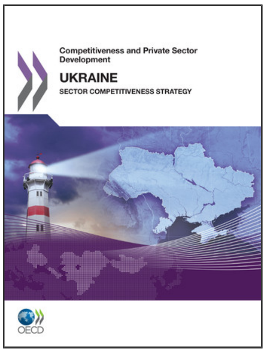


From:
Competitiveness and Private Sector Development: Ukraine 2011
Sector Competitiveness Strategy

Access the complete publication at:
http://dx.doi.org/10.1787/9789264128798-en

Energy-efficiency and renewable technologies: Focus on production of energy based on biomass

Please cite this chapter as:

OECD (2012), "Energy-efficiency and renewable technologies: Focus on production of energy based on biomass", in *Competitiveness and Private Sector Development: Ukraine 2011: Sector Competitiveness Strategy*, OECD Publishing.
http://dx.doi.org/10.1787/9789264128798-11-en

Competitiveness and Private Sector Development: Ukraine 2011
Sector Competitiveness Strategy

Chapter 7

Energy-efficiency and renewable technologies: Focus on production of energy based on biomass

This chapter provides an in-depth analysis of biomass heat and power generation in Ukraine. Examining the demand and supply sides, it explains why the biomass value chain is promising for private domestic and foreign investors given domestic and global trends. It identifies the role that foreign investors could play along the value chain, for instance in producing heat and power or in the designing and engineering of plants. It also presents key issues and policy barriers hindering competitiveness in the sector and proposes a prioritised list of policy recommendations.

Summary

Energy efficiency technologies include several applications along the energy value chain, steps including production, transmission and distribution, and industrial and residential consumption. Within energy production, the use of alternative (non-fossil) sources of energy has emerged as one of the most interesting sectoral case studies for Ukraine. In particular, heat and power production based on biomass was identified as a pilot sub-sector. The sub-sector covers a whole range of activities from the collection of residues and wastes, through their processing, transportation and storage, to their combustion in order to produce heating and electricity. Finally, the distribution of the produced energy is considered as well.

The use of biomass for production of energy has been pioneered by the US and the Nordic countries, such as Denmark, Finland and Sweden, for small-scale heating and for industrial use. Starting in the 1980s, biomass has also been increasingly used for district heating. In 2006, about 10% of global primary energy demand was met by energy from biomass (OECD, 2010). Power and heat production based on wastes and biomass has become increasingly profitable and private sector driven, due to the increase in prices of other traditional sources of energy.

Experiences in several OECD countries, including Sweden and Poland, show that governments can take several steps to stimulate the establishment of a biomass-based energy production sector. On the demand side, a government strategy that stimulates awareness and quick adoption of this alternative energy, including but not limited to tax policy, allows for the necessary investments and organisational measures that in turn stimulate the development of the sector. On the supply side, the development of an easily accessible distribution infrastructure (electricity grid, district heating network) seems to be a key factor for the development of this market. The organisation and regulation of the whole value chain is also a facilitator. For example, the creation of a market for agricultural residues, the establishment of organisations of biomass producers and of equipment manufacturers, and promotional activities to increase awareness are all factors that have allowed for development of this sector.

Ukraine has high potential for energy efficiency technologies as its energy efficiency is only one third of the average for industrialised countries. This reflects a combination of: a bias towards energy-intensive industries, such as cast iron, steel, cement and chemicals; the use of out-dated technologies, both in industries and in energy transit infrastructures; and low energy prices. Ukraine's abundant agricultural waste and increasingly expensive fossil energy could be the basis for the future development of energy production based on biomass. Biomass resources are widely and conveniently available from a sizeable agricultural and forestry sector. The economic potential of crop wastes has been estimated by the National Academy of Sciences of Ukraine at 14 million tonnes of coal equivalent per year (around 60% of Ukraine's measured heat production). The planned convergence of natural gas import prices to Western European levels, agreed by the government with the

IMF under the stand-by arrangement, should further increase the attractiveness of renewable energy sources.

However, administrative barriers substantially limit investment opportunities in the sector, and a national plan defining the role and objectives of biomass in the energy landscape is still lacking. One of the consequences is limited communication and low awareness among farmers, industrial companies and utilities about the possible use of biomass. Development is also held back by the lack of access to capital for most players, indebtedness of local utilities and arrears in payments by consumers. As a result, today fossil fuel-based boilers and combined heat and power plants still dominate the market and produce more than 80% of heat supply in Ukraine.

A strategy for this sector could be based on attracting:

- domestic and foreign utilities in rural and peri-urban areas;
- biomass-related equipment production companies and services;
- investors in agriculture and forestry, who might be interested in the sale of by-products and waste-streams as a means of diversifying or complementing their core activities.

The suggested priority area for reform in this sector is investment policy and promotion. Administrative hurdles to investments in the field should be lifted. Specifically, focus should be on streamlining the administrative processes (*e.g.* permits), implementing a single-window approach for investors, and creating a pre-approval process for green tariffs. A sector-specific plan should be defined by the government, spelling out a long-term strategy for development of biomass-based energy production, and a mid-term action plan including, for example, support mechanisms, R&D and infrastructure investments, and specific measurable targets (*e.g.* biomass as a percentage of total energy production). Other areas for reform are related to the overall energy sector, including alignment of prices, market regulation, solution of the payment arrears problem and privatisation.

Why focus on production of energy based on biomass

The need for energy efficiency

Ukraine has high potential for energy efficiency technologies as its energy efficiency is one third of the average for industrialised countries (Figure 7.1). This reflects a combination of a bias towards energy-intensive industries, such as cast iron, steel, cement and chemicals, the use of out-dated technologies, both in industries and in energy transit infrastructures, and low energy prices.

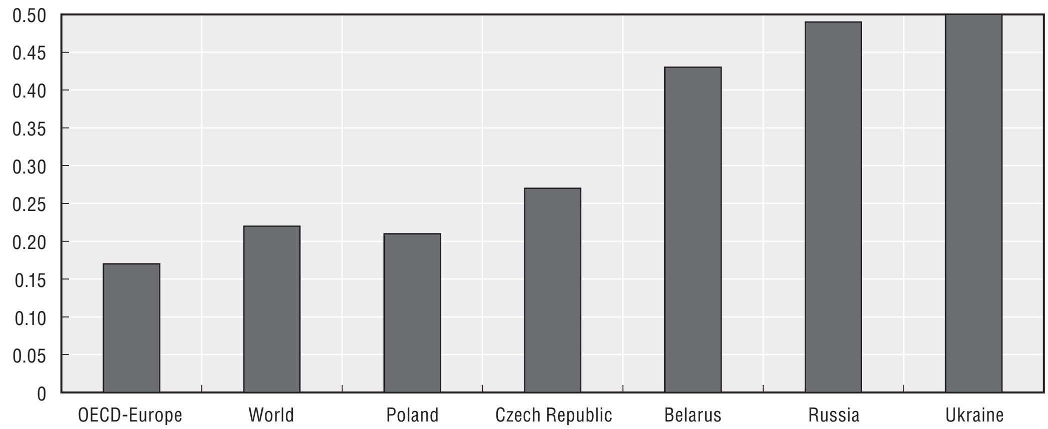
Within the energy sector, key sectors with the potential to improve energy efficiency and develop alternative sources were identified. Traditional technologies for energy production, alternative technologies, and the transmission and distribution system were all evaluated (Figure 7.2).

Traditional energy production, transmission and distribution activities are still dominated by state ownership

Natural gas production, transportation and distribution activities are dominated by the state-owned sector. Gas usage and losses in the transportation and distribution systems are higher than in equivalent OECD countries. There is a need to reduce operational costs and to modernise distribution infrastructures: for example, more than 8 billion cubic meters of gas are spent each year in the transport system, representing a cost of more than USD 1.5 billion.

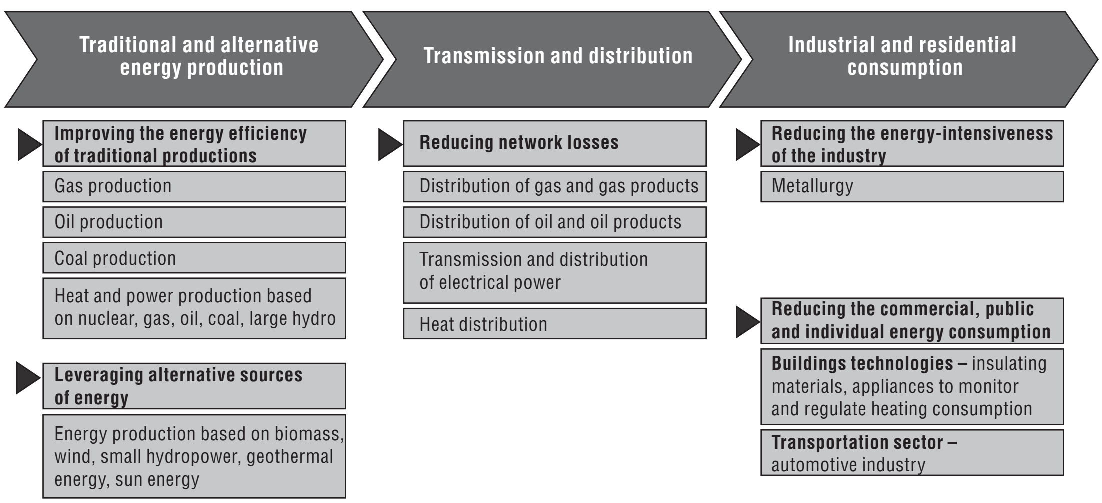
Figure 7.1. **Energy intensity, a cross country comparison**

Tonnes of oil equivalent per thousand USD of value-added, 2006



Source: International Energy Agency (IEA) (2006), *Energy Policy Review Ukraine*, IEA, Paris.

Figure 7.2. **Opportunities to reduce energy-intensity and to develop alternative sources of energy along the value chain**



Source: OECD (2010), *Ukraine Sector Competitiveness Review*, internal working document, OECD, Paris.

Natural gas extraction, transportation and distribution are still heavily regulated and controlled by the government. Naftogaz Ukraine, a company fully owned by the state, dominates the gas value chain in Ukraine (Figure 7.3). The government has direct access to reserves and infrastructure, pricing and tariff setting, import and export transactions. Moreover, administrative procedures for granting exploration and production licences are cumbersome for foreign investors (IEA-OECD). A new gas law was passed in August 2010 giving access to the distribution network to potential gas producers, but it remains to be seen whether implementation will prove effective.

There are also substantial opportunities for improving energy efficiency in oil production, distribution and refining activities. Unlike oil refining and distribution, which are controlled by powerful private domestic and Russian players, oil production is fully owned by the state. State-owned Naftogaz dominates exploration and production, as well as the main oil pipelines (Figure 7.4). Oil exploration and production equipment is old and

Figure 7.3. **Naftogaz (100% owned by the state) dominates the gas-value-chain in Ukraine**

UPSTREAM	MIDDLESTREAM		DOWNSTREAM
Exploration and production	**Transmission**	**Processing**	**Distribution and trade**
> 92% of the production	Monopoly through 2 subsidiaries	One major player in gas processing	Full ownership of the pipes, shares in a majority of the 42 privatised regional distribution companies

Source: International Energy Agency (IEA) (2006), *Energy Policy Review Ukraine*, IEA, Paris; OECD (2010), *Ukraine Sector Competitiveness Review*, internal working document, OECD, Paris.

Figure 7.4. **State-owned Naftogaz dominates exploration and production, as well as the main oil pipelines**

UPSTREAM	MIDDLESTREAM		DOWNSTREAM
Exploration and production	**Transmission**	**Refining**	**Distribution and trade**
> 95% of the E&P is due to state controlled companies – Naftogaz of Ukraine (Ukrnafta, Chornomornaftgas), Nadra of Ukraine	State monopoly through Ukrtransnafta	Private and foreign (Russian) companies own the 6 refineries with some state shares	Private and foreign (Russian) companies control most filling stations State-owned companies – Ukrnafta, Naftogaz – have a share of the oil retail market

Source: International Energy Agency (IEA) (2006), *Energy Policy Review Ukraine*, IEA, Paris; OECD (2010), *Ukraine Sector Competitiveness Review*, internal working document, OECD, Paris.

inefficient and requires upgrades. Oil refining technologies are also outdated. The depth of processing varies between 47 and 70% in Ukraine, while it reaches 90% in OECD countries.

Worn-out and inefficient coal production equipment provides opportunities for improving the efficiency of coal mine operations, especially in state-owned mines. Further efficiencies can be achieved by utilising coal-bed methane, which is currently wasted. The state owns over 150 coal mines producing only half of the volume of coal, which is primarily used for power plants (Table 7.1). The other half is produced by 30 more competitive private mines, primarily producing coking coal for metallurgy. State-owned coal production in Ukraine is currently unprofitable and needs financial support from the government.

Table 7.1. **The distribution of Ukraine's coal mines**

Features of State-owned and Private-owned mines

Ukraine's coal sector	
State-owned	Private
> 150 mines	< 30 mines
Mainly coal for power plants	Mainly coking coal mines
Half of Ukraine's coal production	Half of Ukraine's coal production

Source: International Energy Agency (IEA) (2006), *Energy Policy Review Ukraine*, IEA, Paris.

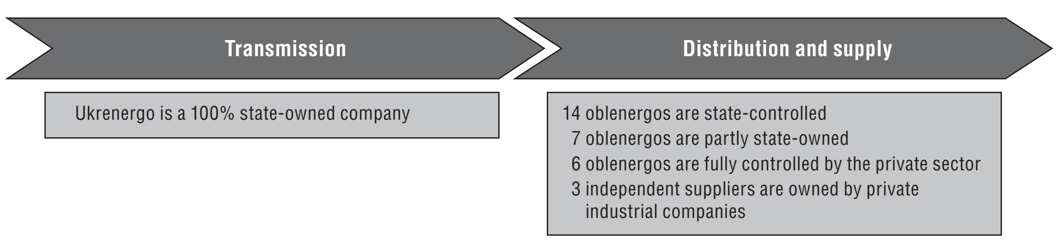
Mining and geological conditions in Ukraine's mines make profitable coal extraction difficult. Average coal prices are below short-term production costs because of rapidly increasing prices of mining equipment and operating costs. Thus, in order to support production the government is forced to provide subsidies. Privatisation of state-owned coal mines is a possibility in the medium-term, but would raise political risks due to the possibility of redundancies and associated social issues.

The efficiency of power plants needs to increase. Ukraines thermal power plants tend to be quite inefficient due to excess capacity and age. The average load factors for thermal power plants are very low, measuring just 28% in 2004 compared to 70% in 1990.

The nuclear and large-hydro power generation sectors are not open to private and foreign investment. To a large extent, state ownership still prevails in power generation, with 100% state ownership of nuclear facilities, 85% ownership of thermal stations and 99% ownership of hydropower plants. Privatisations of thermal power assets might happen in the coming years, according to the economic reform plan of the president, but the timeline remains unclear.

The electricity market is highly regulated with wholesale prices for nuclear and hydro generation set by NERC, a special agency that regulates energy prices and tariffs. At the moment, regulated tariffs are still not high enough to cover depreciation or re-investment in power system assets. There are also opportunities for improving efficiency in the power transmission and distribution sector. The losses of electricity during transmission and distribution in Ukraine amount to about 15% (8% in 1990), compared to 6% in the OECD countries. According to Ukraine's State Agency for Energy Efficiency and Energy Savings, at the beginning of 2011 the actual technical loss of electricity in the grid dropped to 10.7% of the overall electricity supply. Currently, power transmission is fully controlled by the state, while distribution activity is shared between private and public ownership (Figure 7.5). One domestic private investor has a significant degree of control over the market, owning up to 75% of shares in ten distribution companies, which may make it difficult to build a level-playing field for potential newcomers.

Figure 7.5. **State and private ownership of power transmission and distribution assets until mid-2011**



Source: International Energy Agency (IEA) (2006), *Energy Policy Review Ukraine*, IEA, Paris; OECD (2010), *Ukraine Sector Competitiveness Review*, internal working document, OECD, Paris.

However, there are a couple of successful case studies. The distribution companies owned by foreign investors have a very good track of record of reducing losses from electric power lines. AES, a US company, has been making large investments in its distribution lines and billing systems, totalling around USD 80 million during 2003-09.

Alternative sources were selected with a focus on production of energy based on biomass

The dominant presence of the state in most existing energy sub-sectors, high administrative barriers to entry in most markets, and consultations with stakeholders led to the final selection of alternative sources of energy. The low level of state ownership and relatively lower barriers to entry were the key reasons for such a choice.

Production of energy, and in particular of heat and power, based on biomass was selected as a pilot sub-sector on the assumption that gas prices will continue to increase as expected by the government. In the initial stages, government intervention in this sector would be required to define a strategy and launch some pilot projects; however, the economic viability of the biomass sector is sustainable without major government subsidies. This was a key selection factor, as private players would not be interested in a sector highly dependent on uncertain public subsidies.

Ukraine's abundant agricultural by-products and the rise in fossil energy prices are the two elements that are likely to drive the future development of energy production based on biomass. Biomass waste and residues are widely and conveniently available from the sizeable agriculture and forestry sectors. Straw, manure and wood are especially promising as primary biomass sources of heating. The economic potential of crop wastes has been estimated by the National Academy of Sciences of Ukraine at 14 million tonnes of coal equivalent per year. Thus, the use of primary agricultural residue could partly satisfy increasing heat consumption needs and replace traditional heat production systems. At present, fossil fuel-based boilers and combined heat and power plants still produce more than 70% of the heat and power supply. With natural gas prices expected to increase further as a result of the price reform in the internal market, the use of natural gas for production of heat and power will become very expensive. Global prices for other fossil fuels, such as oil and coal, are also expected to rise in future. In contrast, renewable sources of energy, such as hydropower, geothermal, wind and solar energy and biomass energy, are nearly limitless. Generation of energy from renewable sources avoids damaging the climate and environment by eliminating emissions or, in the case of biomass, by recycling the carbon.

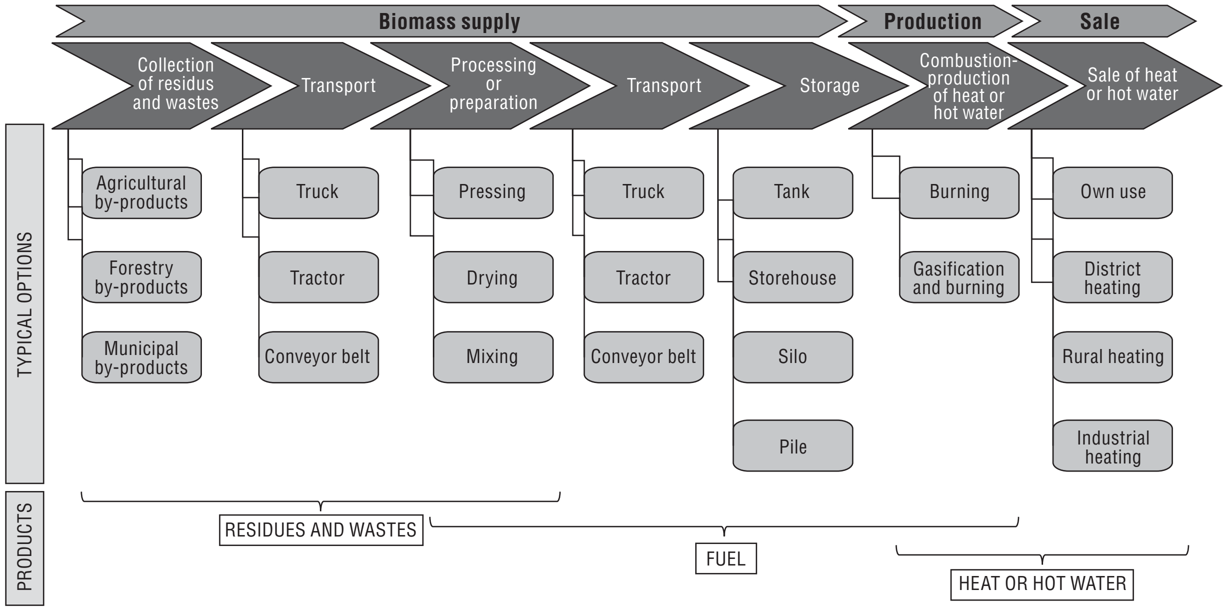
Sector definition and segmentation

The OECD (2010) defines biomass as "any organic material of plant and animal origin, derived from agricultural and forestry production and resulting by-products, and from industrial and urban wastes, used as feedstock for producing bio-energy and other non-food applications". Biomass involves different technological processes and areas of application. Energy generation from biomass is very flexible in terms of production scale. The size of production facilities can be matched to the needs and requirements of consumers and can range from private small-scale installations to industrial multi-megawatt operations.

The biomass and waste energy production value chain includes three stages: fuel supply; production; and the sale of heat, hot water or electrical power. The supply stage includes collection of various types of agricultural and municipal residues, their transportation, processing and preparation, and transportation and storage at the power generation facility (Figure 7.6). Biomass potential of crop origin is not addressed in this study.*

* This kind of study would require an assessment of the potential adverse effects on arable land fertility or food prices.

Figure 7.6. **Biomass residue supply chain for energy production**



Source: OECD (2010), *Ukraine Sector Competitiveness Review*, internal working document, OECD, Paris.

Heating and combined heat and power plants (CHP) can use different types of biomass, including hay, grass, peat, and wood as well as waste. Industrial heating systems are usually based on waste generated by their own production processes and may include paper, manure, wood waste and other materials. The use of traditional stoves and open fireplaces is on the decline as it has very low energy efficiency of 20-25%. Modern biomass boilers provide much higher efficiency in the 70-80% range. They also offer relatively clean combustion and can use different types of fuel, such as wood logs or pellets.

Biomass can also be used along with coal in co-firing systems for either power production or for heat and CHP production (Table 7.2). Requiring moderate initial investments, this option could be considered in the near term as it uses existing facilities that require only minor modifications. It is the most competitive option for using biomass in power generation (IEA, 2007). Several OECD countries, including Australia, Denmark, Finland, the UK and the US, have successfully promoted co-firing, and this has proven to be a key initial step in encouraging the development of a biomass market as well as improving the necessary technical expertise.

Global trends

Renewable sources of energy play an increasingly important role and biomass is amongst the most dynamic segments

Renewable energy sources are playing an increasingly important role in meeting energy needs across the world. Not only do they reduce dependence on fossil fuels but they also help to protect the environment by reducing greenhouse gas emissions, create new jobs and contribute to economic development.

Rapid development of the emerging economies, especially China and India, will drive future demand for all types of energy sources. Rising prices of fuel and energy for the end consumer, high carbon emission penalties and environmental protection policies will

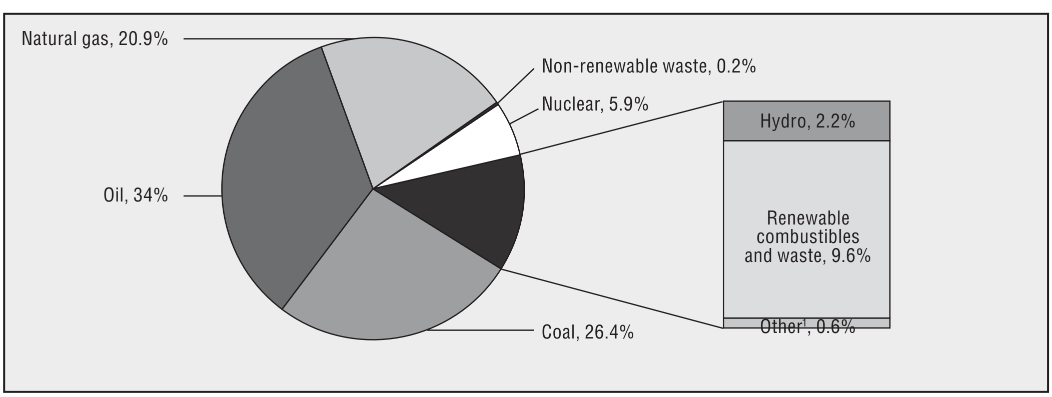
Table 7.2. **Energy uses of biomass**

Scale	Use	Type of heating	Features
Small scale heating and hot water applications, capacity < 1 MW/th	Traditional stoves and open fireplaces	Individual heating	Often low level of efficiency 20-25%
	Modern biomass boilers	Individual heating	Energy efficiency around 70-80% Relatively clean combustion Larger installation used for heating of flats
Large scale applications	Biomass fired CHP plants for district heating	Power and heat	Fuels are hay, grass, peat, wood Interesting alternative in the modernisation of DH grids
	Biomass boilers for district heating	District heating	An alternative in converting coal fired DH plants Smaller installations used for block heating
	Industrial heating biomass boilers	Industrial heating	Fuels are waste products coming from the production process: paper, sawmills, manure from cattle farms Larger installations might be used for small scale DH
	Co-firing	Power and heat	Moderate additional investment required Efficiencies up to 45% is the most cost-effective biomass use for power generation

Source: Van Holsteijn en Kemna (VHK) (2002), "Heat from Renewable Energy Sources", *The RES-H Initiative and related Directives*, VHK., No. 332, the Netherlands.

partially restrain energy demand growth. At the same time, these developments will stimulate the growth of renewable energy, and biomass in particular. In OECD countries energy supply from biomass increased 7.8 Exajoule (EJ) in 2006 from 5.5 EJ in 1990. The share of energy produced from renewable sources in the world total energy supply equalled 12.4% in 2007 (Figure 7.7) with energy generated from renewable combustible and waste materials accounting for 9.6% of the total.

Figure 7.7. **Structure of the global total primary energy supply, 2007**



Source: IEA (2009), *World Energy Statistics*, IEA, Paris.

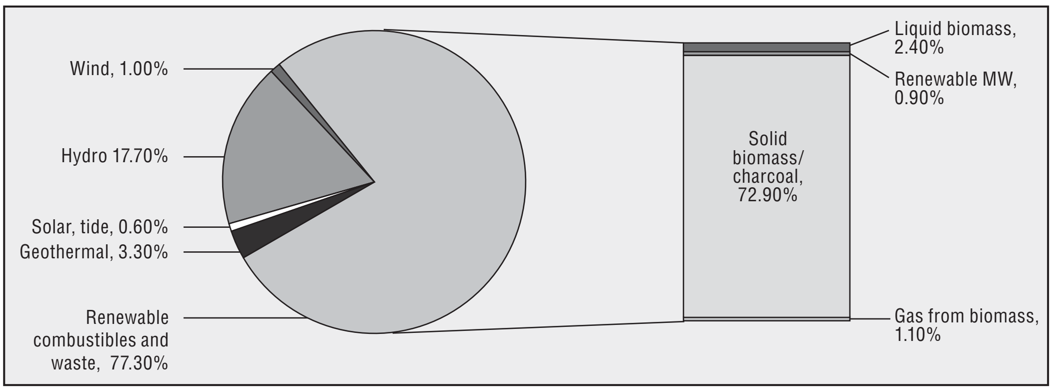
Looking at the application of biomass for production of energy, different forms of biomass are used for different purposes across sectors. According to available data, about 25% of biomass was used for generation of heat and power, about 30% in the residential sector and about 46% in industrial applications in 2006. At the same time, liquid biomass is largely used for the production of fuel for the transport sector and biogas consumption is concentrated in the heat and power generation sector (OECD, 2010).

Although the availability of data on the renewable sector is still rather limited, the majority of biomass in non-OECD countries is still used in the residential sector, while OECD economies have the leading position in the application of biomass for energy production. Generation of heat and electricity from both liquid and solid biomass has been increasing steadily for the past 2-3 decades.

There is a wide variation in the use of renewable sources both among developed and developing countries. Among the OECD countries, more than 75% of energy consumed in Iceland comes from renewable sources, while in Korea it is only 1%.

Renewable combustibles and waste account for over 77% of the total renewable energy supply, 72% of which is generated from solid biomass and charcoal (Figure 7.8). The share of energy produced from biomass in the OECD countries has been higher than energy produced from other renewable sources since 2003.

Figure 7.8. **Structure of world renewable energy sources supply, 2007**



Source: IEA, (2007), "Biomass for Power Generation and CHP", *IEA Energy Technology Essentials*, Paris.

Box 7.1. **The case of biomass adoption in district heating in Sweden**

The use of biomass in Sweden increased by 88% between 1980 and 2002. During this period biomass application increased considerably and reached 14% of the total energy produced in the country. The application of biomass in district heating increased substantially and in 2002 about 43% of district heating was based on biomass.

The existence of a large forest industry and well developed district heating systems provided a good organisational basis for the biomass expansion. The growth of the sector was assisted further by the existence of structures that could handle products from the forestry sector and strong and stable demand from the district heating systems.

Higher demand for biomass has in turn led to reduced production costs as new methods and technical solutions for biomass were continuously introduced during the last decade. Heat production plants benefitted from the growth of the biomass market and the emergence of new suppliers.

Source: Bengt Johansson (2001), "Biomass in Sweden – Historic Development and Future Potential Under New Policy Regimes", *Energy and Environmental Systems Studies*, Lund.

Proximity of resources and stability of supply are key to ensuring profitability of a biomass project

One key success factor at the supply stage is related to the intrinsic physical characteristics of biomass. The low energy density of biomass means that a considerably larger volume is required to generate the same amount of energy compared to fossil fuels. High moisture content increases the weight of fuel and raises the cost of transportation.

Biomass fuels in their raw form are typically consumed on site or transported over short distances, within a 50-80 km radius as a maximum, depending on transportation costs. As a result, collection and transportation represent a major cost for suppliers of biomass material.

Key success factors for the expansion of the biomass sector include the creation of a reliable supply and stable market conditions. In order to operate biomass-based power plants efficiently, operators require a stable supply of fuel throughout the year as well as clear and predictable prices. In many cases the lack of raw materials is the key barrier. Lack of feedstock for the production of wood pellets in many EU countries has led to a reduction in production volumes during the last few years. However, lack of raw materials should not be a problem for countries with large agricultural, forestry and wood processing sectors. Rather, governments have to facilitate the development of suppliers, perhaps by means of demonstration projects. Also, in order to overcome the seasonality of biomass supply, appropriate storage facilities for feedstock have to be built, requiring high initial investments.

Key success factors for profitability at the next stage are related to the distribution costs of heat and power generated from biomass (Figure 7.9). The required investment in distribution should be minimised as heat distribution or electrical power transmission and distribution networks should be present prior to the installation of a bio-heat plant. However, some investment in better insulation in the network and other energy-saving measures might be necessary in order to reduce losses of heat during transmission and to improve efficiency of distribution. There may also be a need to invest in connections to the national electricity grid.

Figure 7.9. **Key success factors for a bio-energy project**

Biomass supply	Production of heat/power	Sale
Biomass fuels must typically be consumed on-site or transported on short distances only	Supplies of biomass must be stable to ensure stability of heat or power production	The heat or electrical power network should exist prior to the installation of a bio-energy plant
Biomass has a low energy density	High utilization rate will ensure stability of heat production and shorter pay-back period	Investments in energy networks distribution should be minimized
A significantly larger volume of biomass fuel is required to generate the same energy as a smaller volume of fossil fuel	Existence of market instruments, *i.e.* long-term contracts with farmers, ensure stable biomass supplies with clarity and predictability of prices	Distribution costs should not be higher than fossil-fuel based heat and power production
The costs of fuel collection and transportation can quickly outweigh the value of the fuel	Storage capabilities near the plant allow to overcome the seasonality of the biomass supply	

Source: Hurstboiler (2010), Corporate website *www.hurstboiler.com,* accessed 15 June 2010.

Sources of competitiveness

Biomass resources are widely available in Ukraine

Ukraine's agricultural sector is a rich source of biomass, including straw from grain crops and rapeseed, residues from the production of corn for grain, residues from the production of sunflowers, secondary agricultural residues (sunflower and rice husks, sugar bagasse), wood residues, and peat (Table 7.3).

Table 7.3. **Straw, wood, husk and manure as primary biomass sources are promising in Ukraine**

Biomass residue source	Origin	Final use
Straw	To conserve humus for soil fertility, straw is left on the field after harvesting if it is not needed for livestock. But this is not mandatory in a well-planned crop rotation.	The straw surplus can be used as fuel in small straw-fired boilers and in straw-fired district heating plants.
Wood	Sawmills, pulpmills, and other wood processing industries generate bark, sawdust, wood chips and other residues.	Residues can be made into wood-chips or pellets to fire boilers.
		The energy produced can help to meet the heating needs of the wood industry or be sold to wood-fired district heating plants or Combined Heat and Power plants.
Manure	National cattle and swine herds of approximately 17 million animals.	The manure can be used in biogas plants to provide heat in small-sized plants for households, villages or in modern plants supplying thousands of people.
	Animal manures are typically disposed of through application to farmlands as organic fertilisers.	The resulting sludge at the end of the process could be used as fertiliser since the nitrogen and phosphorous content is not lost.

Source: Institute for Economic Research and Policy Consulting (2007), "Bioenergy Production in Ukraine: The Competitiveness of Crops and Other Raw Materials from Agriculture and Forestry", *Policy Paper*, No. 11, Institute for Economic Research and Policy Consulting, Kyiv.

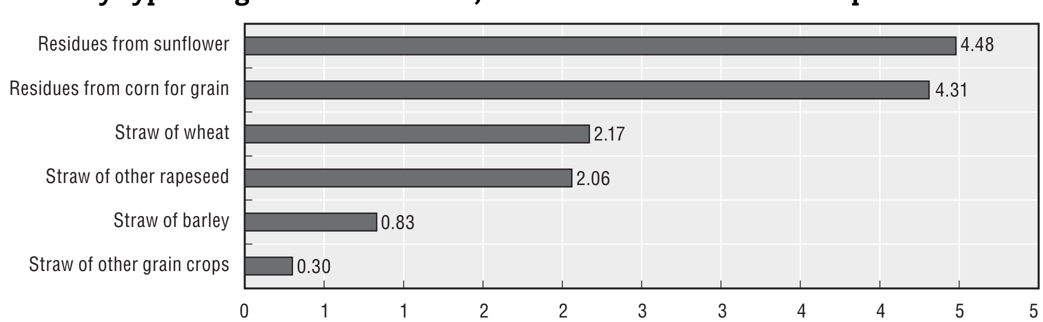
In terms of regional distribution, all regions except the western part of the country and the Crimean peninsula have high economic potential for development of energy generation based on agricultural residues. This primarily correlates with production of wheat and sunflowers, which are the primary sources of agricultural residues, however it is also influenced by other factors, such as the quality of the soil and the region's climate.

According to the National Academy of Science of Ukraine, the economic potential of crop wastes is estimated at 14 million tonnes of coal equivalent per year. For example, this would imply that primary agricultural residues could potentially replace more than half of the measured fossil fuel consumption for heating (Figure 7.10 and Box 7.2). Ukrainian government experts estimate that up to 1.4 million cubic meters of wood, 1.1 million of cubic mters of wooden waste and 3.8 million cubic meters of firewood could be annually used for energy purposes.

Biomass residue use is cost competitive for production of heat and power

Wide availability of biomass resources further ensures a cost advantage, mainly due to the low cost of raw materials, labour and transportation. For example, under certain assumptions, heat produced with straw-based boilers is 67% cheaper than using a gas-fired unit (Figure 7.11).

Figure 7.10. **Economic potential of biomass sources in 2008, breakdown by type of agricultural residue, millions of tonnes of coal equivalent**



Source: Institute of Engineering Thermophysics – National Academy of Science in Ukraine (2010), BEE FP7 Project, Kyiv.

Box 7.2. **Assessing the biomass potential of a country: From "theoretical" to "economic" potential**

Theoretical potential

The overall maximum amount of biomass which can be considered theoretically available for bio-energy production within fundamental bio-physical limits.

Technical potential

The fraction of the theoretical potential which is available under the existing techno-structural framework conditions and with the current technological possibilities, taking into account competition with other land uses (food, feed, fibre production), ecological and other-non-technical constraints.

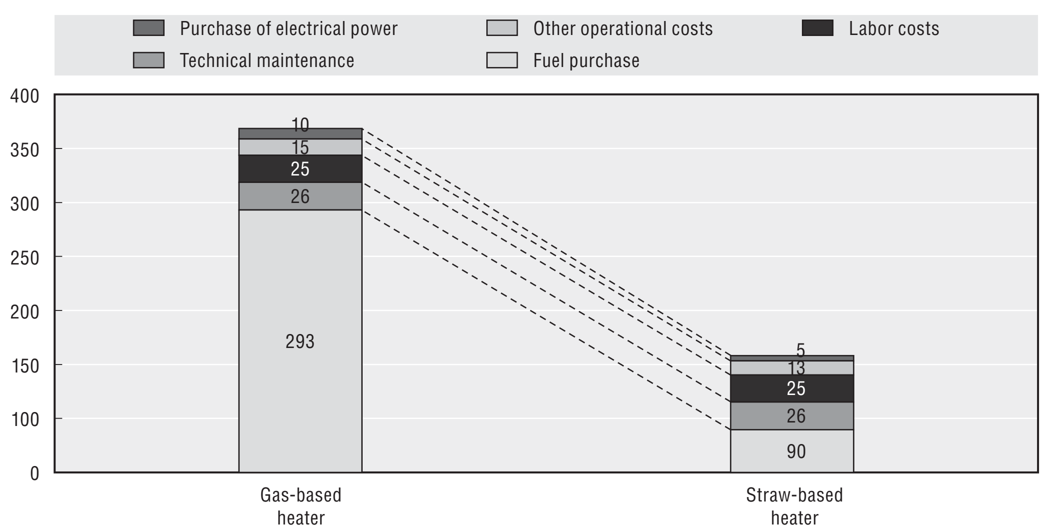
Economic potential

The share of the technical potential which meets criteria of economic profitability within the given framework conditions.

Source: Zhelyezna, T. and V. Leznova, (2008), Presentation of the EC FP7 Project "Biomass Energy Europe", *Presentation* at the 4th International Conference on Biomass for Energy, 22-24 September 2008, Kyiv.

Figure 7.11. **Production costs of heat by straw-based boilers are lower than by gas-fired boilers**

Operational costs of heat production, using a 600 kW boiler, natural gas vs straw-wheat crop residue, '000 hyrvnias, 2007



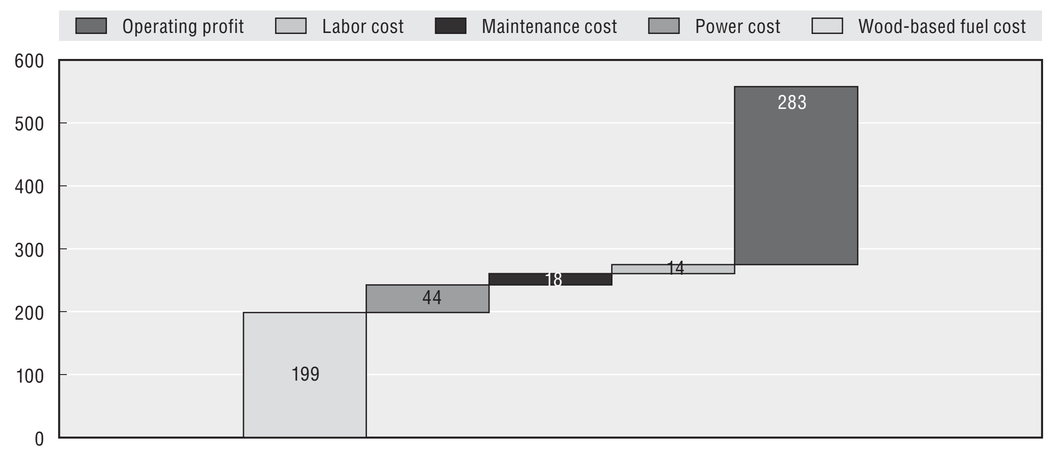
	Gas-based heater	Straw-based heater
Number of utilisation days	Half a year – 4 272 hours	
Fuel quantity needed	293 000 m^3 of gas	746 tonnes of straw
Energy density	35 MJ per m^3	16 MJ per tonne
Fuel price	1 000 grivnas for 1 000 m^3	120 grivnas per tonne
Electrical power consumed	25 000 kWh	13 000 kWh
Total annual heat production	**2 204 Gkcal**	

Note: Amortisation costs are not included.

Source: Zhovmir, N. *et al.* (2007), "Al'ternativnoe teplosnabzhenie za schet ispol'zovanija solomy" (Alternative Heat Supply Through Use of Straw), *Kommunal'noe khozjaystvo*, No. 8, pp. 24-27, December.

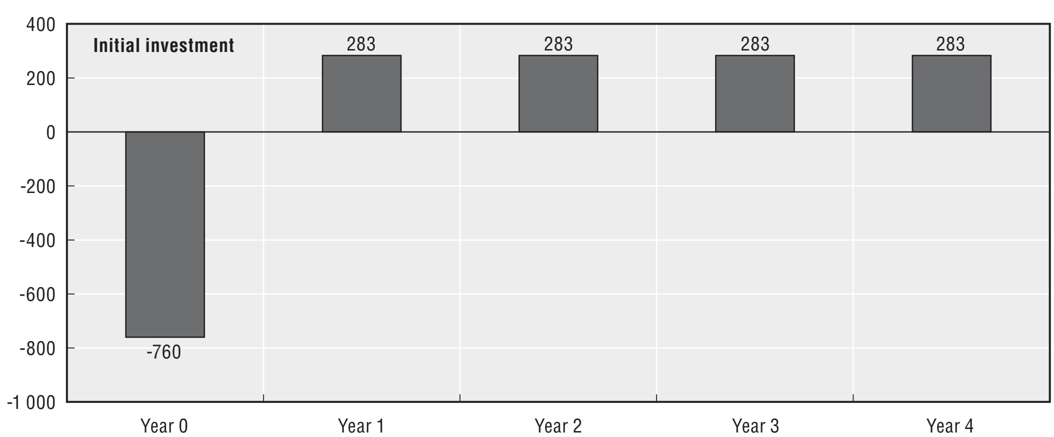
Similarly, as Ukraine has considerable forest resources and a large wood processing sector, it can also use wood for heat generation. Wood-fired boilers for heat and hot water supply require a low upfront investment and ensure a 3-year simple pay-back period (Figure 7.13). For example the operation of a 6.0 MWh hot water boiler plant on wood biomass can generate operating profits of around 50% of annual heat sales revenues (Figure 7.12).

Figure 7.12. **Operating costs and profits of a hot water boiler based on wood biomass for supply of a middle-size city, thousands EUR**



Source: Scientific Engineering Centre "Biomass" *et al.* (2004), *Ukraine: Market Potential for District Heating Projects in the Ukraine and their Modernisation with Austrian Technology*, The Austrian Energy Agency, Wien.

Figure 7.13. **Net cash-flow plan in the five first years of the project, thousands EUR**



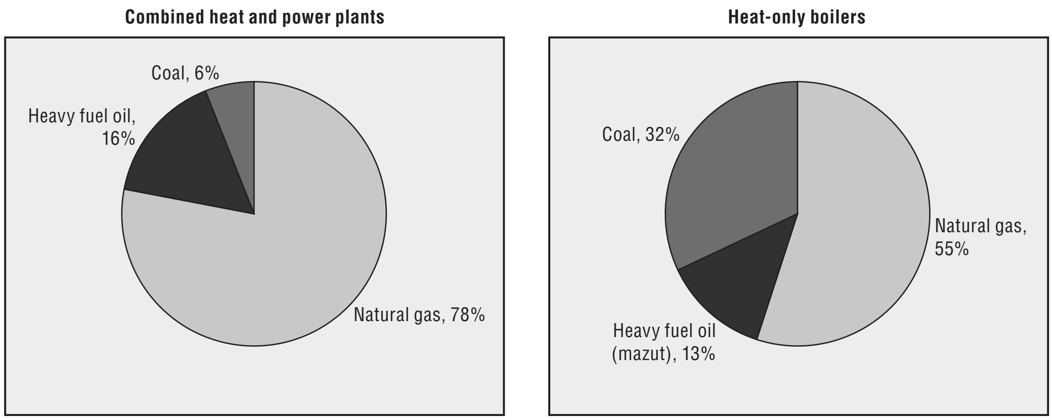
Note: The technical, environmental and economic assumptions are the following: 6.0 MWh hot water boiler plant operating on wood biomass; availability of wood wastes and residues due to neighbouring forests; distance of transportation of wood and residues is no more than 10 km to obtain reasonable cost of wood biomass; existing hot water distribution network to households and companies; tariffs on the supplied heat – 4.03 EUR/GJ; heat supplied to the customers – 138 240 GJ; distribution losses – 20%; fuel consumption – 26 667 tonnes/year; cost of fuel (including transportation and processing) – 7.45 Euro/tonne.

Source: Scientific Engineering Centre "Biomass" *et al.* (2004), *Ukraine: Market Potential for District Heating Projects in the Ukraine and their Modernisation with Austrian Technology*, The Austrian Energy Agency, Wien.

Increasing prices of natural gas in Ukraine should make biomass an even more attractive fuel to utilities

With the vast majority of heat and power produced from fossil fuels, natural gas is the primary source of energy in Ukraine. Ukraine depends on imports for the majority of its energy supplies, including natural gas and oil (Figure 7.14); domestic production of gas meets only 25% of total demand.

Figure 7.14. **Fuel used for power and heat production in Ukraine, 2006**



Source: International Energy Agency (IEA) (2006), *Energy Policy Review Ukraine*, IEA, Paris; OECD (2010), *Ukraine Sector Competitiveness Review*, internal working document, OECD, Paris.

The growing cost of fossil fuels, especially oil and gas, should pave the way for using alternative fuels in power and heat production. As a result of the current gas reform, monitored by the International Monetary Fund, natural gas will become increasingly expensive in Ukraine and will gradually rise to reflect the current market price of the fuel after decades of subsidised prices. The IMF's requirements for gas prices include:

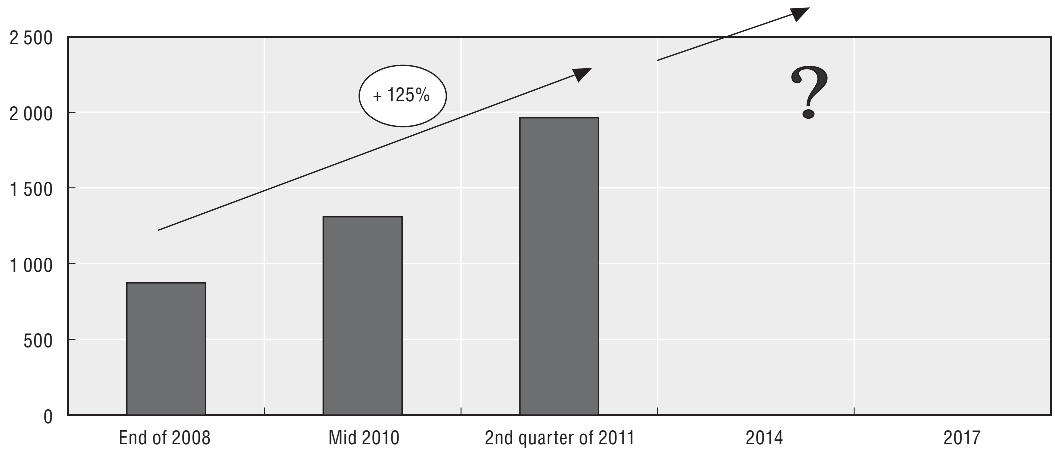
- gradually bringing domestic gas prices to import-parity;
- 50% domestic gas price increases for households and utility companies were implemented on 13 July 2010, effective 1 August 2010, with the next billing period;
- a further 50% increase was planned in 1 April 2011, with semi-annual increases thereafter until import parity is reached for all categories of consumers, with automatic adjustment mechanism planned thereafter; however, in 2011 due to the gas price negotiations between the Russian Federation and Ukraine, the gas price increase was delayed;
- most of the industrial prices are already at market levels, and preferential tariffs for various industries have been eliminated.

According to World Bank estimates, prices of natural gas might increase by more than 400% from 2009 until 2017 in Ukraine (Figure 7.15).

The role of foreign investors in the biomass value chain

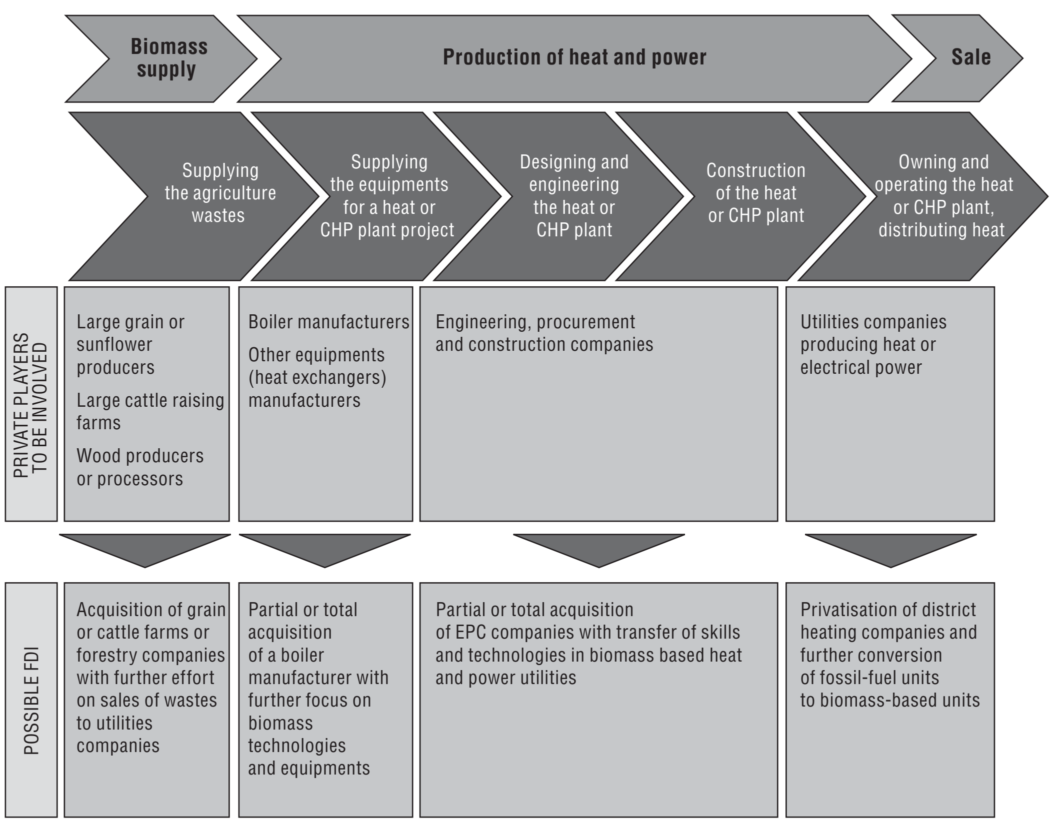
Ukraine offers a number of opportunities for foreign direct investment along the entire value chain of biomass-based heat and power generation, including supply of waste to utility companies, production of biomass burning equipment, design and construction of biomass-based heat and power utilities, and conversion of fossil fuel units to biomass (Figure 7.16).

Figure 7.15. **Price of natural gas for utilities in Ukraine, past trends according to IMF requirements**



Source: International Monetary Fund (2010), *Country Report*, No. 10/262, Country Report Series, International Monetary Fund, Washington, DC.

Figure 7.16. **Potential opportunities for FDI along the value-chain**



Source: OECD (2010), *Ukraine Sector Competitiveness Review*, internal working document, OECD, Paris.

Key issues and policy barriers

Regulatory framework and administrative complexity limit access to utilities companies

Private actors operating in Ukraine face an over-regulated and highly complex administrative and legislative framework, which limits private and foreign access to utilities companies. According to the Enterprise Surveys conducted by the World Bank (World Bank, 2009), in 2008 the major constraints on investment in the country were political instability, high tax rates, endemic corruption, practices in the informal sector, and access to finance. According to the survey's respondents, 31.8% of firms expected to have to pay officials informally to get things done, compared with an average of 23.5% in Eastern Europe and Central Asia. Nearly 60% of the firms surveyed expected to give gifts in order to obtain construction permits, twice as many as the eastern and central European average. On

Box 7.3. **Example of foreign direct investment by AlterEnergyGroup**

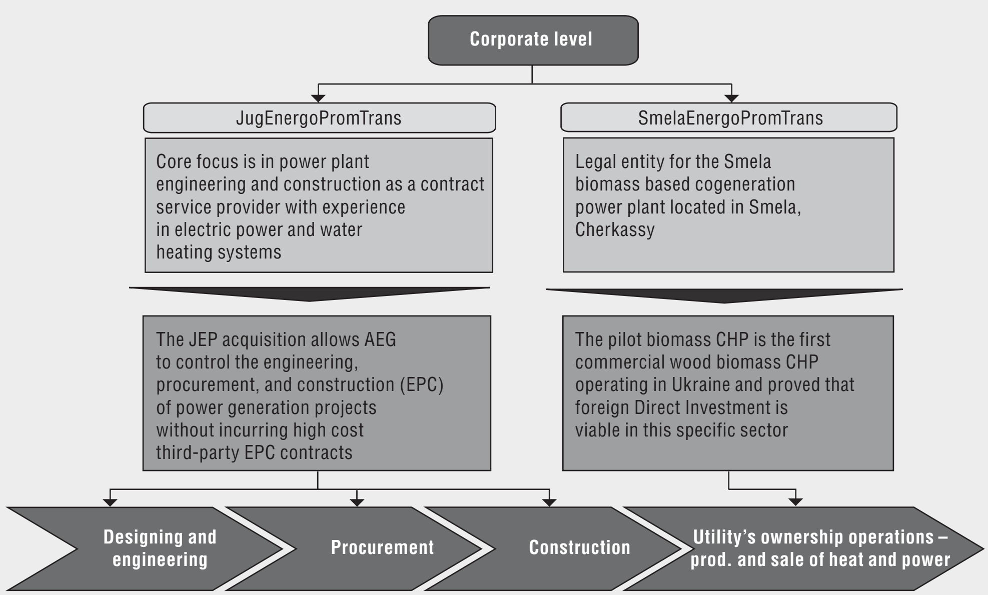
Foreign investor overview: Swiss renewable utility company with its first operating asset located in the small city of Smela in Cherkassy.

Investment characteristics: Full conversion in 2008-09 of a gas-fired CHP to a wood-fired CHP; Capacity – 10 MW/th and 2.5 MW/el; forest of Cherkassy ensures low-cost and stability of supply.

Amount of investment – 1 million euro.

Rationale for investment: "Ukraine was chosen due to the poor state of its existing power generating infrastructure, heavy reliance on imported and domestic hydrocarbon energy sources, abundance of vastly underutilised alternative energy sources, and lack of competitive barriers to entry".

Company structure and activities



Source: AlterEnergyGroup (2010), Corporate internet site, *www.alterenergygroup.com/content/home.php?lang=en*, accessed 15 June 2010.

average, 2.1 days were spent meeting Ukrainian tax officials, compared with an average of 1.6 days in Eastern Europe and Central Asia. Another interesting indicator is the number of days required to obtain a construction-related permit, which was 135.6 days in Ukraine compared with 79.6 days in the region. The IFC, the private sector arm of the World Bank group, estimates that in 2008 private firms and entrepreneurs spent USD 1.55 billion on complying with permits, inspections and technical regulations (IFC, 2009).

Although these issues have been highlighted for some time and there has been a commitment by different governments to simplify procedures, barriers have still not been removed. According to the World Economic Forum Global Competitiveness Index 2010-11, the country dropped by seven positions to 89th (or by five positions in a constant sample) as a result of the weak institutional framework and the lack of competition in the market for goods and services.

In the renewable energy sector a support scheme based on feed-in tariffs for electricity produced from renewable resources was introduced in 2008 and then modified in 2009. The tariff path is fixed until 2029 at a level that is linked to conventional energy prices with an additional guarantee against exchange rate fluctuations, as the calculation contains a floor for prices expressed in euro. However, the business community observed that there is a lack of clarity of certain provisions in the green tariff law (Box 7.4). The changes in the tax code in introduced several tax benefits in favour of renewable energy companies, such as a reduction of taxes on land used for the construction of renewable energy facilities and an exemption from corporate tax of sales of power generated by renewable sources, available until January 2021 (OECD, 2011). But apart from these measures, there are few incentives for existing companies operating in the energy sector to reduce the consumption of natural gas and switch to biomass.

Box 7.4. **The application of feed-in tariff regulations**

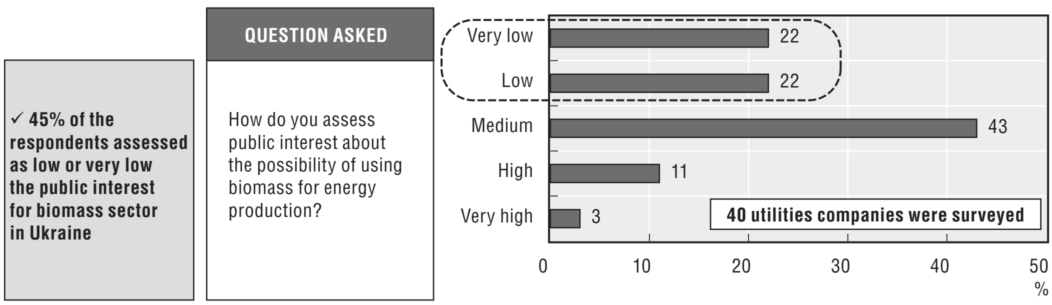
The business community has raised some issues related to the application of feed-in tariff regulations, notably the costs of connecting renewable energy facilities to the grid and the lack of clarity of certain provisions in the green tariff law. It considers in particular that the investment risk of renewable projects could be mitigated if access to green tariffs were guaranteed when the relevant building permits are issued, not only after the plants start producing electricity (International Chamber of Commerce-Ukraine, 2010). However, such modifications would probably increase considerably the risks for the state and the grid operators given frequent delays in the finalisation of renewable energy projects.

Source: OECD (2011), “Investment Policy Reviews: Ukraine 2011”, *OECD Investment Policy Reviews*, OECD, Paris.

Biomass sector is not promoted enough as an area for foreign investment

Despite the synergies and potential that the biomass sector could provide, there is a lack of promotion of alternative sources of energy generally and, more specifically, of biomass. The absence of a clear promotion and communication strategy on the topic affects both the development of the local biomass market and the attraction of foreign investors. The level of public and corporate awareness of the key features of the biomass sector is generally low. According to the OECD Country Capabilities Survey, 43% of the utility companies interviewed reported a medium perception of public interest in biomass energy production, while 45% of them assessed the interest as being either low (around 22%) or very low (around 22%). A significant proportion of the surveyed firms suggested that there is a need to raise the level of awareness both among utility companies (63% of respondents) and among end-consumers (43% of respondents) (Figure 7.17). Investing in the sector would mean taking advantage of the vast natural asset base and transforming it though technology and innovation into a new green industry. The process would create new jobs, develop capabilities and help to reduce Ukraine's dependence on natural gas and other sources of energy. All these elements need to be combined into a clear promotion strategy on energy efficiency and green growth, targeting the business sector and end-consumers.

Figure 7.17. **Lack of public support and awareness for the biomass industry was pointed out**



Source: OECD (2011), *Country Capability Survey*, internal working document, OECD, Paris.

In 2009, the Ukrainian government drafted, with the assistance of the Dutch government, an Action Plan for the Biomass Sector that highlights the lack of effective communication and information exchange between ministries, agencies and other institutional stakeholders as well as among potential consumers of biomass energy. Overall, the actual understanding of issues related to the sustainability of renewable energies remains poor. Workshops and training courses on regulation, financing, standards, sustainability and certification in the sector have been sporadically organised, mainly thanks to the support of international donors, such as the Dutch government. Interestingly, the potential of the Ukrainian biomass sector is seen as an important goal for the development of the country more by foreign counterparts than at the national level.

Power and heat payment arrears

The distribution of power and heat is perceived as a social service in Ukraine, with subsequent free-riding behaviour by final consumers who are not forced to pay their bills in full and can accumulate large arrears (Figure 7.18). Disconnection from the power and heat supply is not common and often delayed, mainly for cultural and social reasons. According to the Ministry of Fuel and Energy the average level of payment for heating services amounted to only 60% of the total due in 2008, with big regional disparities (*e.g.* it was only 36% in the Luhanska oblast compared with 93% in the Odesska oblast).

The toleration of energy sector payment arrears is common in other former-Soviet Union countries. Evidence suggests that it has declined in some of the energy-importing countries, such as Armenia, Kyrgyz Republic and Ukraine, while it has risen in energy-rich countries such as Azerbaijan and Russia (Petri and Taube, 2003). This quasi-fiscal activity has hidden costs that have created inefficiencies and distorted the power and heat market. Firstly, there is an incentive to over consumption and waste, such that resources are not allocated in an efficient way. Secondly, these cumulative debts have a negative, even if not direct, impact on the budget deficit. Thirdly, they create cross-subsidisation between oblasts,

Figure 7.18. **Payment arrears also need to be solved to allow for investment**

The case of heat payment arrears in Ukraine, end of August 2008

- Prices of gas increase on a regular basis
- In order to prevent price rises from causing a social crisis, **tariffs for population and heat generating companies were kept artificially low**
- This has resulted in **debt accumulation among heating companies**
- Heavily subsidized by the government, **energy companies struggled for both payments from final consumers and subventions from government authorities**

#	Region or city of Ukraine	Gas consumption of cubic meters	Level of payment, %	Arrears for gas consumed, Millions of Hrivnas
1	Vinnytska oblast	96.2	54	35.80
2	Volynska oblast	81.1	59	25.64
3	Dnipripetrovska oblast	663.4	53	256.35
4	Donetska oblast	806.9	54	277.27
5	Zhytomyrska oblast	100.3	61	32.54
6	Zakarpatska oblast	29.6	44	14.06
7	Zaporizhska oblast	298.3	69	75.49
8	Ivano-Frankivska oblast	69.2	63	21.70
9	Kyiv City	150.0	83	17.84
10	Kyivska oblast	196.0	76	38.35
11	Kirovohradska oblast	68.4	47	30.65
12	Autonomous Republic of Crimea	195.4	51	76.65
13	Luhanska oblast	288.5	36	143.63
14	Lvivska oblast	255.8	58	83.46
15	Mykolayivska oblast	87.6	80	13.37
16	Odesska oblast	271.8	93	14.80
17	Poltavska oblast	202.4	84	25.30
18	Rivnenska oblast	86.7	57	32.00
19	Sevastopol City	83.1	55	27.68
20	Sumska oblast	141.4	79	23.95
21	Ternopilska oblast	62.2	79	10.63
22	Kharkivska oblast	632.9	37	312.01
23	Khersonska oblast	78.0	52	30.49
24	Khmelnitska oblast	134.9	85	16.93
25	Cherkasska oblast	159.7	58	39.69
26	Chernivetska oblast	30.0	47	13.05
27	Chernihivska oblast	153.1	59	42.89
	Total	5423	60	1732.21

Source: Centre for Social and Economic Economic Research Ukraine (CASE) (2008), *Ukrainian Heating Sector Review*, *www.case-ukraine.com.ua/u/publications/5a6fa8e6557b434db34f03aee0e6e9e9.pdf*, accessed 20 October 2008.

where the complying regions are actually taking the burden and subsidising those that do not comply. Finally, they are detrimental to the restructuring and upgrading of the whole sector, as private or foreign investors would not have an incentive to intervene in an uncompetitive market where the current players are accumulating debts and the profitability of their activities is at risk. For instance, according to the Country Capabilities Survey in Ukraine conducted by the OECD in 2011, 58% of the firms interviewed identified the lack of visibility regarding future profits as a major hurdle to foreign investment in the sector.

Natural gas, heat and electrical power prices are still subsidised

The subsidies that are keeping energy prices at artificially low levels are preventing investments in renewable energy. Despite the recent increase in the price of natural gas, Ukrainian households still enjoy subsidised energy prices, which have typically been artificially below international levels. Prices tend to cover only operating costs, instead of long run marginal costs. For example, at the beginning of 2011 the import price for natural gas (including VAT) stood at around UAH 2000 per thousand while consumers paid an average of UAH 911 per thousand. The IEA estimates that in 2009 the level of energy subsidies in Ukraine was equivalent to some 4.7% of the country's GDP, *i.e.* around twice the levels observed in Russia and Kazakhstan (IEA, 2010). This has hampered both efficiency and investment, minimising competition (IEA, 2006). One of the consequences of the current pricing scheme has been chronic under-investment in building, maintenance, and upgrades of all energy infrastructures, including pipelines and the electricity grid.

The Economic Reform Programme for 2010-14 envisages a gradual increase of gas prices and aims at achieving a liberalisation of the energy industry. Energy sector reforms are facing political resistance, but until the era of subsidies and cheap energy comes to an end, other alternative, more efficient energy sources that are not subsidised will struggle to be competitive. For instance, the bailout granted in July 2010 by the IMF is conditional on structural reforms including a realignment of energy prices with market fundamentals.

State ownership of power and heat production assets

The participation of private actors could bring in much-needed investment in the biomass sector, reduce the costs of processes and upgrade service quality. There is a lack of funding to replace fossil fuel-based boilers with biomass-fired equipment. Private investors could play a key role in the provision of funds as they have the ability to raise financing on capital markets. However, most of the old facilities are currently owned by the state, the regions or the municipalities. Public authorities perceive the production of power and heat as a social service and do not generally link it to market dynamics.

The size of the state-owned enterprises in the energy sector prevents the entry and exit of new players, limiting its modernisation and growth. As a result the private sector has not had the chance to be particularly involved so far. Due to the protracted lack of government investment, the rate of depreciation of existing capital assets has already reached 70% on average and the presence of obsolete equipment raises the inefficiency of current processes. There is therefore an urgent need to modernise or replace existing assets.

Policy recommendations

Streamline administrative processes, including a single-window approach and pre-approval for green tariffs

The licensing, permit and administrative processes need to be streamlined to make them transparent, more predictable and competitive. A "single-window" system for setting up alternative energy activities should be considered. The single-window would provide information on administrative forms, procedures, approvals, clearances and permissions, reporting, filing, payments and compliances. An electronic system would be advisable, so that different players do not need to visit different physical locations anymore, minimising costs. Drawing from the OECD experience, the most advanced single-window systems, such as the one implemented in Korea, also connect entrepreneurs with financial intermediaries, insurance companies, and ICT specialists to facilitate their operations. The single-window approach would improve governance and minimise the opportunities for corruption.

Align energy costs to market prices, as promised to the IMF

The distortions caused by the mismatch between domestic and market energy prices need to be removed with a high priority. The government is already committed to implementing semi-annual increases in gas prices and the process of aligning energy prices with international levels needs to continue. Industrial prices are already at market levels, while consumers still enjoy subsidised tariffs. The upward pressures on prices will give 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 in a more efficient way. The process could also divert attention towards other alternative sources of energy.

To protect the poorest segments of the population from sharp rises in energy costs several welfare mechanisms could be introduced. A targeted welfare approach would be more effective than subsidising energy prices for all consumers. Special cash transfers, such as energy vouchers, would be relatively good in terms of targeting, but they would require some degree of administration and co-ordination. Other options such as lifeline tariffs where the lowest block of consumption is charged at a lower price would be simpler to administer but would require a reliable metering system. The relevant stakeholders need to perform a transparent cost-benefit analysis and select the combination of measures that they would like to adopt in order to offset the impact of the energy price rises. This step is particularly important to ensure that the most vulnerable part of the population does not suffer the greatest losses and ultimately to ensure political stability.

Draft a national action plan for the production of energy from biomass, including demonstration projects and possible green tariffs for heating

A national strategic plan for the biomass sector needs to be drafted, with clear targets for the short and the long terms and key performance indicators to keep track of the work in progress. Some demonstration projects showing the integration of both supply and use are recommended to draw attention to the sector and raise awareness of its relevant features. The experience drawn from international case studies could be also used as a reference for the implementation of a reliable supply chain. An indication of alternative green tariffs for heating could also be provided in order to support investors in their investment decisions through a clear projection of their future revenues and profitability. Predictability of income streams is an important element that investors consider in their business plans; at the moment there is no long-term certainty about the income flows for private players and the national strategic plan could support foreign and domestic investors in this direction.

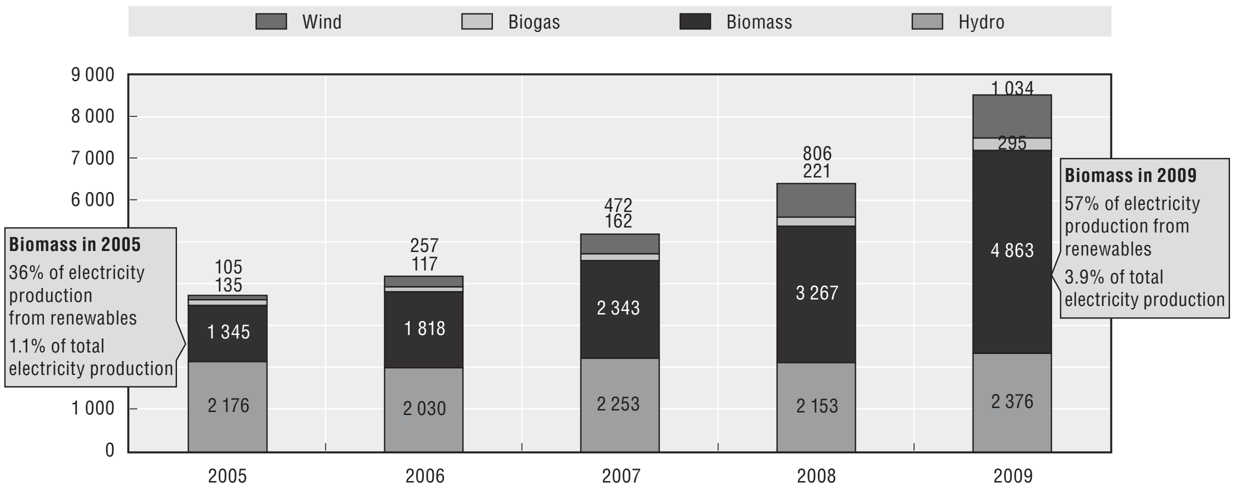
In 2006, the Energy Strategy of Ukraine to 2030 was approved, in an attempt to formulate a policy strategy for the country. In the baseline scenario presented in the report, power generation by other renewable sources is expected to increase at an average growth rate of 16% per year, from 51 million kilowatt hour in 2005 to 2.1 billion kilowatt hour in 2030. The funding required to finance the alternative energy sources for power generation was estimated to be UAH 7.1 billion in the period 2006-30. Unfortunately, the report has not been followed by a phase of structural reforms and the implementation of new alternative energy sources has stalled.

In 2009, the government of the Netherlands supported its Ukrainian counterparts in the preparation of the *Biomass Action Plan for Ukraine*, outlining a general strategy for bio-energy development in the country, defining the current barriers and suggesting concrete solutions to solve existing issues within a defined time frame. The analysis already conducted could be a framework to support and realise a strategic plan. Politicians have the opportunity to overcome inertia and internal disputes, to build an ambitious project that could have an important impact on the country. The national action plan should also include a communication and promotion campaign, to increase the awareness of the biomass sector's potential among the business community and end consumers.

Poland could be taken as a good case study of a country which has been attempting to reduce its dependence on fossil fuels, particularly its use of coal for the generation of more than 90% of its electricity (Figure 7.19). As part of this effort, the Polish government set targets for the use of renewable energy as a percentage of total energy use. The latest targets, set in 2009 in line with EU directive 2009/28/EC, call for an increase in Poland's use of renewable energy to 15% of total energy consumption by 2020. The government subsequently introduced a further target of 20% by 2030 in its strategy document "Poland's energy policy to 2030", released in November 2009. This longer term strategy also includes a target for a 10% share of bio-fuels in the transport fuel market by 2020. In 2009, renewables accounted for 6.6% of gross energy consumption, mostly biomass, although much of this was used for heat rather than electricity generation.

Figure 7.19. **The quick adoption of biomass in Poland has made it a key element in the renewables landscape**

Electricity production from renewables in Poland (GWh), 2005-09



Source: *International Energy Agency (IEA) (2011)*, *Energy Policies of IEA countries, Poland Review*, IEA, Paris; Poland's Ministry of Economy (2010), "Energy Policy of Poland until 2030", *Presentation* delivered by Martin Korolec on 22 September 2010.

The government's strategy for encouraging the use of renewable energy has included both regulation and market mechanisms. The 2005 energy law introduced an obligation on electricity distributors to purchase all of the electricity generated from renewable sources that is offered to them, and to give this electricity priority access to the national grid. Moreover, the government introduced a system of green certificates' setting quotas for the use of renewable energy and imposing charges on distribution companies not meeting these quotas. In addition, electricity generated from renewable sources and fuels containing bio-components (including transport fuels containing additives such as ethanol) are either exempt from or subject to lower rates of excise duty. Also, since 2006 farmers have been permitted to produce bio-fuels for their own use, subject only to minimum quality requirements, without paying excise duty. The government also provides grants and preferential credits for renewable energy investments through the National Fund for Environmental Protection and Water Management and relevant regional funds, partly financed by EU support. These mechanisms are expected to result in further significant increases in bio-energy production and use.

Increase privatisations of energy production and distribution assets to trigger private investment in infrastructures

The state-owned enterprises dominating the energy arena need to go through a phase of privatisation. The past experience shows that the control exerted by the long chain of state-owned enterprises is detrimental to the efficient, profitable and sustainable functioning of the energy market. In the medium- to long-term the whole system, if not reformed properly, will become unaffordable with unfavourable consequences in terms of energy security and direct financial effects on the Ukrainian debt burden. A transparent and competitive process of privatisation of the energy generation and distribution companies should be implemented. In 2010, the Ukrainian Minister of Energy and Coal announced a plan to privatise two power generating companies and around five regional power distribution companies in 2011. Then in June 2011, the government announced the privatisation by the autumn of 2011 of two power

Box 7.5. **The role of private and foreign investment in the Russian privatisation reforms**

Prior to the reforms, the Russian power sector was controlled by RAO UES, the state-owned holding company that controlled, but did not fully own, 72 vertically integrated local power companies (*oblenergos*) accounting for 70% of Russia's electricity generation. In practical terms, it owned all of the transmission and distribution networks in the country (Solanko, 2011).

The scope of the reform of the energy sector was ambitious and could not be financed only with public funds. Therefore it was clear that the reforms needed to provide an attractive environment for private investments, in order to mobilise private and foreign funds. The World Bank's standard model for reform was followed, including the following points (Besant-Jones, 2006):

- Corporatise power sector enterprises.
- Unbundle, meaning disaggregating the total electric service provided by a power utility into its basic components.
- Create an autonomous, transparent regulator.
- Privatise the generators and distributors.
- Develop power markets.
- Streamline the role of the government.

Private and foreign investments in wholesale and territorial generation companies totalled USD 21.5 billion in 2007, including the investments of three major international players, Fortum, Eon and Enel.

plants and nine power distribution companies worth around USD 760 million at current market prices. Ukraine has the opportunity to raise funds, which could help the budget deficit, while at the same time attracting private and foreign investment, which could help the modernisation of the energy infrastructure.

Review of payment mechanisms and market regulation institutions

The energy payment mechanisms need to be redesigned as current tariffs do not cover the real costs of energy supply. Payment collection should be enforced by a dedicated market regulation institution. The regulation should provide incentives for cost reduction and savings. The strengthening of payment discipline will have a positive effect on budget revenues and will also improve energy utilisation efficiency.

The co-ordination of enforcement activities should be done at the national level, with a clear and transparent legal framework and strong enforcement standards across all the oblasts. It could be advisable to support the implementation of meter readings in both industrial and residential buildings and to implement tight controls, linked to fines and sanctions. Currently, local authorities play an important role in determining whether customers in arrears are disconnected. However, the set of rules that determines the disconnection of non-compliant consumers needs to be set at a national level and enforced through systematic and targeted controls.

Solve existing payment arrears

The enforcement of payment collection will have a positive effect on payment arrears: if end consumers pay the full cost of the energy, generation and distribution companies will not accumulate arrears. The problem of payment arrears could also be tackled with the introduction of guarantee schemes by intermediaries. The debt spiral starts with the arrears consumers owe to regional power distributors (*oblenergos*). As a result, the oblenergos do not have enough resources to pay for the power purchased or to maintain and upgrade the distribution network and other assets. The *oblenergos* pile up debts towards Energorynok, the state company selling power to the *oblenergos*. At the beginning of 2006, consumers owed UAH 10 529 million to *oblenergos*. Distribution companies' debt towards Energorynok was UAH 15 962 million. In the same period, Energorynok's liabilities to Ukrenergo, the state company which owns and operates the transmission grid, were UAH 18 323 million (Tsarenko, 2007).

Prospective investors need to receive a signal that the chain of existing payment arrears has come to an end. In June 2010, the Ukrainian parliament passed a law going in the opposite direction, which wrote off UAH 24 billion of debts owed by energy companies to the state budget. The write off, if not followed by a restructuring of the payment system, would give a further incentive to keep the vicious cycle of payment arrears in place, with harsh consequences for the government's budget and for the outlook for the Ukrainian energy sector.

Bibliography

Alter Energy Group (2010), Corporate website *www.alterenergygroup.com/content/home.php?lang=en*, accessed 15 June 2010.

Besant-Jones, J. (2006), "Reforming Power Markets in Developing Countries: What Have we Learnt?", *Energy and Mining Sector Board Discussion Paper*, No. 19, World Bank, Washington, DC.

Biomass Energy Europe (BEE) (2008), "Status of Biomass Resource Assessments", Version 1, Biomass Energy Europe, *www.eu-bee.info/default.asp?SivuID=24158*, accessed 15 September 2011.

Centre for Social and Economic Economic Research Ukraine (CASE) (2008), Ukrainian Heating Sector Review, *www.case-ukraine.com.ua/u/publications/5a6fa8e6557b434db34f03aee0e6e9e9.pdf*, accessed 20 October 2008.

Davydchuk, V. and H. Vandenhove (2003), "GIS-Based Methodology for Chernobyl Contaminated Land Management through Biomass Conversion into Energy. A Case Study for Polessie, Ukraine", *Biomass and Bioenergy*, Vol. 25, No. 4.

Ericsson, K. and L. Nilsson (2006), "Assessment of the Potential Biomass Supply in Europe Using a Resource-Focused Approach", *Biomass and Bioenergy* Vol. 30, No. 1.

Geletuha, G. (1998), "Potential of Biomass and Perspectives of Biomass Conversion Technologies in Ukraine", paper presented at the European Conference and Technology Exhibition "Biomass for Energy and Industry", Würtzburg, Germany, June.

Hurstboiler (2010), Corporate website *www.hurstboiler.com,* accessed 15 June 2010.

Institute for Economic Research and Policy Consulting (2007), "Bioenergy Production in Ukraine: The Competitiveness of Crops and Other Raw Materials from Agriculture and Forestry", *Policy Paper*, No. 11, Institute for Economic Research and Policy Consulting, Kyiv.

Institute of Engineering Thermophysics and National Academy of Science in Ukraine (2010), "Biomass Energy Europe (BEE) project of FP7. Assessment of Biomass Potential in Ukraine", presentation at the VI International Conference on Biomass for Energy, Kyiv, 14-15 September 2010.

International Energy Agency (IEA) (2006), *Energy Policy Review Ukraine*, IEA, Paris.

IEA (2007), "Biomass for Power Generation and CHP", *IEA Energy Technology Essentials*, Paris.

IEA (2009), *World Energy Statistics*, IEA, Paris.

International Farm Comparison Network (2009), *Dairy Report 2009*, *www.ifcnnetwork.org/en/news/2009/09/pressrelease_dairy-report_2009.php*, accessed 15 April 2009.

Author's calculations based on estimates provided by Milkiland Ukraine, Corporate website *www.milkiland.com/en,* accessed 15 April 2009.

IEA (2010), *Fossil Fuel Subsidy Database*, *www.iea.org/subsidy/index.html*, accessed 30 September 2011.

International Finance Corporation (2009), *Investment Climate in Ukraine as Seen by Private Businesses*, IFC, Washington, DC.

International Monetary Fund (2010), “Country Report No. 10/262”, *Country Report Series*, International Monetary Fund, Washington, DC.

Johansson, B. (2001), “Biomass in Sweden – Historic Development and Future Potential under New Policy Regimes”, *Energy and Environmental Systems Studies*, Lund University, Lund.

OECD (2004), “Biomass and Agriculture: Sustainability, Markets and Policies”, proceedings of the OECD Workshop on Biomass and Agriculture, Vienna, 10-13 June.

OECD (2010), *Bioheat, Biopower and Biogas. Developments and Implications for Agriculture*, OECD, Paris.

OECD (2010), *Ukraine Sector Competitiveness Review*, internal working document, OECD, Paris.

OECD (2011), “Investment Policy Reviews: Ukraine 2011”, *OECD Investment Policy Reviews*, OECD, Paris.

OECD/FAO (2011), OECD/FAO *Agricultural Outlook 2011-2020*, OECD, Paris.

Petri, M. and G. Taube (2003), “Fiscal Policy Beyond the Budget”, *Emerging Markets Finance and Trade*, Vol. 39, No. 1.

Poland’s Ministry of Economy (2010), “Energy Policy of Poland until 2030”, presentation delivered by Martin Korolec on 22 September 2010.

Rabobank (2010), *Rabobank Dairy Top 20*, Press Room Rabobank Group, Corporate website, *www.pressroom rabobank.com/publications/food__agri/rabobank_dairy_top-20.html*, accessed 20 June 2010.

Scientific Engineering Centre “Biomass” *et al.* (2004), *Ukraine: Market Potential for District Heating Projects in the Ukraine and their Modernisation with Austrian Technology*, The Austrian Energy Agency, Wien.

Scientific Engineering Centre Biomass (2009), “Biomass Action Plan for Ukraine”, *in http://euea-energyagency.org/userfiles/file/BAP_Sep09_Current_ENG.pdf*, accessed 15 September 2011.

Smeets, E. and A. Faaij (2010), “The Impact of Sustainability Criteria on the Costs and Potentials of Bioenergy Production – Applied for Case Studies in Brazil and Ukraine”, *Biomass and Bioenergy*, Vol. 34, No. 3.

Solanko, L. (2011), “How to Succeed with a Thousand TWh Reform? Restructuring the Russian Power Sector”, *FIIA Working Papers*, The Finnish Institute of International Affairs, Helsinki, January.

Tsarenko, A. (2007), “Overview of the Electricity Market in Ukraine”, *Working Paper*, No. 1, Center for Social and Economic Research – CASE, Ukraine, Kyiv.

Van Holsteijn en Kemna (2002), “Heat from Renewable Energy Sources”, *The RES-H Initiative and related Directives*, VHK., No. 332, the Netherlands.

World Bank (2009), *Business Environment and Enterprise Performance Survey* (BEEPS), World Bank, Washington, DC.

Zhelyezna, T. and V. Leznova, (2008), Presentation of the EC FP7 Project “Biomass Energy Europe”, *Presentation* at the 4th International Conference on Biomass for Energy, 22-24 September, Kyiv.

Zhovmir N. *et al.* (2007), “Al’ternativnoe teplosnabzhenie za schet ispol’zovanija solomy” (Alternative Heat Supply through Use of Straw), *Kommunal’noe khozjaystvo*, No. 8, pp. 24-27, December.