraine still has a long way to go to reach these and other cornerstones of EU energy policy, especially in the gas and electricity sectors. Despite these challenges, adapting Ukrainian legislation to EU legislation would facilitate the emergence of competitive energy markets in the country.

Critique

Since the previous energy policy review of Ukraine, which IEA conducted in 1996, Ukraine has moved towards creating a sound, long-term energy policy. Major areas for further improvement include energy efficiency in supply and demand, effective price signals and greater transparency.

Since Ukraine's independence, energy security and energy efficiency have been key priorities of Ukrainian energy policy. The government under President Yushchenko is putting these issues very high on the overall political agenda and is pursuing most policies initiated under the previous governments. This includes improving energy efficiency, increasing domestic fuel production and electricity generation, diversifying supplies, and creating strategic oil stocks and elements of the nuclear fuel cycle. Continuity of strategic policy directions is important for success, but more efforts could be made to effectively implement these policies.

Encouragingly, the government under President Yushchenko seems to understand the vital importance of energy efficiency and the great potential that Ukraine has in this area. The creation of the National Agency on Efficient Energy Use is a very positive development. On the other hand, consistent political support for energy efficiency has been a challenge in the past.

The government recognises that it should raise energy prices to stimulate energy efficiency and attract the necessary investment to the sector. The National Electricity Regulation Committee (NERC) and the government have made significant efforts to reform the pricing policy, but there is still room for improvement in this area. Today, prices and tariffs for many energy types do not cover long-term costs; sometimes they do not even cover current costs. Moreover, implicit and explicit subsidies and cross-subsidies distort price signals. An adequate pricing policy is particularly important given the sharp increase in gas import prices in 2006.

The creation of NERC is a major accomplishment in modernising Ukraine's energy sector, although NERC's position could be further strengthened and stabilised. To ensure that tariff regulations are unbiased and fair toward both suppliers and consumers, the tariff regulator should be independent both from stakeholder interests and political concerns (IEA, 2001). NERC is not completely independent because it is financed from the state budget and because other state institutions can veto its decisions.

IEA commends the Ukrainian government for its efforts to improve co-ordination among various ministries, agencies and other state institutions in developing energy policy. Energy policy is interrelated with economic, social, environmental, housing, fiscal, financial, industrial and agricultural issues. For example, higher energy prices call for structural adjustment programmes in industry, agriculture, services and the residential sector. Increased use of coal, for instance, may have direct implications for the environment and for public health. On the other hand, housing and construction policies that stimulate efficiency and promote clean energy use may significantly alter energy demand, which will lead to changes in energy supply. Energy policy should not be developed and implemented in isolation; it must be an integrated component of the general economic and social policy.

To enhance economic efficiency and service quality in the energy sector, it is important to improve transparency and create a more competitive environment. Involving private capital could bring additional benefits. Progress in restructuring and attracting private capital varies among different energy sub-sectors. Most energy sector assets are still owned by the state, although the share of private ownership is high in some sub-sectors, particularly oil processing and distribution. International experience demonstrates that the private sector can bring in much-needed investment, reduce costs and improve service quality. To achieve these results, privatisation, concession agreements, leasing and other forms of involving the private sector should be transparent and competition-based.

The Ukrainian government has made important efforts to develop a comprehensive energy strategy. The existing *Energy Strategy to 2030* provides an ample overview of the current situation, but its projections could be improved further (Chapter 2: Energy Trends). Additionally, the actual *Energy Strategy to 2030* puts too much emphasis on energy supply at the expense of energy demand and efficiency. It also puts an unnecessarily strong emphasis on Ukrainian activities abroad, rather than focusing more on reforming domestic energy markets.

Recommendations

The government of Ukraine should:

- Concentrate on improving energy efficiency.
- Eliminate subsidies and cross-subsidies in the energy sector and ensure that tariffs cover costs, including capital investment. Simultaneously introduce targeted social measures to protect the most vulnerable households against price increases.
- Increase the independence of the National Electricity Regulatory Commission from political and stakeholder interests through the following measures: independent budget, autonomy in managing human resources

and salaries, irrevocable mandates, prohibiting any financial interest by the regulator or family members in the industry, and restrictions on working for the industry during or for several years following their terms as regulators. NERC must ensure that it maintains the same approach to each actor on the market.

- Enhance co-operation between government institutions working on energy issues and related environmental, social and macroeconomic concerns.
- Enhance competition and improve transparency in the energy sector to stimulate companies' efficiency.
- Develop transparent and competitive mechanisms to attract private companies to ownership or operation of energy assets.
- Promote policies that allow for well-defined ownership and management of buildings.
- More thoroughly incorporate environmental assessments and issues into energy policy development.

2. ENERGY TRENDS

Overview

Understanding energy demand and supply trends is important for energy policy making. However, data collection and reporting in Ukraine are not sufficient to gain a clear picture of energy demand. In addition, energy projections do not sufficiently take account of demand issues, which undermines the quality of forecasts. Since Ukraine's independence, energy consumption has dropped in all sectors of the economy, largely due to economic recession and some efficiency improvements. Industry continues to be the main energy consumer, followed by the residential sector. Natural gas is the main energy for final consumers, followed by petroleum products and heat. Natural gas is also the main contributor to the Ukrainian primary energy supply; its role has risen since independence. The shares of coal and oil (second and fourth contributors to energy supply) have declined somewhat. The share of nuclear has grown significantly over the last decade, thus becoming the third largest contributor to the energy supply mix. Ukraine is highly dependent on gas and oil imports; in contrast, it produces most of its coal domestically. Net imports account for some 46% of total primary energy supply, and import dependence has decreased only slightly over the last decade. Energy intensity of the Ukrainian economy is very high by European standards, although it has declined since 1996. Inefficiency and losses are particularly high in the energy transformation and transmission sectors.

Key Concepts: Energy Demand and Supply

Inadequate energy demand and supply data complicate the task of designing appropriate and realistic policies in Ukraine. A Soviet legacy, energy balances in Ukraine are essentially based on the principle "resources – distribution" (Lyr, 2005), contrary to the internationally accepted approach "primary supply – final consumption" (Box 2.1). The Ukrainian balances and projections consist of "input" and "output" sections. The input section includes production and imports of primary fuels, as well as electricity and heat generated from hydro, nuclear and renewables. The output section includes exports and domestic consumption of the same energy sources. Thus, the balance does not show transformation of primary energy or total domestic consumption of final energy such as electricity, heat and oil products. The result is that policy makers and other stakeholders do not have reliable information on energy consumption, which makes decision making difficult.

Box 2.1 IEA Methodology: Primary Supply and Final Consumption

According to the IEA methodology, energy balances have two parts: Total Primary Energy Supply (TPES) and Total Final Consumption (TFC). TPES is the total of all sources of supply and the transfers between energy commodities. It includes domestic production, import, export and stock changes of primary energy sources (natural gas, crude oil, coal, nuclear energy and renewable energy sources) as well as imports, exports, changes in international marine bunkers and stock changes of secondary energy commodities (such as electricity and oil products). In other words, it corresponds to total domestic energy demand. The transformation section of the energy balance includes the energy flows (input and output) related to transforming energy from primary into secondary sources.

Total Final Consumption (TFC) is the sum of energy consumption by different end-users. It includes final energy (after transformation), but excludes distribution losses and own use by the energy sector (Annex I shows the Ukrainian TPES and TFC in 2004).

Analysis of historical trends in this chapter is based on IEA statistical data, which in turn are based on official submissions by the Ukrainian State Statistics Committee (Derzhkomstat). Given that IEA does not receive complete data series, particularly on the demand side, some of the data are estimated. This is the case for almost all TFC elements by sector and by fuel for the period 1993-2003, except for electricity. The last available statistics (for 2004) are more comprehensive thanks to the improved quality of the submitted data.

The focus on supply is characteristic of Ukraine and other former Soviet countries, where energy supplies were centrally planned and demand simply followed supply. In market economies, energy demand has more prominence because it drives the need for supply. Ukrainian policy makers should pay much more attention to the evolution of energy demand.

Energy Demand

● Final Energy Consumption by Sector of Economic Activity

Total final consumption (TFC) of energy decreased in all sectors from 1993-2004, primarily due to the economic depression during the 1990s. In 2004, TFC was 84.6 Mtoe,[11] representing 77% of its 1993 level despite economic growth that started in 1999. Industry and residential sectors are the main energy consumers: together, they accounted for about 80% of TFC in 1993

Figure 2.1a

Trend in Total Final Energy Consumption by Sector, 1993-2004

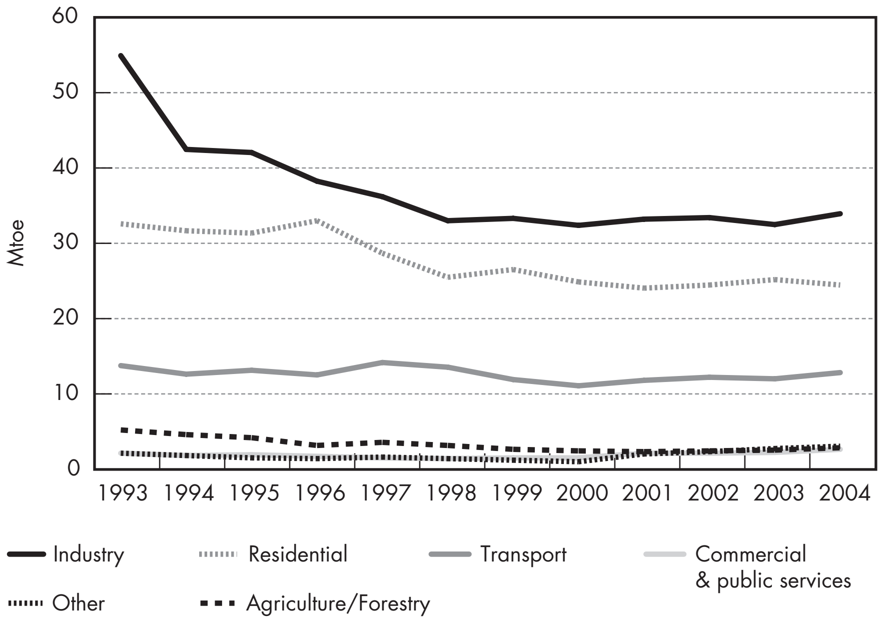
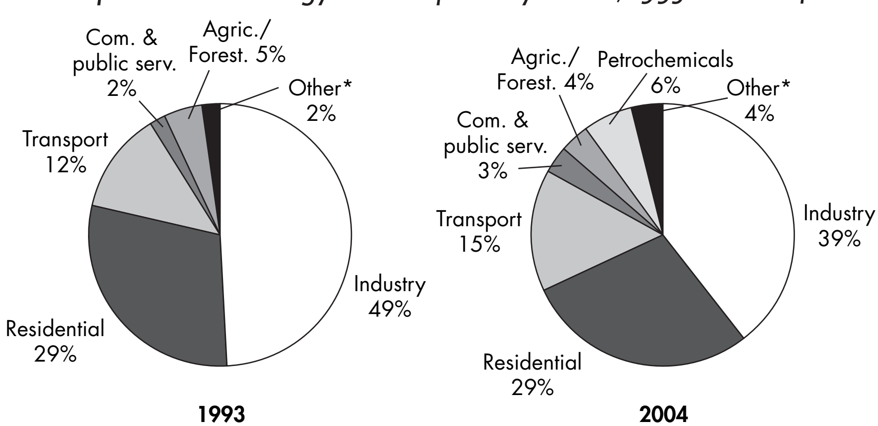


Figure 2.1b

Share of Total Final Energy Consumption by Sector, 1993 and 2004



Source: IEA statistics.

11. Mtoe stands for million tonnes of oil equivalent. Ukrainian documents typically use coal equivalent. To convert a tonne of oil equivalent into a tonne of coal equivalent, divide by 0.7.

and about 68% in 2004. The share of the residential sector in TFC has not changed over the same period (29%).

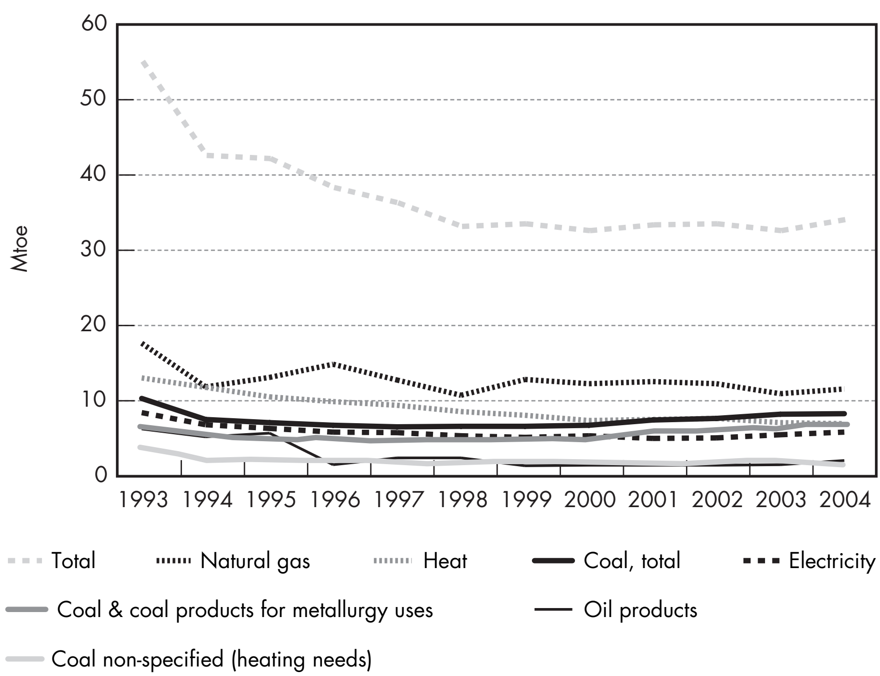
Energy Consumption by Industry

Industry clearly experienced the strongest drop in energy consumption: about -40% from 1993-98 (Figure 2.1). However, energy consumption in energy-intensive industries (mining, metallurgy and chemicals) declined at a lower rate than in other industries, which led to growth in the overall energy intensity of the economy in the early 1990s. From 1998-2004, energy consumption by industry remained relatively stable, despite the growth in industrial production. This reflects energy-efficiency improvements and the slight increase in the share of less energy-intensive industries in total production. In consequence, the share of industry in TFC has decreased from 49% in 1993 to 39.6% in 2004.

Figure 2.2 shows that industry consumption of oil products, heat and natural gas experienced a strong decrease in absolute terms. Natural gas accounted for 32% of industrial consumption in 1993 and 34% in 2004, and electricity

Figure 2.2

Energy Consumption by Industry, 1993-2004



Source: IEA statistics.

for 15% in 1993 and 17% in 2004. The share of coal and coal products in industrial consumption grew sharply (from 12% in 1993 to 20% in 2004). The share of heavy fuel oil, on the contrary, dropped from 9% to only 3%.

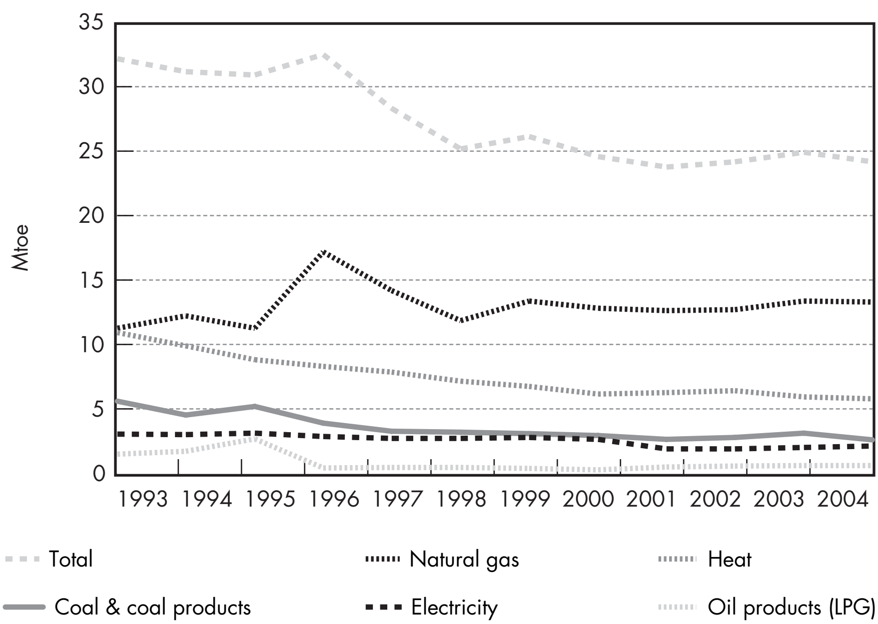
Energy Consumption by the Residential Sector

The residential sector is the second largest consumer of energy in Ukraine (about 29% of TFC in 2004 or 24.3 Mtoe). The decline in energy consumption in the residential sector was less sharp than that in industry. This was due to several factors including energy price distortions and cross-subsidies that support very low tariffs for electricity, gas and heat for residential consumers. In addition, many consumers did not fully pay for energy services, which reduced the impact of prices on the consumers' behaviour. Even more importantly, the general lack of metering equipment reduced incentives to save energy. Overall, the share of the residential sector in TFC remained over 30% from 1994-2003, and decreased to about 29% in 2004 (Figure 2.1).

The share of natural gas in final residential consumption grew from 35% in 1993 to about 55% in 2004, driven by relatively low prices. Over the same period, the share of heat dropped from 34% to 24% and the share of coal decreased from 17% to 11%.

Figure 2.3

Energy Consumption by the Residential Sector, 1993-2004



Source: IEA statistics.

Other Sectors

The share of the transportation sector in TFC increased from 12.4% in 1993 to 15% in 2004. Even though rail is still dominant in freight and passenger transportation, private car ownership has grown significantly over the last 15 years, following the growth in per capita income (during the Soviet period, private car ownership was not common). Increasing private car ownership and more frequent use of cars led to growth in energy consumption for transportation.

The commercial and public services sector was the only one which saw an increase in energy consumption between 1993 and 2004 (from 2.2 to 2.8 Mtoe). Structural changes in the Ukrainian economy are the leading reason for this change, in other words, the share of heavy industry in the economy dropped, while that of services such as shops and banks grew. Services are much more developed now than before independence, however their share in TFC remains low (3%).

● Total Final Energy Consumption by Fuel

The fuel mix in the TFC has changed over the last decade. As mentioned earlier, the reader should consider the TFC data with caution, keeping in mind that the data are estimated to a large extent.

The share of gas in TFC grew from 31% to 42% over the last decade. The consumption of oil and oil products dropped sharply in the 1990s, largely in response to the growth in oil prices; their share in TFC decreased from 19% in 1993 to about 14% in 1999 and 2000. From 2000-04, oil and oil products consumption grew faster than that of other fuels mainly due to the growing number of cars; and their share in TFC rose to over 17% in 2002-04. Since 2003, oil and oil products have been the second largest fuel in TFC (Figure 2.4).

At present, heat is the third most important energy source in TFC (it was the second largest source in 1993). Although its share in TFC apparently dropped from 22% in 1993 to 15% in 2004, heat consumption in Ukraine is still high, in part because demand is driven by the cold climate.[12] It is difficult to tell to what extent the drop is due to statistical errors compared to fuel switching as the data for district heating are particularly problematic. Official data vary widely from expert assessments.

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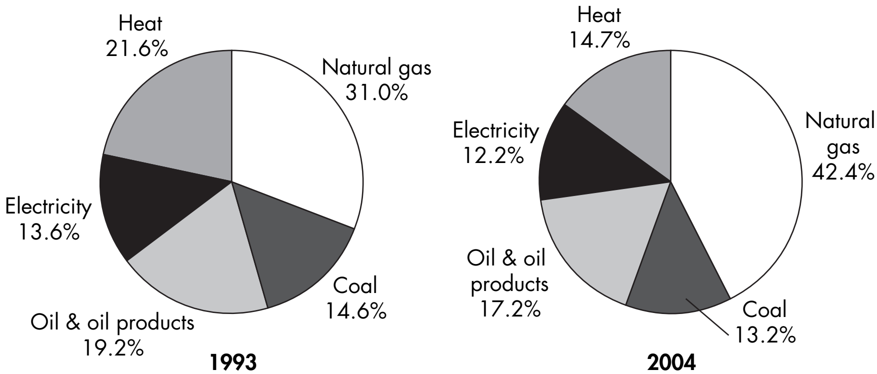
12. In Russia, the share of heat in the TFC is even higher, at 32% in 2003.

The share of coal in total final consumption declined slightly from 14.6% in 1993 to 13.2% in 2004.[13] Coal remained the fourth largest fuel in TFC. The decline of coal consumption in absolute terms was about 30%. This was due to supply difficulties associated with major inefficiencies and financial problems in coal companies, as well as to the price distortions among fuels. Indeed, a significant share of coal consumption for electricity and heat generation was replaced by the relatively cheap gas.

Figure 2.4

Total Final Energy Consumption by Fuel, 1993 and 2004



Source: IEA statistics.

Natural Gas Demand

Natural gas plays a key role in the Ukrainian energy balance. Ukraine consumes approximately 76 bcm of gas yearly (including losses and own use by the gas industry), which places Ukraine among the top ten gas consuming countries in the world. About 40% of gas is used by electricity and heat plants (*i.e.* transformed into secondary energy sources); another 56% is consumed by industry and the residential sector.

Gas intensity of the Ukrainian economy (*i.e.* use of gas per unit of GDP) grew sharply during the 1990s. It began to decline again as the economy recovered, regaining its 1993 level in 2004.

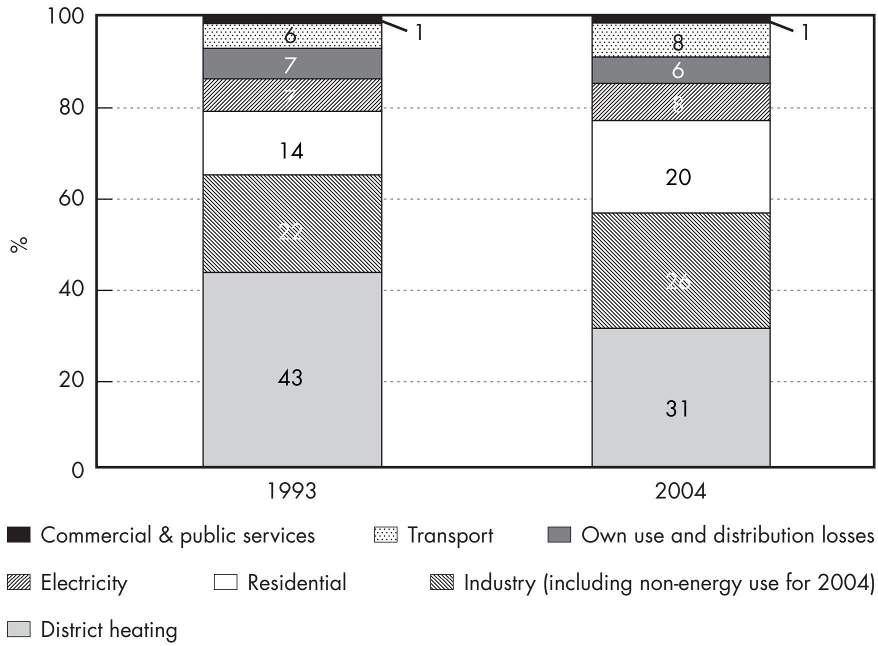
Although the share of gas in TFC has grown, gas consumption in actual terms has declined since 1993. The most remarkable decline in gas consumption occurred in the district heating sector; between 1993 and 2004, it dropped

13. At its minimal level, in 1997-2000, coal consumption represented only 66.5% of its 1993 level.

by 42%. In the electricity sector, natural gas consumption dropped just by 7% from its 1993 level, while total electricity production declined by 22%.[14] As Figure 2.5 demonstrates, the most impressive evolution of natural gas consumption was the increase of the residential sector's share from 14% in 1993 to 20% in 2004, driven by the growing use of natural gas by households for cooking and heating. The sharp increase of gas import price in 2006 will likely lead to decreasing gas demand in Ukraine, as it will prompt efficiency improvements and fuel switching.

Figure 2.5

Natural Gas Demand by Sector, 1993 and 2004



Source: IEA statistics.

● Coal Demand

Two largest consumers of coal in Ukraine are electricity (and heat) plants, and the metallurgical industry. Data on coal use by electricity and heat plants should be considered with caution. Relying primarily on the information submitted by Derzhkomstat, IEA data show that approximately 39% of coal

14. *Taking into account that substantial volumes of natural gas were used to support combustion of low quality coal, we can suggest there is potential for the decline of natural gas consumption in the electricity sector.*

supply (33.2 Mtoe) went to electricity generation and only 0.2% (0.07 Mtoe) to district heating in 2004[15] (Figure 2.6). However, coal consumption by heat plants may be underrepresented because of insufficient reporting of heat data (see section District Heating Demand) and because of the way the Ukrainian data allocate fuel between power and heat in combined heat and power generation. According to the IEA methodology, electricity production accounted for nearly half of Ukraine's coal use in 1993; this figure dropped to 39% in 2004. Coal consumption for electricity generation declined in absolute terms by 50% during the transition period, two times greater than the decline in electricity generation.

Coal consumption by the metallurgical industry remained rather stable from 1993-99, then increased after 2000, due to the growing export demand for steel. Metallurgy (final consumption and transformation) represented almost half of the use of coal and coal products in 2004 as compared with 32% in 1993. In absolute terms, coal consumption by the iron and steel industry in 2004 was 8% higher than in 1993.

Figure 2.6

Coal Demand by Sector, 1993 and 2004

Note: Coal is also used for heat production. This figure may underrepresent coal consumption for heat production as described in the text.

Source: IEA statistics.

15. This does not include coal used to produce heat by industrial companies for their own use.

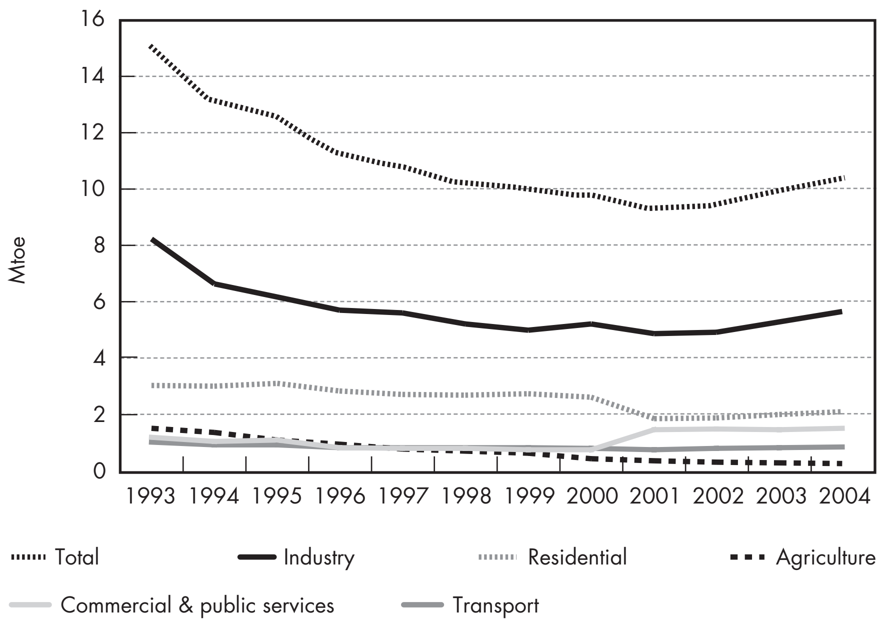
The residential sector currently accounts for some 8% of total coal consumption. Residential consumption of coal (essentially for heating needs) dropped by half between 1993 and 2000, then remained stable.

Electricity Demand

Power consumption dropped dramatically after 1992. By 2004, total electricity consumption was only about 70% of the 1993 level (Figure 2.7).[16] This drop can be attributed to the decrease in economic activity, as well as to supply limitations for big industrial companies and other users that resulted from fuel shortages at power stations. At the same time, a part of the decline is also due to improved efficiency, particularly after 1998. The industrial and the residential sectors have remained the largest electricity consumers over the last decade: combined, they account for some 75% of Ukraine's electricity consumption.

Figure 2.7a

Trends in Electricity Demand, 1993-2004



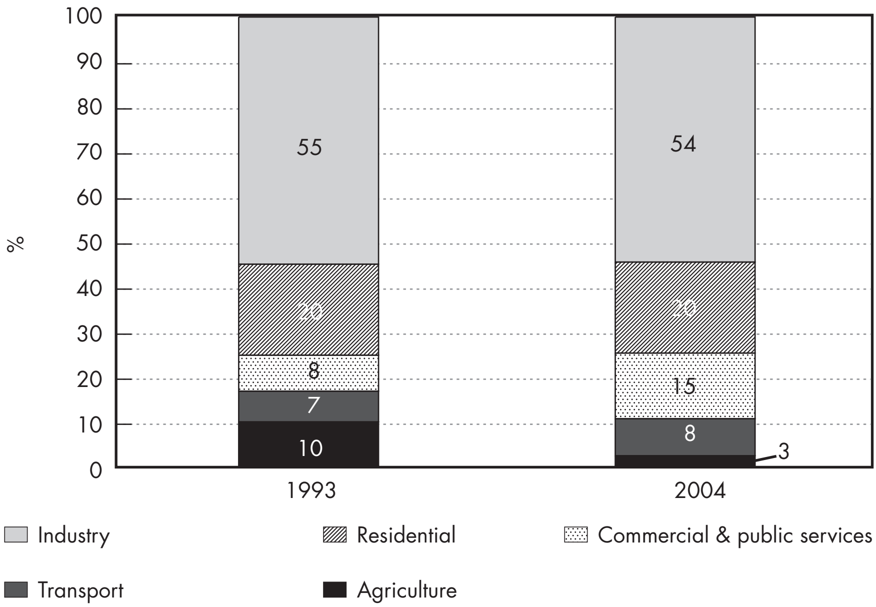
Within industry, the largest percentage declines in power demand from 1993-2004 took place in the textile and leather sector (-74%), the machinery sector (-71%), and the construction sector (-62%), reflecting their economic collapse. The largest nominal declines in consumption occurred in the most

16. *There is substantial excess capacity, mainly in thermal power plants, though over time, the real excess capacity has declined (Chapter 8).*

electricity-intensive industries (mining, metallurgy, machinery, chemicals and petrochemical), accounting for more than one-third of the total drop in national power consumption. However, during the whole period industry remained the largest power consumer, accounting for over 50% of total electricity consumption.

Figure 2.7b

Share of Electricity Demand by Sector, 1993 and 2004



Source: IEA statistics.

The decline in electricity consumption in the residential sector (the second largest consumer of electricity) was less dramatic: in 2000 it was around 90% of its 1993 level. Low tariffs had a very limited impact on the demand; low substitution capacity of electricity in the residential sector also played a role. According to the World Bank (Gochenour *et al.*, 2004), the stability in electricity demand can also be explained by the increased activities of small, private businesses working in residential flats and by the growing use of appliances. In addition, in the mid- to late 1990s, residents supplemented district heating with small electric resistance heaters when district heating plants did not supply enough heat. Starting from 2001, residential electricity consumption declined more significantly: in 2004, it was about 70% of the 1993 levels.[17]

17. This sharp decline may be partly due to changes in the statistical methodology, given the identical sharp increase in the commercial and public sector consumption. It is possible that electricity consumption of small businesses was previously reported as residential and now, as commercial.

Electricity consumption in the commercial and public services increased sharply starting in 2001, due to the growing importance of services in the overall structure of the Ukrainian economy. This is the only sector in which 2004 consumption of electricity was higher than the 1993 level (+26%).

In the transport sector, the drop in power consumption from 1993-2004 came mainly from reduced demand for freight rail and pipeline transportation, linked to the economic downturn. Power demand for rail transport has actually grown since 2001, though it continues to decline for pipelines.

Overall, the share of electricity in TFC decreased slightly from 13.6% in 1993 to 12.2% in 2003. However, in absolute terms, electricity consumption started to recover in 2002 with an annual growth rate of about 5% per year in 2003-04. This was specifically linked to growing electricity demand in almost all sectors (excluding agriculture). The most rapidly growing demand in 2002-04 was observed in industry (5% per year), transport and the residential sector (4% per year).

Electricity use per capita in Ukraine is one-half the EU-25 average. Since 2000, stable growth of this indicator has been observed, due to the economic recovery and growing demand for appliances. The growth can also be linked to the resolution of supply problems associated with reconnecting to the Russian integrated electricity system in 2001.

The Ukrainian economy has become more efficient over time; this is also true for power consumption. Power consumption per unit of GDP (or electricity intensity[18]) has dropped by about 16% since 1993. During the economic recession, electricity intensity actually rose from 1993-96. From this peak level, it dropped by an impressive 32% by 2004. This trend is roughly in line with the percentage change in overall energy intensity.

District Heating Demand

There are no detailed data on district heating consumption by sector. According to the data that the Derzhkomstat submits to IEA, industry consumes roughly 54% of district heating and the residential sector 46%. District heating consumption decreased through the 1990s and until 2004. Both industrial and residential consumption declined in nominal terms over the last decade and represented, in 2004, only 53% of their 1993 level.

The decline in industrial demand (Figure 2.2) was linked to the broader economic and industrial slowdown. Energy-efficiency improvements in

18. Electricity intensity means 1 kWh of final power consumption per USD 2000 of GDP at purchasing power parities.

buildings, coupled with a shift to gas or electric heating, have played a role in the decreasing residential district heating demand (Figure 2.3).[19] Another reason behind the decreasing demand for heat was forced drops in consumption because of supply constraints and disruptions. However, it is hard to assess their precise impact on total consumption. These disruptions are now less common in Kyiv and many other cities, although they still occur in some district heating systems that cannot obtain the fuel or cannot afford the fuel costs because of debt. The wholesale gas company, Gas of Ukraine, regularly suspends gas supply to district heating companies that have substantial gas debt. Frequent and long-lasting disruptions during the transition period provoked a certain decrease in heat demand; some consumers invested in other heating solutions in the interim.

Analysing heat demand in Ukraine is challenging because of the lack of statistical data. The available statistics are not always reliable and complete. There is a difference between IEA and Ukrainian data for methodological reasons. IEA statistics, based on data from Derzhkomstat, reflect heat produced and sold to third parties (in other words, district heating) but do not include heat produced by industrial companies or households for their own use. Data of the Ukrainian Ministry of Fuel of Energy seek to reflect total heat production, including industrial heat and heat produced by individual (apartment-level) boilers, biomass-based installations and solar heaters. In addition to the issue of data compatibility, this raises the question of data accuracy: it is hard to measure the exact amount of heat produced by individual installations.

• Oil Products Demand

The total demand for oil products was 28 Mtoe in 1993; it halved by 2004. More than 50% of this decline was due to the dramatic decrease in the use of heavy fuel oil for electricity and heat production. The share of electricity and heat production in the total consumption of petroleum products in Ukraine dropped from 26% in 1993 to only 1% in 2004, assuming that the existing data are reliable (Figure 2.8).

The transport sector by far is the largest consumer of oil products; its share grew from 29% in 1993 to 46% in 2004. In nominal terms, the transport sector's consumption dropped by 25% over the same period to 6.9 Mtoe. This less dramatic decline – in comparison to the total reduction of petroleum products consumption – was essentially due to the rapid growth of car ownership since 1990[20] and to low substitution capacities for petroleum products in transport.

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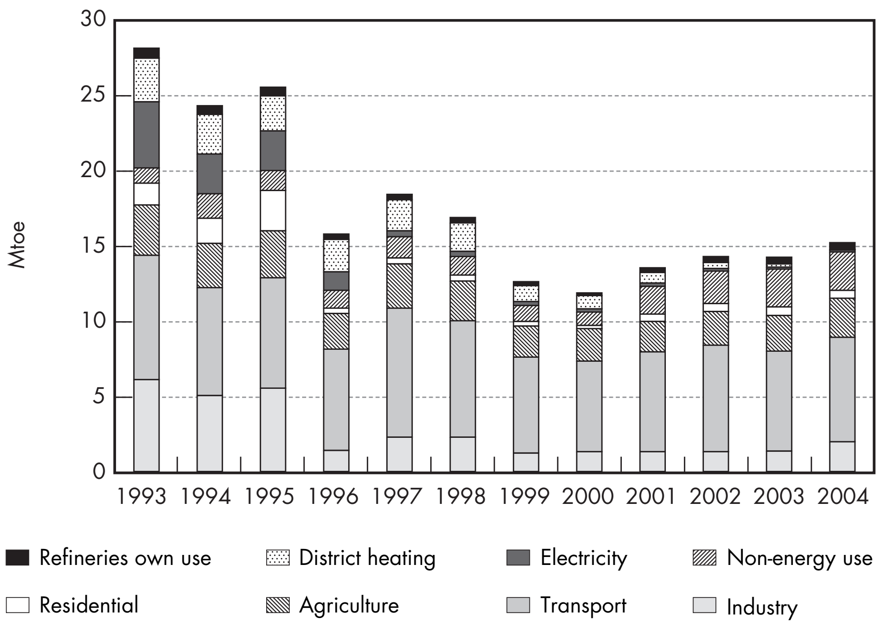
19. However, the consumption by buildings is still much higher than in other countries because of inefficient insulation.
20. The share of road transport in total transport energy consumption increased from 58% in 1993 to 65% in 2004.

Oil product consumption in road transport became more efficient as old Soviet cars were replaced by more efficient models. However, it is possible that oil product consumption is underreported because refineries and filling stations may hide real sales for tax reasons. Another trend, even if marginal, is the substitution of oil products by compressed natural gas.

Figure 2.8

Petroleum Product Demand by Sector, 1993-2004



Source: IEA statistics.

Petroleum product consumption has also changed in other sectors over the last decade. Industry's share declined from 22% to 13%. In absolute terms, industrial consumption in 2004 was only at about one-third of the 1993 level. Following the growth in oil prices, industrial companies reduced their use of oil products for heating and electricity production, and substituted them with other fuels, using oil only as reserve fuel. Agricultural demand declined only slightly and agriculture has been the second largest final consumer of oil products since 1996. It accounted for 17% of total oil product demand in 2004. The non-energy use of petroleum products increased significantly and its share in total demand more than tripled from 5% to 17%. The residential sector, on the contrary, sharply reduced its consumption of oil products from 1996-2000 while increasing the use of natural gas. As a result, the residential sector accounted only for 4% of petroleum product consumption in 2004.

Energy Supply

• Total Primary Energy Supply

Total primary energy supply (TPES) in Ukraine dropped by about one-fourth from 1993-2004, to 140 Mtoe (Figure 2.9). The major reason behind the TPES decline was the economic recession in the 1990s, although energy-efficiency improvements also played a role (see Chapter 6: Energy Efficiency for more details). The Ukrainian economy started recovering in 1999, but improvements in efficiency meant that Ukraine no longer needed as much energy to sustain its economy. In 2004, TPES was 75% of the 1993 level, while GDP was 85% of the 1993 level.

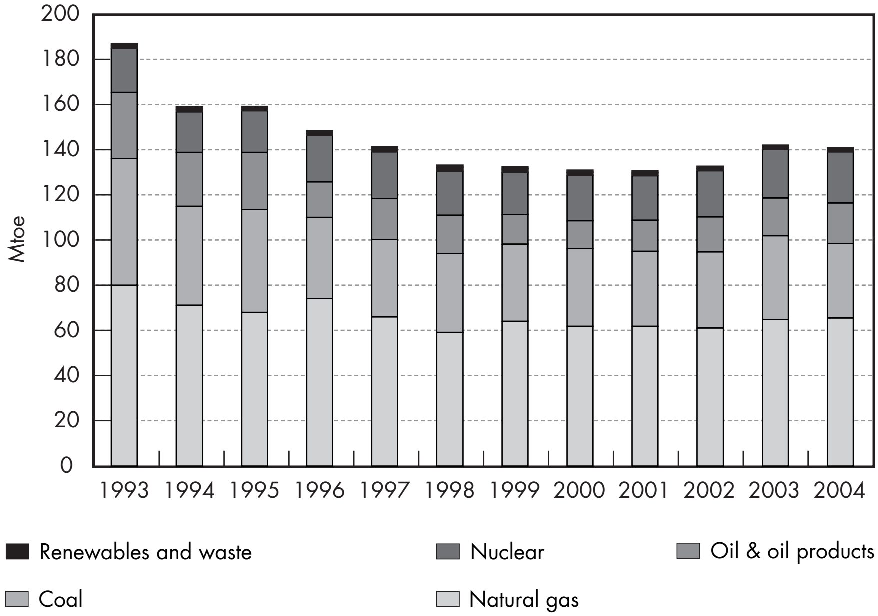
Natural gas is, by far, the most important energy source in Ukraine, and its role has grown since independence. Although gas demand in physical terms has been decreasing since 1990, the share of gas in TPES grew from 43% in 1993 to 47% in 2004 driven by relatively low prices for gas imports. About 75-80% of gas is supplied by imports[21] from Turkmenistan and Russia, although there are questions about the future volumes and sources of gas imports (Chapter 5: Natural Gas and Oil and Chapter 6: Energy Transit). Domestic gas production, which accounts for more than 20% of supply, was relatively stable during the transition period largely because of previous investment in the sector. However, to further maintain and increase production levels, large investments in exploration are necessary to offset the accumulated deficit of geological prospecting.

Coal continued to be the second largest contributor to energy supply (Figure 2.9), although coal's share in TPES declined from 30% in 1993 to 23.6% in 2004. Domestic production accounts for the majority of Ukraine's coal needs (93% in 2004); imports provided some 5-8% of coal supply in recent years (essentially coking coal). In 1993-97, coal production in Ukraine dropped sharply and reached its lowest level of 29.6 Mtoe in 1996 (58% of the 1993 level). During that period, the share of coal imports in total supply was larger than today. This production drop was related to the reduction of budget allocations to the coal industry, growing complexity of extraction conditions and closing of non-economical mines. Ukrainian reporting of historical coal production trends may differ from that of IEA because of methodological differences explained in Box 2.2.

21. The share of imports is calculated as a share of net imports of each fuel in its primary supply.

Figure 2.9

Total Primary Energy Supply by Fuel, 1993-2004



Source: IEA statistics.

Box 2.2 Note on Coal Production Reporting

IEA coal statistics normally refer to coal after washing and screening to remove inorganic matter. However, the Soviet era practice of measuring coal upon extraction (*i.e.* unwashed) continues to this day in some former Soviet-bloc countries. As a result, coal production may be overreported, as compared to international standards. Ukraine has begun to provide official data on both washed and unwashed coal. Therefore, IEA has revised Ukrainian coal supply and demand statistics downward to reflect levels of washed coal. For this reason, IEA data may differ from data found in governmental and private-sector reports.[22]

Nuclear energy[23] has been the third largest primary energy source in Ukraine since 1996. Nuclear power experienced the largest growth from 1993-2004,

22. The Energy Strategy to 2030 *reports the amounts of coal extraction from 1991 to 2005. Production was lowest in 1996. However, the drop from the previous year is not so sharp and the absolute level of production (71.7 Mt) represents 62% of the 1993 level.*
23. *The primary energy equivalent of nuclear energy is calculated with an efficiency factor of 33%.*

largely due to a targeted national policy of increasing the use of nuclear to reduce dependence on hydrocarbon imports. By 2004, the share of nuclear in TPES reached 16.2% – up from 10.5% in 1993. In absolute terms, nuclear energy is the only source of supply that grew significantly higher (by 16%) than its 1993 level (hydro energy grew by 6% and supply from other sources declined).

The share of oil in TPES dropped from 15.7% in 1993 to less than 10% in 1999-2000, largely due to accumulated problems in the refining sector. It then grew to 12.7% by 2004. Imports from Russia and Kazakhstan account for some 83% of Ukrainian crude oil supply. Domestic production of crude oil and gas condensate decreased slightly from 1993-2000, then started recovering in 2001 and reached some 4.3 Mt per year in 2004. Even though they are an important element of the oil balance, IEA does not receive data on oil stock changes in Ukraine. Therefore energy balances account only for domestic production and imports/exports of oil.

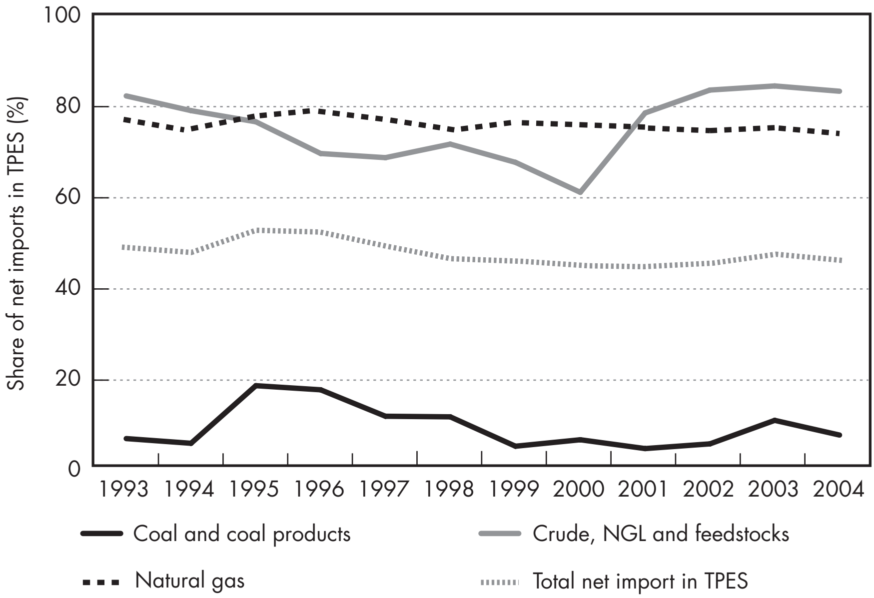
The renewable energy supply remained stable in absolute terms from 1993-2004, at about 1.2-1.3 Mtoe. However, the share of renewables in TPES grew from 0.65% in 1993 to 0.90% in 2004. This reflects the reduced supply of all other energy sources, except for nuclear. Hydro energy accounts for some 80% of renewable energy supply (1 Mtoe) and combustible renewables and waste for 20%. Ukraine also has some wind energy, but its supply is too small to be reflected in the energy balance. Hydro energy supply increased by some 6% over the last decade, but supply of combustible renewables and waste has decreased slightly (from 0.27 to 0.26 Mtoe), according to the data provided by Derzhkomstat. However, non-governmental organisations that deal with renewables report that renewable energy supply has grown in recent years (Chapter 10: Renewable Energy).

National Production and Imports in TPES

Figure 2.10 presents the evolution of the share of imports in the supply of primary fuels in Ukraine. It demonstrates that Ukraine is highly dependent on imports for its oil and natural gas supplies, while most of its coal supply is produced domestically. In relative terms, the share of total net imports in TPES decreased slightly from 49% of TPES in 1993 to some 46% in 2004. It peaked at 52% from 1995-96, essentially due to the deepening problems in domestic coal production.

Figure 2.10

Share of Net Imports in TPES, 1993-2004



Source: IEA statistics.

Transformation of Primary Energy

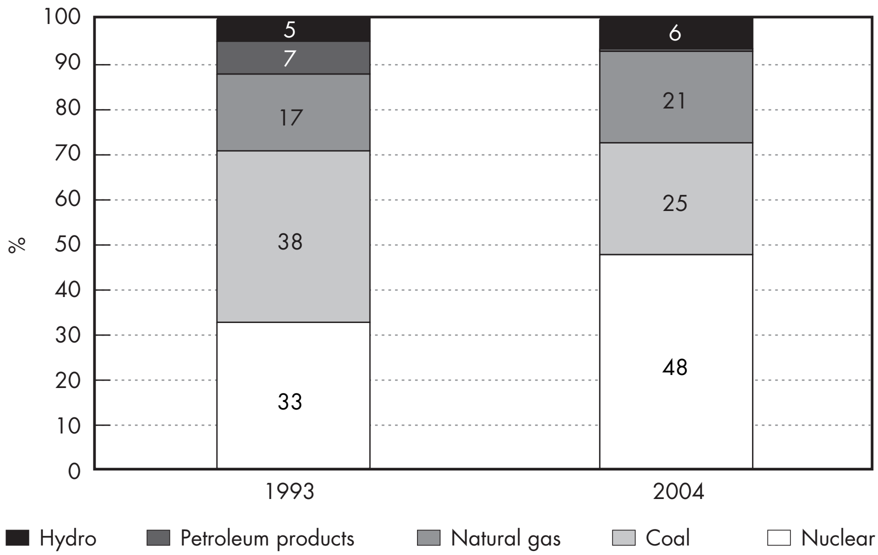
More than 40% of TPES is transformed into secondary energy sources, such as electricity, heat, oil products, coke-oven coke and charcoal. Electricity and heat production accounts for about half of total energy transformation.

• Electricity and Heat

The electricity and heat sectors consume approximately 20% of TPES. Transmission losses reached a pick of 20% in 2001 and decreased to 15% in 2004. The sum of losses and own needs in this sector grew from 24% in 1993 to more than 30% in 2004 (according to the submitted data). The losses are estimated at 25-30% of gross heat production in the district heating sector. The major reason for high losses is underinvestment in replacement, maintenance and repair of ageing infrastructure. In addition, low regulated tariffs for electricity and heat (particularly for residential consumers) and the lack of metering equipment do not provide incentives for reducing losses or inefficiencies. The second reason for high energy intensity in energy transformation is the low efficiency of generation facilities (this issue is addressed in more detail in Chapter 4: Energy Efficiency).

Figure 2.11

Structure of Electricity Production by Fuel, 1993 and 2004



Source: IEA statistics

Electricity generation has declined roughly in line with decreasing demand for power. That said, the decline in production has hit thermal power plants the hardest; over time, the share of power produced from nuclear and hydro power plants has grown. The share of nuclear rose to 48% in 2004-05; the share of thermal-fired power dropped to 45.5% (Energorynok, 2005b; Ministry of Fuel and Energy, 2006b). Most of the displaced thermal power has been from fuel oil. Figure 2.11 compares the structure of power production by type of fuel in 1993 and 2004. Ukraine is a net exporter of electricity, selling approximately 5 300 GWh (4% of Ukraine's generated electricity) abroad in 2004.

District heating production dropped by about one half from 1993-2004. There is little information available on the fuel mix of district heating, although it is clear that natural gas has been the main energy source over the last decade. In absolute terms, consumption of natural gas for heat production was constantly declining in line with heat demand, but at a lower rate than coal consumption. Derzhkomstat and the Ministry of Fuel and Energy provide conflicting information about the shares of coal and petroleum products in the production of heat. According to Derzhkomstat, the use of fuel oil by the district heating sector is insignificant; the Ministry of Fuel and Energy reports that fuel oil accounts roughly for 15% of fuel input at combined heat and power plants and heat-only boilers (Cabinet of Ministers, 2006a).

- **Oil Processing**

Oil refining volumes declined until 1999. Following privatisation of the refineries in 1999, efficiency of refining improved somewhat and the volumes of oil processing started to grow. As a result, Ukraine became a net exporter of oil products. Ukrainian refineries processed some 26 Mt of crude oil in 2004. In 2005, Ukrainian refineries processed only 17.4 Mt, or 28% less than in the previous year (Ministry of Fuel and Energy, 2004, 2005c, 2006b).

Energy Intensity of the Ukrainian Economy

Ukraine is one of the most energy-intensive countries in the region. The energy intensity of Ukraine's GDP[24] is higher than that of resource-rich Russia and more than three times higher that the average energy intensity of the EU.

Primary energy intensity of the Ukrainian economy (*i.e.* the ratio of TPES to GDP) grew sharply during the first years of recession, to 129-132% of its 1993 level. This was due to the growing share of energy-intensive sectors in GDP and to the sustained consumption in the residential sector. In 1996, Ukraine's energy intensity stabilised and began to decline. Since 1996, it has dropped by more than 33%; in 2004, it represented 89% of its 1993 level. This sharp change is related to growing energy prices, introduction of new technologies, and relative expansion of the service sector. (Chapter 4: Energy Efficiency looks at energy intensity issues in greater detail).

The intensity of final energy consumption (TFC/GDP) declined more rapidly than the intensity of primary supply (TPES/GDP). This means that efficiency of energy transformation (*i.e.* production of electricity, heat and other secondary energy sources) was improving slower than end-use efficiency. Keeping in mind the uncertainty of TFC estimates, this could be a rather worrying trend. It would reflect the fact that heat and power systems became less efficient because of ageing infrastructure and minimal investment. Low performance is also observed in coal transformation.

24. Energy intensity is energy use per unit of GDP. In 2004, it was 0.5 toe per thousand USD at 2000 prices and purchasing power parity (compared to the EU-15 average of 0.15 toe/ thousand USD).

Overall, the inefficiencies found throughout the entire energy chain in Ukraine – from energy production to transformation and consumption – represent a huge potential for energy savings. A deeper analysis of energy demand is needed in order to capture this potential and in particular to evaluate sources of energy savings, taking into account the substitutability of different fuels.

These inefficiencies create a tremendous opportunity to save energy. Based on the government's estimates of potential energy-efficiency improvements in 2030, Ukraine's energy savings from all types of energy would be equivalent to the energy production of over 400 nuclear power plants (see Chapter 4: Energy Efficiency for details).

Energy Projections

- **Government Projections**

The government outlined its long-term projections of energy supply and demand in the *Energy Strategy to 2030.* These projections are based on forecasts of economic growth for three distinct periods: the first period of "structural readjustment" (until 2010); the second period of "advanced development of the service industries" (2011-20); and the third period of "transition to a post-industrial society" with corresponding structural changes (2020-30). The government developed three scenarios of energy sector development: optimistic, reference and pessimistic.

The main concern with the approach of the *Energy Strategy to 2030* is that its projections are based not on economic analysis, but on policy goals. In other words, energy supply and demand patterns in the current strategy look more like government aspirations than real projections. These projections/targets may be realised only if the government implements a clear and comprehensive policy to support the desired developments (and this implies the risk of supporting options that otherwise may not be economic). Experience to date demonstrates that many past objectives in the area of energy supply and consumption have not been met because of lacking or inactive policies.

In the *Energy Strategy to 2030*, projections do not sufficiently take into account the potential evolution of demand. The designers of the strategy seem to assume that energy demand will follow the supply trends. The danger of this approach is that future demand will surely be different from the projected supply mix. Structural changes and technological evolution on the demand side, in both the medium and long term, will certainly have an impact on the volumes of energy consumption and on substitutions amongst various energy sources. Thus, estimating future demand is the appropriate starting point for energy projections. If the Ukrainian government could task professional economists to make energy demand projections based on fundamental economic relations, this would be a significant step towards improving the current energy strategy.

Improving energy statistics is another essential action. To make solid demand projections, it is necessary to improve actual and historical energy consumption data. Missing information on demand characteristics could mislead projections of the energy mix, both in primary energy supply and final energy consumption.

Energy pricing is another important issue to take into consideration. At present, most energy prices and tariffs in Ukraine do not cover long-term costs, thus part of consumption is driven by non-economic stimuli. In other words, demand is higher than is economically efficient. If tariffs were increased to cover all long-term costs, demand would decline. However, traditional top-down models that analyse the relationship between prices and demand (Box 2.3) are difficult to apply in Ukraine and other transition economies, in which prices are not yet market-based. Without market pricing for energy, the government does not have sufficient historical data to understand the relation between prices and demand (price elasticity of demand). This creates a risk of overestimating future demand, which would result in more non-economic investments and overcapacity of supply. In making demand projections, Ukrainian policy makers should take into account that price increases in the past did not necessarily lead to decreasing consumption because overall energy prices were not market-based. In the future, as Ukraine moves toward market prices, demand elasticity will certainly be easier to measure.

Box 2.3 Top-Down versus Bottom-Up Modelling Paradigms

Top-down and bottom-up are two modelling approaches that can be applied to study interactions between the economy and the energy sector.

Top-down models are aggregate models that look at a broad equilibrium framework, based on historical indices of prices, demand elasticity and other factors. They are useful in analysing the interaction between energy policies and macroeconomic performance, looking at different factors that influence demand and supply, but generally have limited detail on energy consumption.

Bottom-up models, on the contrary, are disaggregated. They start by examining energy consumption in detail and then determine the most cost-competitive options to meet the projected demand, including energy savings and fuel switching.

Both approaches have advantages and disadvantages. There are various hybrid models that aim to combine the advantages of the two paradigms.

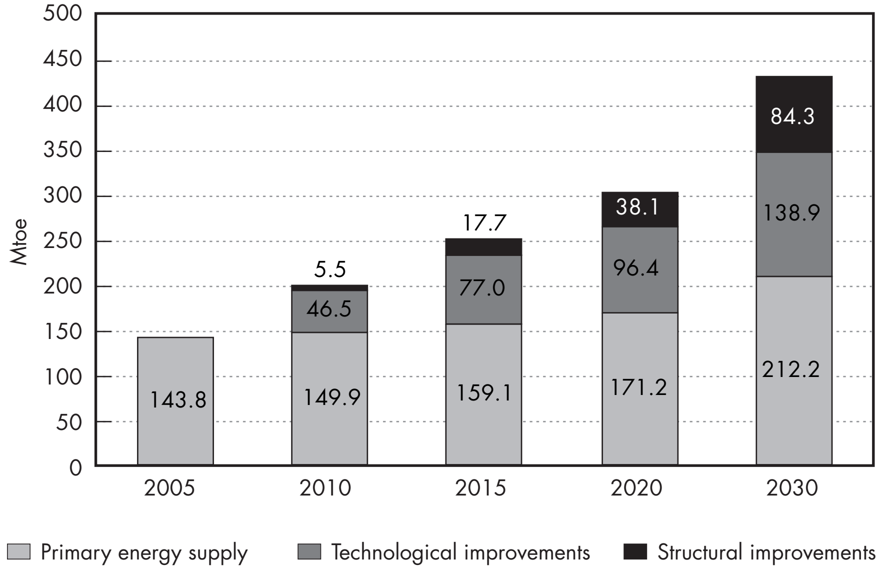
Energy Demand and Supply Projections

The energy balance in the *Energy Strategy to 2030* calls for cutting Ukraine's energy intensity in half, which would reduce the country's energy needs by 223 Mtoe compared to a situation without these intensity improvements. Even at this target, Ukrainian energy intensity level would still be higher than the EU average. For comparison, Poland reduced its energy intensity by nearly 40% in the first ten years of transition. Still, as Figure 2.12 demonstrates, the projected energy savings represent more than 50% of the projected energy demand level.

According to the government's projections, in the short and medium terms (2005-10), technological measures will provide the main source of energy saving, and will continue to play a major role in reducing energy intensity during the entire projection period. Implementing technological energy-saving measures is more expensive and requires greater capital investments from concerned industries (in particular, mines, chemicals and metallurgy). The government expects that the structural changes in the total amount of energy savings will be less impressive in the short term, but will save 61 Mtoe by 2020 and 84 Mtoe by 2030 during the second and third periods of transition. However, the *Energy Strategy to 2030* says little about the structural changes in the economy, in particular the evolution of the share of electricity-intensive or energy-intensive sectors. The *Energy Strategy to 2030* does not mention the relationship between energy price increases and energy efficiency, although price increases likely will be the major incentive for energy savings. Increasing domestic energy prices is inevitable because of the recent growth in gas import prices and because the much-needed capital investments in infrastructure can no longer be postponed.

Figure 2.12

Forecasted TPES and Energy-saving Potential, Reference Scenario, 2005-2030



Note: the category "primary energy supply" in the Ukrainian Energy Strategy to 2030 *is different from the IEA definition of TPES, which is used in the first part of this chapter.*

Source: Cabinet of Ministers, 2006a.

The government projects that the structure of energy consumption will change significantly by 2030. As shown in Figure 2.13, consumption of electricity and coal is projected to grow at a higher rate than that of other energy sources. Coal and electricity consumption is expected to more than double between 2005 and 2030. Oil consumption is projected to grow more slowly than coal (by 32% in 2030); natural gas consumption would decline to only 65% of its 2005 level. This means that considerable substitutions and energy-saving measures should be implemented in sectors that are the main consumers of these forms of energy.

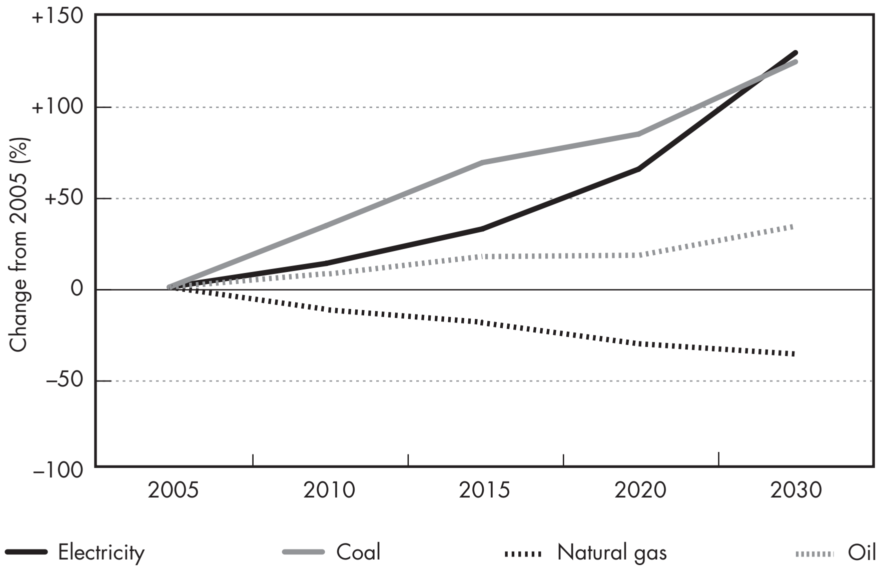
The *Energy Strategy to 2030* sets an objective of changing the energy supply structure by decreasing imports and increasing domestic production. Accordingly, domestic production would account for 89% of coal demand, 81% of gas demand and 32% of oil demand.

Coal

The government projects coal consumption to increase to 99 Mt by 2015 and to 130 Mt by 2030. The government expects that a larger share of electricity will be

Figure 2.13

Forecasted Energy Consumption by Fuel, Reference Scenario, 2005-2030



Source: Cabinet of Ministers, 2006a.

generated by coal-fired thermal plants (in order to decrease Ukraine's current dependence on natural gas imports). It is also likely that the government is anticipating increased coal use in the metallurgical industry, due to a projected boom in consumer goods and continued strong performance in the defence sector. The growing use of coal will lead to the increasing GHG emissions.

Natural Gas

Total consumption of natural gas is projected to fall by one third from 76.4 bcm in 2005 to 49.5 bcm in 2030. The expected decrease in gas consumption is strongest in agriculture (by 71%), metallurgy (by 60%) and electricity and heat production (by 42%). Industry will remain the main natural gas consumer, followed by the residential sector, which will consume more gas than electricity and heat generators. The only sectors with growing gas consumption are transport – but from a very low initial level in 2005 – and the chemical industry. The growth in the transport sector is related to the projected growth in the use of compressed natural gas (CNG), which would substitute other liquid motor fuels. In 2030, 14.4% of oil consumed for transport is projected to be substituted by gas. A projected sharp decline in gas demand would lead imports to decrease to 31.3 bcm in 2015 and 9.4 bcm in 2030 (from the current 56 bcm). This highlights that projections in

Table 2.1

Forecasts for Domestic Production and Imports of Primary Fuels, 2005-30

	2005	2010	2015	2020	2030
Coal and coal products, Mt					
Production	56.9	72.7	91.8	100.2	115.7
Imports	7.7	9.2	7	7.4	14.6
Total supply	64.6	81.9	98.8	107.6	130.3
Share of production in supply	*88.1%*	*88.8%*	*92.9%*	*93.1%*	*88.8%*
Crude oil and NGL, Mt					
Production, including:	4.3	8.7	9.3	10.9	14.6
• Domestic	4.3	5.1	5.3	5.3	5.4
• Overseas	0	3.6	4	5.6	9.2
• Imports	14.7	23.3	26.7	29.1	30.4
Total supply to Ukrainian refineries*	19	32	36	40	45
Share of production in supply	*22.6%*	*27.2%*	*25.8%*	*27.3%*	*32.4%*
Natural gas, bcm					
Production, including:	20.5	25.5	31.1	32.9	40.1
• Domestic	20.5	23.2	25	26.1	28.5
• Overseas	0	2.3	6.1	6.8	11.6
• Imports	55.9	42.1	31.3	20.8	9.4
Total supply	76.4	67.6	62.4	53.7	49.5
Share of production in supply	*26.8%*	*37.7%*	*49.8%*	*61.3%*	*81%*

**For Ukrainian consumers and export.*
Source: Cabinet of Ministers, 2006a.

the *Energy Strategy to 2030* are goal-oriented, and not determined based on economic modelling.

Oil Products

The *Energy Strategy to 2030* does not forecast the evolution of oil product demand. It projects that existing refineries will be upgraded to improve product quality and increase the share of light products in total output.[25]

25. Their efficiency is very low by international standards: depth of processing varies from 45% at Odesa Refinery to 67% at Lysychansk, compared to over 70% in Belarus and close to 90% in Western countries.

The six Ukrainian refineries are expected to increase the volume of crude oil processed from 18 Mt in 2005 to 45 Mt in 2030. They would produce 11.5 Mt of gasoline, 17.2 Mt of diesel, 1.5 Mt of jet fuel and 5.7 Mt of heavy fuel oil. Most of these products would be consumed domestically.

Electricity

The government forecasts that electric power demand will grow significantly between now and 2030. It is not possible to easily compare these data with IEA historical statistics as the forecasts are based on gross production levels, not net electricity consumed per sector. This difference is important because it indicates that the estimates may not be demand-driven, but rather are calculated based on desired production levels.

Total consumption would grow from 176.9 TWh in 2005 to 395.1 TWh in 2030, an increase of 123%. Residential, agricultural sectors and municipal and commercial services would see the strongest growth in electricity consumption – an increase of more than three times – mainly due to the expansion of electric heating. Electricity consumption in industry and transport is projected to grow at a lower rate due to the progressive implementation of energy-efficient technologies.

In the structure of electricity generation, the share of nuclear power generation is expected to grow from 47.9% in 2005 to 52.1% in 2030. The relative shares of other types of electricity production are projected to decline slightly.

Heat

The *Energy Strategy to 2030* does not provide an analysis of heat demand by sector. The most substantial expected change in the structure of the heat balance is a projected active development of electric heaters and heat pumps. Their share in heat production is estimated at only 0.7% for 2005 and the share is projected to reach 9% in 2020 and 42% in 2030. These projections assume a slower growth in electricity tariffs in comparison with oil (heavy fuel) and gas prices, which would drive the demand for electric heating. This evolution would allow a reduction in natural gas consumption for heat production (natural gas is the main fuel for boiler plants) and maximisation of the use of electricity. However, the analysis does not adequately take into account the tremendous cost of changing heating systems nationwide. The share of boiler plants is projected to drop from 61% to 24% of heat production from 2005 to 2030. The shares of other types of heat will change less dramatically during the projection period.

Other Projections

IEA World Energy Outlook

The IEA *World Energy Outlook* (WEO) (IEA, 2004a) publishes energy demand and supply projections in various groups of countries, including "transition economies".[26] WEO projects that energy demand in transition economies (including Ukraine but without Russia) will grow by 1.4% per year, on average, until 2030. The WEO projections for energy supply structure in the region are fundamentally different from the Ukrainian government's projections. WEO forecasts that gas will remain the dominant fuel in transition economies: its share in total primary energy supply will rise from 43% in 2002 to 48% in 2030, as most new power generators will be gas-fired. The share of oil is also expected to increase from 23% in 2002 to 27% in 2030, driven by strong demand for transportation fuels. The share of coal in TPES is expected to fall from 21% to 16%; nuclear's share will also decline as plant retirements will outweigh the addition of new capacity.

National Strategy of Ukraine for Joint Implementation and Emissions Trading

The Ministry of Environmental Protection, supported by the governments of Ukraine and Switzerland and by the World Bank, developed a National Strategy of Ukraine for Joint Implementation and Emissions Trading in 2003. This document made energy consumption projections based on two scenarios. The "innovation" scenario assumes fast economic growth, based on structural changes, innovations and investments. A more conservative "business-as-usual" scenario assumes continuation of recent trends, *i.e.* slow, unstable growth, based on the existing institutional structure, and an increase in the share of raw materials in total exports. The GDP in 2020 is expected to grow to 150% of the 1990 level in the "innovation" scenario and to 90% in the "business-as-usual" scenario (National Strategy Studies, 2003).

The innovation scenario assumes a fast and radical reduction in energy intensity. In the business-as-usual scenario, energy intensity will also improve but it will happen later and less significantly because the share of heavy industries will remain large. This scenario projects no substantial changes in the structure of primary energy sources. By contrast, the innovative scenario assumes important changes in the energy balance including a wider penetration of renewable energy sources. Figures 2.14a and 2.14b show the structure of TPES in both scenarios.

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26. Transition economies include all countries of the former Soviet Union, the former Socialist countries of Central and Southeast Europe, as well as Cyprus, Gibraltar and Malta (for statistical reasons). WEO 2004 considered Russia separately from other transition economies.

Figure 2.14a

TPES Projections in the National Strategy of Ukraine for Joint Implementation and Emissions Trading, 2005-2020: Innovation Scenario

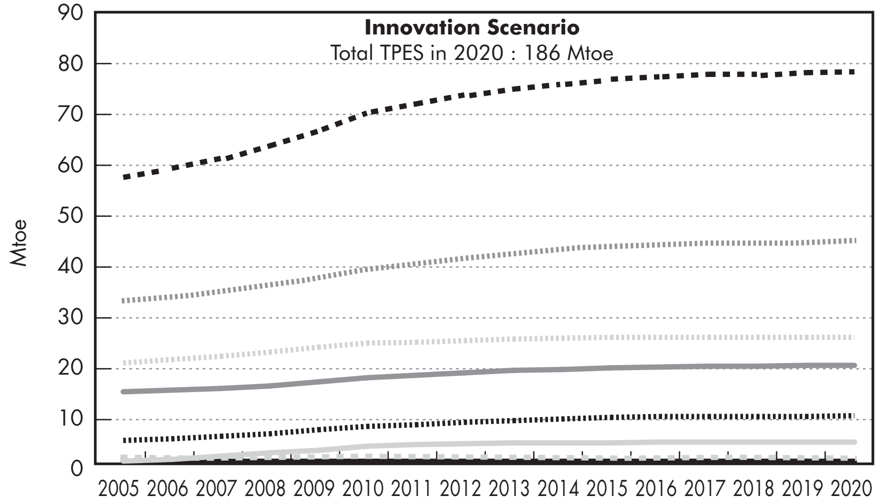
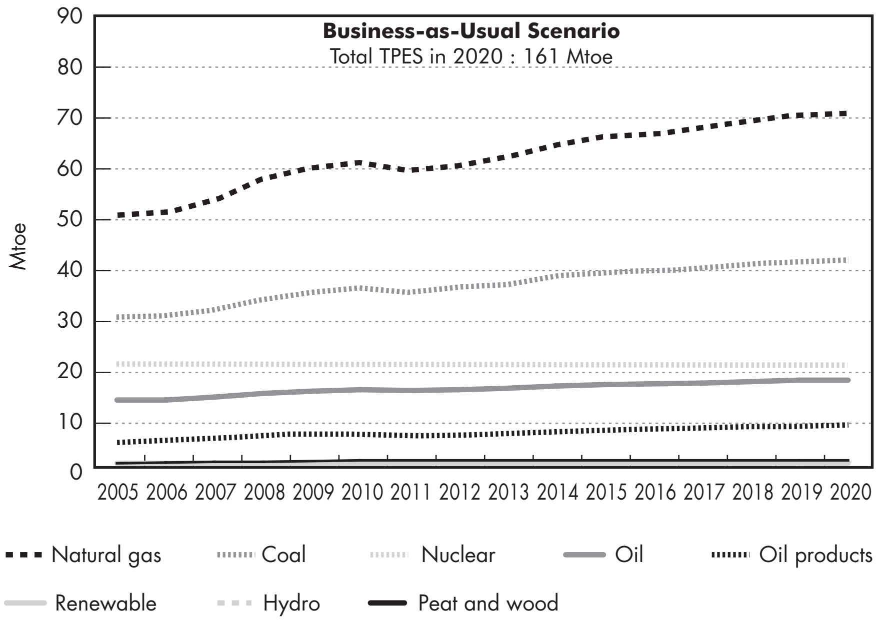


Figure 2.14b

TPES Projections in the National Strategy of Ukraine for Joint Implementation and Emissions Trading, 2005-2020: Business-as-Usual Scenario



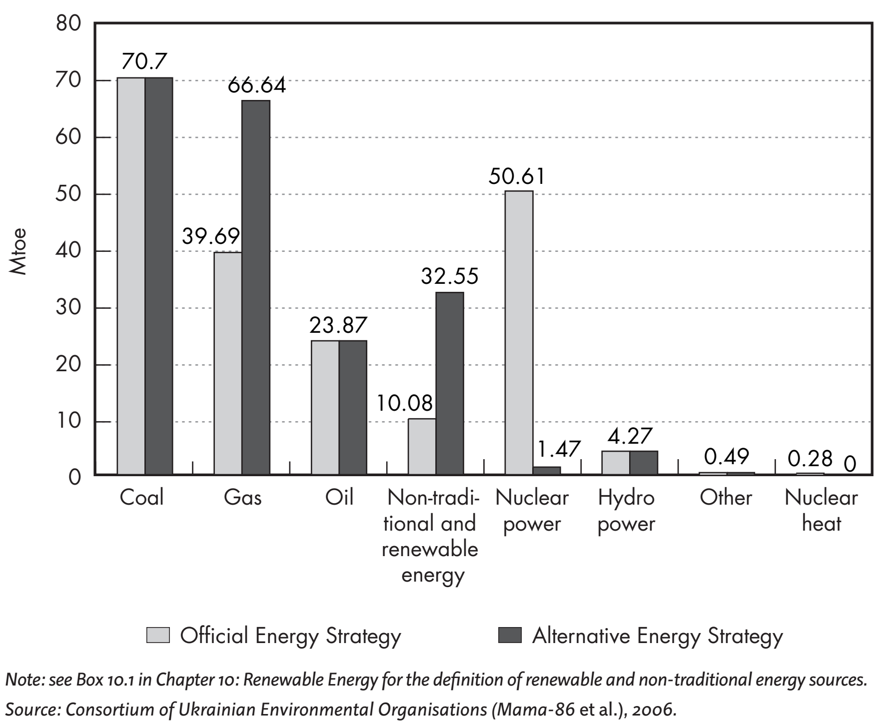
Source: National Strategy Studies, 2003.

Alternative Energy Strategy

Several Ukrainian non-governmental organisations have suggested an alternative ("non-nuclear") energy strategy (Consortium of Ukrainian Environmental Organisations, 2006). Its main difference from the official *Energy Strategy to 2030* is the very low share of nuclear and much higher share of renewable energy in the energy mix. It also expects that gas consumption will grow significantly from the actual level (Figure 2.15). The authors of the alternative energy strategy argue that its implementation would require approximately the same amount of investment (UAH 1 007 billion or USD 201 billion) up to 2030 as the official *Energy Strategy to 2030* (UAH 1 017 billion or USD 203 billion). The alternative energy strategy suggests that renewable energy, non-conventional energy sources and improvements in energy efficiency could lead to savings of 51.2 Mtoe of fossil fuels per year. As in the official *Energy Strategy to 2030*, the alternative strategy does not pay sufficient attention to demand issues, but looks at

Figure 2.15

Projected Primary Energy Supply in 2030, Official versus Alternative Energy Strategy



Note: see Box 10.1 in Chapter 10: Renewable Energy for the definition of renewable and non-traditional energy sources.
Source: Consortium of Ukrainian Environmental Organisations (Mama-86 et al.*), 2006.*

future energy balances from the point of view of supply options (nuclear vs. non-nuclear). This highlights the fact that while there are several theoretical alternatives for the energy supply mix in Ukraine, the actual development of future supply will depend to a large extent on demand.

Critique

A clear understanding of energy demand and supply trends is extremely important for designing a solid energy policy. However, the quality of information on energy flows in Ukraine is quite low due to inadequate collection of energy consumption data, differences in reporting formats for each energy source, and lack of co-ordination between authorities. Derzhkomstat, the State Statistics Committee, is willing to improve the situation but the amount of funding directed to statistics is not sufficient to make significant changes. Lack of reliable information makes energy forecasting and policy making extremely difficult. Most national programmes and targets in the energy sphere, which Ukraine approved since independence, have not been implemented completely. This highlights the need for more pragmatic energy policy making that would rely on solid analysis of demand and supply.

Currently, historical balances are based on the principle "resources – distribution" and do not show the transformation of primary energy and final consumption by sector. This does not give decision makers a clear picture of the energy situation. Adopting the IEA methodology of reporting energy data as "primary supply – transformation and own use by the energy sector – final consumption" would provide a more comprehensible picture of energy flows. It would also facilitate comparisons with other countries, which could help Ukrainian policy makers to learn from their neighbours.

The main shortcoming in the current *Energy Strategy to 2030* – and the overall energy policy – is that it is supply-oriented and does not sufficiently analyse demand. The existing projections are more politically driven goals than realistic forecasts based on market-oriented economic analysis. For example, the *Energy Strategy to 2030* anticipates a dramatic reduction in energy imports without providing a detailed cost-benefit analysis of the enhanced domestic production that is expected to replace imports.

Solid analysis of demand (final consumption) is crucial. More detailed and exact projections of the domestic demand are necessary to determine possible energy-efficiency improvements and to secure advantageous, long-term contracts for energy imports and transit.

The *Energy Strategy to 2030* forecasts large-scale technological improvements in energy intensity, but it is not clear if it takes energy prices into account in making these projections. When prices are below cost, as is currently the case in Ukraine, it is very hard to predict the economic potential of energy-efficiency technologies. Moving to market prices in Ukraine would certainly make energy-efficiency investments more profitable. Global experience shows that higher prices lead to lower demand.

At present, the energy intensity of Ukraine's economy is still very high compared to the EU average, despite some progress over the last ten years. Intensity of energy supply is declining more slowly than intensity of final energy consumption. This highlights the inefficiency of energy transformation and transportation, and the growing need for investments in energy sector modernisation and refurbishment.

Recommendations

The government of Ukraine should:

- Shift its analytical focus from energy supply to demand to improve the *Energy Strategy to 2030* and other energy sector programmes; employ qualified economists to make projections of demand, taking into account price signals.
- Improve collection and reporting of statistics on energy consumption by providing technical and economic support for the offices engaged in data collection and publication.
- Adopt international methodologies for preparing statistical energy balances with the following components: primary supply, transformation and own use by the energy sector, and final consumption.

3. ENERGY AND ENVIRONMENT

Overview

The energy sector in Ukraine is a major contributor to local air pollution; it is responsible for 75% of emissions of sulphur dioxide (SO_2), 50% of emissions of particulates and 45% of nitrogen oxides (NO_x) emissions. Ukraine's energy sector[27] also contributes 69% of total domestic emissions of greenhouse gases. The government sets a number of standards and requirements that aim to control emissions from energy generation and use. Several government initiatives promote energy efficiency and modernisation at power plants.

The *Energy Strategy of Ukraine to 2030* draws some attention to the environmental problems associated with energy production, as well as extraction and transportation of coal, oil and gas. It also mentions environmental damage that stems from air pollution, waste generation, inefficient consumption of water and large-scale land-use. The *Energy Strategy to 2030* provides encouraging figures on the emission reductions envisioned. However, it does not set a clear roadmap on how it will achieve these reductions.

The *Energy Strategy to 2030* itself provides two positive signs. First, it devotes a separate chapter to summarising major environmental concerns. Second, it discusses further details on environmental issues within the chapters on specific sub-sectors (including thermal power production, coal mining, and oil and gas extraction). The IEA and its member countries recognise that integrating environmental concerns into energy policy is a strategic environmental objective and one of the most effective tools to address pollution.

This chapter focuses on the impact of Ukraine's energy sector on two specific areas: climate change and air quality. Environmental concerns related to specific energy sub-sectors are discussed in the related chapters (*e.g.* coal issues in Chapter 7 and nuclear energy issues in Chapter 8).

27. According to the methodology of the Intergovernmental Panel on Climate Change (IPCC), energy sector greenhouse gas emissions include emissions from fuel combustion in the energy industry (electricity and heat), the manufacturing industry, construction, transportation, and other sectors, as well as fugitive emissions from fuels. The climate change section of this chapter uses the IPCC definition of the energy sector.

Climate Change

Ukraine's Commitment

Ukraine has been a Party to the United Nations' Framework Convention on Climate Change (UNFCCC) since August 1997; it is listed in Annex I of this convention, meaning it has an obligation to develop policies and measures that reduce its greenhouse gas emissions. In February 1998, Ukraine submitted its First National Communication on Climate Change to the Secretariat of the Convention. Ukraine became a signatory to the Kyoto Protocol in 1999 and ratified the Protocol in February 2004. Under the Kyoto Protocol, Ukraine's greenhouse gas emission target in the period 2008-12[28] is 100% of its 1990 level (925 Mt of CO_2 equivalent or 260 Mt of carbon equivalent per year).[29]

Historical Trends in Emissions

The energy sector is the main source of carbon dioxide (CO_2) and methane (CH_4) emissions in Ukraine,[30] representing 69% of total greenhouse gas emissions (electricity and heat plants alone are responsible for 24% of total CO_2 emissions) (Figure 3.1). The combustion of fossil fuels, particularly coal, is the most significant contributor to CO_2 emissions. In Ukraine, fuel combustion is responsible for 57% of total greenhouse gas emissions. Fugitive CH_4 emissions contribute 12% of total domestic greenhouse gas emissions. Globally, Ukraine ranks 20th in the emissions of CO_2 from fuel combustion and 8th in energy-related CH_4 emissions.

Greenhouse gas emissions in Ukraine decreased through the 1990s, mostly due to the sharp economic decline. Emissions in 2000 (the lowest point in the last 15 years) were about 60% lower than in 1990. Since 2001, greenhouse gas emissions have grown: they were 399 Mt of CO_2-equivalent in 2001 and 413 Mt of CO_2-equivalent in 2004 (Figure 3.2). In 2004, Ukraine's total greenhouse gas emissions were 45% of their 1990 level. The energy sector greenhouse gas emissions in 2004 represented 41% of their 1990 level. Both the CO_2 emissions from fuel combustion and fugitive CH_4 emissions from coal have fallen significantly since 1990. However, fugitive CH_4 emissions from oil and gas have dropped by only 25% in the same time period (Figure 3.3).

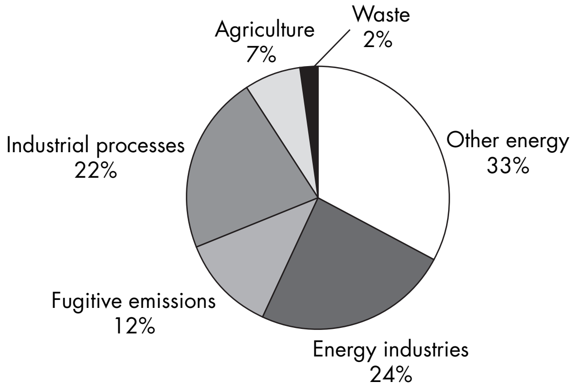
28. 2008-12 is the first compliance period under the Kyoto Protocol.

29. The figure of 925 Mt is presented in the 2006 Ukrainian National Inventory report to the UNFCCC *(Hydrometeorological Institute, 2006).*

30. There are two official sources of information on greenhouse gas emissions: Ukraine's National Inventory Report for 1990-2004 *and IEA energy statistics. (IEA calculates emissions based on standard emission factors for each category of energy use, but does not do detailed bottom-up calculations as are possible in a national inventory.)*

Figure 3.1

Ukraine's Greenhouse Gas Emissions by Sector, 2004

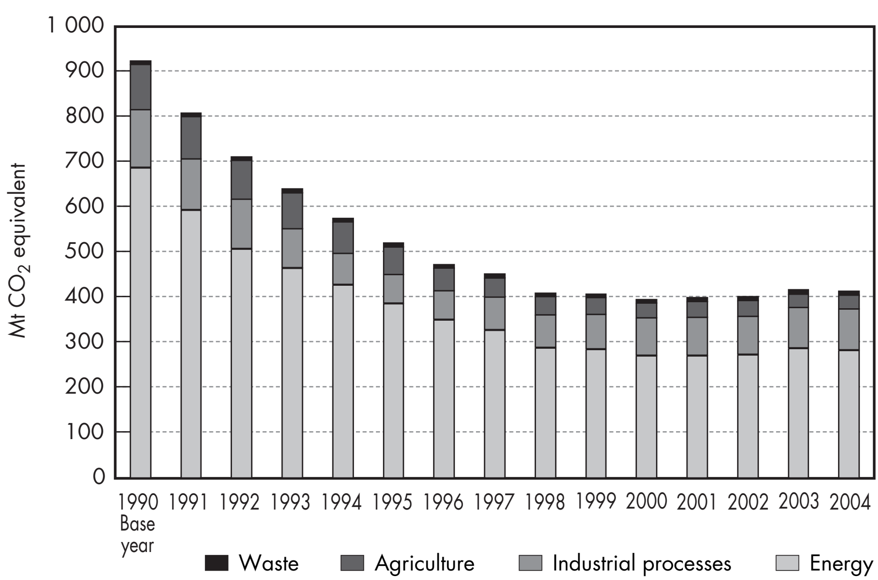


Note: The figure is based on the IPCC categories of sectors. The data include greenhouse gas emissions (CO_2, CH_4, N_2O, and perfluorocarbons, or PFCs) from the energy sector (including fuel combustion in energy industries, manufacturing industries, construction, transport and other sectors, and fugitive emissions from solid fuels, oil and gas), as well as from industrial processes, other fugitive emissions, agriculture and waste.

Source: Hydrometeorological Institute, 2006.

Figure 3.2

Ukraine's Greenhouse Gas Emissions, 1990-2004



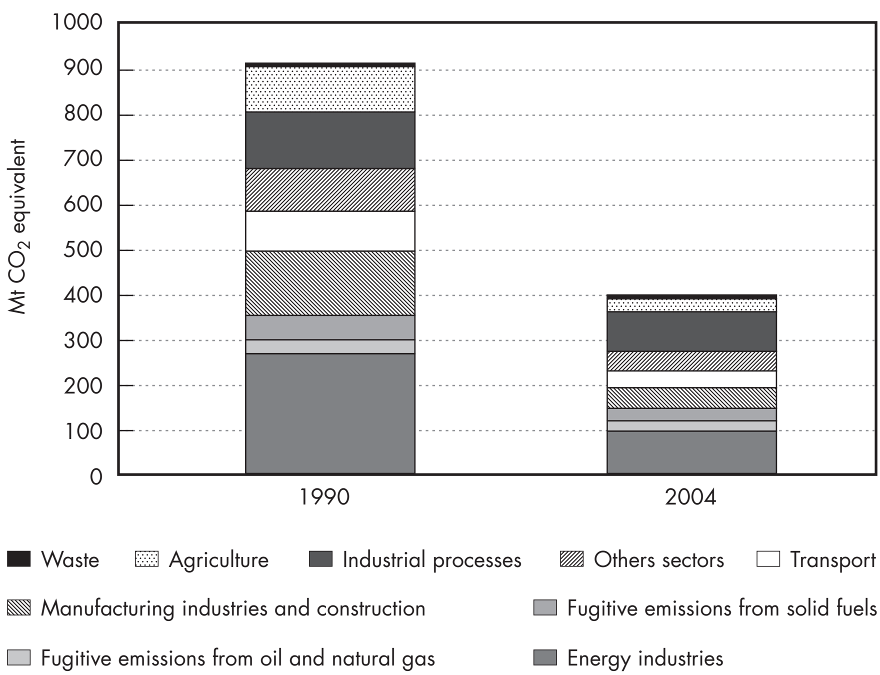
Source: Hydrometeorological Institute, 2006.

In the last decade, the CO_2 emissions from the electricity and heat sectors have also dropped because of changes in the energy balance and efforts to improve energy efficiency. The share of natural gas in Ukraine's TPES increased from 43% in 1993 to 47% in 2004 and the share of nuclear grew from 10.5% to 16% (and is set to increase still more). Coal and oil decreased, respectively, from 30 to 24% and from 16 to 13%[31] over the same period (Chapter 2: Energy Trends).

Without additional policy measures and technological innovations, the country's greenhouse gas emissions will continue to grow with economic recovery. The *Energy Strategy to 2030* envisions a significant increase in coal consumption for electricity and heat production, which will lead to increased greenhouse gas emissions (Chapter 2: Energy Trends and Chapter 7: Coal). Changes in Ukraine's energy intensity will also have a strong, potentially mitigating, influence on emissions.

Figure 3.3

Distribution of Greenhouse Gas Emissions by Sector, 1990 and 2004



Source: Hydrometeorological Institute, 2006.

31. *IEA statistics.*

Ukraine's CO_2 intensity of energy use and economic output (GDP) has changed only slightly since the early 1990s. While Ukraine's energy-related CO_2 emissions have declined by nearly half since 1990, the share of CO_2 emissions per unit of GDP declined by only 14% (according to preliminary data). Ukraine has one of the highest levels of CO_2 emissions per GDP among Annex I countries. However, CO_2 emissions per capita are among the lowest in Annex I countries (Table 3.1).

Targets and Forecasts

Energy-related CO_2 emissions are expected to grow, but most projections assume that they will not exceed the 1990 level by 2012, the end of the commitment period under the Kyoto Protocol.

The paper *Ukraine and the International Greenhouse Gas Emissions Trading Market* (Brunello and Kostukovsky, 2001) summarises the results of domestic and international forecasts of Ukraine's greenhouse gas emissions from 2000-20. It notes that nearly all estimates project 2010 greenhouse gas emissions to be below the 1990 level (except for two that assume very high economic growth).

In addition, a National Strategy Study (NSS) of Ukraine (supported by the Government of Switzerland, the Government of Ukraine and the World Bank) considered two scenarios for economic growth and associated greenhouse gas emissions. The more optimistic scenario (Scenario A in Figure 3.4) predicts that Ukraine will return to its higher, 1990 levels of GDP by 2009, and that greenhouse gas emissions will reach about 68% of the 1990 level by 2010. The second, more moderate, business-as-usual scenario (Scenario B in Figure 3.4) suggests that GDP will be at about 60% of the 1990 level during the Kyoto commitment period (2008-12), while greenhouse gas emissions will increase to only 62% of the 1990 level in the year 2010. The reason for the small difference between the scenarios in terms of greenhouse gas estimates is that the pessimistic Scenario B is associated with low energy efficiency and high greenhouse gas intensity, while Scenario A reflects the projection that, with fast economic growth, energy efficiency will improve significantly.

ARENA-ECO,[32] a Ukrainian energy and environmental think-tank, has also developed projections for Ukraine's energy sector and greenhouse gas emissions using the Energy and Power Evaluation Program (ENPEP).

32. *www.arena-eco.kiev.ua.*

Table 3.1

Key Energy and Environment Indicators in Ukraine and Annex I Parties

	1990	1992	1994	1996	1998	2000	2002	2004	Change 1990-2004
Ukraine									
Total CO_2 Emissions, Reference Approach (Mt of CO_2)	625.8e	562.7	405.7	356.5	321.2	311.0	315.3	324.3	–48.2
Total CO_2 Emissions, Sectoral Approach (Mt of CO_2)	576.5e	533.5	384.8	333.5	297.4	285.3	293.9	304.8	–47.1
CO_2 / TPES (t CO_2 per TJ)	..	60.7	58.0	53.9	53.6	52.4	53.2	51.9	-14.5*
CO_2 / GDP (kg CO_2 per 2000 USD)	8.0e	9.0	9.8	10.7	10.1	9.1	8.2	6.9	-13.6
CO_2 / Population (t CO_2 per capita)	11.1e	10.2	7.4	6.5	5.9	5.8	6.1	6.4	–42.2
Annex I Parties									
Total CO_2 Emissions, Reference Approach (Mt of CO_2)	13848.4e	13520.1	13227.1	13522.1	13482.3	13853.4	13911.5	14286.4	+3.2
Total CO_2 Emissions, Sectoral Approach (Mt of CO_2)	13611.6e	13360.4	13090.4	13442.7	13419.3	13768.3	13794.1	14179.3	+4.2
CO_2 / TPES (t CO_2 per TJ)	..	57.8	57.3	56.29	56.7	56.3	56.3	56.2	-2.9*
CO_2 / GDP (kg CO_2 per 2000 US$)	0.7e	0.7	0.6	0.6	0.6	0.6	0.5	0.5	-23.8
CO_2 / Population (t CO_2 per capita)	11.6e	11.2	10.9	11.0	11.0	11.2	11.0	11.3	-2.4

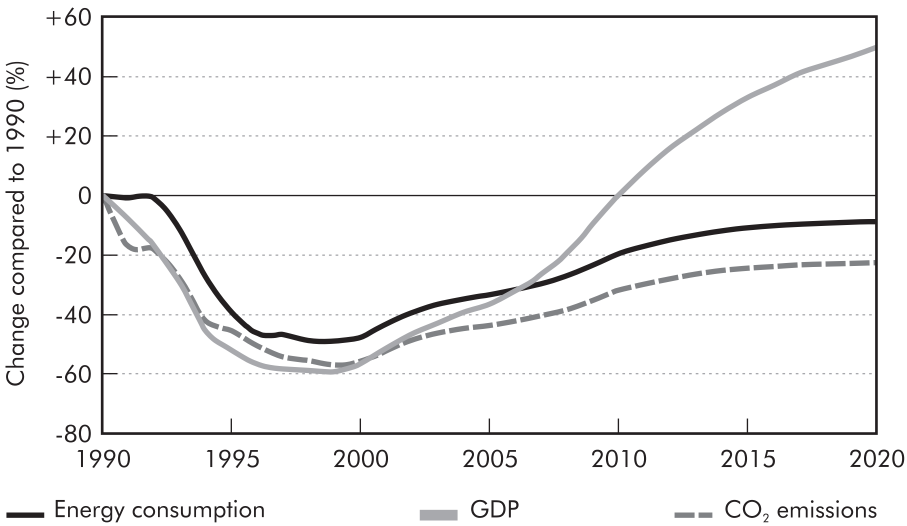
*Notes: * Change from 1992-2004; e – estimated. See Table 1.1 in Chapter 1 for key economic indicators in Ukraine.*

Source: IEA statistics (preliminary data for 2004).

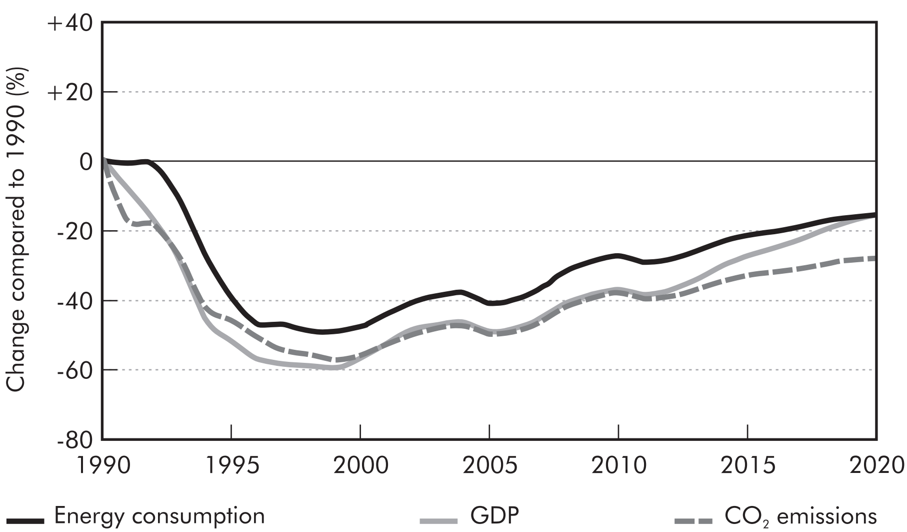
Figure 3.4

GDP, Energy Consumption and CO_2 Emission in Ukraine: Two Scenarios

Scenario A



Scenario B



Source: National Strategy Studies, 2003.

The forecasts projected the level of energy consumption and greenhouse gas emissions in Ukraine up to 2020 using various scenarios of economic development and energy intensity. All scenarios show that greenhouse gas emissions from the energy sector will not return to 1990 levels by 2020, even under a scenario with high economic growth and relatively few energy-efficiency investments. Implementing energy-efficiency measures will reduce Ukraine's energy consumption and greenhouse gas emissions, respectively, by 36% and 46% by 2010, and by 45% and 51% by 2020.

Under any scenario, Ukraine will likely have a surplus emission quota to sell on the international market through emissions trading, as well as opportunities to generate credits for sale through the joint implementation (JI) mechanisms that are envisioned under the Kyoto Protocol. JI, emissions trading and investments through a green investment scheme[33] could provide at least partial financing for projects to reduce greenhouse gas emissions.

Policies and Measures for Greenhouse Gas Emission Reductions

A specific national policy on climate change is still under development in Ukraine. The Ministry of Environmental Protection is the main co-ordinator of climate change programmes and strategy development. In 2005, the Ministry – together with the State Ecological Institute and the Ukrainian Hydrometeorological Institute – created the Climate Centre, a semi-independent institution funded by the Ministry. The Climate Centre is responsible for all issues related to climate change policy implementation in Ukraine, including the greenhouse gas inventory, emission registry, JI process and international and domestic emissions trading.

Several other institutions also play a role in developing Ukraine's climate change policy: the Ministry of Fuel and Energy, the Ministry of Economy, the Ministry of Finance, the Ministry of Foreign Affairs, the Ministry of Transport and Communication, the National Agency on Efficient Energy Use, and the State Statistics Committee. In April 1999, the Cabinet of Ministers created the Interministerial Commission on Climate Change to develop and implement national climate change policy, to reinforce the national administrative structure on climate change, and to ensure fulfilment of Ukraine's obligations under the UNFCCC (Cabinet of Ministers, 1998). The Commission consists of representatives of the relevant ministries, the

33. Ukraine is currently considering whether to create a green investment scheme. The purpose of such schemes is to promote the environmental efficacy of transfers of surplus emission allowances under the Kyoto Protocol. This is done by earmarking revenues from these transfers for environmental purposes in the seller countries.

Cabinet of Ministers, the Verkhovna Rada, the Secretariat of the President of Ukraine and the National Academy of Sciences of Ukraine.

On 18 August 2005, the Cabinet of Ministers of Ukraine adopted a decree[34] approving the *National Plan for Measures to Implement the Kyoto Protocol to the UN Framework Convention on Climate Change* (or *National Action Plan*, for short). The *National Action Plan* foresees a range of measures from 2005-07 with the following priority steps:

- Create a national inventory system to evaluate anthropogenic greenhouse gas emissions and greenhouse gas absorption by sinks.
- Develop an annual inventory of anthropogenic greenhouse gas emissions.
- Establish the infrastructure and legal framework to implement projects aimed at greenhouse gas emission reductions (JI projects).
- Develop national legislation to control greenhouse gas emissions.

Implementing the *National Action Plan* will facilitate Ukraine's compliance with the key UNFCCC and Kyoto Protocol requirements, and might result in Ukraine's eligibility for Track I JI (the fast track, which is associated with lower transactions costs) and emissions trading.

In February 2006, the Ukrainian Cabinet of Ministers issued a decree *On Approving the Procedure for Review, Approval and Implementation of Projects Aimed at Anthropogenic Emission Reduction and Greenhouse Gas Absorption under the Kyoto Protocol to the UNFCCC.*[35] The approval of the guidelines for JI is a significant step in Ukraine's national and international policy to combat greenhouse gas emissions, and makes the JI process in Ukraine fully operational.

By June 2006, the government approved 19 JI projects; more than 100 other projects are in the approval pipeline. With the adoption of JI procedures in Ukraine in 2006, these projects can now be implemented.

With its large potential for cost-effective, greenhouse gas emission reductions, Ukraine has a significant interest in participating in JI. The National Strategy Study estimated potential costs of selected CO_2 mitigation options[36] in Ukraine, which can be summarised in a marginal abatement cost

34. Decree No. 346.

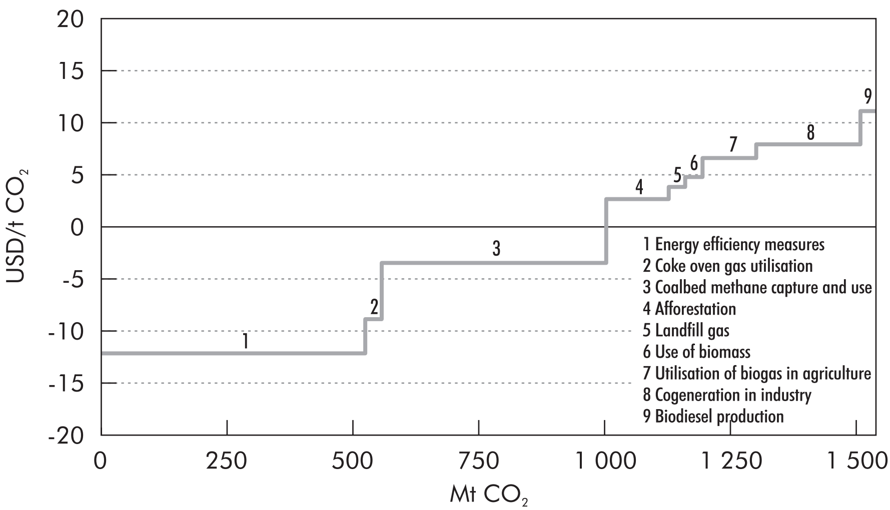
35. Decree No. 206.

36. The marginal abatement cost curve presented in Figure 3.5 does not include all possible measures (e.g. technological modernisation of power plants) that could lead to greenhouse gas emission reductions.

curve (Figure 3.5). This curve shows that Ukraine has significant potential for greenhouse gas emission abatement. From 2002-12, Ukraine could reduce CO_2 emissions by 1 500 Mt at a cost of USD 10/tCO_2 or less, while reducing emissions by 1 000 Mt could be achieved with no cost.[37] Approximately one-third of the total potential is directly related to energy savings.

Figure 3.5

Marginal Costs of CO_2 Abatement, Estimates as of 2003



Source: National Strategy Studies, 2003.

Ukraine is also interested in participating in emissions trading, but it has not yet developed a strategy for emissions trading. Discussions are underway about allocating emission allowances to domestic companies and establishing a domestic emissions trading regime. However, given the limited time remaining before the Kyoto commitment period (2008-2012), it is more likely that Ukraine will engage in international, government-to-government emission trades without allocating the allowances to domestic companies.

Currently, Ukraine co-operates with many Parties to the UNFCCC and the Kyoto Protocol, including the European Commission (EC), Canada, Finland, the Netherlands, Switzerland and the United States. These co-operation programmes assist Ukraine in the development and implementation of

37. Some risks and other barriers may not have been accounted for in all of the underlying studies; thus, these estimates must be taken with care.

relevant climate change related policies and tools. Ukraine is implementing several projects on climate change mitigation in co-operation with international institutions and environmental organisations. Ukraine is also a member of the US-led international initiative *Methane to Markets*, which pledges to reduce global methane emissions.[38] In the past, Ukraine co-ordinated negotiating strategies and other climate-related issues with Russia. Russia potentially has even more emission allowances to sell than Ukraine.

At present the EU, through its technical assistance programme, supports several climate change related activities in Ukraine. These include developing national greenhouse gas inventories, assessing the feasibility of greenhouse gas registries and setting up the national JI infrastructure. Thanks to this assistance programme and the efforts by the Ukrainian government, the national inventory reports were developed and submitted to the UNFCCC in 2005 and 2006, (the latest report includes greenhouse gas inventories for the years from 1990-2004). The United States has also assisted Ukraine with inventories, JI infrastructure and national communications.

Possible Measures to Reduce Greenhouse Gas Emissions

Ukraine's energy sector offers numerous opportunities for cost-effective, greenhouse gas emission reductions. Energy-efficiency measures and modernisation of old equipment will certainly reduce greenhouse gas emissions so that more CO_2 allowances can be sold abroad. These measures will also lead to other benefits for local air quality, worker safety, energy security and the economy.

Detailed descriptions of various measures that facilitate emission reductions are presented in other chapters of this review. This section offers a brief overview of potential measures that can reduce greenhouse gas emissions, in particular.

Energy-efficiency Measures

The *Energy Strategy to 2030* highlights a large potential for energy savings, estimating that energy-efficiency improvements and structural adjustments can cut Ukraine's energy intensity in 2030 in half compared to current levels. It is often hard to find the initial capital to invest in energy-saving measures, despite the fact that energy efficiency might lead to net cost savings. The Kyoto Protocol mechanisms can help finance and implement

38. *www.epa.gov/methanetomarkets/.*

energy-efficiency improvements. Higher energy prices will of course also stimulate such investments.

Cogeneration and District Heating

Improving the efficiency of district heating systems could result in enormous energy savings and reductions in greenhouse gas emissions. Heat production in Ukraine is inefficient because of outdated equipment and cogeneration's relatively low share in total heat production. District heating distribution networks in Ukraine are typically poorly insulated. Final heat consumption is also higher than necessary because of inefficient buildings. Improving district heating efficiency in production, distribution and consumption can result in significant energy savings and avoid greenhouse gas emissions. The inefficiencies and solutions are well understood in Ukraine – the challenge is to put the solutions into practice. JI and international emissions trading could provide at least partial financing for the projects that improve efficiency in district heating and increase the level of cogeneration (see Chapter 9: District Heating for more detail).

Coalbed Methane

Coal mines can reduce methane emissions from their coalbeds by recovering the methane and burning it as an energy source. This creates some CO_2 emissions, but with a much lower total impact on the environment. Eight mines in the Donbas region are currently recovering methane and using it for their operations. Coalbed methane recovery is expected to provide 3-4 bcm/year in 2005-08 and then grow further to 12-16 bcm/year after 2010-15. The Kyoto Protocol mechanisms (*i.e.* JI and international emissions trading) potentially offer additional financing and financial benefits for coalbed methane projects (see Chapter 7: Coal for additional details).

Renewable Energy

The *Energy Strategy to 2030* envisages a wider use of renewable energy sources (Chapter 10: Renewable Energy). By increasing the share of renewable energy, Ukraine would improve its energy security and facilitate the progress in addressing local air quality and global greenhouse gas emissions. Some renewable energy projects can be financed through JI.

Air Quality

The energy sector[39] contributes significantly to air pollution in Ukraine. The sector is a major source of SO_2, NO_x and particulates emissions. Most

39. In the Air Quality section of this chapter, the term 'energy sector' means electricity and heat plants.

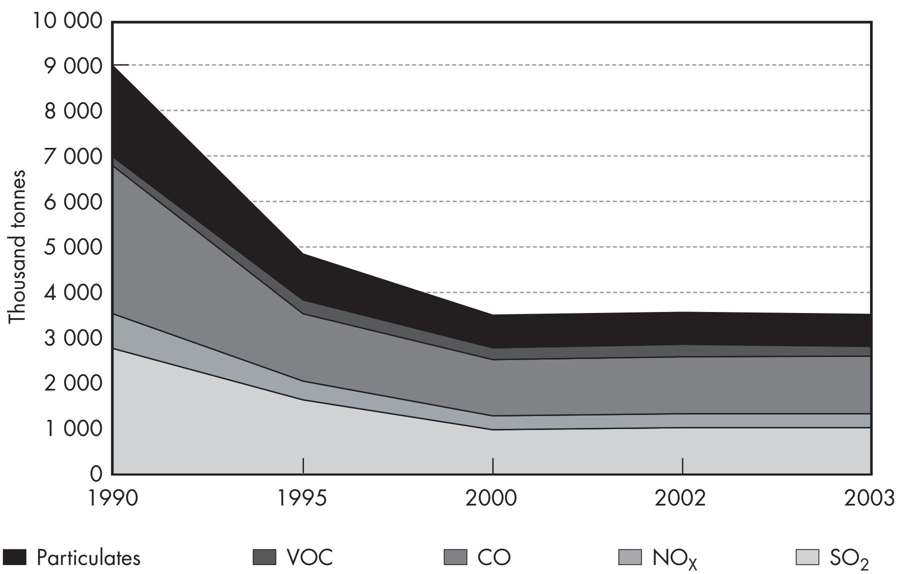
thermal power plants are old, and use obsolete technology and low-quality fuel. Most plants have high stacks, which limits immediate local air pollution and allows ambient air quality to remain within allowable limits at the time of measurements. However, the plant emissions are transported downwind and affect more distant cities and regions. Moreover, almost 60% of power plants burn low-quality coal that has high contents of ash (about 29%) and sulphur (1.5-2%). This leads to large discharges of SO_2 and particulates into the atmosphere. The *Energy Strategy to 2030* envisions a significant increase in domestic coal production and consumption in order to improve energy security and lessen Ukraine's dependence on Russian gas. This strategic objective needs to be evaluated against its impacts on air quality.

• Historical Trends in Emissions

Due to a significant decline since 1990 in Ukrainian production and consumption of coal, oil and other fuels, emissions of criteria air pollutants, such as NO_x, SO_2 and particulates have also decreased (Figure 3.6).

Figure 3.6

Emissions of Key Pollutants from Stationary Sources, 1990-2003

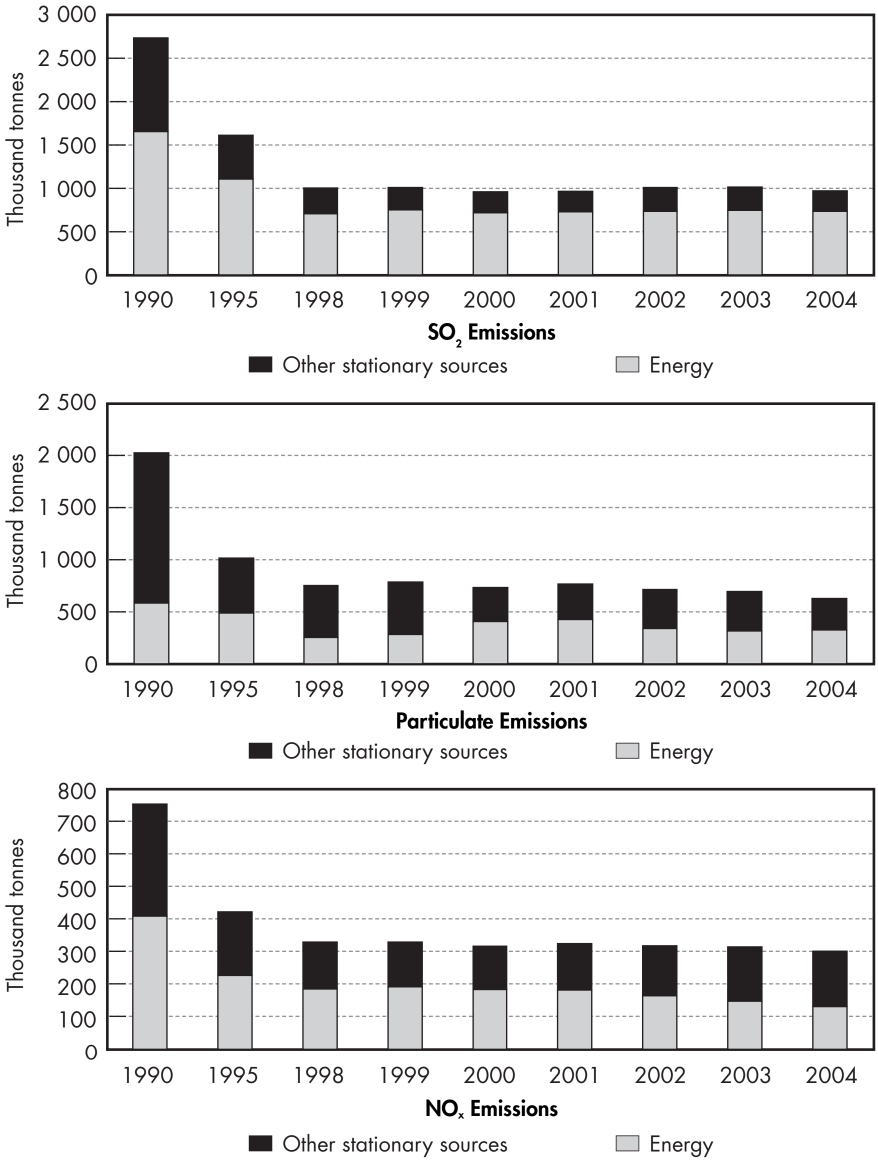


Source: State Statistics Committee of Ukraine, 2004.

Total emissions of SO_2, NO_x and particulates from stationary sources have dropped by two-thirds since 1990. However, emissions from power

Figure 3.7

Ukraine's Emissions of SO_2, Particulates and NO_x from Stationary Sources, 1990-2004



Note: The National Report on Greenhouse Gas Emissions and Absorption (Hydrometeorological Institute, 2006) also contains data on SO_2 and NO_x emissions, however those data differ from the data obtained from the Ukrainian Ministry of Environmental Protection and presented in Figure 3.7

Source: Ministry of Environmental Protection.

plants have not changed as dramatically. After falling more than 50% from 1990-98, SO_2 emissions from the energy sector have remained almost constant since then. A similar picture is observed with energy sector NO_x emissions. While total emissions of particulates from stationary sources have been steadily declining, the same is not true for particulate emissions from the energy sector. Emissions of particulates from the energy sector dropped significantly in 1998, then increased again in 2000, and have been declining since 2002. Currently, of the total emissions from stationary sources, the energy sector contributes around 75% of the SO_2 emissions, 50% of the particulates and about 45% of the NO_x emissions.

The State Hydrometeorological Service within the Ministry of Environmental Protection regularly monitors air quality in 54 cities and towns. Although there is the appearance of general, country-wide compliance with SO_2, NO_x and particulate ambient standards, the problem of heavy pollution persists in big cities where major polluters are located. The apparent compliance with standards may be partially due to high stacks of plants: pollutants are transported downwind to neighbouring cities and regions. Data from the Ministry of Environmental Protection for 1995, 1998 and 1999 show that concentrations of dust are exceeding the maximum allowable concentration (MAC)[40] levels in 27 major Ukrainian cities and NO_x levels exceed the MAC in 24 cities. The most affected cities are Kriviy Rih, Mariupol, Donetsk, Yenakieve, Dnipropetrovsk, Debaltseve, Zaporizhia, Makiivka and Horlivka.

Policies and Measures to Address Local Air Pollution

Ukraine has wide-ranging environmental legislation. The most important acts that regulate environmental issues in the energy sector include the Law on Environmental Protection (1991), the *Law on Protection of Atmospheric Air* (1992) and the *Amendments to the Law on Protection of Atmospheric Air* (2001).

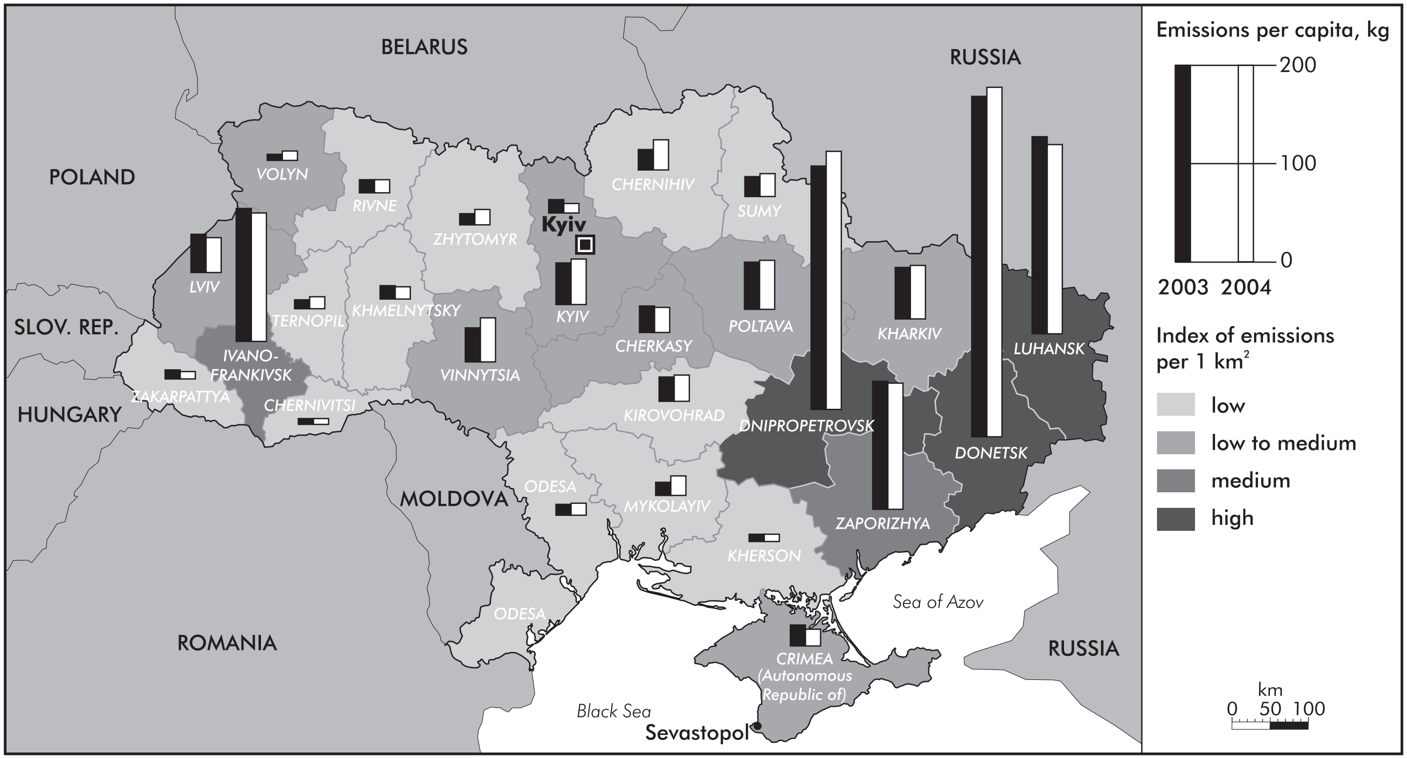
In 1998, the Verkhovna Rada adopted the decree *Principal Directions of State Policy for Environmental Protection, Use of Natural Resources and Ecological Safety*.[41] This decree identified the priorities of Ukraine's environmental policy, which include the following:

- Manage air quality in regions with intensive industrial development (mainly Southeastern Ukraine).

40. Maximum allowable concentration is the standard for ambient air quality defined for each major pollutant in Ukraine. The Ministry of Health sets the allowable levels.
41. Decree No. 188/98.

Figure 3.8

Geographical Distribution of Emissions from Stationary Sources, 2004



Source: Ministry of Environmental Protection, 2004.

- Ensure radiation safety and radioactive protection of the population and the environment, and minimise the effects of the Chornobyl catastrophe.

The decree also laid out more specific objectives and measures for improving environmental conditions in several economic sectors, including the energy sector, and housing and communal services. Enhanced monitoring also plays a prominent role.

The government sets ambient environmental standards and norms for allowable levels of emissions, and fixes penalties for excessive emissions and other damage to the environment. The existing legislation also creates a framework for incentive-based instruments, such as tax benefits for environmentally-friendly actions. However, most measures stipulated in the *Principal Directions* and in the existing legislation have not been effectively enforced. Environmental inspection bodies lack funding and staff to identify violations of environmental requirements. Levies and fines are not collected or imposed appropriately, so they do not encourage companies to invest in end-of-pipe or efficiency technologies. The problem is exacerbated by the fact that many power plants and industrial facilities lack funds to pay penalties and some have already accumulated huge debts to the government. In addition, many also lack capital for investments to reduce emissions.

The Ministry of Environmental Protection currently works with the Ministry of Fuel and Energy to develop technical standards for power plants; the standards recommend specific technologies and end-of pipe measures. The two ministries provide power plants with financial assistance to implement environmental protection measures.

The *Energy Strategy to 2030* sets goals concerning specific pollutants and outlines some measures that should be taken to achieve these goals. For example, it states that by 2030, thermal power generation will emit 85.5% less particulates, 30.5% less NO_x and 70% less SO_2 – even though fuel consumption is expected to increase by 85.9% during the same period. The *Energy Strategy to 2030* indicates that particulate emissions will be decreased by reducing the ash content of fuel and by improving the efficiency of power plants and boilers. It also states that, in 2011-20, new combustion and end-of-pipe technologies will reduce particulate emissions by up to 99.9%. The government hopes to reduce SO_2 emissions by decreasing the sulphur content of fuel and introducing new sulphur capture technologies. Likewise, the government projects that improved operation protocols and technical measures at power plants and boilers will further reduce NO_x emissions.

Ukraine is party to 11 international and bilateral environmental agreements related to air quality. Compliance with these international obligations requires some modifications in domestic policy. Some of these international agreements require or encourage harmonising domestic laws and regulations with the existing international norms and practices.

In particular, Ukraine is party to the 1979 *Convention on Long-range Transboundary Air Pollution Concerning the Control of Emissions of Volatile Organic Compounds or Their Transboundary Fluxes*, as well as to two Protocols to this Convention: *Air Pollution – Nitrogen Oxides* and *Air Pollution – Sulphur 85.* It also signed, but has not yet ratified, the following Protocols to this Convention: *Air Pollution – Persistent Organic Pollutants, Air Pollution – Sulphur 94* and *Air Pollution – Volatile Organic Compounds.* Ukrainian obligations include a 40% reduction of sulphur emissions in 2000-10 compared to the base year 1980.

Critique

The commitment of the Ukrainian government to restructure and modernise the energy sector can have important effects on local air quality and climate change mitigation. While total emissions from the energy sector have declined since 1990, emissions per unit of output remain high. Several estimates show that introducing modern and more efficient technologies will lower emissions, even if total production of electricity and heat increases. However, Ukraine's plans to increase coal consumption to improve its domestic energy security and reduce reliance on Russian gas might lead to an increase in total emissions of SO_2, particulates and CO_2. There is a growing understanding in the Ukrainian government of the large potential and importance of energy efficiency. Wide-scale improvements in energy intensity could dramatically reduce the need for coal-fired power, for example.

The *Energy Strategy to 2030* discusses issues such as old equipment, obsolete technologies, inefficient energy production, the high potential for energy savings and opportunities in alternative energy, but only in general terms. It also mentions some measures that can be taken to address specific types of pollution. For example, in the coal industry, the *Strategy* proposes using coalbed methane and improving the quality of coal.

While the *Energy Strategy to 2030* does a commendable job of addressing the major environmental concerns associated with the energy sector, it lacks concrete steps and plans. Effective implementation has been a problem with previous energy and environmental policies. Thus, more detailed discussions on concrete measures and the emission reductions associated with them would provide more effective guidance to companies, and local and national policy makers.

The Kyoto Protocol offers many financial opportunities. The *Energy Strategy to 2030* mentions Ukraine's interest in participating in JI projects and international emissions trading. The Ukrainian JI procedures, approved in 2006, will facilitate the flow of foreign investment into projects that reduce greenhouse gas emissions. The government may want to encourage JI projects in specific sectors (*e.g.*, demand-side efficiency improvements, coalbed methane and renewable energy) or to promote specific technologies. Incorporating these requirements into the JI project criteria would facilitate this. While institutional and regulatory conditions are sufficient for JI to operate in Ukraine, there is still a need for strong technical and institutional support for JI in order to make implementation as effective as possible.

Higher pollution charges will not help to reduce emissions if companies do not have money to pay the charges or to invest in new technologies. This highlights the need for a new approach. Such an approach could have three elements: increased attention to energy efficiency, better coordination and dialogue, and steps to internalise environmental costs. Energy efficiency offers an opportunity to significantly reduce emissions at little or no net cost, thus it should be the biggest priority. At the same time, enhanced dialogue can make implementation simpler and more effective. An effective and ongoing dialogue between the Ministry of Fuel and Energy, the Ministry of Environmental Protection, the National Agency on Efficient Energy Use and power plant managers could benefit all. Jointly these stakeholders can develop effective strategies to facilitate technological and efficiency improvements in the energy sector. Likewise, internalising a greater share of environmental costs in energy prices would clarify the real costs of various energy sources and, hence, would stimulate reductions in emissions.

Recommendations

The Government of Ukraine should:

- Ensure that environmental assessments and issues are more thoroughly incorporated into energy policy (*e.g.* expanding the role of coal has environmental implications that have yet to be calculated).
- Emphasise measures that simultaneously improve environmental protection and energy efficiency because of their cost-effectiveness. Other

potentially cost-effective measures to reduce emissions include coalbed methane recovery and use, improvements in district heating efficiency, and use of renewable energy.

- Take full advantage of opportunities offered by the Kyoto Protocol and use its mechanisms as financial tools to facilitate climate-friendly investments.
- Facilitate the smooth functioning of the JI process in Ukraine. Develop the necessary domestic infrastructure to participate in Track I JI (the more flexible form of JI) – including developing a credible greenhouse gas inventory and registry.
- Consider developing a green investment scheme or other mechanisms to sell excess greenhouse gas allowances on the international market and to finance energy-efficiency and renewable energy investments.
- In addressing criteria pollutants, focus on the most polluted areas where the population is directly affected by the poor air quality.
- Form working groups with representatives of the Ministry of Fuel and Energy, the Ministry of Environmental Protection, the National Agency on Efficient Energy Use and power plants management to jointly develop effective strategies on modernising and improving the efficiency of energy production.
- Use environmental audits of large power plants to assist companies in identifying cost-effective measures that can improve efficiency and reduce emissions, and develop financial mechanisms that support implementation of these measures.
- Incorporate environmental costs associated with energy generation (such as pollution and waste-processing charges) into energy prices.

PART II:
SECTORAL ISSUES

4. ENERGY EFFICIENCY

Overview

Ukraine has tremendous potential for energy efficiency. It is one of the most energy intensive countries in the world, even more so than energy-rich Russia. In fact, the only countries with more energy intensive economies are the oil producers of the Middle East. This is not news to the government. Ukraine first passed a law on energy conservation in 1994. However, funding for energy efficiency and a willingness to dedicate high-level attention to the issue have not always matched the scope of the problem.

Energy prices are low and do not cover the full, long-term costs of energy supply. The government recognises that it should raise energy prices to improve energy efficiency and the financial health of the energy sector, but finding the political will simultaneously in the government, parliament and regulator has been difficult. This began to change in 2006.

Along with price increases, targeted policy measures are necessary. In fact, the experience of OECD countries after the 1973 oil shock suggests that a two-pronged approach is essential. Cost-reflective prices and energy taxes create general energy-saving incentives. Specific policies to promote energy efficiency – such as standards, labelling, information campaigns, tax incentives and targeted energy-efficiency funds – help overcome additional barriers. Such measures stimulate the market to tap an even larger share of the cost-effective savings potential. Reiterated political commitment at the cabinet, prime ministerial and presidential level, followed by concrete action, is extremely important and can help "lead the way" for consumers throughout Ukraine to follow this example.

Since the Orange Revolution, energy efficiency has become a hot topic in Ukraine. The difficult political negotiations over gas resulted in a twofold increase in wholesale natural gas prices. Reflecting the renewed emphasis on energy efficiency, the government established a National Agency on Efficient Energy Use[1] and developed a number of draft laws and sectoral programmes on energy efficiency. The new Agency on Efficient Energy Use seems to have broader powers and greater support than a previous State Committee for Energy Conservation, which should bode well for the future of energy-efficiency policy.[2]

1. *According to the decree under which it was established, the full name of the organisation is the* National Agency of Ukraine on Questions of Providing Efficient Use of Energy Resources.

2. *Previously, Ukraine had a State Committee for Energy Conservation, which was established in 1995 and then disbanded 10 years later in 2005. Such fluctuating political commitment and changing organisational structures makes it more difficult to turn policy into action.*

Numerous independent organisations are working on energy efficiency, such as the non-governmental organisation ARENA-ECO, and several research and educational institutes. These organisations have played a large role in promoting efficiency and ensuring continuity in the institutional capacity.

Ukraine has taken some important policy steps with the help of the new National Agency on Efficient Energy Use, the former State Committee for Energy Conservation and independent organisations. Thus, while Ukraine remains very inefficient, it is impressively 30% more efficient than it was in 1995. Ukraine has developed appliance standards, created a network of energy-efficiency departments within various ministries and regional administrations, and taken steps to improve the efficiency of vehicles and passenger transportation. Other policies seem to have a less positive impact, for example, normative energy use in industry (with fines for non-compliance) and energy subsidies, which actually hinder energy efficiency. In short, Ukraine still has much work to do. Boosting energy efficiency will improve energy security and economic competitiveness, both critical given Ukraine's growing energy supply concerns and the rising price of energy imports.

Energy Intensity and the Need for Energy Efficiency

Despite recent progress, Ukraine is only one-third as energy efficient as the average industrialised country (Figure 4.1). There are several causes for this poor rating. First, low energy prices do not stimulate efficient energy use, especially for residential consumers. Second, the economy is dominated by energy-intensive industries, such as cast iron, steel, cement and chemicals. Third, most of these industries still use outdated Soviet technologies.[3]

Increasing energy efficiency offers a powerful tool for achieving Ukraine's economic and social targets. Improved energy efficiency can reduce the need for investment in new infrastructure and cut fuel costs, thereby increasing competitiveness for businesses and directly enhancing welfare for consumers (especially in the context of energy price increases). Lower demand for energy will reduce energy security concerns by reducing Ukraine's dependence on imported fuels. Energy efficiency generates environmental benefits and stimulates new services and jobs.

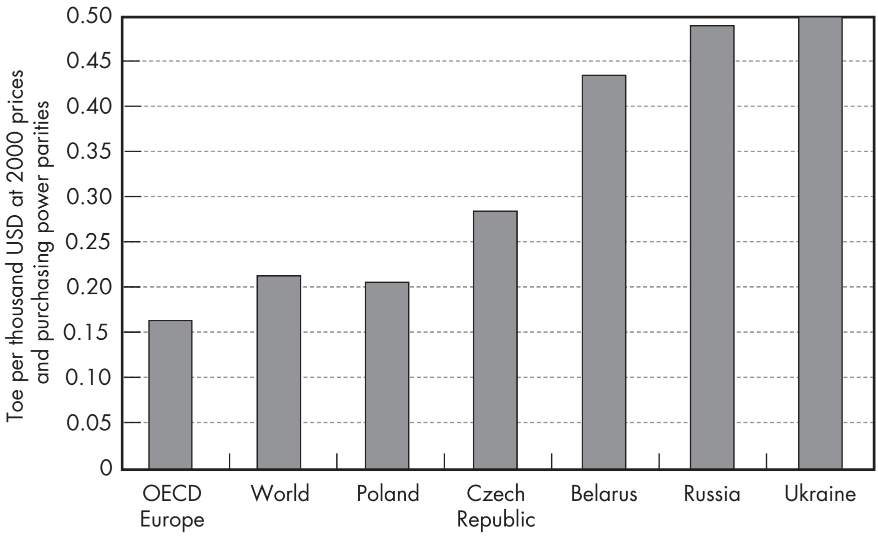
Efficient energy use has substantial implications for Ukraine's national security. Ukraine is highly dependent on energy imports for the majority of

3. Even in the Soviet era, Ukraine's energy intensity exceeded the former Soviet Union average by 25%.

its total primary energy supply. As the majority of primary energy comes from the Russian Federation, Ukraine is vulnerable to political fortunes in its neighbouring country. Reducing energy consumption through more efficient energy use would definitely help break this dependence.

Figure 4.1

Energy Intensity in Ukraine and Other Countries, 2004



Source: IEA statistics.

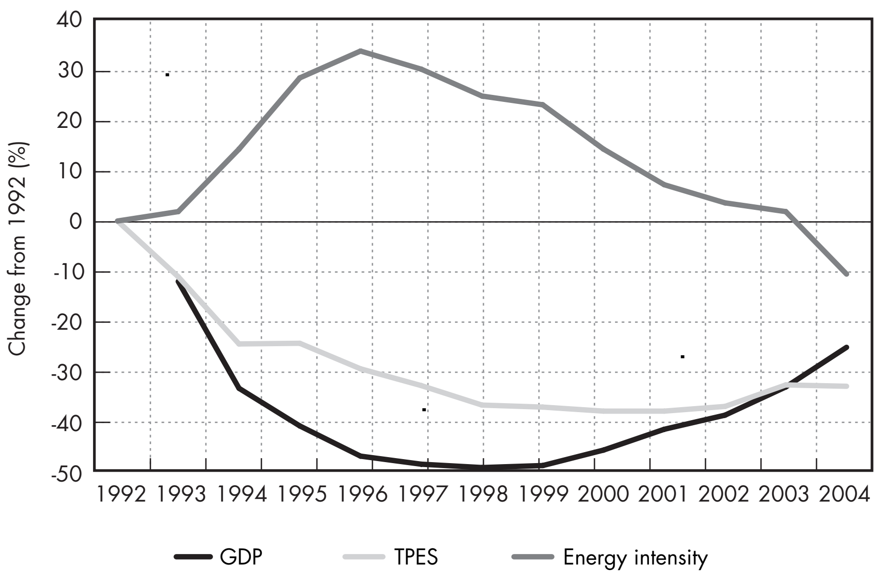
Energy efficiency is also essential for economic growth and improved living standards. At the current level of energy inefficiency, Ukrainian enterprises are forced to keep labour costs – and living standards – artificially low. Direct and indirect subsidies, which are aimed at maintaining the consumer's ability to pay for energy, devastate municipal budgets and erode the quality of public services. In addition, excessive energy consumption skews the distribution of national income, so that the energy sector and energy-intensive industries receive an unusually high share.

In its 15-year path to the current level of energy intensity, Ukraine passed three stages (Figure 4.2). The first stage (1991-95) saw a significant increase in energy intensity; during the second stage (1996-99), the economy stabilised and the intensity began to drop; the final stage (2000-present) saw strong economic growth and a decline in intensity.

After the collapse of the Soviet Union, Ukrainian domestic production dropped substantially, causing a decline in energy consumption. However, production output fell at a slower rate in the export-oriented and energy-intensive sectors. In 1990, the energy sector, metallurgy and chemicals accounted for 25% of the gross industrial output; in 1995, their share exceeded 53%. The share of relatively energy-efficient industries (engineering, light industry and the food industry) dropped from 60-34% over the same period.[4] In this context of rapidly decreasing gross industrial output, factories were not operating at full capacity, which inherently requires more energy per unit of goods and services produced. Energy consumption of households remained at the pre-recession level. As a result, from 1991-95, Ukrainian energy intensity grew by 30%.

Figure 4.2

Energy Intensity, GDP, Total Primary Energy Supply Trends, 1992-2004



Source: IEA statistics.

Energy intensity stabilised from 1996-99, as the economic decline slowed and energy consumption continued to decrease. From 1990-97, electricity and fuel prices rose 40-85% faster than inflation. This tripled the share of energy in total production cost, which provided stronger incentives for the private sector to consume energy more efficiently. Not surprisingly, manufacturers began to introduce new technologies. At the same time, the service sector expanded.

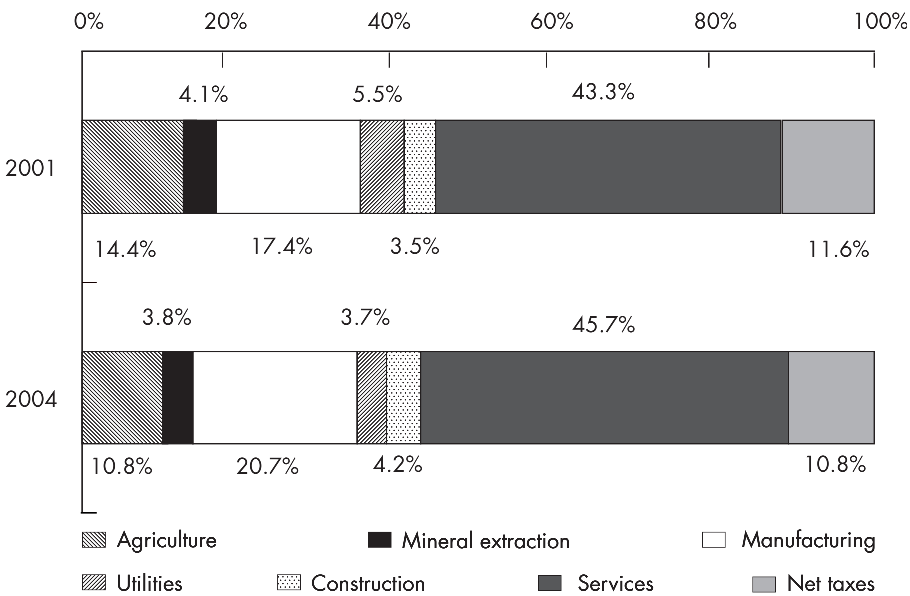
4. *Data of the State Statistics Committee of Ukraine.*

Since 2000, Ukraine has experienced substantial economic growth while energy consumption has remained relatively stable. This is quite an achievement. It means that from 2000-04, energy intensity in Ukraine dropped by 22%, averaging an improvement of 6.1% per year. Ukraine is now about 30% more energy efficient than it was in 1995, based on IEA data.

Economic reforms and favourable markets for Ukrainian exports have accelerated economic growth. Both structural changes and improvements in energy efficiency have played a role in the sharp decline in energy intensity. As the economy has recovered, the share of less energy-intensive industries such as food processing and the service sector has expanded. Likewise, the share of some energy-intensive industries such as mineral extraction and utilities contracted. However, as Figure 4.3 shows, shifts in economic structure were rather moderate, in part because energy prices actually decreased in real terms over this period.

Figure 4.3

GDP Structure, 2001-04



Source: State Statistics Committee of Ukraine.

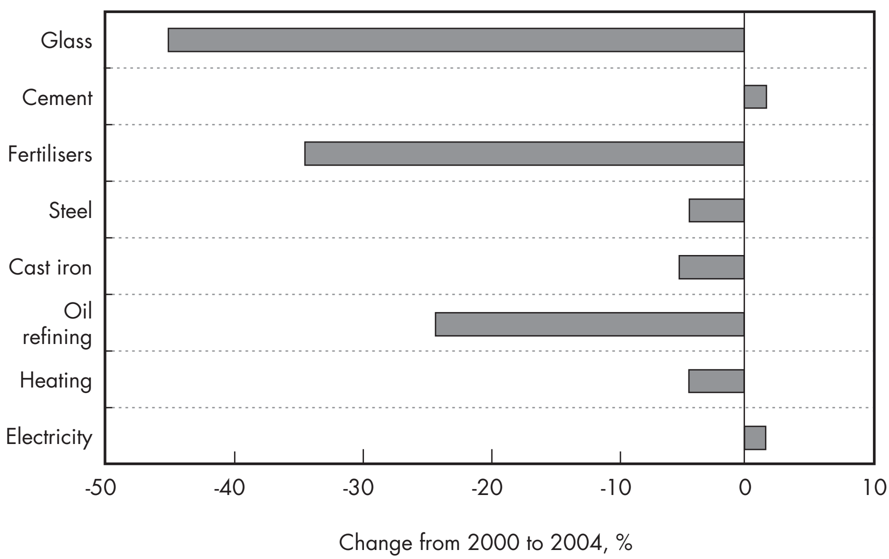
The impact of energy-efficiency improvements (as opposed to structural economic changes) is shown in Figure 4.4. From 2000-04, most energy-intensive industries significantly reduced the rate of energy use. For example, the glass industry used 45% less fuel to produce a unit of goods in

2004 than in 2000; fertiliser production required 35% less energy; and oil refining 25% less.

Reporting of the “shadow economy” may have played a partial role in the recent substantial decline in energy intensity. When economic activity is underreported, energy intensity appears higher than it is in reality. According to estimates produced by the Ukrainian State Statistics Committee and the International Monetary Fund (IMF), the share of the unreported economy dropped from 50% in the mid-1990s to 35% in 2002. The expansion of the reported portion of Ukraine’s economy may have resulted in some apparent reduction in energy intensity that did not take place in reality.

Figure 4.4

Fuel Consumption per Unit of Goods Produced in 2004, as Compared to the Level in 2000



Source: State Statistics Committee of Ukraine.

Given the strategic importance of the energy-efficiency agenda, it is unrealistic to expect the state or international institutions to pay for all energy-efficiency investments. To guarantee adequate financial support for energy-efficiency measures, it is very important to persuade consumers that reducing energy use is in their best business interest. This requires raising energy prices, among other things.

Policies for greater energy efficiency should not be considered in isolation but rather as a major component of national strategies for competitiveness, currency stability and the general well-being and prosperity of the population. For this reason, Ukraine's president, prime minister and government should give energy efficiency publicity and commitment at the highest level – and ensure that energy-efficiency policy is properly implemented.

Potential for Energy Efficiency

Ukraine has enormous potential for reducing its energy consumption. Successive government strategy documents have recognised this, but follow through has been problematic. The *Energy Strategy to 2030* calls for a more than 50% reduction in energy intensity by 2030. This would correspond to energy savings of 223 Mtoe, or slightly more than the planned energy consumption in 2030 as per the reference scenario in the *Energy Strategy to 2030*. Without greater energy efficiency, consumption would be twice as high in 2030. Another way to consider this is that the improvements in energy efficiency would lead to energy savings greater than the equivalent energy production of over 400 nuclear plants, each with a capacity of 1 000 MW.[5] This number is very large indeed, emphasising that the energy-efficiency potential in Ukraine is a tremendous resource even in global terms.

The government anticipated that 84 Mtoe, or 38%, of these savings would come from structural changes, as the economy shifts away from heavy industry to a more service-oriented GDP. An even larger share of the reduction would result from technological improvements (Figure 2.12 in Chapter 2: Energy Trends).

Structural changes foreseen in the *Energy Strategy to 2030* imply a substantial reduction of the industrial and agricultural share in Ukraine's GDP by 2030, and a corresponding increase in the service sector including housing and communal services, transport, and communication. Within industry, the government projects a particularly large decrease in some of the most energy-intensive sectors, such as ferrous metallurgy, energy, and chemicals.

These figures contrast sharply with the cost estimates for new energy production found in the Energy Strategy to 2030. According to the

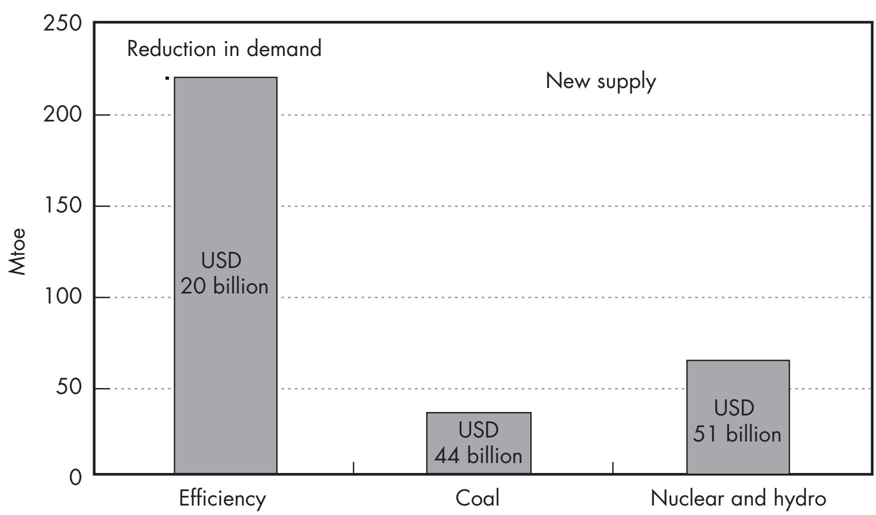
5. The savings will come from all types of energy, not just nuclear power. The purpose of this calculation is to make the savings more tangible and understandable. IEA converted the energy savings using the following methodology and assumptions. The 223 Mtoe of savings is equivalent to 2 593 490 GWh. IEA assumed transmission and distribution losses would be 10% on average. IEA also assumed that the capacity factor of the power plants would be 80%. These assumptions are in line with or more optimistic than actual Ukrainian practice over the past 15 years. For the purpose of this calculation, IEA also assumed that each nuclear power plant has a capacity of 1 000 MW. With these assumptions, the energy savings would offset the demand for the power of 407 nuclear power plants. With a capacity factor of 100%, the avoided capacity would still be equivalent to well over 300 nuclear power plants.

government projections, achieving the estimated energy savings of 223 Mtoe would cost UAH 102.3 billion (USD 20.5 billion), without considering the resulting cost savings (Figure 4.5). At the same time, increasing energy supply by 48% (with total supply of 212 Mtoe) will cost slightly more than UAH 1 trillion (USD 209 billion) in up-front costs. By comparison, Denmark and California both saw little to no increase in energy use from 1973-2003, largely because of strong and cost-effective energy-efficiency policies (despite substantial economic growth). Unlike Ukraine, both Denmark and California were relatively efficient when these policies began, which implies that the scope for limiting energy use is even greater in Ukraine.

Most OECD countries are already more efficient than Ukraine would be in 2030 according to the *Energy Strategy to 2030.* Thus, even greater improvements in Ukraine's energy intensity by 2030 seem both feasible and beneficial.

Figure 4.5

Investment Results: Investment Cost vs. Change in Energy Balance, 2005-2030



Source: IEA compilation based on the Energy Strategy to 2030 *(Cabinet of Ministers, 2006a).*

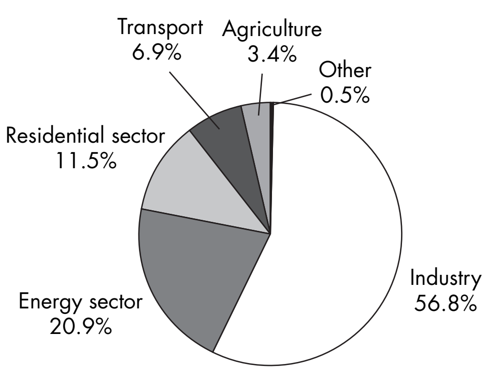
Ukraine's high energy intensity inspires policy makers to develop ambitious objectives for energy efficiency in the medium and long run. However, they do not adequately consider what concrete policy measures, resources and follow through will be required to achieve these objectives. The *Energy Strategy to 2030* relies heavily on projected structural shifts as a major driving force for energy intensity reductions. Achieving these structural shifts will require significantly raising energy prices. Moreover, the experience of Western countries suggests that sustained growth in energy efficiency depends on effective energy-efficiency policies and long-term technological improvements.

Although they are feasible, the scope of the technological changes necessary should not be underestimated; nor should one think they can be achieved quickly. One example is the dominance of open-hearth smelting in iron and steel – a technology that is virtually no longer used in developed countries.

An initiative known as the *Comprehensive State Programme on Energy Conservation* provides detailed energy-efficiency targets for the medium term. This programme estimates the energy-savings potential of Ukraine to be 42-48% of the 1990 demand (equivalent to about 100-120 Mtoe/year). This estimate is based on wider use of existing technology, not new technological improvements. About 21% of this total saving is to be found in the energy sector itself, 57% in industry, 11% in housing and communal services (utilities), and 7% in transport (Figure 4.6). The *Energy Strategy to 2030* also provides some sectoral estimates, but only for a small portion of the total savings involving technological investments unique to a given sector. By contrast, IEA assessments of potential energy savings in OECD Europe and in Russia show that the greatest savings potential is in the residential sector (IEA, 2004a). District heating in particular offers very large opportunities for energy-efficiency gains in Russia and other transition countries.

Figure 4.6

Structure of Energy-efficiency Potential



Source: Cabinet of Ministers, 1997.

Energy-efficiency Institutions

The mid-1990s saw several important steps in energy-efficiency policy. This included the creation of the State Committee for Energy Conservation in 1995, which co-ordinated government energy-efficiency policy. The Committee began as an independent government body, reporting to the Cabinet of Ministers, and was later subordinated to the Ministry of Economy. The president abolished this Committee by decree in 2005, instructing the Ministry of Fuel and Energy to assume responsibility for energy-efficiency policy in Ukraine. The decision was questioned by many energy-efficiency experts, who argued that, as a large owner of conventional energy assets, the Ministry could not be an effective advocate and manager of energy-efficiency programmes.

Pressure to improve energy efficiency mounted as Ukraine faced a sharp increase in energy import prices. In December 2005, the president signed a *Decree on Establishing the National Agency of Ukraine on Efficient Energy Use*, in order to make government policy on energy efficiency more effective. This Agency reports to the Cabinet of Ministers. As a government body with special status, the Agency is charged with:

- Carrying out state policy in the area of energy consumption and energy conservation.
- Securing an increase in the share of non-traditional and renewable energy production.
- Establishing a state system to monitor energy production, consumption, exports, and imports; improving the system of registering and controlling energy consumption.
- Ensuring the functionality of the system of industrial energy consumption norms.

The new Agency began operating in the spring of 2006. It has a chairman and has hired approximately 60 staff. It also has a substantial budget for energy efficiency projects on paper (UAH 600 million or USD 120 million). This is larger than the budget of the old State Committee for Energy Conservation. However, in the past, promised budget allocations for energy efficiency have not always arrived. To be effective, the Agency will need adequate funding, political clout and experienced personnel on an ongoing basis.

To date, the Agency on Efficient Energy Use seems to have worked very actively to develop and implement policies (see section Recent Policy Changes and Future Outlook). The Agency also has broader powers than the old State Committee; for example, it can participate in designing government tariff policies. The head of the Agency has proposed turning his Agency into an energy-efficiency ministry, which would give it a larger role in setting overall energy policies.

Several other government bodies are particularly important in implementing energy-efficiency policy. The government created the State Inspectorate for Energy Conservation in 1999 to oversee compliance with energy-efficiency regulations and standards. The Inspectorate establishes norms for energy use in industry according to product type, and then monitors manufacturers' compliance with these norms. (More on these energy norms is provided below.) It also conducts technical analyses and monitors compliance with building energy codes. It now reports to the National Agency on Efficient Energy Use. The Inspectorate has two city and 23 regional energy-efficiency inspectorates, with several hundred staff total (several times more than the Agency).

The Ministry of Construction, Architecture, Housing and Communal Services is also very active on energy-efficiency issues in district heating and buildings. It is making energy efficiency a major focus of its work, holding nationwide discussions on the topic and developing plans for a major energy-efficiency fund. Many regional governments also have energy-efficiency departments that have been quite active in promoting energy efficiency.

In addition to the state institutions, other organisations are also working on energy efficiency. Within Ukraine, there is now a strong base of expertise on energy efficiency. Several non-governmental organisations actively promote the principles of energy efficiency. The non-profit Agency for Rational Energy Use and Ecology (ARENA-ECO) is the oldest and largest of such organisations (Box 4.1). It is fair to say that these institutions and the former State Committee for Energy Conservation played a major role in the energy intensity improvements Ukraine has seen since 1995.

Box 4.1 Major Independent Organisations Working on Energy Efficiency

- **Private**

The **Agency for Rational Energy Use and Ecology** (ARENA-ECO) was founded in 1994 by the Pacific Northwest National Laboratory, the Ukrainian National Academy of Sciences and the World Wildlife Fund. It has a staff of 20 who promote sustainable economic development and environmental protection through energy-efficiency improvements in the energy, industrial, transport, utility, housing, agricultural and other sectors. ARENA-ECO has advised the government on policy and worked with energy users to help develop more than USD 270 million in financing for energy-efficiency improvements.

The **Alliance to Save Energy** is a US-based, non-governmental organisation with staff in Lviv and Kyiv, which began operating in Ukraine in 1997. The Alliance has worked with numerous cities to improve energy efficiency, including Lviv and Ivano-Frankivsk, and has led Ukrainian efforts under the USAID-funded Municipal Utility Network for Energy Efficiency.

The **International Centre for Policy Studies and the Ukrainian Centre for Economic and Legal Analysis** are private think tanks whose work includes economic and policy aspects of energy efficiency and district heating.

Several industry organisations also work on energy efficiency. Examples include the **Association of Ukrainian Housing Services Companies,** the **Association of Energy Service Companies** (working with local ESCOs), and the **Association of Industrialists and Entrepreneurs.** In addition, there are numerous local organisations that promote energy efficiency.

- **State**

UkrESCO was the first true Ukrainian energy service company; it started operating in 1999. UkrESCO implements energy-efficiency projects in industry and the municipal sector, using a loan facility from the European Bank for Reconstruction and Development. UkrESCO is state-owned, but the government has committed to privatise it.

Numerous state institutes focus on energy efficiency. The most comprehensive is the **Institute for Energy,** which used to be called the Institute of Energy Savings Problems. The National Technical University has an **Institute for Energy Saving and Energy Management,** which trains students and experts. The **Institute for Technical Heat Physics** has many experts working on energy efficiency in buildings and district heating systems. **KyivZNIIEP**, a civil engineering institute, has a Centre of Energy Saving that focuses on buildings. The **Gas Institute** primarily focuses on energy efficiency as well.

Policy Framework and Directions

The Ukrainian government created a legal framework for promoting energy efficiency quite early, compared to other post-Soviet states. In 1994, Parliament adopted the *Law on Energy Conservation*. This law defines institutional, regulatory and economic mechanisms for energy conservation, the role of technical analysis, and monitoring and standards for energy efficiency. According to the law, the state should stimulate energy efficiency by providing preferential financing for energy-saving projects and by approving tax privileges for renewable energy, as well as for energy-efficient equipment and materials. The law is mainly declarative in nature, so implementation has not always been smooth. Nonetheless, approval of this law played an important role in starting the policy debate and implementation.

In 1997, the government approved its first strategy for energy efficiency, called the *Comprehensive State Programme on Energy Conservation*. The programme covers the period to 2010 and is based on energy and economic growth forecasts. It identifies energy-efficiency potential in various sectors and lists specific technical measures to modernise existing production assets and implement new energy-efficiency technologies. For example, one of the measures in ferrous metallurgy is to reduce the waste of coke oven gas. Steel mills themselves are targeted to pay for the measure, but the programme places no obligations on them to do so. Because of poorly defined implementation mechanisms and the economic decline in the 1990s, the programme did not meet its energy-efficiency targets. The programme forecasted savings of 33 Mtoe in 1996-99; the actual figure was 11 Mtoe, or 34% of the planned volume.

As a result, the Cabinet of Ministers developed amendments to the comprehensive programme in 2000; the amendments are called *Additional Measures and Specified Indicators of the Comprehensive State Programme on Energy Conservation.*[6] The amendments took into account changes in GDP and energy consumption growth that occurred in 1996-99, re-estimating the energy-efficiency potential for 2000-10. The amendments also included a new initiative on energy-efficiency measures in state facilities.

The Ukrainian government is planning to develop a new comprehensive state programme on energy conservation for 2007-20. In recent statements, the government has indicated its desire to place particular emphasis on energy efficiency in industry, district heating and buildings. The head of the Agency

6. *Decree No. 1040, 27 June 2000.*

on Efficient Energy Use has also frequently mentioned the need to promote renewable and alternative energy sources. He is particularly interested in promoting synthesis gas, though based on experience in IEA countries, it is not clear that synthesis gas is the most cost-effective approach to reducing energy imports.

One of the key problems these programmes have faced is that there has been a vacuum of political will at the highest levels of decision making. This has made it difficult to push through the most important policy changes needed to improve energy efficiency, including tariff reform. Many of the government-wide policies were mainly declaratory in nature, with too little concrete action and funding, despite the best efforts of the Agency on Efficient Energy Use, the former State Committee for Energy Conservation and other targeted bodies. As a result, the incentive to use energy efficiently and to invest in energy-efficient technologies remains low and Ukraine remains a very energy intensive country. Market-oriented economic mechanisms for improving energy efficiency are essential; this includes both prices and energy-efficiency policies such as standards and labelling. In both cases, active, consistent follow through is obviously essential for the policies to be effective.

Normative Energy Use

The government has directed a large portion of energy-efficiency funding and human resources at defining and monitoring compliance with normative energy use. In fact, the 2001 *Amendments to the Ukrainian Code on Administrative Violations,* regarding energy-efficiency legislation violations, has become the main mechanism for regulating energy efficiency. This law defines the responsibilities of managers in enterprises and other organisations, both private and state, and introduces fines and administrative sanctions for non-compliance with energy-efficiency regulations. Because companies must meet prescribed energy consumption targets per unit of output, this approach can make it difficult for companies to respond to changing market conditions. It is not an approach to energy efficiency used widely in IEA countries. In Ukraine, the norms and fines seem to have made some companies resistant to energy efficiency because of the system's rigidity and potential for corruption.

Energy-efficiency standards and norms are also regulated by two decrees from the Cabinet of Ministers: *Decree on Procedure for Setting Norms for Energy Unit Costs* issued in 1997, and *Decree on Measures to Achieve Rational Use of Energy* in 2000. The latter establishes sanctions for companies exceeding unit cost allowances (norms). The National Agency on Efficient Energy Use is planning to raise the penalties under these norms and establish a system of energy passports (stating allowed energy use) for each industrial enterprise.

- **Energy Efficiency in State Institutions**

Under an initiative of the former State Committee for Energy Conservations, the Cabinet of Ministers approved a *Decree on Managing Energy Savings* in January 1996. This decree required government ministries and regional administrations to establish energy-saving departments. These departments, in turn, are responsible for increasing the effectiveness of activities to improve energy efficiency.

The budget sphere, as state institutions are collectively known, is of special concern to the government. A *Special Order of the President of Ukraine on the Measures to Reduce Energy Consumption by Budget Institutions, Organisations and Budget Enterprises* was issued in 1999, followed by several decrees of the Cabinet of Ministers on reducing energy consumption in the budget sphere and on the use of budget allocations for energy-efficiency projects.

The State Committee for Energy Conservation drew from the example of the US Federal Energy Management Program in developing this concept. The idea was that the government could significantly reduce its energy bill by investing in energy efficiency at its own facilities. The State Committee received government funding for these investments, and while it was not able to use ESCOs to multiply the effect of the funding (as in the US programme), it did take an innovative approach to financing. Specifically, the State Committee held competitions under which budget organisations (from municipalities to ministries) could apply for the funding. The budget organisations had to compete based on several criteria including their ability to provide co-financing, the amount of energy savings that would be achieved and the feasibility of the project. While the amount of funding the government allocated was relatively small, the programme appears to have achieved a great deal with what the resources it had available.

The National Agency on Efficient Energy Use is now proposing to allow state institutions to retain the money saved with energy-efficiency improvements. This would give these institutions a greater incentive to save energy, as they now lose any funding for energy that they do not spend, making it difficult to recover the cost of energy-efficiency investments.

Recent Policy Changes and Future Outlook

The recent price increase for natural gas imports inspired the Verkhovna Rada to adopt a number of legislative amendments relating to energy efficiency. In December 2005, the Verkhovna Rada amended the *Law on Energy Conservation*, adding new provisions for energy audits and new definitions of energy-efficient goods, technologies, equipments and projects.[7] In January 2005, the Verkhovna Rada adopted the first reading of amendments to the *Law on Electricity*, specifically regarding the introduction of "green energy tariffs".[8] The draft amendments, if enacted fully, would stimulate the use of renewable energy and the electricity produced at the small hydro power stations. A month later, the Verkhovna Rada passed the first reading of a separate bill on amendments to several existing laws; these amendments would create new mechanisms to stimulate energy efficiency.

Then in June 2006, the National Agency on Efficient Energy Use announced a proposal for a new law on energy efficiency; the proposal includes tax benefits for energy-efficiency investments in industry and zero-interest loans to finance energy-efficiency technologies. On 4 July 2006, the Ministry of Finance passed a decree to provide loans with favourable terms to companies investing in energy-efficient and renewable energy technologies. The decree specifies categories of technologies that are eligible under the programme, which includes industrial technologies that reduce energy consumption by at least 10%. Commercial banks will make the loans and the government will reimburse the interest.

In addition to the legislative improvements, the government has developed energy-efficiency programmes in key areas. In January 2006, the Ministry of Construction, Architecture, Housing and Communal Services prepared an energy-efficiency programme which, if successful, would reduce natural gas consumption in the residential sector by 15-20%. The programme envisages the modernisation and replacement of district heating systems as well as wide use of cogeneration technologies. The national gas monopoly, Naftogaz of Ukraine, has recently developed an energy-efficiency programme called *Own House* which foresees the replacement of old individual gas boilers by new energy-efficient ones. During the first stage of programme implementation, 200 000 boilers will be replaced. It is not yet clear whether these programmes will be fully funded, which has been an issue in the past.

7. It also adopted a Law on Combined Heat and Power and Waste Energy Potential and a Law on Heat Supply in 2005.
8. Under Ukrainian law, a bill must pass through three readings in the Verkhovna Rada before it is adopted. The president of Ukraine must also sign it before it can be officially promulgated.

Energy Efficiency in Buildings

Overall, information about energy use and efficiency in buildings is scarce and of poor quality. This is exacerbated by the lack of widespread metering. Currently less than 10% of residential buildings with district heating have heat meters. Gas meters are common in cities, but residential gas metering in villages is still problematic. The existing information on energy use is usually based on norms and does not necessarily reflect real consumption. Estimating potentials and identifying savings is, therefore, more demanding but not impossible.

The range of saving potentials in existing buildings varies widely, from 10% up to even 50% depending on the measures. The Ministry of Construction, Architecture, Housing and Communal Services estimates that it is possible to save up to 20% of current building energy consumption in the short run. With careful implementation, an average goal of 20-30% real annual savings in existing buildings is realistic, based on the few Ukrainian projects to date. Such estimates are corroborated by the results of Russian heating substation installations (15-30%), Lithuanian housing renovation projects (20-40%) and long-term savings in Helsinki (34% between 1973-2005). New buildings can be even more efficient as it is usually more cost-efficient to design for efficiency than to retrofit a building later.

Policy

Ukraine has standards for energy use in new buildings. The Ministry of Construction, Architecture, Housing and Communal Services is responsible for developing the building standards and overseeing their implementation, although the State Inspectorate for Energy Conservation actually inspects new buildings for compliance. The Agency on Efficient Energy Use can also influence the direction of policy on energy codes and it supports significantly improving the codes.

The content of the building standards has not changed radically regarding energy efficiency. Most of the changes were adopted from 1994-99 and addressed new issues such as building-level heating systems or air conditioning. The changes also included a new requirement to add temperature regulation (thermostats in buildings and controls at heat points), though it is not clear that this is being enforced. One important, more recent change was to allow architects to design buildings for higher indoor temperatures during the heating season. In the past, the design temperature was 18°C, and now the average is 22°C, which improves comfort and will also mean that buildings must be more efficient. A significant problem with all the building energy codes, according to Ukrainian building design experts, is that they are regularly ignored (KyivZNIIEP Energy Savings Centre, 2005).

Significantly, Ukraine adopted a draft new building code in 2006; the code is scheduled to enter into force in 2007. The new code represents a radical change in energy-efficiency requirements and approach. Previously, the code was prescriptive: architects and building designers had to use specific measures in each part of the building. Now the code will allow more flexibility by focusing on total building heat loss (or performance), as in most IEA countries. Box 4.2 describes the differences between performance-based and prescriptive codes. The new code will enhance energy efficiency and allow greater flexibility to building designers in meeting code requirements. The US Environmental Protection Agency and Department of Energy have funded technical assistance efforts to improve the building code and the efficiency of windows in Ukraine.

Clearly, building codes are important given the scale of construction going on in Ukraine. IEA member country experience has shown that building codes are a very cost-effective way of improving energy efficiency and lowering customer energy bills. At the same time, improvements must address both the level of efficiency and compliance.

Building ownership and management policies are also very important for energy efficiency. In Ukraine, building ownership is not always clear. Residents may own their apartments, but the municipality owns the communal spaces and the building envelope. In some cases, municipalities own the apartments as well (more details in Chapter 1). Heating bills are also split between the residents and municipalities (which subsidise district heating). These shared roles complicate decision and loan negotiations for energy-efficiency projects. Residents and municipalities also split the benefit of energy efficiency, so both have a smaller incentive to save than they would otherwise.

Box 4.2 New Approaches to Building Codes

Building codes primarily follow one of two approaches: they are either "prescriptive" or "performance-based". Most IEA countries have been moving toward performance-based building codes because of the benefits they provide in flexibility, reduced cost and increased efficiency. Ukraine is considering a similar move.

Prescriptive codes provide specific performance ranges for individual building components, such as windows or walls. They are simple to implement because they do not require detailed calculations or verification. Thus, the main advantage of prescriptive codes is that verifying compliance is quite straightforward. However, they can limit a building designer's ability to adapt to customer requirements, which can create incentives for poor compliance. They also may not improve energy efficiency as much and as cost-effectively as possible. For example, a long, narrow building with a large ratio of exterior walls as compared to the building volume will not necessarily be very efficient.

Performance-based codes rely on easy-to-use software for compliance. Building designers meet a single energy target based on the whole building, not each component of the building. The performance approach in codes allows developers to design buildings with greater creativity and expanded flexibility to optimise costs, while keeping energy performance equivalent to – or better than – what would be possible with prescriptive requirements. For example, a building designer could select larger windows, but would possibly need to install more roof insulation or more efficient windows to compensate. The software automatically calculates the losses of each option. The building inspector then just needs to check the software results, and compare the plan with construction.

Many codes also use a combination approach. For example, developers may be able to use a simplified prescriptive method if they want, but the overall stringency of the requirement would typically be higher. Alternatively, a code may have an overall performance based requirement, but developers may also need to also satisfy certain prescriptive measures.

Compliance with performance-based codes is typically as good as compliance with prescriptive codes when building inspectors and designers get basic training in the new approach. Russia, for example, has used performance-based codes for several years with good results. Under the directive On Energy Performance in Buildings, all members of the European Union must use performance-based requirements from 2006, although a few are delayed. Bulgaria, for example, has used a performance-based approach since 2005.

Building Stock and Integration with Heating Systems

Residential and public buildings are responsible for a considerable share of national energy consumption. Residential buildings alone consume more than 30% of the energy used in Ukraine; commercial and public services (which are often located in buildings) consume another 10% of the energy. Both of these sectors have seen their share in total energy use grow in the past decade. Overall, there is substantial potential to save energy in Ukrainian buildings, especially those connected to district heating. Regardless of the heating system, the potentials and relevant measures are similar.

● Appliances

Ukraine is experiencing a boom in electric appliances. Because of double-digit growth in real wages and incomes over the past six years in Ukraine, retail sales of some durables tripled or even quadrupled during this period. For example, sales of vacuum cleaners and washing machines increased by about five times from 2000-04; sales of refrigerators and televisions more than tripled over the same period. This trend of increasing use of appliances inevitably puts domestic electricity demand under high pressure. This trend should not be mistaken as a sign of inefficiency. However, if energy efficiency standards are not in place, it will increase the residential sector's energy consumption dramatically.

The appliance standards system in Ukraine is based on the *Law on Standardisation*, which was passed in 2001. Before this law came into effect, Ukraine had energy standards for boilers, heating and cooling systems based on old Soviet standards, which generally dealt with safety and technical issues rather than with energy efficiency.

The former State Committee for Energy Conservation first introduced energy-based appliance standards and labelling to Ukraine in a 2003 order on technical regulations of appliances. This document envisages adopting standards in Ukraine based on the EU appliance standard directive. Following this order, the State Committee developed and approved several standards. The standards are called DSTU, which stands for state standard of Ukraine. They now cover:

- Refrigerators and freezers.
- Washing machines and dryers.
- Dishwashers.

- Ovens.
- Water heaters.
- Lighting equipment.
- Air-conditioning units.

Each of these appliances must now bear a special label highlighting its class and energy-efficiency index; it must also meet a minimum energy performance standard. As they draw heavily from the EU standards, these standards seem to set a high level for appliance efficiency. Although they have been adopted, they are not being enforced. Enforcement is critical to making progress in appliance efficiency.

The former State Committee for Energy Conservation also developed energy-efficiency standards for other household appliances, but these standards have not yet been approved. The National Agency on Efficient Energy Use plans to reinvigorate this standards programme. Consulting with appliance manufacturers and other stakeholders in setting the standards may facilitate compliance.

Energy labelling is also reflected in the recent amendment to the *Law on Energy Conservation* adopted by the Verkhovna Rada in December 2005. Introduction of energy labelling for household electric appliances is defined as one of the principles of state policy on energy conservation (Article 3 of the law).

Energy Efficiency in Industry

Ukrainian industry is dominated by energy-intensive sectors, such as mining, metallurgy and chemicals, which negatively influences the country's energy intensity. Despite the severe industrial decline and corresponding fall in energy consumption in the 1990s, most energy-intensive industries experienced smaller declines in energy use than the economy as a whole,[9] as they were major contributors to GDP and state revenue, representing about a half of total Ukrainian exports. In certain manufacturing industries, energy intensity increased during the economic downturn because of large fixed energy use.

Policy

Ukrainian policy toward industrial energy efficiency focuses on four main points: normative regulation of energy use, energy audits, financing mechanisms and training. Normative regulation appears to be, by far, the

9. From 1990-99, the share of energy-intensive industries in gross industrial output rose from 27-60%.

most important in terms of human resources: the State Inspectorate for Energy Conservation has several hundred staff, a large share of whom focus on developing norms for energy use by sector and product. They then negotiate the application of these norms on a plant-by-plant basis and inspect plants for compliance. Manufacturers that exceed their allowed energy use per unit of output can be fined and the managers can face administrative sanctions. Industrial plants are, by and large, very opposed to this regulation. IEA countries do not take such mandatory normative approaches to production because it is difficult for regulators to adapt norms to changing market conditions. Thus, normative regulations may hinder manufacturers' competitiveness when demand falls temporarily and production facilities become relatively less efficient, or when a company needs to launch a new type of product (for example, more appealing bottles). Use of such inspectorates also creates significant opportunities for corruption.

The Inspectorate also conducts energy audits of plants. However, there is no obligation to implement the measures identified through the audits; financing can be an issue, particularly at state-owned companies that have difficulty providing collateral. The *Energy Strategy to 2030*, legislative amendments and energy-efficiency programmes that have recently been developed in Ukraine envisage broad use of norms and unit-cost allowances for the enterprises as the major tool for improving energy efficiency.

The government provides funding for energy-efficiency investments in state entities, which can include state-owned industrial facilities (this programme is described in more detail above). However, this funding by itself is not sufficient to address the full need for efficiency improvements in state facilities. The State Committee for Energy Conservation also created UkrESCO to finance projects in industry and other sectors (see Box 4.1).

The State Committee for Energy Conservation had a well-developed outreach programme with training, seminars and information on energy efficiency for industrial managers and workers. The outreach programme played a crucial role in promoting energy efficiency in the industrial sector of Ukraine. In 2004, about 200 seminars and 120 conferences on energy efficiency in industry took place in Ukraine. New energy-efficient technologies and energy-saving equipment have been exposed at 70 specialised exhibitions. In particular, more than 150 industrial enterprises unveiled new energy-saving equipment, heat-insulating materials, and metering and controls at the "Home and Office Construction" exhibition in Luhansk. It is not clear what will happen to this outreach programme in the future, though it is likely to continue under the Agency on Efficient Energy Use.

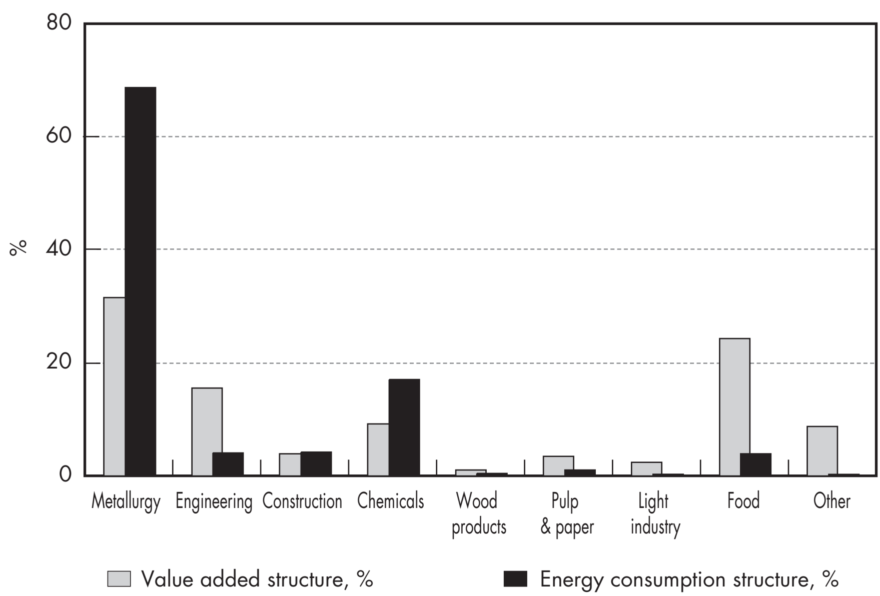
Industrial Energy Use and Intensity

In 2004 Ukrainian industry accounted for 40% of total final consumption of energy. Within manufacturing, energy use is concentrated in a few energy-intensive sectors, which account for a relatively small portion of total value added. The most energy-intensive sectors are metallurgy and chemicals: together, they account for about 86% of total industrial energy use, while their output constitutes only 40% of total industrial value added (Figure 4.7).

The ratio of energy consumed per tonne of industrial output is very high in Ukraine compared to other industrialised countries of the OECD. This is especially true in metallurgy. According to IEA and Ukrainian estimates, Ukraine consumes three times as much energy to produce one tonne of cast iron and twice as much to produce steel as the OECD European average. Ukraine produces over half of its steel in inefficient open-hearth furnaces. In fact, the share of open-hearth furnaces in Ukrainian iron production decreased only slightly, from 50-47%, between 1996 and 2004.[10] More modern electric arc furnaces represent less than 10% of Ukraine's steel production (compared to 40% in OECD Europe).

Figure 4.7

Industrial Energy Use and Value Added in Ukraine, 2000: Sub-sector Shares in Industrial Total



Source: State Statistics Committee of Ukraine.

10. For comparison, in energy-rich Russia, open-hearth furnaces accounts for one-third of the country's steel production.

The second most energy-inefficient industry – the chemicals sector – produces large amounts of energy-intensive ammonia and other fertilisers. Ukraine consumes three times as much electricity to produce one tonne of ammonia as the United States and about two times as much as Russia. The manufacture of ethylene and propylene is quite limited in Ukraine; still, the manufacturers that produce these materials use two to three times more energy per unit than such facilities in OECD countries.

After metallurgy and chemicals, one of the most energy-intensive processes in Ukraine is cement production. Cement is manufactured using an inefficient wet process, rather than a dry process. Ukraine consumes 70% more energy to produce one tonne of cement than OECD countries.

Industrial Energy-efficiency Outlook and Strategy

According to the *Energy Strategy to 2030*, the energy-efficiency potential in industry is enormous. Energy, metallurgy and chemicals are regarded as top priority sectors for implementing energy-efficiency measures. As their output is used by other economic sectors, improved energy efficiency and reduced cost in these sectors will have a significant impact on the national economy as a whole. Metallurgy is also very important because of its high share in exports (about 40%) and its contribution to state budget revenue.

Potential energy savings in the short term appear significant, based on audits of industrial plants conducted by the Ukrainian Agency for Rational Energy Use and Ecology, and the Pacific Northwest National Laboratory (USA). A number of enterprises have participated in this audit programme since 1997, investing millions of dollars of their own funds in recommended energy-efficiency measures (Box 4.4). As energy prices grew in the 1990s, some privatised industrial plants were able to pay their energy bills and finance energy-efficiency investments, and achieved remarkable returns.

Experience shows that as energy prices rise, energy savings in industry can reach 30-40% of current consumption; these numbers can be even higher when manufacturers introduce totally new production processes (as with modern steel technologies). Even at 2005 prices, most plants could cost-effectively improve efficiency by up to 20%; energy prices have risen significantly since then. Obviously, these gains require capital investments, but the savings provide ongoing and long-term financial benefits.

The *Energy Strategy to 2030* foresees the introduction of a number of new technologies and energy-efficient production processes in Ukrainian industry, including:

- Expanding the use of continuous steel casting, replacing open-hearth furnaces.
- Using more efficient gas compressor units on gas pipelines.
- Replacing wet cement production with the more efficient dry production process.

It is important that the government not select specific technologies; rather it should provide the right conditions to stimulate efficiency, and then allow industry to make its own decisions. Industrial companies will be paying for the improvements, after all. It should be noted that most energy intensity improvements in industry are undertaken for reasons that may not relate directly to energy savings; enterprises may be pursuing other objectives such as improved product quality and expanded output.

Simple, low-cost measures also hold much promise for improving efficiency. Among these are "good housekeeping" measures such as plugging leaks, maintaining equipment properly and switching off equipment when not in use. Quality training for staff is very important for such measures. Improved energy metering and controls for industrial end-users also offer great potential for energy savings, with relatively low capital requirements and quick payback times.

Steam production for industrial processes offers further opportunities for savings as it is one of the largest energy uses in industry. Steam is produced in inefficient boilers, which often could be converted to cogeneration units to improve fuel efficiency. Most industrial boilers also lack modern combustion control devices. Steam distribution systems can save energy with measures such as better insulation, steam traps and leak repair. Compressed air systems and lighting are two other standard sources of significant energy savings.

Ukraine's energy service companies, in particular UkrESCO, have also done much work to improve energy efficiency in industry by conducting audits and financing improvements.

Energy Efficiency in the Transport Sector

The share of the transport sector in Ukrainian energy consumption is small (15% in 2004) compared with that in the OECD area (34%).

According to official data, the structure of the transport sector has not changed considerably since 1990 and remains relatively energy efficient (Tables 4.1 and 4.2). Rail transportation dominates, representing about half of total freight turnover in Ukraine and about 40% of passenger turnover.

The share of relatively energy-efficient pipeline transport has doubled since 1990 at the expense of sea transportation. Road transport accounts for only 6% of total freight turnover in Ukraine.

However, the data do not seem to adequately capture the growing use of private cars. Data on car registrations and traffic congestion in major cities make it clear that private car use has grown considerably. In 2005, for the first time, the share of automobile passenger turnover (in billion passenger kilometres) exceeded the share of rail transportation in official data. In terms of total trips, cars and buses greatly exceed rail, but car and bus trips tend to be shorter than rail trips.

The government has implemented some measures to limit the increase in road traffic, namely high excise taxes on fuels and investments in rail and public transport systems. However, the major factor that explains the significant dominance of rail over the road transportation is the very low tariffs for rail transportation. While prices for gasoline and diesel have nearly reached world-market levels in Ukraine, tariffs for rail transport remain subsidised. Road construction is also subsidised.

It is worth noting that, in the late 1980s, Ukraine's transportation system was relatively energy efficient, featuring a high share of public transportation and a low level of car ownership. The economic transition has spurred the demand for private cars. From 1990-2004, car ownership increased from 3.3 million (63 per 1 000 residents) to 5.1 million (108 per 1 000 residents). The market is still far from saturation, car ownership being only about 1/3 of the per capita level found in Western Europe. This reflects a low base of comparison that dates back to the Soviet period, when car ownership per capita stood at only 25-40% of Eastern European levels and 15-20% of Western European levels. Despite strong growth in real wages and incomes over the past six years, monthly wages still only average around UAH 1 060 (USD 211). As a result, new cars remain a luxury item for much of the population; the vast majority of cars on the road are more than eight years old.

Soviet-era cars are now being replaced by more energy-efficient Western-style cars. Government policy has played a role in this by providing numerous monetary incentives to promote domestic automotive manufacturers (including those who assemble Western-style cars in Ukraine) and imposing restrictions on used car imports. Customs officials charge a duty of 20% on imports of used cars less than five years old, and 30% for cars five to eight years old. The government has banned imports of cars more than eight years old; in mid-2004, it also banned imports of trucks and buses more than five years old.

Table 4.1

Breakdown of Total Freight Turnover, 1990-2004 (%)

	1990	1995	2004
Rail	46.0	36.0	49.0
Road	8.0	6.0	6.0
Pipeline	20.0	34.0	41.9
Sea	25.0	23.0	2.0
River	1.0	1.0	1.0
Air	0.0	0.0	0.1
Total	**100.0**	**100.0**	**100.0**

Source: State Statistics Committee of Ukraine.

Table 4.2

Breakdown of Total Passenger Turnover, 1990-2004 (%)

	1990	1995	2004
Rail	34.0	53.0	40.0
Road	41.0	29.0	37.0
Trams	6.0	4.5	5.0
Trolleybuses	9.0	7.3	8.6
Metro	2.0	3.0	5.0
Sea	0.5	0.4	0.1
River	0.3	0.1	0.0
Air	7.2	2.7	4.3
Total	**100.0**	**100.0**	**100.0**

Source: State Statistics Committee of Ukraine.

To the extent that commercial transportation becomes private and the share of private cars increases, fuel-price incentives become more effective and lead to improved efficiency. This will not reverse the trend towards increased demand for transport fuel, but it is likely to slow it down. On the other hand, because Western-style cars tend to be more efficient than Soviet-era cars, increasing the share of Western-style cars in car purchases would lead to greater energy efficiency. In any case, the number of cars per capita has grown dramatically since 1991 and is likely to grow far faster than efficiencies can increase.

Other forms of transportation are also becoming more efficient. For example, the Ukrainian national railway, Ukrzaliznytsia, has announced plans to invest UAH 30 million (USD 6 million) in energy-efficiency improvements starting in 2005. The company began investing in energy efficiency in 1997, but this new programme marks an important expansion of that initial effort. Energy made up almost 20% of Ukrzaliznytsia's costs in 2005, even with low energy prices. In 2007, the company will also begin a major programme to electrify Ukraine's railways. Airplanes as well have become more efficient on average as more and more Ukrainian airlines use Western-built aircraft. Although electric buses are not new to Ukraine, some cities have started buying more efficient electric buses.

Efficiency in Energy Transformation

The share of energy consumed during transformation is very high in Ukraine, in part because of the high share of district heating and metallurgy in overall energy consumption. According to the State Statistics Committee of Ukraine, energy transformation accounted for 58% of total fossil fuel consumption in 2004. Compared to OECD averages, in 2004 Ukraine consumed 14% more energy to produce each kWh of electricity, and Ukrainian district heating is comparatively even less efficient. This can be attributed to old technology, low use of combined heat and power, poor-quality coal (an important fuel in the power sector), and the very low load factor of Ukrainian thermal power stations (28% in 2004 compared to 70% in 1990). Moreover, the losses during electricity transmission and distribution currently amount to about 15% (8% in 1990) compared to 6% in the OECD.

• Power

Most thermal power stations in Ukraine have already exceeded their useful life. In 2004, the average age of large thermal power blocks was 36 years; the average age of large cogeneration plants was 42 years.

The *Energy Strategy to 2030* envisages significant energy-efficiency improvements in the energy sector by modernising thermal power units and decreasing energy losses. Improvements in energy transformation would include efforts to:

- Modernise and replace worn-out equipment in the energy sector.
- Install automated metering systems for better accounting of energy consumption.
- Expand use of new technologies for electricity generation.

- Introduce combined heat and power generation, which offers efficiencies of 80-90%.
- Reduce electricity transmission losses to 9-12%.

Cogeneration

Cogeneration is the combined production of heat and electricity; it typically results in much greater efficiency because the “waste” heat is reused for industrial processes or district heating. In fact, cogeneration typically saves at least 30% compared to separate production of electricity and heat. Ukraine currently has a very low share of cogeneration in its heat production. In principle, Ukraine’s large district heating load creates a favourable market environment for cogeneration. However, because there is so much excess power capacity at present, new cogeneration facilities need to be planned carefully. The existing thermal power plants and boiler houses are typically very old and outdated. Thus, as these facilities are replaced, cogeneration offers an opportunity to significantly improve efficiency.

District Heating

District heating systems account for 45% of Ukrainian natural gas consumption; the energy-efficiency potential in this sector is enormous. Energy consumption for heating Ukrainian buildings is two times higher than in OECD Europe. Residential energy consumption, in which district heating accounts for at least one-quarter of the energy consumed, amounted to 29% of total final consumption in 2004. Most district heating distribution networks are outdated and poorly insulated, with losses of up to 30%. In addition, poorly insulated buildings lose about 30-50% of the heat delivered. The Ministry of Construction, Architecture, Housing and Communal Services had announced plans to launch an innovative UAH 750 million (USD 150 million) investment fund for energy efficiency in district heating and buildings, but these plans now seem in doubt. This is concerning because it indicates that even with the high-level attention to energy efficiency in 2006, follow through with commitments is still problematic.

Organisational measures are crucial to improving efficiency in district heating. Cost-reflective prices would provide stronger incentives for energy consumers. The challenge in Ukraine is not developing new technical approaches; these are well-known. Rather it is putting known solutions into practice. Obstacles to success can be addressed through a more effective legal environment, policy and institutional reforms and improved public awareness. NGOs, private companies and government authorities have undertaken some efforts to improve district heating systems, often with the assistance of international donors.

It is critical to consider the entire energy chain, from production to end use. This is true both in designing good policy and in improving energy efficiency in individual systems. End use must be taken fully into account and regularly monitored. Each element of the chain – end use, distribution, transmission and production – can then be separately investigated and planned, making it possible to optimise the system through investments, operation, network dimensioning, production systems, the fuel mix and maintenance. At the same time, efficiency goals and measures can be set and implemented for each part. Specific performance indicators are useful for evaluating, implementing and monitoring of measures.

There is a huge overall efficiency potential in Ukrainian district heating. There is also a huge need for investment so improving the sector as a whole will take time and money. But letting it slowly collapse is probably even more expensive.

Oil Refineries and Coke Production

Energy intensity is also very high in oil refining. The two major reasons for this are underutilisation of the installed capacity at the country's six refineries, as well as the worn-out, outdated technologies still in use. The total installed refinery capacity substantially exceeds the demand. In 2004, the six refineries used only 40% of their capacity.

As described in Chapter 5: Natural Gas and Oil, Ukrainian refinery output is characterised by high yields of heavy fuel oil and low yields of high-value light products. The share of light products and lubricants remains very low at 65%, compared with 85-90% in Western Europe. The current product mix does not reflect consumer demand in Ukraine. All six refineries were built during the Soviet era and were oriented toward producing fuel oil to be used at Ukrainian power plants and in agriculture.

Coke production also tends to be quite inefficient in Ukraine, partly because of lost opportunities to use waste gases and heat, and partly because the installations themselves tend to have inefficient ovens, leaky steam systems and other sources of energy waste. Most of the coking plants are located at steel mills, though some are not, which makes re-using waste gases even more problematic because coke gas cannot be transported easily.

Regional and Municipal Policies

Under an initiative of the State Committee for Energy Conservation, each regional administration established a department for energy saving. These departments usually focus on:

- Managing energy-efficiency activities at the regional and municipal levels by establishing and co-ordinating the corresponding departments in municipal administrations.
- Monitoring energy consumption within the region.
- Identifying the top priority energy-efficiency measures.
- Comparing actual energy consumption with the established norms.
- Ensuring realisation of energy-saving programmes at the regional and municipal levels.
- Providing information support for energy-efficiency activities.
- Organising training for local staff who deal with energy efficiency.

In accordance with methodological guidelines established by the State Committee for Energy Conservation, almost all the regions of Ukraine have developed comprehensive energy-conservation programmes. The programmes usually contain two main sections. The first is data and analysis of the current situation and a forecast to 2010 of regional energy consumption with consideration of the energy-efficiency potential. The second is a list of energy-saving measures in all sectors, including the budgetary sphere, as well as potential sources of funding.

At the municipal level, energy-saving programmes are less common. Some city administrations do not have energy-saving departments at all. The lack of municipal programmes is compensated by regional programmes that consider measures for implementation in the cities.

Regional departments play a crucial role in raising public awareness of energy efficiency, providing information support for local enterprises and budget organisations as well as training the local energy managers. Some regions have a well-developed system of education centres that raise the level of energy-efficiency skills. For example, since 2003, the Rivne regional administration has held one-day training courses on energy efficiency, which are open to all civil servants and to directors of budget organisations or state-owned companies. In addition, Rivne Region schools and colleges teach a new course called the “Basics of Energy Efficiency”.

Each region hosts a number of energy-related exhibitions that promote energy efficiency and renewable energy. Most regions organise a special event every year called “Energy-efficiency Week”, during which energy-efficiency principles are disseminated through the press and TV. During the Rivne Region's 2004 Energy-efficiency Week, about 24 TV programmes, 210 radio speeches and 322 newspaper articles were devoted to energy-efficiency issues in the region. Two consulting centres and two magazines provide ongoing informational support on energy efficiency. Non-governmental organisations also play a role in disseminating energy-saving measures. Local NGOs (the Eco-club and the Rivne Media Club) promote energy-efficient behaviour and practical measures to improve energy efficiency such as weatherisation and metering.

Many energy-efficiency initiatives developed at the municipal level are implemented by NGOs or private firms, often with international support. An example is the Lviv Boarding School Pilot Project, undertaken by the Alliance to Save Energy (Box 4.3).

Box 4.3 Lviv Boarding School Pilot Project

As part of its Lviv Municipal Energy-efficiency Initiative, the Alliance to Save Energy and city officials selected the Lviv Boarding School for Children with Cardiovascular Disease as a demonstration site for energy efficiency. In particular, they wanted to show the effectiveness of a state-of-the-art control system for district heating and low-cost weatherisation techniques.

During Phase I of the project, the new control system reduced energy use by 26%. Phase II added temperature setback features in the evenings and on weekends. This not only increased savings, but also raised comfort levels by heating the building more evenly.

The Education and Engineering Department of the City Administration and the district heating company co-operated closely with the Alliance in implementing the project. The private sector also participated by providing training in weatherisation techniques to representatives of five small enterprises, who then weatherised the school.

The combination of Phases I and II, plus weatherisation, generated total energy savings of approximately 45-50%. This impressive result prompted a high level of interest among city officials, who were quick to recognise that energy efficiency represents a practical way to relieve the burden on the local budgets – without lowering the quality of municipal services.

Source: Alliance to Save Energy website: www.ase.org.

Many cities in Ukraine devote one-third or more of their budgets to pay for energy bills; often the bulk of that money is used to pay heat subsidies. An analysis of pilot energy-saving projects in Ukraine demonstrates that cities have a financial incentive to improve energy efficiency in housing: it lowers subsidies and saves the cities money.

A study of residential buildings before and after the installation of metering equipment showed a 12-57% reduction in subsidy payments once metering was in place. The meters created this effect by providing an incentive for building managers to reduce heat use. In turn, the housing blocks saved money as they were no longer charged for heat distribution losses (Alliance to Save Energy, 2006).

The former State Committee for Energy Conservation introduced a competitive rating system among the regional administrations to encourage local energy-efficiency efforts. Each region received a rating based on its level of activity in areas such as reducing energy intensity, raising funds for energy-efficiency measures, installing metering devices, implementing regional energy-conservation programmes and preparing full reports on energy efficiency. Tables with these indicators and final competition results were posted on the internet.

Investment in Energy Efficiency

Financing is crucial to the government's targets on energy savings. Private capital is particularly important because state budget funds are limited. The role of government is thus less one of financier and more one of champion, creating the right conditions. This requires cost-reflective energy pricing, but also policy stimuli such as standards and information campaigns.

According to the State Committee for Energy Conservation, total investments in energy efficiency increased substantially, from USD 193 million to USD 249 million from 2002-04 (Table 4.3). Funds from enterprises accounted for 60-70% of these investments. Other sources of private financing such as bank loans and foreign investments also play a significant role (15-20%). Local budget financing has been growing, although budget financing at the national level has been very small to date.

It is important to note that Table 4.3 probably underestimates the level of private investment for two reasons. First, there is a lack of centralised statistics on such investment. Second, many investments may improve energy efficiency but their main purpose is to improve comfort or product quality, thus it is hard to capture such investments in surveys.

Table 4.3

Investments in Energy Efficiency (USD million)

	2002	2003	2004
Enterprises funds	142.7	204.0	154.2
Loans, foreign investments	36.1	63.6	40.9
Local budgets	13.9	21.8	52.5
State budget	0.3	1.3	1.2
Total investments	**193.0**	**290.7**	**248.8**

Source: State Committee for Energy Conservation.

While previous drafts of the *Energy Strategy to 2030* provided specific ideas on how to attract financing for energy efficiency (for example, tax privileges and steps to encourage energy suppliers to invest in end-use efficiency), the final version of the document provides more generic financing categories with less detail on mechanisms. However, mechanisms are important to successfully implement energy-efficiency policy goals. Some common mechanisms in IEA countries include: tax benefits and subsidised interest rates for energy-efficiency investments, and rules to promote performance contracting and utility-sponsored investments in customer efficiency.

In recent years, Ukrainian state budget investments in energy efficiency accounted for only 0.01% of total budget spending; in local budgets the figure is higher but still only 0.7%. As a result, total budget investments in energy efficiency in Ukraine amount to only UAH 5 (USD 1) per capita in 2004, though state funding for efficiency may rise in the future. By contrast, state budget subsides for energy production are orders of magnitude higher than this, which is the crux of the problem.[11]

• Commercial Financing

Commercial financing will likely remain the most important source of investment in energy efficiency. In most cases, the best sources of commercial financing are internal corporate resources. Energy-efficiency projects can start small: companies that establish a good track record with small energy-efficiency projects are more likely to attract investment for larger modernisation projects. It is rare to see a bank or other external investor pay for 100% of a project. Instead, most projects acquire financing

11. In the coal sector alone, the government spent UAH 8.2 billion (USD 1.6 billion) in 2005 on coal subsidies, capital investments, mine closure and worker safety. This equals approximately UAH 170 (USD 33) per capita.

from a variety of sources, including internal funds, commercial banks, investment funds and strategic investors. Box 4.4 provides examples of industrial energy-efficiency investments.

Box 4.4 Examples of Industrial Investments in Energy Efficiency

Avdiivka Coke-Chemical Plant

Invested USD 400 000 in new energy-efficient lighting system, steam pipeline modernisation and controls for the compressed air system. The steam measures had an internal rate of return of more than 1 000%. Plant management has also approved a plan to build a new waste gas-fired cogeneration system with a total capacity 15 MW.

Hostomel Glass Plant

The plant implemented a series of energy-efficiency and modernisation projects including installation of a new glass furnace, heat recovery boilers, efficient compressors and other energy-efficiency equipment. The total value of these investments is more than USD 24 million, financed from the plant itself, EBRD, UkrESCO and other sources.

Zaporizhya Ferro-Alloy Plant

Following an audit, the enterprise invested USD 170 000 in energy efficiency; it intends to invest an additional USD 2.9 million for measures that will result in annual energy savings of 40 million kWh (3% of the current consumption) and 11% of current gas consumption. The measures include upgrading the steam-condensing system and installation of modern boilers. The annual cost savings are estimated at USD 1.6 million.

Rosich Food Processing Plant

Rosich installed steam traps and a steam recovery system, and eliminated air inflow in gas ducts at a cost of USD 10 300 from its own sources. It has since seen annual energy cost savings of almost USD 23 000.

Donetsk Metallurgy Plant

The project involves installing a combined heat and power unit to use low-quality steam, and other measures for efficient utilisation of waste blast-furnace and coke gas. Annually, the measures will save 215 million kWh (35% of current consumption), 61 000 Gcal of heat (10% of current consumption), and 9 Mtoe of gaseous fuel (13% of current consumption). The annual cost savings are estimated at USD 37 million. The company is implementing the project in phases.

Sources: Agency for Rational Energy Use and Ecology (ARENA-ECO); Pacific Northwest National Laboratory.

Some Ukrainian commercial banks already offer commercial loans to their best industrial customers; however, local banks tend to have a poor knowledge of the energy-efficiency market. In countries such as the Czech Republic and Hungary, governments and NGOs have worked with commercial banks to help them understand how to assess loans for energy-efficiency projects, and to demonstrate the large potential of this market. Some international banks in Ukraine have expressed an interest in tapping this market, particularly given rising industrial energy prices. Multilateral banks are also very active, as are a few foreign investment funds.

Major modernisation projects usually require access to capital markets or strategic investors. A good example of this is Mittal Steel Krivoy Rog, which sees energy-efficiency upgrades and modernisation at its Ukrainian plant as a major opportunity for profit. Mittal purchased Kryvorizhstal in 2005 in the largest privatisation sale to date in Ukraine. It plans to invest hundreds of millions of dollars in energy efficiency and plant modernisation.

Commercial financing is also very common in the residential sector. No detailed estimates exist for residential energy-efficiency investments paid for by residents or housing service companies, but anecdotal evidence indicates such investments are probably well more than UAH 500 million (USD 100 million) annually. This includes activities such as installing efficient windows, adding insulation, and upgrading to more efficient refrigerators.

Government Financing

While there is clearly an imbalance in the government funding for energy efficiency versus new energy supply, the government cannot – and should not be expected to – pay for all investments. As noted above, the government's main role should be in creating the right investment conditions.

That said, there is also a place for targeted government financing for energy efficiency. Such funding will have the most impact if it leverages additional financing and stimulates private sector investment. Loan guarantees and reduced interest rates are techniques to leverage additional financing, and can fill an important gap while the private sector is still unsure of how to assess the risks. As government funding will always be limited, it is important to target it. Investing in state-owned facilities, such as schools and hospitals, is wise because it will reduce future government spending on energy. The same is true for investments in energy efficiency in low-income housing. Even in these sectors, well-planned investments may be able to leverage private financing, for example, from energy service companies.

The government of Ukraine allocated financing for energy-efficiency measures for the first time in 2001. Planned budget investments amounted to UAH 25 million (USD 5 million) in the form of grants. Unfortunately, only 30% of this amount was, in fact, financed that year. This has been a problem every year since; Table 4.3 reflects actual expenditures. In 2006, the state budget includes over UAH 1.5 billion (USD 300 million) for energy-efficiency loans and related programs, but because of the parliamentary crisis, it was not clear when and if the funds might be released. If this money is made available in full, it would represent a significant increase in energy-efficiency funding.[12] At the same time, the 2006 case of the cancelled plans for an energy-efficiency investment fund illustrates that the old trend may continue (see the District Heating section above for more details). This type of unplanned reduction in outlays can create major problems for project developers, actually delaying projects rather than facilitating them. Only high-level support can solve this problem, which is essentially one of priorities and planning.

To date, regional budgets have provided most of the government energy-efficiency financing. Dnipropetrovsk Region provides one example of the growing regional interest in financing energy-efficiency projects. As the second largest region for energy consumption, it consumes a large share of energy in Ukraine. In 2006, the region announced that it had allocated UAH 236 million (USD 47 million) for energy efficiency. The regional administration says the investments are part of a regional plan to reduce gas use by 45% and total energy use by 18% by 2010 (ARENA-ECO, 2006).

• Partnering for Financing

Most projects have multiple financing sources. This can be true for both public and private sector projects. For example, the Lutsk City Administration launched the programme “Light for Each Street”. The programme ultimately

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12. According to the head of the National Agency on Efficient Energy Use, several budget line items related to energy efficiency in 2006: UAH 1 billion (USD 200 million) for measures to reduce losses in municipal district heating production, distribution and use; UAH 250 million (USD 50 million) in privatisation revenue for energy-efficiency investments in various sectors; UAH 384 million (USD 77 million) for low-interest loans to finance energy-efficiency and renewable energy investments.

obtained UAH 35 million (USD 6.7 million) in financing from the state and local budgets, and from the private sector.

In 2003, the Western NIS Enterprise Fund (a US-sponsored fund), along with the Hostomel Glass Plant (Ukraine's largest glass producer) and Turbo-Spektr (a Kharkiv engineering company), jointly set up a new private energy service company called Energy Alliance. Energy Alliance provides cogeneration systems to local companies that want to improve their energy efficiency. It finances the purchase, installation and service of power generation equipment that is designed to substantially reduce the energy costs for manufactured goods. Energy Alliance principally targets medium-sized, financially robust companies in energy intensive industries such as pulp and paper, petrochemicals, and oil refining. In February 2004, Energy Alliance received an EBRD line of credit worth USD 10 million, thus strengthening its ability to respond to growing local demand for energy-saving technologies.[13]

Energy Service Companies

Ukraine has successfully applied Western experience through its own energy service companies (ESCOs), which offer a wide range of energy-saving projects and, in some cases, provide financing as well. ESCOs finance projects on their own and/or by attracting bank loans or other third-party financing. Energy performance contracting, the contract approach usually used by Western ESCOs, is very attractive for Ukrainian companies that lack working capital or are restricted in borrowing. However, the legal basis for energy performance contracting is weak in Ukraine: ESCOs cannot be assured payment if the re-payment is conditional on energy savings.

In 1998, the EBRD issued a sovereign loan of USD 30 million to establish UkrESCO; this financing pool was recently expanded by USD 20 million. The aim of UkrESCO is to identify and implement energy-efficiency investments in small- and medium-sized enterprises and in public sector institutions in Ukraine. UkrESCO finances projects in several sectors including petrochemicals, glass, food processing and power, as well as in the residential and district heating sectors. Since 1998, UkrESCO has financed a total of 16 projects. For example, UkrESCO built a 2 MW combined heat and power plant for the Vozko tannery. At the Shostka Dairy Plant, UkrESCO reconstructed the heat supply system both for industrial and residential heat.

In addition to UkrESCO, several other companies include the word "ESCO" in their names. Several regional ESCOs are members of Ukraine's

13. Western NIS Enterprise Fund website: www.westnisefk.com.

Energy Service Companies Association. Other Ukrainian companies and organisations that offer energy-saving services include ARENA-ECO, Aqua-Ukraine, the Alliance to Save Energy and the Ukrainian Centre for Clean Technologies.

Ukrainian legislation could be updated to more easily promote ESCO-type services. The legislation would need to clearly allow companies to receive payment from future savings. Current legislation often requires ESCOs to use standard loan or lease agreements, which may not provide the customer the security of true energy performance contracting.

Multilateral Banks, Technical Assistance and the Kyoto Protocol

In addition to the ESCO projects, EBRD and the World Bank are preparing a number of large energy projects in several regions of Ukraine. EBRD will help finance the energy-efficiency improvements at Mittal Steel Krivoy Rog. In Lviv and Dnipropetrovsk, EBRD is preparing two projects on district heating improvements worth, respectively, USD 20 million and USD 36 million. In Kyiv, EBRD plans to support the modernisation of Kyivenergo's heat supply and distribution facilities (USD 91 million). EBRD is also planning to make USD 100 million available in credit lines for industrial energy-efficiency projects; it will set up the credit line facilities with local banks, who can then lend the money to industrial enterprises. The World Bank has also recently announced plans to invest some USD 200 million in energy efficiency in Ukraine.

Western governments have also provided considerable technical assistance. For example, the European Union's TACIS[14] programme provided the equivalent of USD 10 million for energy efficiency; assistance from the United States was about two to three times as large. Some of these were related to efforts to offset the power generated at Chornobyl, others were part of separate assistance programmes. In total, these programmes directly reduced energy demand by the equivalent of hundreds of megawatts of power capacity.

Examples of these technical assistance efforts in Ukraine include the following: *Industrial Energy Efficiency in Ukraine* and *Kyiv Institutional Building Assessment* (financed by the US Department of Energy), *Climate Change Mitigation in Ukraine through Energy Efficiency in Municipal District Heating*, *Pilot Project in Rivne* (organised by the UN Development Programme), *Municipal Network for Energy Efficiency* (US Agency for

14. TACIS stands for Technical Assistance in the Commonwealth of Independent States.

International Development), and *Municipal Energy Management Project* (Eurasia Foundation).

Kyoto Protocol mechanisms, such as joint implementation, have the potential to attract substantial investments in energy efficiency (see Chapter 3: Energy and Environment for more details).

Critique

Ukraine has made important progress on energy efficiency since the mid-1990s. In particular, it has adopted a *Law on Energy Savings* and issued energy standards for appliances and regulations that promote efficient transportation. It made significant institutional progress with the creation of the State Committee for Energy Conservation and, more recently, the creation of the National Agency on Efficient Energy Use. Ukraine also has a solid institutional basis for energy efficiency, as evidenced by the current depth of its energy-efficiency community. Numerous state and private organisations promote energy efficiency in business, policy or research. As a result of these achievements, Ukraine saw its energy intensity drop significantly after 1995. This highlights the importance of strong energy-efficiency policy.

However, high-level support for efficiency has not always been consistent. Because of this and the fact that Ukraine started from such a high base of intensity, it still has one of the most energy-intensive economies in the world. This is unsustainable, particularly because Ukraine imports the majority of its energy. High energy intensity limits Ukraine's international competitiveness and economic development. Sharply rising energy costs can derail economic growth in Ukraine because of energy's large role in GDP.

This high energy intensity is not just a shortcoming; it is also a tremendous opportunity to improve Ukraine's energy security in the future. In fact, it is fair to say that energy efficiency offers the single best opportunity for Ukraine to reduce energy imports and improve security. In addition, it can do this while promoting economic growth and competitiveness.

The new National Agency on Efficient Energy Use is a welcome development, particularly if it leads to urgent and sustained policy action. Because the new Agency is receiving a very high level support, it has an opportunity to take bold steps to encourage energy efficiency in Ukraine. Clear national strategies and policies – and consistent government measures to support them – are important.

Raising energy prices to reflect their full, long-term economic cost is essential for Ukraine to achieve its energy-efficiency goals. The Ukrainian government should be commended for its actions to raise natural gas and electricity tariffs in 2006 and its plans to make tariffs for all consumer groups fully cost reflective by mid-2008. Higher prices will give energy consumers a better understanding of what their energy consumption is worth to the economy as a whole, and hence, a stronger incentive to use energy wisely. Higher energy prices also mean that more energy-efficiency measures will be cost effective. Raising prices is never easy, but coupling price increases with clear and strong policies to promote energy efficiency should help ease the economic and social pain. Targeted welfare support is a more effective way of helping the poor than subsidising energy prices for all consumers.

Metering is also important for energy efficiency because it allows users to benefit financially when they save energy. Without metering, there is no incentive to save energy. Metering should be required in every building and facility that uses energy.

IEA member country experience has shown that energy-efficiency policies can have a clear impact on energy use. Energy standards, labelling and information campaigns boost energy efficiency, usually at very little cost to the government. Such efforts also create lower net costs for energy consumers. Standards should be focused on specific energy uses (such as buildings, lighting, refrigerators and motors), rather than on normative energy use per unit of industrial output. For example, before a manufacturer or importer could sell a refrigerator in Ukraine, it would have to prove that its refrigerator meets the standard for energy use, based on its size and class. In addition, clear labels help consumers understand the benefits of more efficient products. Ukraine has made important first steps in developing such standards and labelling requirements for certain types of appliances, but these new standards need to be enforced. Additional standards covering a broader range of appliances are also necessary.

To date, much of Ukraine's experience with norms and standards has focused on economic outputs: energy use per tonne of rolled steel, for example. Such norms cannot compensate for distorted tariff policies. Moreover, these norms are difficult to implement, and restrict industrial flexibility with regard to new products and changing demand. They also create a bureaucratic burden and opportunities for corruption. In IEA member countries, fully cost-reflective and competitive energy prices serve the function of stimulating producers to reduce per unit costs. Voluntary agreements with industry may also be a more flexible way to provide added encouragement and support for energy efficiency, without tying the hands of industry in competitive global markets.

Ukraine has not made as much progress on updating its building energy codes as it has on appliance standards, although this may change soon. Building energy codes can have a very large impact on energy use because they set a target for all new buildings. Over time, the accumulated savings are great. Requiring energy-efficiency improvements at the time of major renovations can further enhance the impact.

Clarifying building ownership and management issues is another very important means of ensuring that building owners and residents have an incentive to save energy. This simplifies decision making and, hence, facilitates investments and actions to save energy. Housing companies or condominium associations are both good options for ownership. Competent and competitive energy management, as well as operation and maintenance services should be available at reasonable costs. President Yushchenko has announced that Ukraine will open building maintenance and services to competition; when implemented, this will be an important improvement.

Public awareness and training programmes can have a significant influence on consumer behaviour. Ukraine has good experience in this area, particularly in industry. For the most part, the existing information campaigns focus on technology and technical approaches to energy efficiency. As financing is a major barrier to energy-efficiency initiatives, more effort should be devoted to providing information on how to finance projects.

Better information and guidance is needed for all stakeholders, especially building owners, managers and the general public. Advisory services, as well as printed guides and instructions, should be widely available, not just in regions that have the greatest initiative. This requires stronger national support for such information and awareness campaigns.

Taxation is another mechanism Ukraine can use to promote energy-efficiency. For example, the government could provide tax benefits for investments in energy-efficient equipment. The benefits could affect import duties, value added taxes and profit taxes paid by companies that have invested in energy efficiency.

Several countries have successfully used energy-efficiency funds to stimulate the energy-efficiency market. The Ministry of Construction's initial plans to create a UAH 750 million (USD 150 million) energy-efficiency fund for the heat and buildings sectors were encouraging; the government may want to reconsider its decision to put these plans on hold. International experience demonstrates that such funds can be an effective tool to facilitate financing: they can be used to guarantee commercial bank loans (which expand the impact of the initial pool of financing) or to provide low-interest loans directly. To ensure the financial strength of such funds, countries often delegate their management to professional private banks. To finance this fund, Ukraine may also want to consider putting a surcharge on the tariff for electricity, gas and heat, where the revenues would go directly into the fund. At the same time, these surcharges would provide an added incentive to use energy wisely. Revenue from privatisation or carbon credit sales could also help finance the fund.

State and regional budget financing and support mechanisms are very important, particularly for state-owned facilities and low-income households. Such support should be expanded to better balance government investments in the energy sector. At the same time, energy subsidies and other price distortions should be phased out.

Ukraine also has a unique opportunity to attract financing for energy efficiency through the Kyoto Protocol and its carbon credits trading mechanisms, joint implementation and emissions trading. Effort must be taken to ensure that Ukraine realises the full potential of these mechanisms.

Recommendations

The government of Ukraine should:

- Ensure that prices cover the full, long-term cost of energy supply. Help ease the pain of rising energy prices by investing in energy-efficiency measures in low-income households.
- Make it mandatory for all buildings and other energy consumers to have heat, electricity and gas meters.
- Provide ample staff and funding for the new National Agency on Efficient Energy Use. Ensure that this Agency has continued high-level support that reflects the importance of its mission.
- Develop and implement energy-efficiency standards for equipment and buildings rather than relying on normative use of energy per unit of output and its associated penalties.
- Strengthen and improve enforcement of building energy codes.

- Implement the existing appliance standards and develop new ones to cover a broader spectrum of the appliances available.
- Use tax policy to promote energy efficiency.
- Proceed with creating the planned energy-efficiency fund. Explore opportunities to expand this fund using revenue from carbon credits, privatisations and/or a surcharge on energy sales.
- Create incentives for efficient energy use at state-owned enterprises through performance-based contracts for enterprise management.
- Enhance dialogue between the government and major energy consumers through voluntary agreements.
- Realise the full potential of the energy-efficiency capacity that exists in Ukraine, particularly in non-governmental organisations, energy service companies and academic institutions.
- Expand existing public awareness campaigns and training programmes, and consider establishing a nationwide network of energy-efficiency service centres that can inform the public about the issue.
- Use monitoring and evaluation as tools to understand the benefits and impacts of energy-efficiency policies and programmes, and to expand and replicate the most successful programmes.

5. NATURAL GAS AND OIL

Overview

Ukraine relies heavy on imported oil and gas. These imports are high on the political agenda, particularly as prices rise. The government is planning to reduce the imports and enhance domestic production. Achieving this goal requires reforms to attract investment to the sector. Today, the oil and gas industry in Ukraine is largely dominated by state-owned companies, though private and foreign investors have made some inroads. The presence of the state is most direct and pronounced in exploration and production, main pipelines (both oil and gas), gas imports and transit, and gas distribution. In contrast, refining and distribution of oil products are mostly in private hands.

The industry is heavily regulated. The government has many direct and indirect controls over the terms of investors' access to reserves and infrastructure, pricing and tariff setting, import and export transactions, and other key aspects of the market. Oil refining and distribution are the only elements of the Ukrainian energy sector that have well-developed competition and market-set prices. Refineries do not use state-of-the-art technology, and need significant investments in modernisation.

Domestic gas prices for many consumer groups are below cost and are cross-subsidised by higher industrial prices. The increased price for gas imports in 2006 has been of great concern for the economy, given the large dependence of the industrial and residential sectors on natural gas. Thus far, the economy has shown resilience, though prices may rise further. That said, the Ukrainian government should introduce more effective measures to stimulate long-term performance and efficiency in the oil and gas sectors, and in the economy at large. To date, lack of competition, strong state involvement and inadequate price signals have undercut efforts to increase performance and efficiency.

Institutional and Legal Framework

- **Natural Gas and Oil Industry Structure**

The largest company in the oil and gas industry of Ukraine is the national joint-stock company Naftogaz of Ukraine (which literally means "oil & gas of

Ukraine"). Table 5.1 demonstrates that Naftogaz of Ukraine dominates the exploration and production (otherwise known as the upstream), as well as main oil and gas pipelines, gas processing, the imports and transit of gas, and gas distribution in Ukraine. The presence of other actors is significant only in the oil refining and oil product retail markets, which are liberalised and open for competition. Foreign (mostly Russian) companies control four of the six Ukrainian refineries and most filling stations.

Table 5.1

Ukraine's Oil and Gas Industry Structure

	Exploration and production	Transmission	Refining and processing	Distribution and trade
Oil	**Naftogaz of Ukraine** (97% of production) • Ukrnafta • Chornomor-naftogaz **Others** (3% of production) • Nadra of Ukraine (exploration) • State-owned and private companies	**Naftogaz of Ukraine** • Ukrtransnafta	**Private/foreign companies with some state shares** (6 refineries)	**Naftogaz of Ukraine** • Naftogaz • Ukrnafta **Others** • Private and foreign companies
Gas	**Naftogaz of Ukraine** (96% of production) • Ukrgazvydo-buvannia • Chornomor-naftogaz • Ukrnafta **Others** (4% of production) • Nadra of Ukraine (exploration) • State-owned and private companies	**Naftogaz of Ukraine** • Ukrtransgaz (out-side of Crimea) • Chornomor-naftogaz (in Crimea)	**Naftogaz of Ukraine** • Ukrgazvydo-buvannia (2 gas processing plants and 1 condensate stabilisation unit) • Ukrnafta (3 gas processing plants)	**Naftogaz of Ukraine** • Gas of Ukraine **Regional gas supply companies** (Naftogaz of Ukraine's share >50% in 19 companies; 10-50% in 6 companies)

Naftogaz of Ukraine

Naftogaz of Ukraine was created in 1998 as a holding company and is 100% owned by the state. Via its affiliates, it produces, transports and trades oil and natural gas, processes gas and condensate, distributes some oil products and holds shares in gas distribution companies. It also handles oil and gas transit, exports and imports.

Natural gas operations far outweigh other company business: until 2005, some 51% of the company's revenues were from the sale of gas, and about 20% from gas transportation (primarily transit) (Naftogaz of Ukraine, 2005). In 2004, Naftogaz of Ukraine accounted for some 13% Ukraine's GDP and approximately 10% of the state budget. As a consequence, any change in the terms of gas business has a large-scale and immediate impact on Naftogaz of Ukraine's financials and on the economy at large.

The structure of the holding company is very complex, organised generally around technical aspects of the work and not around customer types. Various affiliates handle the business, but overall operational and especially financial decision-making is largely vested in the holding company, as are asset management functions. International experience shows that the decision-making process in such large state-owned companies is often inefficient and politically driven; costs and benefits are not always adequately identified and allocated. In Naftogaz of Ukraine, political considerations often take a prominent position in business decisions. Business operations at Naftogaz of Ukraine are not particularly transparent: the company has never been subject to a consolidated, financial audit by an independent auditor, though independent auditors have reviewed some aspects of its business.

Although Ukrainian legislation prohibits government officials from holding positions in business entities, such overlapping of political and commercial functions has happened in the past. For example, the former head of Naftogaz of Ukraine, Olexiy Ivchenko, simultaneously acted as deputy minister of fuel and energy. Encouragingly, in December 2005, a presidential decree liquidated the position of Deputy Minister-Head of Naftogaz of Ukraine, and dismissed Ivchenko from his ministerial functions.

Table 5.2 lists affiliate companies of Naftogaz of Ukraine and their main activities. Naftogaz of Ukraine owns 100% of its three subsidiary companies, five subsidiary enterprises, two state joint-stock companies and one open joint-stock company. It also owns 50+1% share in another open joint-stock company, Ukrnafta. Naftogaz of Ukraine has majority holdings in 19 regional gas distribution companies and several industrial and service companies. It has minority holdings in several other companies.

Table 5.2

Structure of Naftogaz of Ukraine by Type of Ownership

Subsidiary companies	Subsidiary enterprises	State joint-stock companies	Open and closed joint-stock companies
Ukrtransgaz (main gas pipelines, gas storage)	Naftogaz (LPG marketing)	Chornomornaftogaz (offshore exploration and production, and operation of gas pipelines and storage in Crimea)	Ukrtransnafta (main oil pipeline operation)
Gas of Ukraine (gas trading and distribution)	Gaz-Teplo (supplying gas to district heating companies)	Ukrspetstransgaz (LPG transportation by railroad)	Ukrnafta (oil production, gas processing): 50%+1 share
Ukrgazvydobuvannia (gas and condensate production and processing)	Ukrnaftogaz-komplekt (equipment and material supply, maintenance services)		Various shares in regional gas distribution companies and several industrial and service companies
	Naukanaftogaz (R&D, including G&G data processing)		
	LIKVO (emergency and rescue services)		

Source: Naftogaz of Ukraine.

Naftogaz of Ukraine is actively borrowing abroad. The company has raised more than EUR 500 million (USD 640 million) from a Eurobond issue in Luxemburg in 2004. It has also arranged a credit line of up to EUR 2 billion (USD 2.6 billion) with Deutsche Bank (although this line was ultimately frozen).[15] The credits are used, at least partially, for operational purposes, such as paying taxes and debts in arrears. In June 2006, according to press reports, Naftogaz of Ukraine was seeking loans of several hundred million US dollars to pay off its rising debts for gas imports (Interfax Ukraine, 2006). Some in the government fear that Naftogaz of Ukraine, overextended

15. *Naftogaz of Ukraine is also negotiating loans with several other banks.*

with debt, would not be able to repay these loans and would technically go bankrupt. This raises a concern that Ukraine might be forced to sell oil and gas assets, in particular its gas pipelines, to repay the debt, or face an expensive bail out. In July 2006, the head of Naftogaz of Ukraine, Oleksandr Bolkisev, said that Gazprom was interested in acquiring Ukraine's gas transportation system in exchange for debt.

Other Actors

In January 2006, a Swiss-registered company, RosUkrEnergo, became an important actor on the Ukrainian gas market, handling all gas imports to the country (Chapter 6: Energy Transit). A joint venture between RosUkrEnergo and Naftogaz of Ukraine, called UkrGaz-Energo, began supplying gas to industrial consumers in the spring of 2006 (section Domestic Market Structure).

Several foreign companies (TNK-BP, Lukoil, Tatneft, ExxonMobil and Shell) control a large share of oil refining and distribution in Ukraine. The Pryvat Group, a Ukrainian industrial and financial group, owns significant assets in the oil industry, including 42% of Ukrnafta's shares, the majority of shares of the Nadvirnya refinery and 32.9% of shares in the Drohobych refinery. The Pryvat Group also controls several hundreds gas retail stations, mostly in the East and the South.

Several private and public companies have been exploring and producing hydrocarbons in Ukraine since 1995, but their collective share of total oil and gas output is less than 3% and 4%, respectively. The most important companies working in the oil and gas upstream sector in Ukraine are listed in Table 5.3.

In June 2000, a presidential decree created a new state joint-stock company called Nadra of Ukraine (which means "Subsoil of Ukraine"). The decree integrated the assets of several geological exploration companies. Nadra of Ukraine belongs to the Ukrainian state and cannot be sold or used to form other companies. Its affiliates subsequently entered into more than 40 joint ventures, covering various fields and exploration sites. The vast majority of the investment partners are Ukrainian; only six out of 41 are foreign, although it is not clear that the domestic investors have significant resources to invest. The affiliates of Nadra of Ukraine hold 119 geological exploration permits (as of mid-2005). The company specifically indicates its interest in cooperating with other parties to develop the leases and produce hydrocarbons (Nadra of Ukraine, 2005). However, the unfavourable investment climate and difficult terms of access for foreign investors hinders foreign participation. Naftogaz of Ukraine is apparently seeking to dissolve Nadra of Ukraine and take over its functions. Some policy makers think Nadra of Ukraine should remain a strong

Table 5.3

Independent Oil and Gas Production, 2001 and 2003

Company	Oil production, thousand tonnes		Gas production, bcm	
	2001	2003	2001	2003
Poltava Petroleum Company (PPC), a subsidiary of JKX Oil & Gas (UK)	65.4	88.0	0.26	0.36
Nadra of Ukraine, state joint-stock company	16.3	28.0	0.16	0.2
Joint venture Ukrnaftogaztechnologia	2.9	13.2	0.10	0.28
Delta	0.5	0.3	0.045	0.042
Plast	5.0	7.7	0.069	0.126
Kashtan Petroleum	8.4	28.3	0.0007	0.002
JV Borislavska Naftova Kompania	18.1	20.6	0.028	0.03
Oberon-Voutillia	0.2	0.1	0.01	0.005
UkrKarpatOil	5.7	11.4	0.006	0.006
Dniprogazresurs Ltd.				0.061
Maryinske Ltd.				0.056
Others		2.4	0.021	0.132
Total independents	122.5	200	0.7	1.3

Sources: Poltava Petroleum Company, 2006; Energy Charter Secretariat, 2002; World Bank, 2003a.

actor, dealing only with exploration; others believe that it should become a vertically integrated company involved in both exploration and production.

General Legal and Regulatory Framework

The most important laws regulating the oil and gas sector in Ukraine include: the *Law on Oil and Gas* (July 2001); the *Law on Concessions* (July 1999); the *Law on Pipeline Transport* (May 1996); the *Law on Subsoil* (July 1994); and the *Law on Production Sharing Agreements* (September 1999). Additional laws that influence activities in the oil and gas sectors include: the *Law on Licensing Certain Types of Economic Activities* (2000), the *Law on Natural Monopolies* (2000) and the *Law on Protecting Economic Competition* (2001). In addition, international agreements regulate some legal aspects of the oil and gas sector (Chapter 6: Energy Transit).

Ukraine announced its objective of acceding to the *Energy Community Treaty*, which extends the EU *acquis* on electricity and gas markets to non-member countries in Southeast Europe. In early 2006, the Ministry of Fuel and Energy was drafting a proposal of a law on the natural gas market. This bill focuses on transitioning to a competitive gas market and harmonising Ukrainian legislation with major EU directives - in particular, the EU Gas Directive 2003/55. It is not yet clear whether and when the Ukrainian parliament might adopt this bill.

Upstream Terms of Access

The actual terms of access do not encourage investment upstream, especially in the gas sector. Administrative procedures are cumbersome, especially for foreign companies. In addition, the *Law on Production Sharing Agreements* does not work in practice. Moreover, companies exploring new fields are not guaranteed a production licence if they discover hydrocarbons. Even when companies do get production licences, most gas produced in Ukraine must be sold to domestic residential consumers at the lowest regulated prices;[16] and quotas restrict gas exports.

To explore oil and gas fields, interested companies must buy a 5-year exploration licence for each individual site (be it a deposit or a field). Exploration licences are different from production licences, which are issued for 20 years. A company that buys an exploration licence does not necessarily receive a production licence if it makes a discovery. This makes oil and gas companies reluctant to undertake the risky and costly investments necessary to explore new fields. This gap between exploration and acquiring production licences has caused several disputes, which have put off potential investors. The Ministry of Environmental Protection sells licences at auctions,[17] but there are problems with transparency both in the public geological data and in the tender procedures for licensing. This lack of transparency hampers competition, thus harming the government's ability to attract investment into the oil and gas sector and to get fair prices for licences.

Another issue is that obtaining a licence does not automatically grant access to the site: for that purpose, investors must first obtain a separate siting permit. The Ministry of Labour and Social Policy grants siting permits for hydrocarbon fields deemed of national importance and underground storage facilities. For other sites, the local municipality grants the permit.

16. Companies in which the state owns more than 50% are obliged, by law, to sell all gas produced to the residential sector.
17. In 2004, the authority to issue licences for oil and gas exploration and production was transferred to the newly created State Committee on Natural Resources. In 2005, the government (under President Yushchenko) merged the Committee back into the Ministry of Environmental Protection in order to reduce abuses of power that had reportedly been taking place in the Committee.

These cumbersome and non-transparent procedures for issuing permits create an administrative burden and generate extra costs that discourage investment in the upstream oil and gas sector.

The 1999 *Law on Production Sharing Agreements* (PSA) introduced some benefits for investors such as exemptions from the profit repatriation tax, value-added tax (VAT) and customs duties for exported PSA products. However, up to the end of 2005, no PSAs were signed. This is an indication that the law did not create a framework sufficiently attractive to investors. In particular, the ownership of oil and gas produced under PSAs is not straightforward. First, the Ukrainian state gets the ownership rights; thereafter they are shared between the PSA parties. Another barrier to PSA is the 40% limit for foreign participation in offshore areas. Limiting foreign participation results in less investment; it also restrains opportunities for using the most advanced technologies.

Ukraine adopted a *Law on Rental Payments on Oil, Natural Gas and Gas Condensate* in 2004, which was expected to stimulate domestic production of hydrocarbons through improved price and tax mechanisms. As of early 2006, the law was not yet implemented. In 2004, Ukraine also adopted modifications to the *Law on Oil and Gas,* aiming to improve the competitive bidding mechanism for hydrocarbon exploration and production in the Black and Azov Seas.

In early 2006, the government held a competitive tender for the right to conclude a Production Sharing Agreement for the 12 900 km^2 Prykerchensky Block in the Black Sea, offshore of Kerch (Crimea). Vanco International Ltd, a subsidiary of Houston-based Vanco Energy Company, won the tender. If the government approves it, it will be Ukraine's first PSA for hydrocarbons. The Ukrainian government expects that the Kerch Region area could generate up to USD 2 billion in foreign direct investment into oil and gas exploration and extraction.

Another positive development is the May 2005 agreement that Shell signed with Naftogaz of Ukraine to jointly conduct a study of a 31 000 km^2 area of the Dnipro-Donetsk basin in Northeastern Ukraine. The agreement can be extended to include joint exploration and production. In June 2006, Shell signed an oil and gas exploration joint activity agreement with Naftogaz of Ukraine's subsidiary Ukrgazvydobuvannia.

For the most part, the long-lasting legal battles over licences, such as in the case of the UK-based Regal Petroleum, have discouraged potential investors. More recently, the announcement of possible cancellation of a large number of exploration and production licences, which were presumably issued in violation of the law in 2004, had a negative effect on investors' confidence.

Overall, the terms of access to hydrocarbon reserves seem excessively cumbersome and harbour too many risks to attract the desired investors. At the same time, the revenue potential is too small, especially for investments in gas. Reform is needed to assure an adequate flow of investment into the sector, and to increase domestic supply of hydrocarbons, particularly natural gas.

Transportation and Distribution

The *Law on Pipeline Transport* (1996) prohibits privatisation of main pipelines and main oil and gas storage facilities. It also prohibits a change of ownership of the government-owned enterprises in the sector. However, the *Law on Oil and Gas* (2001) allows private and municipal ownership of new main pipelines and trans-shipment terminals for gas and oil. If a private or municipal entity builds a pipeline or a terminal subsequent to the enactment of the *Law on Pipeline Transport,* the facility can be retained in private or municipal ownership.

The *Law on Concessions* (1999) allows both main and distribution gas pipelines (but not oil pipelines) to be contracted out on concession terms to Ukrainian and foreign entities. The granting of a concession does not lead automatically to the granting of a licence. If a licence is needed for the specific activity in question, the concessionary must apply for a licence separately. The term of a concession is minimum 10, and maximum 50, years.

Licences are required for the storage of natural gas in volumes exceeding 5 Mcm (million cubic metres), as well as for other aspects such as: the supply of natural gas; repairs, upgrades and rehabilitation of oil and gas pipeline systems; transportation of crude oil and refined products by main pipelines; and transportation of natural gas by pipelines. The National Electricity Regulatory Commission (NERC) issues licences for transportation services on main oil and gas pipelines, and sets the tariffs for these services. By law, licences are valid for at least three years.

The *Law on Oil and Gas* (2001) introduced the notion of a "Unified Gas Transportation System of Ukraine" and directed the development and implementation of a common set of technical and safety regulations within the system. Dispatch was entrusted to a state-owned body, a department of Ukrtransgaz.

A NERC decree[18] requires holders of gas transportation licences to assure non-discriminatory access to pipelines for all gas supply companies. A Naftogaz of Ukraine order[19] defines technical requirements, procedures and terms of access to the company's pipelines. These regulations contain few details on congestion management, which is a key issue in fair access. One of the reasons may be the available excess capacity throughout almost the entire system of pipelines.

Natural Gas

Imports

Natural gas imports play a vital role for the Ukrainian economy, accounting for 75-78% of the country's gas consumption. (Domestic production supplies the remaining 22-25%.) Until 2001, Ukraine imported most of its gas from Russia. With a deal signed in May 2001, Turkmenistan became the largest gas supplier to Ukraine. In 2004-05, Turkmenistan supplied about 44% of Ukraine's gas needs; Russia supplied another 30-33%. In the first half of 2006, Ukraine reportedly received no gas directly from Turkmenistan. Rather, it was getting a mix of Central Asian and Russian gas from the intermediary, RosUkrEnergo. Even with these shifts in suppliers, all imports pass through Russia. Thus, Russia's gas monopoly, Gazprom, maintain effective control over gas imports to Ukraine.

The January 2006 Gas Agreement (Chapter 6: Energy Transit) has significantly changed Ukraine's gas imports arrangements. The sharp increase in import price in 2006 has raised concerns that the competitiveness of Ukrainian industries may be put at risk. Ukraine's economy has seen strong growth in 2006, though domestic gas prices are likely to rise further. More importantly, uncertainty about gas supplies and gas prices in the second half of 2006 destabilised the political and economic situation in Ukraine. Signs of gas supply troubles were already evident during the first half of 2006: by June, Naftogaz of Ukraine had injected less gas in the underground storage facilities than planned, reportedly because Ukraine did not receive gas from Turkmenistan directly. In July 2006, Prime Minister Yekhanurov publicly stated that Ukraine may potentially have an 11 bcm deficit of gas in the second half of the year.

18. Decree No. 856, 30 September 2005. The previous decree of 13 September 1999 also had such a provision.
19. Order No. 79, 26 March 2001.

Imports of natural gas to Ukraine and gas transit have been interlinked for many years. Import and transit arrangements are set through both commercial contracts and intergovernmental agreements with producing countries. As a general rule, the government provides guarantees and approval of activities and terms, but details on commercial terms are made legally binding in contracts.

Imports from Russia

In 2005, Ukraine received approximately 23 bcm of gas from Russia, as payment for transiting Russian gas to Europe. The implied price of this gas was USD 80 per 1 000 m^3, although most public sources quote the price of USD 50 per 1 000 m^3 (the lower price factored in a lower price formula for the gas transit and storage fees). Relations between Russia and Ukraine became tense when Gazprom stated, in June 2005, its plan to raise gas price to Ukraine. Gazprom explained that it wanted to move to market prices. Ukrainian officials claimed that such a move violated the existing contract (more details in Chapter 6: Energy Transit).

On 4 January 2006, Naftogaz of Ukraine and Gazprom signed a deal with a third party, RosUkrEnergo. According to this deal, which has become known as the January 2006 Gas Agreement, RosUkrEnergo would acquire gas from Turkmenistan and Russia, and sell it to Ukraine for USD 95 per 1 000 m^3 at the Ukrainian border (the price being valid for the first six months of 2006). This was a significant price increase, and a further price rise was expected for the second half of 2006. The January 2006 Gas Agreement established cash payments for imported Russian gas and for transiting Russian gas via Ukraine. However, the service of transiting Turkmen gas to the Ukrainian border is still charged in natural gas (*i.e.* by barter). By mid-2006, Naftogaz of Ukraine reportedly accumulated a debt of more than USD 500 million for natural gas supplied by RosUkrEnergo. The total debt of Naftogaz of Ukraine was presumably much larger. The debt is attributed to at least three factors: *i)* domestic gas prices did not rise fast enough; *ii)* Naftogaz of Ukraine's income from gas export and transit dropped; and *iii)* payment collection decreased.

Gas supply and transit agreements with Russia, as well as gas storage, are discussed in more detail in Chapter 6: Energy Transit.

Imports from Turkmenistan

Under the deal signed in May 2001, Turkmenistan provided Ukraine with approximately 35 bcm per year at a price of USD 44 per 1 000 m^3. Ukraine paid for about half of these supplies in barter (equipment and machinery). In late December 2004 Turkmenistan asked for a 32% price increase in 2005. Turkmenistan cut off gas supplies to Ukraine over the latter's refusal to pay more for imports, and several days after, officials from Naftogaz of Ukraine and Turkmenneftegaz signed a deal calling for Turkmenistan to provide Ukraine with 36 bcm of gas at a price of $58 per 1,000 m^3. In June 2005, the two countries renegotiated the supply terms and reportedly signed a new agreement. Under this agreement Turkmenistan was to supply Ukraine with 15.5 bcm of gas until the end of 2005 and 33 bcm in 2006 at a price of USD 44 per 1 000 m^3. In exchange for the lower price, Naftogaz of Ukraine agreed to pay for Turkmen gas fully in cash as of 1 July 2005.[20]

On 29 December 2005, Naftogaz of Ukraine reportedly signed another contract with Turkmenistan that would provide up to 41 bcm of natural gas in 2006, at USD 50 per 1 000 m^3 for the first half of the year and USD 60 for the second half of the year. However, in the first half on 2006, Ukraine apparently did not receive any Turkmen gas in accordance with a direct contract with Turkmenistan. As this book was being prepared, it was not clear if Ukraine would receive any gas directly from Turkmenistan in 2006, or at what price. One possible reason behind the suspension of Turkmen supplies to Ukraine is that the gas must first transit through Russia, and Russia's Gazprom would also like to get the gas. Turkmenistan apparently signed a contract with Gazprom for the same gas soon after it signed a contract with Ukraine.

Significantly, in the medium and longer term, Turkmen gas supply to Ukraine is also under question. Russia and Turkmenistan have signed a long-term, memorandum-of-understanding-type agreement, setting the volumes of Turkmen gas that Gazprom can buy starting from 2007. Gazprom and Turkmenistan must agree on prices and volumes on a year-to-year basis. Ukraine is also seeking to sign a 25-year gas supply agreement with Turkmenistan for imports of 60 bcm per year, starting from 2007. Turkmenistan will likely not have enough gas available to cover all the export demand. There is no certainty about Turkmenistan's production capacity.

Transporting gas from Turkmenistan to Ukraine may present another challenge in that upgrades may be needed on Turkmenistan's pipeline system. At present, the Central Asia-Centre pipeline reportedly has a capacity of around 50 bcm per year at its "narrowest" point.

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20. According to Naftogaz of Ukraine, as of March 2006, Ukraine owed Turkmenistan some USD 170 million for gas supplies to Ukraine in 2003-05. On 26 March 2006, the parties signed an agreement on the schedule of the debt repayment. By the end of July 2006, Ukraine reportedly had reduced the debt to USD 43.7 million.

Prospects for the Future

According to Ukrainian projections, Ukraine will continue to rely on gas imports from Russia and Central Asia in the short and medium term. The *Energy Strategy to 2030* projects that dependence on natural gas imports will drop to 31.3 bcm by 2015 and to 9.4 bcm by 2030, down from the current 55.9 bcm. The *Energy Strategy to 2030* expects that total gas consumption in Ukraine will decrease from 76.4 bcm in 2005 to 49.5 bcm by 2030, primarily due to switching to coal and nuclear, and improved energy efficiency. Such a sharp decrease in gas imports seems unrealistically challenging and possibly not economic. It is interesting to note that an earlier draft version of the energy strategy projected natural gas use to rise to nearly 87 bcm by 2030, with net imports reaching around 60 bcm. Obviously, policy has a large impact on gas demand; strong energy-efficiency policies could help constrain gas demand.

Ukraine is studying the possibilities of importing gas from Kazakhstan (through existing pipelines), as well as from Azerbaijan, Iran and Iraq (possibly through a branch of the proposed Nabucco pipeline). Naftogaz of Ukraine proposed two options for building a gas pipeline from Iran to the EU through Ukraine, but there are doubts about whether the project would make economic sense (Chapter 6: Energy Transit). Norway has also been mentioned as a potential gas supplier: Norway may build a 10 bcm pipeline to Poland. Poland needs only 5 bcm, so an eventual extension to Ukraine could make that pipeline viable. Naftogaz of Ukraine has examined possibilities of producing gas in other countries such as Libya, Algeria, Turkmenistan and Uzbekistan. The *Energy Strategy to 2030* projects that Ukraine's gas balance in 2030 will include nearly 12 bcm of gas produced by Ukrainian companies abroad. It is unclear how Naftogaz of Ukraine would bring this gas to Ukraine. Thus, even if Ukrainian companies actually start producing hydrocarbons abroad, it is doubtful that this will result in actual gas deliveries to Ukraine. It would probably make more economic sense to sell them at market prices in other countries instead of building expensive transportation routes to bring them to Ukraine.

• Gas Exports

Ukraine sets gas export quotas; two explanations underlie this measure. First, the contracts with Gazprom and the Russian-Ukrainian intergovernmental agreements provide restrictions on the export of Ukrainian gas because Russia wants to keep Ukraine from re-selling Russian gas. Second, the government uses gas export quotas to ensure that gas companies meet the domestic demand at prices that are much lower than in most other countries. Gas export quotas rise with production volumes. In 2004, Naftogaz of Ukraine exported more than 4 bcm. In June 2005, the government prohibited Naftogaz of Ukraine from exporting gas until the company concluded additional contracts for gas imports to meet domestic demand. The January 2006 Gas Agreement also prohibited gas exports from Ukraine.

Domestic Production

Ukrainian gas production in the last 15 years was approximately 18-20 bcm per year, compared with its record of 68.7 bcm in 1975.[21] Three Naftogaz of Ukraine affiliate companies produce the vast majority of Ukrainian domestic gas: Ukrgazvydobuvannia produces about 75%; Ukrnafta more than 17%; and Chornomornaftogaz another 4.2%.

Domestic production started growing in 2001; almost half of the increase in production has been from independent producers. This is an important point as it indicates the role private investors can play in increasing gas production in Ukraine. Ukrainian policy makers should consider measures that might further increase such private investment.

According to the national programme *Oil and Gas of Ukraine to 2010* (adopted in 1995 and amended in 2001), domestic gas production is projected to reach 24.5 bcm in 2010. In its basic scenario, the *Energy Strategy to 2030* suggests that domestic gas production will reach 23.2 bcm in 2010, 26.1 bcm in 2020 and 28.5 bcm in 2030. The *Energy Strategy*'s optimistic scenario projects domestic production of 30.1 bcm in 2030. The World Bank estimates that a production increase of 10 bcm per year from proven reserves would require capital investment of USD 1.5 billion. If gas production grows at the optimistic rate, Ukraine will have produced more than 630 bcm from 2005-30. This is more than half of the official estimates of the actual proven reserves, which are estimated at 1 030 bcm. These figures highlight the importance of new prospecting and exploration activities.

Exploration and Reserves

There are three major oil and gas basins in Ukraine: the Carpathian basin in the West, the Dnipro-Donetsk basin in the East, and the Black Sea/Azov Sea basin in the South. Little investment has gone into geological exploration and prospecting over the last 15 years, so the reserve additions rate declined

21. This drop mainly reflects the depletion in existing fields.

Table 5.4

Gas Production in Ukraine (bcm)

Year	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Total production	20.9	19.2	18.3	18.2	18.4	18.1	18.0	18.1	17.9	18.3	18.7	19.2	20.5	20.6
Naftogaz of Ukraine	20.9*	19.2*	18.3*	18.2*	18.1*	17.8*	17.5	17.5	17.6	17.7	17.8	18.2	18.9	19.2
Other producers	-	-	-	-	0.3	0.3	0.5	0.6	0.5	0.7	1.0	1.3	1.2	1.3

** Production by companies that were integrated into Naftogaz of Ukraine when it was created in 1998.*

Note: Because the data come from different sources, the components may not add up to the total.

Sources: IEA statistics; Naftogaz of Ukraine.

until 1997. Since then, drilling has increased slightly and today stands at about 200 000-220 000 metres per year. In the national programme *Oil and Gas of Ukraine to 2010* and the *Energy Strategy to 2030*, the Ukrainian government notes that it expects to increase exploration drilling activities 2.5 times to 415 000 metres per year by 2030. This would add 670 bcm to the gas reserves by 2030 in the pessimistic scenario, or 1 023 bcm in the optimistic scenario. Exploration drilling is a very expensive and risky activity. To achieve the targets of the programme, it would be necessary to invest some UAH 60 billion (USD 12 billion) from 2003-10, an amount that cannot be secured from Ukrainian sources. This highlights the need to improve incentives and assurances to foreign investors.

The *Energy Strategy to 2030* estimates the remaining gas reserves at 1 024 bcm. This is significantly higher than independent estimates, which assess Ukrainian gas reserves at 317 bcm. At the end of 2003, an independent audit company, Miller and Lents Ltd., estimated Ukraine's gas and oil reserves based on international standards. The company analysed 124 fields owned by Naftogaz of Ukraine that presumably hold some 80% of Ukraine's oil and gas reserves. This audit showed significantly lower numbers than Naftogaz of Ukraine's estimates. Miller and Lents Ltd extrapolated the average difference between its own and Naftogaz of Ukraine's estimates to assess the total reserves by type in Ukraine. These assessments are listed in the Table 5.5

Table 5.5

Proven Natural Gas Reserves of Naftogaz of Ukraine, as of 31 December 2003 (bcm)

Reserve type	Net reserves of 124 fields (independent estimates)	Net reserves of other fields (extrapolated)	Total reserves
Developed, producing	234.1	46.8	280.9
Developed, non-producing	9.9	2.0	11.9
Non-developed	20.3	4.1	24.4
Total	**264.3**	**52.9**	**317.2**

Note: Conventional definition of reserves is applied (Box 5.1).

Source: Naftogaz of Ukraine, 2004.

Box 5.1 Proven Reserves: The Issue of Definition

According to the conventional definition, proven reserves are those reserves from which oil and gas can be extracted profitably – at a given time and taking into account the existing geology, technology, economic conditions and current legislation. Proven reserves do not include additional quantities of oil and gas that might be discovered as a result of extending the exploration area or using secondary or tertiary recovery methods that have not yet been used or are not known to be economically viable. Proven developed reserves are those that are expected to be extracted from the existing wells with the use of existing equipment and production methods.

Oil and gas prices are an important element for determining the potential profitability of reserves. If the price is set below market value (as with the gas price for Ukrainian consumers), producers can profitably extract less oil and gas.

Contrary to this conventional definition of proven reserves, the Ukrainian notion of reserves states that: "Reserves are the amount of oil and condensate or amount of gas in deposits discovered, explored and being developed as of the day of the calculation, under standard conditions (P=0.1 MPa, t°= 20°C)". This definition means that Ukrainian reserves include every molecule of oil or gas that presumably exists in a reserve; the definition does not address the economic viability of the reserves.

Should the conventional definition be applied in the Ukrainian context, it is possible that some 50% of the known oil and gas deposits may be uneconomic.

The US Geological Survey (USGS) estimates that the best prospects for yet-to-be discovered gas reserves are in the Dnipro-Donetsk basin onshore, with a potential of 673 bcm of gas (including 62.2 bcm of associated gas). The total mean expected discoveries of gas are estimated at 779.7 bcm, of which 79.3 bcm is associated gas (USGS, 2000). Ukrainian experts calculate that approximately 30% of Ukraine's potential hydrocarbon reserves are situated offshore. Eight gas and gas condensate fields were recently discovered in the Black Sea, along with six more in the Azov Sea. Naftogaz of Ukraine has adopted a programme to more intensively explore and use Black and Azov Sea reserves through 2015. A long-lasting dispute with Russia over the demarcation of the Sea of Azov can potentially jeopardise investment in the disputed areas. Although it will not resolve the outstanding dispute, market pricing for gas on the domestic market and elimination of export quotas could significantly accelerate the development of these reserves.

Ukraine also has good prospects for coalbed methane (Chapter 7: Coal), as well as other unconventional hydrocarbons that are largely untouched to date.

Liquefied Natural Gas

Naftogaz of Ukraine proposed building a regasification plant for liquefied natural gas (LNG) on the Black Sea coast, with the intention of importing LNG from Libya, Egypt and other countries. In January 2006, Naftogaz of Ukraine announced that it had finished the feasibility study for a terminal with an initial annual capacity of 10 bcm. The project would cost about USD 3 billion.

Theoretically, an LNG terminal would help Ukraine diversify its gas supply. However, such a project would need a careful costs-and-benefits analysis, taking into account supply options, projected global LNG prices, transportation costs and potential demand for LNG priced at world market levels. It is quite doubtful whether an LNG project could be economically feasible in the context of Ukraine's actual gas industry structure and low domestic gas prices. At the same time, it is evident that financing would be an issue. Naftogaz of Ukraine states it would finance the project through its own funds and credits, but the company's indebtedness has already raised concerns. An additional difficulty to consider would be the transit of LNG cargoes via the Bosphorus Strait, which the Turkish authorities oppose. Nevertheless, further increases in the price of Russian and Caspian gas, and broad reforms in the Ukrainian gas sector may eventually improve the prospects of constructing an LNG terminal in the country.

Domestic Market Structure

The Ukrainian gas market is monopolistic and heavily regulated. Until 2006, almost all of the gas consumed in Ukraine was handled by Naftogaz of Ukraine, which marketed the gas via its affiliates Gas of Ukraine and Gaz-Teplo. Gas of Ukraine is a wholesaler that supplies gas to regional distribution companies (oblgaz), electricity and heat companies and large industrial consumers. Gaz-Teplo supplies gas to some district heating companies (Chapter 9: District Heating). Independent suppliers (specifically, domestic producers and wholesale traders not controlled by Naftogaz of Ukraine) supplied some 4-5% of gas to final users (mostly to industrial companies). Independent traders supply gas to industries at non-regulated prices, but they must obtain a licence from NERC. By the end of 2002, more than 1 000 entities had obtained licences to independently supply natural gas.

Ukraine privatised most of its local gas distribution companies in 1998. There are 42 distribution companies in Ukraine's regions today, which operate the distribution networks and supply gas to end-users. These companies do not own the distribution pipelines, just the gas flowing through them, although newly-constructed pipelines can be privately-owned. Gas distribution networks in Ukraine are more than 300 000 km in length. About 76% of towns and 32% of villages have access to natural gas supply. At present, the main focus for investment in this sector is the expansion of distribution networks by using polyethylene pipe rather than steel, which cuts costs and time.

Table 5.6

Gas of Ukraine Sales, by Consumer Category, 1999-2005 (bcm)

	1999	2000	2001	2002	2003	2004	2005
Households	17.6	16.7	16.9	16.6	17.5	16.6	17.5
Including commercial losses	*1.7*	*1.5*	*1.9*	*1.5*	*1.6*	*0.8*	*0.5*
Public institutions	1.0	1.0	0.9	0.9	1.0	1.0	1.1
District heating companies	11.4	8.7	8.8	9.3	9.9	7.9	7.5
Own needs and losses	0.6	0.6	0.7	0.7	0.8	1.1	1.2
Industry	7.6	7.7	9.3	9.2	18.7	21.4	25.5
Electricity and combined heat and power companies*	8.6	3.0	7.2	7.7	8.6	8.2	6.9
Other	0.147	1.342	0.031	0.096	0.033	0.006	0.002
Total	**47.0**	**39.0**	**43.9**	**44.4**	**56.6**	**56.2**	**59.8**

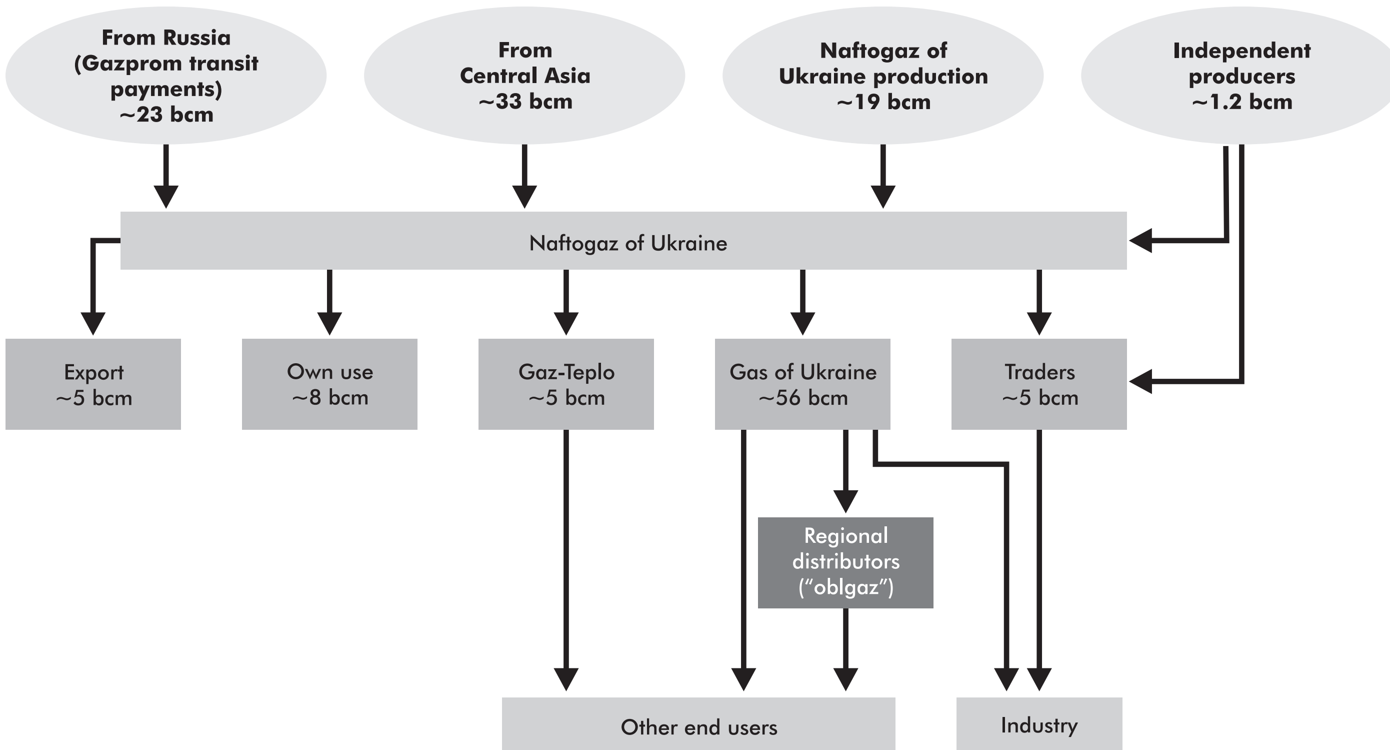
** Including Kyivenergo.*

Note: In 2003, the amount of gas that Gas of Ukraine supplied to industry increased two-fold. Following the instruction of the Ministry of Fuel and Energy, Naftogaz of Ukraine cut out some middlemen who purchased gas from Naftogaz of Ukraine and sold it on to industrial consumers. Gas of Ukraine started handling these volumes instead of those middlemen.

Source: Gas of Ukraine.

Figure 5.1a

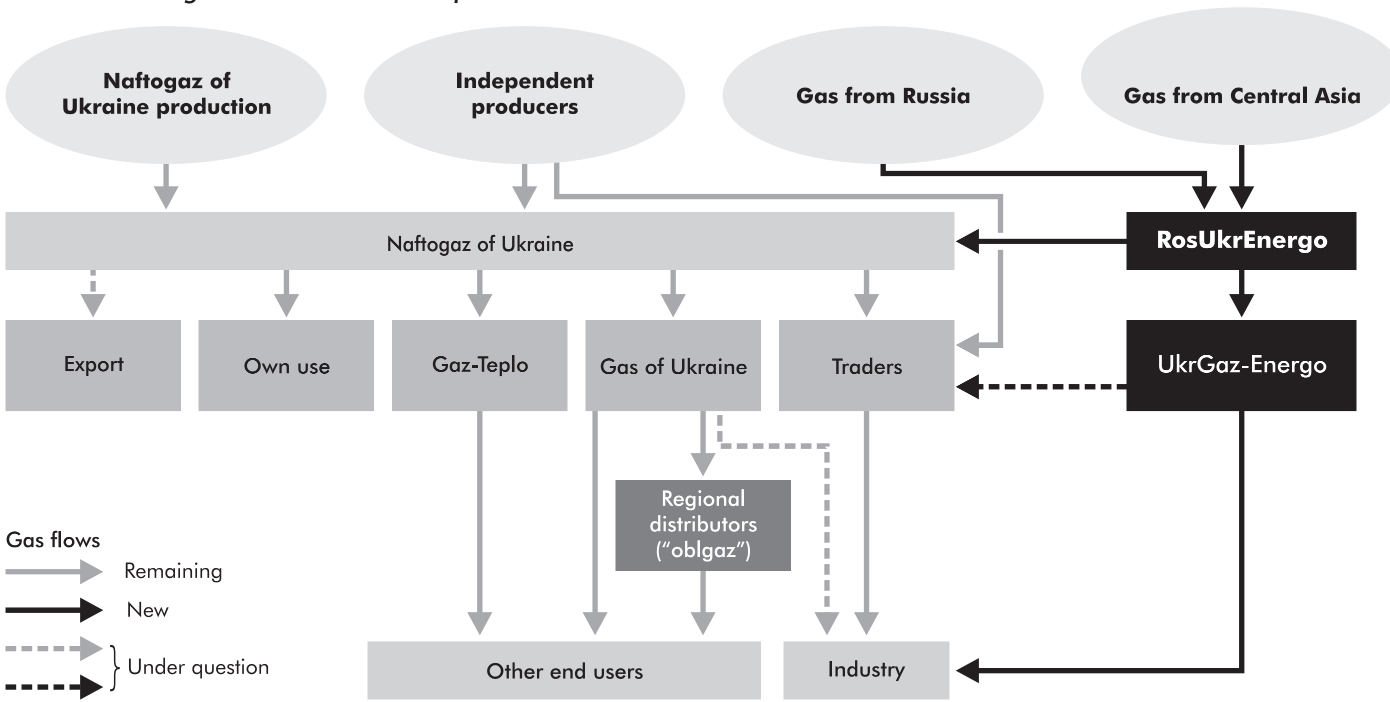
Gas Market Organisation in Ukraine until 2005



Note: Numbers are for 2004.

Figure 5.1b

Gas Market Organisation in Ukraine from 2006



Note: This figure does not include gas storage changes. In 2005, Naftogaz put into storage some 15.5 bcm of gas and withdrew approximately 17.9 bcm.

Sources: Gas of Ukraine, IEA analysis.

Until the end of 2005, the breakdown of revenue for wholesaler Gas of Ukraine was as follows: up to two-thirds (66%) derived from sales to industry; about 24% from sales to residential and commercial customers and district heating companies; and about 11% from sales to power generating companies.

The situation on the gas market changed in 2006. Following the *January 2006* Agreement (Chapter 6: Energy Transit), the intermediary RosUkrEnergo became the principle gas supplier, expected to import 34 bcm of gas to Ukraine in 2006. In February 2006, Naftogaz of Ukraine and RosUkrEnergo created a joint venture, UkrGaz-Energo, to supply gas to Ukrainian domestic consumers. Initially, UkrGaz-Energo received a licence for supplying only 5 bcm at unregulated prices in Ukraine. It contested NERC's decision in court. It is likely that UkrGaz-Energo will continue supplying gas to the most lucrative industrial customers, either directly or via traders. This means that – as in the past – Naftogaz of Ukraine, via its subsidiary Gas of Ukraine, must supply households, district heating companies and the public sector. Only now Gas of Ukraine must do so without being able to recover its losses through sales to industry. This puts destabilising financial pressure on Naftogaz of Ukraine and the Ukrainian gas system as a whole.

Metering

Metering is essential for improving efficiency and transparency of gas market operations. Encouragingly, metering of gas consumption has significantly increased in Ukraine due to targeted regional programmes and the possibility for households to obtain gas meters on credit. In 2001-04, new meters were installed at a rate of about 450 000-650 000 per year. In spring 2005, about 5 million households had meters, which made it possible to meter approximately 67% of total residential gas consumption (Zerkalo Nedeli, 2005). By May 2006, the number of households with meters was nearly 5.7 million (Ministry of Fuel and Energy, 2006d). The government has created an incentive for residential and commercial consumers to install meters: those that have meters are charged a lower tariff compared non-metered consumers.

Potential for Efficiency

There is a great deal of potential for improving gas sector efficiency and reducing operational costs. More than 8 bcm of gas are used yearly to transport gas.[22] This represents a cost of almost USD 760 million, based on the import price of USD 95 per 1 000 m³. Ukrtransgaz uses 5.5 5.8 bcm to meet its own operational needs in gas transportation, and distribution companies use an additional 0.016 bcm for their own needs. Gas losses are another area for improvement: commercial losses in gas distribution networks were 1.9 bcm in 2004, or 2.8% of total gas supply to final consumers. In 2004, gas losses in transportation were 1.06 bcm or 0.5% of transported gas volume. The *Energy Strategy to 2030* expects that gas distribution losses will decrease to 2% and gas transportation losses to 0.3%. Although the gas sector is, by nature, less energy intensive than some other sectors of the Ukrainian economy (such as steel or chemical industries), gas use and losses in transportation and distribution systems are higher than in equivalent systems in OECD countries.

Naftogaz of Ukraine itself actively implements various energy-efficiency measures, including: replacing physically worn-out gas compressor units with new, more energy-efficient models; using exhaust gas to generate electricity; and installing meters at end-users. Thanks to these measures, the company saves the equivalent of 0.27 Mtoe yearly, including 300-340 Mcm of gas.

A significant potential for improving gas use efficiency lies beyond the gas industry per se, *i.e.* at the user end. This is particularly true in the district heating and industrial sectors, which together consume more than 50% of the gas in Ukraine. If captured, the potential for reducing gas consumption in the district heating and industrial sectors is likely to translate into savings of many billion cubic metres of gas, which now go to waste. To realise the benefit from this potential for gas savings, energy efficiency and market pricing must become policy priorities (more details in Chapter 4: Energy Efficiency and Chapter 9: District Heating).

● Price Setting

From 1999, NERC approves methodologies for pricing natural gas, and for transmission and distribution services for all consumer categories. NERC sets natural gas price caps for all customers, as well as tariffs for transporting gas via main and distribution pipelines, and for gas distribution and storage. The Ukrainian authorities deem that such regulation is necessary because natural gas sector is dominated by monopolies.

A central feature of current regulations is the differentiation of tariffs, which is based on the status of the consumer (*e.g.* industrial vs. residential), not on the

22. *Ukrtransgaz transits more than 140 bcm of gas per year.*

real cost of supply. This practice establishes a complicated system of cross-subsidies: relatively high tariffs for industry[23] cross-subsidise low tariffs for residents and public institutions. The Ministry of Fuel and Energy estimates that, by supplying gas to households and other consumers at artificially low regulated prices, Naftogaz of Ukraine provides implicit subsidies of UAH 4 billion (USD 0.8 billion) per year (Cabinet of Ministers, 2006a). An assessment by the World Bank estimates that implicit subsidies in the gas sector reached USD 1 billion in 2001 and 2002. This is equivalent to 2.5% of GDP, which interestingly was also the size of gas transit's contribution to GDP at the time. The World Bank attributes these implicit subsidies to the tariff structure and to other factors including non-payments (World Bank, 2003a).

Because of artificially low consumer prices, Naftogaz of Ukraine cannot cover its costs related to domestic gas supply; it is forced to use income from its other activities to recover losses from domestic gas sales. The company reportedly uses funds from the very expensive credit lines to cover current operations, which may ultimately lead it into bankruptcy. Its financial situation may deteriorate further as the new company, UkrGaz-Energo, acquired the most profitable industrial customers, leaving the residential and public sector to Naftogaz of Ukraine's subsidiary Gas of Ukraine.

A second aspect of the gas price regulation is the idea that gas is supplied and priced depending on its source. Following a Cabinet of Ministers' decree (Cabinet of Ministers, 2001), Naftogaz of Ukraine was forced to supply gas from specific sources to particular groups of consumers – and to price gas at differentiated levels. The same decree discontinued the practice of gas auctions, which existed before 2002. From 2002, the intent was to supply gas as follows: residential consumers and public institutions were to receive domestically produced gas; district heating companies received gas acquired as payment for transiting Russian gas (until the end of 2005); and other industries were supplied with gas purchased from Turkmenistan and other countries. Final consumer prices were thus set on the basis of the gas balance, while the purchase price of gas depended on its origin (domestic production, payment as transit fee or import). This practice does not encourage transparency and undermines the attractiveness of gas production in Ukraine, which is key to energy security.

The Cabinet of Ministers modified this rule in March 2006 (Cabinet of Ministers, 2006b), after Ukraine stopped receiving gas from Russia as payment for transit services. However, the modified decree still requires Naftogaz of

23. Even the industrial tariffs do not always cover all long-term costs.

Ukraine (and other companies in which the state holds more than 50% shares) to supply domestically produced gas to the residential sector.[24] In reality, this requirement has not been fully implemented. For example, one of the leading Ukrainian gas producers, Ukrnafta, refused to sell gas to residential consumers in 2005 and early 2006, arguing that residential tariffs would not allow it to recover its costs. If domestic gas continues to be sold at the lowest prices, there will be little incentive for investment in domestic production.

Regulated Tariffs

Regulated gas tariffs for the population did not change from 1999 to April 2006. From 1 May 2006, NERC raised the natural gas tariffs by 25% for households, district heating companies and budget-funded institutions. In June 2006, NERC raised gas tariffs to households by 85% (Table 5.7). The Cabinet of Ministers requested NERC to set tariffs at cost-recovery levels from January 2007.

The total gas tariff for end-users consists of several components. The energy charge (the price of the gas itself) is paid to Gas of Ukraine or another wholesaler. The charge for transportation via the main pipelines (the same for all gas consumers regardless of their location) is paid to Ukrtransgaz. A charge for transportation via distribution pipelines and supply service charge are paid to oblgaz (local distributor). Consumers directly linked to main pipelines do not pay distribution and service charges.

Table 5.7

Regulated Final Gas Tariffs for End Users (UAH or USD per 1 000 m^3)

Consumer group	Tariffs in 1999		Tariffs on 1 January 2006		Tariffs on 1 May 2006		Tariffs on 1 July 2006	
	UAH	USD	UAH	USD	UAH	USD	UAH	USD
Households with meters	175.0	40.0	175.0	35.0	220.0	44.0	407.0	81.4
Households without meters	190.0	43.7	190.0	38.0	240.0	48.0	444.0	88.8
Budget-financed public organisations	231.0	53.1	288.0	57.6	360.0	72.0	648.0	130.0
District heating companies	189.0	43.5	304.5	60.9	383.4	77.0	686.0	137.0

Sources: Naftogaz of Ukraine; Verkhovna Rada.

24. Naftogaz of Ukraine is also obliged to supply budget institutions, district heating companies and electricity generators that supply heat and electricity to the population.

NERC sets the total tariff cap for different groups of final consumers, as well as a tariff for gas transportation via main pipelines. It then approves the distribution and supply tariffs for each individual gas company on a cost-plus basis. The cost-plus approach to regulation does not provide incentives for cost reductions and efficiency improvements. Moreover, the tariff components do not always cover all costs and provide adequate profit to the relevant company. It is impossible to revise the tariff for any particular service (transportation, distribution, supply) mid-year without amending the overall tariff for end users. In some regions, the transportation or distribution tariff is higher than cost; in others, this tariff is below cost.

VAT Issue

By law, natural gas imported to Ukraine under intergovernmental agreements is exempt from the value added tax (VAT). Until January 2006, industry, district heating and power companies received gas without VAT because all gas imports from Russia and Turkmenistan were in the framework of intergovernmental agreements. The 20% VAT was only applied to domestically produced gas that was supplied to residential and public buildings. In the first half of 2006, no intergovernmental agreement was in place. Thus, industries (including electricity and heating) had to pay VAT on the price of imported gas. This significantly increased the non-payment problems. At the same time, it does not make sense to give imports preferential treatment over domestic supplies. The lost government revenue from the VAT exemption is similar to a subsidy.

• Non-payment Problem

Several years ago there were significant non-payment problems for natural gas, especially among district heating companies and public institutions. The situation has improved significantly in 2004 and 2005. Residential consumers paid more than 100% of their gas bills, *i.e.* paid their current bills and a portion of the accumulated debt. District heating companies' payments also improved, although did not reach 100%. Naftogaz of Ukraine created a special subsidiary, Gaz-Teplo, to address gas debt in district heating companies, although Gaz-Teplo's approach is not necessarily favourable for the sustainability of district heating (more details in Chapter 9: District Heating). Following the rise in gas prices in 2006, the non-payment issue has returned. Gas of Ukraine reported a drop in the average consumer payments from 83% in the first quarter of 2005 to 74% in the first quarter of 2006.[25] Even industries and electricity

25. Most of the non-payments are from district heating companies and state organisations.

generating companies, which had no major problems with paying bills in the past, have started accumulating debt for gas in 2006. The fact that the VAT exemption no longer applied to imported gas in 2006 certainly played a role. Gas of Ukraine has introduced measures to limit gas supplies to non-payers.

Oil and Oil Products

Crude Oil Imports

Ukraine is a net oil importer. Domestic production covers only 16-20% of the country's crude oil demand. Ukraine receives the vast majority (more than 96%) of its crude oil imports from Russia. A small amount (less than 4%) comes from Kazakhstan, although in 2005, Ukraine did not receive any Kazakh oil. Ukraine is seeking to diversify its oil sources, but Russia will likely remain the main supplier.

Naftogaz of Ukraine plans to buy 2-4 Mt of Kazakh oil per year out of the volumes transited through Ukraine's territory, and up to 2 Mt of Libyan oil per year. Naftogaz of Ukraine also plans to produce oil abroad. It has signed Production Sharing Agreements with the United Arab Emirates (UAE) and with Libya. It has also been looking for exploration and production opportunities in Iraq, Syria and several other countries. In addition, Ukraine has signed initial agreements to produce oil and gas in Central Asia, although it is not clear that it will have the financing to invest without other partners. There is also the question of transit through Russia, which has been difficult to negotiate in the past.

Ukraine's refineries were designed to process the Russian Urals grade of crude for a high yield of fuel oil. This low degree of sophistication of the refineries is now a major impediment to the diversification of oil supply. Oil from potential suppliers outside of Russia is of better quality (lighter and less sour) compared to the Urals. It makes no economic sense to process oil of this higher quality at refineries that turn out mostly low value products: the operation would result in a substantial loss on a netback basis.

Domestic Production

Ukraine annually produces about 4.2-4.3 Mt of light, sweet crude oil and gas condensate, 97% of which is produced by Naftogaz of Ukraine. As of 2005, Naftogaz of Ukraine operated 225 oil and gas fields with 2 393 producing oil wells. The major oil production company is Ukrnafta, which produces about

Table 5.8

Crude Oil and Natural Gas Liquids Production in Ukraine (thousand tonnes) 1992-2004

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Crude oil	3 617	3 335	3 155	2 993	2 951	2 855	2 699	2 670	2 626	2 617	2 625	2 814	3 003
Natural gas liquids	857	913	1 043	1 097	1 147	1 248	1 204	1 128	1 067	1 086	1 107	1 153	1 311
Total	**4 474**	**4 248**	**4 198**	**4 090**	**4 098**	**4 103**	**3 903**	**3 798**	**3 693**	**3 703**	**3 732**	**3 967**	**4 314**

Sources: IEA statistics.

2.9 Mt. The *Energy Strategy to 2030* expects that domestic oil production will reach 5.1 Mt in 2010 and 5.4 Mt in 2030. Companies that produce oil and gas condensate in Ukraine must sell them at oil auctions, operated by the Auction Committee.

Exploration and Reserves

The *Energy Strategy to 2030* states that initial proven reserves at producing fields in Ukraine were 422 Mt of oil and 138.6 Mt of gas condensate; the remaining developed reserves, as of 1 January 2005, are 116 Mt (about 847 Mb) of oil and 70 Mt (701 Mb) of gas condensate.[26] This is significantly higher than conventional estimates, which tend to put total Ukrainian reserves in the range of 53.4 Mt (390 Mb).

An independent audit company, Miller and Lents, Ltd, analysed 124 fields owned by Naftogaz of Ukraine and extrapolated the average difference to assess the total reserves in Ukraine. These assessments are listed in Table 5.9.

Table 5.9

Proven Oil and Gas Condensate Reserves of Naftogaz of Ukraine, as of 31 December 2003 (Mb)

Reserve type	Net reserves at 124 fields (independent estimates)	Net reserves at other fields (extrapolated)	Total reserves
Developed, producing	163.2	32.6	195.8
Developed, non-producing	14.1	2.8	16.9
Non-developed	10.5	2.1	12.6
Total	**187.8**	**37.6**	**225.4**

Note: Conventional definition of reserves is applied (Box 5.1).

Source: Naftogaz of Ukraine, 2004.

Most proven oil reserves in Ukraine have already been developed. At fields operated by Naftogaz of Ukraine, nearly 74% of initial proven oil reserves have been depleted (Troika Dialog, 2005). Difficult-to-develop fields account for about 70% of the remaining proven reserves and their share has been growing. Two-thirds of these reserves are situated at depths exceeding 2.5 km, which makes exploitation costly.

26. *Conversion factor for crude oil is 7.3 barrels per tonne; for gas condensate, 10.01 barrels per tonne.*

Ukraine has a fair potential for adding to reserves from yet-to-be discovered resources. The US Geological Survey (USGS) estimates that future discoveries of liquids could amount to about 300 Mt (2 200 Mb), including 92.8 Mt (929 Mb) of natural gas condensate. The USGS estimates that most of the undiscovered oil and gas resources are located onshore in the Palaeozoic system of the Dnipro-Donetsk basin – and could reach 267 Mt (1 952 Mb) of liquids, including 85.2 Mt (853 Mb) of natural gas liquids (USGS, 2000). These are the estimates of potential reserves that are physically available; drilling is necessary to assess the amount of reserves that can be extracted economically. Despite this significant potential, oil and gas exploration activities dropped sharply in the 1990s, resulting in net depletion of reserves. Recently, exploration drilling has increased but it is still not enough to achieve a substantial growth in reserves.

Strategic Stocks

In the autumn of 2004, the government, under former president Kuchma, launched the idea of building strategic oil stocks in Ukraine. Under President Yushchenko, the Cabinet of Ministers included the creation of a 90-day strategic oil reserve in its *Towards the People* programme, and is now considering several options for building oil stocks. One possibility, supported by the Ministry of Economy, is introducing a requirement for distribution companies to create 60- or 90-day stocks of oil products. Another option is to use state budget funds to build state-owned strategic stocks to a level equal to 10% of annual crude oil consumption. The Ministry of Fuel and Energy supports a third option that envisages joint public-private stocks. Regarding who will manage the strategic stocks, two options are under discussion: the State Committee on Material Reserves or the National Security and Defense Council.

Box 5.2 IEA Oil Stocks

IEA requires that its net oil importing countries hold the equivalent of at least 90 days of net oil imports, based on consumption of the previous year, at all times. IEA countries meet this requirement through three broad types of oil stockholding systems:

- **Company stocks,** including compulsory stocks and commercial stocks.
- **Government stocks,** which are financed by the central government budget and held exclusively for emergency purposes.

- **Agency stocks,** which are under government authority and maintained for emergency purposes. These stocks are usually held by a public or private body under a co-operative, cost-sharing arrangement.

About two-thirds of total IEA stocks are held by the oil industry; the remaining one-third is held by governments and specialised agencies. Government stocks and agency stocks are often referred to as public stocks. Since 1980, the number of countries holding agency stocks has increased, whereas the number of countries with government stocks has decreased. The percentage of company stocks in total emergency stocks has declined.

To meet IEA requirements, stocks may be held either in oil products or as crude oil. One benefit of product stocks is that they are available even when refineries are inoperative. However, crude oil is cheaper to store as it is technically easier to maintain. It also provides more flexibility, in that it can be processed into the products needed at the time of the supply disruption. Industry stocks tend to include relatively high proportions of petroleum products, which are used to meet seasonal fluctuations in consumer demand.

During a supply disruption, an IEA collective action would be initiated in which countries would use oil stocks only to assist the market. No such action would be taken for price management purposes, which could cause market distortions.

Oil Refining

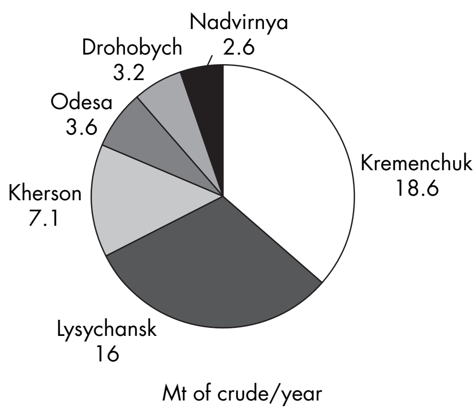
There are six oil refineries in Ukraine. The Ukrainian State owns 43%, 25% and 26% of shares in the Kremenchuk, Drohobych and Nadvirnya refineries, respectively. These shares are operated by Naftogaz of Ukraine. However, it is noteworthy that foreign interests control four out of the six Ukrainian refineries, with an installed capacity of 45.3 Mt per year (about 88% of total). The Ukrainian refineries are as follows:

- Kremenchuk (CJSC Ukrtatnafta), controlled and operated by Ukrtatnafta, a joint venture between the Russian Autonomous Republic of Tatarstan and Ukraine.
- Lysychansk (LiNOS Ltd), controlled and operated by the Russian TNK-BP.

- Kherson (OJSC Khersonnaftopererobka), operated by the Russian Alliance Group; the majority share belongs to the Kazakh national oil and gas company Kazmunaigaz.
- Odesa (OJSC LUKoil-Odesa oil refinery), controlled and operated by the Russian company LUKoil.
- Drohobych (OJSC Halychyna oil complex), controlled by private Ukrainian companies and Pryvatbank.
- Nadvirnya (OJSC Naftokhimik Prykarpattya), controlled by the Ukrainian Pryvat Group.

Figure 5.2

Oil Processing Capacity by Refinery, 2005



Source: Cabinet of Ministers, 2006a.

Ukraine began privatising its refineries in 1999-2000, when refinery output reached its lowest point. From 2001, crude oil processing grew at a high rate and reached more than 21 Mt in 2003 and 2004, when Ukraine became a net exporter of petroleum products. In 2005, both crude oil supply to refineries and refinery production declined; Ukrainian refineries processed only 17.4 Mt of crude, or 28% less than in the previous two years (Ministry of Fuel and Energy, 2004, 2005c, 2006b).

On 23 December 2004, the government adopted a law to suspend the privatisation of oil refining assets. This measure was taken to halt privatisations until the government adopted a comprehensive national privatisation programme and a law on the particularities of privatising oil processing companies (Energobusiness, 2005).

Table 5.10

Oil Product Production and Use in Ukraine, 2004-05 (thousand tonnes)

	Production		Consumption in Ukraine	
	2004	2005	2004	2005
Gasoline	5 209.1	4 648.3	4 990.5	4 761.3
Diesel fuel	6 458.7	5 373.2	5 586.7	5 159.1
Heavy fuel oil	7 761.0	5 832.3	714.7	584.5

Note: About 90% of heavy fuel oil is exported.

Source: Ministry of Fuel and Energy.

In an episode of government interventionism, the Ukrainian government led by the former prime minister Yulia Tymoshenko talked about the possibility of re-privatisation of several dozens of companies, including some refineries, which were seen as having been privatised in a non-transparent and unfair way. Many observers criticised this move, arguing that simply the discussion of "re-privatisation" had a negative impact on the country's investment climate. The Yuri Yekhanurov government subsequently backed away from all re-privatisations.

Ukrainian refineries have excess production capacity: they actually process only 17-21 Mt (124-153 Mb) of crude oil per year, while their design capacity is about 51 Mt (372 Mb) per year. In early 2006, available capacity dropped to around 44 Mt (321 Mb) per year due to the mid-2005 closure of LUKoil's Odessa refinery for a three-year programme of repairs and upgrades (World Markets Research Centre, 2005). The Kherson refinery also closed for reconstruction in August 2005. Several other refineries did not operate full time in 2005.

In recent years, refinery margins in Ukraine have been thin or negative. This is because of three factors: the high export duties on oil in Russia (Ukraine's main competitor in this field); the low taxes and custom duties on imports of refined products; and the inability to sell to markets with higher margins because of the low product quality (primarily high sulphur content).

Refineries are required to pay VAT on imported crude oil. At the same time, tax authorities are supposed to reimburse VAT on oil products that are exported. Several refineries, particularly Kremenchuk and Drohobych, have problems in acquiring the VAT reimbursements. Reportedly, the state tax authorities owe these refineries tens of millions of hryvnias, which exacts a heavy toll on the overall financial position of the refineries.

Ukrainian refineries are not sophisticated by international standards. The "depth of processing" (*i.e.* the share of clean, light products obtained, as opposed to residual heavy fuel oil) varies from 47% at Kherson and 54% at Odesa refineries to 70% at Lysychansk and Kremenchuk (as of 2005). This compares to more than 75% in Belarus and close to 90% in Western countries. In addition, products often do not meet the quality requirements of major export markets. At present, most of the products do not meet EURO 1 standards (*i.e.* those established in 1992), let alone more recent standards with higher aims.[27] The government has undertaken some commitments toward meeting EURO 2 standards. To achieve this goal, Ukrainian refineries would need to invest billions of hryvnias over many years. Additionally, the government has not been very consistent in its policy regarding the quality assurance of refined products. The government has periodically waived limits on sulphur content, and work on the adoption of international standards and legal harmonisation is advancing slowly. Moreover, few laboratories have the capacity to carry out the required analyses.

At present, refining light, low-sulphur crude oil[28] in Ukraine yields low value products, in terms of both quantity and quality. It is therefore less attractive on international markets than the sale of the crude oil. Ukrainian refineries have had little success in convincing suppliers of light crude oil (*e.g.* Azerbaijan and Kazakhstan) to process oil in Ukraine. The low degree of sophistication of Ukrainian refineries can be seen as an impediment to diversifying oil supply and improving energy security. Thus, it makes sense for the Ukrainian government to encourage refineries to upgrade and improve efficiency, which would make them more competitive on the international market.

Although progress is slow, the situation is changing. Recently, TNK-BP undertook upgrades on its Lysychansk plant. LUKoil's programme to modernise its Odesa refinery is another example of progress: while the refinery's capacity will stay the same, the depth of processing is projected to increase from 54% to 80%. The resulting products will meet EU standards and the share of light products in the total output will increase to 65%, from the current 43%. The *Energy Strategy to 2030* calls for an increase in the average depth of processing across the sector, to 73-75% by 2015 and to 85% by 2025.

27. The European Union has introduced emission standards, known as EURO 1-5, that all new road vehicles must meet. These standards become increasingly stringent over time: EURO 1 (1992); EURO 2 (1995); EURO 3 (1999); EURO 4 (2005); and EURO 5 (2008). Fuel standards change simultaneously with EURO standards, reflecting the fact that fuel quality is an important component of meeting vehicle emissions standards.

28. Light, low sulphur oil is generally more expensive than the average Russian crude.

Gas Processing

Affiliates of Naftogaz of Ukraine own and operate several gas processing plants and units. Ukrgazvydobuvannia controls the Iablunivsky gas processing plant, the Shebelynka gas condensate and oil processing plant, the condensate stabilisation unit Basilivchshina, and the Yuliivsky gas liquefaction unit. Ukrnafta controls the Dolynsky, Kachanivsky and Hnidyntsivsky gas processing plants. Shebelynka is the largest and most modern plant. Together, the affiliates of Naftogaz of Ukraine produced 650 000 tonnes of light petroleum products (gasoline and diesel fuel) and almost 343 000 tonnes of propane-butane (LPG) in 2004 (Naftogaz of Ukraine, 2006).

Compressed Natural Gas

There are more than 160 natural gas filling stations in Ukraine that service about 55 000 motor vehicles using compressed natural gas (CNG). Ukrtransgaz owns and operates some 90 CNG filling stations; other public and private companies own the remaining 70. About 400 000 tonnes of light oil products were substituted with CNG in 2005. Many IEA countries would be proud of that kind of achievement because natural gas typically results in lower emissions than oil products. Ukrtransgaz believes that expanding their CNG filling stations network would be a sound business strategy and has included plans to do so in its investment programme. The company also plans to expand its network of service centres for maintenance and repair of CNG vehicles. With the sharp rise of gas import price in 2006, the economics of expanding the CNG business are not very clear.

The *Energy Strategy to 2030* envisages a set of administrative and economic measures to encourage the substitution of liquid motor fuels with CNG. It projects that the use of compressed and liquefied natural gas as motor fuel will substitute up to 4.3 Mt of light oil products, or about 14.4 % of projected demand by 2030. The environmental benefits of this policy are obvious. This policy would also reduce Ukraine's need for oil, but would mean additional demand for natural gas.

Oil Product Distribution

The retail market for oil products has been increasingly competitive since its liberalisation in 1999. Several international and particularly Russian companies (ExxonMobil, Shell, TNK-BP, Lukoil, Tatneft and Yukos) now operate filling stations across the country. TNK-BP had more than 50 filling stations and six storage facilities at the end of 2005, and is planning to increase its network to 150 stations by 2010. Lukoil had more than 160 stations in Ukraine as of October 2005 and was planning to increase the number of its stations to 300-350 with the hope of boosting its market share to 20%.

The Naftogaz of Ukraine's affiliate, Ukrnafta, aggressively entered the retail market and bought more than 390 filling stations by July 2005. It subsequently announced plans to build or purchase more than 1 000 stations across the country by 2007. These plans are consistent with the government's intention to create a national, vertically-integrated oil company. However, such concentration of market power may reduce competition and cause prices to increase.

- **Vertically Integrated National Oil Company**

Under former president Kuchma, Ukraine started moving towards the creation of a vertically integrated national oil company (VINOC) in order to participate in the development of upstream resources, consolidate state-owned stakes in several refineries, and extend the state's role in the retail market for petroleum products. The benefits of this move towards integration are not entirely clear. In fact, an integrated company, particularly one backed by the state, might inhibit competition and distort the market. Moreover, experience worldwide has demonstrated that nearly all state-owned companies perform less efficiently than their private competitors. Such companies run the risk of mixing economic decisions with political considerations; their business interests are often undermined by social programmes, which results in less funds available for research and development, and for investment in new fields.

Nevertheless, the government supports this policy. A presidential decree ordered the transfer of the state stakes in Drohobych, Nadvirnya and Kremenchuk refineries to Ukrnafta. As noted above, Ukrnafta is establishing a chain of retail fuel stations across the country in line with the consolidation move. Supposedly, the processing capacity of the new VINOC would be 13 Mt of crude per year; its distribution network is expected to exceed 2 000 stations, or more than 30% of the existing stations. According to the existing proposals, the VINOC's processing plants would receive all the crude oil produced in Ukraine (about 3-4 Mt) and part of the imported oil. This approach implies the risk that domestically produced oil, sold to one powerful buyer, could be undervalued. It makes more sense to auction Ukrainian oil to the highest bidder.

The creation of a VINOC was delayed because of legal obstacles. To create a VINOC on the basis of Ukrnafta, which is an open joint-stock company with private interests, significant changes in the legislation would be necessary. A special governmental working group considered other possible approaches to creating the VINOC, for example on the basis of Naftogaz of Ukraine or a subsidiary specially created for this purpose.

Import-export Policies

The current policies are designed to discourage export and re-export of crude oil and (to a lesser degree) refined products. The restrictions are also part of the intergovernmental agreements signed with Russia regarding import and transit of crude oil. Another major policy goal is to provide an important stream of revenue into the budget from custom duties and excise tax. In 2005, custom duties and excise tax levied on crude oil and refined products (both imported and domestic) generated about 70% of the revenue in a specially designated fund of the state's budget. Duties and taxes are set by virtue of law, but quantitative restrictions are set by regulations, usually in decrees issued by the Cabinet of Ministers. For example, a Cabinet of Ministers decree of April 2005 set the export quotas for crude oil at zero for 2005.

Neither crude oil, nor refined products are listed as goods that require import or export licences. However, to actually perform export operations, a company must obtain a special permit from the Ministry of Economy.

Given Ukraine's great dependence on Russia for imports of crude oil, some restrictions on re-exports of crude oil and possibly refined products may continue. The primary explanation for these policies is the existence of a two-tier price differential: prices in Ukraine are somewhat lower than prices on international markets, and prices in Russia (where most crude oil originates) are even lower than in Ukraine. Therefore, removing export restrictions and further liberalising the domestic market in order to move closer to competitive international prices would probably result in greater supply of crude oil and higher load factors at Ukrainian refineries. In turn, this would increase revenue for the state budget and create jobs. These benefits would have to be compared to the potential extra cost of imports and higher pump prices of products. At present, the government is pursuing a policy of removing restrictions on exports of products, but discouraging exports of crude oil, in an effort to increase load factors at refineries.

Domestic Market Policies

The retail market for petroleum products is liberalised and highly competitive. However, major disruptions in recent years prompted the government to increase its influence on this market on several occasions.

Following a sudden price rise in the spring of 2005, Tymoshenko's government claimed that the increase was a result of a conspiracy among the Russian companies that dominate the retail market and introduced a slate of new regulations. These included a wholesale price cap, a "recommended" retail price, and a 15% cap on trader and dealer mark-ups. This intervention resulted in a deficit of oil products on the Ukrainian market; refineries preferred to export their products to neighbouring countries, where prices were not capped. A similar situation happened in the United States in the 1970s, when the government's cap on the prices resulted in a severe shortage of oil products and a subsequent economic recession, which lasted several years.

The government and the Verkhovna Rada ultimately addressed the deficit by introducing additional short-term regulatory measures to encourage imports of petroleum products. These measures included introducing a fixed excise duty (instead of the previous minimum duty) and a zero import duty on gasoline and diesel, as well as cancelling the pension fund levy on imported oil products. As a result, oil product imports flooded the country. At the same time, exports of Ukrainian crude oil were prohibited until the end of 2005 and export of gasoline and diesel fuel was forbidden during periods of intensive agricultural activity (April-May and August-September).

President Yushchenko later issued a decree that ordered the government to revoke its regulations. The government of Yekhanurov continued a more market-based approach to oil markets. By the end of 2005, pump prices trended downwards in most regions (Kievskie Vedomosti, 2005).

The oil product crisis forced the government to seek various longer-term measures to reduce energy dependence. The president instructed the government to create stocks of light products, to consolidate the state-owned minority stakes in oil refineries (by transferring those stakes to the state company Ukrnafta), and to develop a programme for the diversification of oil supply. In August 2005, the government created a Commission on Fuel Processing and Retail Market, headed by the Minister of Fuel and Energy, to analyse the market situation and the issues of refineries reconstruction.

The Ukrainian government has announced a desire to build a refinery in Odesa or Brody with a capacity of 8-10 Mt per year. The overall aim is to increase Ukraine's energy security by diluting the power of Russian companies that control the refining and product retail sectors. Many experts predict that this would not be economically justifiable, given the overcapacity at the existing refineries. The construction of a modern oil refinery may cost about USD 1 billion. In contrast, rehabilitating and modernising the Kremenchuk refinery, where the state holds 43% of shares, may cost only USD 200 million. The future of this project is not clear. If the government finances this or similar projects from the state budget, without commercial investment, there is a strong chance the refinery would not find adequate commercial demand. Moreover, state financing of this size would distort the market.

Prices and Taxes

Crude oil and oil product prices in Ukraine are not regulated, although the domestic crude oil market is not entirely competitive. The domestic oil market is somewhat protected due to restrictions on exports and re-exports. In addition, most crude oil is imported to Ukraine by affiliates of vertically-integrated companies involved in refining and distribution, such as TNK-BP, Lukoil and Alliance. Prices for crude are thus driven by company business considerations (profit and tax optimisation) rather than by the market itself. Oil produced domestically is an exception; it must be sold at auctions. However, NERC regulates prices of oil sold to the affiliated companies of Naftogaz of Ukraine. Ukraine is not the only country without a true crude oil market. Azerbaijan, Bulgaria, Georgia, Lithuania, Macedonia and many other countries have markets dominated by vertically integrated companies.

Generally, oil prices in Ukraine are higher than in Russia, but somewhat lower than on truly competitive markets. Low prices are not necessarily a positive thing: if they are the result of distorted and non-transparent price setting, they undermine domestic production, thus reducing energy security.

The oil products market is more competitive than the crude oil market, primarily because refineries sell a large portion of their output to non-affiliated parties (wholesale and retail traders).

Tariffs for transportation of crude oil and refined products via main pipelines are regulated. NERC sets oil transmission tariffs for Ukrainian use and transit. Transportation tariffs vary depending on the volume, distance and direction of transportation, which is a common practice in the world. For example, in December 2002, domestic oil transportation tariffs varied from UAH 2-26.5 (USD 0.36-4.8) per tonne; in December 2003, they varied from UAH 5.3-31.8 (USD 1-5.8) per tonne (net of 20% VAT).

On 1 August 2005, Ukraine introduced new royalty regulations differentiating royalties on oil and gas condensate extraction depending on the field depth. Royalties for extraction from a depth of less than 5 000 metres were increased by 83% – from UAH 300 (USD 58) per tonne to UAH 550 (USD 107) per tonne. At the same time, the royalty on oil and gas condensate extraction from a depth of 5 000 metres and more was lowered to UAH 250 (USD 48) per tonne. The measure is expected to boost state revenue from oil and gas condensate production and simultaneously provide a tax break for more expensive investments in projects at a greater depth.

Critique

Ukraine has pursued many positive developments in the oil and gas sectors over the past years. The retail market for oil products has become highly competitive, with private and foreign companies present in oil refining and distribution. Efforts have been made to attract foreign investment in the oil and gas sector, and to improve the investment climate. In particular, the new royalty regime, with variable rates depending on the depth of the resources, will likely provide better incentives for investment in oil and gas fields.

It is important to note that private companies created almost half of the increase in gas production since 1996, starting from a base of zero. This fact highlights the role private investors can play in increasing gas and oil production in Ukraine and, thus, in improving energy security. However, Ukrainian policy makers have yet to make significant efforts to attract private investment to exploration and production of hydrocarbons. At present, the terms of access to oil and gas reserves for private (and particularly foreign) investors are very complicated. Excessive bureaucracy, corruption, property rights concerns, obligatory sales of gas on domestic market at regulated prices, and export quotas – all of these factors discourages private investment. A major impediment to developing oil and gas reserves in Ukraine is the practice of having separate licences for exploration and production.

The *Law on Production Sharing Agreements* (PSA) introduced many constructive measures to stimulate investment. Unfortunately the law has not been properly implemented. If the government introduces the necessary regulations to enforce the PSA law, it can significantly increase private investment in oil and gas production.

Increasing transparency in the oil and gas sector is important for building investors' confidence and, thus, for attracting the much needed capital.

Public debate seems to have a bigger impact on policy decisions than in the past. Another positive development is the separation of ministerial and business functions, due to the liquidation of the position of Deputy Minister/Head of Naftogaz of Ukraine. In the future, top managers of companies should not be able to hold political office, and vice versa. Yet, more effort is needed to improve the transparency of the market rules on the one hand, and of market actors and operations, on the other hand.

The government and NERC have made significant efforts in the area of the natural gas pricing policy. The gas tariff increases were absolutely necessary for maintaining the sustainability of the Ukrainian gas sector. Further reforms are necessary, though. In particular, current policies that assign prices based on the type of consumer and source of gas supply are untenable, particularly in the face of further upward pressure in import gas prices. Upstream, pricing domestic gas at the lowest rates discourages exploration and production activities. Downstream, multi-tier pricing creates huge opportunities for arbitrage on a grey market and for implicit subsidies that discourage efforts to increase payment discipline and gas utilisation efficiency. The end result is the propensity to import gas rather than produce it domestically, which has a negative impact on the balance of trade and payments, and on investment and employment.

Energy efficiency is another area for improvement. Large losses and inefficient use of gas in the transportation and distribution sectors highlight the need for incentives to reduce leaks and improve efficiency of compressors. Inefficient use by final consumers could also be addressed through specific policies and higher end-user prices. Metering is also extremely important for encouraging efficiency, both of supply and demand. Gas meters provide incentives for end users to save gas, while also prompting suppliers to reduce gas losses in transportation. Significant progress has been made in installing gas meters.

Reforms in the oil processing and distribution sector are somewhat more advanced than in other energy sub-sectors, which can provide useful lessons. Ukraine has a vibrant and competitive oil product market, which generally works quite well. An episode of government intervention has demonstrated that heavy market regulation is counterproductive and should be avoided. Introduction of price regulation in the spring of 2005 led to a deficit of oil products; refiners preferred to export them to other countries where prices were unregulated. When regulations were ultimately cancelled, the stable supply of oil products quickly returned. This supports the argument that a market-based approach is more effective than government intervention.

Another lesson learned is that privatisation can resolve many difficulties but it is not a panacea: effective policies are necessary to stimulate further improvements. Ukraine privatised its refineries when domestic oil processing was in a very difficult situation and production was at the lowest point. For several years following the privatisations, oil refining levels increased and Ukraine became a net oil product exporter. However, the oil processing decline in 2005 demonstrated that Ukrainian refining still faces significant challenges because of outdated equipment, high costs and low quality of oil products. The low degree of sophistication of Ukrainian refineries is an impediment to diversifying oil supply and improving energy security: Ukraine cannot easily draw high-quality Kazakh or Azeri crude to its refineries. From the energy security perspective, it is therefore very important to introduce policies to stimulate refinery modernisation.

Restrictive export policies can also be counterproductive to enhancing energy security. Removing export restrictions and further liberalising the domestic market, while also moving closer to competitive international prices, would probably result in greater supply of crude oil and higher load factors at Ukrainian refineries.

Ukrainian policy makers have a clear objective to increase market stability, which is commendable. However, the means they have used to achieve this objective are not always the most effective. In particular, creating a vertically integrated national oil company (VINOC) seems to be a move in the wrong direction. An integrated company, particularly one backed by the state, might inhibit competition and distort the market, which can ultimately destabilise the market.

Diversification of supplies is another legitimate objective of Ukraine, but diversification improves energy security only when it is economically justified. The Ukrainian government and Naftogaz of Ukraine have recently suggested several options for new supplies that do not seem realistic from the economic point of view (*e.g.* a pipeline from Iran). To have a truly positive impact on energy security, investments must be driven by economics, not only by political considerations.

Creating strategic oil stocks is a valid and necessary policy: they are an important element of national energy security and can significantly reduce vulnerability in case of supply disruptions. There are several possible approaches to creating oil stocks; Ukraine needs to find the most appropriate solution and one that is compatible with its national situation and its aspirations of European integration.

Recommendations

The government of Ukraine should:

General

- Commit to more a market-based approach, based on the lessons learned from the government interventions on the oil product market; use regulation to enhance competition and efficiency.
- Clearly separate business and political functions in running Naftogaz of Ukraine and other state companies.
- Ensure that investments are driven by economics, not by politics.
- Clarify and simplify the rules and conditions for third-party access to pipelines.

Upstream Oil and Gas

- Use transparent, competitive tender procedures for exploration and production licences. Create a mechanism whereby companies that make discoveries have the right to acquire production licences without a new bidding procedure.
- Streamline licensing and permit processes to make them more predictable; make the conditions for revoking licences and permits clear and transparent. This would imply wider reforms in other relevant sectors and in the judicial and court system, which highlights the need for enhanced policy integration.
- Implement and enforce the rules for production sharing agreements.
- Improve taxation and other revenue sharing terms and conditions.
- Set up a national database and a single portal for geology and geophysics information.
- Allow ownership of oil and gas by operators and/or investors at the wellhead.

Natural Gas

- Gradually eliminate cross-subsidies and subsidies; discontinue the practice of pricing gas depending on its source and end user.
- Continue notable efforts to install gas meters.

- Develop a clear strategy for transition to market prices and for enhancing competition on the domestic market. In the meanwhile, continue regulating gas companies to avoid abuses of a monopoly position, accounting for the fact that import supply to the country is controlled by one company (Gazprom and its affiliates).
- Improve regulation to stimulate efficiency; move from cost-plus tariffs toward regulation that provides incentives for cost reduction.

Oil and Oil Products

- Maintain market-based pricing and avoid government intervention.
- Provide incentives for increasing the sophistication of refineries; adopt higher fuel standards and control their implementation.
- Develop a comprehensive plan to create 90-day oil stocks; consider the agency-type approach to stock-holding.
- Remove export restrictions and further liberalise the domestic market.
- Abandon the plan to create a national vertically integrated oil company.

6. ENERGY TRANSIT

Overview

Energy transit in Ukraine is an important economic activity, a source of budget revenue and a guarantee of energy supplies for the country. Ukraine's strategic interest is to maintain and enhance transit volumes. However, the Russian policy of diversifying transit routes could lead to decreasing transit via Ukraine. Oil transit volumes have been declining steadily. Gas transit volumes via Ukraine have remained stable in recent years, although they may decline initially if Russia builds the North European Gas Pipeline. For the most part, oil and gas transit infrastructure in Ukraine is obsolete and needs large investments. Modernising business practices and increasing transparency of transit operations are vital requirements for sustaining the importance of transit via Ukraine. Gas transit operations, in particular, lack transparency, which undermines Ukraine's reputation as a stable transit country. The controversial RosUkrEnergo and the previous gas trading intermediaries have contributed to the opaqueness of the gas transit business. The role of RosUkrEnergo even increased following the January 2006 Gas Agreement, in which Russia and Ukraine renegotiated the previous transit and supply arrangements. To diversify oil supplies and transit opportunities, the Ukrainian state has made significant investments in a new pipeline from Odesa to Brody with the objective to transport Caspian oil to Ukraine and further to Europe. However, this project has been implemented without commercial partners and has not brought the expected outcomes. The pipeline is now used in a reverse mode and only for part of its capacity.

The chapter is based on information publicly available and some materials provided by the Ukrainian government. However, transit arrangements lack transparency. Thus, it is possible that this chapter does not provide a truly accurate, overall picture; some additional, non-disclosed elements may not be reflected in the content. In addition, Russian and Ukrainian officials, experts and journalists have controversial interpretations of the events and agreements discussed in this chapter. This controversy and lack of transparency creates challenges for both countries, particularly in that it undermines the confidence of European countries in regards to Russia as a supplier and Ukraine as a transit country.

Background

• Significance of Energy Transit for Ukraine and Europe

The energy transport infrastructure is a key strategic asset for Ukraine – one that takes advantage of Ukraine's geographic location. In fact, the gas and oil transit infrastructure plays a strong role in determining Ukraine's geopolitical position, as well as its economic and political relations with neighbouring countries. Oil and gas transit pipelines reinforce Ukraine's energy security by ensuring that oil and gas supplies also flow to Ukrainian domestic markets. The transit sector has significant economic importance and has been a major source of state budget revenue. The state company that deals with transit, Naftogaz of Ukraine, received UAH 11.4 billion (USD 2 billion) in 2002 and UAH 10.7 billion (USD 1.9 billion) in 2003 for oil and gas transportation (Naftogaz of Ukraine, 2004). In 2003, Naftogaz of Ukraine paid more than UAH 2.3 billion (USD 420 million) in gas transit royalties and UAH 3.2 million (USD 580 million) in oil transit royalties. Ukrtransgaz, the state gas transportation company, employs 28 000 people; Ukrtransnafta, the oil transportation company, employs 7 000 people (Naftogaz of Ukraine, 2004).

Ukrainian transit is also an integral factor in Europe's energy security. Ukraine is the supply route for approximately 84% of Russian gas exports and about 14% of oil exports to Europe. This makes Ukraine the world's most significant hydrocarbon transit country. European countries rely heavily on Russia for gas and oil imports: on average, 35% of gas imports to European members of OECD (OECD-Europe) come from Russia and Russian gas accounts for 24% of total gas consumption in these countries. The dependence of Central and Eastern European countries on Russian gas imports is even higher: from 74% in the Czech Republic to 100% in the Slovak Republic.

The share of gas in European energy balances is projected to grow. The reference scenario of the IEA World Energy Outlook projects that gas demand in OECD-Europe will increase from 520 bcm in 2003 to 691 bcm by 2020 and to 778 bcm by 2030 (IEA, 2005a). Although EU policy aims to diversify energy supply and sources, Russia will likely remain one of Europe's key gas suppliers. Thus, Ukraine has an opportunity to continue to play an important role in gas transit. At the same time, it is important to note that deliberate Russian policy to diversify export routes may reduce the significance of transit via Ukraine. The relative importance of transit through Ukraine can only be maintained by modernising operations and business practices.

The dependence of European countries on Ukraine for oil transit is relatively high, although much smaller than for gas transit. Russia supplies 34% of crude oil needs in OECD-Europe. Although the bulk of Russian oil is exported through pipelines crossing Belarus and via sea terminals, some 27-32 Mt per year or 14-17% of Russian oil exports still transit Ukraine. The Ukrainian oil transit system capacity is underutilised, and oil transit volumes have decreased in recent years. Oil demand in OECD-Europe is projected to grow to 15 Mb/day in 2010 and 15.7 Mb/day in 2030 from the current 14.5 Mb/day (IEA, 2005a), and the oil import dependence of these countries, currently 54%, will significantly increase in the coming two decades. Russia will remain one of the key oil suppliers to Europe, while oil exports from the Caspian region are expected to grow. Ukraine can remain an important oil transit corridor for Europe if it modernises the system.

In the future, Ukraine can potentially play a large role in electricity transit and cross-border trade. Ukraine itself has been exporting power. The Russian electricity company RAO UES plans to significantly increase electricity production and exports to Europe; these exports could be routed via Ukraine. Cross-border electricity trade is discussed in more detail in Chapter 8: Electricity.

Legal and Regulatory Framework

Ukraine has a *Law on Pipeline Transport*, adopted in May 1996. The law creates the legal framework for the trunk and distribution pipelines for transporting oil, gas, water, heat, sewage, and irrigation systems. High-pressure gas pipelines and the large diameter oil pipelines are considered strategic assets for the country; thus, their privatisation is prohibited.

In 2002, Ukraine adopted a *Comprehensive Programme on Establishing Ukraine as a Transit Country in 2002-10.* This programme outlines measures for improving Ukraine's attractiveness for road, railway, sea and pipeline transit. It proposes the reconstruction and modernisation of oil and gas pipelines, completing the Eurasian oil transport corridor project (Odesa-Brody and Brody-Plock pipelines) and other measures.

According to the 1993 Ukrainian *Law on International Treaties*, international treaties ratified by Ukraine prevail over provisions established in national legislation. In addition to the *Energy Charter Treaty* (Box 6.1), other important international agreements related to energy transit include:

- *Conduct of Co-ordinated Policies in the Area of Transit of Natural Gas* (among CIS countries, 1995).

- *Conduct of Co-ordinated Policies in the Area of Transit of Crude Oil and Refined Products by Main Pipelines* (among CIS countries, 1997).
- *Institutional Basis of the Establishment of Interstate Oil and Gas Transportation System*s (among 21 countries, 2001).

Box 6.1 Energy Charter Treaty

The *Energy Charter Treaty* and the *Energy Charter Protocol on Energy Efficiency and Related Environmental Aspects* were signed in December 1994 and entered into legal force in April 1998. Ukraine ratified both the Treaty and the Protocol in 1998.

The Energy Charter Treaty is a legally-binding multilateral instrument that aims to strengthen the rule of law on energy issues. Thus, it also minimises the risks associated with energy-related investments and trade. The governing and decision-making body for the energy charter process is the Energy Charter Conference, which meets on a regular basis. The Energy Charter Conference is served by a small, permanent Secretariat based in Brussels. To date, 51 states (plus the European Union) are members of the Energy Charter Conference; five, including Russia and Belarus, have not ratified the *Energy Charter Treaty*.

In accordance with the GATT/WTO principles of freedom of transit, the *Energy Charter Treaty*'s existing transit provisions oblige signatory states to facilitate transit on a non-discriminatory basis. However, a growing consensus has emerged within the Energy Charter Conference that these provisions need to be enhanced and strengthened, particularly with regard to problems affecting inter-state transit in the CIS region. Therefore in 2000, the members of the Energy Charter Conference started negotiations on an *Energy Charter Transit Protocol*, aimed at strengthening the existing transit-related obligations on governments. Agreement was reached on the bulk of the Protocol's text by the end of 2002. However, significant outstanding issues, primarily related to differences in position between the European Union and Russia, remain unresolved.

Source: Energy Charter website, www.encharter.org.

Ukraine also has bilateral intergovernmental agreements with several countries, including Russia, Kazakhstan, Turkmenistan, the Czech Republic and Turkey.[29] In addition, it has an agreement with the countries participating

29. *For example, an agreement between the governments of Ukraine and Kazakhstan on* Principles of Co-operation in the Oil and Gas Sectors, *signed in July 1996. The Verkhovna Rada ratified this agreement on 21 November 1997 (Law No. 668/97).*

in the project for the integration of the Druzhba and Adria pipelines (see a further discussion below). As these intergovernmental agreements are part of Ukraine's national legislation, commercial entities must comply with the agreements when entering into contracts and conducting their operations. Supply contracts to the country are heavily intertwined with transit arrangements, especially in the gas sector. The section Transit and Supply: Intertwined Issues discusses intergovernmental agreements between Russia and Ukraine in the gas sphere.

Ukraine also has signed several oil transit agreements. For example, in August 2004, the Ukrainian Cabinet of Ministers signed an agreement with the Russian government on oil transit across the Ukrainian territory. In the same year, it signed an agreement with Kazakhstan on oil transit and supply. The Verkhovna Rada has not ratified these two agreements.

The Interstate Oil and Gas Transport to Europe (INOGATE) Umbrella Agreement, in force since February 2001, sets out an institutional and legal system designed to rationalise and facilitate the development of interstate oil and gas transportation systems – and to attract the investments necessary for their construction and operation. At present, 21 countries participate in the INOGATE Umbrella Agreement,[30] with Ukraine acting as host. Priority goals of INOGATE include upgrading and enhancing the entire Druzhba pipeline, and extending the Odesa-Brody pipeline to Plock.

Gas Transit and Storage

• Gas Transportation System

Ukraine has about 37 600 km of gas transportation pipelines with diameters from 500-1 400 mm and working pressures of 5.4-7.5 MPa (Figure 6.1). Gas distribution networks have a total length of 210 000 km, working pressures of 1.2 MPa and diameters from 50-1 000 mm. The gas transportation assets are owned by the State Property Fund. Ukrtransgaz, a subsidiary of Naftogaz of Ukraine, has the exclusive right to operate almost all of them (except in Crimea). Chornomornaftogaz, another subsidiary of Naftogaz of Ukraine, operates the Hlibivske storage facility and transmission and distribution pipelines on the Crimea peninsula. (See Chapter 5: Natural Gas and Oil

30. Twenty-one countries participate in INOGATE and have signed or acceded to the INOGATE Umbrella Agreement: Albania, Armenia, Azerbaijan, Belarus, Bulgaria, Croatia, Georgia, Greece, Kazakhstan, Kyrgyzstan, Latvia, Former Yugoslav Republic of Macedonia, Moldova, Romania, Serbia & Montenegro, Slovakia, Tajikistan, Turkey, Turkmenistan, Ukraine and Uzbekistan. Source: INOGATE, www.inogate.org.

for more information on the gas sector structure and ownership). Box 6.2 shows the main characteristics of gas transportation pipelines.

The Ukrainian transit system has numerous pipelines running in parallel, with multiple compressor stations serving these lines. This makes the entire system stable and reliable. If one compressor station were disabled, the rest of the system could pick up the load quite easily as there is excess transport capacity in the system. Gas enters Ukraine from several points along the Russian border and from Belarus. Most of the gas exports transit through to the Slovak Republic and then on to other countries (more than 74 bcm in 2004); in addition, some gas is transported to Southern Russia, Moldova, Romania, Hungary and Poland.

Box 6.2 Ukraine's Gas Transportation System at a Glance

• Total length of pipelines:	37 600 km
• Gas transmission capacity	
- input	290 bcm
- output	175 bcm
- including to Western European countries	140 bcm
• Compressor stations	73
• Capacity of compressor stations	5 400 MW
• Underground storage facilities	13
• Capacity of underground storage facilities	32 bcm
• Gas distribution stations	more than 1 600

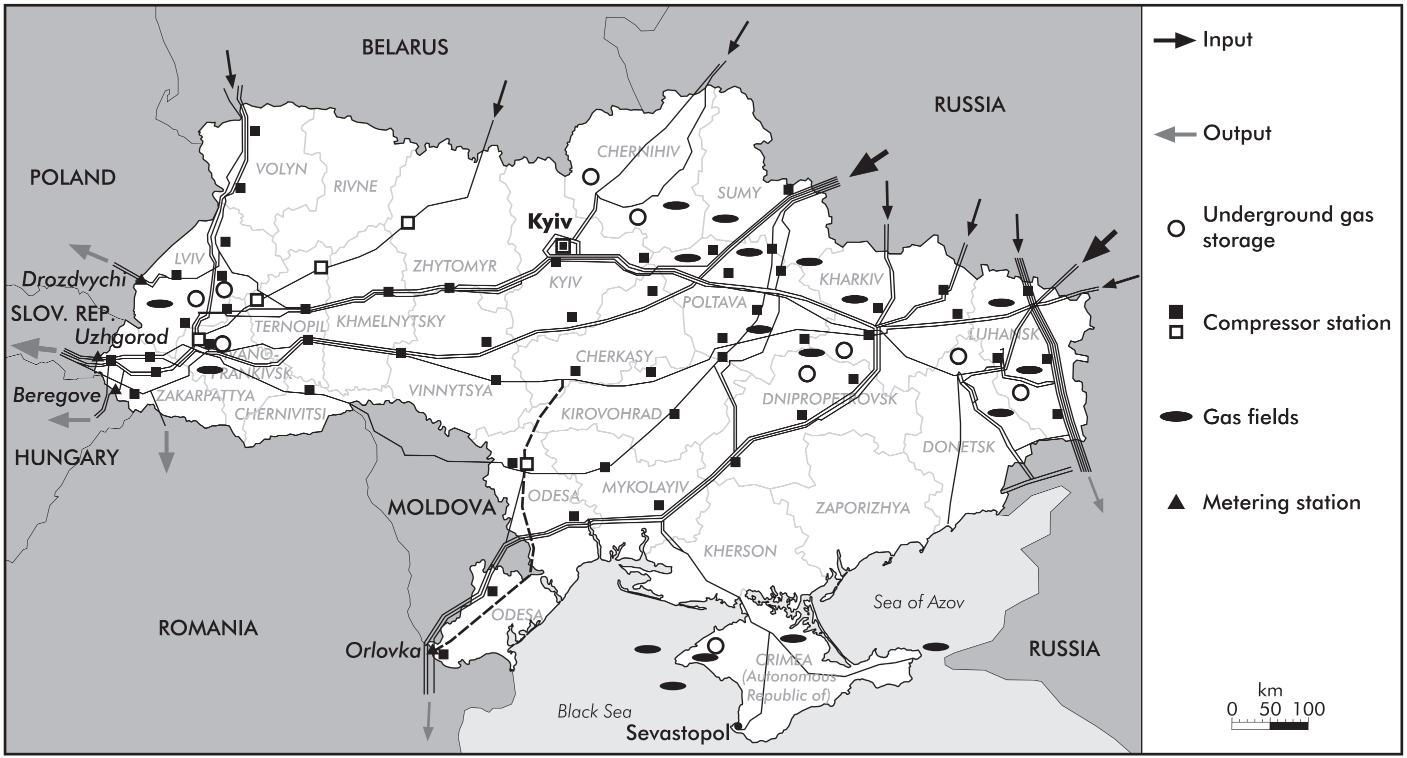
Sources: Naftogaz of Ukraine; Saprykin, 2005a.

Transit Volumes

The total transit volume, including transit to Western Europe, Southern Russia and other CIS countries, was 137 bcm in 2004 and more than 136 bcm in 2005, which represented about 78% of the system's transit capacity (Ministry of Fuel and Energy, 2006b). Total transportation volume, including for domestic use, was around 230 bcm in 2004 and 228 bcm in 2005. Figure 6.2 presents the volumes of natural gas supplies to Europe via Ukraine from 1991-2005. Gazprom has repeatedly declared its plans to

Figure 6.1

Natural Gas Transportation System of Ukraine



Source: Naftogaz of Ukraine.

diversify export routes to bypass Ukraine, thus, the future growth in transit volumes is in question.

Storage

Ukraine has significant gas storage capacity at 13 facilities grouped in four large areas: Carpathian in the West, Kyiv, Donetsk and South Ukrainian, the Western one being the largest. According to Naftogaz of Ukraine, Ukraine accounts for 21% of gas storage capacity in Europe (Russia has 45%).[31] Ukrtransgaz operates 12 of the underground gas storage (UGS) facilities (ten in depleted gas fields and two in aquifers); Chornomornaftogaz operates another facility. On several occasions, Gazprom has indicated its interest in acquiring equity in underground gas storage facilities, but Naftogaz of Ukraine declined.

The storage facilities can contain up to 33 bcm of active gas.[32] In recent years, Naftogaz of Ukraine has injected some 15-18 bcm of gas into storage every summer and has pumped it out in winter, when demand is at its peak. In 2005, for example, Naftogaz of Ukraine pumped in 15.5 bcm and pumped out 17.9 bcm of gas. When the storage facilities are full, it is possible to pump out up to 240-255 Mcm per day (for comparison, the daily demand in winter is around 400-500 Mcm). At the end of the winter season, a significant amount of "cushion gas" remains in storage (this is technically unavoidable). The *Energy Strategy to 2030* states that the gas storage capacity can be increased by 7 bcm per year by reconstructing and modernising three storage facilities: Solokhivske, Proletarske and Bilche-Volynsko-Uherske.

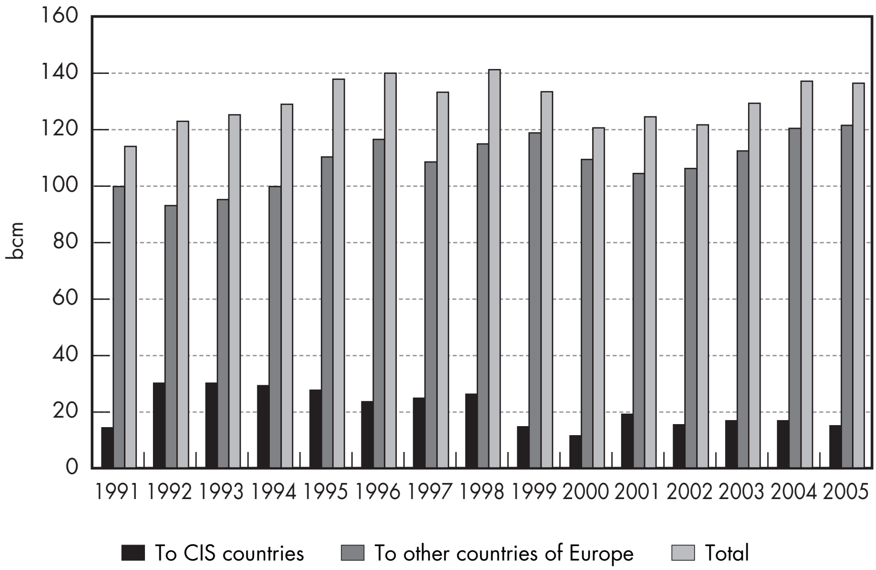
The storage facilities situated in Western Ukraine are used almost exclusively for servicing export; the one in Crimea is used only for servicing markets in the peninsula. Therefore Ukraine cannot use much of its vacant storage capacity for the domestic market. Naftogaz of Ukraine has been trying to sell storage services in Western Ukraine to customers in France, Poland and Germany, but with little success. Gazprom previously stored some gas in Ukraine, which was intended for export to Europe. According to the National Gas Union of Ukraine, Gazprom injected, stored and withdrew nearly 73 bcm of gas to and from the Ukrainian storage facilities between 1993 and 2005 (National Gas Union, 2006); this is equal to about 6 bcm of storage on an average annual basis. However, in the first half of 2006, Gazprom reportedly did not have any gas in Ukrainian storage facilities. According to preliminary Naftogaz of Ukraine data, the 8.8 bcm injected

31. Naftogaz of Ukraine website: www.naftogaz.com.

32. Active gas is gas that can be withdrawn from underground storage facilities without causing damage.

Figure 6.2

Natural Gas Transit via Ukraine, 1991-2005



Sources: Ministry of Fuel and Energy; Naftogaz of Ukraine.

into Ukrainian storage facilities by the end of July 2006 included 2.6 bcm belonging to Naftogaz of Ukraine, 1.6 bcm to RosUkrEnergo, 4.3 bcm to UkrGaz-Energo and the rest to Chornomornaftogaz and other owners (Energobusiness, 2006).

In the summer of 2006, Ukrainian gas storage became a headline issue. As noted, Russia's Gazprom stopped pumping gas into Ukrainian storage in 2006, though it is not clear where it is storing the gas to meet peak winter demand in Western Europe. At the same time, Gazprom and some countries such as Italy publicly expressed concern that Ukraine was not pumping enough gas into storage for its domestic demand, which could potentially result in a gas deficit in the coming winter. The Ministry of Fuel and Energy expressed its concern that it had not been able to obtain a viable supply contract for filling the storage. Former prime minister Yekhanurov publicly confirmed the delay in filling up the storage facilities but stated that Ukraine would be able to inject the necessary volumes by the start of the winter season. The Ministry of Fuel and Energy ultimately announced that the volume of gas in storage would reach 24 bcm by mid-October 2006 (Energobusiness, 2006). When this book went to press, it was not clear who would inject the remaining gas and in what volumes.

Table 6.1

Basic Features of Ukrainian Underground Storage Facilities, as of 2005

Storage Facility	Year of construction	Maximum daily capacity, Mcm		Volume of gas in storage, bcm				Wells		
				Total		Active		Total	Operational	
		Designed	Actual	Designed	Actual	Designed	Actual		Designed	Actual
Bilche-Volynsko-Uherske	1983	160.0	90.0	33.5	32.1	17.0	15.7	423	341	341
Uherske	1969	23.0	20.0	4.0	3.7	2.0	1.8	119	89	88
Dashavske	1973	25.0	25.0	5.3	5.3	2.2	2.2	148	106	99
Loparske	1969	28.0	20.0	4.1	4.8	2.4	2.1	102	103	75
Bohorodchanske	1979	50.0	46.0	3.4	3.4	2.3	2.3	169	160	156
Solokhivske	1987	9.5	9.9	2.0	2.0	1.2	1.2	112	82	81
Oleshivske	1964	3.0	2.5	0.7	0.6	0.3	0.3	79	40	40
Chervono –Partyzanske	1968	13.0	12.5	3.0	3.0	1.5	1.5	105	68	67
Kehychivske	1988	8.7	8.5	1.3	1.3	1.0	0.7	66	64	52
Proletarske	1986	12.2/30.6	8.2/-	2.0/6.8	2.0/1.2	1.0/ 3.4	1.0	292	84/162	82/32
Krasnopopivske	1973	5.5	4.4	0.8	0.8	0.4	0.4	57	40	40
Verhunske	1987	11.0	3.0	0.9	0.9	0.4	0.4	112	77	73
Hlibivske	1983	13.5	4.0	2.8	1.0	1.5	0.5	132	119	84
Total		**393**	**254**	**68.5**	**62.2**	**35.6**	**30.0**	**1 916**	**1 535**	**1 310**

Source: Naftogaz of Ukraine.

Storage fees relating to international contracts are set in US dollars (USD) through negotiations between companies. Gazprom reportedly paid, on average, USD 4.95 per 1 000 m^3 for gas injection, storage and withdrawal in 1993-2005 (National Gas Union, 2006). NERC regulates storage tariffs for the gas that is supplied to Ukrainian consumers. Gas storage tariffs for the Ukrainian market remained constant from 2000-05 at the rate established by NERC at UAH 10 (USD 1.80) per 1 000 m^3 (without VAT) for injection, storage during one year and withdrawal (Naftogaz of Ukraine, 2004). In May 2006, NERC decided to raise storage tariffs more than three-fold to UAH 33 (USD 6.60) per 1 000 m^3: UAH 18 (USD 3.60) for storage and UAH 7.5 (USD 1.5) each for injecting and withdrawing (Interfax Ukraine, 2006). This is significantly higher than the USD 2.25 per 1 000 m^3 that RosUkrEnergo reportedly pays for storage in Ukraine, according to the January 2006 Gas Agreement.

Gas Storage Controversy

In April 2005, Gazprom claimed that Ukraine had not satisfied its requests to extract Gazprom's gas intended for exports from underground storage, and that 7.8 bcm of gas had "disappeared". Ultimately, Gazprom officially accepted that the gas was not missing. The incident was odd as Gazprom maintains staff at important points in the Ukrainian gas transportation system.

The issue was settled on 17 July 2005, when Naftogaz of Ukraine, RosUkr-Energo and Gazprom signed a package of agreements on the following:

- 2.55 bcm of the gas in storage was to be transferred to Naftogaz of Ukraine in lieu of payment for the increased gas transit in 2005.
- Gazprom sold 5.25 bcm of the gas in underground storage to RosUkrEnergo at about USD 150 per 1 000 m^3. RosUkrEnergo is drawing down this gas in three stages to finish by the end of 2006. This means that Russian storage in Ukraine to meet peak European demand has declined.
- Russia was to increase gas transit through Ukraine by 8 bcm in 2005 and by 8-11.5 bcm in 2006. However, this has not yet happened.

Metering and Dispatch

Metering is provided at 12 entry points to and 10 exit points from the gas transmission system, as well as at gas distribution stations, at compressor stations and underground gas storage injection/withdrawal sites. Representatives of Gazprom work at the entry and exit points and the central gas dispatch centre in Kyiv, thereby allowing Gazprom to monitor the volumes of transited gas. Gas used by compressors as fuel is also metered. The main metering stations at the entry and exit points to the system are also capable of chemical analysis of the gas. In recent years, considerable work has been done to introduce modern flow meters and automatic modes of operation management at compressor units and dispatch units. However, there are still opportunities for improvement. The European Commission is collaborating with Ukraine and Russia on improving border metering installations. Also, more effort is needed to ensure that the entire Ukrainian transportation system will be able to use the modern SCADA[33] systems.

The United Dispatch Directorate of Ukrtransgaz manages the overall operational dispatch of the gas passing through the Ukrainian transportation system, including the transit volumes and the gas for Ukrainian consumers and for the underground storage facilities. Each of the six main pipeline departments of Ukrtransgaz[34] has a dispatch division of its own, with functions similar to those of the central dispatch. Further dispatch is carried out at the subdivisions of the main pipelines and at local gas distribution stations. However, information on dispatch operations at the local level is not always well collected and reported. Thus, while there is careful monitoring on the flows in and out of the country, the quality of information on flows within the country could be enhanced.

Investment Needs and Plans

A large share of gas transportation assets in Ukraine needs modernisation or replacement. About 29% of gas pipelines and gas compressor units have already exceeded their designed service life; more than 60% of pipelines have been in use for 10-33 years. The gas transit system in Ukraine is extremely inefficient. For example, turbo-compressors at the pumping stations are very old and much less efficient than similar installations in Western Europe (on average, turbo-compressors in Ukrainian gas pipelines have a 25% efficiency rate). This inefficiency burdens the system, diverting financial resources from more extensive upgrades and making it more difficult to operate the system in a profitable way.[35]

The Ukrainian government estimates suggest that UAH 92.4 billion (USD 18 billion) must be invested in the gas transportation network by 2030. According to a Ukrainian expert, the gas transportation system needs annual

33. SCADA - Supervisory Control And Data Acquisition – refers to software systems that are used in industrial processes.
34. Kyivtransgaz, Kharkhivtransgaz, Lvivtransgaz, Prikarpattransgaz, Donbastransgaz and Cherkasytransgaz.
35. Optimising Russian Natural Gas: Reform and Climate Policy *(IEA, 2006) is a book that examines efficiency at Russian compressor stations and how Kyoto mechanisms can help attract investment in gas savings and emission reductions. This study can be useful for Ukraine as well.*

Table 6.2

Projected Investments in the Gas Transportation System Reconstruction and Modernisation under the National Programme Oil and Gas of Ukraine to 2010 *(USD million)*

	2001	2002	2003	2004	2005	2010	Total 2001-10
Reconstruction, including							
Pipes	85.84	101.29	117.24	128.94	133.32	219.22	1 459.35
Compressor stations	36.20	82.40	101.70	114.82	82.60	22.00	729.60
Underground storage	69.20	94.70	112.40	115.40	99.20	59.40	661.80
Treatment units	0.81	0.80	1.20	1.31	0.74	-	6.06
Automobile gas filling stations	2.83	2.63	4.46	2.21	8.10	5.16	95.38
Scientific and technical support	18.20	19.10	20.00	20.90	20.90	22.10	214.50
Reconstruction, total	**213.08**	**300.92**	**357.00**	**383.56**	**344.86**	**277.48**	**3 166.69**
New construction, total	**125.10**	**379.60**	**618.20**	**368.00**	**351.00**	**2.10**	**1 953.60**
Combined total	**338.18**	**680.52**	**975.20**	**751.56**	**695.86**	**279.58**	**5 120.29**

Note: Data for 2001 are statistical; data for the other years are projections.

Source: Razumkov Centre, 2002.

investments of USD 1.2 billion. In fact, Ukrtransgaz invests some USD 750 million per year, which is primarily for maintenance and not for upgrades (Saprykin, 2005a). Naftogaz of Ukraine has declared that it is looking to attract foreign investment for implementing large projects that include (Babiyev, 2002; Ukrtransgaz, 2002):

- Efficiency upgrades at compressor stations, including replacing the existing compressor units and control systems with new domestically-produced equipment rated at 31-37% efficiency.
- Use of cogeneration technologies at gas compressor stations to produce up to 16 billion kWh of electricity per year.
- Turbo-expanders at gas distribution stations or gas control points.
- Rehabilitation of existing pipelines to enhance their reliability and efficiency; construction of new gas pipelines.
- Rehabilitation of Ukrtransgaz cable communication lines.

- Metrological support to gas metering within GTS; possible creation of an automated monitoring system (SCADA).
- Rehabilitation of the Uherske underground gas storage facility.

Naftogaz of Ukraine announced, in the autumn of 2005, that it was planning to invest USD 2 billion in the gas transportation system in the next three years. This investment would be partially financed by a USD 2 billion credit from the Deutsche Bank, which Naftogaz of Ukraine secured for seven years at LIBOR[36] rate plus 5% interest. According to Naftogaz of Ukraine's official announcements, this loan would be used to invest in new gas fields and modernise the gas transportation and distribution system. However, part of the credit funds has reportedly been spent on current operations. According to press reports, Deutsche Bank has frozen further disbursement of the loan. The company has also discussed a possible loan of EUR 2.5 billion (USD 3.2 billion) with the French bank Société Générale.

The protracted lack of investment in maintenance and modernisation of the Ukrainian gas transportation system has raised questions about its cost-effectiveness and reliability over the long term (although no major outages have occurred to date).

International Gas Consortium

The Ukrainian government initially signed a tri-partite agreement on a consortium with the governments of Russia and Germany in June 2002. The negotiations that followed focused only on Russian involvement and, in October 2002, Russia and Ukraine founded the International Consortium for the Control and Development of the Gas Transportation System of Ukraine.[37] The negotiations on legal, ownership and business issues related to allowing a third party into the Consortium have been very limited, according to press reports. From the beginning, the decision to create a consortium was quite controversial. Proponents argued that such a consortium would help Ukraine effectively attract much-needed financing for the gas transportation system. At the same time, many Ukrainian experts and policy makers publicly expressed concern that a consortium would allow Russia and Gazprom to exert their influence over Ukrainian policies.

The initial idea of the Consortium was to focus on refurbishing and operating some of Ukraine's main transit lines and building at least one new line. However, as negotiations proceeded, Gazprom made it clear

36. London Interbank Offered Rates (LIBOR) is a widely used international benchmark for short-term interest rates.
37. The formal document that created the Consortium is the Agreement between the Cabinet of Ministers of Ukraine and the Government of Russia on Strategic Co-operation in the Gas Sector, *7 October 2002.*

that it wanted the Consortium to take on debt to finance the investment. The Ukrainians decided soon afterwards that, without direct capital investments, they should not give Gazprom the majority ownership of the Consortium. Gazprom and Naftogaz of Ukraine then decided to refocus the consortium on building and operating a small additional pipeline, not on operating the main pipeline system. Thus, the scope of the Consortium was reduced in 2004-05 to only the construction of a new 234-km line from Bohorodchany to Uzhgorod, a de-bottlenecking exercise to raise the transit capacity by 19 bcm. Subsequent disputes between Naftogaz of Ukraine and Gazprom delayed construction. In April 2006, the Consortium announced that a Ukrainian company, Naftogazbud, had won the tender to construct the Bohorodchany-Uzhgorod pipeline, which would cost about USD 560 million.

In early 2005, soon after the presidential elections, there were renewed discussions on reviving and restructuring the Consortium. President Yushchenko insisted on having a third party, likely Germany's E.ON Ruhrgas, participate in the Consortium. Gazprom seemed reluctant to do this. Bringing a third party into the Consortium is clearly in Ukraine's interest: a Western firm could bring investment that Gazprom alone would not provide. Additionally, a third party would limit Russian control over the Consortium, which is an important concern for Ukraine. A third party from a European gas-consuming country could contribute to a better dialogue within the whole gas supply chain, which would increase the stability of gas supply and transit via Ukraine. Alternately, a third party could also be an investor from a non-European country (*e.g.* from North America or Asia) that could bring in modern technology and business operation practices.

The Consortium is not the only possible option to attract investment in the reconstruction and modernisation of Ukraine's gas transportation system. One key reason for stalling development of the Consortium is Ukraine's concern about foreign control over its strategic assets, particularly in light of the fact that Gazprom has seized control of gas sector assets in many other countries of the former Soviet Union (see the section Gazprom's Leverage). With careful planning and transparent rules, Ukraine could eventually involve foreign partners in the much-needed investment in the gas transportation system without unduly jeopardising its energy security. Other countries in similar positions have successfully used leases, concession agreements and even privatisation to achieve such goals.

Transit and Supply: Intertwined Issues

Background

For many years, gas transit and domestic production have allowed Ukraine to keep domestic prices at a low level. Additionally, gas transit has been an important source of budget revenue because Naftogaz of Ukraine is required to pay a royalty to the state budget for the gas transited through Ukraine.[38]

Transit and supply arrangements have been settled between Russia and Ukraine on two levels – in intergovernmental agreements and in contracts between Russian and Ukrainian gas companies. In general, the intergovernmental agreements provide the policy framework, guarantees and approval of terms; volumes, prices and other commercial terms of supply are made legally binding in contracts.[39] Analysis of transit and supply arrangements is difficult because the texts of commercial contracts are not publicly available and their interpretation by the Russian and Ukrainian officials has been quite controversial. Even though more information has become available (Box 6.3), the complete picture is still vague. For example, it is unclear why Ukraine did not seek recourse to international arbitration when Gazprom demanded a drastic increase in the price of gas in 2006. According to Annex 4 to the Long-term Contract between Gazprom and Naftogaz of Ukraine, reportedly signed in August 2004 (see below),[40] the price of USD 50 per 1 000 m^3 of gas that Ukraine received as transit payment was not subject to change from 2005-09. Nor is it clear why Gazprom did not seek arbitration before disrupting gas flows to Ukraine.

The *Agreement between the Governments of Ukraine and Russian Federation on Export of Russian Natural Gas to Ukraine and its Transit through the Territory of Ukraine to European Countries* of 18 February 1994 (the 1994 Gas Agreement) established a policy framework that apparently persisted until 2005. The keystone of that framework was the idea of balancing Russian and Ukrainian interests in the gas sphere through a combination of interrelated arrangements in supply, transit, storage and, at times, other services. The 1994 Gas Agreement provided that, from 1994-2005, the Russian government allowed Gazprom to:

- Export 50-70 bcm per year to Ukraine.
- Transit 112-144 bcm per year through the Ukrainian territory to Europe.

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38. From the beginning of 2001, Naftogaz of Ukraine paid a royalty of USD 0.29/1 000 m^3/100 km.

39. The role of intergovernmental agreements has changed somewhat over the years. Between 2002 and 2005, the agreements "clarified" the price, but the price was also set in the contracts. Because the commercial contracts are not, for the most part, publicly available, it is not possible to know the relationship and respective roles of the intergovernmental agreements and contracts with precision.

40. A copy of this document was released by Yulia Tymoshenko.

Box 6.3 Documents and Transparency in the Gas Sector

The free press and "opposition" politicians in Ukraine have played an extraordinary role in releasing information about the gas relations between Ukraine and Russia. Former prime minister Yulia Tymoshenko released the text of the January 2006 Gas Agreement soon after it was signed. A few weeks later, Ukrainian journalists obtained copies of additional "secret" agreements signed on 4 January 2006. Previously, gas contracts were never released and are still considered commercial secrets. Ukrainian newspapers have also printed documents relating to RosUkrEnergo's creation and many details about the gas supply. For example, Ukrainian trade journals now regularly publish gas balances that list the companies and sectors that buy and sell gas, as well as stock changes. That said, there is much about the gas sector that is not known; basic decisions about gas trade are kept in the hands of relatively few people.

- Transit 25-35 bcm of Central Asian gas through the Russian territory to Ukraine (Central Asian imports to Ukraine are discussed in more detail in Chapter 5: Natural Gas and Oil).

In turn, the Ukrainian government agreed to the transit of the stipulated volumes of Russian gas and to ensuring the expansion of transit capacities through its territory. The 1994 Gas Agreement prohibited the re-export of Russian gas supplied to Ukraine and limited the export of gas produced in Ukraine.

According to the 1994 Gas Agreement, the Russian and Ukrainian gas companies, Gazprom and, at that time, Ukrgazprom, were to sign annual contracts defining commercial and technical details of gas transit, export and storage. Transit and storage fees and export prices for Russian gas were negotiated as a package. Ukraine could pay for part of the gas imports in barter, in other words, by providing transit and storage services, as well as other services or goods. In subsequent years as part of annual contract negotiations, the parties amended the fees for transit and storage of Russian gas several times, with the corresponding amendments to the price of gas supplied to Ukrainian consumers. However, the overall balance of interests in the "package" remained approximately the same. According to the National Gas Union of Ukraine, from 1993-2005, the average fee for transiting Russian gas through Ukraine was USD 1.19 per 1 000 m^3 (varying from USD 0.65 to 1.75 per 1 000 m^3). The average price for gas imports to

Ukraine was USD 57.60 per 1 000 m^3 over the same period (varying from USD 50 to 80 per 1 000 m^3) (National Gas Union, 2006).[41]

Box 6.4 Transit Volumes and the Debt Issue

In 1998, Gazprom alleged that Ukraine had illegally diverted gas from transit. In response, Russia unilaterally suspended exports of oil and electricity to Ukraine in 1999. According to press reports, Gazprom declared that it would charge for the allegedly illicit gas off-take at a rate of USD 83 per 1 000 m^3. Gazprom also claimed that Ukraine's debt had, accordingly, reached USD 2.8 billion. The parties initially settled the debt issue on 4 October 2001, when Russia and Ukraine signed an intergovernmental agreement on *Additional Measures Regarding the Provision of Transit of Russian Natural Gas on the Territory of Ukraine* (the 2001 Transit Agreement). Ukraine agreed to pay USD 1.43 billion plus almost USD 200 million of interest. Naftogaz of Ukraine was required to repay the debt at LIBOR plus 1 percent over 13 years; it issued Eurobonds to restructure and secure this debt. However, Gazprom asked for a delay in implementing the agreement when it realised that it would have to pay Russian taxes on the income.

Because of Gazprom's tax concerns, in July 2004, Gazprom and Naftogaz of Ukraine signed an amendment to their Long-term Contract, which changed the debt repayment mechanism. Gazprom on paper paid Naftogaz of Ukraine USD 1.25 billion for transiting 19.2 bcm/year in 2005-09. The payment occurs in annual advances of USD 250 million, which are immediately put against the debt. As a result of this amendment and the use of the advance payments to repay debt, Ukraine was to transit a total of 19.2 bcm/year of Russian gas without physical payment in gas in 2005-09. Thus, the volume of gas that Ukraine expected to receive as in-kind payment for transit services was decreased by some 5 bcm/year. This created a gas deficit in Ukraine.

According to press statements, in the second half of 2005 Naftogaz of Ukraine sought to re-negotiate the debt restructuring agreement, and particularly to return to cash payment for the debt in order to receive more gas as transit fee. Mass media quoted Gazprom officials

41. In January 2006, Russia's President Putin stated that Russia had been subsidising Ukraine for the last 15 years by providing cheap gas. In response, the National Gas Union of Ukraine released calculations, which, if correct, show that Ukraine's losses from providing transit and storage services were presumably greater than Gazprom's losses from supplying gas to Ukraine.

as saying that Gazprom could not accept cash payment from Ukraine and supply more gas to Ukraine in 2006. Ukraine apparently faces a significant shortfall in gas supply in the second half of 2006, based on government statements.

Following the 1998-99 dispute over the alleged diversion of gas (Box 6.4), the Ukrainian Cabinet of Ministers and the Russian government signed two intergovernmental agreements on 22 December 2000: *On Guarantees for Transit of Russian Natural Gas on the Territory of Ukraine* (the 2000 Transit Guarantee Agreement) and *On Terms of Backup Supply of Russian Gas to Ukraine and Payment in 2001* (the 2000 Supply Agreement).[42] These agreements included provisions to address possible non-contracted use of Russian gas by Ukraine. Ukraine had to pay USD 80 per 1 000 m^3 plus interest for any gas taken above the volume specified in the contract between Naftogaz of Ukraine and Gazprom. Russia, in turn, agreed to act as a balancing supplier in cases of shortfall of Turkmen deliveries (up to 5 bcm/year) and during the winter (up to 1 bcm per month as a technical credit). Such supplies were not to be considered as "non-contracted" gas use. Because they were part of an intergovernmental agreement and not a contract, these provisions may still have been in force in January 2006 when Gazprom complained about excessive Ukrainian withdrawals during an extreme cold snap.

According to the 2001 Transit Agreement (Box 6.4), Russia and Ukraine are required to sign (every year) an intergovernmental protocol that specifies and provides the governments' approval of five elements: i) The volume of gas transiting through the territory of Ukraine; ii) The volume of payments for the transit services in gas and/or in monetary payments; iii) The rate of payment for transit; iv) The price of gas supplied as payment for the services; and v) The volume of gas exported from the territory of Ukraine. As it was between governments, this agreement did not contractually oblige the companies. Thus, the 2001 Transit Agreement also required Gazprom and Naftogaz of Ukraine to sign a long-term contract on gas transit and supply. In response, Naftogaz of Ukraine and Gazprom signed, on 21 June 2002, a long-term contract on the volumes and conditions for transiting Russian natural gas through the territory of Ukraine for the period from 2003-13 (the Long-term Contract). In August 2004, Gazprom and Naftogaz of Ukraine signed Annex 4 to the Long-term Contract, according to which the price of

42. Ukraine ratified both 2000 agreements on 15 November 2001. On the same date it ratified the 2001 Transit Agreement, which extended (until 2013) most provisions of the 2000 Transit Guarantee Agreement.

USD 50 per 1 000 m3 of gas, which Ukraine received as transit payment, was apparently not subject to change between 2005-09.

Developments in 2006

In implementing the 2001 Transit Agreement, Ukraine and Russia were required to sign annual intergovernmental protocols on gas transit and gas supply – by the end of the first six months of each year, for the forthcoming year. In June of 2005, Gazprom informed Ukraine that it wanted to set a new price for gas supply to Ukraine. The parties continued their difficult negotiations for the rest of 2005 and only managed to reach a compromise in early 2006, after Gazprom briefly stopped deliveries of both Russian and Turkmen gas to Ukraine in January 2006.

On 4 January 2006, Naftogaz of Ukraine, Gazprom and RosUkrEnergo signed the *Agreement on Regulating the Relations in the Gas Sphere* (the 2006 Gas Agreement).[43] In this Agreement, fees for transiting Russian gas via Ukraine are set separately from prices of imported gas and are fixed for five years at USD 1.60 per 1 000 m^3. This can be seen as an important first step to move away from the previous practice, in which transit and import of Russian gas were closely intertwined. However, RosUkrEnergo still requires payment in kind for its transit services from Central Asia to Ukraine. (Ukraine will reportedly pay RosUkrEnergo 14 bcm for transporting gas to Ukraine in 2006). The barter arrangement with RosUkrEnergo now apparently includes Russian gas, whereas previously it applied only to Central Asian gas. If gas imports and transit continue to be entangled in the future, the potential for conflicts and disputes will remain rather high. This approach makes both sides of the import/transit equation rather opaque and makes contract management difficult.

Naftogaz of Ukraine has not been able to enforce its alleged contract with Turkmenistan, signed in late December 2005. All deliveries to Ukraine have been taken over by RosUkrEnergo, which is to first buy gas from Gazprom at a formula-based price (set at USD 230 per 1 000 m^3) and from suppliers from other countries (Turkmenistan, Uzbekistan and Kazakhstan) – and then re-sell it to Ukraine at its border. (There have been conflicting statements about whether Ukraine is getting any Russian-sourced gas in 2006). The 2006 Gas Agreement set the gas price for the first half of 2006 at USD 95 per 1 000 m^3 and prohibits all Ukrainian exports. Subsequent pricing and tariff setting is left open to negotiations. RosUkrEnergo is to supply 34 bcm in 2006 and up to 58 bcm per year from 2007. In early July 2006, RosUkrEnergo agreed

43. An agreement between companies does not have the same legal force as an intergovernmental agreement.

to allow Ukraine to continue paying USD 95 per 1 000 m^3 for an unspecified period of time.

The 2006 Gas Agreement leaves open many issues such as gas supply after June 2006, the contracting of gas transit on an annual basis, and the prices from the second half of 2006 onwards. In addition, the Agreement fails to clarify the status of Ukraine's contract for Turkmen gas, although it does indicate that Naftogaz of Ukraine will provide RosUkrEnergo with Turkmen gas, presumably based on a contract with Turkmenistan. RosUkrEnergo would then supply this gas to Ukraine at a higher price. The Agreement does not directly cover gas transit through Russia, nor does it affect the advance payments for transit through Ukraine, which are deducted annually from Naftogaz of Ukraine's debt to Gazprom.

In fulfilling a requirement of the 2006 Gas Agreement, Naftogaz of Ukraine and RosUkrEnergo created a joint venture, Ukrgaz-Energo, on 2 February 2006. This company will sell the gas supplied by RosUkrEnergo on the domestic market (Chapter 5: Natural Gas and Oil).

Soon after the signing of the 2006 Gas Agreement, the Verkhovna Rada voted to dismiss the Ukrainian government, partially justifying its vote with the claim that the government had "betrayed" national interests in the gas deal with Gazprom and RosUkrEnergo. President Yushchenko rejected the vote and the decision as "unconstitutional". The Verkhovna Rada created an investigation commission to monitor the economic activity of Naftogaz of Ukraine, its personnel policy and its work to supply Ukrainian consumers with natural gas in 2006.

Gas Trading Intermediaries

Since the collapse of the Soviet Union, the gas trading middlemen companies have been among the most opaque and controversial issues in the gas business in the region. Starting in the mid-1990s, Itera managed transit of Turkmen gas through Russia to Ukraine. A Hungarian-registered company, EuralTransGas, took over from Itera in January 2003; RosUkrEnergo replaced EuralTransGas in mid-2004 (Box 6.5).[44]

For many years, these intermediary companies purchased gas at Turkmenistan's border and sold it to buyers in Ukraine and Eastern Europe. These companies did not own or operate the pipelines that transported gas through Russia and Ukraine, but dealt with paperwork related to gas transit

44. EuralTransGas announced the closure of its office in Ukraine in August 2005.

Box 6.5 EuralTransGas and RosUkrEnergo

EuralTransGas, registered in Hungary, named three previously unknown Romanians and one Israeli as its principals. Allegations of corruption and of EuralTransGas' links to organised crime (although they were not officially proved) may have contributed to Gazprom and Naftogaz of Ukraine's decision to move away from EuralTransGas. EuralTransGas was replaced by RosUkrEnergo, which began operations on 1 January 2005.

RosUkrEnergo was registered in Zug, Switzerland, on 22 July 2004. Its shares were split equally between ARosgas Holding AG and Centragas AG. The documents available do not clearly identify the beneficiaries of either part of RosUkrEnergo. ARosgas Holding AG apparently was linked to Gazprombank, though it is not clear if was directly owned by Gazprombank. Gazprom reportedly later purchased the 50% of RosUkrEnergo that Gazprombank controlled. However, existing documents suggest that the real ownership of 50% shares may still be unclear.

Centragas AG, the other RosUkrEnergo owner, belongs to Raiffeisen Investment AG holding, which is, in turn, part of the Austrian RZB Group. In August 2005, the Ukrainian government announced that it had made an official proposal to Raiffeisen Investment to purchase its shares in RosUkrEnergo. In late 2005 and early 2006, there were also talks about Naftogaz of Ukraine acquiring 50% of RosUkrEnergo's shares, but Raiffeisen Investment AG refused to sell them. In April 2006, the Gazprom-owned newspaper Izvestia disclosed that the beneficiaries of the 50% shares of RosUkrEnergo were two Ukrainian businessmen, Messrs Firtash and Fursin.

Sources: Radio Free Europe / Radio Liberty; Interfax-Ukraine; Kyiv Post; Zerkalo Nedeli.

and exports, typically receiving extraordinarily lucrative compensation for their services. EuralTransGas reportedly exported 35.7 bcm in 2003 (including 33 bcm to Ukraine) and made a profit of USD 180 million. RosUkrEnergo's profit was reportedly USD 740 million in 2005. Itera was acquiring 41% of Central Asian gas that it supplied to Ukraine; EuralTransGas received 38%, and RosUkrEnergo was receiving 37.5% until the end of 2005. In 2006, RosUkrEnergo apparently will receive 14 bcm for transiting 22 bcm of Turkmen gas, which will be equivalent to 64% of the gas that it transits.

The price that Ukraine pays for the intermediaries' services seems extremely high. In 2005, Ukraine paid RosUkrEnergo 13.2 bcm for transiting 36 bcm of gas from Turkmenistan via Russia. The market value of these 13.2 bcm of gas was USD 2.1 billion assuming a price of USD 160 per 1 000 m^3.[45] This means that the implicit transit fee that Ukraine paid RosUkrEnergo is very high.

Ukrainian state security police started a criminal investigation against RosUkrEnergo in 2005. According to the head of the state security police, the abuses by RosUkrEnergo management might have led to losses to the state budget of more than USD 1 billion (Gas Matters, 2005). There were allegations in the press that RosUkrEnergo was related to organised crime groups, but Raiffeisen Investment managers denied that RosUkrEnergo has such links.

Despite strong voices in favour of eliminating intermediaries and negotiating new methods of managing gas imports, the 2006 Gas Agreement effectively increased the role of RosUkrEnergo, making it the only gas importer to Ukraine. This led to renewed questions about transparency in the gas sector.

It is obvious that Ukraine should be interested in eliminating the use of opaque intermediaries that do not add value to transit operations. To do so, Ukraine would have to sign direct supply contracts. At present, it is virtually impossible to import Central Asian gas independently of Russia because Central Asian gas must cross the Russian territory. Ukraine should insist on eliminating the intermediary services in its future negotiations.

Regional Factors Affecting Ukraine's Position in Gas Supply and Transit

Market Prices

Ukraine is not the only country that has seen a sharp price increase for Russian gas. In July 2005, the Russian parliament, Duma, approved a bill that stipulated increasing the gas price for Ukraine and other former Soviet Union states to the level of Western Europe. Gazprom's officials, Russia's President Putin and the Minister of Foreign Affairs all publicly supported the drive to bring prices to "market levels". Other countries (besides Ukraine) that faced Gazprom's requests for contract price renegotiations include Armenia, Azerbaijan, Belarus, the three Baltic States, Bulgaria, Georgia, Moldova and Poland. The results of these negotiations varied, depending on the country's geopolitical situation and other factors.

45. Wholesale prices in Western Europe in 2006 were approximately USD 260 per 1 000 m^3, while in some Central European countries, they were still below 200 per 1 000 m^3. The import price in Ukraine was USD 95 per 1 000 m^3.

Bringing prices up to market levels is, in principle, a reasonable proposition. However, at least two other considerations should be kept in mind. First, Gazprom has consistently prevented access to competing sources of gas, establishing for itself captive markets in Eurasia. Second, there seems to be no clear indication of exactly how prices are set in these captive markets. For example, it is not very clear, from the economic point of view, why the gas price for Belarus has long remained much lower than for neighbouring countries. Another concern related to Gazprom's new pricing policy is security of supply. Frequent demands to increase the gas price ahead of schedule in many countries leads to continuous haggling over prices and greatly increases the risk of gas supply interruptions.

Gazprom's Leverage

Ukraine's seemingly weak position in the international gas business is not unique. Many other countries are affected by the growing influence of Gazprom. By 2004-05, Gazprom had entered in virtually all segments of the gas supply chain (gas production or purchase, transportation, imports, trade and distribution) in Central Asia, Caucasus, the Balkans, Ukraine, Moldova, Belarus and in some new EU member states (Box 6.6). The Russian-Ukrainian gas dispute has strengthened Turkmenistan's position and has given Turkmenistan more impetus to push for an increase in its gas prices. However, since Russia is the only outlet for all gas in Central Asia (other than a small quantity shipped from Turkmenistan to Iran), Gazprom's influence on gas producers in the region is very strong. Gazprom's consolidated network starts in Turkmenistan, transits Uzbekistan and Kazakhstan, enters Russia and veers towards Ukraine and Belarus to supply the local markets. It also directs the remaining gas to consumers in the Baltics, Central, Western and Southeast Europe. It is not surprising that Ukraine has less leverage in its negotiations on gas supply and transit contracts with such a powerful actor. However, Ukraine does have leverage due to its geographical position between Russia and Europe. Unfortunately, Ukraine has not made particularly good use of this leverage.

The expanding vertical monopoly of Gazprom is in contrast to the EU's policy of liberalising gas markets in EU members and neighbouring countries. It becomes quite impossible to pursue gas market liberalisation in a country that is dependent on a single supplier (which is also present in domestic distribution) and is forced to assign its transit capacity to a single user. One may question whether prices established by such a monopoly are really "market prices". These developments run contrary to the spirit of widely accepted market rules – and of multilateral instruments such as the Energy Charter Treaty.

Box 6.6 Gazprom's Increasing Control

• Upstream: Taking over Access to Pipelines

Over the last few years, Gazprom and its affiliates have been actively establishing special relationships in Uzbekistan and Kazakhstan to take control of the capacity of all main gas pipelines leading out of these countries.

In Kazakhstan, Gazprom signed an agreement with Intergaz Central Asia, a subsidiary of the state-controlled KazTransGaz, itself a joint venture between Gazprom and Kazmunaigaz. According to this agreement, Gazprom is to restore the old gas supply system in Central Asia, including all main transit and export routes (Central Asia-Centre, Bukhara-Ural, and Orenburg-Novopskov pipelines) and to manage the entire capacity of the restored system.

As part of its "special relationship" with Russia, Uzbekistan transferred to Gazprom the management of the transit and export gas pipeline infrastructure in the West of the country. The understanding is that Gazprom will arrange for purchases of Turkmen gas and operate the system that transports Turkmen gas across Uzbekistan (2 trillion m^3 until 2028) (Energy Charter Secretariat, 2005).

• Transit: Taking over Routes

Gazprom has tried to restrict transit of Central Asian gas to markets by taking over transit pipelines in key transit countries. This is usually done by establishing joint ventures with the pipeline owner/operator in the relevant country. By obtaining majority stakes in these joint ventures, Gazprom positions itself to influence market developments and transit fees. By mid-2006, Ukraine, Bulgaria and Georgia rejected such an offer from Gazprom; Kazakhstan accepted it partially; and Belarus, Moldova and Uzbekistan accepted it. Requests to set up joint ventures in which Gazprom has more than 50% interest are often timed when contracts expire or are renegotiated. The requests are coupled with promises to ease contract terms, invest in system upgrades, or reduce or waive debt for earlier gas supplies (if such debt exists).

• Downstream: Taking over Distribution

Gazprom has pursued a strategy of buying out or setting up new distribution companies throughout its already captive markets. There is virtually no former Soviet Union or Eastern European country in which Gazprom is not present in gas distribution. In some countries, it has either a dominant or monopoly position as a distributor, as well.

Russia's Export Route Diversification

The Russian government and Gazprom officials declared Russia's objective to decrease its dependence on transit countries, including Ukraine. Russia reduced the volume of gas transited through Ukraine in 1999, when the Yamal-Europe pipeline started shipping Russian gas via Belarus to Poland and further to Western Europe. Today, the Yamal pipeline's capacity is 33 bcm per year and there are plans to increase it to more than 60 bcm per year. Another alternative route, the USD 3.4 billion Blue Stream pipeline linking Russia and Turkey under the Black Sea, came into operation in February 2003. An agreement between Russia and Turkey intends to increase gas supplies up to 16 bcm by 2008, though only 1.3 bcm of Russian gas was delivered to Turkey by way of the Blue Stream Pipeline in 2003 and deliveries in 2004 and 2005 were much lower than initially contracted.

In January 2004, the Russian government approved the construction of the North European Gas Pipeline (also known as the North Transgas pipeline) designed to deliver Russian gas to Germany and possibly Sweden via the Baltic Sea. Russia and Germany signed an agreement on this pipeline in September 2005. If completed, this USD 5.7 billion sub-sea pipeline, with a capacity of 27.5 bcm per year,[46] would allow Gazprom to bypass Belarus and Ukraine and open up a new – though expensive – route for Russian gas exports to Western European markets. Gazprom has started construction of the onshore leg of the pipeline. However, progress on financing the pipeline has been slow, and Gazprom pushed back the plans to launch the pipeline to 2010 from the originally planned 2007. In the meantime Russia will continue to rely heavily on Ukraine for transit services to Europe.

In theory, Russia's diversification plans would not necessarily affect Ukraine's gas transit in a negative manner if Russia increases its export volumes (both through Ukraine and by bypassing it) to meet the projected demand growth in Europe. However, Gazprom is making very few investments in its production fields. If the Russian gas sector manages to finance its expensive planned pipelines, but is not able to increase production to meet both domestic demand and growing export needs then

46. When the first 27.5 bcm line is built, Gazprom and its partners will decide if a second line is needed, which may bring the total capacity to 55 bcm.

transit via Ukraine may shrink. (Transit may also decrease if Gazprom builds the new pipelines and then finds demand lagging, as happened with Blue Stream.) Under any circumstances, the North European Gas Pipeline will give Gazprom more market power, and will have the effect of weakening the leverage that Ukraine now enjoys as Russia's pre-eminent export route. The incremental effect of this weakening may be significant.

Diversifying Ukraine's Transit Opportunities

Russia is trying to diversify its exports routes to reduce its dependence on Ukraine for gas and oil transit. At the same time, Ukraine is aiming at diversification of gas and oil sources and at exploring other transit opportunities. In July 2005, Ukraine and Iran signed a Memorandum of Understanding on building a pipeline that would carry Iranian gas to Ukraine and further to Europe. The two countries now envisage conducting a feasibility study of this pipeline that would carry about 20 bcm via one of two possible routes: Iran-Armenia-Georgia-Russia-Ukraine-Europe or Iran-Armenia-Georgia-Black Sea-Ukraine-Europe. There are, however, serious geopolitical, economic and technical concerns that indicate the proposal may never materialise. The long distance and very high cost – preliminarily estimates are USD 5-10 billion – raise questions about the economic viability of the pipeline. Financing is also an issue. The nuclear weapon proliferation issue with Iran is one significant barrier for potential investors. The Black Sea option may cause technical operational problems; not to mention possible environmental and political opposition from both Russia and Turkey.

Oil Transit

Oil Transportation Network

The oil transportation network in Ukraine includes 19 main oil pipelines and has the capacity of 114 Mt per year at the intake and 56.3 Mt at the output. Box 6.7 shows its main characteristics. The oil transportation system includes a railway loading terminal at Brody with the capacity of 4.5 Mt per year and an oil terminal at the port Pivdenny[47] with the oil shipment capacity 14.5 Mt per year. There is also an export terminal for shipping crude oil and oil products in Odesa with the capacity 315 000 barrels per day (b/d) (which actually ships 192 000 b/d) and a small oil terminal in Feodosia (Cabinet of Ministers, 2006a; Saprykin, 2005a; Kliuk, 2002).

47. In Russian sources, the port Pivdenny is often called Yuzhny.

Box 6.7 Ukraine's Oil Transportation System at a Glance

Total length of pipelines:	4 600 km
Oil transmission capacity	
- input	114 Mt/year
- output	56.3 Mt/year
Pumping stations	51
Capacity of pumping stations	550 MW
Accident response units	22

Source: Naftogaz of Ukraine.

The oil network consists of three main pipelines: Druzhba, Prydniprovsky and Odesa-Brody. The Druzhba pipeline splits into two branches at Mozyr in Belarus; its Southern branch crosses nine Ukrainian regions and runs to the Hungarian and Slovak borders. The other branch supplies oil to the Drohobych and Nadvirnya refineries in Ukraine. The Prydniprovsky pipeline system interconnects nine pipelines that enter Ukraine in the Northeast and the East, and crosses eleven regions of Central, Southern and Eastern Ukraine. It transports crude oil to the Odesa, Kherson, Lysychansk and Kremenchuk refineries and transports Russian and Kazakh oil for export through the sea terminal at Odesa (Figure 6.3).

The oil transportation network is operated by Ukrtransnafta, a joint-stock company within the holding company Naftogaz of Ukraine. It signs oil transportation and transit contracts with oil producing and trading companies.

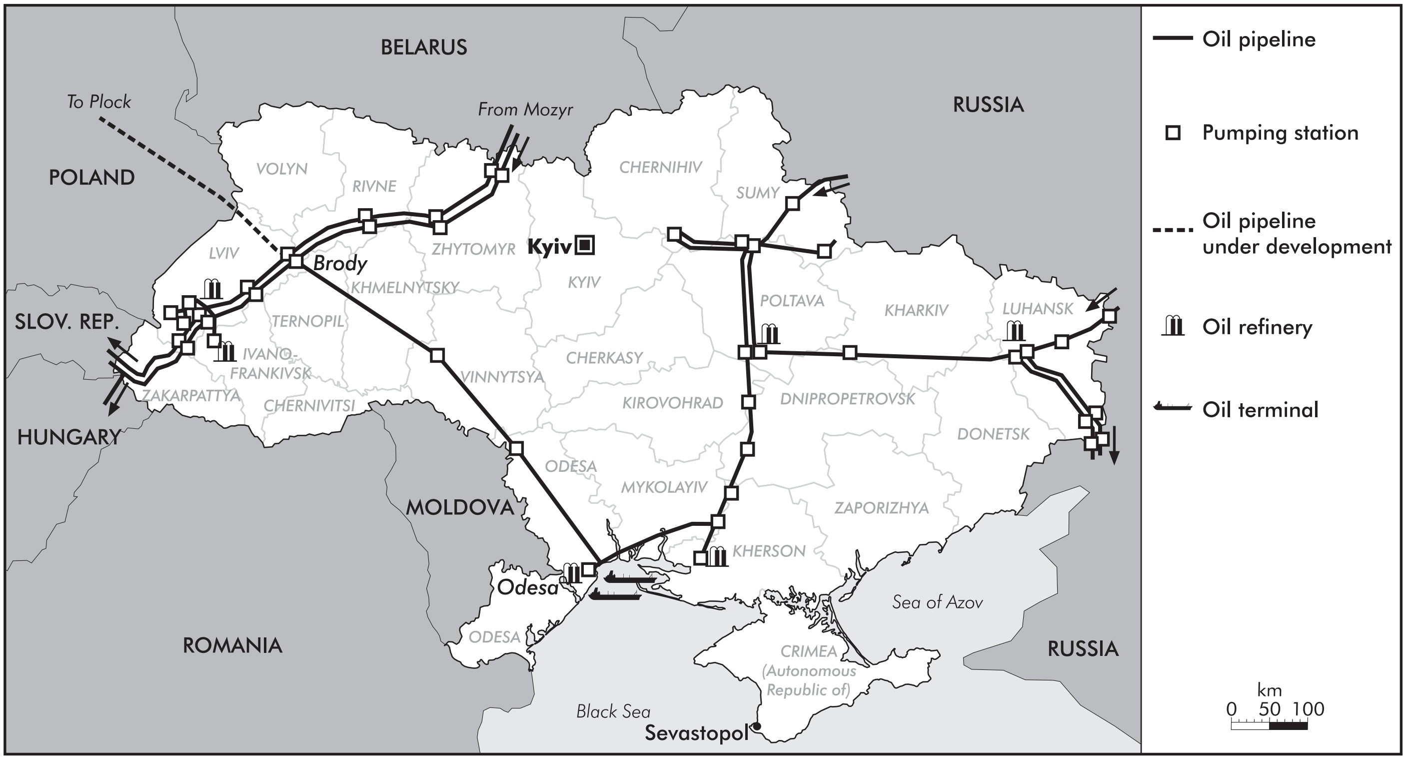
Transit Volumes

In comparison with gas, oil transportation volumes have been decreasing since 1991 (Table 6.3 and Figure 6.4). In 2005, the volume of oil transported in Ukraine was 46.7 Mt, almost 16% less than in the previous year. Oil transit (31.8 Mt) decreased insignificantly in 2005, but deliveries to Ukrainian refineries dropped sharply. Oil transportation through the Odesa-Brody pipeline grew from 1.05 Mt in 2004 to 5.7 Mt in 2005. This increase took place at the expense of reduced transportation via other Ukrainian pipelines.

Transit of Russian oil via Ukraine is decreasing, although oil production in Russia continues to grow. This is related to the diversification of Russian

Figure 6.3

Oil Transportation System in Ukraine



Source: Naftogaz of Ukraine.

Table 6.3

Characteristics and Utilised Capacity of Ukraine's Oil Transport System

Name of pipeline	Design capacity, Mt/year	Actual transmission capacity, Mt/year	Volume shipped in 2004, Mt	Capacity utilisation in 2004, %
Samara – Lysychansk	90.0	62.0	27.8	45.0
Michurinsk – Kremenchuk	18.0	18.0	6.1	34.0
Mozyr – Brody	34.0	34.0	20.2	60.0
Odesa – Brody	14.5	14.5	1.0	7.0
Total	**156.5**	**128.5**	**55.2**	**43**

Source: Cabinet of Ministers, 2006a.

oil export routes (see section Diversification of Russian Export Routes). For example, the Ukrainian pipeline Lysychansk-Tikhoretsk has been practically unused since 2002 because Russia built an alternative pipeline, the Sukhodolna-Rodionivka, which does not cross Ukraine.

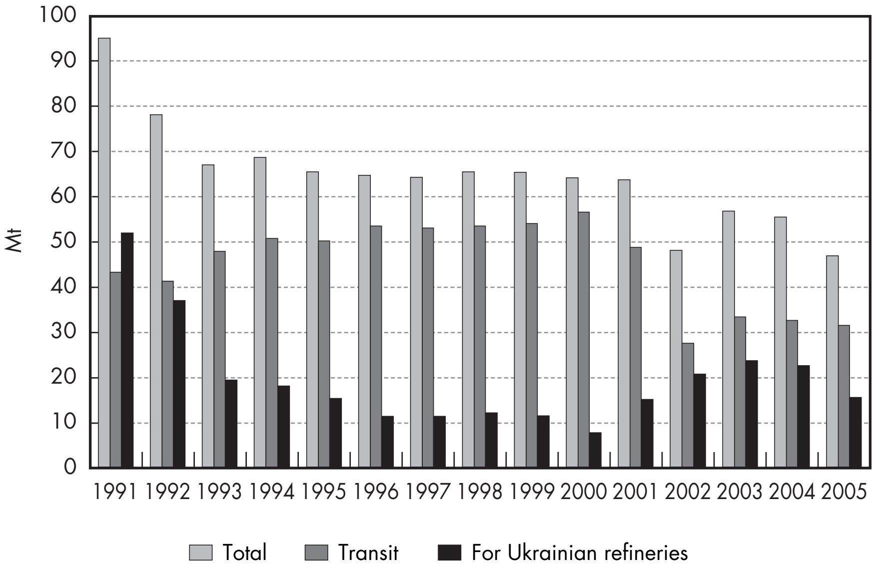
Kazakh oil transit through Ukraine has been growing in recent years: 7.15 Mt in 2002, 7.82 Mt in 2003 and 7.66 Mt in 2004; estimated 6.5 Mt in 2005. However, Kazakh oil supply to the Ukrainian refineries has been decreasing from 2.31 Mt in 2002, 1.13 Mt in 2003, 0.8 Mt in 2004 to no supplies in 2005 (Energobusiness, 2005). Longer term, there may also be an issue of security of Kazakh oil flows to Ukraine: Kazakh flows through Russia to other countries (particularly to the Baltic States) have been disrupted in the past.

Investment Needs and Plans

According to the *Energy Strategy to 2030*, oil pipelines and related equipment have been in use for 20-44 years; up to 90% of them are outdated. According to Ministry of Fuel and Energy estimates, day-to-day maintenance and repairs to keep these outdated facilities operating cost at least UAH 500 million (USD 100 million) per year. The total investment needs for repairs and modernisation through 2010 are estimated at UAH 4 billion (USD 0.8 billion). In 2005, according to the *Programme of Technical Examination and Diagnosis of the Oil Pipeline System*, Ukrtransnafta planned to invest in three areas: UAH 200 million (USD 40 million) in construction, reconstruction and modernisation of pipelines; UAH 145 million

Figure 6.4

Oil Transportation through the Ukrainian Oil Transportation System, 1991-2005



Sources: Naftogaz of Ukraine; Ministry of Fuel and Energy.

(USD 29 million) in major repairs; and UAH 20 million (USD 4 million) in diagnostic examination of pipelines.

The *Energy Strategy to 2030* highlights the need to raise the characteristics of Ukraine's oil transportation system to international standards. This requires adopting modern, more energy-efficient technologies and improving management. In the *Energy Strategy to 2030*, the government outlines plans to increase oil transportation volumes to 65 Mt by 2010 and to 70 Mt by 2015. However, the actual trend toward the decrease of oil transit via Ukraine suggests that these plans may not be realistic. The government assumes that two projects would drive this increase: integrating the Druzhba and Adria pipelines and extending the Odesa-Brody pipeline to Plock (Poland). Many international experts believe, however, that both of these projects will unlikely be realised. Surprisingly, the *Energy Strategy to 2030* does not talk much about modernising the main Ukrainian oil transit route, the Druzhba pipeline. Ukrtransnafta has announced its goal of increasing the capacity of Prydniprovsky oil pipelines between the towns of Kremenchuk, Snigurivka and Avgustrivka.

Integrating the Druzhba and Adria Pipelines

Ukraine is participating in a project to integrate the Druzhba and Adria pipelines. This project, initiated by the Russian state company Transneft aims to reverse the flow of the Adria pipeline, so that it will run from the Druzhba pipeline in Slovakia to the sea terminal of Omisalj in Croatia. The reversed line will provide Russian crude a direct access to the Mediterranean market. The route is more than 3 000 km and passes through Russia, Belarus, Ukraine, Hungary, Slovakia and Croatia. In December 2002, these six countries signed a co-operation agreement to develop the project. If implemented, this project will increase oil transit through Ukraine by 5-15 Mt per year. However, its implementation has been delayed because of strong opposition to the project in Croatia and the Balkans more generally.

Eurasian Oil Transit Corridor and Odesa-Brody Pipeline

The Ukrainian government views the proposed Eurasian Oil Transit Corridor as a strategic direction for developing Ukraine's transit potential, particularly as transit of Russian oil is expected to decrease. Ukraine plans to transport up to 10 Mt of oil by 2010 and up to 20 Mt by 2015 from the Caspian region (Kazakhstan, Azerbaijan) and the Persian Gulf (Iran, Iraq and others) via this corridor. Some international experts are concerned about whether this proposal is economically feasible.

In 1998, the Ukrainian authorities decided to build a new pipeline to transport oil from Odesa to Brody (a point in Ukraine, on the Druzhba oil pipeline), as part of the proposed Eurasian Oil Transit Corridor. However, the project was not supported or financed from the beginning by upstream and downstream companies. The investment required included the construction of a major new sea terminal at Pivdenny (9-12 Mt initial capacity), storage facilities of 200 000 m^3 and the pipe itself. The 674 km long pipeline has an initial rated capacity of 9-12 Mt per year (180 000-245 000 b/d) with a possible expansion up to 45 Mt. It was built at a minimum cost of UAH 500 million (USD 96 million), or UAH 1 billion (USD 192 million) with the sea terminal. The project was financed by loans to the Ukrainian state from domestic banks.

Many international observers believe that the financial burden created by the project is disproportionately large, and criticise the decision to build the pipeline as economically unjustified. In addition to its high cost, the following factors undermine the prospects for the Odesa-Brody pipeline:

- Transportation of oil from Caspian countries via Odesa-Brody is more expensive than the current routes.

- There is no significant oil consumption at the pipeline's end point, Brody, so an extension to Central or Western Europe is necessary. However, the vast majority of oil refineries in Central Europe were designed to process Russian crude, not lighter Caspian crude.
- Exporting oil from Odesa to Brody, then onward via the Druzhba pipeline, requires only a partial use of the Odesa-Brody pipeline capacity. Moreover, there are economic, legal and geopolitical barriers to this option.

Nevertheless, there are several factors that may ultimately increase the economic attractiveness of the Odesa-Brody pipeline:

- Demand for lighter Caspian oil may grow in Europe in the medium term, in response to modernisation of refineries in Central Europe (such as the recent modernisation of the Czech Kralupy refinery), increased capacities, and more stringent environmental requirements for refinery emissions and oil products.
- Oil export capacity through the Black Sea is limited due to existing bottlenecks; oil transportation costs by sea tankers are constantly growing; Turkey is strengthening regulations related to tanker transportation through the Bosphorus and the Dardanelles.

The Odesa-Brody pipeline was tested in May 2002, but then remained unfilled due to the absence of commercial proposals. In 2004, Naftogaz of Ukraine signed a three-year contract with TNK-BP and Transneft, according to which TNK-BP was to supply up to 9 Mt per year using the pipeline in a reverse mode (*i.e.* from Brody to Odesa). Many criticised this move as giving Russian oil suppliers even more power over Ukraine. However, given the absence of contracts for the direct use, the Ukrainian government felt, at the time, that the reversal would be the more pragmatic approach to secure needed revenues for the coming years. In 2005, TNK-BP transported 5.75 Mt from Brody to Odesa.

President Yushchenko has announced his intention to reverse the pipeline again and operate it in the originally planned mode. The pipeline can be realistically re-reversed only if Ukraine and Naftogaz of Ukraine manage to sign sufficient supply contracts with Caspian producers, primarily from Kazakhstan and Azerbaijan. It is not yet clear if this is possible.

The prospects for operating the pipeline in the direct mode will also depend on whether it will be extended further. Several options for extending the Odesa-Brody pipeline have been discussed, but the main option currently under consideration is to build a new pipeline through Plock to Gdansk (Poland). There is an oil refinery in Plock and an oil terminal and refinery in Gdansk.

The estimated cost of Brody-Plock extension, with the capacity of 10 Mt per year, is about USD 300 million. To increase the capacity to 25 Mt, an additional USD 150 million would be needed. The Ukrainian section of the extension would be 104 km and would require an investment of about USD 80 million. Ukraine and Poland created an International Pipeline Company Sarmatia, which organised, with the European Commission, a tender for a technical and economic assessment of extending the Odesa-Brody pipeline to Plock. The successful tenderer – a consortium formed by SWECO PIC (Finland), ILF GmbH (Germany) and KANTOR (Greece) – is expected to complete a technical and economic study of the extension by the end of 2006. High oil prices have made the economics of such an extension more favourable.

Diversification of Russian Export Routes

In 2001, Russia began exporting oil though the Russian Black Sea ports without crossing Ukraine. Russia also significantly reduced its dependence on oil transit countries by building the Baltic Pipeline System (BPS) in December 2001. The BPS allows Russia to export crude from the port of Primorsk in the Gulf of Finland. Its capacity is 42 Mt per year. Transneft is planning to further expand capacity at the Primorsk export port to 62 Mt of oil per year.

The BPS gives Russia a direct outlet to Northern European markets, allowing the country to reduce its dependence on transit routes through Estonia, Latvia, and Lithuania. In fact, crude oil shipments have dropped off almost 100% since 2000 at the port of Ventspils in Latvia. (Some oil products do flow through Ventspils.) Ukraine has also experienced a drop in oil transit volumes since the construction of the Primorsk port.

Transit Fees

Transit fees are negotiated between Naftogaz of Ukraine's affiliate Ukrtransnafta and exporting companies. Transit fees for European customers varied from USD 1.04-5.20 per tonne in 2002 and from USD 1.42-5.70 per tonne in 2003. Transit tariffs are exempt from VAT. Ukrainian law has a non-discrimination requirement, which stipulates that oil transit fees for foreign companies must not be higher than domestic transportation tariffs.

Oil transportation tariffs for Ukrainian consumers are regulated by NERC. They were set at UAH 5.3-31.8/tonne (USD 0.96-5.78/tonne) (without VAT) in 2003 (Naftogaz of Ukraine, 2004). A 20% VAT applies to domestic transportation tariffs. This higher taxation rate for domestic companies contradicts the policy on non-discriminatory transit fees.

For every tonne of oil transited, Naftogaz of Ukraine pays royalties to the state budget. In 2003, these royalties were USD 0.685 per tonne (Naftogaz of Ukraine, 2004). Oil exporting companies that use sea ports must pay sea terminal charges. Some reports indicate that high terminal charges in the port Pivdenny were one reason why the Odesa-Brody did not attract more subscribers – although the government temporally reduced the port charges by 50% in 2005.

Critique

Ukraine's stated intention to strengthen and increase the role of energy transit is commendable. Ukraine rightfully tries to take advantage of its unique geopolitical situation and developed energy infrastructure to position itself as a key country for transiting gas, oil and, possibly, electricity. The Ukrainian government and policy makers identify oil and gas transit infrastructures as strategic assets for good reason. However, Ukraine cannot take its strategic position for granted: Russia is already diversifying its exports routes, and in the medium and long terms, other options for transporting oil and gas that bypass Ukraine may become available. Given these factors, Ukraine's priority should be to prove that it is a reliable and economically attractive transit option and will remain such over time. To achieve this, two elements are essential: improving transparency and the overall conditions for doing business in the country, and attracting investment in repair and modernisation of the transit infrastructure.

Political will alone cannot sustain or increase transit volumes, particularly if this will does not reflect the business reality. For example, Ukraine's willingness to diversify oil transit options by building the Odesa-Brody pipeline is understandable in light of the fact that transit of Russian oil has been decreasing over the last years. However, this project goal has been jeopardised by the fact that the government made investments without sufficient economic and commercial justification – and without engaging suppliers and consumers in other countries. If investment is driven by political goals, without adequately accounting for economics and market needs, there is high risk of project failure.

Ukraine intends to preserve state ownership over the gas and oil transportation systems, even though this decreases economic efficiency. This approach is common to other countries in the former Soviet Union. In contrast, many Western countries encourage private ownership of transmission assets, coupled with state regulation to prevent monopoly abuses. Both state and private ownership can be acceptable, as long as regulation is effective and conditions for investment are good. Leasing or concession of transportation assets can be an effective way of attracting investment, but it must be done transparently via open tenders.

Transparency is key for positioning Ukraine as a reliable transit state. At present, there are at least three factors that contribute to the perception that gas transit through Ukraine is non-transparent. First, the controversial intermediary RosUkrEnergo and its predecessors have made the transit business opaque, without adding much value. It is in Ukraine's interest to move to direct contracts with suppliers. Second, statistics on gas consumption and local-level dispatch are of poor quality. The government knows that this is a problem. This hinders policy making and it raises transparency questions, even if systems are in place to monitor international gas flows. Third, the structure of Naftogaz of Ukraine is another impediment to higher transparency. The company produces, buys and transports gas and oil in Ukraine, and apparently covers losses from some operations by using revenues from other activities. Separate accounting of transit and other activities would improve transparency.

Interdependence between transit and gas supply arrangements is another issue that undermines transparency, thus making potential consumers in Europe uncomfortable. The negotiation of gas prices and transit fees is a tricky issue, not only for Ukraine. It is obvious, however, that both transit fees and gas supply prices should be based on fair market value. This implies contract separation, or at least separate accounting of transit and supply. The partial replacement of the previous in-kind payments for transiting Russian gas by real gas transit fees (the January 2006 Gas Agreement) is an important step toward transparent, market-based relationships. In the future, complete separation of the commodity contracts and the transit/transportation contracts with gas suppliers would certainly increase the confidence of potential investors and gas importers in Western Europe. Greater transparency has the potential to give Ukraine a better negotiating position, which will attract more support from the West.

The renegotiation of transit and supply agreements in early 2006, and the consequent rise in gas prices, is a difficult challenge for the Ukrainian economy. Ukraine cannot do much to influence the price of imported energy. However, it can reduce the negative impact of price increases on the economy by implementing effective energy-efficiency policies and switching to other fuels, in cases in which it is economically justified.

Recommendations

The government of Ukraine should:

- Ensure that future investments in transit infrastructure involve commercial partners and are, thus, driven by economics and market demand.
- Develop a clear, unambiguous method of pricing gas imports and gas transit services: prices for both activities should reflect market fundamentals. Contracts for supply and transit should remain separate and payments should be cash-based only.
- Raise transit fees and domestic gas prices to cover the cost of the necessary upgrades in pipeline systems; at the same time provide incentives for reducing transmission costs. Gradually move to market-based prices.
- Allow Ukrtransgaz and Ukrtransnafta to use the transit fees collected for investment in the transportation systems.
- Reduce leakages and improve the efficiency of compressor stations to enhance sector performance and limit environmental impact.
- Reduce administrative and fiscal barriers in order to provide incentives for increasing oil transit through Ukraine.
- Eliminate intermediary companies that do not add value to transit operations. As a transitional step, improve the transparency of intermediaries by requiring the publication of full ownership information and independent audit reports, as a prerequisite for acquiring licences.
- Improve transparency of other operators to strengthen investors' confidence.
- Proceed with the restructuring of Naftogaz of Ukraine to completely separate supply from transportation. In the longer term, move to gas market liberalisation.
- Take steps to attract investors to gas transport and storage projects. If international consortia are used to meet this objective, make sure they are very transparent and have a balance of interests, including not just the main gas supplier but also key consumer(s).
- Continue efforts to sell gas storage services and optimise use of excess storage capacity where it is economically justified and does not endanger

domestic energy security. Make sure that storage facilities have enough gas to meet domestic gas demand in winter.

• Improve collection and reporting of gas flow data.

7. COAL

Overview

Ukraine's coal industry is economically troubled. Most of its mines are more than 40 years old. These mines are among the deepest, most dangerous and most inefficient in the world. Coal seams are typically less than 1.3 metres thick, more than 700 metres underground and have high levels of coalbed methane. Ukrainian coal production has been in decline for decades, though production has stabilised and even grown slightly since the mid-1990s, when Ukraine began reforming its coal sector. Initial reforms had limited results, though a new round of reforms launched in 2001 has succeeded in boosting production, closing unprofitable mines, improving efficiency and reducing mining deaths. Several mines have been privatised and now account for a large share of total production.

Coal is the only segment of the energy sector in which there are explicit government subsidies to support production. Today, average coal prices are below short-term production costs, in part because of rapidly increasing prices for mining equipment and materials. Many mines are in dire financial condition and unable to invest in their future. There appear to be governance problems in the coal sector that drive up the price of materials at the same time that the private industrialists selling these materials seek to keep coal prices down. This is particularly problematic in state-owned mines, which are under the supervision of the Ministry of Coal Industry. The government has a detailed plan to close additional mines and privatise most of those that will remain in operation. The *Energy Strategy to 2030* envisages major increases in coal production to reduce Ukraine's reliance on imported natural gas. However, Ukraine's ability to accomplish this hinges on the success of further reforms.

Coal's Role in the Ukrainian Economy

Ukraine was one of the world's leading coal producers and consumers from World War II until the 1970s. Since that time, with the development of Russian mines and the increasing depth (and cost) of Ukrainian coal extraction, Ukraine's coal industry has been in decline. Major miner strikes helped to usher in the collapse of the Soviet Union, and the first six years of Ukraine's independence made evident the need for coal reform. Coal production dropped by more than 65% in this period to a low of 57.6 Mt in 1996. Wages went unpaid and social benefits were curtailed.

Since 1996, when the reforms began, Ukraine has been following a policy of privatisation and of shutting down unprofitable mines. In spite of this, the government still provides significant subsidies to the heavily-indebted sector and increases in efficiency have only been moderate. Difficult social conditions, the late payment of wages, and insufficient re-training and job-placement programmes make reform and privatisation particularly controversial and delicate issues. This is especially true among the largest group of miners (in Eastern Ukraine).

Box 7.1 Ukraine's Coal Industry at a Glance

Production (2004): 59.7 Mt.

Net coal imports (2003): 6.5 Mt.

Production (government projection for 2030): 122-146 Mt.

Coal use: Power plants (40%); industry (45%); district heat (10%); residential (5%).

Number of mines (2005): 164, of which 25 are private.

Number of employees: Approximately 250 000.

Average wage (2002): USD 103/month.

Accident rate: 2.54 deaths per 1 Mt of coal.

Labour productivity (2005): 27.6 tonnes per month per worker.

Production cost breakdown: materials (38%); wages (28%); social costs (14%); debt repayment (10%); administrative and other (10%).

Coal sector debt (1 May 2005): USD 1.86 billion.

Wage arrears (1 July 2003): USD 216 million.

CO_2 emissions (from coal combustion, 2004): 119 Mt (preliminary data).

Sources: IEA statistics, State Statistics Committee of Ukraine, Energobusiness.

Over time, industrial groups have gained increasing control over the coal sector. Both the government and independent analysts have noted this trend with concern because of the governance issues it raises. The industrial groups have increased prices of materials and machinery, while often requiring mines (even state ones) to sign exclusive, low-price contracts for coal sales. Thus many coal companies are in dire financial situations, despite substantial subsidies. The industrial groups are typically privately held and own both metallurgical and machine building companies. Steel, which these groups produce, is one of Ukraine's major exports.

Most of Ukrainian coal supply is transformed into other energy forms, such as power, heat and coke. According to the Ministry of Coal Industry,[48] in 2005, 46% of coal was used in power or cogeneration plants. The coke and steel industries took a further 29%. Heat-only boilers in municipal district heating systems used 3% of total supply, and home owners used slightly less. The remaining 20% was used by other types of consumers.

Though coal's share in total primary energy supply has declined from 32% in 1990 to 24% in 2004, coal production has increased by 3% since 1996. To counterbalance Ukraine's onerous dependence on Russia for oil and gas imports, the government hopes to increase production even more, to 90.9 Mt of raw coal by 2010 and to 130 Mt by 2030 (in the reference scenario),[49] thereby increasing coal's share in Ukraine's energy supply. It remains to be seen whether these aspirations are realistic. Coal production has been relatively stable in recent years, although there has been a small decline since 2001; in 2004, Ukrainian mines produced 59.7 Mt washed coal (80.2 Mt unwashed). Mine closures and privatisations are advancing. Thus, the restructuring programme does seem to be bearing some fruit, though it is important to note the high social cost and the challenge of expanding future production.

Coal Production and Reserves

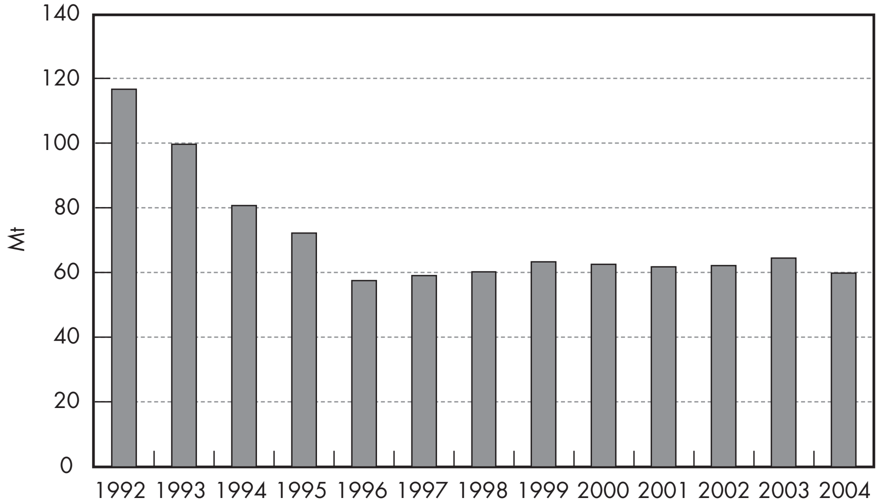
Ukrainian coal production has declined dramatically since the country gained political independence (Figure 7.1), although the decline began several decades earlier as production costs in Ukraine rose compared to other Soviet coal basins.

48. IEA data, which are based on official statistics from Derzhkomstat (the State Statistics Committee), differ somewhat from this in previous years. IEA data show greater use for coke production, and less for power production and the residential sector.

49. The Energy Strategy to 2030 *has three scenarios, pessimistic, reference and optimistic. In the pessimistic scenario, raw coal production grows to 87.6 Mt in 2010 and 121.5 in 2030, while in the optimistic scenario, it grows to 100.4 in 2010 and 146.3 by 2030.*

Figure 7.1

Coal Production, 1992-2004



Source: IEA statistics.

Figure 7.2 shows the government's planned coal balance to 2030.[50] The government would like to increase coal production by 60% over this period. Based on historical data, this increase would be a major challenge: at minimum, it would require radical reform with consistent follow through.

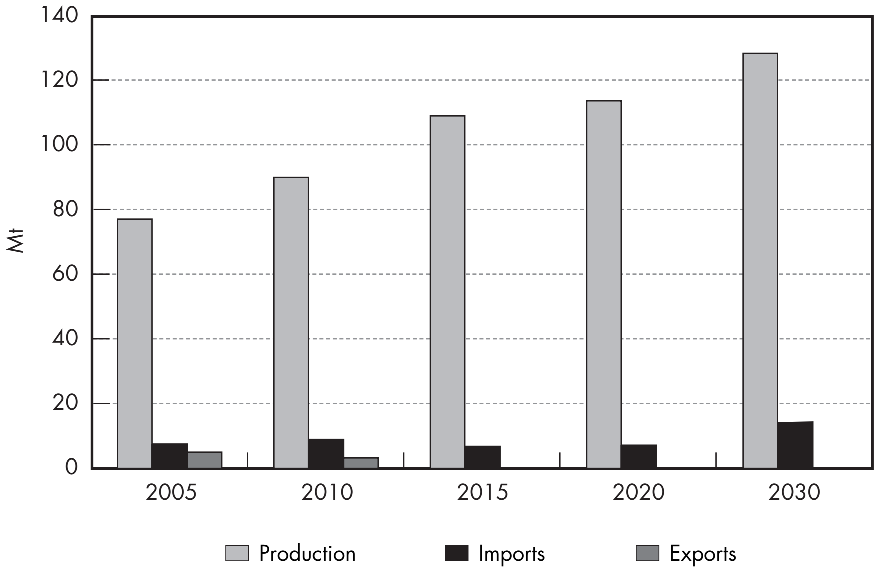
With the deterioration in the quality of coal since 1991 (particularly in terms of sulphur content), Ukraine has gone from a net exporter to a net importer of coal. Quality has suffered as seams have been exhausted; in addition, the geology of remaining seams is such that the coal is of lower quality. Ukraine now buys coal from Russia and, to a lesser extent, Kazakhstan. In 2003, Ukraine imported 7.1 Mt of coal; most of these imports were of coking coal. Coal exports from Ukraine have grown in recent years, but they are still quite small.

According to the government, Ukraine's current production capacity is 91.5 Mt per year, which is less then half of what it was in 1991. The estimates of Ukraine's total and proven coal reserves vary widely. The World Energy Council (WEC) estimates total coal reserves in Ukraine at 52 billion tonnes (World Energy Council, 2000); the government puts its estimate at 117.5 billion tonnes (Cabinet of Ministers, 2006a).

50. Figure 7.1 shows data for washed coal; Figure 7.2 shows data for raw coal.

Figure 7.2

Projected Volumes of Raw Coal Production, Imports and Exports (Reference Scenario)



Source: Cabinet of Ministers, 2006a.

Similar discrepancies are found in relation to proven reserves – *i.e.* those reserves from which coal can be extracted profitably (on the basis of assumptions about geology, technology, market conditions, future prices, etc.). WEC calculates them to be 34.2 billion tonnes, including 16.3 billion tonnes of bituminous coal and anthracite, 16 billion tonnes of sub-bituminous coal, and 1.9 billion tonnes of lignite. The government estimates proven reserves to be at 56.7 billion tonnes, only 6.5 billion tonnes of which are located in active mines. Moreover, for a variety of reasons, about 15% of the resources in a given mine are typically lost during exploitation.

At present, no international standards exist for determining what constitutes proven reserves. This contributes to the wide variance of the estimates for Ukraine and makes it difficult to ascertain true reserve levels. In addition, it is not clear what economic assumptions and analyses the government has used to arrive at its estimates. (WEC figures are widely accepted and are used by IEA's annual *World Energy Outlook*.) Given the poor physical condition of Ukraine's mines and mining equipment, the high costs of production and the low projections for future prices of coal (compared to other energy sources), it is likely that the less optimistic estimates of reserve levels are more realistic. In the absence of substantial improvements in coal quality and market conditions, it is possible that even these could be revised downward in the future.

The coal in the active mines will last for approximately 40-90 years, depending on depletion rates.[51] The increased production planned in the *Energy Strategy to 2030* will obviously accelerate depletion rates. Tapping new coal reserves requires attracting substantial investment and entails a certain degree of risk, due to uncertainty about the size of the reserves and future coal prices. Private investors will only be interested when prices for coal cover the full costs of production and also provide a reasonable return on mine investments. This likely requires establishing a competitive market for coal.

Mines

Ukraine's three major coal basins are the Donetsk and Lviv-Volyn hard coal basins and the Dnipro lignite basin. These basins are located in the following six regions: Donetsk, Luhansk, Dnipropetrovsk, Lviv, Kirovohrad and Volyn. More than 95% of coal reserves are concentrated in the first three of these regions. The Donetsk basin contains more than 98% of Ukraine's hard coal reserves (Figure 7.3).

Mining and geological conditions in Ukraine's mines make profitable coal extraction difficult. Average mine depth is more than 700 metres; in approximately 20% of mines it is 1 000-1 400 metres. In addition, coal beds are very thin – 85% of those containing extractable coal are less than 1.2 metres thick – and often very steep, which makes mechanised extraction costly and difficult or impossible. In the Donbas region, 35% of coal beds are steep enough to make the extraction of coal possible only by hand (Razumkov Centre, 2003). This environment creates hazardous working conditions, reduces labour productivity and raises the marginal cost of extracting coal.

Ukraine has the oldest mine stock in the former Soviet Union; the average mine is 40 years old. Only 4% of the mines have been renovated in the last 20 years. Fully two-thirds of the mining equipment has operated longer than the lifespan for which it was designed. The average annual coal production per mine is less than 800 000 tonnes (Figures 7.4 and 7.5), which is low compared to neighbouring coal-producing countries. The coal quality is

51. This projection relies on government estimates for reserves; there are no other public estimates of reserves in active mines. In other categories of reserves, government estimates tend to be approximately double those of international experts.

Figure 7.3

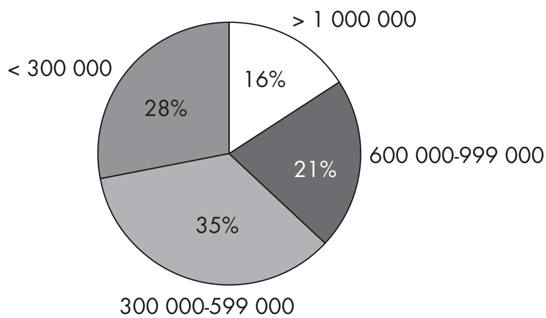
Ukraine's Major Coal Basins

Source: Razumkov Centre, 2003.

also poor. Ash content in extracted coal is extremely high (partially due to the thin coal seams), at 37.9% for coal used domestically, and 25.5% for coal intended for export (Energobusiness, 2005). These levels have risen steadily since 1991 when they were, respectively, 29.8% and 18.3%. Sulphur content, at 2.5% on average, is also high. The poor quality of the extracted coal makes significant treatment of the coal prior to its sale necessary and renders Ukrainian coal less competitive in global markets. In fact, the decrease in quality since 1991 is a major factor behind the decline in coal exports.

Figure 7.4

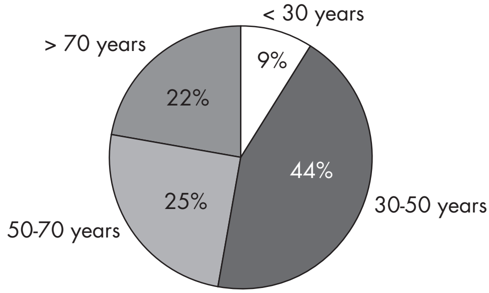
Coal Mines by Annual Output (tonnes per mine)



Note: % refers to the percentage of mines in each category of output.
Source: Cabinet of Ministers, 2006a.

Figure 7.5

Coal Mines by Age



Source: Cabinet of Ministers, 2006a.

According to the *Energy Strategy to 2030*, the coal industry's most critical problem is that many mines are so obsolete and depleted that they have not been able to attract the investment in the new technologies necessary to compete.

Ownership and Administrative Structure

Ukraine currently has 164 active mines. Three privately-held companies – Krasnodonvuhillya, Krasnoarmeiska-Zakhidna and Pavlohradvuhillya – own 25 of these mines. These 25 mines are primarily coking coal mines and they attract the majority of the investment in the sector. The remaining mines are owned by 24 state enterprises, which, in turn, are held and supervised by the Ministry of Coal Industry.

The coal industry has seen numerous administrative changes in recent years. In the late 1990s, the Ministry of Coal Industry oversaw coal issues and state production. That Ministry was closed in 2000, and its functions were transferred to the new Ministry of Fuel and Energy. Then, in 2005, the government re-established the Ministry of Coal Industry. Around the same time (early 2005), the government also created a new state company called Coal of Ukraine, to which it transferred 24 state enterprises that own most of the coal mines. Later the same year, the government closed Coal of Ukraine and transferred the enterprises to the new Ministry of Coal Industry. Such frequent reshuffling is expensive and disrupts work, making continuity in reforms much more difficult. The changes also make it more difficult to monitor and address corruption and price fixing.

Reforms and Restructuring

Ukraine began the process of reforming its coal sector in 1996 with the presidential decree *On Coal Industry Restructuring.* This laid out a policy framework for reforming the sector's structure and ownership, cutting state subsidies and introducing market incentives. It began the long process of restructuring the centrally-planned Soviet system and closing down unprofitable mines. However, the reform stalled in the face of underfunding, understaffing, poor management and popular dissent.

In September 2001, the government launched a *Comprehensive Programme on Ukrainian Coal*, which laid out a three-stage plan to be completed by 2010. Under this plan, the government would first denationalise mines, then corporatise them and finally auction them off to strategic investors. In addition, the Verkhovna Rada passed numerous pieces of legislation aimed at improving safety standards and dealing with the social consequences of mine closures from 2001-05. Under the *Comprehensive Programme on Ukrainian Coal*, the government successfully closed several mines and privatised others. Production remained roughly stable and labour productivity increased. However, the programme was severely underfunded and did not adequately incorporate job retraining and other social programmes. Wage arrears accrued, many miners died in mining-related accidents and major miner strikes occurred. Thus, it is too much to say that the programme was entirely successful. By 2003, privatisations were delayed, mines were reorganised into state enterprises and the sector regained a vertically-integrated structure.

On 7 July 2005, the Cabinet of Ministers of Ukraine issued a new *Concept for the Development of the Coal Industry*, which outlines plans for the restructuring and developing the coal sector through 2030. The government will continue to corporatise state-owned mines, and then privatise them through competitive tenders. Based on an order from President Yushchenko, the government is now setting up a working group to prepare the privatisation of additional coal enterprises. The working group will first develop a list of enterprises to be privatised and then prepare documents and take other steps to move the privatisations forward. However, the working group will not actually prepare the privatisation tenders. The government will also continue to close unprofitable mines.

Under the current coal policy, the government's main goals are to:

- Develop the existing production capacity by attracting investment in better technology.
- Use coal reserves efficiently by overhauling production facilities.
- Adapt coal industry enterprises to market conditions, providing a viable legal framework to encourage private investment.
- Transform the structure of the industry through clear segregation of functions among various governing bodies.
- Enhance worker safety and social protection of all workers.
- Ensure compliance with applicable environmental regulations.

In the first phase of this programme (2006-10), the government will focus on upgrading the technology at mines and privatisation. Some 17 Mt of raw coal mining capacity would be added as expansion of three mines is completed and other mines are overhauled. In the second phase (2011-15), coal production and capacity would continue to increase as an additional three mines were expanded and others overhauled. In the third phase (2015-30), new mines would be opened to meet the increased targets for coal production.

The government hopes to meet these targets through privatisation and a more transparent coal market. In 2005, only 7% of mines were private but they produced 40% of Ukrainian coal. However, there does not appear to be a clear link between the mechanisms (privatisation and markets) and the production goals, as private companies would likely set their own production schedules based on market conditions. Indeed, setting production goals and privatising mines might be seen as mutually inconsistent.

In 2005, the government allocated UAH 1.4 billion (USD 278 million) to technological investment in existing mines and UAH 800 million (USD 160 million) to restructuring, including closing mines and addressing the environmental consequences of doing so. In addition, subsidies for producing coal in past years have amounted to more than UAH 6 billion annually (USD 1.2 billion). The new Ministry has a Department of Social and Administrative Issues and a Unit of Labour Protection and Social Relations. Together, these units will manage social programmes for job training and placement, as well as implement workplace safety measures. These social programmes also receive assistance from the Ministry of Economy, which contributes money from its budget to regional administrations.

• Mine Closures

Mine closures present several social policy challenges and are difficult in the best of circumstances. The challenges begin with the decision to close a mine and the process by which that decision is made. On average, the government has closed 15 mines per year in recent times (Prudka and Kadochnikova, 2005). By 2005, more than half of the 122 mines slated for closure in 2001 had already been shut down, though this was behind the original schedule. The government hopes to close down approximately 50 more mines over the course of the next five years. The government has also announced that mines will be classified into three categories: *i)* those that are currently profitable and are thus ready for privatisation; *ii)* those that have economic potential though are currently not profitable; and *iii)* those that are not economically viable and must be shut down. This categorisation suggests that additional mines will likely be added to the closure list.

Closing a mine has social consequences, both for individual workers and for the mining communities as a whole. Finding new jobs for workers can be difficult and expensive. However, World Bank analysis shows that more workers are able to acquire new jobs on their own than policy makers may project (World Bank, 2003b). The Donetsk Region, where many mines are concentrated, is economically better off than Ukraine as a whole, so neighbouring communities often have the ability to provide jobs to former miners. Older workers or women may have a harder time finding new jobs, which indicates that funding for job retraining and creation might be better targeted. Handling the housing, heating systems and social assets of mining towns is also challenging, particularly during and after mine closures. Municipalities may need assistance to develop viable plans in these areas.

Mine closure also creates environmental concerns: who will be responsible for cleaning up the mine site and for purifying mine waste water to ensure that it does not contaminate drinking water or local rivers? For now, the government has special funding set aside for environmental restoration as part of its mine closure programme. However, this funding is rarely enough for more than initial efforts to decommission a mine. Ensuring that these costs are covered fully is important not just for the environmental health of mining areas, but also in providing the proper market signals regarding the environmental costs of energy.

Strategy for the Sector's Future Development

The government's policy establishes a clear goal of significantly increasing the production and use of coal over the next 25 years. The government has calculated that the coal sector will need UAH 221.7 billion (USD 44.3 billion) in investment through 2030, UAH 48 billion (USD 9.6 billion) of which will come from the state budget (Table 7.1).

No funding is specifically mentioned for addressing the environmental consequences of coal mining, although the government does plan to dedicate money from the State Fund for Environmental Protection to install emission controls and treatment at a few power plants, including several coal-fired plants.

The creation of the new Ministry of Coal Industry does not appear to change the direction or strategy of the reforms. It remains to be seen whether the new policy will be funded as planned.

Table 7.1

Projected Coal Sector Expenditures, 2006-2030

	Billion UAH	Billion USD
New technologies in existing mines	76.3	15.3
Capital construction	82.8	16.6
Mine decommissioning	9.1	1.8
Mine rescue and coal research	4.0	0.8
Maintenance	49.5	9.9

Note: USD figures are the converted equivalent of the UAH numbers.

Source: Cabinet of Ministers, 2006a.

Costs and Prices

Coal Pricing and Market Mechanisms

Coal prices in Ukraine are theoretically freely set by the market. In reality, there are many price distortions. The largest are coal subsidies, state fuel allocation in the power sector and the influence of private, monopoly buyers. Because of their dominant role and exclusive contracts to buy coal from some mining companies, private industrial groups have tremendous market power. Thus in practice, the government and large industrial groups set the price in a non-competitive manner.

There is a wholesale market for coal in Ukraine but the production costs exceed the prices at most mines. The government compensates a portion of the difference through direct production subsidies. In 2004, the government distributed subsidies of UAH 15.50 (about USD 3.00) per tonne of coal – equal to approximately 9% of the average wholesale price. The government also funds other, long-term coal mining costs at state-owned mines, including many capital expenditures, and mine closure and decommissioning costs.

As part of the coal sector restructuring programmes, the government has made significant investments in coal mines to try to make them profitable. However, these investments come directly from the government budget and are not reflected in the coal price. In 2005, the government made UAH 1.4 billion (USD 277 million) of capital investments in coal mine technology and paid another UAH 800 million (USD 158 million) for restructuring and closing mines (including addressing the environmental consequences of the mining operations). Additional funds have been allocated for job retraining and addressing the social consequences of mine closure.

Most mines are still state-owned and many consumers (particularly power plants) are in state hands. The Ministry of Fuel and Energy allocates fuel to power plants. Thus while there is a wholesale exchange, the market does not set the prices; it only has a muted influence on them.

As indicated above, large industrial groups have tremendous influence over the price of coal. According to the 2003 Razumkov Centre study, as well as the 2003 World Bank study, Ukrainian coal is under priced by 20-40% at the mines because private intermediary structures monopolise distribution. Moreover, the price of coking coal is lower than the price of steam coal – a situation that does not occur anywhere else in the world and thus points to a major market distortion. Industrial groups that own metallurgical plants control both the distribution and purchase of coking coal. The Industrial Union of Donbas is one of the most powerful industrial groups in Ukraine. It owns – either directly or indirectly – a large number of metallurgical and machine-building companies, coal mines, and intermediaries. The Razumkov Centre report gives the example of two particular mines, Dobropillyavuhillya and Selydivvuhillya, at which a large percentage of all coal extracted was sold to a single intermediary, Closed Joint-stock Company ARS. The company then resold this coal to steel mills and other industries at a 20-30% mark-up.

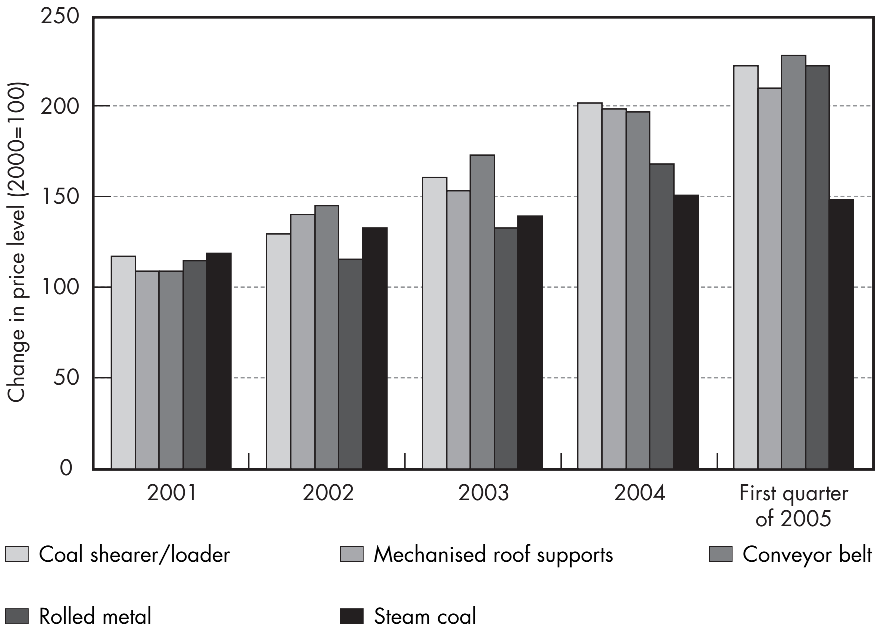
In turn, the metallurgical groups supply equipment and materials to the mines at prices that appear to reflect their monopoly over the production of these items. As a result, the prices of materials and equipment sold to mines increased by approximately 220%. Over the same period, steam coal prices increased by 49% from 2000-05 (Figure 7.6) (Cabinet of Ministers, 2006a). The 2003 Razumkov report states that:

> *A fairly simple closed-circuit scheme is employed at the inter-sector market: coal industry (underpriced coal) – metallurgy (metal exports), power engineering – machine building (overpriced equipment and hardware) – coal industry. The losses of state enterprises are covered at the expense of the State Budget (or, in fact, the "corruption tax" on Ukrainian citizens); otherwise, the accumulation of debts by any enterprise in that chain is often organised artificially, to proclaim it bankrupt and privatise it for debts, or at the residual cost (Razumkov Centre, 2003) (Figure 7.7).*

In its *Energy Strategy to 2030*, the government also highlights that private businesses with a monopoly on the production of certain types of coal mining equipment gain excessive profits, while coal mines have large losses. These private companies are able to amass these profits at the state's expense because of the subsidies and the state ownership of the mines. The

Figure 7.6

Price Dynamics of Steam Coal and Selected Mining Equipment, as Compared to 2000



Source: Cabinet of Ministers, 2006a.

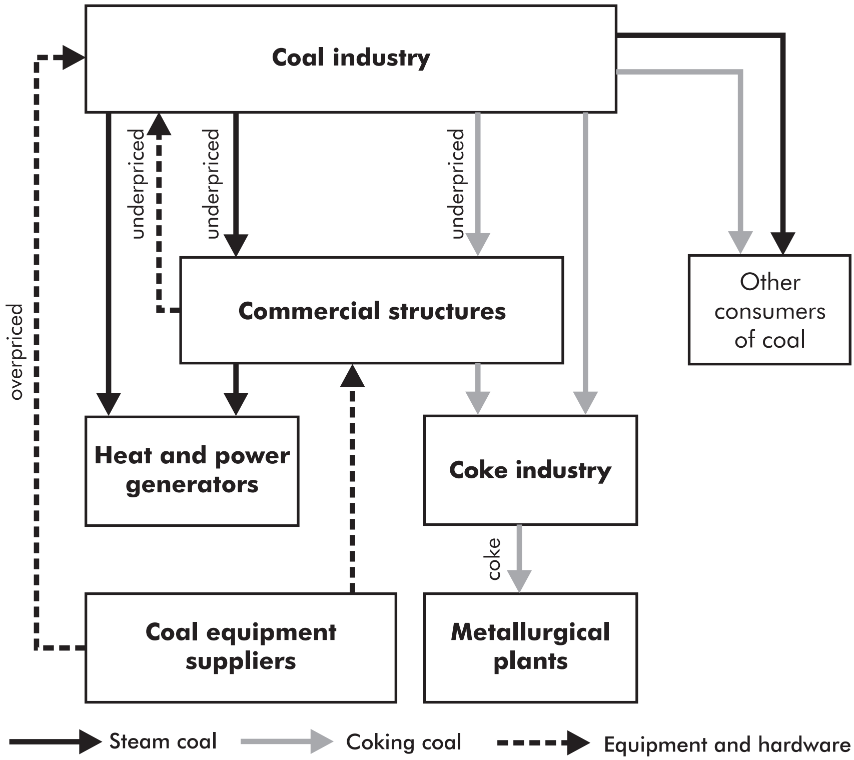
trend is particularly evident for coking coal, where the coal is eventually used to produce steel for export markets. This form of corruption keeps coal prices artificially low and the cost of coal extraction high. It also creates a mechanism for funnelling state funds intended to subsidise a troubled sector into the hands of private companies controlled by rich industrialists. Several of these individuals have also benefited by purchasing indebted coal mines at far below market prices.

• Profitability of Coal Extraction

According to a World Bank report, in 2003 the coal sector's average production cost was approximately USD 29 per tonne, 15% higher than the average coal price of USD 25 per tonne (World Bank, 2003b). By 2005, mines were still not profitable on average, but the losses were decreasing. Average prices were 5% lower than average costs in 2005, though among state-owned mines, this spread was 19% (Energobusiness, 2006). State-owned mines had costs 14% higher than average Ukrainian costs, and these higher costs were equally distributed among all the major cost elements (such as

Figure 7.7

Financial Pressure and Control in the Coal Sector: Commodity and Money Flows



Source: Cabinet of Ministers, 2006a.

materials and labour). Moreover, the profitability of coal extraction in mines varies widely and mines with higher output tend to be more profitable. Privatised mines are also significantly more profitable than those owned by the state.

As of 1 December 2005, the coal sector had unpaid debts of UAH 9.4 billion (USD 1.86 billion) and net indebtedness of UAH 7.1 billion (USD 1.4 billion). A large portion of these debts are for taxes or workers' pay. Though unpaid debts are increasing from year to year, the rate at which they are increasing has been declining since 1996. An adjustment of the artificially-low coal prices to market conditions, coupled with investment in capital and new technologies, should make it possible for coal to be extracted in an economic and sustainable way, at least from a significant percentage of mines, without relying indefinitely on large state subsidies.

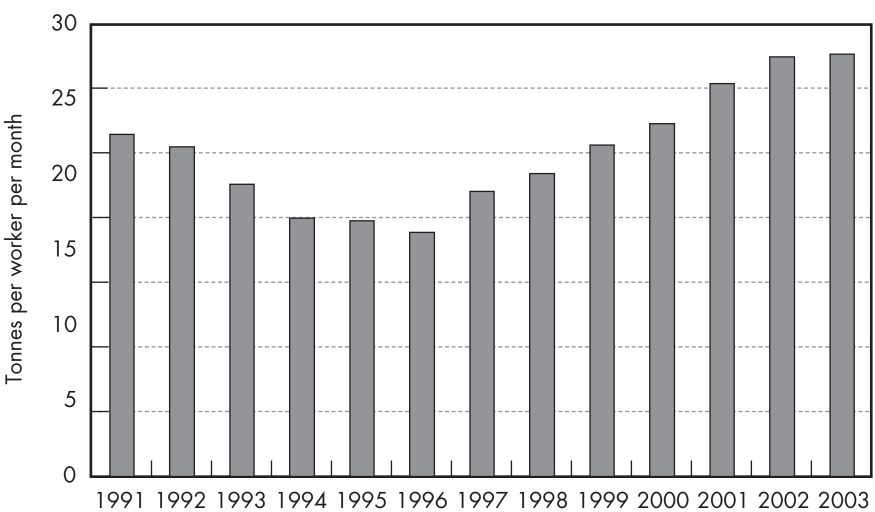
Labour Productivity

Labour productivity is an important indicator of a coal industry's viability; improving labour productivity is also the main mechanism for boosting coal workers' standard of living. Labour productivity in Ukraine is significantly lower than in most other comparable coal-producing countries: the labour force in Ukraine is one-half as productive as in Poland, one-fifth as productive as in Western Europe, and one-twentieth as productive as in the United States. Labour productivity also varies widely from region to region and between private and state-owned mines. It ranged from slightly more than one tonne per month per worker in one mine in the Donetsk Region to close to 95 tonnes per month per worker at the Krasnoarmeiska-Zakhidna mine in the first five months of 2005. The national average over this period was 27.6 tonnes per month per worker, while the average among state-owned mines was 23.3 tonnes per month per worker. The average among privately held mines was 57 tonnes per month per worker. It is clear that labour productivity has been increasing steadily since the beginning of the reforms in 1996 and appears set to continue to rise (Figure 7.8).

Labour productivity is also important because of its relationship to safety in coal mines. Typically the fewer miners required per tonne of coal, the lower the number of fatalities simply because fewer miners are exposed to risk.

Figure 7.8

Labour Productivity



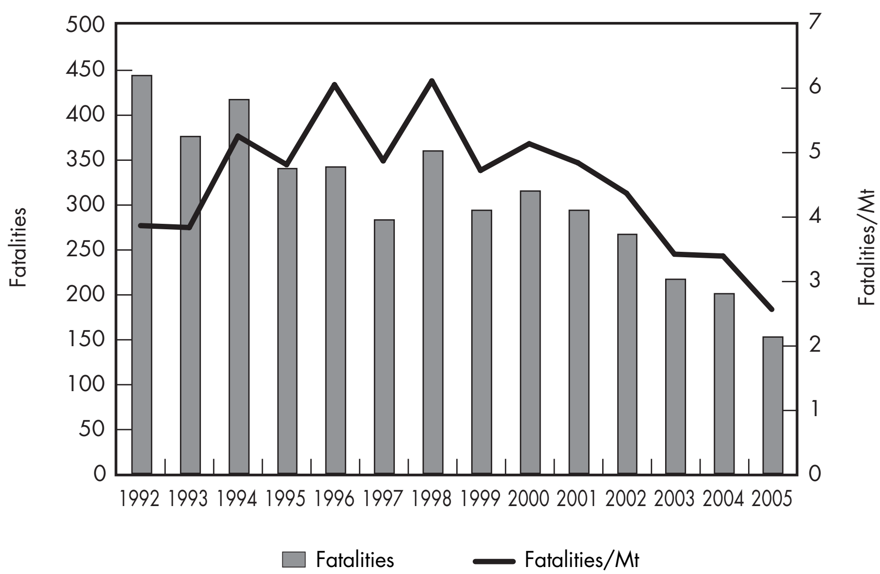
Source: Razumkov Centre, 2003.

Mine Safety

Ukraine's coal mines are among the most dangerous in the world. Ukrainian coal mining accidents have caused more than 3 000 deaths in the past decade. However, fatalities and fatality rates in coal mines have declined consistently since 2000 (Figure 7.9). To a large extent, this is due to improvements in mine safety within the context of coal-sector reforms. There were approximately 250 000 workers at Ukraine's mine enterprises in 2004.

Figure 7.9

Coal Mining Fatalities in Ukraine



Sources: IEA statistics, Ministry of Fuel and Energy, and PEER.

Still, with a fatality rate of more than 2.5 workers per 1 Mt of coal, Ukraine remains a dangerous place for those who earn a living in this sector. This is significantly worse than the fatality rates in the United States, India and even Russia (in Russia, fatality rates are less than one worker per 1 Mt, which itself is high by international standards). The only country with a higher fatality rate is China, where there were 5.8 fatalities per 1 Mt in 2000.

Safety problems are often exacerbated when mines have intense pressure to increase production and profitability. In some cases, particularly at coking coal mines, output is up to double the design capacity, which leads to unsafe working conditions and additional fatalities (World Bank, 2003b).

The Ministry of Fuel and Energy has prepared an analysis of fatalities in 2005 indicating that the main causes of fatal coal mining accidents include human error (both poor worker discipline and engineering mistakes), slow or inadequate medical attention, poor training of experts and managers, equipment failures, lack of reinforcing materials, and a low level of mechanisation for auxiliary jobs. The majority of these cases are the physical result of explosions of methane gas that leak from coal seams and the surrounding rock. Ukraine's mines tend to have large quantities of methane trapped in the coal seams and inadequate safety provisions.

In February 2004, the Cabinet of Ministers approved a revised *Programme to Raise the Worker Safety in Coal Mines.* The government allocated UAH 105 million (USD 19 million) for the programme in 2004 and UAH 117 million (USD 23 million) in 2005. Much of this money was spent on technical measures to improve safety in the mines, for example, degasification equipment and telecommunications. The mines themselves are expected to provide additional funding. The programme lists a dizzying 130 actions that various ministries and government institutions must undertake in various categories including research activities, steps to develop better degasification and ventilation systems, and administrative actions such as developing new regulations. A wide range of stakeholders are involved in implementing the programme including the Ministry of Fuel and Energy, the Ministry of Labour, and the Ministry of Environmental Protection, along with mines, regional administrations, research institutes and other entities. The programme does not list specific goals, such as reducing fatality rates by a certain amount, but rather focuses on the actions that would likely lead to improved safety.

The Partnership for Energy and Environmental Reform (PEER), a US-Ukrainian non-govermental organisation, is working with Ukrainian mines and with the US Department of Labor on mine safety in Ukraine. PEER believes that the fatality rate can be reduced with the installation of enhanced methane degasification systems, utilisation of rock dust, underground water filtration, improved ventilation systems, and the enforcement of safety laws and regulations.

Coalbed Methane

Evacuating methane from coal beds is necessary in order to prevent fatal explosions within mines. Moreover, if recovered, it can be used as an energy source, either as a substitute for natural gas or burned on-site for heat or power generation. Recovering and using coalbed methane also helps to reduce CO_2 emissions, and could possibly be used in the future to help Ukraine obtain carbon credits.

According to PEER, Ukraine ranks fourth in the world for coalbed methane resources, with an estimated 11-12 trillion m^3. The Ukrainian government estimates that up to 3 bcm of methane escapes from coal beds every year and only a fraction of this gas is collected. PEER has done extensive research and published detailed studies on the feasibility of implementing coalbed methane projects in the Donetsk Region of Ukraine. It has also created an inventory of methane emissions from Ukrainian mines.

In 2004, the Ukrainian government held talks with two companies (one American and one Japanese), both of which are interested in investing in coalbed methane programmes in Ukraine. Pilot projects are already under way and it is possible that larger-scale coalbed methane projects will be implemented in the near future, with investment from foreign companies. The Krasnodonvuhillya, the largest coal company in Ukraine, recently completed a project to collect coalbed methane at one of its mines, primarily for use in on-site heating and for power generation. The project cost UAH 1.8 million (USD 350 000) and will pay for itself in less than one year. The European Union's TACIS programme has funded a feasibility study for a EUR 2.5 million (USD 3 million) project to improve mine safety, which includes EUR 750 000 (USD 900 000) for methane evacuation and recovery. The United States, through its Environmental Protection Agency and Department of Labor, has funded extensive work on coalbed methane in Ukraine.

The Verkhovna Rada is considering a *Law on Coalbed Methane.* The law would clarify legal principals related to extracting and using coalbed methane. Competitive pricing for gas would help stimulate investment in coalbed methane. Fair access to gas pipelines is also important, as is streamlining the licensing regime. Until now, companies have expressed concerns that they cannot acquire licences for coalbed methane capture at the largest, most profitable sites, but rather are limited to working at smaller, less attractive sites. This makes investment less likely. Companies should be able to choose sites based on commercial principals.

Environmental Impact

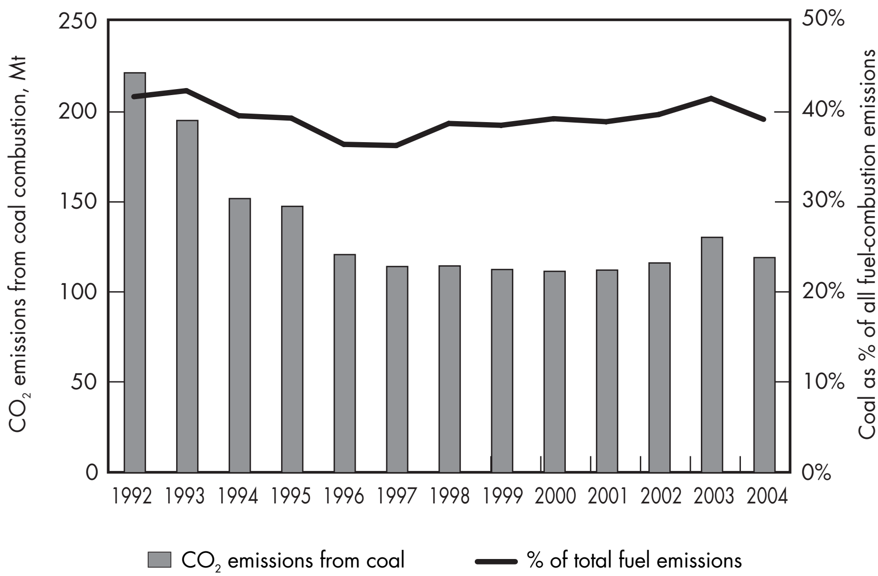
Coal mining can have significant, negative impacts on the environment, including emissions during coal combustion and environmental impacts of mine operations. The situation in Ukraine is worse than in most other major coal mining countries because of the lack of funding, limited laws and poor enforcement.

• Coal Combustion

Coal is a dirty fuel, and a major source of greenhouse gases and other emissions. Based on IEA data, coal accounted for nearly 40% of all Ukrainian CO_2 emissions from fuel combustion in 2004, even though coal's share in the energy balance was 24%. Total coal-related CO_2 emissions have declined as coal demand has dropped in recent years (see Figure 7.10). Ukraine now emits more than 130 Mt of CO_2 per year from its coal use.

Figure 7.10

CO_2 Emissions from Coal Combustion, 1992-2004



Note: 2004 data are preliminary.

Sources: IEA statistics and estimates.

Ukrainian coal has particularly high levels of sulphur and ash. These impurities have been increasing as the quality of Ukrainian coal has declined over the past 15 years. The Ukrainian government does not prepare data on other emissions from coal use specifically. While rising levels of impurities in coal would have lead to higher emissions, total coal use has dropped. Thus, it is likely that total emissions from coal use have dropped. As total coal consumption has held relatively steady in recent years, total emissions of SO_2 have grown and total emissions of NO_x and particulates have declined slightly or remained flat. However, these emissions reflect much more than coal use alone.

Ukrainian power plants and steel mills typically have limited or non-existent pollution control equipment. For example, coking facilities in Ukraine often vent large volumes of toxic coke-oven gas, while most IEA countries have strict limits and penalties for such emissions.

The data show emissions for coal mining separately, but these numbers would be small compared to the emissions for coal combustion. Nonetheless, emissions of criteria pollutants during coal mining have declined in recent years. For example, particulate emissions from coal mining declined by 18% from 2000-04, according to the Ministry of Environmental Protection. These declines may be related to the closure of small, unprofitable mines.

Given the deteriorating quality of Ukrainian coal, the environmental and health implications of greatly expanding coal use could be very significant. The government aims to increase coal use by 70% from 2005-30. However, the government has not estimated the potential emissions from such a significant expansion. IEA estimates that such an increase in coal use will cause CO_2 emissions to grow by between 213-230 Mt, based on the current coal use profile. Without more detailed information on the government's assumptions, it is difficult to understand what the full impacts might be. However, it is almost certain to lead to growth in emissions of greenhouse gases, particulates, SO_2, nitrogen dioxide and other pollutants.

Mine Operations

Mine operations affect the environment in several ways. One of the most problematic issues is that they release methane, a powerful greenhouse gas, into the atmosphere. Ukraine uses mining techniques that tend to result in greater release of methane from coal seams, which is typically not captured as is done in many other coal-mining countries. The US Environmental Protection Agency has published an inventory of coal mine methane in Ukraine. Ukrainian coal mine methane emissions were 2.6 Mt in 1990 and dropped to 1.2 Mt by 2003.[52] However, the decrease is primarily related to the drop in coal production.

A second issue is that as coal is mined, significant waste (or tailings), accumulate. These waste piles can scar the landscape and even ignite if not properly treated. In OECD countries, mining companies usually must

52. U.S. EPA website: www.epa.gov/coalbed/pdf/inventory2002.pdf and IEA statistics.

fund extensive restoration works to cover the tailing piles with earth. Such practice is rare in Ukraine, even though mines occupy 22 500 hectares of land. Mining also affects the hydrology of the area around the mine. If not carefully handled, mining operations can pollute natural bodies of water and, ultimately, local drinking water. At present, because of inadequate mine water purification, more than 1 Mt of mineral salts seep into rivers every year. Mines extract 600 Mcm of water per year and reuse less than half of this. The Ukrainian government estimates that improving mine water management to counteract these environmental impacts would cost UAH 230-240 million (USD 46-48 million) per year (Cabinet of Ministers, 2006a).

Critique

Ukraine has taken important steps to restructure its coal sector, beginning with the closure of unprofitable mines and the privatisation of others. The government recently renewed its commitment to the restructuring process with its July 2005 *Concept for the Development of the Coal Industry*. Around the same time, the Verkhovna Rada and the government also made an important move to resolve the sector's debt crisis by adopting legislation on energy sector debt restructuring.

Despite these key advances, the Ukrainian coal sector still has many hurdles to overcome in order to become competitive. Poor governance is of great concern. The *Energy Strategy to 2030* highlights this with its analysis of the rising cost of materials and machinery in the coal sector. These materials are supplied by a limited number of companies that often charge excessive, monopolistic prices. While most coal companies remain under state ownership, they are effectively controlled by private industrial groups that buy their coal output and sell them mining equipment. As a result, Ukrainian mines are, on average, loss making, even with substantial subsidies. In fact, the subsidies may actually perpetuate the system of unofficial private control by providing an additional source of attractive cash for the taking. Reforming the mining sector must involve improving transparency and clarifying business relationships.

Moving to more market-oriented prices could help. The government mentions the need to move to market prices in the July 2005 *Concept for the Development of the Coal Industry*, starting with the proposed establishment of coal auctions, which seems a sound approach. These auctions can minimise the possibility that private industrialists will manipulate prices through inappropriate control of individual mining enterprises. Once the market is established, the government plans to allow companies to use long-term contracts again, which is logical as long as the government monitors the competition carefully for fairness. Monitoring the competition means reviewing sales prices on an ongoing basis, and referencing international prices, costs and other relevant benchmarks, to ensure that a competitive market develops quickly. Such steps can reduce the likelihood of continued undervaluation of Ukrainian coal. Current oversight of financial transactions at state-owned mines is often weak, creating opportunities for private industrial groups to gain excessive control over sales and purchases, and hence, the mining enterprises themselves. An auction-based market will help to address this, but the government can also improve state management of the mining enterprises.

Government subsidies should be reduced. This applies both to production and most capital subsidies. As noted, production subsidies often encourage corrupt control by private entities; thus such subsidies do little to improve the sector's future prospects. Moreover, subsidies for technological improvements do not make much sense if privatisation is planned in the near future. Private investors would be in a better position to make investment decisions, and investments now may not result in a net increase in the sale price at privatisation. One area in which there is a clear-cut need for continued state spending is in mine closure and addressing the associated social consequences. At the same time, state management of these budgets could be improved to ensure that the funds are used efficiently and effectively, targeting groups most in need.

The government has accelerated its programme to close unprofitable mines, which is difficult socially and politically. However, a large number of unprofitable mines remain open; the government should revisit its lists of mines and reinforce its efforts to move decisively to close individual mines in order to stabilise the sector as a whole. It has wisely decided to categorise mines based on their profitability and prospects (profitable, potentially profitable and unprofitable) based on clear criteria and a transparent process. Now, follow through is important. Delaying closure of unprofitable mines will only worsen the sector's overall financial standing and result in more job losses over the medium to long term.

Privatising coal mines can help improve the sector's performance, as shown by the profitability and output of the mines that have been privatised to date. Today 93% of Ukrainian mining enterprises are still in state hands. The 2005 *Concept for the Development of the Coal Industry* wisely places high priority on the need to privatise mining enterprises by competitive tender. International experience has shown that privatisation in troubled industries is typically most successful when strategic investors are brought in through competitive tenders. Such investors can help guide the mining enterprise to stronger performance in a way that portfolio investors typically do not. Portfolio investors buy shares after the company is put up for sale on the stock market; they typically do not have specific expertise in the coal industry or in transforming coal companies. Competitive tenders are important to ensure that the government realises the maximum value and that the new investor has the best and most credible plan for the company's future. Privatising coal mines through debt swaps, which is common today, may not meet these goals. Debt-swap privatisations are not competitive and may not attract strategic investors that are interested in the mining enterprise's long-term prospects.

Improving mine safety and environmental management are also critical to the sector's development. Ukraine has the second worst mine fatality rate in the world – a rate significantly higher than those in neighbouring countries. This is not simply a result of Ukraine's geography or the financial condition of the sector. Clear labour safety regulations and consistent enforcement could play an important role in making Ukrainian mines less dangerous. So could enhanced safety training for managers, workers and mining engineers, and greater accountability of mining managers for safety violations.

Coalbed methane is both a problem and a possibility for Ukraine. It is the cause of many mining fatalities and a source of economic opportunity because of the intrinsic value of methane as a fuel. Ukraine has some of the best coalbed methane resources in the world, but relatively few mines use technologies to capture and collect the gas. The Verkhovna Rada is considering legislation that would help promote coalbed methane as a resource. Following through on such legislation and taking steps to remove barriers – such as open access to gas pipelines for coalbed methane producers and market reflective pricing – could play an important role in developing this resource. Licensing regimes also need to be simplified and structured to ensure that investors can sell the gas at competitive prices.

Currently, the majority of the environmental costs of coal production and coal use are not factored into the cost of coal. Requirements to treat flue gases from coal combustion or mine tailings are weak and are not always enforced. Stronger regulations and enforcement could help reduce the environmental impact of coal. Coal quality has been declining in recent years. While the government cannot change the geography of coal mines, it could encourage improvements in coal quality through regulations on emissions and through efforts to develop standards for coal products. At the same time, mine closures result in ongoing environmental concerns, which is particularly problematic in that the closed mines no longer have income to pay the cost of remediation. The government could consider mechanisms to ensure that these costs will be covered. For example, it might consider setting up a fund to pay for such expenses for state-owned mines, possibly using a portion of the royalties the government earns from coal companies.

It is important to better understand the economic and environmental implications of expanding coal use before making major policy decisions. This information is essential to designing a balanced policy for energy security; it also speaks to the need for reinforced co-ordination among government agencies. For example, increased coal use will increase greenhouse gas emissions, which could prove very costly to Ukraine under the Kyoto Protocol and future international climate mitigation agreements.

To date, management of coal reforms, budgetary outlays and the state-owned mines has fallen short of government or industry expectations. More clearly defining policy goals at the top level could help initiate improved management. For example, the current policies identify few measurable goals, such as sector profitability or fatality rates, against which to track progress. Clear goals – and progress toward them – can also help build coalitions of support for further reforms. On the other hand, frequent management and organisational changes can be a distraction, particularly if they are not clearly matched to goals. The numerous reorganisations of the coal sector in recent years seem to have caused delays in the reforms. Time, energy and money are lost in setting up new institutions that are swept away again a few years later.

The government would like to turn the coal sector around, making it an engine of growth rather than a source of budgetary pressure. Given the tremendous problems facing the sector, an obvious question is: how realistic are the plans to greatly expand production, particularly in the short to medium term? A 65% increase in coal production is large. If this goal is not realistic, the government may not properly prioritise the various elements of its energy policy.

Without restructuring, Ukraine's coal sector will never be profitable. Rather it will serve as a constant drain on the state budget and endanger plans to expand domestic energy production for energy security. It will also create ongoing social problems for miners and mining communities as mines become more and more indebted. Profitability is a prerequisite for the investment needed to help the sector grow. Thus, restructuring the coal sector with resolve is critical to the future of coal in Ukraine.

Recommendations

The government of Ukraine should:

- Enhance oversight of transactions at state-owned mines. Ensure that contracts are not under the de facto control of private groups and prices are not artificially deflated.
- Establish auctions for coal and coal products. Initially, consider specifying that a minimum of approximately 90% of all coal must be sold through such auctions.
- Phase out subsidies for coal production and capital investments as quickly as possible; redirect some of the funds to efforts to address social and environmental consequences of mine closure.
- Reinforce efforts to quickly close unprofitable mines.
- Follow through with privatisation of coal mining enterprises; use competitive tenders to attract strategic investors as described in the Concept for the Development of the Coal Industry.
- Establish clear labour safety regulations and consistently enforce them; require enhanced safety training for managers, workers and mining engineers, and make mining managers personally accountability for safety violations.
- Strengthen environmental regulations and their enforcement; consider using royalties to establish a fund to pay for environmental remediation after mine closure.
- Seek to improve management of coal reforms and of financial outlays related to the reforms.
- Assess whether plans to expand production are realistic; involve potential industrial investors, economists and other analysts in this assessment to improve the accuracy of estimates; calculate the environmental implications of expanding coal use before finalising current policy proposals.
- Promote coalbed methane with clearly defined and enforced rules to access natural gas pipelines and licensing regimes that allow sales of the gas at competitive prices.

8. ELECTRICITY

Overview

The Ukrainian power sector has undergone major changes in the past two decades. While the sector may be most famous internationally for the Chornobyl nuclear power plant accident in 1986, since then significant changes have taken place in demand, market structure and ownership. Ukrainian power demand dropped by 42% from 1992-2001, but began to grow again in 2002.[53] In the mid-1990s, the government unbundled the sector into generation, transmission and distribution. In 1997, Ukraine launched a wholesale market for power with a single buyer, called Energorynok, which also sells to distribution companies and large industrial consumers. The wholesale market has been distorted by the effects of non-payments, debts and state fuel allocation. The country plans wide-ranging reforms to reinvigorate the market including tariff reform and a move toward a system of bilateral contracts instead of a single buyer model. From 1998 to 2001, the government also sold off several of the power distribution companies to local and international strategic investors. In 2004, the government shifted gears and consolidated its assets in the sector into a new state holding company called the Energy Company of Ukraine. This company now owns the majority of non-nuclear generation and distribution assets. Formally, the wholesale power market still exists. However, it is not clear how competitive the market can be given the current ownership structure and government intervention of fuel allocation to power plants.

Electric Power Capacity

Power demand dropped dramatically after 1992 as the economy shrank. By 2000, total generation was only 68% of what it was in 1992. After 2000, the economy stabilised, and power demand grew somewhat. By 2005, generation had climbed back up to 74% of the 1992 level. There is still substantial excess capacity, mainly in thermal generation.

In fact, Ukraine has the 12th largest installed capacity in the world. The majority of the capacity (64%) is in thermal power plants. Nuclear power plants account for 26% of the capacity and hydro for 9%. Ukraine also has a small amount of wind capacity, primarily in Crimea. Nuclear energy plays a

53. Electricity production dropped less dramatically, by only 31%. Imports dropped and distribution losses increased, which explains the difference in the consumption and production numbers.

much larger role in actual production of electricity than its share of capacity would indicate. This is because as demand declined, Ukraine reduced production at the thermal power plants so thermal plants had lower capacity (or load) factors. Figure 8.1 shows where key Ukrainian power production and transmission assets are located.

Ukraine currently has significant excess power production capacity. In 1990, the country's power system had a load factor of 77%; by 2001 this number was down to 54%. Private investment analysts estimate that the current amount of capacity will be sufficient to meet demand for the next decade (Troika Dialogue, 2005).

Because of this excess capacity and low power prices, relatively little investment has been directed toward new capacity at Ukrainian utilities in the past 15 years. Several projects have gone forward of late, mainly with public subsidies or sponsorship. The Ukrainian government financed the completion of two 1 000 MW nuclear reactors, Khmelnytsky-2 and Rivne-4, which came on line in 2004. Two of the largest thermal power plants, Starobeshevo and Zmiyev, have both received investment to extend their lives. With World Bank and other financing, Ukrhydroenergo is investing USD 374 million to extend the life of its hydropower plants. In addition, industrial plants have made large investments in on-site power production. However, there is very little centralised data regarding the amount of capacity and investment.

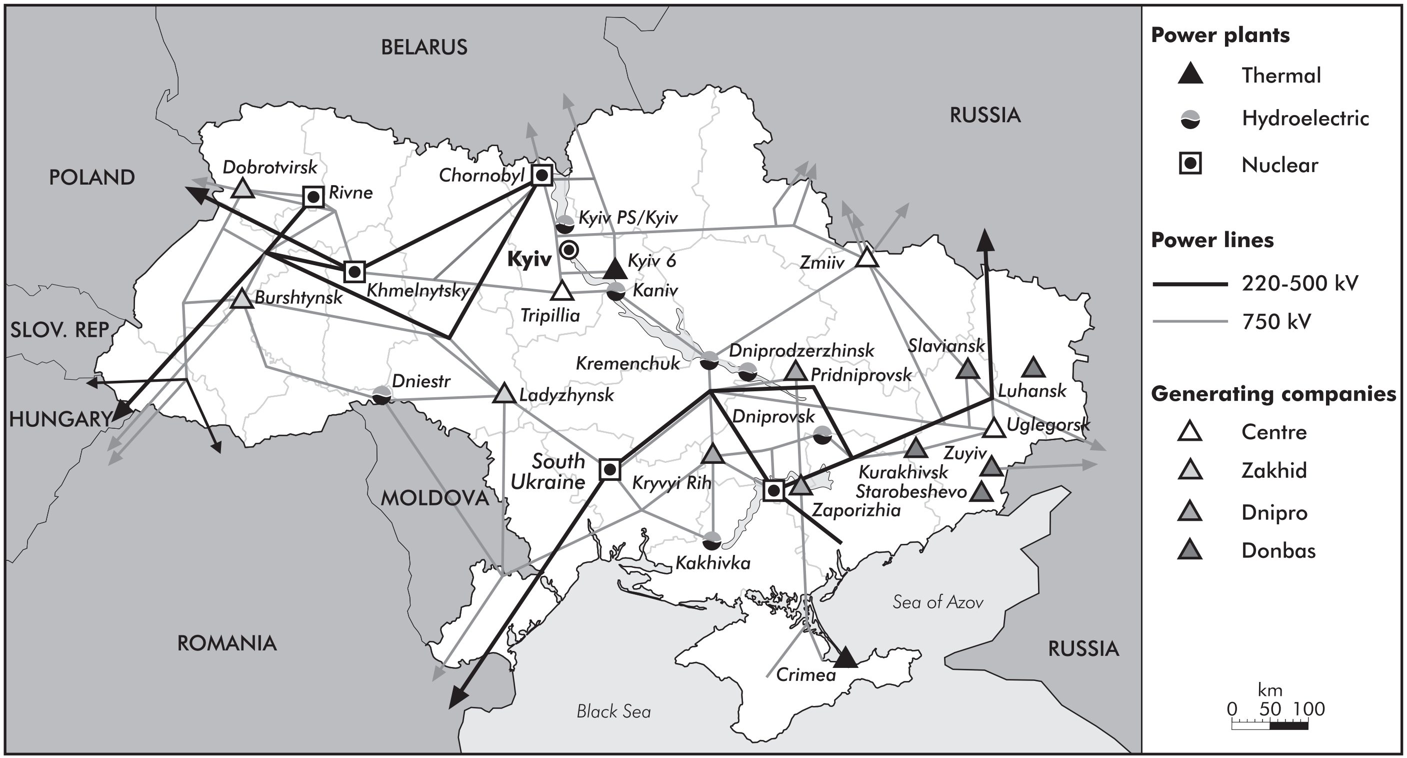
Over the past 15 years, some of the installed thermal power capacity has lost its functionality. Equipment has become worn or damaged through lack of use; some plants have been cannibalised to repair others. The World Bank estimates that about one-quarter of installed thermal capacity at utilities is not, in fact, available, even though the Ukrainian government and generating companies continue to list the capacity.[54] Also, the Ukrainian government shut down the last reactor at the Chornobyl Nuclear Power Plant in December 2000, which also decreased capacity.

Ukraine has 17 major, utility-owned thermal power plants, ranging from 470 MW to 3 600 MW in capacity. There are four nuclear power plants in Ukraine, with a total of 15 reactors. The country also has four large hydropower stations along the Dnipro and Dnistr rivers with a combined capacity of 3.3 GW, and a total hydro capacity nationwide of 4.7 GW. Table 8.1 describes the capacity levels and load factors in Ukraine. Average load factors are significantly below Western averages, indicating both that there

54. The companies hope to eventually repair the assets.

Figure 8.1

Ukrainian Power Network



Source: EBRD.

is excess capacity and that plants are not being operated very efficiently. Peak demand in Ukraine reached a new high of 30.8 MW in January 2006, but this is significantly lower than the 53 MW of installed capacity reported. Even if a full quarter of the thermal capacity is not available, there is still 14 GW (or 25%) more capacity than needed at times of peak demand.

Table 8.1

Installed Power Capacity in Ukraine, 2004

Plant type	Installed capacity, GW	Average load factor, %
Thermal, of which:	33.6	28.0
• *Combined heat and power*	*6.4*	*n.a.*
• *Power-only (condensing)*	*27.2*	*n.a.*
Nuclear	13.8	81.4*
Hydro	4.8	26.0
Total	**52.2**	**39.0**

** Energoatom lists a load factor of 81.4% in 2004, though this number dropped to 75% in 2005. In contrast, the independent analysts at Troika Dialog, show a lower load factor for 2004: 72%.*
n.a. – not available.
Sources: Ukrenergo and Energoatom.

Most of Ukraine's thermal power plants are power-only (also known as condensing power plants). Only three of the 17 major power plants are combined heat and power plants, with 1 670 MW of installed capacity. Regional power distribution companies have additional combined heat and power capacity of 4 100 MW. Thus, only 17% of Ukraine's thermal power capacity is from combined heat and power plants, despite Ukraine's substantial demand for district heating. While most of Ukraine's power capacity is owned by generation and distribution utilities, industrial enterprises own at least 2 600 MW of capacity, primarily in condensing power plants. Chapter 10: Renewable Energy describes Ukraine's renewable power capacity and potential in more depth. At present, the most significant sources of renewable electricity are hydro and wind power.

Overall, Ukraine's power plants tend to be quite inefficient, a function of both design and age. Ukraine also has some of the highest volume losses from power transmission and distribution in the world. From 1999-2004, transmission and distribution losses were more than 18%. However, in 2005, they dropped to 14.7% as a result of targeted actions that the Ministry of Fuel and Energy and regional distribution companies took to reduce transmission losses. The losses are both technical and commercial. Because of their low efficiency and out-dated equipment, Ukrainian thermal power plants also tend to be quite polluting. This area is examined in more depth in Chapter 3: Energy and Environment.

Industry Structure and Ownership

In the mid-1990s, the government re-structured the power sector to allow for competition between electricity producers. It split the ownership and management of the sector into generation assets, the transmission network, distribution assets and the power market (Energorynok). In principle, this split was a wise move. However, blurring of roles (for example distribution companies' ownership of significant generation assets) limits its effectiveness. The sector was unbundled in the mid-1990s as part of broad power sector reform that included establishment of an independent regulator and steps toward privatisation. At present, most of the Ukrainian power sector is still in state hands, as privatisation did not proceed as quickly as initially anticipated. In 2004, most of the non-nuclear generation and distribution assets were consolidated into a single state company, the Energy Company of Ukraine. The wholesale power market still exists and operates, but it is even less clear than before how much competition the sector supports, particularly given the dominance of the Energy Company of Ukraine. This section will first describe the design of the system following the power reforms of the mid-1990s, and then the changes involving the Energy Company of Ukraine.

• Generation

Generation is divided into three categories. Thermal power plants are owned by regional generation companies, known as "gencos". Ukrhydroenergo owns the 11 hydro power plants. The Energy Company of Ukraine holds the government's shares of both the gencos and Ukrhydroenergo. In contrast, the four nuclear power plants are owned by the state company Energoatom.

Initially after the reforms, there were four regional gencos: Zakhidenergo, Centrenergo, Dniproenergo and Donbasenergo. These companies managed 14 large thermal power stations. A new genco, Skhidenergo, emerged out of a debt restructuring process through which Donbasenergo transferred three of its five power plants to settle unpaid claims. This transfer of shares has been very controversial because of complaints about asset stripping and what was effectively a non-competitive privatisation of state assets. While Skhidenergo is privately held, the Energy Company of Ukraine owns the majority of shares in the other companies. Still, even the majority state-owned gencos have significant volumes of shares traded on the stock market: all four are among the top ten companies by market capitalisation on the Ukrainian stock exchange. The gencos theoretically compete on the power market, called Energorynok. Energoatom and Ukrhydroenergo also sell power to Energorynok at regulated prices representing about 60% of traded volumes. Skhidenergo had profit margins of 12% in 2005 and of 28% in the first half of 2006, compared to Energy Company of Ukraine's margins of 4 and 8%, respectively.

Distribution

There is a distribution company in each of Ukraine's 25 regions, plus one each in the cities of Kyiv and Sevastopol. Among these 27 regional distribution companies, there is a mix of state and private ownership. The distribution companies, called oblenergos, also own small cogeneration assets, mainly to produce heat for district heating. Kyivenergo is somewhat unique in that it is a vertically integrated joint stock utility, which both generates and distributes power and heat to the capital, Kyiv. In general, the distribution companies buy power from Energorynok and sell it to all but the largest consumers in their service territory.[55] Thus, they each have a monopoly on electricity supply to end users.

The National Electricity Regulatory Commission (NERC) sets distribution tariffs on a cost-plus basis. It also reviews investment proposals of each oblenergo. Since September 2005, while NERC still reviews and approves costs regionally, it also sets a unified distribution tariff for the whole country. Local authorities also play an important role in that they determine whether customers in arrears are disconnected. In the past, they have often tried to delay disconnections for social reasons, which contributed to growing debts in the electricity sector. Collection levels have significantly improved in recent years; in 2005, they stood at an impressive 99.3%.

The government privatised six distribution companies in two privatisation rounds; the first round was criticised because of the lack of transparent criteria for bidders; the second round brought in two international investors (AES and the Slovak/Dutch company VS Energy). The remaining distribution companies are partially privatised, with a mix of free floating shares, state-owned shares and shares owned by other major shareholders. Companies in the Surkis Group are the largest in this last category, owning up to 75% of the shares in ten distribution companies (Jacob, 2003). Hryhory Surkis, the president of the Surkis Group, is one of the largest business owners in Ukraine and also a member of parliament.

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55. The largest industrial consumers buy electricity directly from Energorynok.

VS Energy has announced that it will sell the shares it owns in oblenergos. It currently holds positions in Sevastopolenergo (95%), Khersonoblenergo (95%), Kirovohradoblenergo (94%), Zhytomyroblenergo (76%), Odesaoblenergo (20%), Chernivtsyoblenergo (22%), Khmelnytskoblenergo (12%) and Zakarpattyaoblenergo (11%). Both AES and the Czech electricity company CEZ have expressed an interest in buying these shares.

Overall, the private distribution companies have a better track record than the state-owned ones with reducing losses from electric power lines. Private companies have also invested more on average. AES, for example, has been making large investments in its distribution lines and in its billing systems. From 2003-05, it invested UAH 61 million (USD 12 million) in Rivneenergo and UAH 114 million (USD 22 million) in Kyivoblenergo. In 2005, it signed a loan agreement with the International Finance Corporation for an expanded investment programme worth USD 45 million. Some majority state-owned distribution companies are also working to improve their networks, although the size of investments is typically smaller. For example, Mykolaivoblenergo has announced that it will invest UAH 20 million (USD 4 million) in 2006. Moreover, all of the companies privatised in the second round of privatisation have very high collection rates (more than 100% in 2005) and almost all have low levels of debt compared to the other distribution companies.

In addition to the distribution companies, there are also several hundred supply and service companies that operate the last kilometre or so of electric wires going to households and other small consumers.

Transmission and Single Buyer

The state company Ukrenergo owns and operates the transmission grid.[56] It is independent of the generation and distribution companies. Ukrenergo collaborates closely with the market operator, Energorynok, of which it is a member, but the two are separate entities with distinct budgets. It operates the central dispatch centre in Kyiv and the high-voltage transmission lines, and is also responsible for maintaining and upgrading those lines as necessary. NERC regulates the transmission tariff.

Energorynok operates the wholesale power market and is a 100% state-owned enterprise. Energorynok has accumulated significant debt because oblenergos have not paid in full for their power purchases. In turn, generating companies did not get paid in full, which compromised the effectiveness of the market. The Ministry of Fuel and Energy frequently intervened to

56. Specifically, Ukrenergo holds these assets on its balance sheet. This includes 220-750 kV transmission lines and almost all interstate transmission lines.

allocate fuel under emergency rules. These allocations reduced the ability of generators to freely compete in producing and selling power. The power market and debt problems are described in more detail below. Figure 8.2 outlines the electricity and monetary flows in the power sector.

Market Interactions and Recent Changes

The government had planned to fully privatise all the oblenergos, but the last privatisation round took place in 2001. Initially, the reason for the halt was to make sure the privatisations were as transparent as possible. Many policy makers raised concerns about this because powerful oligarchs were able to get many assets for small investments. The World Bank has analysed the effectiveness of the private versus state-owned distribution companies and found that particularly those that were privatised in the second round have seen improvements in collections, efficiency and loss reduction (Gochenour *et al.*, 2004). However, the improvements were not as dramatic as those seen in other regions of the world, such as South America, possibly because the non-payments problems had an impact on the ability to make investments.

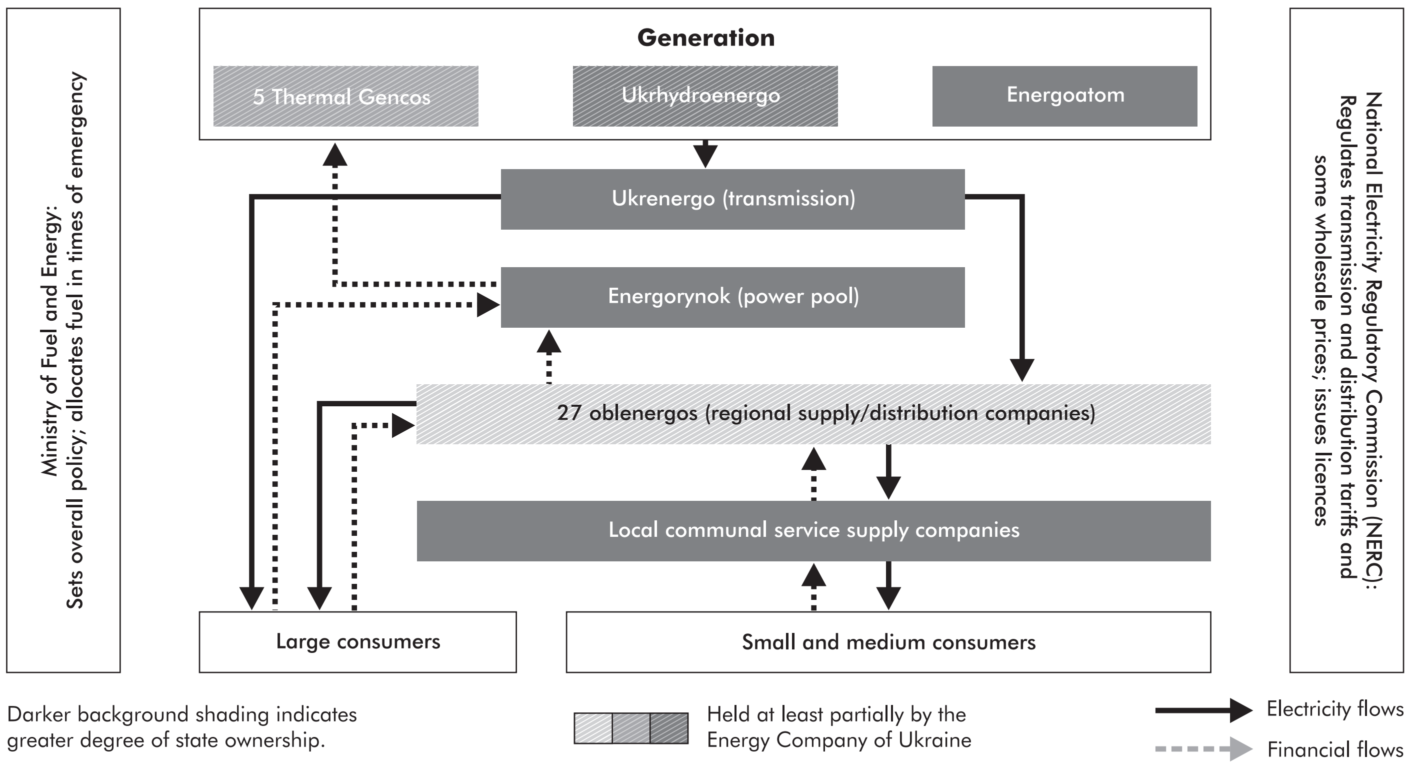
In January 2004, former president Kuchma created, by decree, the Energy Company of Ukraine, a state-owned holding company. The government then consolidated its power sector holdings by transferring most of them to the Energy Company of Ukraine, which in turn reports to the Ministry of Fuel and Energy. The stated goal behind this reorganisation was to improve management of power sector enterprises in order to enhance energy security, efficiency and reliability. It is part of a trend to create vertically integrated energy companies based on state holdings. However, it is not clear that this move helps the government achieve its goals of increased competition and efficiency.

Figure 8.3 lists the holdings of the Energy Company of Ukraine, which include stakes in most of the Ukrainian distribution companies, thermal power producers and a hydro power company (the Energy Company of Ukraine does not own Energoatom or any nuclear assets). Previously, the State Property Fund held the shares in the companies the Energy Company of Ukraine now owns. Initially, the transfer was slated to incorporate the state transmission grid operator as well.[57] However, Kuchma changed this decision with a new decree in June 2004 following significant criticism about the impact such a consolidation would have on the power market. Nonetheless, overnight the Energy Company of Ukraine became the largest power company in Ukraine and one of the largest in Europe. Several power sector companies and their shareholders have protested this move, which they felt was a violation of their ownership rights or in some

57. In Ukraine, the grid is known as the Unified Energy System of Ukraine.

Figure 8.2

Electricity and Financial Flows in the Ukrainian Power Sector



Source: IEA analysis.

Figure 8.3

Holdings of the Energy Company of Ukraine

Energy Company of Ukraine

Power distribution and supply companies

Vinnytsyaoblenergo – 75.00%
Volynoblenergo – 75.00%
Dniprooblenergo – 75.00%
Zakarpattyaoblenergo – 75%
Khmelnytskoblenergo – 70.01%
Chernivtsyoblenergo – 70.00%
Krymenergo – 70.00%
Mykolayivoblenergo – 70.00%
Donetskoblenergo – 65.06%
Kharkivoblenergo – 65.00%
Zaporizhyaoblenergo – 60.25%
Luhanskoblenergo – 60.06%
Ternopiloblenergo – 51.00%
Kyivenergoo – 50.00%
Cherkassyoblenergo – 45.00%
Lvivoblenergo – 26.98%
Odesaoblenergo – 25.01%
Poltavaoblenergo – 25.00%
Prykarpattyaoblenergo – 25.00%
Sumyoblenergo – 25.00%
Chernihivoblenergo – 25.00%

Power generating companies

Thermal
Donbasenergo – 85.77%
Centrenergo – 78.29%
Dniproenergo 76.04%
Zakhidenergo 70.10%

Cogeneration (CHP)
Dniprodzerzhynsk CHP – 100.00%
Mykolayiv CHP – 100.00%
Kherson CHP – 100.00%
Odesa CHP – 100.00%
Kharkiv CHP -5 – 100.00%
Crimean Generating Systems*
Severodonetsk CHP*
Lysychansk CHP*
Zuyiv Experimental CHP*
CHP -2 Eshar*

Hydro
Ukrhydroenergo – 100.00%
Dnistr pumped storage – 87.40%

+ two small wind stations*

Other enterprises

Ukrintrenergo*

+ several scientific research institutes*

Note: * – property

Source: Kubrushko, 2005a.

cases, the terms of long-term leases. In a few cases, these actions slowed down or stopped the transfers, but they did not substantially change the Energy Company of Ukraine's dominance in the sector.

After President Yushchenko came to power, the government decided to continue with this policy, at least for now. Some in the government have questioned whether or not privatisation has improved results in the power sector. There is also a sense in the government that it can better manage the assets if they are vertically integrated, keeping in mind that the Ministry of Fuel and Energy continues to have a major role in every day operations in the power sector. On the other hand, there has also been discussion of fully privatising all the assets now held by the Energy Company of Ukraine, once the groundwork is set. However, for privatisation to begin now, the government would first need to transfer the assets back to the State Property Fund. Privatising the Energy Company of Ukraine would significantly complicate free competition on the power market in that competing gencos would have the same owner. Unbundling a private monopoly would be very complicated. Privatisation of the company as a whole would likely give the government less value for the privatised assets: the new private company would likely face new price regulation because of its dominant position. Private bidders would factor this into their bid price. It makes more sense to unbundle the Energy Company of Ukraine before privatising the assets.

The Power Market

Ukraine's Wholesale Electricity Market (WEM) began operating in 1997. The state company Energorynok (or "power market") operates the market, serving as a single buyer of power. In principle, the large thermal gencos compete to sell power to Energorynok. Energoatom and Ukrhydroenergo also sell power (nuclear and hydro) to Energorynok, but at prices set by NERC. Thus, the competitive wholesale supply accounts for only about 35-40% of the power sold to Energorynok. Energorynok then sells power to the oblenergos and large industrial firms. NERC sets the regulated prices for transmission and distribution services (Kalchenko, 2004). In turn, the oblenergos sell to customers at rates that are based on the wholesale price plus the transmission and distribution tariff.

Several pieces of legislation regulate the market, including the 1997 *Law on Electricity*, Presidential decrees, orders from the Cabinet of Ministers and NERC, and the agreement between the members of the WEM. Since the electricity law was adopted, parliament has passed several important amendments. These amendments cover issues such as payments in the

WEM, reducing fines on customers in arrears, ensuring fairness in tenders and proportional payments for electricity sold on the WEM.[58]

The market was set up as a replica of the England and Wales power pool, at least in theory. However, problems with non-payment and debt have significantly hampered market function. First, Energorynok accumulated UAH 17 billion (USD 3 billion) in debt on its own books. Second, the fact that Energorynok did not receive full payment meant that it could not pay the generators in full. It ended up making payments based on a complicated algorithm negotiated with the WEM participants. In turn, the generators did not have enough money to pay for fuel, so the Ministry of Fuel and Energy allocated fuel to plants, distorting the market. The World Bank writes that "Price bidding in the WEM was really a shadow exercise that had little impact on actual wholesale prices or on the dispatch of energy from power stations" (Gochenour *et al.,* 2004). In the end, thermal power generators were sometimes shut down, brief supply interruptions were common and, at times, the system operated at dangerously low frequency levels.

Ultimately, the WEM members agreed that only NERC (not the Ministry) could change the algorithm for cash allocations to power suppliers, and only in times of clearly defined technical emergencies. Nonetheless, the Ministry of Fuel and Energy continues to allocate fuel to power plants, which means that for all practical purposes, there is no competitive market. This lack of a competitive market has led to uneconomic dispatch decisions, which one consultant calculated has caused an almost 13% increase in fuel consumption for fossil-fired power production nationwide (as the most efficient plants were not dispatched first).[59]

By 2002, the WEM participants decided that the WEM concept needed reform: the single buyer system was not working in Ukraine. Non-payments burdened the power market with heavy levels of debt. Government intervention in fuel allocation and prices also reduced the market's efficiency. The risks of new non-payments or supply problems in a re-invigorated market prompted the participants to consider whether this was the best model for Ukraine.

WEM participants proposed a new market concept that would involve three separate types of transactions: bilateral purchase agreements (generally long-term), standard agreements through an exchange and a residual balancing

58. Communication from the Secretariat of the Parliament's Committee for Fuel and Energy, Nuclear and Nuclear Safety.
59. The Ministry of Fuel and Energy is still developing projections for fuel use in thermal power plants, drawing from the energy targets (or balance, as they are known in Ukrainian) outlined in the Energy Strategy to 2030. *For example, the Ministry projects that in 2006, some 69% of coal purchases (all sales from state-owned mines) will be made through the WEM. Sales from private coal mines will be made on a bilateral basis.*

market under a revised set of market rules. The benefits of the new WEM Concept would include simplified payments, reduced likelihood of government intervention, and revenue clarity for investment decisions. A WEM Concept Commission and working group have developed detailed proposals on a five-year transition period to move from the current single-buyer model to the bilateral model. These proposals include: addressing the accumulated debts; upgrading equipment; transitioning to an automated transaction system; optimising tariff methodologies and mechanisms to eliminate unfair competition; reforming tariffs to remove cross-subsidies; and preparing the legislative basis for the new power market model. All these proposals are aimed at improving the financial condition of the power sector.

The direction and objectives of the reform are encouraging but questions remain over how competitive the market will be. The structure of the market at the point of final supply (*i.e.* insignificant retail competition) implies that there is unlikely to be significant competitive pressure passed up the supply chain. Also, a significant proportion of energy sold into the market is at regulated prices. One must question whether many of the objectives could be achieved, in large part, by focussing on fundamentals, such as removing cross-subsidies, without redesigning the market.

Collections saw significant improvement after 2000 when the government began requiring payment in cash through special bank accounts instead of barter. This secured the integrity of transfers and made payments easier to track. However, the past non-payments were still a weight on the industry because many companies were effectively bankrupt. In June 2005, the Verkhovna Rada passed legislation that addresses this by developing a verified registry of the debts and levying a surcharge for debt payment on the sale of electricity (Verkhovna Rada, 2005). This law is now being implemented and debts between WEM participants have dropped steadily over the past year.

The ownership status of the power sector assets also has important implications for the power market. It is hard to imagine a truly competitive power market when the government has consolidated the majority of production and distribution assets into a single holding company. For now, however, the advent of the Energy Company of Ukraine has not resulted in a change in the power market structure or rules.

Regulation and Pricing

NERC plays several roles in the power sector. It licenses power plants to connect to the grid and participate in the wholesale market. It also sets the price of power from nuclear, hydro, wind and cogeneration plants, based on a cost-plus type methodology.[60]

NERC also sets retail electricity tariffs with a cost-plus formula that factors in the market price of electricity purchased on the wholesale market, losses, operation and maintenance costs, and the allowed rate of return on investments by distribution companies. On average, the wholesale price of electricity makes up about 77% of the tariff, the transmission and distribution tariffs are, respectively, about 12% and 1% of the total, and covering the cost of losses on power lines makes up the remaining 9%. The cost of electricity is calculated based on the average wholesale price of all types of power. NERC sets the tariff for power distribution and local supply at a level that should cover costs and provide some profit, though oblenergos have expressed concerns that the tariff does not allow them to make all the necessary investments. NERC's strategic objective is to optimise the retail price of electricity in each link of the energy chain and to balance the interests of all participants in the energy market. It sets the retail price according to customer class, which involves a cross-subsidy from industry to residential users.

Until September 2005, NERC had separate retail prices for each region, reflecting the different costs for each distribution company. However, it has now decided to set unified national prices. The logic behind this decision is that this approach is fairer to all consumers. In reality, unless costs are broadly equivalent across the country, a unified tariff introduces another cross-subsidy.

There is little discussion of allowing retail competition. In fact, over the past several years, fewer and fewer large manufacturers have been allowed to buy power directly from producers. The government felt the *ad hoc* nature of such sales was unfair and raised prices for other consumers.

As discussed in Chapter 1: General Energy Scene and Energy Policy, NERC is independent of the Ministry of Fuel and Energy but it does not have complete budgetary and administrative freedom. Also, its rulings can be – and are – overruled at times.

Ukraine has relatively low prices for power, even compared to Russia or Belarus. Table 8.2 shows average residential and industrial power prices in Ukraine and in other Eastern Europe countries in mid-2005. NERC has since raised regulated tariffs, but Ukrainian tariffs remain lower than those in most of its neighbouring countries.

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60. A cost-plus methodology calculates costs and adds a fixed percentage profit to these costs. Thus, higher costs lead to higher profits, which provides a built-in counter-incentive against efficiency.

Table 8.2

Comparison of Electricity Tariffs in Ukraine and Neighbouring Countries, Mid 2005

Country	Average residential tariffs	Average industrial tariffs
	USD/kWh	USD/kWh
Ukraine	0.023	0.0356
Belarus	0.033	0.0600
Russia	0.035	0.0420
Moldova	0.058	0.0580
Estonia	0.068	0.0604
Latvia	0.069	0.0602
Lithuania	0.081	0.0665
Poland	0.081	0.0638

Source: Ministry of Fuel and Energy.

Regulated tariffs for wholesale electricity in Ukraine are not high enough to cover depreciation, or re-investment, in power system assets. This affects nuclear, hydro and most thermal power plants. In the case of nuclear energy, the tariff calculations do not seem to adequately include allowances for future decommissioning costs or the full costs of nuclear safety. The latter are partly funded by the Ukrainian government directly and partly by Western governments, in addition to investments made by Energoatom. In the case of combined heat and power, the allocation of costs between heat and power tends to put more of the costs toward heat than would be warranted based on the split in energy output. Moreover, non-payments further lower the effective tariff (or, put otherwise, create an implicit subsidy for electricity).

The government and NERC decided in late 2005 to increase all electricity tariffs to rates that were "economically justified". Cross-subsidies will also be phased out as part of this move. NERC had decided to raise tariffs by 10% per quarter until these goals are met. The first of these increases took place in January 2006; even sharper increases have occurred since. In July 2006, NERC accelerated its schedule for increasing prices; it now plans to raise prices by 25% every six months for the next two years. According to NERC and the Ministry of Fuel and Energy, prices in July 2006 covered only 36% of the total long-term production costs (Energobusiness, 2006).

Debt and Investment

Debt and non-payments have been serious problems in the Ukrainian power sector. Before 2000 in particular, many consumers did not pay in full for their power bills, or paid partially through barter instead of in cash. This meant that the oblenergos did not have enough money to pay for the power they purchased (nor to properly maintain their distribution lines and other assets). The oblenergos, in turn, did not pay Energorynok, which then did not fully pay the gencos. While collections have improved dramatically, Energorynok is still saddled with large debt.

Table 8.3

Energorynok's Payment Collections, 1996-2001

Year	1996	1997	1998	1999	2000	2001
Total collections (%)	89.9	74.3	80.1	79.5	86.5	80.7
Cash collections (%)	1.1	9.1	7.1	7.7	32.8	65.1

Source: Gochenour et al., *2004.*

In 2004, oblenergos had an average collection rate of 97.4%; in the first half of 2005, this improved further to 98.4%, which is good by Western standards. Nonetheless, in 2004 alone, Energorynok was left with UAH 877 million (USD 160 million) of unpaid bills, primarily from Donetskoblenergo, Ukrenerhovuhillia and Luhank Energy Union (Energorynok, 2005b). All three of these enterprises are in Eastern Ukraine and are closely related to the coal and metallurgical sectors. In fact, either directly or indirectly, many of the unpaid bills benefit private, profitable steel companies owned by Ukrainian or Russian oligarchs.

By January 2004, consumers had total accumulated arrears of UAH 10.5 billion (USD 2.0 billion) owed to the oblenergos. Oblenergos and other companies owed Energorynok UAH 16.6 billion (USD 3.2 billion) and Energorynok owed the generation companies UAH 18.1 billion (USD 3.5 billion). The generation companies in turn owed fuel suppliers and have not paid their taxes in full because of this debt. It is, in fact, this debt that forced Donbasenergo to sell power plants at what many feel were undervalued prices. While many final consumers did not pay in full, state organisations often had the lowest payment rates. Barter also allowed intermediaries to profit and amplified the debt problems at Energorynok.

Obviously, attracting investment in this climate was not easy, nor was it easy to privatise the utilities. In June 2005, the government and the Verkhovna

Rada adopted a comprehensive debt restructuring plan to put the sector on sounder financial footing. The law provides provisions for the government to fund past unpaid debts of state organisations, once they have been clearly documented and registered. It also seeks to cancel debt between organisations through negotiations and inter-organisational debt clearance. The hope is that these measures will make it easier to attract financing and create a more stable power supply in the long term.

The *Energy Strategy to 2030* provides a few pivotal facts highlighting the status of power assets. More than 92% of thermal power plants have outlived their design life. Some 34% of above-ground 220-330 kV transmission lines have operated for 40 years or more, and need to be replaced. In addition, 76% of sub-stations have operated for longer than they were designed to.

The *Energy Strategy to 2030* also outlines estimated investment needs in the power sector of UAH 522.3 million (USD 104 billion) through 2030, approximately half of which would be for nuclear power development. This investment estimate includes:

Table 8.4

Investment Needs in the Power Sector, 2006 to 2030

	Billion UAH	Billion USD
Modernising and improving the safety of nuclear reactors and managing nuclear waste	27.0	5.4
Extending the life of 13 nuclear reactors	11.7	2.3
Constructing 22 new nuclear reactors, a hydro power plant, and nuclear decommissioning	169.5	33.7
Building nuclear fuel production facilities	21.7	3.3
Extending the life of condensing thermal power plants, reconstructing existing plants and building new ones	183.4	33.1
Hydropower development	19.0	3.8
Upgrading transmission and distribution by 2030 (including investments to upgrade the interconnection with the UCTE)	82.9	16.5
Promoting renewable energy	7.1	1.4

Note: USD figures are the converted equivalent of the UAH numbers.

Source: Cabinet of Ministers, 2006a.

Electricity Exports and Interconnections with Neighbouring Countries

Ukraine is a net exporter of electricity, selling approximately 3 500 GWh of power abroad in 2005. Ukraine would like to increase these exports and become a more important transit route for electricity from Russia to Central Europe. Significantly increasing exports requires improving the reliability of the grid and stabilising system frequency. Currently, only the so-called Burshtyn Island of power plants in Western Ukraine is connected to the UCTE European grid (see Box 8.1). Ukraine re-synchronised its grid with Russia's in 2001, though exports to Russia dropped significantly after NERC decided to raise the export tariffs in mid-2005. The Ukrainian system also began working in parallel with the Belarusian system in 2006. Table 8.5 provides an overview of Ukraine's power exports.

Table 8.5

Electricity Exports in 2005 and Early 2006 (million kWh)

Country	2005	Jan.-June 2006
Belarus	3*	1 107
Hungary	3 319	1 776
Moldova	799	1 034
Poland	983	436
Romania	129	35
Russia	2 829	0
Slovakia	279	278
Total	**8 341**	**4 665**
Transit	8 358	n.a.

** Transmitted on two 330 kV transmission lines between towns near the border.*
n.a. – not available.
Sources: Ukrinterenergo and Energobusiness.

Until 2006, Ukrinterenergo was the sole authorised power exporter from Ukraine, buying power from Energorynok and also arranging electricity transit through Ukraine. NERC regulated export prices and Ukrinterenergo's average revenue per kWh was significantly lower than the average price of power across the border in Hungary and Slovakia, which indicates that Ukraine was losing money (and possibly that middlemen were making a large profit). Concerns about the loss of export revenue prompted the Ministry of Fuel and Energy to change the export regime in early 2006. The government allowed multiple companies to compete in exporting power and the ministry audited existing export contracts. Following these changes, total reported income from power exports more than doubled, despite a drop in export volumes.

Regional Integration of Networks

Ukraine's high-voltage power grid is connected to the power systems of neighbouring countries, including Russia, Moldova, Belarus, Poland, Slovakia, Hungary and Romania. This makes it part of the large regional integrated power system (IPS/UPS) of the Commonwealth of Independent States (CIS) and the Baltics, as well as part of the trans-European electric grid. However, integration exists only at a technical level; there is no common electricity market.

In 2002, the Electricity Power Council of the CIS and Baltic States requested the Union for Co-ordination of Transmission of Electricity (UCTE) to consider a synchronous interconnection of the IPS/UPS power systems with UCTE. In April 2005, the UCTE-Consortium and the IPS/UPS companies signed a Co-operation Agreement in Brussels, which defines the overall legal framework for co-operation. Synchronising IPS/UPS with UCTE will be challenging because the two systems have different historical, technical, organisational and legal background. Western European power companies support interconnection but emphasise that CIS producers must meet EU nuclear safety and environmental standards prior to full grid interconnection. The European Commission is providing Ukraine with technical assistance to facilitate integration with UCTE. The Ministry of Fuel and Energy aims to connect Ukraine's grid with the European grid by January 2008. Moving from a technical connection to greater market integration will likely take longer than this.

Box 8.1 UCTE

The Union for the Co-ordination of Transmission of Electricity (UCTE) is an association of transmission system operators in 23 countries in continental Europe, from Portugal to Poland and from the Netherlands to Romania and Greece. It co-ordinates the operation and development of the electricity transmission grid: in particular, it issues international technical standards and monitors the balance between generation and consumption in the interconnected systems. UCTE also monitors and supervises the development of transmission infrastructure in the UCTE synchronous area. Moreover, it provides statistics on electricity generation and transmission in the European mainland.

Source: UCTE website, www.ucte.org.

Burshtyn Island

In 1995, the Western Ukrainian generating company Zakhidenergo and Ukrainian national grid operator Ukrenergo applied to UCTE for permission to synchronise operations. Burshtyn Island subsequently upgraded its system according to UCTE requirements. The synchronisation took place on 1 July 2002. After a successful one-year trial operation, a permanent synchronous connection was approved by UCTE in September 2003.

The "island" includes Burshtyn Thermal Power Plant (Ivano-Frankivsk Region), Kaluska Combined Heat and Power Plant (Ivano-Frankivsk Region) and Tereblya-Rikska Hydropower Power Plant (Zakarpattya Region). It also includes the adjacent network and consumers in the Zakarpattya Region and in parts of the Lviv and Ivano-Frankivsk regions. In total, the island covers 27 000 km^2, an area with 3 million inhabitants. The total working generation capacity of the island is estimated at 1 950 MW (though the total installed capacity is more than 2 500 MW). It has the following connections with UCTE countries and Romania:

- Hungary: one 750 kV transmission line, one 400 kV line and two 220 kV lines.
- Slovakia: one 400 kV line.
- Romania: one 400 kV line.

These high-voltage lines extend West toward the Czech Republic and beyond, and South toward Bulgaria and the Balkans. Thus, they offer more opportunities for trade and transit with Central Europe and the Balkans when, and if, technical conditions are met.

Ukraine's Strategy

Synchronising IPS/UPS with UCTE seems to be a good opportunity for Ukraine in the long term, assuming that its domestic market is well-functioning and prices for Ukrainian consumers are market-based and cover all costs. The *Energy Strategy to 2030* projects an increase in electricity exports. The plan is to upgrade transmission networks and expand generating capacity of the Burshtyn Island.

It should be borne in mind that, at present, the electric grid systems in most of the country are technically connected with the rest of the former Soviet Union, while only the Burshtyn Island is synchronised with UCTE. Synchronisation between the two systems is technically impossible, *i.e.* electricity generated in the island can not be sold in the East of the country. This raises the question of finding a balance between domestic energy security and export revenues. The expense of refurbishing outdated power plants is not small, particularly if exports expand. Table 8.6 demonstrates Ukraine's electricity transmission capacity and the existing export/transit potential.

Table 8.6

Interstate Electric Power Transmission Lines of Ukraine and the Potential for Exports of Electric Power to Neighbouring Countries

Country	Number of overhead lines by voltage					Power line transmission capacity, billion kWh/year
	750 kV	400-500 kV	220-330 kV	110-35 kV	Total	
Russian Federation	1	3*	10	18	**32**	26.3
Moldova			7	18	**25**	
Belarus			2	6	**8**	6.1
Poland	1		1		**2**	(UCTE area) 5.0** 490***
Slovakia		1		1	**2**	
Hungary	1	1	2		**4**	
Romania	1	1			**2**	

** One 400 kV direct current power transmission line; ** Under Burshtyn Island operating mode; *** Under parallel operating mode.*

Source: Cabinet of Ministers, 2006a.

Nuclear Energy

• Nuclear Power Reactors and Energoatom

Ukraine has four nuclear power stations with a total of 15 working reactors (Table 8.7). Nuclear energy is now the largest source of electricity output in Ukraine. In the future, the government projects that nuclear's share will remain at the 2005 level (around 50% of total power production) while total production will more than double. Energoatom, a 100% state-owned company created in 1996, owns and manages all of the nuclear power stations; it co-ordinates its work closely with the Ministry of Fuel and Energy. The Ministry has a nuclear department and a deputy minister responsible for nuclear energy issues.

Ukraine closed the last reactor at Chornobyl nuclear power plant in 2000. In 2004, it started operating two new reactors at the Khmelnytsky and Rivne nuclear power plants. In the *Energy Strategy to 2030*, the Ukrainian government outlines plans to build or complete 22 new reactors with a

Table 8.7

Nuclear Power Plants in Ukraine

Plant name	Year opened	Capacity (MW)	No. of reactors	Reactor type
Zaporizhya	1984	6 000	6	VVER-1000[61]
South Ukraine	1982	3 000	3	VVER-1000
Rivne	1980	2 835	4	VVER-440, VVER-1000
Khmelnytsky	1987	2 000	2	VVER-1000

Source: Energoatom.

total capacity of 29 GW by 2030; the share of nuclear would rise to 52% of power production. As Ukraine does not have a domestic reactor industry, it will need to purchase the technology internationally. One means to do this would be by international tenders to select the new reactors. It is possible that private companies will operate these new reactors.

The Ukrainian government would like to use the nuclear power industry to reduce its energy dependence on Russia. Currently, Ukraine buys its nuclear fuel rods from Russia, but exports uranium and zirconium to Russia (zirconium is required to make the reactor fuel rods). It would like to build facilities for some elements of the fuel cycle to eliminate fuel rod imports from Russia and potentially lower fuel costs. Ukraine mines and mills uranium; in the future it also plans to make fuel rods using imported enriched uranium.[62] Ukrainian uranium extraction now equals about one-third of its needs for nuclear fuel. Thus, decreasing dependence on Russia would require significant investments in both uranium production and uranium processing. Ukraine has 2% of world uranium reserves; most of its resources are associated with deep, low-grade deposits with relatively high extraction costs. The country has also bought an experimental batch of nuclear fuel from Westinghouse, but the cost is some 40% higher than that of the Russian fuel. In the near term, this is not a realistic source of fuel for Ukraine (Uranium Information Centre, 2005; Bernadsky 2005; IAEA, 1998). However, TVEL, the Russian nuclear fuel company, may increase prices in future contracts, particularly if uranium prices continue to rise globally.

61. VVER is a Russian acronym for a pressurised water reactor. In a literal translation, the Russian abbreviation, VVER, stands for water-cooled, water-moderated energy reactor.

62. Former prime minister Yekhanurov announced in 2006 that Ukraine would not seek to enrich uranium domestically, scaling back Ukraine's fuel cycle plans because of international non-proliferation concerns.

Costs and Pricing

The State Nuclear Regulatory Committee (SNRC) provides data on the cost elements of the wholesale nuclear power tariff in Ukraine. Fuel purchases account for almost one-third of the cost. Labour makes up slightly more than 10% of the cost. Profit is set at 30%. However, the profit must be used for what would be considered production costs by international accounting standards. Most of the nuclear safety upgrades are funded out of depreciation or profit. This means that virtually no money goes toward capital reinvestment in new capacity. In fact, capital costs for the two new nuclear reactors at Khmelnytsky and Rivne were funded from a special charge on all power sold and were not included in the nuclear tariff rate base. Decommissioning has also been excluded from the costs of nuclear power in the past, and it is not yet clear that new decommissioning funds will be adequately financed.

The costs of nuclear waste storage and disposal are also not part of the nuclear tariff rate base (although costs for removing spent fuel from the reactor are included). The tariff base also includes a small charge for what is called the "nuclear fuel cycle fund", though it is not clear if the charge would be enough to fully cover the capital costs of planned investments in this area. As indicated elsewhere, the governments of Ukraine and several other countries fund nuclear safety at Ukrainian reactors directly, though the tariff base also covers some of these costs.

In sum, a significant portion of the costs of nuclear power are not passed on directly to consumers through the tariff structure. While this is true to some extent for all power production (because capital replacement costs are chronically underfunded), it seems particularly a problem for the nuclear industry where capital costs make up such a large portion of total costs. This lack of cost coverage will make it much more difficult for the government to implement its plans to expand nuclear power.

NERC sets the tariff for nuclear power sold to Energorynok. The wholesale tariff for nuclear power in 2005 was UAH 0.078 (USD 0.016) per kVh, approximately 33% lower than the average wholesale power price. Despite tariff and price increases in 2006, the ratio of average and nuclear wholesale prices has remained virtually the same (Table 8.8).

Public Opinion

Public opinion has played an important role in the development of nuclear power in most democratic countries. The Razumkov Centre surveyed

Table 8.8

Average Wholesale Power Price by Type of Power Plant, July 2006

Type of power plant	Cost	
	(UAH/kWh)	(USD/kWh)
Nuclear*	0.080	0.016
Thermal condensing	0.192	0.038
Hydro*	0.077	0.015
Combined heat and power*	0.175	0.035
Wind*	0.242	0.048
Average	0.129	0.026

**The wholesale price of power from these types of plants is regulated.*

Notes: On 27 July 2006, the regulator approved an increase in the nuclear tariff to 0.0888 UAH/kWh (USD 0.018/kWh); the hydro tariff also rose in late July to 0.0869 UAH/kWh (USD 0.017/kWh).

Source: Energorynok, 2005a.

Ukrainian public opinion on nuclear energy in 2005. The Centre found that while 39% of the public felt nuclear energy could provide Ukraine with greater energy independence, 55% thought it was not necessary to build new nuclear power plants. Some 65% expressed the view that Ukraine's reactors were rather or extremely hazardous to the environment. A surprising 84% said they do not receive enough information from the government on its intentions to build new nuclear power plants. Volodymyr Saprykin, director of energy programmes at the Razumkov Centre, says this lack of information creates a risk for these construction plans and the government should engage the public in a dialogue on the topic. This would build trust and understanding, and decrease the chance that public opposition might halt work on a key aspect of the government's energy strategy (Saprykin, 2005b).

Nuclear Regulatory Framework and Nuclear Safety

Nuclear safety is another major concern in Ukraine's energy sector. The former head of the parliamentary fuel and energy committee listed it as one of his top two energy concerns, the other being the increase in the price of imported natural gas.

The State Nuclear Regulatory Committee (SNRC) is responsible for licensing nuclear facilities, monitoring their compliance with nuclear safety norms and developing relevant regulations. It also provides oversight for Chornobyl decommissioning and the management and transport of nuclear waste. The

Committee was created in 2000 following a government reorganisation. It is an independent body, but like NERC, it receives its budget from the government. Until 2005, the chair of the SNRC was appointed and removed by the president of Ukraine. Under the new Constitution, the parliament and prime minister will take over these responsibilities.

Since independence, Ukraine has taken several steps to develop its nuclear safety legislation and regulations. These include the following pieces of legislation:

- *On the Use of Nuclear Energy and Radiation Safety.*
- *On Radioactive Waste Management.*
- *On Uranium Ore Mining and Processing.*
- *On Permitted Activity in the Area of Nuclear Energy Utilisation.*
- *On Human Protection from the Impact of Ionising Radiation.*
- *On Physical Protection of Nuclear Facilities, Nuclear Material, Radioactive Waste and Other Radiation Sources*.
- *On Basic Grounds of Continued Operation and Decommissioning of the Chornobyl NPP and Transfer of the Destroyed Unit No. 4 of the Chornobyl NPP into an Environmentally Safe System.*
- *On Regulating Issues Related to Nuclear Safety.*[63]
- *On Arrangements for Decision Making on Siting, Planning and Construction of Nuclear Facilities and Installations Designated for Handling Radioactive Waste.*

Ukraine has also ratified a number of international treaties focused on nuclear energy and safety, including: the *Convention on Early Notification of a Nuclear Accident* (1987); the *Convention on the Physical Protection of Nuclear Material* (1993); the *Convention on Nuclear Safety* (1997); the *Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management* (1997); and the *Vienna Convention on Civil Liability for Nuclear Damage* (1996).

Liability and the costs of nuclear accidents are issues with which Ukraine has particularly relevant experience. The Ukrainian government states that through 2000, its economy experienced USD 148 billion in losses as a result of the Chornobyl catastrophe. The Belarusian government calculates that its economy will experience USD 235 billion in damages from Chornobyl through 2016. Under international conventions currently in force, nuclear signatories must not limit a nuclear operator's liability to less than

63. This law primarily deals with financial issues related to closing and decommissioning nuclear facilities.

150 million special drawing rights[64] (SDRs) (equivalent to approximately USD 225 million). Signatory governments as a group take on additional, collective liability of approximately 125 million SDRs and state liabilities of 25 million SDRs. Additional protocols, which are not yet in force, would raise the total liability coverage from today's USD 450 million to approximately USD 2.2 billion (United Nations, 2002; SNRC, 2004a).

Ukraine has not ratified all of the international agreements governing nuclear liability, although it has voluntarily adopted national legislation that sets the liability of its operators to 150 million SDRs. Ukrainian insurance companies established a Nuclear Insurance Pool in 2003, and Energoatom pays into the pool (though the government subsidised these payments for the first few years). During the transition period, the coverage is being ramped up to 150 million SDRs.[65]

While Western experts feel the nuclear safety systems in Ukraine meet basic standards, malfunctions are frequent at the 15 working reactors, which are often shut down for repairs and maintenance. Ukraine's SNRC shows that the situation has been improving in recent years. In 2000, there were 71 unplanned shutdowns; in 2004, there were only 25 such occurrences. On the International Nuclear Event Scale, Ukraine had three Level-1 incidents in 2004 (Level 1 is the lowest of seven levels); it also had 33 deviations.[66] The two new reactors launched in mid- and late 2004 had one Level-1 incident and six deviations in the remaining months of 2004. Such events are more serious than typical unplanned shutdowns, but still do not involve radiation release. The International Atomic Energy Agency (IAEA) recently completed reviews of operational safety at two of Ukraine's nuclear power plants and found that the plants have made significant efforts to improve and have a strong commitment to safety. At the same time, the IAEA indicates that there are areas of concern such as event reporting, training and fire protection (IAEA, 2003, 2004; SNRC, 2004a, 2005).

In September 2005, a major shutdown occurred at the new Khmelnytsky reactor, only one year after the reactor was put into commercial operation. The reactor was shut down for 2.5 months for repairs including removing the fuel from the reactor core, examining the reactor, checking the pipes

64. Special drawing rights are international reserve asset, created by the International Monetary Fund in 1969. They are essentially a "currency" that acts as basket of other currencies, with the value being based on a few key currencies. They are used most often for treaties and other such purposes.

65. Ukraine has ratified the Vienna Convention, but not the Paris and Brussels Conventions. The Paris/Brussels regime has higher liability limits. The Vienna Convention only applies liability limits to nuclear operators; these limits are currently the equivalent of about (USD 50 million). Ukraine meets this limit, even in its transition period.

66. Deviation is the term used in Ukraine for nuclear events that the Ukrainian regulator feels are below Level 1 on the International Nuclear Event Scale.

and conducting significant repairs of part of the emergency core cooling system. Preliminary information for 2005 shows that the number of shutdowns and other events rose compared to recent years. While this lowers the efficiency of the plants, it is positive in that it demonstrates that the operator and regulator inspect the plants and take them offline when they find problems.

The Ukrainian Government has undertaken several steps to improve nuclear safety. These include the legislation and regulatory structure described above. They also include efforts at nuclear power plants to improve the safety culture, like sponsoring "Safety Days" and requiring training centres at each plant. Ukraine has a quality assurance policy and monitors the implementing programmes and documentation at each nuclear facility.

Nuclear safety is funded in several ways in Ukraine. In 2004, the tariff base for electricity produced by Energoatom included UAH 680 million (USD 135 million) for nuclear safety upgrades and UAH 25 million (USD 5 million) for operational safety at the 15 reactors. The Ukrainian government also provides subsidies for nuclear safety from the state budget. Western governments have provided significant funding to improve the safety of the nuclear reactors and the way in which they are operated. These include funds from the US Department of Energy, the Nuclear Safety Account at the European Bank for Reconstruction and Development (ERBD), the European Commission, and other countries and organisations. The SNRC was concerned in the past that Energoatom was not able to adequately fund nuclear safety because of non-payments. In recent years, tariff-based funding has increased significantly, so that Energoatom spent almost nine times more on nuclear safety in 2003 than in 2001. However, it is still not entirely clear if this is enough given the decrease in Western funding and the significant needs. For example, the SNRC expressed considerable concern about safety issues at the Khmelnytsky-2 reactor in its pre-commissioning assessment; this is the same reactor that was closed for repairs in September 2005 (SNRC, 2004b).

The SNRC seems to have tried very hard to make objective nuclear safety assessments, but at times, its technical concerns may come into conflict with political concerns. The Khmelnytsky-2 pre-commission report is one example of this. Another example is the decision to re-start Chornobyl reactors 1 and 3 in 1992, despite the regulator's concerns. The SNRC should be commended in its efforts to openly present information on its work and the status of nuclear safety in Ukraine. For example, the SNRC posts information on unplanned nuclear plant shutdowns on its website.

Fuel Production and Waste Treatment

Ukraine currently produces uranium and zirconium, which are sent to Russia to manufacture nuclear fuel rods. Ukraine produces about one-third of the uranium needed to fuel its own reactors annually. Russia supplies the remaining uranium. Ukrainian uranium production has dropped in recent years as its existing mines are depleted (Table 8.9). Eastern Mining and Enrichment Combine (or SkhidGZK) operates the uranium mines and milling plants. This enterprise is owned by the Nuclear Energy Department in the Ministry of Fuel and Energy.

Table 8.9

Ukrainian Uranium Production

	2000	2001	2002	2003	2004
Tonnes U (ore)	1 005	750	800	800	800
Share of world production (%)	2.8	2.0	2.2	2.3	2.0

Source: NEA and IAEA, 2003 and 2005.

Ukraine would like to boost its uranium production to meet all domestic needs. The government believes this is important because using its own uranium resources will boost security of supply and reduce the potential impact of rising global uranium prices. Thus, the government plans to open new mines at the Novokonstiantynivsky deposit, where it will invest UAH 1 billion (USD 200 million). In 2002, Ukraine also opened a new mine called Slipa-2 at an actively used deposit. The Nuclear Energy Agency estimates that Ukraine will be able to produce 1 500- 2 000 tonnes of uranium per year by 2015. Ukrainian reactors currently consume the equivalent of about 2 350 tonnes per year.

Most of Ukraine's Reasonably Assured Resources of uranium are relatively expensive to extract. Ukraine has an estimated 86 910 tonnes of uranium that it can recover at or below USD 130/kgU; of this, 76 150 tonnes could be extracted at or below USD 80/kgU.[67] At current uranium prices, Ukraine's resources would allow it to produce 2 000 tonnes of uranium annually for about 43 years, based on data compiled by the Nuclear Energy Agency (NEA). If prices rise, Ukraine could cost-effectively extract more. Uranium can also be bought on international markets (NEA and IAEA, 2005).

67. NEA and IAEA categorise uranium reserves by cost: <USD 40/kgU, <USD 80/kgU and <USD 130/kgU. Ukraine has 2.2% of the world's reserves at a <USD 80/kgU and 2.0% of reserves at <USD 130/kgU. Ukraine, thus, does not have major reserves by global standards.

In order to reduce its reliance on Russian energy imports, the Ukrainian government plans to build a nuclear fuel processing facility in Ukraine, using its domestic uranium and zirconium as resources (though this will not include uranium enrichment). Progress toward this goal has been slower than hoped primarily because Energoatom has not adequately funded the Nuclear Fuel Cycle Fund. As of mid-2004, Energoatom had a debt toward this fund of UAH 770 million (USD 141 million), which reflects the fact that Energoatom itself had not received payment for UAH 7.4 billion (USD 1.4 million) worth of power produced in recent years (Lesik, 2004; Danilova, 2006).

The Ministry of Emergency Situations[68] is responsible for both spent fuel storage at Chornobyl and decommissioning at all facilities. Energoatom is responsible for spent fuel treatment and storage at active nuclear power plants, with oversight provided by the Ministry of Fuel and Energy. In theory, the nuclear power plants are responsible for funding spent fuel storage, though non-payments have been a problem and the government seems to supplement even the base amount that the plants pay. Ukraine stores the spent fuel from its VVER reactors in reactor cooling pools for five years, after which time it sends the spent fuel to Russia for re-processing or puts it into its own interim storage facility in Zaporizhya.

High-level radioactive waste generated during the fuel re-processing in Russia should be sent back to Ukraine for permanent disposal. Spent fuel from Chornobyl's reactors is stored on site and does not go to Russia. Ukraine is building a dry interim spent fuel storage facility at Chornobyl for spent Chornobyl fuel; it is also exploiting a second such facility at the Zaporizhya Nuclear Power Plant for spent fuel from this plant. In 2005, Energoatom signed a contract with the US company Holtrec International to build a pilot version of a centralised, interim dry storage facility to serve other nuclear plants in Ukraine. The government is now looking for a suitable site for a larger facility. In addition, a specialised state enterprise is working to bring the radioactive disposal points used in the immediate aftermath of the Chornobyl accident into compliance with nuclear and radiation safety norms. This waste will be transferred to the new facility being built at Chornobyl.

Efforts to build a geological repository for long-term storage and disposal have not begun in earnest, although the official policy of Ukraine is to eventually build such a repository. Several decades ago, the Soviet

68. The full name of this ministry is the Ministry of Emergency Situations and Issues of Protecting the Population from the Consequences of the Chornobyl Catastrophe. Currently, Chornobyl is the only plant slated for decommissioning, but this ministry has the broad responsibility on future decommissioning and decommissioning costs.

government commissioned studies that showed that the region of the Korostensky crystalline shield could be an acceptable location for geological storage, though no specific site has been identified. Russia is willing to accept high-level radioactive waste from other countries and Ukraine could manage its high-level waste this way, at least for the time being. However, government estimates indicate that this would cost more than building long-term, geological disposal facilities in Ukraine (SNRC, 2003; Liven', 2005).

● Decommissioning

Decommissioning the first of Ukraine's other nuclear power plants may start around 2010, as the country begins to turn over its nuclear stock. Most of the existing reactors are actually scheduled for decommissioning before 2020. However, life extensions may delay this by up to 15 years.

In the past, Ukraine did not set aside funding for decommissioning. Under the *Law on the Use of Nuclear Energy* adopted in 1996, all new nuclear installations must have a plan to contribute to a decommissioning fund before they can be licensed. In practice, the two reactors that began commercial operation in 2004 did not meet this requirement. The Verkhovna Rada tried to further enhance the legal basis for funding decommissioning by adopting a new *Law on Regulating Issues Related to Nuclear Safety* in 2005.[69]

Because there are no accumulated decommissioning funds from past nuclear power sales, the government may ultimately need to subsidise decommissioning costs. Even with the 2005 law, it is not yet clear that adequate funding is flowing into the decommissioning funds to meet the anticipated requirements. Ukraine can ease the budgetary burden of decommissioning by setting up the new decommissioning funds quickly and including these costs in the tariff. NERC and the government would need to raise nuclear tariffs enough to cover realistic decommissioning costs related to both current and past nuclear power use. The Ministry of Emergency Situations will oversee the funds for decommissioning and waste treatment.

● Chornobyl Accident and Consequences

Reactor 4 at Chornobyl Nuclear Power Plant exploded on 26 April 1986, releasing 100 times more radiation than the bombs dropped on Hiroshima

69. The Ministry of Fuel and Energy reported that some funds for decommissioning are now being collected. During the review visit, Energoatom indicated that the legal infrastructure for collecting funds for decommissioning is not yet functioning, although there is a law requiring special decommissioning funds. As of July 2006, Energoatom's webpage on decommissioning still provided only a concept document written in 2004.

and Nagasaki. The accident occurred during a test of possible emergency power options to keep coolant pumps running. The plant staff had deliberately turned off the safety systems to make sure that the test would not be shut off. During the test, power output surged and the reactor's emergency shutdown failed. Within less than a second, the power level and temperature rose many times over. Two explosions in rapid sequence blew off the top of the reactor building and the fuel rods melted, causing an intensely hot fire. The fire burned until 6 May 1986, ejecting radioactive material into the atmosphere.

Within ten days of the accident, 130 000 people living within 30 kilometres of the reactor were evacuated. This territory has been designated an "Exclusion Zone" and access to it remains restricted. The radioactive plume also affected areas farther away. It travelled Northwest through Belarus and the Baltics, then on toward Western Europe. Many parts of Belarus have been abandoned because of the contamination. Contamination farther away tended to be less intense and depended on rainfall when the plume passed over.

There has been much debate in the past 15 years about the health and environmental consequences of the accident. The IAEA, in collaboration with several UN agencies, issued a report in September 2005 concluding that the impacts of the accident had been significantly overstated in the past. The report found that 56 people have died as a direct consequence of the accident to date and 4 000 deaths could be attributed to the accident long term. The report highlighted that the largest health consequences might be the psychological stress and fear linked to the evacuees' exposure (Chernobyl Forum, 2005).

This contrasts with previous statements by Belarusian and Ukrainian government entities about the number of deaths attributed to the Chornobyl accident. Estimates of some researchers also paint a grimmer picture. International organisations tend to take a more conservative view on the number of deaths (United Nations, 2002), based on an understanding that not every death of a Chornobyl evacuee or liquidator will be linked to the accident. While the Ukrainian government is a member of the Chernobyl Forum[70] that helped produce the IAEA report, several Ukrainian governmental and non-governmental organisations have been cautious in embracing the IAEA report. The Ministry of Emergency Situations of Ukraine has emphasised that Chornobyl is and will remain one of Ukraine's biggest problems, and that the health consequences are underreported in the Chernobyl Forum report.

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70. The spelling here reflects the official spelling of the Forum.

Chornobyl Closure, Decommissioning and the Sarcophagus

Chornobyl Nuclear Power Plant initially had four reactors. Reactor 4 exploded in 1986; reactor 2 was closed after a turbine fire in 1991. Reactors 1 and 3 were closed in 1991, but reopened at lower capacity in 1992. The West was concerned about the safety of these RBMK reactors.[71] In 1995, Ukraine and the G-7 signed a Memorandum of Understanding (MOU) on closing the reactors and providing Ukraine with assistance on alternatives to Chornobyl and assistance with closing and decommissioning the site. (The MOU also included several conditions including power sector reform and nuclear safety.) Ukraine closed reactor 1 in 1996 and reactor 3 in 2000.

Much of the attention on alternatives soon focused on two partially completed nuclear reactors at Khmelnytsky and Rivne. Under the MOU, the EBRD was to assess the feasibility and cost-effectiveness of completing these two reactors and then assist with financing the work. The assessments took longer than anticipated because there were serious concerns that the plants were not cost-effective, given the high cost of making them safe and the forecast for Ukrainian power demand.

EBRD eventually approved the funding, but Ukraine rejected it because much of the funding would have been for nuclear safety improvements and the funding came with conditions. Specifically, Ukraine had to improve nuclear safety at all its nuclear power plants, ensure the independence of the nuclear regulator and make progress on electricity market reforms. Ukraine ultimately decided to finance the plants on its own, using local financing and a bond issue to be repaid with a surcharge on the tariff for all electricity sold. Under a more recent loan agreement, EBRD will finance post-start-up safety upgrades at the two reactors.

Khmelnytsky reactor 2 and Rivne reactor 4 were completed and began operating in 2004. Since then, they have been shut down frequently because of operational and safety problems, including an extensive overhaul of Khmelnytsky-2 beginning in September 2005 (as noted above).

Energoatom previously owned and operated the Chornobyl Nuclear Power Plant and was responsible for its decommissioning until 2001, when Chornobyl was transferred to a specialised state company owned by the Ministry of Emergency Situations. This means that Energoatom is no longer responsible for any decommissioning costs at Chornobyl,

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71. RBMK is an acronym for the Russian Reaktor Bolshoy Moshchnosti Kanalniy, *which means "channelised large power reactor". It is a type of reactor that uses light water for cooling and graphite for moderation; it was produced only in the Soviet Union.*

which is controversial because of the potential precedent it sets and the economic distortions it creates. The West is funding much of the Chornobyl decommissioning, as agreed under the MOU.

The state of the Sarcophagus covering Chornobyl's damaged nuclear power unit is also a potential threat. The Sarcophagus was quickly constructed after the disaster of 1986. It was designed as a temporary protection measure, built to last 10-15 years. It still contains some 200 tonnes of radioactive material and needs urgent capital refurbishment. Repairing the Sarcophagus had long been delayed but the project is now on track with funding from the G-8, the European Commission, the EBRD, Ukraine and other donors. The new Chornobyl Shelter will cost approximately USD 1 billion and should be complete by 2009. The project will encase the destroyed reactor 4 and the original Sarcophagus in a 20 000-tonne steel shelter. The new Shelter is designed to last 100 years, during which time an even longer-lasting solution to the Chornobyl problem must be found.

Critique

Ukraine has made significant progress in stabilising electricity supply and handling the sector's debt crisis. Less than a decade ago, electricity supply was quite erratic because of non-payments and resulting fuel shortages. The grid is much more stable now, allowing Ukraine to export electricity from Western Ukraine and begin efforts to interconnect its main grid to the UCTE in the West.

Significant progress has been made in improving electricity payments at all levels. In addition, the government and Energorynok are moving forward with a carefully designed debt resolution programme that will make the sector solvent again.

Ukraine has also taken important steps toward establishing a competitive market for electricity and privatising the sector. However, since the late 1990s, little has been done to consolidate the initial efforts. Ukraine now has an opportunity to build on its early successes in market opening and privatisation.

The participants in the wholesale electricity market have agreed to transition the system from a single buyer model to bilateral contracts. This move could be appropriate to Ukrainian market conditions. However, some of the core problems today seem less related to the market structure than to imbalances in market fundamentals (for example, tariffs that do not fully cover costs, lack of competition on fuel markets, government fuel allocations, and unwillingness in the past to take sanctions against customers in arrears). It is important that the market participants and government move swiftly and methodically in implementing any transition. Experience in IEA countries shows that uncertainty about electricity market and regulatory systems stunts investment.

A key condition for any system to work is full cost coverage. The regulated components of the tariff – namely for nuclear energy, hydro power, transmission and distribution – make up the majority of total system payments. Current tariffs do not cover full costs for capital investments, maintenance, or environmental protection. This is true for all sources of power, but seems to be particularly problematic for nuclear installations. In the nuclear sector, tariffs fall short of fully covering not only capital investments, but also waste storage and disposal, and decommissioning costs.

If Ukraine wants to attract investment and ensure reliable electricity supply in the future, it must raise tariffs. Ukraine now has some of the lowest electricity tariffs in the region, even lower than in energy-rich Russia. After 15 years of underinvestment in the electricity sector, the government itself highlights that many electricity assets are operating beyond their design life. Continued underinvestment only pushes back the time when investment is needed, which ultimately means that the price shock from rapidly rising tariffs will be that much more severe. NERC has begun the politically difficult task of increasing tariffs. Perseverance and consistency in the long term will be key to addressing the problem.

Tariff regulations must have adequate provisions to support capital investment. While it is reasonable for NERC to ensure that total costs are not excessive, capital investments are a challenging regulatory issue: they may raise costs in the short term before lowering them over the long haul. NERC and the government need to be careful to reach the right balance in designing regulations that protect consumers from monopolistic prices and yet allow companies to make their own investment decisions.

Currently, Ukraine's electricity assets are not used to their full value, in part because the prices do not provide the necessary incentives. A good example is hydro power, which is regulated and is the lowest cost power in Ukraine. Hydro power is extremely valuable for balancing frequency on the grid. By pricing it so low, there is little incentive to use it when it is most valuable. Moreover, there is little incentive to invest in more hydro. Hydro could be priced based on its value as part of a vibrant wholesale electricity market.

Increasing tariffs can take place in stages to minimise the impact on the population and to ensure that non-payments do not resurface as a problem. The first step, raising tariffs to cover short-term marginal costs, has already occurred. The second step, restoring the sector's financial health, is just starting. The third and fourth steps are covering capital costs (or amortisation) and profit. When Ukrainian tariffs have reached the fourth step, consumers will cover long-term marginal costs, which should position Ukraine to attract required investment. NERC's plan to raise tariffs by 25% every six months for two years is a welcome development and should be supported.

As tariffs are raised, the Ukrainian government needs to make sure that it has effective welfare networks in place to assist low-income households. The point of raising tariffs is not to cause the poor to suffer but rather to allow the system as a whole to operate in a sustainable manner and to allocate resources efficiently.

Raising tariffs will also help promote energy efficiency, which Ukraine needs in order to decrease its energy import dependence. The *Energy Strategy to 2030* shows some impressive increases in power capacity and production. However, in reviewing its energy strategy, the government could improve the feasibility of its plans by ensuring that they are based on comprehensive economic analysis. Rising energy prices should reduce demand, reducing the need for some capacity investments. Likewise, policies to improve energy efficiency in end uses can further reduce the need to add capacity. Co-ordinating the analysis on these various trends could sharpen the electricity projections and hence the plans based on them.

Privatisation is also important to attracting investment and rationalising costs. The Kryvorizhstal privatisation in 2005 can serve as a model: it was transparent, attracted a range of solid proposals and brought in significant funds. Experience around the world has shown clearly that privatising electricity sector assets can improve sector performance. This is particularly true where non-payments and low efficiency are common, because the potential benefits of reform are that much larger. Privatisation is also important because it can lead to greater competition, which improves investment decisions.

The Energy Company of Ukraine seems to create an unnecessary layer in the ownership structure of the industry. By re-bundling the generation and distribution assets, the Energy Company of Ukraine removes an effective tool for competition and efficiency gains in the sector. Experience in IEA countries has shown that over the long term, unbundling electricity assets is essential for vibrant competition. Thus, the Energy Company of Ukraine may be an impediment to competition, privatisation and reform. Before considering privatisation, the government should unbundle the assets of the Energy Company of Ukraine.

In the nuclear sector, the government has made important progress in improving the safety of nuclear power plants. At the same time, Ukraine is in an excellent position to understand the importance of constant vigilance in this area. Further efforts to train workers and improve the physical reliability of nuclear plants would benefit not only plant safety but also operating efficiency and output. An important part of this is ensuring that nuclear safety is adequately funded through the tariff.

As part of raising tariffs, it is also important to look more critically at the nuclear power costs that are not fully covered today: capital expenditures, waste disposal and decommissioning. In IEA countries, these three areas of cost comprise the majority of nuclear power costs; underfunding them makes the nuclear industry financially unsustainable and distorts the electricity market. Likewise, future nuclear power plants and plant extensions would better serve the market if they were funded directly from the price of nuclear power, not from a surcharge on all electricity or other cross subsidy.

More effort needs to be expended on fully understanding both the costs of nuclear power and the availability of domestic uranium before deciding on new nuclear infrastructure. This will increase the likelihood that plans will proceed smoothly and that nuclear can play an appropriate role in improving Ukraine's energy security. The issue of uranium reserves is important. If less uranium can be extracted at competitive prices than planned, Ukraine will have to import uranium to meet its targets. Likewise, if global prices are lower than domestic costs, Ukraine will raise the cost of nuclear power by relying solely on domestic sources.

Recommendations

The government of Ukraine should:

- Continue to allow tariffs to rise until they cover full, long-term marginal costs of power production, in other words, the total production, capital and administrative costs, plus the cost of financing and profit.
- Take steps to reinforce the independence of the regulator, NERC. NERC should be allowed to raise its own budget through licensing fees and should have the ability to hire and manage staff without government

involvement. The government and parliament should also take steps to ensure that NERC cannot be overruled on tariff decisions.

- Encourage NERC in its efforts to eliminate cross-subsidies between consumer groups.
- Enhance the role of economic analysis and public dialogue in developing electricity policies and plans, including those related to investment; develop policies that allow investors to make decisions based on market signals.
- Consolidate efforts to develop a wholesale market for electricity. Moving to bilateral contracts makes sense, but only if market fundamentals are sound and if supported by thorough follow through in implementation. To be most effective in the long term, a shift to bilateral contracts will require giving customers choice and freeing electricity prices.
- Remove barriers to competition; specifically, un-bundle power generation and distribution to allow the market to function.
- Stop allocating fuel to thermal power generators. Such allocations distort the market and add significantly to fuel use and costs.
- Consider reinvigorating a transparent and competitive privatisation process to bring new investment to the sector and enhance sector efficiency.
- Reassess whether current regulations adequately encourage – and fairly price – combined heat and power production and other efficient technologies.
- Ensure that the nuclear power industry can operate sustainably in the long term by requiring that nuclear power prices cover the full costs of nuclear power, including capital, waste treatment, decommissioning and nuclear safety. Resolve any outstanding legal issues related to the creation of funds for decommissioning and waste disposal.
- Reassess domestic uranium reserves to ensure that their size and extraction cost match the extent to which policy makers plan to draw on them to support Ukraine's nuclear power production.
- Adopt cost-reflective prices for traditional power production, which will make it easier to promote new technologies (including renewable power) and to place exports in their proper economic context.

9. DISTRICT HEATING

Overview

District heating is of great economic and social importance in Ukraine. It accounts for a large share of Ukrainian total primary energy use and provides heat to more than 65% of Ukrainian homes and offices. Public authorities perceive district heating companies as providers of public services, not as qualified business players operating on a true market. The perception of district heating as a social service, the current tariff policy, the protracted lack of investment and inefficiency – all of these factors undermine the sector's sustainability. District heating generation and transportation facilities are inefficient and need urgent replacement and modernisation. Efficiency of heat consumption must also be improved, especially in residential and commercial buildings, which consume nearly half of district heating. However, the current structure of the building sector does not stimulate energy efficiency. Moreover, Ukrainian cities do not fully exploit the economic and environmental benefits of district heating: the current use of cogeneration, waste heat and renewable energy sources is rather low. The government understands the major problems of the sector and has announced positive reforms such as installing meters, increasing the share of cogeneration, introducing competition and involving the private sector. However, the actual implementation of these reforms has been very slow, and much remains to be done. Lack of reliable statistics, especially on heat demand, makes the development of district heating policy challenging.

District Heating: Main Characteristics

Box 9.1 Definition of District Heating

In IEA statistics, district heating is defined as heat produced at various heat sources (such as combined heat and power plants, heat-only boilers, industrial waste heat), transported via heat networks, and sold to third parties. It does not include heat produced by final consumers (industry, condominiums, households, etc.) for their own use, but does include, for example, excess heat produced by an industrial plant or an incinerator and sold into a local heating grid.

Benefits of District Heating

Well-organised district heating has significant economic, environmental and social benefits in urban areas with high population density or large industrial heat demand. District heating provides the heat load, which makes combined heat and power generation possible. Combined heat and power generation saves about 30% of the fuel, compared to separate production of heat and power. These savings diminish the national energy bill and reduce emissions. District heating systems also provide an opportunity to use local heat sources that otherwise would be wasted, such as industrial waste heat, municipal waste or biomass. District heating plants can also offer flexibility by using various fuels such as natural gas, fuel oil and renewable fuels; therefore district heating can play an important role in energy security and economic development. At present, the district heating sector in Ukraine does not fully realise all these possibilities.

Capacity and Production

There are about 450 combined heat and power plants in Ukraine (about half of which are in industry) and 100 000 industrial and municipal heat-only boilers (Cabinet of Ministers, 2006a). District heating production dropped by more than half from 1992-2004. Table 9.1 demonstrates that total heat production (including district heating and other sources such as individual boilers, biomass-based installations and solar heaters) started growing in 2003, while district heating production continued to decline. However, there are differences between the datasets from various sources, which highlights the need to improve heat statistics.

District heating systems in Ukraine were designed to have significant excess capacity. The overcapacity grew even further as production declined in the 1990s due to economic recession. Shrinking demand and overcapacity are important factors behind the financial hardship of district heating companies. Overcapacity leads to excessive fuel consumption because boilers and other system components are less efficient when operating at partial capacity. Excess capacity, especially in systems with a small number of large boilers, also makes it more difficult and expensive to respond rapidly to demand changes. District heating companies with excess capacity also have less incentive to promote energy conservation.

There are many benefits to cogeneration, but Ukraine will only capture them if it uses cogeneration more widely. Combined heat and power generation now accounts for a small share of district heating supply, while heat-only

Table 9.1

Total Heat Production and District Heating Production in Ukraine, 1992-2005 (PJ)

Year	1992	1994	1996	1998	2000	2001	2002	2003	2004	2005
IEA data										
District heating, gross production*	1 464.4	1 204.0	1 010.9	870.6	746.8	761.7	777.0	721.2	702.7	n.a.
District heating production level, compared to 1992 (%)	100	82	69	60	51	52	53	49	48	n.a.
Ukrainian data										
Total heat production	n.a.	n.a.	n.a.	n.a.	945.4	904.3	904.7	973.8	992.7	1 009
District heating	n.a.	n.a.	n.a.	n.a.	517.9	507.7	497.5	546.8	536.8	532.7

**Distribution losses in district heating networks are estimated at about 25% of gross production. Own use of heat at electricity plants, combined heat and power plants, and heat plants is estimated at 1% of gross production.*

n.a. – not available.

Note: 1 PJ = 238.8 Pcal or 238.8 million Gcal.

Sources: Data in the row "District heating, gross production" come from IEA statistics, which IEA acquires from the Ukrainian State Statistics Committee, and includes heat sold to third parties (Box 9.1). "Total heat production" data were obtained from the Energy Strategy to 2030 *(Cabinet of Ministers, 2006a); it is not entirely clear which categories are included, but it appears to include heat consumed onsite in buildings and other facilities where it is produced. "District heating" data were submitted by the Ministry of Construction, based on the bulletins of the State Statistics Committee.*

boilers produce nearly 75%. By comparison, in Finland, Denmark and Germany, cogeneration provides up to 75-80% of heat for district heating, and heat-only boilers meet peak demand. The *Energy Strategy to 2030* rightfully plans to increase the role of cogeneration and reduce the use of heat-only boilers.

Natural gas is the main fuel used for district heating in Ukraine, followed by coal and heavy fuel oil (Table 9.2). Coal use in boilers in city centres has substantial environmental implications.

Table 9.2

Fuel Use at Combined Heat and Power and Heat-only Plants in Ukraine in 2005 (%)

	Gas	Heavy fuel oil (mazut)	Coal
Combined heat and power plants	76-80	15-18	5-6
Heat-only boilers	52-58	12-15	27-36

Source: Cabinet of Ministers, 2006a.

Energy-efficiency Potential and Investment Needs

There is huge potential for efficiency in each part of the district heating chain: production, transmission, distribution and end use. The exact amount of losses is difficult to measure because of a lack of metering equipment, but the Ministry of Construction estimates that up to 60% of energy is wasted within the district heating chain – and that the largest losses occur at end-user facilities (Table 9.3). Industrial consumers recently began to invest in energy-saving measures to reduce their heat consumption. However, residential buildings still require huge investments to improve energy efficiency.

Table 9.3

Energy Losses in District Heating Systems Operated on Natural Gas (%)

	Current average losses	Level of losses after technologically possible efficiency improvements
Heat production	22.0	14.5
Heat transportation	25.0	13.0
Heat exchangers	5.0	2.0
Final use	30.0	10.0
Total losses	**60.0**	**38.0**

Sources: Ministry of Construction, Architecture, Housing and Communal Services.

The inefficiency and losses are largely due to the protracted lack of investment in district heating systems. This implies that many systems are in financial trouble and also at high risk for outages and technical failures. A case in point is the district heating system of Alchevsk, a town of 120 000, which suffered a severe outage in the cold winter of 2006. One of the main heat pipes burst and heat stopped flowing. Because of very cold temperatures, pipes throughout the system froze and cracked. As result, the government declared a national emergency and took action to replace almost the entire system. Avoiding such problems in the future is clearly important. In reality, it requires systematic reform and follow through.

The sharp rise of imported gas prices in 2006 also highlighted the urgent need to modernise district heating systems to improve their efficiency and reduce losses. Improving the sector's efficiency can significantly reduce Ukraine's gas consumption thus reducing the need for expensive gas imports. Today, heat boilers and electricity plants account for almost 40% of all natural gas consumption in Ukraine.

For all types of energy, improving efficiency at all stages – from production to final consumption – is vitally important. The most logical place to begin efficiency studies is in end use, primarily because it provides the information needed to optimise the total energy chain. Accurate knowledge of end-use needs and detailed consumption patterns facilitate accurate design and development of the district heating system as a whole. In turn, this supports both optimised operation and investment planning. In the case of Ukraine, a lack of reliable heat consumption data presents a major problem. Existing information is based largely on normative consumption or estimates. Thus, it is very important to meter heat consumption and to improve heat statistics.

Ukrainian estimates of energy-efficiency potential in buildings vary from 20-50%. According to Russian, Baltic and Finnish experiences, 30% energy savings in buildings seem quite achievable at a relatively low cost. Even higher savings are technically possible.

Distribution and transmission networks are in urgent need of reconstruction or improvement. Losses are high, up to 25-30% of production, providing a significant saving potential but at considerable costs. Reducing transmission losses would improve the reliability of heat supply.

Most heat production plants are old and their efficiency is low. Replacing old plants or renewing existing ones is vital to efforts to reduce energy consumption. The *Energy Strategy to 2030* projects that efficiency improvements will result in significant reductions in fuel use at heat and combined heat and power plants per unit of generated heat, estimating a decrease of 8% by 2010 and of 16% by 2030. This will correspond to fuel savings of 2.98 Mtoe and 4.13 Mtoe, respectively.

Heat Market

Heat Market Structure

In Ukrainian cities most district heating systems are natural monopolies, and a competitive heat market – in the conventional meaning of the word – does not really exist. Competition between heat sources in not prohibited and a variety of heating options are available, especially for new buildings. These options include large district heating systems, roof boilers, heat pumps or individual apartment heaters that operate on gas or electricity. However, in practice, district heating consumers do not often switch to other heat options for economic, financial and technical reasons. Additionally, the building norms and standards do allow installation of individual gas heaters in multi-apartment buildings.

Competing operators provide a choice of heating options; these operators work in various environments, each with its own regulations and rules. The specific characteristics of electricity, gas, oil products, biofuel and other possible heat sources influence Ukrainian end-users' choice of heat options. Subsidised prices and other market distortions may lead to non-economic decisions in heating. For example, gas and electricity are relatively cheap for Ukrainian households, which creates incentives to install individual gas boilers or electric heaters. However, residential gas and electricity prices are rising rapidly, which may ultimately make district heating a more economically attractive option.[72] But users who already invested in individual or building-level systems will be unlikely to switch to cheaper district heating. In order to keep the district heating sector in good financial health, it is important for the government to move quickly to eliminate subsidies and tariff distortions for gas and electricity and, more generally, ensure a level playing field for all heat options.

District heating supplies approximately 65% of heating needs in the residential, commercial and public sectors. Given the significant market share and the great social importance of district heating, public authorities largely perceive it as a public service, such as water supply or waste disposal. This implies that district heating companies are perceived as "social actors" rather than providers of commercial services. This undermines the

72. Operating individual heating systems may become expensive when gas and electricity prices reflect their full costs. In addition, owners of individual systems will have to bear the cost of maintenance – and eventual replacement – of the system.

sustainability of district heating companies: they have neither the incentives nor the means to modernise systems and improve service quality.

The market share of district heating seems to have declined in recent years while individual or building-level heating systems have won new markets, although reliable statistical data to prove this trend are not available. One reason for the decline is that district heating still remains supply-driven, not demand-oriented: district heating companies are not sufficiently attuned to consumer needs and do not actively cultivate their relations with current and potential customers.

The *Energy Strategy to 2030* envisages a rapid decline in heat production at heat-only boilers while decentralised heat sources, particularly electric heaters, will see the highest growth rate (Table 9.4). Such a dramatic substitution of district heating by electric heating does not seem to be a viable approach and does not have many precedents in other countries (except for cities ravaged by war or natural disasters). It would be more logical to thoroughly assess heating systems in all cities and develop energy plans, which would take into account various heating options (district heating, building-level and individual heating systems) as well as end-use efficiency improvements. Such energy plans must take into account the cost of replacing the existing district heating by other options. In towns and cities where district heating is economically justified, it makes sense to reform this sector to improve efficiency, rather than switching to other options.

Structure and Ownership of the District Heating Sector

There are almost 900 local heat supply companies (teplokomunenergos) in Ukraine that operate heat plants and district heating networks and also supply heat to final consumers. Most district heating networks (20 800 km out of 24 300 km) are owned by municipalities; 3 500 km of large-diameter heat pipes are owned by the Ministry of Fuel and Energy (Cabinet of Ministers, 2006a). Large, combined heat and power plants belong to the state-owned Energy Company of Ukraine; smaller cogeneration plants typically belong to regional electricity distribution companies (oblenergos) and industrial companies (more details are provided in Chapter 8: Electricity). Teplokomunenergos buy gas, coal and heavy fuel oil to produce heat at their own plants; they purchase heat from combined heat and power plants and from heat plants belonging to other actors. The teplokomunenergos supply heat to final consumers but, in most cases, municipal service companies (so-called “ZhEKs”) handle billing and collection.

Table 9.4

Projected Growth in Heat Production by Source, Reference Scenario (PJ)

		2005	2010	2015	2020	2030	Growth 2005-30 (%)
Combined heat and power (CHP) plants		12.3	12.4	12.9	13.9	17.4	41.5
Fuel inputs for CHP	*Gas and liquid fuels*	*11.0*	*11.0*	*9.6*	*8.6*	*6.9*	*-37.0*
	Solid fuels	*1.3*	*1.4*	*3.3*	*5.3*	*10.5*	*685.7*
Heat only boilers		35.5	44.4	48.9	52.3	24.8	-30.2
Nuclear plants		0.4	0.5	0.6	0.6	0.7	66.7
Electric heaters and heat pumps		0.4	0.6	3.4	7.8	43.0	10 488.2
Individual heat systems		5.7	5.9	6.5	7.0	8.0	38.8
Renewable heat sources		2.7	2.3	2.6	3.2	4.5	64.3
Other sources		0.4	0.5	0.9	2.3	4.5	1 011.8
Total heat production		**57.6**	**66.8**	**75.7**	**87.0**	**102.9**	**78.8**

Source: Cabinet of Ministers, 2006a.

Chapter 1: General Energy Scene and Energy Policy discusses the relationship between building owners, ZhEKs, district heating companies and final consumers in more detail. That chapter demonstrates that unclear ownership and management of buildings are important barriers for renovation and energy-efficiency investments. The main issues are that no one is really responsible for the common parts of the building, including district heating pipelines, and households have no incentives to organise condominiums and effectively manage their buildings. This situation in the building sector is especially harmful for district heating, which is, by nature, closely linked to buildings.

Gaz-Teplo (which literally means gas-heat), a subsidiary of Naftogaz of Ukraine created in 2003, has a specific position in the district heating sector. In the heating season of 2003-04, Gaz-Teplo signed contracts with 53 heat supply companies. By early 2005, Gaz-Teplo had contracts with some 80 heating companies.

Gaz-Teplo supplies gas to municipal district heating companies as a commodity credit; in exchange it acquires heat and pays a commission to the district heating company for selling this heat to final customers. Gaz-Teplo receives customer payments on its consolidated account and then redistributes the money according to the established algorithm. (In some cities, Gaz-Teplo not only manages financial flows, but also operates the entire heat network under a leasing agreement.) Many district heating companies complain that their contract with Gaz-Teplo is destroying their financial situation and service quality. They say that the amount of money they receive from Gaz-Teplo is too little to cover even current costs, not to mention long-term investment costs. For its part, Gaz-Teplo, recently announced plans to invest in district heating systems or decentralised heating options. It remains to be seen how it will implement its investment plans. In any case, the present activities and future plans of Gaz-Teplo should be carefully analysed because they may have serious implications for both the heat and gas markets in Ukraine.

Current Ukrainian legislation prohibits privatising district heating assets and public combined heat and power plants. However, the wisdom of this provision is being vigorously debated and laws may change in the near future. The *Law on Rent* (leasing) and the *Law on Concession* allow private companies to operate district heating systems; this does not happen in practice. The 2005 *Law on Heat Supply* envisages competitive tenders for investment projects. It also mentions the possibilities of changing ownership of district heating assets and of involving the private sector through leasing, concession and other agreements.

• District Heating Consumers

As mentioned earlier, there are not detailed data on heat consumption in Ukraine. According to the data that IEA receives from the State Statistics Committee, industrial companies account for more than half of total district heating consumption; residential, commercial and public buildings consume approximately 46%. Some industrial companies have built their own heat generators and disconnected from local district heating systems. If they hope to survive, district heating companies must make an effort to retain their industrial consumers by improving service quality.

The status of residential end users is ambiguous. In most cases, they have no contract with the district heating provider and do not know who to contact in case of poor service quality or other problems. In addition, households do not know how much heat they are consuming; nor do they understand their contractual rights and responsibilities. To ensure high service quality, there should be a clear contractual relationship between service providers and all users of these services.

Policy, Institutional, Legal and Regulatory Framework

- **Policy Institutions**

District heating policy is characterised by unclear distribution of responsibilities and a certain lack of co-ordination between the government institutions that deal with various aspects of it. These institutions include: the Ministry of Construction, Architecture, Housing and Communal Services; the Ministry of Fuel and Energy; the National Electricity Regulatory Commission; and local authorities.

Until the summer of 2005, the development and implementation of district heating policy was the responsibility of the State Committee on Housing and Communal Services. On 1 June 2005, President Yushchenko signed a decree that established the Ministry of Construction, Architecture, Housing and Communal Services (the Ministry of Construction, for short). Two previous committees were integrated into the new Ministry: the State Committee on Construction and Architecture and State Committee on Housing and Communal Services.

The Ministry of Fuel and Energy develops the general energy policies, which have direct influence on the district heating sector. This Ministry also plays an important role in day-to-day operations in the power sector, including cogeneration. It has frequently intervened to allocate fuel to heat and power generators under emergency rules. This Ministry supports the development of electric heating in Ukraine.

The National Electricity Regulatory Commission (NERC) issues licences, regulates activities and tariffs for heat from combined heat and power plants and renewable energy sources. Local executive authorities issue licences, regulate heat tariffs and activities from local heat-only plants. The fact that two different bodies regulate products sold on the same market makes regulation complicated and unfair. As a result of this dual regulation, prices for cogenerated heat in Ukraine are often higher than prices for heat from heat-only boilers. This situation is not cost-reflective: it makes cogenerated heat non-competitive and puts the overall cogeneration sector in danger. Moreover, the fact that local authorities carry out several functions – such as political decision-making, owning district heating systems and regulating district heating companies – creates conflicts of interest within municipalities and undermines the effectiveness of regulation.

Additionally, the combination of ownership and regulatory functions creates the potential for non-transparency and corruption. Local authorities may have an incentive (and opportunity) to include in district heating tariffs various costs, which are not related to heat supply, such as maintaining community facilities, sponsorship, doubtful debt, fines and penalties.

There are plans to transfer all regulatory functions in the heating sector from municipalities to NERC. This has not yet been implemented in practice. NERC needs more staff and the network of NERC's regional offices needs to be strengthened in order to effectively regulate district heating nationally while also addressing local peculiarities. The Ministry of Construction has also suggested creating a separate independent institution to regulate district heating and other communal services.

● Legal Framework

On 24 June 2004, former president Kuchma signed the *Law on Housing and Communal Services*, which creates a legal framework for services in the residential sector, including district heating. Ukraine has subsequently adopted a number of laws and regulations that relate more specifically to district heating. On 5 April 2005, the *Law on Combined Heat and Power and Waste Energy Potential* entered into force, introducing provisions to stimulate cogeneration. For example, until 2015 the products of cogeneration are exempt from a special targeted charge on heat and electricity.

The *Law on Heat Supply* entered into force in June 2005. This law outlines the legal, economic and institutional base for the heating sector and regulates relations linked to production, transportation, supply and use of heat. To enforce the implementation of these laws, the Cabinet of Ministers approved, in July 2005, the *Rules on Providing District Heating Services, Supplying Hot and Cold Water, and Waste Water Disposal.* The Ministry of Construction has been actively developing proposals of regulations to help improve and enforce the current legislation.

● Policy Related to Heat Markets and Competition

Worldwide, there are two basic policy approaches to heating policy. Finland or Sweden have completely liberalised heat markets such that district heating competes freely with other heat options and district heating prices are not regulated. By contrast, in Denmark there is no competition between district heating and other heat options; district heating is fully regulated. Danish cities are legally obliged to develop local energy plans and set mandatory separate zones in which all buildings are connected to either district heating or gas networks (IEA, 2005b). Ukrainian heating policy seems to rely generally on the second approach. At the same time, Ukrainian policy exhibits some elements that suggest a move toward more competitive relations on the heat market. In particular, there are plans to stimulate wholesale competition in district heating within the regulated context.

The Ukrainian *Law on Heat Supply* requires local authorities to develop and implement heating plans for five to seven years. These plans must consider both district heating and decentralised/individual heating alternatives, and select the most cost-effective options. However, these plans are not required to compare lifecycle costs and benefits of new supply options (including maintenance and replacement costs) against energy-efficiency options in the district heating systems and in end-use facilities.

The *Law on Heat Supply* and several policy documents envisage introducing competition on heat markets. The law introduces equal access to heat transmission lines and requires companies that operate district heating networks to purchase heat from other sources, based on competitive bidding principles. The bidding must be organised by local authorities. If a heat transmission company also owns heat generation assets, by law, it must participate in the bidding process. It is not clear whether this requirement is being implemented in practice. International experience shows that this type of competition can stimulate improved production performance and encourage efficient, low-cost production in large systems. Many Ukrainian systems are simply too small for meaningful wholesale competition. However, in the future, competition could work in larger cities in which a great deal of heat is consumed.

The heat law also envisages giving customers a choice of heat suppliers, where possible. Given the relatively small size of each district heating market, the question arises whether retail competition between district heating producers is a viable – or effective – way to provide choice.

The role and functioning of Naftogaz of Ukraine's subsidiary Gaz-Teplo undermines the principles of free competition. Gaz-Teplo contracts seem to be neither competitively awarded nor transparent. Also, Gaz-Teplo can effectively limit the district heating companies' freedom to choose fuel sources other than gas. In addition, Naftogaz of Ukraine and Gaz-Teplo have announced ambitious plans to enter other segments of the heat market. Their *Own House* programme envisages installing thousands of individual or building-level gas boilers across the country. Although the installation of such boilers may be economically justified in some specific cases, such an aggressive strategy on behalf of a monopolistic, state gas supplier is worrying.

● Tariff Regulation

The current practice of regulating heat tariffs in Ukraine has proven unsatisfactory and needs improvement. Major problems with the current approach include:

- Unclear distribution of responsibilities between central and local authorities.
- Conflict between the regulatory and ownership/management functions in local authorities.
- Lack of professional regulatory competence at the local level.
- Inadequate legal and regulatory framework regarding the principles, methodologies and rules of setting heat and combined heat and power tariffs.

Current regulatory practices endanger the security, quality and availability of fundamental heating services. Additionally, tariffs are not clear and understandable to final consumers, which makes district heating less attractive compared to individual heat options. The Ukrainian government and policy makers understand that tariff policy needs improvement. The recently adopted laws have several positive provisions; the next step is to implement them effectively.

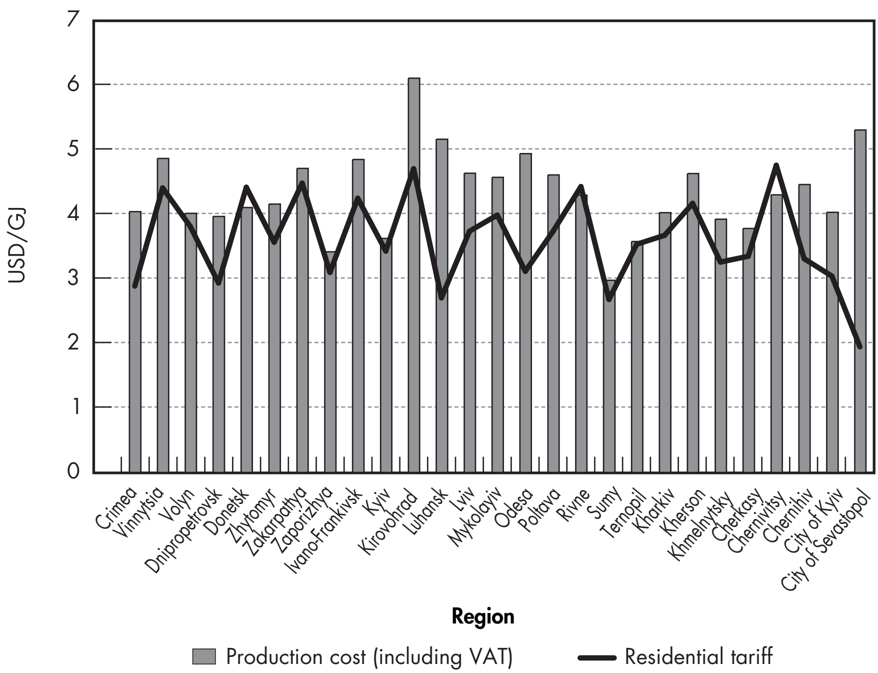
The 2004 *Law on Housing and Communal Services* and the 2005 *Law on Heat Supply* require that tariffs for district heating and hot water supply cover all economically justified costs. The *Law on Heat Supply* also states that if the regulator sets costs at a lower level, it must develop compensation mechanisms – in other words, the regulator must find ways to cover the difference. In reality, district heating tariffs vary greatly across the country and do not always cover cost. In 2005, residential tariffs covered more than 100% of current costs in the Rivne and Chernivitsy regions, but only 45% of costs in Sevastopol (Figure 9.1). There is evidence that local authorities often set tariffs below cost for political and social reasons. Then local budgets lack the finances to cover the difference. Even in cases in which tariffs cover current costs, they do not generally include a component for major capital investments and other long-term costs. On the other hand, tariffs sometimes include costs that are not related to heat supply (see section Policy Institutions). This also can deny district heating companies of much needed income for investment.

To improve the competitiveness of combined heat and power, the *Law on Heat Supply* stipulates that heat tariffs from combined heat and power generation must not be higher than tariffs for heat from other sources. In practice, this provision can be difficult to implement because local authorities maintain the ability to set heat tariffs from heat plants at a below-cost level, and are allowed use the local or regional budget to compensate the difference to the district heating company. NERC cannot apply the same instrument to cogenerated heat, as it cannot make modifications in the State Budget.

The Ukrainian *Law on Heat Supply* stipulates that tariffs must be established as a sum of generation, transmission, distribution and supply costs – plus a profit margin, which is set by the Cabinet of Ministers. Figure 9.2 shows the average cost structure of heat generation. Cost-plus tariffs encourage companies to raise costs in order to raise profit and provide no incentive to make investments that would lower operating costs. However, the law does introduce one concept of incentive regulation: it allows companies that decrease their costs through efficiency improvements to preserve the same tariff level for three years. Thus, they realise greater profit as a reward for their effort.

Figure 9.1

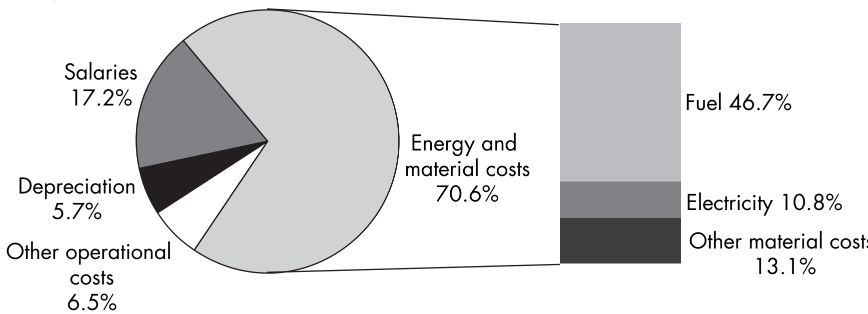
Residential District Heating Tariffs versus Production Costs, 2005



Source: Ministry of Construction, Architecture, Housing and Communal Services.

Figure 9.2

Average Heat Production Cost Structure of District Heating Companies, 2005



Source: Ministry of Construction, Architecture, Housing and Communal Services.

• Subsidies

Although they have been significantly reduced over the last few years, subsidies and cross-subsidies at various levels still create distortions on the Ukrainian heat market. The subsidies begin at the fuel level and are evident throughout the chain. To start with, district heating companies receive natural gas at a below-market price. For example, in 2005 Gas of Ukraine supplied gas to district heating companies at UAH 189 (USD 35) per 1 000 m^3; electricity generating companies paid UAH 331 (USD 61) per 1 000 m^3.[73] Companies that produce combined heat and power thus have an incentive to allocate most of their fuel costs to heat to be able to get cheaper gas. Even more importantly, the difference between the gas price for heating companies and for manufacturers may give district heating companies an incentive to illegally re-sell gas at higher market prices.

As discussed earlier, district heating tariffs do not cover costs and the difference must be covered by direct subsidies to heat providers, which come from local or state budgets. Budget payments, however, are often delayed, which results in significant accumulated debt to district heating companies.

Residential tariffs are also cross-subsidised by higher industrial tariffs. Such cross-subsidies have been reduced over the last few years but still exist in many regions. For instance, in Crimea, industrial tariffs for heat and water are 3-4 times higher than residential tariffs (Kucherenko, 2005b). As a result, many industries switch away from district heating and build their

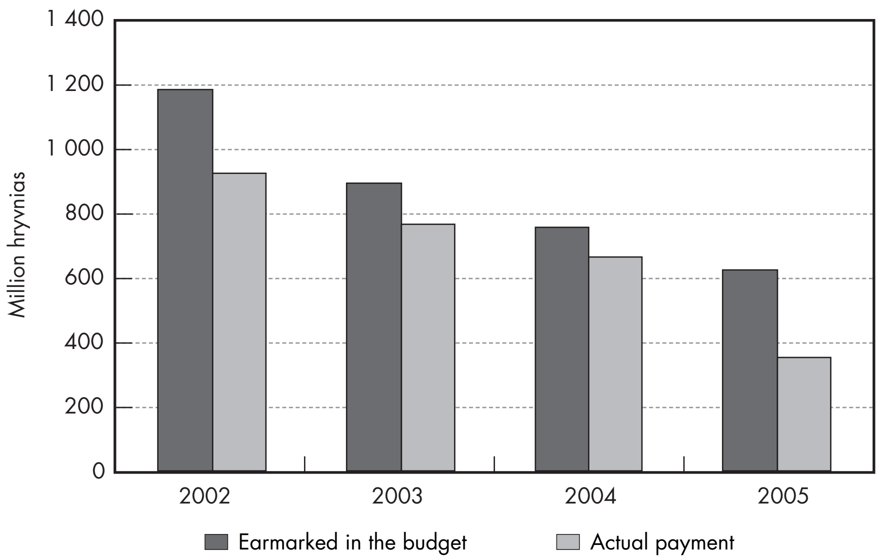
73. Households were able to obtain gas at even lower prices.

own boilers. When they lose large industrial customers, district heating companies are forced to put even greater costs on the shoulders of their remaining consumers.

Finally, households that spend more than 20% of their income on housing and communal services are eligible for targeted social subsidies. In addition, several population groups, such as war veterans or Chornobyl victims, benefit from discounted ("privileged") tariffs for communal services. Contrary to subsidies, such privileges are not income-based. Consumers eligible for subsidies or privileges pay only a portion of the bill, and the state budget compensates the remaining amount directly to service providers. This scheme does not necessarily motivate households to consume less energy. The number of households applying for these subsidies has been declining in the recent years because household incomes have been growing faster than tariffs for communal services (Figures 9.3 and 9.4).

Figure 9.3

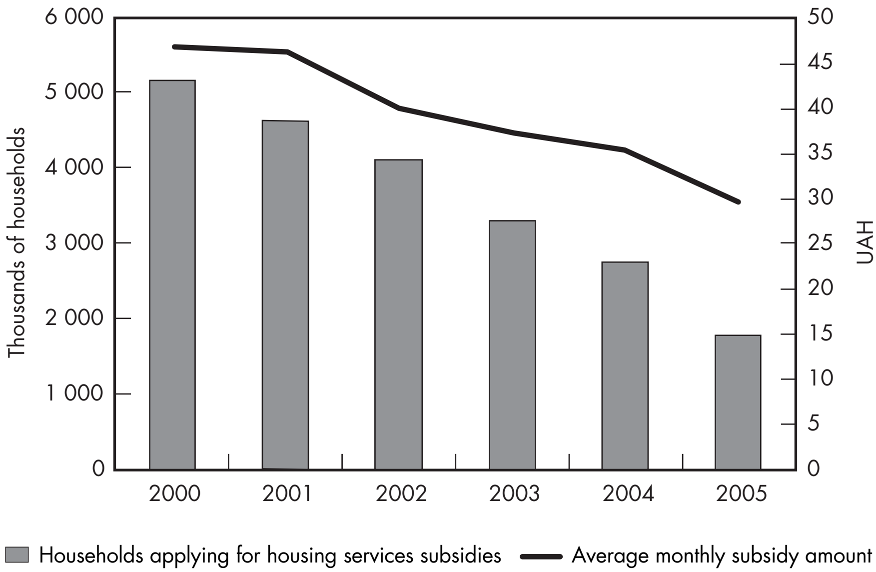
State Budget Subsidies for Housing and Communal Services Payments, 2002-05



Source: Ministry of Construction, Architecture, Housing and Communal Services.

Figure 9.4

Households Applying for Housing Services Subsidies and Average Monthly Level of Subsidies, 2000-05



Source: Ministry of Construction, Architecture, Housing and Communal Services.

Main Policy Directions and Future Trends

The June 2004 *Programme for Reforming and Developing Housing and Communal Services* identifies the following main directions of reforms through 2010:

- Improve management in housing and communal services.
- De-monopolise the sector; create a competitive environment.
- Ensure reliable operation of companies.
- Facilitate modernisation of district heating infrastructure.

In March 2006, the Ministry of Construction suggested an updated roadmap for the reforms in the district heating sector (Kachur, 2006). The roadmap envisages that local authorities will conduct energy audits of local heating systems and develop new energy plans in 2006. Municipalities are then expected to transfer district heating assets to private companies under concession, leasing and management agreements by 2007 and to begin privatisation of heat sources in 2008-10. The Ministry of Construction expects that the legal and regulatory framework needed to authorise and pursue these reforms will be created by the end of 2006. It is very important to fix the legal and regulatory framework before involving the private sector on a large scale. The experience in Central and Eastern Europe demonstrates that the private sector may bring very positive results – but only if the overall market conditions are right and if privatisations or long-term concessions are undertaken in a transparent manner (IEA, 2005b).

The Ministry of Fuel and Energy is considering the feasibility of expanding electrical heating in order to reduce gas and oil consumption for heating purposes. The logic behind this policy proposal is that Ukraine is heavily dependent on oil and gas imports while it has excess thermal electric generation capacity and is a net electricity exporter. However, much of the electricity is also produced from natural gas, and using electricity for heating purposes is short-sighted given the existing district heating potential. The move to electric heating contradicts the general trend in industrialised countries of promoting district heating and combined heat and power because of their economic, environmental and social benefits. The long-term negative impact of this policy path on district heating will certainly outweigh its possible short-term positive effects.

The *Energy Strategy to 2030* suggests that other policy priorities include attracting investment to develop renewable energy and waste heat utilisation, and to convert heat-only boilers into combined heat and power plants. As a result, the share of renewables, waste heat and cogeneration in district heating production is expected to grow, while the share of heat-only boilers is expected to drop. This policy should be pursued.

Experience in Ukraine to date demonstrates, however, that political declarations and approved programmes have not been fully implemented. The government needs to put more efforts in the implementation of the planned reforms.

Investment Policy

The current regulatory framework and tariff policy makes it difficult to attract private investors to district heating. Yet the main stakeholders, *e.g.* municipalities and residents, in most cases lack the necessary financing capacity.

The Ukrainian government understands the urgent need of attracting investment in the district heating sector, and has implemented several concrete measures and programmes. More effort is needed, however, to create an adequate policy framework for stimulating such investments. The government's plan to create a fund for investment in energy efficiency in district heating and buildings is very encouraging and should be pursued.[74] Western energy-efficiency financing approaches, such as loan guarantees, could be used to increase the impact of this funding. Other realistic financing possibilities include leasing or concession agreements, contracts with energy service companies (ESCOs), and commercial loans from funds and other financing institutions (see Chapter 4: Energy Efficiency for more details). It is necessary to create the legal, regulatory and institutional conditions favourable for implementing these financing options.

- **Reducing Non-payment and Debt**

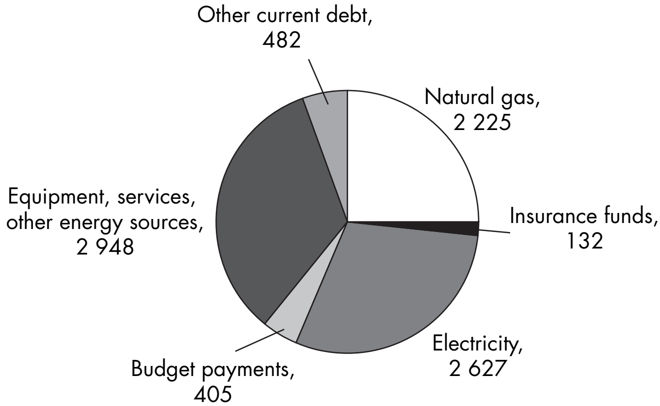
Non-payment has been a major challenge undermining the district heating sector, as well as other energy sectors that supply fuel to district heating companies. The payment discipline has improved in recent years, but the accumulated debt still remains an issue. Many consumers in the past did not pay – or paid only partially – for district heating and other communal services. In turn, district heating companies have not been paying for fuel. At the beginning of 2006, consumer debt to companies in the housing and communal services sector[75] was UAH 7.6 billion (USD 1.5 billion). Heating debt accounts for a large share of this total amount, and the main non-payers are households (Figure 9.5). At the same time, the accumulated debt of communal services companies to various suppliers and the state was UAH 8.8 billion (USD 1.8 billion) (Figure 9.6).

In recent years, the Ukrainian government has made progress in resolving the non-payment issue because of several effective measures. Consumer payment rates have been growing: households paid 96% of their current district heating bills in 2004, up from 92% in 2003. In 2005, the average level of end users' payment for district heating and hot water services was 115.5%, varying from 101% to 123% among regions, which indicates that end users paid their current bills in full and part of their old debt. In 2004, the accumulated consumer debt slightly decreased for the first time in ten years to UAH 8.45 billion (USD 1.54 billion) from UAH 8.6 billion (USD 1.56 billion) in 2003. In 2005, it decreased further to UAH 7.6 billion (USD 1.47 billion). A reduction in the debt level was observed in 20 Ukrainian regions, most notably in Kyiv region, Vinnytsia and Rivne. However, in 2006, the sharp increase of gas price has significantly exacerbated the non-payment problem. Many district heating companies reduced or suspended their payments for natural gas, even though end-users continued to pay their

74. Initial plans were for a fund of UAH 700 million (USD 140 million), drawing on revenue from the sale of Kryvorizhstal. International investors were also going to be invited to participate in the fund. These plans seem to be put on hold.
75. Including district heating, water supply, waste discharge, building maintenance, and other service companies.

Figure 9.5

Outstanding Debt of Housing and Communal Services Companies as of January 2006 (UAH million)

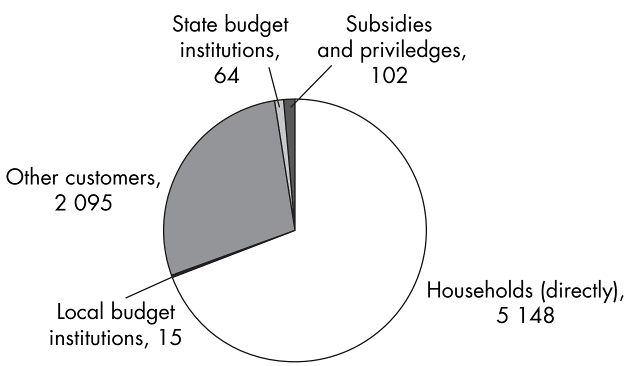


Total debt: UAH 8 819 million or USD 1 760 million

Source: Ministry of Construction, Architecture, Housing and Communal Services.

Figure 9.6

Consumer Debt to Housing and Communal Services Companies as of 1 January 2006 (UAH million)



Total debt: UAH 7 562 million or USD 1 500 million

Source: Ministry of Construction, Architecture, Housing and Communal Services.

heat bills almost in full. The gas price increase highlights the necessity for the government to understand the real reasons behind the non-payment problem of district heating companies and to address this issue with effective measures.

The gas price increase also underlines the need for efficiency improvements in district heating systems. Such improvements would reduce natural gas consumption thus decreasing the burden of fuel costs.

In 2003, Ukraine adopted the *Law on Restructuring the Debt for Housing, Communal Services and Residential Electricity and Gas*. This law allows indebted households to restructure their debt over a period typically of five years. Additionally, the Cabinet of Ministers introduced a mechanism to cross-cancel debt in 2005 (Box 9.2).

Box 9.2 Cross-cancellation of Debt

In 2005, Ukraine's Cabinet of Ministers initiated a plan for cross-cancelling debts between individuals and the Ukrainian state bank Oshchadbank. During the Soviet era, many Ukrainian citizens placed savings in the Ukrainian branch of Sberbank (now Oshchadbank). These savings devalued significantly when the Soviet Union collapsed. Under the plan, individuals who have communal services debts accumulated before September 2004 can have them cancelled; in exchange the State cancels its obligation concerning devalued savings. Essentially Oshchadbank writes off the appropriate amount of debt from the person's "frozen" account with devalued savings, and the communal services company ultimately gets paid from the state budget. This procedure is complicated and time-consuming but, nevertheless, it seems quite popular. The mechanism was extended until July 2006.

The 2005 *Law on Heat Supply* permits district heating companies to disconnect and fine customers who do not pay for heat, although disconnection is not allowed in winter. A special service of the Ministry of Justice can seek court orders to evict non-payers from their homes if they refuse to sign a debt restructuring contract. However, several categories of citizens cannot be evicted. In practice, it still remains very difficult for district heating companies to put pressure on non-payers.

Metering

Very little residential heat in Ukraine is metered. In Kyiv, for example, only 3% of residential buildings are equipped with heat meters, and only 1.8% have hot water meters (Dubovyk *et al.,* 2005). The government recognises that without meters and regulation devices, consumers cannot control their heat use and companies have little incentive to reduce the tremendous network losses. In the absence of metering, it is impossible to know the exact heat losses, which makes improvements challenging. Metering at buildings or substations is a prerequisite to modernising and reforming district heating systems to make them more customer-friendly and demand-driven.

In 1995, the Cabinet of Ministers approved a national programme that aims to install heat and water regulation devices and meters in the housing sector. Because of difficulties in implementing it, the Cabinet has extended the programme's timeframe on several occasions. However, implementation continues to be much slower than planned.

- **Policy Integration**

Although district heating is managed locally, the sustainability of this sector very much depends on a strong national policy. District heating in Ukraine is perceived as a housing and communal services issue, rather than an integrated element of the energy sector. Given that district heating is closely related to electricity and gas sectors, and is a large consumer of primary fuels, district heating policy must be integrated within Ukraine's broader energy policy. It should also be integrated with general economic, social and financial policies to better reflect the importance of district heating for the Ukrainian economy and for people's well-being.

Critique

District heating, when well-managed, has significant economic, environmental and social benefits, especially when it is based on cogeneration. With adequate policy, district heating can be a reliable and relatively cheap source of heat and can contribute to reducing emissions of greenhouse gases and local air pollutants.

District heating in Ukraine suffers from inefficiency and urgently needs investment in refurbishment and modernisation. The increasing gas price highlights the urgent need for efficiency improvements, which would reduce gas consumption and, ultimately, reduce the burden of fuel cost on final consumers. Yet, the current policy framework does not make district heating attractive for investment, which undermines its sustainability. Barriers to investment and efficiency improvements include (but are not limited to): the current pricing policy; lack of metering; the focus on heat production, not consumption; unclear ownership and management of buildings; and difficult access to financing for interested parties. It is vital to create adequate policy and regulatory conditions for attracting private investments in the sector.

The current system of regulating district heating has clear disadvantages. The major problem is that local authorities act as both owners and regulators of district heating, which leads to a conflict of interest and provides incentives for non-transparency. Heat prices are often below operational costs, which creates financial distress for district heating companies. At the same time, the tariffs are quite high because the current regulation does not stimulate efficiency and cost reduction. The plan to transfer heat regulation functions from municipalities to NERC is commendable and must be implemented in practice. The proposal to create a separate agency for regulating district heating and other communal services has pros and cons. In any case, either NERC or the new regulating institution must be truly independent from both political and stakeholder interests.

Lack of metering equipment in buildings is a fundamental barrier for successful reforms and improvements in energy efficiency. Without meters district heating companies have no incentives to reduce costs and end-users have little incentive for consuming less energy.

The major problem of district heating in Ukraine is that public authorities perceive it as a social service rather than as part of the commercial sector. District heating companies are perceived as providers of public services, not qualified business players operating on a true market. A corollary of this approach is that service quality and customer satisfaction is not a priority. Laws, strategies and policies tend to focus strongly on production and supply, while end users and end-use efficiency do not receive sufficient attention.

At present, the main stakeholders (municipalities, district heating companies, building owners and end users) are not able to finance investments in district heating and buildings. It is important to introduce policies that facilitate and stimulate private financing through leasing or concession, third-party financing mechanisms, preferential loans and other measures. Based on international experience, a state-sponsored fund can also be a very effective instrument, especially when state guarantees leverage additional financing from the private sector. To maximise effectiveness of such a fund, it should be professionally managed by a private bank or investment fund.

Ukraine already has a number of strategies, programmes and laws with wise provisions on district heating. For example, increasing combined heat and power utilisation and reducing the use of inefficient heat-only boilers are positive goals for Ukrainian energy policy. So far, the government has not implemented many of its planned reforms, which thus remain political declarations. Consistent implementation and enforcement are more important than declarations.

Some of the suggested reforms require further consideration. In particular, the plan to reduce the use of district heating by increasing electric heating is not a sustainable option. Well-organised district heating has numerous benefits; in the long term, it makes more sense to improve district heating rather than to move to other heat options. In some specific cases, switching to decentralised heating options may be economically justified (for examples, in settlements with a warm climate, low population density or long distances from the heat plant). However, both consumers and local authorities must clearly understand all consequences of such a move, including future maintenance and energy costs. Switching to individual or building-level heat options, where it is economic, must be done in a transparent and competitive way.

Despite political declarations about moving toward competitive relations in the heating sector, some recent developments hinder competition. In particular, the current expansion of Gaz-Teplo in the heat market without competitive bids and transparency is a problem in itself. Even more worrying is the fact that the Gaz-Teplo model could create a monopoly within a monopoly: district heating companies may lose the freedom to choose from various fuels or fuel suppliers.

Clear understanding of the current situation is necessary for developing a solid district heating policy. Such understanding is challenging because of the inadequate statistical data. It is therefore vital to improve heat data collection.

There is a lack of co-ordination – and even major disagreements – regarding key policy directions between various institutions that deal with district heating policy (the situation with Gaz-Teplo is just one example of disagreements between institutions). In addition, heat policy is not sufficiently integrated into general energy, economic and social policy. Given the importance of district heating for the economy and for the people of Ukraine, a comprehensive heat policy should be developed on the highest national level and integrated with other relevant policies.

Recommendations

The government of Ukraine should:

- Create a level playing field for competitive heating options by phasing out price distortions and other factors that discriminate against district heating and may lead to uneconomic decisions in the long term.
- Clearly separate ownership/management and regulatory functions in municipalities.
- Enhance the independence of the regulator by creating either: i) the necessary conditions to allow NERC regulate tariffs for heat from all sources; or ii) a separate, independent body for regulating communal services, including district heating.
- Design and implement a national heating strategy in order to develop a competitive and well-functioning heat market. Require local authorities to examine the existing heat systems and to conduct local energy plans to determine the least-cost options of providing high-quality heat services at reasonable prices. These energy plans should consider district heating, building-level and individual heat options as well as end-use energy-efficiency measures.
- Require independent financial audits of municipal district heating companies.
- Ensure that tariffs are not kept artificially low as a substitute for social support programmes; introduce targeted social schemes to protect the most vulnerable households against price increases.
- Improve tariff regulation by developing clear methodologies for setting heat, hot water, and combined heat and power tariffs. Move away from "cost-plus" regulation and develop pricing principles that will provide incentives for efficiency improvements, such as price caps or benchmarking. Set clear rules for the third party access to heat pipelines. Make the tariff setting procedure more transparent.
- Require contracts between district heating providers and end users.
- Enhance efforts to install energy metering equipment.
- Create incentives for investing in energy efficiency in district heating and buildings. Focus on improving efficiency throughout the energy chain, from production to end use.

- Make sure that national policies and measures to stimulate combined heat and power are properly implemented.
- Establish systematic data collection for district heating.
- Put more emphasis on integrating district heating policy with energy, economic, housing and social policy and enhance co-operation between different policy institutions.

10. RENEWABLE ENERGY

Overview

In Ukraine, the share of renewable energy in domestic energy supply is insignificant, but the *Energy Strategy to 2030* projects that it will grow. Most of the country's renewable energy today is concentrated in hydropower and biomass-fired heating boilers. There are also several wind power plants and geothermal heating systems. Ukraine has developed some renewable energy technologies, but their quality and reliability need to be improved. The most significant challenges in expanding renewable energy are cost competitiveness and financing of technologies and projects. Existing subsidies for traditional energy and other market distortions heighten these challenges. Ukrainian policy makers have introduced a number of incentives to stimulate renewable energy production and use, but most have yet to be implemented. More effective policies and regulations are needed to enhance the use of renewable energy and fully capture its environmental, economic and social benefits.

Renewable Energy Market and Industry

- **Market Position**

Renewable energy (see definition in Box 10.1), including large hydro, accounts for some 0.9% of total primary energy supply (TPES) in Ukraine or 1.3 Mtoe.[76] Large hydro comprises 80% of the total figure, and only 20% comes from other renewable sources. By comparison, renewables typically account for more than 6% of TPES in OECD member countries and 13.5% worldwide. Only hydropower and biomass are used commercially in Ukraine; other renewable energy technologies are still at the stage of research and development or demonstration (RD&D), and their share in energy supply is insignificant (Table 10.1).

The state Energy Company of Ukraine, either directly or through its subsidiary Ukrhydroenergo, owns Ukraine's hydro and wind power facilities. It sells hydro and wind power on the wholesale market at tariffs regulated by NERC. Owners of small, distributed renewable energy

76. Ukrainian sources report a larger number (3.6% of TPES), primarily because of difference in definitions.

Box 10.1 Renewable Energy: Definition Issues

There is no universally accepted definition of *renewable energy.* In IEA publications, renewable sources include: hydro (large, medium and small), geothermal, solar photovoltaic, solar thermal, tide, wave, ocean, wind, solid biomass, gases from biomass, liquid biofuels and renewable municipal waste (*i.e.* waste containing biodegradable materials).

In Ukraine the definition of renewable energy is somewhat broader. It is often used as a synonym for *non-traditional* or *alternative* energy, which includes peat, heat 'created' due to heat pumps and 'secondary' energy sources such as waste heat, municipal and industrial waste, pressure of blast-furnace gas and pressure of natural gas during its transportation. Some Ukrainian sources further broaden the definition of *alternative* energy sources to include synthesis gas (syngas), coalbed methane, natural gas from small-scale non-conventional fields and other non-renewable fuels, the extraction of which requires innovative technologies.

Small hydro is another controversial term. IEA considers hydro plants as small if their capacity is less than 10 MW; in many former Socialist countries, small hydro is that below 30 MW. In Ukraine, hydropower stations are classified as follows: *small* – with the capacity below 20 MW, *mini* 100-1000 kW and *micro* below 100 kW.

systems (*e.g.* farms, industrial companies and households) are both energy producers and consumers. The heat and electricity that such systems produce are not sold on the market. Collecting viable statistical data is therefore challenging.

Most renewable energy technologies are capital intensive, and high cost is the main constraint to the expansion of renewable energy sources (except in the case of large hydro). For example, wind power tariff in Ukraine is UAH 0.24 (USD 0.05)/kWh, while the nuclear tariff is only UAH 0.08 (USD 0.016). Direct and hidden subsidies for traditional energy, as well as other market distortions, effectively work against broader use of renewables.

Some forms and uses of renewable energy are already economically viable in Ukraine. Large hydropower is the most mature and least-cost technology. Tariffs for hydropower are the lowest on the Ukrainian wholesale market. In areas with available biomass resources, biomass-fired boilers are often

Table 10.1

Renewable Energy Technologies in Ukraine

Technology	Energy product	Status in Ukraine
Biomass combustion	Heat, electricity or combined heat and power	Used for cooking and space heating by residential and commercial sector, and for heat and steam production by industry and district heating. Electricity generation from combined heat and power is insignificant.
Biomass hydrolysis and fermentation	Ethanol	RD&D; some industrial production.
Biomass digestion/ extraction	Biodiesel or biogas	RD&D, several pilot projects. One operating large-scale combined heat and power plant on biogas.
Wind turbines	Electricity	70 MW installed power capacity.
Traditional wind mills and water pumps	Movement, power	Used in agriculture.
Hydropower stations	Electricity	Large-scale capacity: 4 600 MW. Small-scale capacity: less than 100 MW.
Geothermal energy direct use	Heat	13 MW installed thermal capacity.
Solar photovoltaic power systems	Electricity	Manufacturing PV panels and systems, mostly for export.
Solar heating	Heat	Manufacturing solar collectors for domestic use.

Source: IEA analysis.

competitive with gasoline and diesel engine generators. Other renewable energy sources can be more cost-effective than conventional energy in some applications, including off-grid (distributed) electrification and heating, biomass-fired district heating and specific industrial uses. The sharp growth in oil prices in recent years may make biofuels competitive, especially if the government effectively implements the announced support policies. However, cost-competitiveness of most types of renewable energy depends on the availability of resources and other local conditions. Availability of technologies on the local market also plays a role.

The cost of renewable energy technologies decreases as their use increases. International experience shows that targeted governmental policies can significantly reduce costs and increase the economic attractiveness of renewables by creating a "virtuous circle". Supportive policies lead to increased use of renewable energy, which further brings their costs down. In turn, lower prices open new market opportunities, which leads to further cost reductions via economies of scale.

Financing is another challenge in expanding renewable energy. Potential users of renewable energy such as agricultural enterprises, rural settlements, residents of houses not connected to district heating and gas networks generally have low incomes and have no access to commercial financing. State budget financing is limited to wind energy only and is not enough to significantly boost the development of the sector. District heating companies, potential large users of biomass, have no money to invest in converting boilers to use biomass (most boilers were historically designed to use gas). At least two elements are needed to enhance investment in renewable energy technologies: facilitating end-users' access to financing and improving the financial situation of district heating and electricity companies.

RD&D and Industry

Several scientific organisations and institutes in Ukraine are pursuing renewable energy research, development and demonstration (RD&D). In addition, some companies in the defence and aerospace industries have converted to manufacturing renewable energy systems or their components. There have been many attempts to use the existing research, technology and engineering base. However, very few have been successful, especially when it comes to commercialising technologies.

Several Ukrainian engineering laboratories have designed wind turbines with capacities of 0.2-400 kW. Windenergo, a joint venture with the American company Wind Power created in 1994, has produced (under a Wind Power licence) approximately 750 turbines with a 107 kW capacity. These turbines cost about USD 420/kW, which is lower than in the United States (USD 800-1 400/kW) due to lower labour and material costs in Ukraine. However, this particular type of turbine has a low efficiency (10-18%) and, thus, is not very cost-effective. In 2003, the Dnipropetrovsk plant Yuzhmash bought another licence from a Belgium company (Turbowinds) and is planning to start production of 600 kW turbines with a projected efficiency of 38%. All components for both 107 kW and 600 kW turbines are produced domestically. There are plans to produce new generation turbines with capacities of 2.5 and 3 MW, and efficiencies of close to 50%.

Ukraine historically produced photovoltaic panels for the Soviet space programme. Today, the plant Kvasar (Kyiv) produces up to 2 MW of photovoltaic systems per year and nearly 120 MW of silicon photovoltaic panels. As there is no market for photovoltaic products in Ukraine, almost all of these panels are exported to Europe. Ukraine also has about 10 companies that manufacture several hundred square metres of solar collectors per year.

While the cost of Ukrainian technologies is somewhat lower than that of technologies from industrialised countries, their quality and reliability are generally lower. Additional financing into RD&D would be necessary to improve their performance and reliability, and further reduce costs. The government should carefully assess the costs and benefits of supporting renewables, and focus on technologies that already have a competitive advantage. In the case of less advanced Ukrainian technologies, it may be difficult to realise good value from investing additional state resources on RD&D. It may make more sense economically to let other countries improve such technologies.

IEA has created a framework of international technology co operation to allow interested member and non-member countries to pool resources and research the development and deployment of particular technologies (Box 10.2). Ukraine could consider entering into IEA technology agreements on renewables (*e.g.* the Photovoltaic Power Systems Programme[77]) to maximise national RD&D efforts and to achieve technological innovation at lower cost.

Box 10.2 IEA Technology Agreements

Since its creation in 1974, IEA has provided a framework for international co-operation in energy technology research, development and demonstration (RD&D). IEA brings together experts in specific technologies from IEA member and non-member countries that wish to jointly address common challenges and share the results. Within this framework, there are currently 40 active programmes, known as the IEA Implementing Agreements. Ten of these focus on renewable energy in the following sectors:

- Bioenergy.
- Geothermal.
- Heat pumping technologies.

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77. Website for the IEA Photovoltaic Power Systems Programme: www.iea-pvps.org.

• Hydropower.

• Ocean energy systems.

• Photovoltaic power systems.

• Renewable energy technology deployment.

• Solar heating and cooling.

• SolarPACES.

• Wind energy systems.

Implementing Agreements help to reduce technological risks and eliminate duplication of effort, thus contributing to faster technological progress and innovation at lower cost. The Implementing Agreement mechanism is flexible and accommodates various forms of energy technology co-operation. It can be applied at every stage in the energy technology cycle – from R&D through to validation of technical, environmental and economic performance, and on to final market deployment. Some Implementing Agreements focus solely on information exchange and dissemination. Financing arrangements for the Implementing Agreements fall into two broad categories: a) Cost sharing, in which participants contribute to a common fund to finance the work; and b) Task sharing, in which participants assign specific resources and personnel to carry out their share of the work. Some Implementing Agreements use a combination of these two mechanisms.

More information is available online at: www.iea.org/techagr.

Renewable Energy Use: Current Status and Future Opportunities

● Resources and Potential

Efficiency of most renewable energy technologies is site-specific. Thus, detailed information on available resources and their relative economics is very important for their successful development. Renewable energy resources in Ukraine are fairly well studied and reported, but the economic potential of these resources is quite difficult to determine. The existing estimates of technical potential for renewable energy vary significantly, as shown in Table 10.2. It is obvious that only a portion of the technical potential can be realistically met. Moreover, the estimates of technical and economic potential are only indicative and are likely to change over time. The technical potential will likely grow with the development of available technologies. The economic potential of renewables in the medium and long term will very much depend on their cost compared to prices for fossil fuels. The latter are difficult to predict, which makes the prospects for renewables' competitiveness unclear. The cost of renewable energy technologies will also very much depend on governmental policies.

Table 10.2

Estimates of Technically Feasible Renewable Energy Potential in Ukraine by Various Sources (TWh/year)

Energy source	Estimates by various experts		
	Zabarny and Shurchkov (Institute of Technical Thermal Physics)	Renewable Energy Atlas (State Committee for Energy Conservation)[78]	Geletukha *et al.* (Scientific Engineering Centre Biomass)
Biomass	35.93	n.a.	126.50
Solar	16.89	345.1 *	48.00
Geothermal	53.50	n.a.	97.70
Wind	24.85	30.00	25-30.00
Small hydro	2.04	8.25	3.7**
Low-potential heat (Heat pumps)	100.91	146.44	n.a.
Total	**234.12**	**n.a.**	**n.a.**

** Economic potential is 53.8 TWh/year.*

*** This is economic potential.*

n.a. – not applicable.

Sources: Zabarny and Shurchkov, 2002; State Committee for Energy Conservation, 2001; and Geletukha et al.*, 2003b.*

78. In 2001, Ukrainian scientists compiled a comprehensive atlas of renewable energy resources of Ukraine at the request of the former State Committee for Energy Conservation. The Atlas data were updated in 2005 and used in the Energy Strategy *to 2030.*

Bioenergy

Bioenergy is probably the most promising renewable energy source in Ukraine. In 2001, the use of wood or wood waste and agricultural residues (straw, stems and ears of maize, stems and husks of sunflower) for energy production was equivalent to 8.1 TWh/year (Geletukha *et al.*, 2005). Most of the existing biomass installations are for heat production. Additional projects are being considered for biogas power generation, as well as for straw and wood combustion for combined heat and power production. Heat production is likely to remain the key use of biomass.

Ukraine has various sources of biomass including agricultural residues, targeted production of energy crops, and wood and wood waste (Table 10.3).

Table 10.3

Bioenergy Potential in Ukraine (Mtoe/year)

Type of energy	Potential
Straw of cereal crops (excluding corn)	3.92
Corn stalks, ears and grains	1.68
Sunflower stalks and husks	1.61
Biogas from manure	1.12
Biogas from sewage water	0.14
Wood waste	1.4
Landfill gas	0.21
Combustible pellets from municipal solid waste	1.33
Liquid fuels (biodiesel, bioethanol)	1.54
Energy crops (willow, poplar, etc.)	3.57
Total	**16.52**

Source: Consortium of Ukrainian Environmental Organisations (Mama-86 et al.*), 2006.*

Combustion of Biomass

Some industries and district heating companies burn biomass in their boilers to acquire heat and steam. Certain households in rural areas also use wood and wood waste for heating purposes. The Ukrainian Renewable Energy Agency and the Scientific Engineering Centre Biomass estimate that there is a potential market for various types of biomass-fired boilers with a total projected demand of 9 000 MW. Using these boilers would save 5 bcm of natural gas per year. The total investment cost required to bring them into production, UAH 2.4 billion (USD 0.48 billion), is lower than the market price of 5 bcm of gas.

Biofuels

The Ministry of Agriculture supports rapeseed cultivation and biofuel development. The Ministry, as well as several regional administrations and private companies, recently announced plans to build plants for producing biofuels from rapeseed in Zhytomyr, Sumy, Vinnytsia, Khmelnytsky and other regions. Each plant would reportedly cost about USD 35 million and would produce 100 000 tonnes of biofuels per year.[79] Harvests of rapeseed have grown from 100 000 tonnes several years ago to some 300 000 tonnes in 2005 (Olearchyk, 2005). To date, most rapeseed has been exported to Europe. The Ministry of Agriculture plans to increase further the surface of rapeseed fields, from 234 000 ha in 2005 to 1.3-1.5 million ha by 2010, to supply the proposed biofuel plants.

Biogas

Total biogas utilisation was the equivalent of 0.02 TWh in 2000 (Geletukha *et al.*, 2003a). A modern biogas plant was constructed in the Dnipropetrovsk Region and has been in operation since December 2003; a demonstration landfill biogas utilisation project operates in Luhansk. According to Ukrainian experts, there is potential market for many more such plants. There are 700 landfill sites in Ukrainian cities that annually receive approximately 9 Mt of solid municipal waste. Nearly 140 of these landfill sites are large and could be used for collecting landfill gas.[80] According to the Scientific Engineering Centre Biomass, up to 400 Mcm per year of landfill gas could, theoretically, be collected and used for energy (Matveev *et al.*, 2004). The Renewable Energy Agency suggests that the technical potential of biogas is 2.3 bcm from manure, 0.33 bcm from sewage sludge, 2.3 bcm from landfill gas – which corresponds to a total of 28.2 TWh/year. However, because detailed cost analysis of this potential is lacking, it is not clear what amount of landfill gas can be extracted economically.

Ukraine also plans to develop its production of synthesis gas (syngas) from biomass, waste, coal and peat.

79. One tonne of rapeseed is needed to produce approximately 270 kg of biofuel. Ukraine produced 59 100 tonnes of rapeseed in 2003 and 148 880 tonnes in 2004.

80. The calorific value of low- and medium-grade landfill gas is about two times lower than that of natural gas. Landfill gas can be further processed to produce high-grade fuel, which can be substituted directly for natural gas in pipeline applications.

Hydro

Hydropower is the most developed renewable energy source in Ukraine today and is the least expensive power source on the wholesale market. Of the country's 4 600 MW of hydropower capacity, the majority is in large-scale hydro, which is a mature technology. Eight power stations on the Dnipro River have the total capacity of 3 907 MW and the Dnistrovska station on the Dnistr River an additional 700 MW. Combined, these stations produce 11-13 TWh/year. As of 1 January 2005, Ukraine has 65 small and 7 micro hydropower stations with a total operational capacity of 106 MW, and generation of 280-390 GWh/year. Additionally, there are some small hydropower stations that are not operational today but could eventually be restored. Ukraine also has plans for five additional hydro power plants with a total capacity of 8 143 MW (EBRD, 2005). Environmental organisations in Ukraine project that hydropower production may reach 15.1 TWh/year by 2030 (including 3.7 TWh/year of small hydro) and up to 25 TWh/year in 2050 (Consortium of Ukrainian Environmental Organisations, 2006). These organisations estimate that Ukraine has realised only 10% of its small hydro economic potential.

Wind

Ukraine has eight wind power plants: four in Crimea and one each in the Sea of Azov; near Mariupol; near Mykolaiv; and near Truskavets in the Carpathians. These plants have a total capacity of more than 70 MW (Woronowycz, 2000; Vasko, 2000; EBRD, 2005; Windenergo, 2005). Prior to 2006, wind energy development was funded from a charge of 0.75% on all electricity sales. At the beginning of 2006, the government began supporting wind energy through a fixed budget allocation (about UAH 80 million or USD 16.7 million per year). At present, wind power stations supply the most expensive electricity to the wholesale market. The estimated technical potential of wind energy capacity is 16 GW, which could generate up to 30 TWh/year. The *Energy Strategy to 2030* projects that wind power will generate 2 TWh/year in 2030, which will substitute the consumption of 0.5 Mtoe of fossil fuels per year.

Solar

According to estimates, there were approximately 1 000 solar collectors (10 000 m^2) installed in Ukraine in 2002 (Matveev and Konechenkov, 2002). Ukraine has potential for developing solar heating, particularly in the Southern part of Ukraine, where insulation reaches 1 450 kWh per m^2 per year (the country's average is 1 200 kWh per m^2 per year). Solar heating could be attractive in areas with low population density, where district heating is not economically justifiable. Ukrainian environmental organisations project that solar collectors may supply up to 23 TWh/year of heat in 2050.

Photovoltaic systems are used very little in Ukraine because of their high cost. Most photovoltaic panels manufactured in Ukraine are exported.

Geothermal

Ukraine has 13 MWth of geothermal capacity installed. There is potential demand for small geothermal power plants using existing wells at abandoned oil and gas fields; a 1.5 MW pilot project in Poltava was installed in 2005. The best conditions for geothermal energy development are in the Carpathian area, in Crimea and in the regions of Kharkiv, Poltavsk, Donetsk, Luhansk and Chernihiv. Experts estimate that geothermal energy use could be equivalent to 8 TWh/year by 2030 and 14 TWh/year in 2050 (Geletukha *et al.*, 2003a).

Policy, Legal and Regulatory Framework

Policy Institutions

Renewable energy sources are formally the responsibility of the new National Agency on Efficient Energy Use. However, other institutions play important roles as well. The Ministry of Fuel and Energy, via the Energy Company of Ukraine, controls hydro and wind power plants. The Ministry of Agriculture promotes biofuels production and cultivation of rapeseed and other crops for energy purposes. Ukraine also has a number of non-governmental institutions that provide policy recommendations on renewable energy issues to the government and policy makers.

NERC regulates tariffs for hydro and wind electricity. Regulation does not always account for specific characteristics of renewables such as intermittency. NERC also regulates heat tariffs from biomass-fired cogeneration plants. Quite often heat produced at such plants is not competitive with heat produced at municipal heat-only boilers, which are regulated by local authorities that tend to push tariffs downward (Chapter 9: District Heating).

Policy Goals

The government of Ukraine has set several goals concerning renewable energy; it has not met most as yet. The 1996 *National Energy Strategy until 2010* and the 1997 Cabinet of Ministers' *Programme for State Support of Non-traditional and Renewable Energy Sources* set a target to meet 10% of domestic energy demand with non-traditional and renewable energy by 2010. A number of sectoral programmes have set targets for specific renewable energy technologies. For example, the *Comprehensive Programme to Build Windmills to 2010*, approved by the government in 1997, has a goal of installing 190 MW of wind capacity by 2010. The government now says it is unlikely to meet this goal. *The Comprehensive Programme on Using Non-traditional and Renewable Energy Sources in Architecture and Urban Construction*, developed in mid-1990s, envisaged installing 766 500 m^2 of solar collectors by 2005 and 8 737 900 m^2 by 2010 (Rabinovich and Fert, 1998), but these targets will not be met.

The *Energy Strategy to 2030* estimates that Ukraine will nearly quadruple its use of renewable energy, waste and non-conventional energy sources, from 10.9 Mtoe in 2005 to 40.4 Mtoe in 2030. This would require investing some UAH 60.4 billion (USD 12.6 billion) in the sector. The highest growth is expected in the use of solar energy, coalbed methane and low-potential heat, although the growth will start from a very low base (Table 10.4). The *Energy Strategy to 2030* projects that electricity production based on renewable energy will grow to 1.6 billion kWh in 2020 and 2.1 billion kWh in 2030.

Policies and Legislation

Ukraine has adopted a significant number of programmes, laws and regulations related to renewable energy in recent years. However, the impact of these measures has been rather limited because of the lack of comprehensive policy and enforcement mechanisms. The *Law on Alternative Energy Sources* (Verkhovna Rada, 2003b), adopted in 2003, defines the legislative, economic, ecological and organisational framework for the use of renewable and non-traditional energy. The earlier drafts of this law proposed mechanisms to provide financial, economic and regulatory support for renewable energy sources. However, following two presidential vetoes, all financial stimuli and support measures were excluded from the final text. Still, the law is an important document as it provides official government support for renewable energy in Ukraine.

Table 10.4

Projected Use of Renewable and Non-conventional Energy Sources, Optimistic Scenario (Mtoe/year)

	2005	2010	2030	Growth 2005-2030, %
Bioenergy	0.910	1.890	6.440	707.7
Solar energy	0.002	0.022	0.770	36 666.7
Small hydropower	0.084	0.364	0.791	941.7
Geothermal energy	0.014	0.056	0.490	3 500.0
Wind energy	0.013	0.147	0.490	3 888.9
Low potential heat	0.140	0.210	15.890	11 350.0
Total renewable energy	**1.163**	**2.689**	**24.871**	**372.2**
Non-conventional energy sources	**9.730**	**11.200**	**15.540**	**159.7**
Total	**10.893**	**13.889**	**40.411**	**371.0**

Source: Cabinet of Ministers, 2006a.

Ukrainian policy makers have tried to stimulate biofuels production since the mid-1990s, but the result has been modest so far. The *Law on Alternative Liquid and Gaseous Fuels* (Verkhovna Rada, 2000), adopted in 2000, introduces the framework for financial mechanisms to stimulate biofuels and other alternative fuels that are not necessarily renewable. The state programme on ethanol was adopted in 2000, but has not been fully implemented. A presidential decree of September 2003 announced new measures to stimulate production of fuel ethanol, biodiesel and biogas. In December 2005, the Cabinet of Ministers adopted the *Proposal for a Programme to Develop Biodiesel Production,* which stipulates that Ukraine will produce and consume about 520 000 tonnes of biofuels in 2010. To achieve this target, about EUR 170 million (UAH 1 billion or USD 213 million) should be invested in equipping biofuels production plants and developing energy crop fields.

In recent years, the Verkhovna Rada considered several proposals for laws on renewables. For example, in 2005, it approved, in the first reading, the draft law on bioethanol.[81] The draft law introduces a preferential excise duty

81. It will become a law only if the Verkhovna Rada adopts the final version and if the President signs it.

for blended gasoline-ethanol motor fuels and eliminates the excise duty on bioethanol used to produce such fuels. At the beginning of 2006, the Verkhovna Rada approved, in the first reading, the draft law on green tariffs (tariffs with a special premium) for power based on renewable sources.

To date, legislation on renewable energy has not received broad and effective support in the Verkhovna Rada. This contrasts significantly with countries where renewables are widely used. If Ukraine seriously envisages decreasing its energy import dependence by developing domestic sources, it should consider stronger policies and legislative measures to enhance the production and use of renewables. Such measures will not necessarily require large spending from the state budget if they focus on renewable energy sources that already have a competitive advantage. In this respect, it is important to compare the costs and benefits of supporting renewables with other energy-supply and efficiency options.

Renewable Energy and Environment

Renewable energy policy should be thoroughly integrated into environmental policy to fully realise the benefits of renewable energy and mitigate any negative environmental impacts. Renewable energy is usually more environmentally friendly than conventional energy sources, especially with regard to greenhouse gas emissions and air pollution (IEA, 2002). Renewable energy, however, can potentially cause some negative environmental impacts. For example, large-scale hydropower projects may disturb local ecosystems, reduce biological diversity, modify water quality or lead to methane emissions if old hydrocarbon reservoirs are flooded. Other renewable sources can make land unavailable for competing uses, disrupt flora and fauna, or produce visual and noise pollution. These effects are usually small, reversible and site-specific, and there are many ways to minimise them. Energy and environmental policies should address these issues.

Using renewable energy sources help reduce greenhouse gas emissions. Thus, the Ukrainian ratification of the Kyoto Protocol has increased the attractiveness of renewables and opened new opportunities to finance them. The Kyoto Protocol's joint implementation mechanism (JI) can potentially bring foreign investment into Ukraine's renewable energy sector (Chapter 3: Energy and Environment). Several renewable energy projects are now in the final preparatory stage for JI approval. For example, a project for landfill gas utilisation in Luhansk is expected to reduce methane emissions by 61 700 CO_2 equivalent per year when implemented (Filonenko and Matveev, 2004). Ukrainian experts estimate that the payback period for JI investments in large landfills is approximately 2.5 years. The Kyoto Protocol should be viewed as an important tool that can facilitate financing for renewable energy projects.

Critique

Wider use of renewable energy sources can improve Ukraine's energy security by reducing the country's dependence on oil and gas imports. Renewable energy can also reduce emissions of greenhouse gases and local air pollutants. Additionally, it has social and economic benefits: using renewable energy creates jobs and contributes to local and regional economic development.

Ukraine has significant potential for renewable energy, particularly biomass, but the current use of renewables is quite small. The future prospects of renewable energy in Ukraine will depend to a large extent on government policy. International experience demonstrates that countries with wide-scale use of renewable energy (*e.g.* Germany or Brazil) typically have targeted governmental policies to support them.

In recent years, Ukraine has adopted a large number of laws and programmes related to renewable energy. However, the existing legislation is not effectively enforced and many provisions are not implemented in practice. If Ukraine wants to strengthen energy security through wider use of renewable energy, it will have to develop a more comprehensive policy and ensure it is properly implemented.

Subsidies for fossil fuels and other price distortions are the most important constraints on more extensive use of renewables. The recent price increases for oil and gas will certainly make some renewables more economically attractive. The government should enhance its efforts to eliminate subsidies and cross-subsidies in order to create a level playing field for all energy sources. Given the capital intensity of many renewable energy technologies, another key area for improvement is facilitating financing for renewable energy developers through mechanisms like loan guarantees.

One reason for Ukraine's lacklustre performance in promoting renewables is that its policy goals were not based on a solid cost-benefit analysis. Worldwide, there are three groups of policies that affect technology and market development of renewables (IEA, 2004b):

- **Research and innovation policies** support the development of renewable energy technologies from basic and applied research up to the demonstration phase, either by providing budget financing or attracting private financing.

- **Market deployment policies** facilitate introducing technologies into the market by enhancing public awareness, improving technology cost-competitiveness and technical performance, and encouraging producers and end users of these technologies. Such policy support is generally introduced for a limited time as is necessary to make new technologies competitive.
- **Market-based energy policies** provide a competitive market framework, and may internalise some externalities that reflect aspects such as energy security, environmental protection and economic efficiency.

Ukraine needs to carefully consider each of these policies. To adopt realistic policies, not just political declarations, it is important to evaluate costs and benefits – both direct and indirect – of various policy options. This requires more rigorous efforts to collect and analyse information on energy markets, technology costs and energy demand patterns.

Recommendations

The government of Ukraine should:

- Conduct a comprehensive cost-benefit analysis of policy options in order to develop realistic policies to support renewable energy.
- Focus on facilitating renewable energy development in areas in which they have a competitive advantage (*e.g.* biomass) rather than subsidising more expensive options. Let other countries with more advanced technologies perfect their cost-effectiveness.
- Facilitate access to financing for potential developers and users of renewable energy sources.
- Continue efforts to create a level playing field for renewable energy by removing subsidies and cross-subsidies for fossil fuels.
- Adopt policies to help renewable energy enter the energy market through fiscal incentives, increased awareness, improved regulations for renewable energy planning and integration into energy systems.

ANNEX I

ENERGY BALANCES AND KEY STATISTICAL DATA

Unit: Mtoe

SUPPLY		1993	1995	1997	1999	2001	2003	2004
TOTAL PRODUCTION		**91.87**	**76.04**	**71.46**	**71.76**	**71.99**	**75.54**	**76.29**
Coal[1]		51.22	37.20	30.32	32.48	31.75	33.19	30.83
Oil		4.27	4.11	4.12	3.81	3.72	3.98	4.33
Gas		15.56	15.23	15.20	15.17	15.38	16.09	17.17
Combustible Renewables & Waste[2]		0.27	0.26	0.26	0.26	0.26	0.26	0.26
Nuclear		19.61	18.38	20.70	18.78	19.85	21.21	22.68
Hydro		0.95	0.86	0.85	1.25	1.03	0.79	1.01
Geothermal		-	-	-	-	-	-	-
Solar/Wind/Other[3]		-	-	-	0.00	0.00	0.00	0.00
TOTAL NET IMPORTS[4]		**90.42**	**82.50**	**69.19**	**59.85**	**58.01**	**65.46**	**64.30**
Coal[1]	Exports	1.60	1.24	1.44	1.39	2.76	3.05	3.92
	Imports	5.31	9.58	5.38	3.06	4.22	7.01	6.38
	Net Imports	3.71	8.34	3.94	1.67	1.46	3.96	2.45
Oil	Exports	0.37	1.47	1.43	4.53	5.67	11.12	9.88
	Imports	25.31	22.65	15.58	13.66	15.59	24.06	23.51
	Bunkers	-	-	-	-	-	-	-
	Net Imports	24.94	21.18	14.15	9.13	9.92	12.94	13.62
Gas	Exports	0.15	-	1.18	0.91	0.85	1.68	3.42
	Imports	62.06	53.24	52.29	50.26	47.74	50.67	52.10
	Net Imports	61.91	53.24	51.11	49.35	46.89	49.00	48.68
Electricity	Exports	1.49	1.09	0.85	0.89	0.45	1.05	0.65
	Imports	1.36	0.84	0.84	0.60	0.18	0.62	0.19
	Net Imports	-0.13	-0.25	-0.01	-0.30	-0.26	-0.42	-0.46
TOTAL STOCK CHANGES		**4.15**	**-**	**-**	**-**	**-**	**-**	**-0.25**
TOTAL SUPPLY (TPES)		**186.44**	**158.54**	**140.65**	**131.61**	**130.01**	**141.00**	**140.33**
Coal[1]		56.13	45.54	34.26	34.15	33.21	37.15	33.15
Oil		29.20	25.29	18.27	12.94	13.64	16.92	17.83
Gas		80.41	68.46	66.31	64.52	62.27	65.09	65.85
Combustible Renewables & Waste[2]		0.27	0.26	0.26	0.26	0.26	0.26	0.26
Nuclear		19.61	18.38	20.70	18.78	19.85	21.21	22.68
Hydro		0.95	0.86	0.85	1.25	1.03	0.79	1.01
Geothermal		-	-	-	-	-	-	-
Solar/Wind/Other[3]		-	-	-	0.00	0.00	0.00	0.00
Electricity Trade[5]		-0.13	-0.25	-0.01	-0.30	-0.26	-0.42	-0.46
Shares (%)								
Coal		*30.1*	*28.7*	*24.4*	*26.0*	*25.5*	*26.3*	*23.6*
Oil		*15.7*	*16.0*	*13.0*	*9.8*	*10.5*	*12.0*	*12.7*
Gas		*43.1*	*43.2*	*47.1*	*49.0*	*47.9*	*46.2*	*46.9*
Combustible Renewables & Waste		*0.1*	*0.2*	*0.2*	*0.2*	*0.2*	*0.2*	*0.2*
Nuclear		*10.5*	*11.6*	*14.7*	*14.3*	*15.3*	*15.0*	*16.2*
Hydro		*0.5*	*0.5*	*0.6*	*0.9*	*0.8*	*0.6*	*0.7*
Geothermal		-	-	-	-	-	-	-
Solar/Wind/Other		-	-	-	-	-	-	-
Electricity Trade		*-0.1*	*-0.2*	-	*-0.2*	*-0.2*	*-0.3*	*-0.3*

0 is negligible, – is nil, .. is not available

Unit: Mtoe

DEMAND

FINAL CONSUMPTION BY SECTOR

	1993	1995	1997	1999	2001	2003	2004
TFC	**109.84**	**93.46**	**85.28**	**76.67**	**75.22**	**76.78**	**84.63**
Coal[1]	16.03	12.04	9.55	9.44	9.84	11.05	11.15
Oil	21.01	19.91	15.57	11.01	12.28	13.41	14.55
Gas	33.95	29.80	32.23	31.47	30.04	29.44	35.88
Combustible Renewables & Waste[2]	0.27	0.26	0.26	0.26	0.26	0.26	0.26
Geothermal	-	-	-	-	-	-	-
Solar/Wind/Other	-	-	-	-	-	-	-
Electricity	14.90	12.34	10.68	9.90	9.26	9.82	10.32
Heat	23.68	19.10	16.99	14.59	13.53	12.80	12.47
Shares (%)							
Coal	*14.6*	*12.9*	*11.2*	*12.3*	*13.1*	*14.4*	*13.2*
Oil	*19.1*	*21.3*	*18.3*	*14.4*	*16.3*	*17.5*	*17.2*
Gas	*30.9*	*31.9*	*37.8*	*41.1*	*39.9*	*38.3*	*42.4*
Combustible Renewables & Waste	*0.2*	*0.3*	*0.3*	*0.3*	*0.3*	*0.3*	*0.3*
Geothermal	-	-	-	-	-	-	-
Solar/Wind/Other	-	-	-	-	-	-	-
Electricity	*13.6*	*13.2*	*12.5*	*12.9*	*12.3*	*12.8*	*12.2*
Heat	*21.6*	*20.4*	*19.9*	*19.0*	*18.0*	*16.7*	*14.7*
TOTAL INDUSTRY[6]	**56.13**	**42.85**	**37.16**	**34.01**	**34.75**	**34.60**	**41.54**
Coal[1]	10.00	6.87	6.33	6.40	7.23	7.95	8.02
Oil	8.00	6.81	3.68	2.27	3.17	3.86	4.49
Gas	17.22	12.78	12.45	12.53	12.25	10.63	16.69
Combustible Renewables & Waste[2]	-	-	-	-	-	-	-
Geothermal	-	-	-	-	-	-	-
Solar/Wind/Other	-	-	-	-	-	-	-
Electricity	8.18	6.12	5.57	4.97	4.83	5.26	5.62
Heat	12.73	10.27	9.13	7.84	7.28	6.89	6.71
Shares (%)							
Coal	*17.8*	*16.0*	*17.0*	*18.8*	*20.8*	*23.0*	*19.3*
Oil	*14.2*	*15.9*	*9.9*	*6.7*	*9.1*	*11.2*	*10.8*
Gas	*30.7*	*29.8*	*33.5*	*36.8*	*35.2*	*30.7*	*40.2*
Combustible Renewables & Waste	-	-	-	-	-	-	-
Geothermal	-	-	-	-	-	-	-
Solar/Wind/Other	-	-	-	-	-	-	-
Electricity	*14.6*	*14.3*	*15.0*	*14.6*	*13.9*	*15.2*	*13.5*
Heat	*22.7*	*24.0*	*24.6*	*23.1*	*20.9*	*19.9*	*16.2*
TRANSPORT[7]	**13.66**	**13.09**	**14.06**	**11.84**	**11.75**	**11.99**	**12.73**
TOTAL OTHER SECTORS[8]	**40.04**	**37.52**	**34.06**	**30.82**	**28.72**	**30.20**	**30.36**
Coal[1]	6.02	5.17	3.22	3.03	2.62	3.10	3.06
Oil	4.79	5.80	3.35	2.42	2.50	2.94	3.14
Gas	12.31	12.17	15.09	14.25	13.40	14.25	14.27
Combustible Renewables & Waste[2]	0.27	0.26	0.26	0.26	0.26	0.26	0.26
Geothermal	-	-	-	-	-	-	-
Solar/Wind/Other	-	-	-	-	-	-	-
Electricity	5.70	5.29	4.28	4.11	3.68	3.74	3.86
Heat	10.95	8.83	7.85	6.74	6.26	5.92	5.76
Shares (%)							
Coal	*15.0*	*13.8*	*9.5*	*9.8*	*9.1*	*10.3*	*10.1*
Oil	*12.0*	*15.4*	*9.8*	*7.9*	*8.7*	*9.7*	*10.3*
Gas	*30.7*	*32.4*	*44.3*	*46.2*	*46.7*	*47.2*	*47.0*
Combustible Renewables & Waste	*0.7*	*0.7*	*0.8*	*0.8*	*0.9*	*0.9*	*0.9*
Geothermal	-	-	-	-	-	-	-
Solar/Wind/Other	-	-	-	-	-	-	-
Electricity	*14.2*	*14.1*	*12.6*	*13.3*	*12.8*	*12.4*	*12.7*
Heat	*27.3*	*23.5*	*23.1*	*21.9*	*21.8*	*19.6*	*19.0*

Unit: Mtoe

DEMAND

ENERGY TRANSFORMATION AND LOSSES

	1993	1995	1997	1999	2001	2003	2004
ELECTRICITY GENERATION[9]							
INPUT (Mtoe)	**96.10**	**78.21**	**69.24**	**65.07**	**63.39**	**70.43**	**62.91**
OUTPUT (Mtoe)	**19.75**	**16.67**	**15.29**	**14.80**	**14.86**	**15.50**	**15.65**
(TWh gross)	229.71	193.82	177.83	172.12	172.80	180.20	182.02
Output Shares (%)							
Coal	*38.0*	*36.0*	*31.1*	*31.3*	*30.8*	*30.4*	*24.7*
Oil	*7.4*	*5.4*	*1.1*	*0.7*	*0.5*	*0.3*	*0.3*
Gas	*17.1*	*17.1*	*17.6*	*17.7*	*17.6*	*19.0*	*20.7*
Combustible Renewables & Waste	-	-	-	-	-	-	-
Nuclear	*32.8*	*36.4*	*44.7*	*41.9*	*44.1*	*45.2*	*47.8*
Hydro	*4.8*	*5.1*	*5.5*	*8.4*	*7.0*	*5.1*	*6.5*
Geothermal	-	-	-	-	-	-	-
Solar/Wind/Other[3]	-	-	-	*0.00*	*0.00*	*0.00*	*0.00*
TOTAL LOSSES	76.48	64.65	54.59	54.47	54.16	63.25	55.62
of which:							
Electricity and Heat Generation[10]	44.52	35.87	31.12	30.66	30.34	37.71	30.47
Other Transformation	12.85	12.06	8.81	10.01	9.73	11.62	11.67
Own Use and Losses[11]	19.10	16.71	14.66	13.80	14.09	13.91	13.47
Statistical Differences	**0.13**	**0.43**	**0.78**	**0.47**	**0.62**	**0.97**	**0.08**

INDICATORS

	1993	1995	1997	1999	2001	2003	2004
GDP (billion 2000 USD)	51.04	34.54	30.15	29.52	34.14	39.29	44.04
Population (millions)	52.18	51.51	50.59	49.67	48.68	47.81	47.45
TPES/GDP[12]	3.65	4.59	4.66	4.46	3.81	3.59	3.19
Energy Production/TPES	0.49	0.48	0.51	0.55	0.55	0.54	0.54
Per Capita TPES[13]	3.57	3.08	2.78	2.65	2.67	2.95	2.96
Oil Supply/GDP[12]	0.57	0.73	0.61	0.44	0.40	0.43	0.40
TFC/GDP[12]	2.15	2.71	2.83	2.60	2.20	1.95	1.92
Per Capita TFC[13]	2.11	1.81	1.69	1.54	1.55	1.61	1.78
Energy-related CO_2 Emissions (Mt CO_2)[14]	462.2	377.3	316.5	293.3	289.7	315.5	304.8
CO_2 Emissions from Bunkers (Mt CO_2)	1.0	0.5	0.9	0.9	0.8	1.1	1.1

Note: Rounding may cause totals to differ from the sum of the elements.

Energy Balance 2004

SUPPLY AND CONSUMPTION	Coal	Crude Oil	Petroleum Products	Gas	Nuclear	Hydro	Geotherm., Solar, etc.	Combust. Renew. & Waste	Electricity	Heat	Total
Thousand tonnes of oil equivalent											
Production	30 831	4 330	-	17 173	22 678	1 011	2	262	-	-	76 287
Imports	6 377	22 131	1 375	52 100	-	-	-	-	189	-	82 172
Exports	-3 923	-482	-9 401	-3 420	-	-	-	-	-647	-	-17 873
Intl. Marine Bunkers	-	-	-	-	-	-	-	-	-	-	-
Stock Changes	-135	-	-118	-	-	-	-	-	-	-	-254
TPES	**33 150**	**25 979**	**-8 145**	**65 854**	**22 678**	**1 011**	**2**	**262**	**-458**	**-**	**140 333**
Transfers	-	-	-	-	-	-	-	-	-	-	-
Statistical Differences	-85	-	-	-	-	-	-	-	-	-	-85
Electricity Plants	-12 736	-	-147	-3 326	-22 678	-1 011	-2	-	13 447	-	-26 454
CHP Plants	-115	-	-7	-5 261	-	-	-	-	2 207	2 208	-968
Heat Plants	-	-	-1	-17 624	-	-	-	-	-	14 572	-3052
Gas Works	-	-	-	-	-	-	-	-	-	-	-
Petroleum Refineries	-	-25 979	23 298	-	-	-	-	-	-	-	-2681
Coal Transformation	-8 992	-	-	-	-	-	-	-	-	-	-8 992
Liquefaction Plants	-	-	-	-	-	-	-	-	-	-	-
Other Transformation	-	-	-	-	-	-	-	-	-	-	-
Own Use	-75	-	-447	-1272	-	-	-	-	-2 523	-111	-4 429
Distribution Losses	-	-	-	-2 495	-	-	-	-	-2 349	-4 195	-9 039
TFC	**11 147**	**-**	**14 550**	**35 877**	**-**	**-**	**-**	**262**	**10 323**	**12 474**	**84 632**
INDUSTRY SECTOR	**8 015**	**-**	**1 956**	**11 243**	**-**	**-**	**-**	**-**	**5 621**	**6 712**	**33547**
Iron and Steel	6 815	-	-	6 566	-	-	-	-	2 294	-	15 675
Chemical and Petrochemical	25	-	-	593	-	-	-	-	571	-	1 190
Non-Ferrous Metals	28	-	-	184	-	-	-	-	331	-	544
Non-Metallic Minerals	149	-	-	2 146	-	-	-	-	273	-	2 567
Transport Equipment	25	-	-	104	-	-	-	-	145	-	274
Machinery	129	-	-	296	-	-	-	-	374	-	798
Mining and Quarrying	97	-	-	416	-	-	-	-	767	-	1 280
Food and Tobacco	49	-	-	318	-	-	-	-	341	-	708
Paper Pulp and Printing	1	-	-	24	-	-	-	-	82	-	107
Wood and Wood Products	1	-	-	30	-	-	-	-	32	-	63
Construction	10	-	-	51	-	-	-	-	87	-	148
Textile and Leather	1	-	-	9	-	-	-	-	44	-	54
Non-specified	686	-	1 956	508	-	-	-	-	279	6 712	10 141
TRANSPORT SECTOR	**59**	**-**	**6 919**	**4 915**	**-**	**-**	**-**	**-**	**840**	**-**	**12 733**
International Aviation	-	-	384	-	-	-	-	-	-	-	384
Domestic Aviation	-	-	6	-	-	-	-	-	-	-	6
Road	-	-	4 476	50	-	-	-	-	-	-	4 525
Rail	58	-	2 052	-	-	-	-	-	423	-	2 533
Pipeline Transport	-	-	-	4 835	-	-	-	-	48	-	4 883
Domestic Navigation	-	-	-	-	-	-	-	-	-	-	-
Non-specified	1	-	-	31	-	-	-	-	369	-	401
OTHER SECTORS	**3 064**	**-**	**3 142**	**14 269**	**-**	**-**	**-**	**262**	**3 863**	**5 762**	**30361**
Residential	2 555	-	544	13 321	-	-	-	-	2 084	5 762	24 265
Comm. and Public Services	416	-	-	843	-	-	-	-	1 505	-	2 764
Agriculture/Forestry	35	-	2 570	105	-	-	-	-	270	-	2 979
Fishing	-	-	-	-	-	-	-	-	4	-	4
Non-specified	59	-	29	-	-	-	-	262	-	-	349
NON-ENERGY USE	**9**	**-**	**2 532**	**5 450**	**-**	**-**	**-**	**-**	**-**	**-**	**7 991**
in Industry/Transf./Energy	9	-	2 532	5 450	-	-	-	-	-	-	**7 991**
of which: Feedstocks	*9*	-	-	*5 215*	-	-	-	-	-	-	*5 224*
in Transport	-	-	-	-	-	-	-	-	-	-	-
in Other Sectors	-	-	-	-	-	-	-	-	-	-	-
Electr. Generated - GWh	***45 035***	-	***574***	***37 613***	***87 022***	***11 751***	***25***	-	-	-	***182 020***
Electricity Plants	*44 632*	-	*549*	*12 379*	-	-	-	-	-	-	*156 358*
CHP Plants	*403*	-	*25*	*25 234*	-	-	-	-	-	-	*25 662*
Heat Generated - TJ	***2514***	-	***168***	***699 997***	-	-	-	-	-	-	***702 679***
CHP Plants	*2514*	-	*135*	*89 799*	-	-	-	-	-	-	*92 448*
Heat Plants	-	-	*33*	*610 198*	-	-	-	-	-	-	*610 231*

Notes to Energy Balances and Key Statistical Data

1 *Includes lignite.*

2 *Comprises solid biomass, liquid biomass, biogas, industrial waste and municipal waste. Data are often based on partial surveys and may not be comparable between countries.*

3 *Other includes ambient heat used in heat pumps.*

4 *Total net imports include combustible renewables and waste.*

5 *Total supply of electricity represents net trade. A negative number indicates that exports are greater than imports.*

6 *Includes non-energy use.*

7 *Includes less than 1% non-oil fuels.*

8 *Includes residential, commercial, public service and agricultural sectors.*

9 *Inputs to electricity generation include inputs to electricity, combined heat and power (CHP) and heat plants. Output refers only to electricity generation.*

10 *Losses arising in the production of electricity and heat at main activity producer utilities (formerly known as public) and autoproducers. For non-fossil-fuel electricity generation, theoretical losses are shown based on plant efficiencies of approximately 33% for nuclear, 10% for geothermal and 100% for hydro.*

11 *Data on "losses" often include large statistical differences covering differences between expected supply and demand and mostly do not reflect real expectations on transformation gains and losses.*

12 *Toe per thousand USD at 2000 prices and exchange rates.*

13 *Toe per person.*

14 *"Energy-related CO_2 emissions" have been estimated using the IPCC Tier I Sectoral Approach. In accordance with the IPCC methodology, emissions from international marine and aviation bunkers are not included in national totals. Projected emissions for oil and gas are derived by calculating the ratio of emissions to energy use for 2004 and applying this factor to forecast energy supply. Future coal emissions are based on product-specific supply projections and are calculated using the IPCC/OECD emission factors and methodology.*

ANNEX II

INTERNATIONAL ENERGY AGENCY "SHARED GOALS"

The 26 member countries* of the International Energy Agency (IEA) seek to create the conditions in which the energy sectors of their economies can make the fullest possible contribution to sustainable economic development and the well-being of their people and of the environment. In formulating energy policies, the establishment of free and open markets is a fundamental point of departure, though energy security and environmental protection need to be given particular emphasis by governments. IEA countries recognise the significance of increasing global interdependence in energy. They therefore seek to promote the effective operation of international energy markets and encourage dialogue with all participants.

In order to secure their objectives they therefore aim to create a policy framework consistent with the following goals:

1. **Diversity, efficiency and flexibility within the energy sector** are basic conditions for longer-term energy security: the fuels used within and across sectors and the sources of those fuels should be as diverse as practicable. Non-fossil fuels, particularly nuclear and hydro power, make a substantial contribution to the energy supply diversity of IEA countries as a group.

2. Energy systems should have **the ability to respond promptly and flexibly to energy emergencies.** In some cases this requires collective mechanisms and action: IEA countries co-operate through the Agency in responding jointly to oil supply emergencies.

3. **The environmentally sustainable provision and use of energy** is central to the achievement of these shared goals. Decision-makers should seek to minimise the adverse environmental impacts of energy activities, just as environmental decisions should take account of the energy consequences. Government interventions should where practicable have regard to the Polluter Pays principle.

4. **More environmentally acceptable energy sources** need to be encouraged and developed. Clean and efficient use of fossil fuels is essential. The development

** Australia, Austria, Belgium, Canada, the Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Japan, Korea, Luxembourg, the Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, the United Kingdom and the United States.*

of economic non-fossil sources is also a priority. A number of IEA members wish to retain and improve the nuclear option for the future, at the highest available safety standards, because nuclear energy does not emit carbon dioxide. Renewable sources will also have an increasingly important contribution to make.

5. **Improved energy** efficiency can promote both environmental protection and energy security in a cost-effective manner. There are significant opportunities for greater energy efficiency at all stages of the energy cycle from production to consumption. Strong efforts by governments and all energy users are needed to realise these opportunities.

6. Continued **research, development and market deployment of new and improved energy technologies** make a critical contribution to achieving the objectives outlined above. Energy technology policies should complement broader energy policies. International co-operation in the development and dissemination of energy technologies, including industry participation and co-operation with non-member countries, should be encouraged.

7. **Undistorted energy prices** enable markets to work efficiently. Energy prices should not be held artificially below the costs of supply to promote social or industrial goals. To the extent necessary and practicable, the environmental costs of energy production and use should be reflected in prices.

8. **Free and open trade** and a secure framework for investment contribute to efficient energy markets and energy security. Distortions to energy trade and investment should be avoided.

9. **Co-operation among all energy market participants** helps to improve information and understanding, and encourage the development of efficient, environmentally acceptable and flexible energy systems and markets worldwide. These are needed to help promote the investment, trade and confidence necessary to achieve global energy security and environmental objectives.

(The Shared Goals were adopted by IEA Ministers at their 4 June 1993 meeting in Paris.)

ANNEX III

ABBREVIATIONS, UNITS, PROPER NAMES AND TRANSLITERATED WORDS

Abbreviations

AES	An international power company; www.aes.com
ARENA-ECO	Agency for Rational Energy Use and Ecology; www.arena-eco.kiev.ua
BPS	Baltic Pipeline System
CEZ	Czech electricity company; www.cez.cz
CH_4	Methane
CHP	Combined heat and power, also known as cogeneration
CIS	Commonwealth of Independent States (includes all countries of the former Soviet Union with the exception of Estonia, Latvia and Lithuania)
CNG	Compressed natural gas
CO_2	Carbon dioxide
DSTU	State Technical Standard of Ukraine (Ukrainian abbreviation)
EBRD	European Bank for Reconstruction and Development; www.ebrd.com
EC	European Commission
ENPEP	Energy and Power Evaluation Program
EPA	Environmental Protection Agency (US government agency); www.epa.gov
ESCO	Energy service company
EU	European Union; http://europa.eu
EUR	Euro, currency of the European Union

G-7	Group of Seven (Canada, France, Germany, Italy, Japan, the United Kingdom and the United States)
G-8	Group of Eight (includes G7 and Russia)
GATT	General Agreement of Tariffs and Trade; www.gatt.org
GDP	Gross domestic product
Genco	Generation company
GHG	Greenhouse gas
GTS	Gas transmission system
IAEA	International Atomic Energy Agency; www.iaea.org
IEA	International Energy Agency; www.iea.org
IMF	International Monetary Fund; www.imf.org
INOGATE	Interstate Oil and Gas Transport to Europe; www.inogate.org
IPCC	Intergovernmental Panel on Climate Change; www.ipcc.ch
IPS/UPS	Integrated Power System/United Power System: the power systems of the Baltic States (Estonia, Latvia and Lithuania), Armenia, Azerbaijan, Belarus, Georgia, Moldova, Kazakhstan, Kyrgyzstan, Russia, Tajikistan, Ukraine and Uzbekistan
JI	Joint implementation (a Kyoto Protocol mechanism)
KyivZNIIEP	Ukrainian State Zonal Scientific and Research Design Institute of Civil Engineering (Ukrainian abbreviation), www.zniiep.com.ua
LIBOR	London Interbank Offered Rates (international benchmark for interest rates)
LNG	Liquefied natural gas
LPG	Liquid petroleum gas
MAC	Maximum allowable concentration
MOL	Magyar Olaj-és Gázipari, Rt. (Hungarian oil and gas company)
MOU	Memorandum of Understanding

NERC	National Energy Regulatory Committee (of Ukraine)
NGL	Natural gas liquids
NGO	Non-governmental organisation
NIS	Newly independent states (all states of the former Soviet Union)
NO_X	Nitrogen oxides
N_2O	Nitrous oxide
NPP	Nuclear power plant
NSS	National Strategy Studies (World Bank programme); www.worldbank.org/nss/
OECD	Organisation for Economic Co-operation and Development; www.oecd.org
OSART	Operational Safety Review Team
PEER	Partnership for Energy and Environmental Reform; www.peer.org.ua
PFC	Perfluorocarbon
PPP	Purchasing power parity
PSA	Production sharing agreement
RAO UES	Russian joint stock company - United Energy Systems; www.rao-ees.ru
RBMK	Channelised large power reactor (Russian abbreviation for type of nuclear reactor); Chornobyl reactors were of this type
RD&D	Research, development and demonstration
SCADA	Supervisory Control and Data Acquisition
SDR	Special Drawing Right
SkhidGZK	Eastern Mining and Enrichment Combine (Ukrainian abbreviation)
SNRC	State Nuclear Regulatory Committee
SO_2	Sulphur dioxide
SolarPACES	Concentrating Solar Power and Chemical Energy Systems (an IEA Implementing Agreement); www.solarpaces.org

TACIS	Technical Aid to the Commonwealth of Independent States (European Union programme); http://ec.europa.eu/comm/external_relations/ceeca/tacis/index.htm
TFC	Total final consumption
TNK-BP	Tiumenskayia Neftianaya Kompaniya-British Petroleum (a Russian-British oil company); www.tnk-bp.com
TPES	Total primary energy supply
Track I JI	Fast track of the joint implementation (JI) mechanism, which is associated with lower transactions costs
TVEL	Russian nuclear fuel company; www.tvel.ru
UAE	United Arab Emirates
UAH	Hryvnia (Ukrainian currency); approximate exchange rates in the first half of 2006: USD 1 = UAH 5; EUR 1= UAH 6.4
UCTE	Union for the Co-ordination of Transmission of Electricity; www.ucte.org
UGS	Underground gas storage
UkrESCO	Ukrainian Energy Service Company
UN	United Nations; www.un.org
UNFCCC	United Nations' Framework Convention on Climate Change; http://unfccc.int
US	United States
USA	United States of America
USAID	United States Agency for International Development; www.usaid.gov
USD	United States dollars
USGS	United States Geological Survey; www.usgs.gov
VAT	Value-added tax
VINOC	Vertically integrated national oil company
VVER	Pressurised water reactor (Russian abbreviation)
WEC	World Energy Council; www.worldenergy.org
WEO	*World Energy Outlook* (IEA publication)

WEM	Wholesale Electricity Market (of Ukraine)
WTO	World Trade Organisation; www.wto.org
ZhEK	Housing maintenance company (Ukrainian abbreviation)

Units*

This book uses the following codes for complex unit signs:

k	kilo or 10^3
M	mega or 10^6
G	giga or 10^9
T	tera or 10^{12}
P	peta or 10^{15}

b	barrel; equivalent to 159 litres (l)
bcm	billion cubic metres
b/d	barrel per day
cal	calorie, equivalent to 4.1868 joules (J)
Gcal	gigacalorie
GW	gigawatt
GWh	gigawatt-hour
J	joule; equivalent to 0.2388 calories (cal)
kV	kilovolt
kWh	kilowatt-hour
l	litre
m^3	cubic metres

* *See IEA unit converter: www.iea.org/Textbase/stats/unit.asp.*

Mb	million barrels
Mb/d	million barrels per day
Mcm	million cubic metres
MPa	megapascal
Mt	million tonnes
Mtoe	million tonnes of oil equivalent; equivalent to 1.4285 million of tonnes of coal equivalent (Mtce); Mtce are known in Ukraine as “the reference fuel”.
MW	megawatt
MWh	megawatt-hour
Pa	pascal
t	tonne
t CO_2	tonne of carbon dioxide
TJ	terajoule
toe	tonne of oil equivalent
TW	terawatt
TWh	terawatt-hour
V	volt
W	watt

Proper Names

Ivchenko, Olexiy	Chairman of the Board, Naftogaz of Ukraine (March 2005-May 2006)
Kuchma, Leonid	President of Ukraine (1994-2005)
Tymoshenko, Yulia	Vice prime minister for fuel and energy (January 2000-February 2001); Prime minister of Ukraine (February-September 2005)

Yanukovych, Viktor	Prime minister of Ukraine (November 2002-December 2004 and from 4 August 2006)
Yekhanurov, Viktor	Prime minister of Ukraine (September 2005-July 2006)
Yushchenko, Viktor	Prime minister of Ukraine (1999-2001); President of Ukraine (January 2005 to present)

Frequently Used, Transliterated Ukrainian Words

Derzhkomreserv	State Committee on Material Reserves of Ukraine
Derzhkomstat	State Statistics Committee of Ukraine
Oblenergo	Regional power supply/distribution company
Oblgaz	Regional gas supply/distribution company
Teplokomunenergo	Local heat supply company
Verkhovna Rada	“Supreme Council”, Ukrainian Parliament

ANNEX IV

BIBLIOGRAPHY

Alliance to Save Energy (2006), "MUNEE in Ukraine: Success Stories", Alliance to Save Energy, www.ase.org/content/article/detail/1163.

ARENA-ECO (2006), "Dnipropetrovsk Oblast to Allocate 236 Million hrn. for Energy Conservation", ARENA-ECO, 7 February 2006, www.arena-eco.kiev.ua/news/newsdetail.php?type=ukr&id=468&offset=0&lang=en.

Babiyev, G. (2002), "ST Ukrtransgaz Represents Investment Project", *Ukrainian Investment Magazine*, No.2, 2002, Kyiv.

Baysarov, L. *et al.* (2003), "Outcome and Prospects of Ukraine's Coal Industry Restructuring: The Expert View", *National Security and Defence*, No. 8 (44), Ukrainian Centre for Economic & Political Studies Named after Olexander Razumkov (Razumkov Centre), Kyiv.

Bernadsky, V. (2005), "Диверсификация по-украински..." (Diversification, Ukrainian Style...), *Energobusiness*, No.37, 13 September 2005, Kyiv.

Biomass (2004), *Resolution of the First International Conference on Cogeneration for Industry and District Heating Systems*, 18-20 October 2004, Kyiv, Ukraine, www.biomass.kiev.ua.

Brunello, A. and B. Kostukovsky (2001), *Ukraine and the International Greenhouse Gas Emissions Trading Market*, August 2001, quoted in National Strategy Studies (2003).

Cabinet of Ministers (1997), *Про Комплексну державну програму енергозбереження України (On the Comprehensive State Programme on Energy Conservation of Ukraine)*, Decree No. 148, 5 February 1997, Cabinet of Ministers, Kyiv.

Cabinet of Ministers (1998), *Про Міжвідомчу комісію із забезпечення виконання Рамкової конвенції ООН про зміну клімату (On the Interministerial Commission on Ensuring the Implementation of UNFCCC)*, Decree No. 583, 14 April 1999, Cabinet of Ministers, Kyiv.

Cabinet of Ministers (2001), *Про забезпечення споживачів природним газом (On Ensuring Natural Gas Supply to End-Users)*, Decree No. 1729, 27 December 2001, Cabinet of Ministers, Kyiv.

Cabinet of Ministers (2005), *Про заходи щодо проведення у 2005 році розрахунків з погашення зобов'язань держави за знеціненими грошовими заощадженнями громадян в установах Ощадного банку колишнього СРСР шляхом погашення заборгованості за житлово-комунальні послуги (On Cross-cancellation of Debts)*, Decree No. 664, 29 July 2005, Cabinet of Ministers, Kyiv.

Cabinet of Ministers (2006a), *Енергетична стратегія України на період до 2030 року (Energy Strategy of Ukraine to 2030)*, Decree No. 145, 15 March 2006, Cabinet of Ministers, Kyiv.

Cabinet of Ministers (2006b), *Про внесення змін до постанови Кабінету Міністрів України від 27 грудня 2001 р.* No 1729 *(On Making Modifications to the Cabinet of Ministers' Decree No. 1729 from 27 December 2001)*, Decree No. 244, 2 March 2006, Cabinet of Ministers, Kyiv.

Chernobyl Forum (2005), *Chernobyl's Legacy: Health, Environmental and Socio-economic Impacts and Recommendations to the Governments of Belarus, the Russian Federation and Ukraine*, International Atomic Energy Agency, Vienna.

Consortium of Ukrainian Environmental Organisations (Mama-86 *et al.*) (2006), *Концепція «неатомного» шляху розвитку енергетики України (Strategy for the Non-Nuclear Development of Ukrainian Energy Sector)*, All-Ukrainian Environmental Non-Governmental Organisation "Mama-86", Kyiv.

Danilova, M. (2005), "Ukrainian Officials, NGOs Warn Chornobyl is still a Problem", Associated Press, 5 September 2005.

Danilova, M. (2006), "Ukraine Wants to Produce Own Nuclear Fuel," Associated Press, 13 January 2006.

DHCAN (District Heating in Candidate Countries) (2005), *District Heating System Modernisation and Rehabilitation Guide*, Euroheat and Power, Brussels.

Diak, I.V. and Z.N. Osinchuk (2000), *Газова промисловість України на зламі століть (Gas Industry of Ukraine at the Turn of Centuries)*, Lilea-NB, Ivano-Frankivsk.

Diak, I.V. (2001) *Енергетична безпека України (Energy Security of Ukraine)*, Ukrpoligraphservice, Kyiv.

Diukanov, V. (2005), "Надо что-то делать с этим углеродом" (Something Must be Done with This Carbon), *Zerkalo Nedeli*, No. 25 (553), 2-8 June 2005, Kyiv.

Dubovik, V., B. Piriashvili, V. Sanzharovskaya (2005), "Энергообеспечение и энергосбережение Киева на период до 2010 года" (Energy Supply and Energy Efficiency in Kyiv to 2010), *Energy Policy of Ukraine* No.1, 2005, Kyiv.

Energobusiness (2005 and 2006), weekly bulletin *Energobusiness*, various editions, Information and Analysis Centre Energobusiness, Kyiv.

Energorynok (2005a), *Аналіз цін, що склалися в ОРЕ з 01 по 10.09.2005 (Analysis of Prices on the WEM, 1-10 September 2005)*, Energorynok, Kyiv, www.er.gov.ua/catforms.php?f=371.

Energorynok (2005b), *Звіт ДП Енергоринок на щорічних Загальних зборах членів Оптового ринку електричної енергії України (Report of the State Enterprise Energorynok for the Annual General Meeting of Members of the Wholesale Electricity Market of Ukraine)*, Energorynok, Kyiv, www.er.gov.ua.

Energy Charter Secretariat (2002), *Ukraine: Investment Climate and Market Structure in the Energy Sector*, Energy Charter Secretariat, Brussels.

Energy Charter Secretariat (2005), *In-depth Report on the Investment Climate and Market Structure in the Energy Sector of Uzbekistan*, Energy Charter Secretariat, Brussels.

EBRD (European Bank for Reconstruction and Development) (2005), *Ukraine - Latest Developments: Renewable Development Initiative*, EBRD, London, www.ebrdrenewables.com/sites/renew/countries/Ukraine/default.aspx.

European Business Association (2005), *Barriers to Investment in Ukraine*, European Business Association, February 2005, Kyiv.

Filippov, A., A. Pisarenko and J. Triplett (2000), *Coal Mine Methane in Ukraine: Opportunities for Production and Investment in the Donetsk Coal Basin*, Partnership for Energy and Environmental Reform (PEER), Donetsk.

Filippov, A., A. Pisarenko and J. Triplett (2002), *Coal Mine Methane Recovery in Ukraine: Inventory of Methane Emissions from Coal Mines in Ukraine: 1990-2001*, PEER, Donetsk.

Filonenko A., and I.B. Matveev (2004), "Перспективы проектов совместного внедрения с использованием биомассы в Украине" (Prospects for Joint Implementation Projects to Use Biomass in Ukraine), paper presented at the 2nd International Ukrainian Conference on Biomass for Energy, 20-22 September 2004, Kyiv.

From UA.com (2006), "Укртрансгаз теряет репутацию надежного партнера" (Ukrtransgaz Loses its Reputation as a Reliable Partner), *From UA.com*, 4 January 2006, www.from-ua.com/hotline/43bb8f015f454/.

Gas Matters (2005 and 2006), monthly magazine *Gas Matters*, various editions, Gas Matters, London.

Geletukha, G. *et al.* (2003a), "Energy Supply in Ukraine: Outlook to 2050", *Green Energy*, No. 4 (12), Kyiv.

Geletukha, G. *et al.* (2003b), *Ukraine: Outlook to 2050*, Renewable Energy Agency, Kyiv, www.rea.org.ua/index.php?page=projects&sub=2&lang=en.

Geletukha, G. *et al* (2005), "Present State and Prospects for Bioenergy Development in Ukraine", *Industrial Heat Engineering* (*Промышленная теплотехника*), No. 1 (27), Kyiv.

Global Insight (2005), *Ukraine: Country Reports*, Global Insight, Boston.

Gochenour, C. *et al* (2004), *Ukraine: Key Challenges Facing the Electricity Sector*, World Bank, Washington, DC.

Haney, M. (2003), "Reform of Ukraine's Coal Industry: The Opinion of the World Bank Experts", *National Security and Defence*, No. 8 (44), Razumkov Centre, Kyiv.

Hydrometeorological Institute (Ukrainian Hydrometeorological Scientific Research Institute) (2006), *Национальный отчет о кадастре выбросов парниковых газов и их поглощения в Украине за 1990-2004 гг. (National Report on the Inventory of Greenhouse Gases Emissions and Absorption in Ukraine in 1990-2004)*, Ministry for Environmental Protection, Kyiv (National Report submitted to the UNFCCC Secretariat in 2006).

Interfax Ukraine (2005 and 2006), *Interfax Ukraine Daily Business Report*, various editions, Interfax Ukraine, Kyiv.

IAEA (International Atomic Energy Agency) (1998), *Critical Review of Uranium Resources and Production Capability to 2020, IAEA, Vienna*, www.pub.iaea.org/MTCD/publications/PDF/te_1033_prn.pdf.

IAEA (2001), "Country Nuclear Fuel Cycle Profiles", *Technical Report Series*, No. 404, IAEA, Vienna.

IAEA (2003), *Report of the OSART (Operational Safety Review Team) Mission to the Rovno Nuclear Power Plant, Ukraine, 22 September to 9 October 2003*, IAEA, Vienna.

IAEA (2004), *Report of the OSART (Operational Safety Review Team) Mission to the Zaporozhe Nuclear Power Plant, Ukraine, 6-22 September 2004*, IAEA, Vienna.

ICPS (International Centre for Policy Studies) (2005a), "Privatisation is no Panacea for Ukraine's Coal Industry", *ICPS Newsletter*, No. 15 (274), ICPS, Kyiv.

ICPS (2005b), "Behind the Economic Failures of 2005: the Outlook for 2006–2007", *ICPS Newsletter*, No. 45 (304), ICPS, Kyiv.

IEA (International Energy Agency) (2002), *Renewable Energy*, Free information paper, IEA/OECD, Paris, www.iea.org/Textbase/publications/free_new_Desc.asp?PUBS_ID=1034.

IEA (2001), *Regulatory Institutions in Liberalised Electricity Markets*, IEA/OECD, Paris.

IEA (2003), *Renewable Energy into the Mainstream*, IEA Renewable Energy Working Party, Paris.

IEA (2004a), *World Energy Outlook*, IEA/OECD, Paris.

IEA (2004b), *Renewable Energy - Market and Policy Trends in IEA Countries*, IEA/OECD, Paris.

IEA (2005a), *World Energy Outlook*, IEA/OECD, Paris.

IEA (2005b), *Coming in from the Cold: Improving District Heating Policy in Transition Economies*, IEA/OECD, Paris.

IEA (2006), *Optimising Russian Natural Gas: Reform and Climate Policy*, IEA/OECD, Paris.

Jacob, H. (2003), *The Ukrainian Utilities Sector: Better or Worse than Russia*, Renaissance Capital, 3 November 2003, Moscow.

Kachur, P.S. (2006), *Першочергові заходи реформування житлово-комунального господарства (Priority Measures for Reforming the Housing and Communal Services Sector),* Presentation of the Minister of Construction, Architecture, Housing and Communal Services, Kyiv, www.kmu.gov.ua/minbuild.

Kalchenko, V.N. (2004), "Развитие организационно-правовых и экономических принципов функционирования Оптового рынка электрической энергии Украины" (Developing Institutional, Legal and Economic Principles for the Functioning of the Ukrainian Wholesale Market), presentation at the International Energy Forum, September 2004, Yalta, www.er.gov.ua/doc.php?f=968.

Karp, I. and B. Orlik (2002), “Проблемы обеспечения государства углеводородными энергоносителями” (Questions of Securing Hydrocarbon Energy Supply to the Country), paper presented at the International Conference *Energy Efficiency*, 29-30 October 2002, Kyiv.

Kievskie Vedomosti (2005), edition of 19 November 2005, *Kievskie Vedomosti*, Kyiv.

KyivZNIIEP Energy Savings Centre (2005), “Что нового в украинских нормах проектирования систем отопления и вентиляции жилых домов” (What is New in Ukrainian Design Norms for Heating and Ventilation Systems in Residential Buildings), *Energy Savings in Buildings*, No. 3 (26), Kyiv.

Kliuk, B.A. (2002), Украина – важный газо-нефтетранспортный узел Европейского континента (Ukraine as an Important Oil and Gas Transportation Hub in Eurasia), paper presented to the Committee on Non-member Countries, International Energy Agency, Paris, 16 October 2002.

Kovalko, M.P., *et al.* (2002), *Трубопровідний транспорт газу (Pipeline Gas Transportation),* ARENA-ECO, Kyiv.

Kravchenko, A. (2005), “Конец газовой истерии?” (The End of Gas Hysteria?), *Zerkalo Nedeli*, No. 26 (554), 9-15 July 2005, Kyiv.

Kubrushko, Y. (2005a), “Orange Revolution to Speed up Sector Reform”, *Energy in East Europe*, Issue 55, January 2005, Platts.

Kubrushko, Y. (2005b), “Waiting for Guidance,” *European Electricity Review*, London.

Kucherenko, O. (2005a), Press Conference of the Head of the State Committee on Housing and Communal Services, Oleksiy Kucherenko, 25 March 2005, Kyiv, www.djkg.gov.ua.

Kucherenko O., (2005b), “Задабривание тарифами оборачивается против населения” (Using Tariffs to Win over People May Actually Hurt Them), *Zerkalo Nedeli*, No. 37 (565), 24-30 September 2005, Kyiv.

Kupchinsky, R. (2005), "Problems in Ukraine's Coal Industry Run Deep", *Radio Free Europe/Radio Liberty*, 9 February 2005, www.rferl.org/featuresarticle/2005/02/3b577f06-f2dc-4933-a6b9-5d48d0f9440a.html.

Lesik, L. (2004), "Фонд ядерно-паливного циклу мусить наповнюватися" (The Nuclear Fuel Cycle Fund Needs to be Funded), Ministry of Fuel and Energy, Kyiv, 12 September 2004, http://mpe.energy.gov.ua/minenergo/control/uk/publish/article?art_id=10000110246&cat_id=900005100341.

Liven', O. (2005), "Вопрос долгосрочного хранения РАО в Украине – до сих пор вопрос" (The Question of Long-term Storage of Radioactive Waste in Ukraine – It is Still a Question), *Energobusiness*, No. 38 (407), September 2005, Kyiv.

Lyr, V. (2005), "Энергетический баланс страны – уравнение из неизвестных" (The Country's Energy Balance – the Equation of the Unknown), *Strategia TEK*, Kyiv.

Matveev, I.B. and A.E. Konechenkov (2002), "Концепция развития солнечной энергетики в Украине" (Concept of Solar Energy Development in Ukraine), ESCO (Electronic Magazine of the Energy Service Company "Ecological Systems"), No. 9, September 2002, Kyiv, http://esco-ecosys.narod.ru.

Matveev, I.B., *et al.* (2004), "Prospects of the Landfill Gas Recovery and Utilisation Systems Implementation at Ukrainian Municipal Solid Waste Landfills", presentation at the 2nd International Ukrainian Conference on Biomass for Energy, 20-22 September 2004, Kyiv.

Ministry of Construction (2006), *Пояснювальна записка до пропозицій підгрупи з технічних питань (Explanatory Note on the Proposals of the Subdivision on Technical Questions)*, Ministry of Construction, Architecture, Housing and Communal Services, Kyiv.

Ministry of Environmental Protection (1998, 1999, 2000, 2001, 2002, 2004), *National Report on the State of Environment in Ukraine*, Ministry of Environmental Protection, Kyiv.

Ministry of Fuel and Energy (2003), *Аналитическая справка о работе угольной отрасли* (Analytical Report on Coal Industry Performance), 1 August 2003, Ministry of Fuel and Energy, Kyiv, http://mpe.energy.gov.ua/minenergo/control/ru/publish/article?art_id=10000101410&cat_id=900001400128.

Ministry of Fuel and Energy (2004), *Підсумки роботи паливно енергетичного комплексу у 2003 році (Performance Results of the Fuel and Energy Sector in 2003)*, Ministry of Fuel and Energy, Kyiv.

Ministry of Fuel and Energy (2005a), *Основні напрями Енергетичної Стратегії України на период до 2030 року* (Main Directions of the Energy Strategy of Ukraine until 2030), Ministry of Fuel and Energy, Kyiv.

Ministry of Fuel and Energy (2005b), *Тарифи на електричну енергію та газ в Україні та ближньому зарубіжжі (Tariffs for Electricity and Gas in Ukraine and Neighbouring Countries)*, http://mpe.energy.gov.ua.

Ministry of Fuel and Energy (2005c), *Підсумки роботи паливно енергетичного комплексу у 2004 році (Performance Results of the Fuel and Energy Sector in 2004)*, Ministry of Fuel and Energy, Kyiv.

Ministry of Fuel and Energy (2006a), *Інформаційна довідка про основні показники розвитку галузей паливно-енергетичного комплексу України за червень та 6 місяців 2006 року (Main Indicators of the Development of the Ukrainian Fuel and Energy Sector in June and the First Six Months of 2006)*, Ministry of Fuel and Energy, Kyiv.

Ministry of Fuel and Energy (2006b), *Підсумки роботи паливно енергетичного комплексу у 2005 році (Performance Results of the Fuel and Energy Sector in 2005)*, Ministry of Fuel and Energy website http://mpe.kmu.gov.ua, accessed 30 January 2006.

Ministry of Fuel and Energy (2006c), *Preliminary Summary of the Work of Energoatom in 2005*, Ministry of Fuel and Energy, 12 January 2006, Kyiv.

Ministry of Fuel and Energy (2006d), *В Україні встановлено близко 5,7 млн. побутових лічильників природного газу (Nearly 5.7 Million Residential Gas Meters Have Been Installed in Ukraine)*, Ministry of Fuel and Energy, http://mpe.kmu.gov.ua, accessed 23 May 2006.

Nadra of Ukraine (2005), *Инвестиционная деятельность (Investment Activity)*, www.nadraukrayny.com.ua/invest_rus.htm, accessed on 9 December 2005.

Naftogaz of Ukraine (2004), *Консолідована фінансова звітність за міжнародними стандартами за рік, що закінчився 31 грудня 2003 року (Consolidated Financial Report, Based on International Standards, for 2003)*, Naftogaz of Ukraine, Kyiv. (Note: The report does not include the accounts of all companies in which Naftogaz of Ukraine has a significant stake. Therefore, the document is not truly a consolidated audit report.)

Naftogaz of Ukraine (2005), Information Presented by the Science and Technology Department and Information Technologies Department, Naftogaz of Ukraine, Kyiv.

Naftogaz of Ukraine (2006), *Переробка (Refining)*, www.naftogaz.com, accessed 3 July 2006.

National Strategy Studies (2003), *National Strategy Study of Ukraine for Joint Implementation and Emissions Trading*, National Strategy Studies, Kyiv.

NEA and IAEA (Nuclear Energy Agency and International Atomic Energy Agency) (2003), *Uranium 2003: Resources, Production and Demand*, OECD, Paris.

NEA and IAEA (2005), *Uranium 2005: Resources, Production and Demand*, OECD, Paris.

Olearchyk, R. (2005), “High Oil Prices Life Biofuel Prospects”, *Kyiv Post*, 6 October 2005.

Oruskaya, M. (2004), "Experience of Regulatory Body Functioning in Energy Industry of Ukraine: Prospects for Future Development of State Reg-ulation of Energy" presentation by NERC, World Energy Council, London, www.worldenergy.org/wec-geis/global/downloads/croatia/11forum_oruskaya.pdf.

Poltava Petroleum Company (2006), *Gas Production in 1996-2005, Mcm*, and *Oil Production in 1996-2005, ths. t*, Poltava Petroleum Company, www.ppc.net.ua/vurob_en.html.

Prudka, N. and O. Kadochnikova, (2005), "Угольная отрасль на пороге перемен" (Coal Industry at the Threshold of Changes), *Energobusiness*, 14 June 2005, Kyiv.

Prusakov, D. and O. Rakovich (2006), "Разработка проектов совместного внедрения в сфере ветровой энергии" (Developing JI Projects in the Wind Energy Sector), *Energy Policy of Ukraine*, No. 2, Kyiv.

Rabinovich, M.D. and A.R. Fert (1998), "Использование солнечной энергии для теплоснабжения на Украине" (The Use of Solar Energy for Heat Supply in Ukraine), *Renewable Energy Bulletin*, No. 3, Intersolar, Moscow, www.intersolar.ru.

Razumkov Centre (Ukrainian Centre for Economic & Political Studies Named after Olexander Razumkov) (2002), "The EU-Ukraine-Russia 'Gas Triangle': The Positions, Interests and Prospects of Ukraine", *National Security and Defence*, No. 3 (27), Kyiv.

Razumkov Centre (2003), "Ukraine's Coal Industry: Its State and Trends Against the Background of Restructuring", *National Security and Defence*, No. 9 (44), Razumkov Centre, Kyiv.

Razumkov Centre (2004), "Ukraine's Gas Transportation System: Ready for Cooperation?", *National Security and Defence*, No. 1 (49), Razumkov Centre, Kyiv.

Renaissance Capital (2003), *Ukraine: Bigger, Bolder...& Back*, Renaissance Capital, 26 September 2003, Moscow.

Reuters (2004), http://today.reuters.com, accessed on 12 February 2004.

Saprykin, V. (2003), *Ukraine's Odessa-Brody Pipeline: Whose Oil and Where Should It Go?*, Razumkov Centre, 1 June 2003, Kyiv.

Saprykin, V. (2004), "Restructuring Ukraine's Coal Industry: Key Problems and Priority Measures", *National Security and Defence*, No. 11 (59), Razumkov Centre, Kyiv.

Saprykin, V. (2005a), *Ukraine as Eurasia's Oil and Gas Hub: Realities and Prospects*, paper presented at the International Energy Agency, 10 March 2005, Paris.

Saprykin, V. (2005b), "Public Opinion on the Safety at Ukrainian NPPs and the Future of Nuclear Power Engineering: Razumkov Centre Sociological Survey", *National Security and Defence*, No. 6 (66), Razumkov Centre, Kyiv.

Somov, A. (2005), "НАК «Энергетическая Компания Украины» обеспечивает энергетическую безопасность страны" (Energy Company of Ukraine Provides the Country with Energy Security), *Zerkalo Nedeli*, 2-8 July 2005, Kyiv.

State Committee for Energy Conservation (2001), *Атлас Енергетичного потенциалу відновлюваних та нетрадиційних джерел енергії України (Atlas of Energy Potential of Renewable and Non-traditional Energy Sources)*, State Committee for Energy Conservation, Kyiv.

State Committee on Housing and Communal Services (2005), *Concept of State Regulation of Natural Monopolies' Activities in the Sphere of Housing and Communal Services*, State Committee on Housing and Communal Services, Kyiv.

SNRC (State Nuclear Regulatory Committee of Ukraine) (2003), *National Report Document Developed in Compliance with the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management*, State Nuclear Regulatory Committee of Ukraine, Kyiv.

SNRC (2004a), *Nuclear and Radiation Safety in Ukraine: Annual Report 2003*, State Nuclear Regulatory Committee of Ukraine, Kyiv.

SNRC (2004b), *National Report of Ukraine on Compliance with Obligations of the Convention on Nuclear Safety,* State Nuclear Regulatory Committee of Ukraine, Kyiv.

SNRC (2005), *Nuclear and Radiation Safety in Ukraine: Annual Report 2004*, State Nuclear Regulatory Committee of Ukraine, Kyiv.

State Statistics Committee of Ukraine (1998), *Паливно-енергетичні ресурси України (Fuel-Energy Resources of Ukraine)*, State Statistics Committee of Ukraine, Kyiv.

State Statistics Committee of Ukraine (2001), *Паливно-енергетичні ресурси України (Fuel-Energy Resources of Ukraine),* State Statistics Committee of Ukraine, Kyiv.

State Statistics Committee of Ukraine (2004), *Паливно-енергетичні ресурси України (Fuel-Energy Resources of Ukraine)*, State Statistics Committee of Ukraine, Kyiv.

Stern, J. (2005), *The Future of Russian Gas and Gazprom*, Oxford University Press, Oxford.

Svistukhin, D. (2005), "Перемены на рынке тепла" (Changes on the Heat Market), *Energy Policy of Ukraine*, No. 3, Kyiv.

Tochilin, V.O. (ed.) (2004), *Формування галузевих ринків Україны*: *перехідний період (Building Up Sectoral Markets in Ukraine: Transition Period)*, National Academy of Sciences of Ukraine and Institute of Economic Forecasting, Feniks, Kyiv.

Troika Dialog (2005), *Ukraine: Broadening Horizons*, Troika Dialog Research, August 2005, Moscow.

Ukrtransgaz (2002), *Investment Programme for Gas Transmission System Upgrading*, Ukrtransgaz, Kyiv.

United Nations (2002), *The Human Consequences of the Chernobyl Nuclear Accident: A Strategy for Recovery*, UNDP, UNICEF, UNOCHA and WHO, www.undp.org/dpa/publications/chernobyl.pdf.

USGS (United States Geological Survey) (2000), *World Petroleum Assessment 2000*, United States Geological Survey, http://pubs.usgs.gov/dds/dds-060/.

Uranium Information Centre (2005), *Nuclear Power in Ukraine*, Briefing Paper No. 63, Uranium Information Centre, Melbourne, Australia, www.uic.com.au/nip70.htm.

Vasko, V. (2000), "Wind Industry in Ukraine," *Sustainable Energy News*, 28 February 2000, Hjortshøj, Denmark.

Verkhovna Rada (2000), *Про альтернативні види рідкого та газового палива* (On Alternative Liquid and Gaseous Fuels), Law of Ukraine No. 1391-14, *Vidomosti Verkhovnoi Rady*, No. 12, 2000, Kyiv.

Verkhovna Rada (2003a), *Про реструктуризацію заборгованості з квартирної плати, плати за житлово-комунальні послуги, спожиті газ та електроенергію* (On Restructuring the Debt for Housing, Communal Services and Supplied Gas and Electricity), Law of Ukraine No. 554-15, *Vidomosti Verkhovnoi Rady*, No. 23, 2003, Kyiv.

Verkhovna Rada (2003b), *Про альтернативні джерела енергії* (On Alternative Energy Sources), Law of Ukraine No. 555-15, *Vidomosti Verkhovnoi Rady*, No. 24, 2003, Kyiv.

Verkhovna Rada (2004), *Про Загальнодержавну програму реформування і розвитку житлово-комунального господарства на 2004-2010 роки* (On the All-state Programme on Reforming and Developing Housing and Communal Services in 2004-10), Law of Ukraine No. 1869-15, *Vidomosti Verkhovnoi Rady*, No. 46, 2004, Kyiv.

Verkhovna Rada (2005), *Про заходи, спрямовані на забезпечення сталого функціонування підприємств паливно-енергетичного комплексу* (On Measures to Provide for Stable Operation of the Fuel and Energy Complex Enterprises), Law of Ukraine No. 2711-15, 23 June 2005, *Vidomosti Verkhovnoi Rady*, No. 33, 2005, Kyiv.

Volynets, M. (2003), "Restructuring of Ukraine's Coal Industry: The Realities and Prospects", *National Security and Defence*, No. 8 (44), Razumkov Centre, Kyiv.

Western NIS Enterprise Fund, www.westnisefk.com.

Windenergo (2005), "Wind Farms in Ukraine", Windenergo, Kyiv, www.windenergo.com.ua/ves_eng.htm.

World Bank (2003a), *Ukraine: Challenges Facing the Gas Sector*, World Bank, Washington, DC.

World Bank (2003b), *The Coal Sector and Mining Communities of Ukraine:*

Advancing Restructuring to the Benefit of All, World Bank, Washington, DC.

World Bank (2005), *Ukraine: the Impact of Higher Natural Gas and Oil Prices*, 6 December 2005, World Bank, Washington, DC.

World Energy Council (2000), *Restructuring and Privatizing the Coal Industries in Central and Eastern Europe and the CIS*, World Energy Council, London.

Woronowycz, R. (2000), "Non-traditional sources of energy may be key to Ukraine's future", *The Ukrainian Weekly*, 30 April 2000.

Zabarny, G.M. and A.V. Shurchkov (2002), *Енергетичний потенциал нетрадицийних джерел енергії України (Energy Potential of Non-Traditional Sources of Energy in Ukraine)*. Institute of Technical Heat Physics, National Academy of Sciences of Ukraine, Kyiv.

Zerkalo Nedeli (2005), "Нафтогаз Украины – об учете газа" (Naftogaz of Ukraine about Gas Metering), *Zerkalo Nedeli*, No. 13 (541), April 2005, Kyiv.

Zhovtiansky, V. (2002), "Энергосбережение: больше, чем Клондайк для экономики Украины или цена прерванной культурной традиции" (Energy Saving: More than Klondike for Ukrainian Economy, or the Price of Interrupted Tradition), *ESCO*, February 2002, Kyiv, http://esco-ecosys.narod.ru/.

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