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Energy sector in Belarus: Focus on wood and peat fuels

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Abstract

The energy sector in Belarus makes up approximately 30% of the industrial structure of the country. The role of the sector is large both in exports (36% of the total export value) and imports (39% of the total import value). Previously access to cheap gas from Russia and a lack of energy diversification policies have prevented Belarus from developing its potential local energy resources for energy generation. Nowadays energy security, which is determined primarily by the share of local energy resources in the overall energy balance, is the top priority. Currently, the share of local fuels is about 16% of the gross consumption of primary energy and 17% in the use of boiler and furnace fuel. According to the concept of energy security of Belarus the latter figure must be increased to 25% by 2012.

Belarus is poorly endowed with fossil resources, which have met only about 7% of the country's primary energy consumption in recent years. The most valuable Belarusian fossil energy resource is high quality oil, but its residual reserves are estimated at only 55 million tons. The total reserves of peat in the country are identified as 4 billion tons, but most of these are in agricultural land, or assigned to environmental areas. The natural conditions of Belarus do not allow a large-scale use of such renewable energy sources as wind, solar and hydro. The greatest potential sources of renewable energy in Belarus are the forests. The annual increment of forests is about 28.6 million m^3; which can provide approximately 4.6 million toe per year. Therefore, it is wood and peat which will be the main sources of growth in the share of local energy resources in the energy balance of Belarus until 2020. The current annual harvest of woody biomass for energy is about 9 million m^3 whereas the share of peat is over 3 million tons. In 2009, Belarus produced 5.6 million m^3 of wood in rough, 0.6 million solid m^3 of wood chips, 57,000 ton of wood pellets and briquettes, 1.2 million tons peat fuel briquettes.

The government has developed a series of regulatory documents to create a legislative, economic, financial, organizational and technical framework in the use of wood and peat fuels (Local Fuels Programme 2004, Woodfuels Programme 2009, Peat Programme 2008, Forestry Programme 2006). The target is 7 million m^3 of wood in rough, 1.5 million solid m^3 of wood chips, 0.8 million tons of wood pellets and briquettes, and 1.5 million tons of peat fuel briquettes. However, there is a risk that the targeted increase in the production of woodfuels may cause an extensive use of high-quality logs as woodfuel, which will have negative environmental implications and cause a suboptimal exploitation of the forest resources. Many of these issues are not unique to Belarus and are being faced by several countries who plan to promote renewable energy.

Keywords
renewable energy, woody biomass, woodfuels, wood harvesting, wood chips, wood pellets, wood briquettes

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Other information

Contents

Preface

This report was written under the umbrella of the project "Central and Eastern European Forest Information Service". The aim of the project is to create an information service for the Estonian, Latvian, Lithuanian, Polish, Czech, Belarusian, Ukrainian and Romanian forest sectors and to strengthen knowledge relating to it. The goal is to find business opportunities and new markets in the Central and Eastern European (CEE) countries. The project's target groups are Finnish forest sector enterprises and technology manufacturers planning to enter the business or expand it to the CEE countries. The project is funded by the European Social Fund (ESF).

This report is the second publication within the project. The report describes briefly the current situation of the energy sector in Belarus with a focus on wood and peat fuels. The thematic and cartographic material is grouped to woody biomass and peat resources and potential, production and the most important producers of woodfuels (energy wood in rough, wood chips, wood pellets and briquettes), as well as peat fuels (briquettes and pellets). This review serves the information needs of different stakeholders and those interested in the bioenergy sector in Belarus. All maps can be downloaded from the Metla information service on Central and Eastern European countries in the Internet (www.metla.fi/metinfo/kie). The report is a part of a publication series which will be prepared about CEE countries during 2010–2012.

Finally, a word of appreciation to Timo Karjalainen, Elina Välkky, and Juhani Marttila who have reviewed the first full draft. Their comments greatly helped to improve the quality of this report.

Introduction

Belarus, officially the Republic of Belarus, is a landlocked country in Eastern Europe with an area of 207,600 km² (Kostevich et al. 2010a). It has a common border with Latvia in the north, Lithuania in the north-west, Poland in the west, Russia in the north and east and Ukraine in the south. Belarus is landlocked, relatively flat, and contains large tracts of marshy land. Belarus' highest point is Dzerzhynsk Hill (Дзержинская гора) at 345 metres, and the average elevation of Belarus is 160 metres above sea level. Many streams and 11,000 lakes are found in Belarus. Three major rivers run through the country: the Neman (Неман), the Pripyat (Припять), and the Dnepr (Днепр). The Neman flows westwards towards the Baltic Sea, and the Pripyat flows eastwards to the Dnepr; the Dnepr flows southwards towards the Black Sea. Approximately 70% of the radiation from neighbouring Ukraine's 1986 Chernobyl nuclear disaster entered Belarusian territory, and as of 2005 about one fifth of its area (principally farmland and forests in the south-eastern regions) continues to be affected by radiation fallout (Geography of Belarus 2010).

The proximity of the Baltic Sea (257 kilometres at the closest point) means that the country has temperate continental climate. Winters last between 105 and 145 days, and summers last up to 150 days. Winters are cold and summers are cool and moist, and there is a great need for heating during the winter months. The climate ranges from harsh winters, with average January temperatures at −6 °C, to cool and moist summers with an average temperature of 18 °C in July. Belarus has an average annual rainfall of 550–700 mm. The country has a transitional form between continental and maritime climate (Geography of Belarus 2010).

Natural resources are limited and include peat deposits, small quantities of oil and natural gas, granite, dolomite (limestone), marl, chalk, sand, gravel and clay. The most important natural resource is the forests, which cover 40% of the country (FAOSTAT 2010, Gerasimov and Karjalainen 2010).

Belarus with a population of 9.480 million is divided into regions (область), which are named after the cities (namely Brest, Grodno, Mogilev, Minsk, Gomel and Vitebsk) that serve as their administrative centres. Each region has a regional legislative authority, called a regional council (областной совет), which is elected by the region's residents, and a regional executive authority, called a regional administration (областная администрация), whose leader is appointed by the president. Regions are further subdivided into districts (район). As with regions, each district has its own legislative authority, called a district council (районный совет) elected by its residents, and an executive authority, called a district administration (районная администрация), appointed by higher executive powers. As of 2010, there are six regions, 118 districts, 112 towns and 94 urbanized settlements (Kostekevich 2010b). The city of Minsk itself is split into nine districts and is given a special status, due to the city serving as the national capital. Minsk city is run by an executive committee and granted a charter of self-rule by the national government.

Belarus was one of the USSR's major industrial republics, specializing in the production of machinery and agriculture. Although industry has declined significantly since independence from the USSR in 1991, industry and manufacturing continue to make an important contribution to the economy. Belarus has retained close political and economic ties with Russia, and has signed a treaty on a union that envisions greater political, trade and economic integration. Belarus suffered greatly from the 1998 financial crisis in Russia but is recovering with a GDP growth at 5% in 2002 (minimum), 11% in 2004 (maximum) and 10% in 2008. The industrial sector has continued to be

the source of this growth, at 5% in 2002 (minimum), 16% in 2004 (maximum) and 12% in 2008 (Kostevich et al. 2010b).

The Government of Belarus officially welcomes foreign investment (National Investment Agency 2010). Belarus offers a number of considerable advantages to potential investors – its central location, well-educated and relatively inexpensive work force, low crime rate and easy access to the Russian market. The Investment Code of the Republic of Belarus came into force in 2001 and states that investors' rights are guaranteed by the state. It guarantees property rights and the right to remit profits abroad. Investments cannot be nationalized without complete and timely compensation. The government has also worked out the National Programme for Attracting Investment, which is aimed at improving the general investment climate. Nevertheless investments in all sectors, including the energy sector, have been hindered by low levels of privatization.

1 Energy Sector

1.1 Macroeconomic role

The energy sector makes up approximately 30% of the industrial structure of the country. The role of the sector is large both in exports (36% of the total export value1) and imports (39% of the total import value) (Gavrilova et al. 2010). The energy sector has played a key role in supporting Belarus' recovery after the USSR collapsed by providing affordable, reliable, and sufficient energy to the national economy over the past decade. However, Belarus is a net importer of energy resources, and it imports significant volumes of oil, gas and electricity. Furthermore, over 95% of all primary energy supply comes from Russia. On the one hand, Russia supplies energy to Belarus for a considerably low price compared with world market price due to the specific relations between the countries. On the other hand, this creates significant risks to energy security. Russia's recent actions to introduce market-based prices for its energy exports to the former USSR countries (CIS) are likely to result in the phasing out of Russian energy subsidies to Belarus. This creates a risk of depriving the sector of the hefty margins that allowed it to finance its investments directly from cash flows and compensate for weaknesses and limitations associated with state ownership and the vertical monopoly structure of the energy companies. This situation underscores the need for reforms that would allow the sector to raise financing and improve efficiency.

Table 1.1. Energy exports.

	2007	2008	2009
Crude oil			
Volume, million ton	0.851	1.453	1.716
Crude oil subtotal cost, US$ million	483.8	988.1	738.1
Price, US$/ton	568.5	680.0	430.1
Petroleum products			
Volume, million ton	15.1	15.2	15.5
Petroleum products subtotal cost, US$ million	7,626	10,613	7,005
Price, US$/ton	505.0	698.2	451.9
Electricity	547	613.4	349.4
Volume, TWh		0.558	
Electricity subtotal cost, US$ million		35.269	
Price, US cents/kWh		6.3	
Peat			
Volume, million ton	0.2168	0.305	0.4332
Peat subtotal cost, US$ million	8.744	14.212	20.923
Price, US US$/ton	40.3	46.6	48.3
Woodfuels			
Volume, million ton	0.093	0.136	0.092
Woodfuels subtotal cost, US$ million	5.306	8.332	7.263
Price, US$/ton	57.2	61.4	78.9
Total fuel and energy export, US$ million	8,124	11,659	7,771
Total export, US$ million	24,275	32,571	21,282
Fuel and energy export to total export, %	33%	36%	37%
GDP, US$ million	45,275	60,313	48,973
Fuel and energy export to GDP, %	18%	19%	16%

Source: Belstat 2010

1 Real export of Belarusian energy without Russian transit energy flow

An important feature that emphasizes the macroeconomic role of the energy sector is that in almost all previous years there was a rise in the contribution of exports of primary energy (oil) in the overall export growth in Belarus. Since 2005 Belarus has significantly increased exports of oil and petroleum products, which was the result of growth in the share of energy products in the exports from 8% in 2000 to 36% in 2009. This is made possible by the favourable conditions of crude oil deliveries to Belarus from Russia. Customer benefits of supply declined slightly after 1 January 2007, when Russia forced Belarus to pay part of its oil duties (one-third).

Import of energy resources is also an essential part of all Belarusian imports. Belarusian industrial enterprises use a significant amount of intermediate imports – mostly energy resources and metals, producing products with low value added. It should be noted that the growth of exports and imports of energy resources are not equally reflected in the balance of foreign trade in energy. Since 2006 it has been consistently negative, i.e. energy imports exceeded its exports. This is largely due to a gradual rise in prices for natural gas imported from Russia, but also due to a change in the terms of the supply of Russian oil (Gavrilova et al. 2010, Myroshnychenko 2006).

Table 1.2. Energy imports.

	2000	2005	2007	2008	2009
Natural gas					
Volume, billion m³	17.1	20.12	20.6	21.1	17.6
Natural gas subtotal cost, US$ million	525	949.5	2,088.7	2,675.5	2,601.1
Price, US$/1000 m³	30.7	47.2	101.4	126.8	147.8
Crude oil					
Volume, million ton	12.01	19.32	20	21.5	21.5
Crude oil subtotal cost, US$ million	1,636	4,222	7,234	9,492	7,065
Price, US$/ton	136.2	218.5	361.7	441.5	328.6
Petroleum products					
Volume, million ton	1.08	0.57	0.89	2.49	3.78
Petroleum products subtotal cost, US$ million	210.1	152.6	486.8	1,527.3	1,320.8
Price, US$/ton	194.5	267.7	547.0	613.4	349.4
Electricity					
Volume, TWh	7.2	4.94	4.34	2.4	4.48
Electricity subtotal cost, US$ million	128.9	99.93	129.1	113.1	193.8
Price, US cents/kWh	1.8	2.0	3.0	4.7	4.3
Total fuel and energy import, US$ million	2,500	5,424	9,939	13,808	11,181
Total import, US$ million			28,693	39,381	28,564
Fuel and energy import to total import, %			35%	35%	39%
GDP, US$ million	11,417	29,575	45,275	60,313	48,973
Fuel and energy Import to GDP, %	22%	18%	22%	23%	23%

Source: Belstat 2010

The energy sector of the country not only plays an important macroeconomic role, but also ensures the reliability of transit, in addition to the geopolitical importance of bringing the country profit (Rakova 2010, Myroshnychenko 2006). The capacity of transit gas pipelines in Belarus is 63 billion m³ per year (Figure 1.1). In 2008, Belarus transited to Western Europe 51.2 billion m³ of natural gas and 44.2 billion m³ in 2009. Transit of natural gas is mainly controlled by the Russian side, thus providing transit revenues worth about US$ 250 million. Construction of the natural gas pipeline "Nord Stream" in Baltic Sea has reduced the importance of the Belarusian direction.

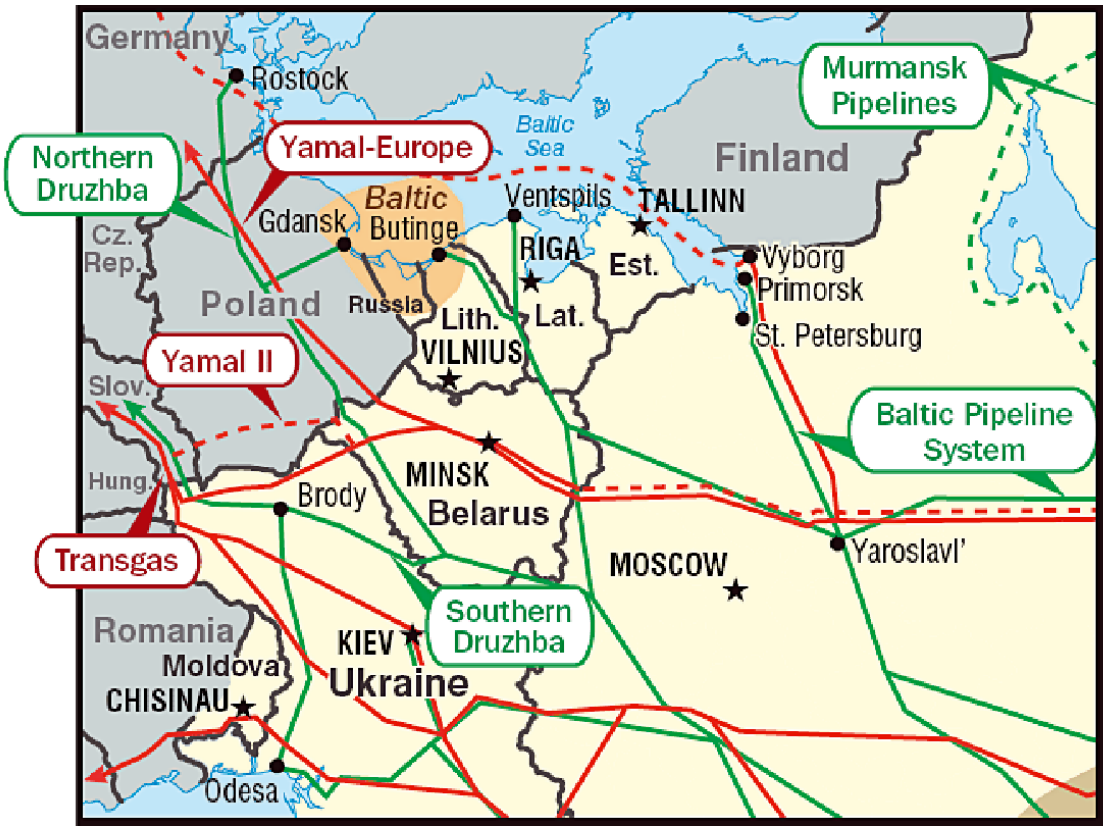

Figure 1.1. Main natural gas (red) and oil (green) pipelines in Eastern Europe (Source: Wikipedia)

All attempts of the Belarusian government to convince Russia of the benefits of building a second branch of the Russian gas pipeline ”Yamal–Europe” have failed.

The volume of oil transportation through pipelines in Belarus in 2009 amounted to 89.6 million tons, an increase of 53% compared with 2008. Oil transit also tends to reduce its significance in terms of financial flows. Closing the Russia–Baltic pipeline ”Friendship” and the construction of new pipelines have reduced the importance of the Belarusian direction.

The growing role of Belarus in the transit of electricity from Russia to the Baltic countries and Kaliningrad Region after closing the Ignalina nuclear power plant in Lithuania in 2010 should be particularly emphasized. This may explain the conflict with Russia which emerged in early 2010, when Belarus demanded a significant increase in transit fees.

1.2 Energy source and supply

Energy use by source and by sector for Belarus in 2007 is presented in Table 1.3 and Figure 1.2.

Table 1.3. Energy use by source and by sector for Belarus in 2007 in 1,000 ton of oil equivalent (ktoe).

Source and consumption	Coal and peat	Crude oil	Petroleum products	Natural gas	Hydro	Combus-tible renewables and waste	Electri-city	Heat	Total
1. Energy sectors									
1.1. Electricity plants	0	0	15	3,753	3	0	0	0	3,771
1.2. CHP plants	19	0	56	5,909	0	51	0	0	6,035
1.3. Heat plants	108	0	300	2,969	0	452	0	0	3,829
1.4. Petroleum refineries	0	19,411	0	0	0	0	0	0	19,411
1.5. Own use	13	0	513	0	0	22	322	358	1,228
1.6. Distribution Losses	44	385	14	154	0	0	320	617	1,534
2. Industry sector	57	0	564	1,692	0	157	1,214	1,980	5,664
3. Transport sector	7	0	1,698	432	0	0	157	0	2,295
4. Other sectors									
4.1. Residential	231	0	1,214	1,199	0	580	517	2,230	5,972
4.2. Commercial and public services	2	0	4	3	0	155	297	1,127	1,589
4.3. Agriculture/Forestry	3	0	760	40	0	37	123	157	1,120
4.4. Non-specified	58	0	62	16	0	0	160	0	296
5. Non-energy use	10	1,659	453	1,179	0	0	0	0	3,301

Source: IEA 2010

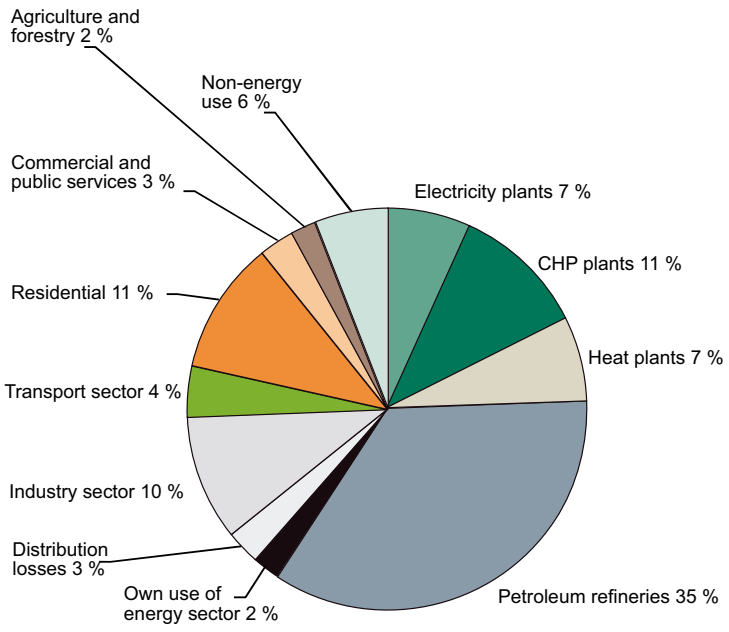

Figure 1.2. Distribution of energy use by sector.

Energy resources such as oil and gas are limited in Belarus, and the country is highly dependent on imports. In 2009, 88% of the total energy consumption in Belarus came from foreign sources, most of this in the form of natural gas from Russia (Gavrilova et al. 2010). These imports are purchased partly by hard currency, which gives the current government very strong economic and political incentives to reduce energy consumption. As indicated in Table 1.4, Belarus consumes approximately 26 million tons of oil equivalents (Mtoe) of primary energy resources annually but produces only a little over 4 Mtoe. The balance is imported from Russia, with crude oil and natural gas topping energy imports. While the bulk of imported crude oil is processed at the Belarus refining complex and then petroleum products are exported, imported natural gas is fully consumed domestically. As a result, imported gas accounts for about 70% of the country's primary energy consumption.

Energy exports and imports have substantial macroeconomic implications for Belarus. As indicated in Table 1.2, the cost of energy imports amounted to about 23% of the country's GDP in 2008. Revenues stemming from energy exports (largely dominated by petroleum products) reached 19% of GDP in the same year. Though the revenues from energy exports largely offset the cost of energy imports, the latter, especially natural gas imports, do cause a significant strain on the Belarusian trade balance.

Table 1.4. Belarus primary energy supply and consumption

	2000	2005	2007	2008	2009
Production					
Crude oil, million tons	1.851	1.785	1.760	1.740	1.720
Natural gas, billion m³	0.257	0.228	0.201	0.203	0.205
Peat and wood, million ton	6.6	7	7	7	7
Hydropower, TWh	0.03	0.03	0.03	0.03	0.03
Total production, million toe	*4.02*	*4.06*	*4.03*	*3.95*	*3.93*
Import					
Crude oil, million ton	12.01	19.32	20	21.5	21.5
Natural gas, billion m³	17.12	20.12	20.6	21.1	17.6
Petroleum products, million ton	1.08	0.57	0.89	2.49	3.78
Electricity, TWh	7.22	4.94	4.34	2.40	4.48
Coal, million ton	0.43	0.14	0.05	0.05	0.05
Total import, million toe	*26.68*	*35.07*	*36.27*	*39.29*	*38.59*
Export					
Crude oil, million ton	0.35	1.35	0.85	1.45	1.72
Petroleum products, million ton	7.78	13.49	15.1	15.2	15.5
Peat and wood, million ton					
Electricity, TWh		0.9		0.56	
Total export, million toe	*8.13*	*15.0398*	*15.95*	*16.77*	*17.22*
Primary energy consumption, million toe	22.57	24.09	24.35	26.47	25.31

Source: Belstat 2010
Note: The applied conversion factors are: crude oil and petroleum products – 1.0; natural gas – 0.86; coal – 0.7; peat and wood – 0.3; electricity – 0.22.

Existing infrastructure and geographical proximity ensure that Russia will be Belarus' primary source of energy supply for the foreseeable future. However Belarus would benefit from enlarged use of domestic energy resources.

1.3 Energy sub-sectors

1.3.1 Oil

The oil business plays a significant role in the Belarusian economy. The oil sub-sector is represented by two oil refineries in Novopolotsk (Vitebsk region) and Mozyr (Gomel region): "Belarusneft" (oil and gas production, oil service, hydrocarbon processing, sales of oil and gas inside country and abroad) and the state oil trader "Belarusian Oil Company" (БНК). In addition to this, there are independent oil suppliers to the refineries.

In 2009, Novopolotsk and Mozyr refineries processed 21.6 million tons of oil; 10.7 and 10.9 million tons respectively. Both plants were privatized in 2002 with a view to the subsequent sale of a controlling stake to Russian investors. About 43% of shares of the Mozyr refinery belong to Russian investors, while the Novopolotsk refinery is virtually 100% owned by the Belarusian government.

"Belarusneft" produces about 1.7 million tons of oil per year – 6% of needs. Despite the lack of its own raw materials, export of petroleum products remained one of the main Belarusian export products, and the proceeds from their sale are an important source of foreign currency into the country. Exports of Belarusian petroleum products during previous years grew steadily: from 7.7 million tons in 2001 to 15.5 million tons in 2009. At the same time the profitability of the oil processing industry gradually declined: 5.3% in 2009 versus 7% in 2008 and 12% in 2007, and it is lower than the average in Belarusian industry. As a result the inflow from the oil refining business to the Belarusian budget in 2009 compared to 2008 fell almost twofold due to the decreasing prices of exports and the continued increasing duties on imported Russian oil. Revenue from export duty on exported oil was less than 7% of all revenues in 2009 (12% in 2008) (Rakova 2010).

The development of fuel prices of producers in Belarus in 2000–2009 is shown in Table 1.5. At present, the fuel oil for residential customers is Br 580/kg or €0.15/kg.

Table 1.5. Development of average residual fuel prices in Belarus in 2000–2009.

Fuel	2000	2005	2006	2007	2008	2009
Residual fuel oil, 1,000 Br per ton	113.2	289.1	384.2	452.1	562.9	579.6
Diesel fuel, 1,000 Br per ton	278.0	468.7	738.9	999.2	1,037.2	1,239.8
Peat briquettes, 1,000 Br per ton	18.9	53.6	63.0	76.5	92.4	108.3

Source: Palkovskaya et al. 2010

1.3.2 Natural gas

Natural gas is a strategic raw material for the Belarusian economy. By trying to reduce production costs of domestic producers through the use of cheap Russian gas, Belarus increased the share of natural gas consumption in the energy sector from 43% in 1990 to 80% by 2000. This greatly increased the risks of the country in terms of energy security, especially taking into account the dominant role of natural gas in the energy balance of the country and the only actual monopoly supplier of natural gas – Russia.

In 2009, Belarus consumed 17.6 billion m³ of natural gas and continued to buy it from Russia at a relatively low price. According to the contract on natural gas supply and transit in 2007–2011, which was signed by "Gazprom" and "Beltransgaz" (the Russian side owned 37.5% of "Beltransgaz" shares in 2009), the formula for calculating the natural gas price for Belarus is tied to the average price with the discount factor. In 2009, Belarus had to pay 80% of the average European price minus transportation costs and customs duties (30% of the selling price of "Gazprom"), US$ 150 per m³ in average. For comparison, the average European price was around US$ 280 per 1,000 m³ (Rakova 2010).

1.3.3 Electricity generation

In 2009, Belarus produced 30.4 TWh of electricity, which is 14% (4.7 TWh) less than was produced in 2008. Belarus can provide its own electricity, but imports in the summer are economically feasible. In 2009 Belarus imported 4.1 TWh, including 2.9 TWh from Russia, which is 86% (2.1 TWh) more than in 2008 (Rakova 2010).

Item name	Description	Item name	Description
Nuclear Power Plant	⦿	Overhead transmission line OHTL 750 kV	
CHP, Power Station	⬓	OHTL 330 kV	
Substation 750 kV	○	OHTL 220 kV	
Substation 330 kV	◑	OHTL 110 kV (double-circuit)	
Substation 220 kV	●		

Figure 1.3. Energy system of Belarus (Source: Kuzmich 2009)

Natural gas plays a vital role in electricity generation in Belarus. The total installed electrical capacity of 2 condenser type (only-electricity) power plants and 32 combined heat power plants (CHP) using natural gas is 8,247 MW (Belenergo 2010). Moreover in the electricity generation system there are 35 small hydropower stations with a total installed capacity of 14.99 MW and 71 power electrical stations at industry with installed electrical capacity of 336.6 MW. The locations of the main power stations are presented in Figure 1.3.

The power sector in Belarus is managed by the state production association "Belenergo" (Belenergo 2010), which is responsible for the production, delivery and distribution of electricity and heat. It consists of six regional energy enterprises (обленерго), a joint dispatch management unit "ODU" (Объединенное Диспечерское Объединение), as well as several other related electric power companies (construction, governments, research and development, repair, installation, etc.). There is no special operator of the electricity transmission system in Belarus. This function is divided between "Belenergo", regional electricity enterprises and "ODU". The system of energy transfer is in public ownership, and controlled by the regional energy enterprises.

In 2009 the power plants belonging to "Belenergo" produced 28.6 TWh of electricity or 94% of the total electricity production in Belarus (Table 1.6). The Vitebsk region is the biggest producer of electricity (over 40% of the total production), and the Grodno region is the smallest (only 4%).

There are no significant independent (private) power plants, and "Belenergo" is the sole purchaser of all electricity (including imported or produced in the country's small independent producers of wind energy).

The tariff for electricity exchange between regions is set by the Ministry of Energy (Minenergy 2010) and does not reflect the real costs. The main purpose of the Ministry is to maintain financial stability in regional enterprises in accordance with the annual plans and the targets set by the government.

The development of electricity producer prices and tariffs for residential customers in Belarus in 2000–2009 is shown in Table 1.7. At present, the electricity tariff for residential customers is 173 Br/kWh or 0.045 €/kWh by the decision of the Council of Ministers of the Republic of Belarus on 16 December 2008 № 1942 (Minzhilkomhoz 2010).

Table 1.6. Electricity production in Belarus in 2008–2009, billion kWh.

Region	2008	2009	2009/2008, %
Brest	4.852	3.489	72
Vitebsk	15.138	12.150	80
Gomel	3.039	2.604	86
Grodno	0.985	1.021	104
Minsk	8.225	7.855	96
Mogilev	1.422	1.501	106
"Belenergo"	33.66	28.62	85
Belarus	35.1	30.4	87

Source: Belenergo 2010, Kostevich 2010b

Table 1.7. Development of average electricity prices and tariffs for residential customers in Belarus in 2000–2009.

	2000	2005	2006	2007	2008	2009
Electricity price of producers, Br per kWh	476.3	114.0	140.4	190.0	241.0	298.0
Electricity charge in residential houses not equipped with electric cooker, Br per kWh	14.4	88.1	93.4	112.1	145.0	173.0

Source: Palkovskaya et al. 2010

1.3.4 Heat generation

Heat supply in cities and urban settlements is carried out from CHP, district boiler houses, and boiler houses of industrial plants. Heating and hot water is predominantly supplied through two types of district heating systems.

The first type is the large CHP systems and heat-only boilers operated by the state energy company "Belenergo", which has 32 CHP plants, and 35 regional boiler houses with capacities from 80MW to 700MW. The "Belenergo" CHP plants and boilers are predominantly fuelled by natural gas (90%).

In 2009 the power plants belonging to "Belenergo" produced 142.3 million GJ (Table 1.8) or about a half of the total heat production in Belarus (Mihalevich 2009). The Minsk region is the biggest producer of heat (over 37% of the total production), and the Brest region is the smallest (only 7%).

The second type is the smaller, heat-only boilers operated by the Ministry of Communal Services and other ministries, state industrial enterprises, and private companies. There are over 10,000 boiler houses with capacities below 10 MWth that provide district heating and process heat in the Republic of Belarus, where the majority of these (65%) burn heavy oil (mazut), diesel and coal, and the remainder burn natural gas. The combustion of these fossil fuels leads to high levels of greenhouse gas (GHG) emissions since boilers are frequently inefficient because of age (commonly 20 to 30 years old), and operate far below their design capacities as a result of reduced industrial demand (Department for Energy Efficiency 2010).

Table 1.8. Heat production in Belarus in 2008–2009, million Gcal.

Region	2008	2009	2009/2008, %
Brest	2.253	2.428	107.8
Vitebsk	4.918	5.423	110.3
Gomel	5.143	5.144	100.0
Grodno	3.152	3.420	108.5
Minsk	12.132	12.638	104.2
Mogilev	5.012	4.939	98.5
"Belenergo"	32.61	33.99	104.2

Source: Belenergo 2010

The Ministry of Communal Services owns about 1,700 heat-only boiler-houses with an average installed capacity of 5 MW. Of these, 50% run on natural gas, 40% on heavy oil, 6% on coal, and the rest (4%) on peat and wood. They operate in 204 cities and towns. Individual municipalities operate the boilers of the Ministry of Communal Services, and financial resources come via municipal budgets. Heat power equipment is produced in Gomel city by the companies "Energy" and "Kommunalnik" under the Ministry of Communal Services of the Republic of Belarus or are exported. Since 2004 Belarusian companies have produced boilers for various woodfuels such as firewood, wood chips and wood pellets (Minzhilhoz 2010).

In addition to the boilers of the Ministry of Communal Services, there are about 10,000 boiler houses with below 10MW heat capacity under the ownership of other ministries, state and private industrial enterprises, schools and hospitals. They include approximately (Department for Energy Efficiency 2010, Biomass Energy 2010):

- 5 300 boiler houses with an installed capacity of less than 0.5 MW;
- 3 350 boiler houses with an installed capacity from 0.5 to 3 MW;
- 740 boiler houses with an installed capacity from 3 MW to 5 MW; and
- 580 boiler houses with an installed capacity from 5 to 10 MW.

These boiler houses operate on natural gas (35%), heavy oil and diesel oil (30%), as well as on coal, peat and wood (35%). They are typically 20 to 30 years old and are operated below their design capacity (meaning low efficiencies). Boilers are operated by both state and private industrial enterprises. In addition to providing heat for their own needs, they usually provide heat and hot water to surrounding apartment buildings or the Ministry of Communal Services in cities and villages.

A comprehensive market study carried out within the framework of the EU project BYE/00/G42 shows that the Ministry of Communal Services owns approximately 27% of boiler houses in 0.5–10 MWth size, with 20% in the agricultural sector, 21% in the social sector (education and health), and 32% in industry (Department for Energy Efficiency 2010). About 2,000 boilers sized between 0.5 and 10 MWth burning coal or heavy oil are suitable for conversion to woodfuels. On the fuel supply side, approximately 4.7 million m³ of woody biomass, which are currently unused, could be used as fuel, increasing to 12.9 million cubic metres in 2015 (Woodfuels Programme 2009).

The development of average heat producer prices and tariffs for the population in Belarus in 2000–2009 is shown in Table 1.9. At present, the heat tariff for residential houses is 10.38 Br/GJ or about 2.7 €/GJ by the decision of the Council of Ministers of the Republic of Belarus on 16 December 2008 № 1942 (Minzhilkomhoz 2010).

Table 1.9. Development of average heat prices and tariffs for residential customers in Belarus in 2000–2009.

Charges	2000	2005	2006	2007	2008	2009
Heat energy of producers, 1,000 Br per Gcal	21.702	33.010	40.044	51.057	56.382	70.407
Central heating charge, Br per m^2 of total floor space	70	587	607	732	722	889
Hot water charge in residential houses, monthly 1,000 Br per person	0.396	6.884	7.225	8.515	8.571	10.538

Source: Palkovskaya et al. 2010

1.4 Energy policies

The government has begun properly and promptly to raise issues of energy efficiency and renewable energy, and set targets for improvements. There are two major state bodies responsible for energy policy in Belarus. In 1993 the State Committee of Energy Saving under the Council of Ministers of the Republic of Belarus (Комитет по энергосбережению) was formed, which was mandated to develop and implement a national strategy to improve energy efficiency. This Committee was later transformed into the Department of Energy Efficiency of the State Committee on Standardization (Департамент по энергоэффективности Государственного комитета по стандартизации) of the Republic of Belarus. At the end of 2001, the government created the Ministry of Fuel and Energy (Минтопэнерго). This Ministry was later transformed into the Ministry of Energy (Минэнерго).

The need for action in these areas has been recognized by the government and has been reflected in a number of strategic programmes that outline the government's strategy and develop concrete action plans to modernize the energy sector, improve energy efficiency, and increase the use of domestic energy resources. The main energy sector strategic documents developed by the government in the past years are as follows:

- The Law of the Republic of Belarus "On energy saving" (Закон Республики Беларусь "Об энергосбережении").
- The National Programme on energy saving and renewable energy utilization in 2001–2005 (Республиканская программа энергосбережения на 2001–2005 годы).
- National Energy Saving Programme for 2006–2010 (Республиканская программа энергосбережения на 2006–2010 годы).
- State Integrated Programme for Modernization of Basic Production Assets of Belarus Energy System, Energy Saving and Enhanced Use of Local Fuels and Energy Resources for 2006–2010 (Государственная комплексная программа модернизации основных производственных фондов белорусской энергетической системы, энергосбережения и увеличения доли использования в республике собственных топливно-энергетических ресурсов в 2006 – 2010 годах).
- The concept of energy security of the Republic of Belarus (Концепция энергетической безопасности Республики Беларусь).
- Main Areas of Belarus Energy Policy for the Period up to 2020 (Основные направления энергетической политики Республики Беларусь на 2001 - 2005 годы и на период до 2015 года).
- Target Programme of Ensuring Generation of at least 25% of Electricity and Heat from Local Fuels and Alternative Energy Sources in Belarus for the Period up to 2012 (Целевая программа обеспечения в республике не менее 25 процентов объема производства электрической и тепловой энергии за счет использования местных видов топлива и альтернативных источников энергии на период до 2012 года).
- National programme to transform the boilers in the mini-CHP, 2007–2010 (Республиканская программа по преобразованию котельных в мини-ТЭЦ на 2007–2010 годы).

The government has developed five-year programmes for energy saving and the use of domestic energy resources, as well as has implemented a number of other initiatives, including education and providing information. Government policies on energy are supported by appropriate funding. The amount of energy efficiency funding has been increased from US$ 47.7 million in 1996 to US$ 1,213.9 million in 2008.

The first document was the National Programme on Energy Saving up to 2000, approved in 1996, but a more systematic document was the second National Programme on Energy Saving for 2001–2005.

1.4.1 National Programme on Energy Saving 2001–2005

The government set a conceptual task to ensure planned GDP growth without increasing the consumption of energy resources, i.e. reducing the energy intensity of GDP in 2005 in reference to 2000 by 15–19% while the growth rate of GDP over the same period was 18–23%. In fact GDP in 2005 compared with 2000 increased by 42.5%, while gross consumption of energy resources increased only by 6.5% (Table 1.10). The plan to save energy resources in 2005 compared with 2000 by reducing the energy intensity of GDP was estimated at 4.3–5.6 Mtoe, but in fact it amounted to 7.4 Mtoe.

Table 1.10. Key results of implementing the National Programme on Energy Saving in Belarus in 2001–2005.

Indicators	2000	2001	2002	2003	2004	2005	2001–2005
GDP growth rate, %	5.8	4.7	5.0	7.0	11.4	9.4	37.5
Gross consumption of primary energy, %		0.5	-0.9	1.5	2.8	2.6	6.5
Reducing energy intensity of GDP, %	5.3	4.0	5.6	5.1	7.5	6.1	25.3
Funding for energy saving, US$ million		92.5	91.3	205.7	360.1	438.9	1,188.5

Source: Energy Saving Programme 2006–2010

It should be noted that due to the desire to increase the efficiency of large Belarusian CHPs and reduce carbon dioxide emissions, share of natural gas in the gross fuel and energy consumption rose from 58% to 63% in 2001–2005. In addition, the value of imported electricity dropped sharply in 2005; its share in the gross consumption of primary energy in 2000 was 6% versus 3% in 2005. The energy intensity of GDP for five years decreased by 25% (Fedoseev 2006).

1.4.2. National Programme on Energy Saving 2006–2010
The third National Programme on Energy Saving was adopted in 2006. Its adoption was needed due to a high proportion of imported energy resources (85%) and high energy output. In addition, prior to its appearance the country had already established an entire regulatory framework of programmes and concepts, as follows:

- The concept of energy security of the Republic of Belarus (Presidential Decree of the Republic of Belarus on 17 September 2007 № 433)
- Directive of the President of the Republic of Belarus of 14 June 2007 № 3 ”Economy and thrift – the principal factors of the economic security of the state”
- State complex programme of modernization of basic production funds of the Belarusian energy system, energy efficiency and increasing the share of own energy resources for the period until 2011 (Decree of the President of the Republic of Belarus on 15 November 2007 № 575).
- Programme of Socio-Economic Development of Belarus in 2006–2010 (Decree of the President of the Republic of Belarus on 12 June 2006 № 384)
- Target Programme of Ensuring Generation of at least 25% of Electricity and Heat from Local Fuels and Alternative Energy Sources in Belarus for the Period up to 2012 (Decision of

the Council of Ministers on 30 December 2004 № 1680)
- The Main Directions of Energy Policy of the Republic of Belarus for 2001–2005 and until 2015 (Decision of the Council of Ministers on 27 October 2000 № 1667).

In 2006–2010 the government has been tasked to reduce the complete energy capacity of the GDP by at least 31% and the growth rate of GDP by 56%. The target is to save 6.4–6.9 million ton of oil equivalent (toe) during 2006–2010 (Table 1.11).

To achieve such significant savings the following organizational, economic and technical activities are pointed in the program:

- The adoption of the Law "On the use of alternative and renewable sources of energy"
- Improving the normative framework in the production and use of local fuels
- Development of new market mechanisms for financing energy efficiency in the state sector
- Improving state expertise for energy efficiency in the development of industries and design solutions.
- Certification of products by energy and power consumption
- Creation of conditions for increased use of bank loans for the implementation of energy-efficient innovation projects
- Introduction of widespread institutional and personal incentives for energy saving in organizations financed from the budget, and other public organizations
- Creation of economic and institutional conditions to reduce the payback time of alternative and renewable sources of energy for subsequent large-scale introduction, etc.

Under the programme, the main sources of financing for energy efficiency projects will be own means of enterprises (50%), funding in the form of equity participation from the national and local budgets (15%), and innovation funds of the national bodies subordinated to the Government of the Republic of Belarus (20%). The funding will be provided to social organizations and the public sector and organizations implementing effective interventions in priority areas of energy saving. Implementation of activities to improve the efficiency of energy resources and increase the share of local fuels demands US$ 5.2–5.85 billion. At the same time credits, loans and other attracted funds amount to 10% of the total funding.

Table 1.11. Key indicators of economic development of Belarus in 2006–2010.

Indicators	2006	2007	2008	2009	2010
GDP growth rate, %	9.9	8.6	8.5–10.0 (10.2)*	8.5–10.0 (0.2)	8.5–10
Gross consumption of primary energy, Mtoe	27.3 (28.27)	27.3 (27.29)	27.2–27.4 (27.10)	27.0–27.4 (25.99)	27.2–27.9
Savings of primary energy, Mtoe	1.18	1.27	1.23–1.36	1.32–1.50	1.39–1.59
Increased use of local fuel to the previous year, 1,000 toe	207.3	215.9	208.7	267.5	323.7
Reducing energy intensity of GDP, %	4.3	7–8	7–8	7–8	7–8
Funding for energy saving, US$ million	599.9	775–803	959–1,150	1,260–1,500	1,606–1,798

Source: Energy Saving Programme 2006–2010
*Actual value (in brackets) according to the Department of Energy Efficiency of the State Committee on Standardization (energoeffekt.gov.by)

Thus, as noted above, programs have resulted in decreasing energy intensity. Over the period 1996–2008 energy consumption in Belarus has fallen almost 50%. This is an important parameter of the growth of national competitiveness. The main factor in this success was a state policy aimed at both the capacity of a specialized state body (Department of Energy Efficiency of the State Committee Standardization), and providing substantial funding for relevant programmes.

However, despite the measures taken, energy efficiency in Belarus is still lower than in Western countries.

1.4.3 Measures to improve the efficiency of energy resources up to 2012

At the beginning of 2010 the government adopted another document on more efficient use of energy resources in Belarus which provides a list of objects for introducing new power technologies and improving current processes and equipment by the Decision of the Council of Ministers on 22 February 2010 № 248 (О мерах по повышению эффективности использования топливно-энергетических ресурсов на период до 2012 года. Постановление Совета Министров Республики Беларусь от 22 февраля 2010 г. № 248). This document includes the modernization of boiler equipment and reconstruction and repair of heating systems. It is planned to exclude the commissioning of new boiler equipment using natural gas (except "Belenergo" boilers) with fuel consumption for heat supply of more than 26.92 kg of oil equivalent (koe) per GJ in 2011 and more than 26.75 kg of oil equivalent (koe) per GJ in 2012.

Administration bodies together with the State Committee for Standardization of the Republic of Belarus (Госстандарт) should develop and introduce the norms of the energy resources consumption on the production of tractors, trucks, glass and its products, mineral fertilizer, automobile and motorcycle tyres, oil refining, transportation of oil, production of chemical fibres and yarns and other products. The Ministry of Energy should develop and approve a programme on the reduction of energy losses in the electric network in 2010–2012. A programme of construction and import substitution of biogas plants will also be developed. Many other activities have called for the development and implementation of energy efficiency. The State Committee for the Standardization of the Republic of Belarus is monitoring the implementation of the planned measures.

1.4.4 Electricity and heat tariff policy

In accordance with the laws of the Republic of Belarus ("On natural monopolies", "On pricing", the presidential decree "On some measures to stabilize prices (tariffs) in the Republic of Belarus") electricity and heat tariffs for consumers in the open market are regulated by the Ministry of Economy of the Republic of Belarus, whereas the prices for residential customers are regulated by the Council of Ministers of the Republic of Belarus.

In accordance with the degree of the Council of Ministers on 25 November 1992 № 709 "On the uniform tariff for the electricity", electrical energy in Belarus is released on state controlled uniform tariffs which are differentiated by consumer groups.

For industrial and similar consumers with a connected load of 750 kVA and above, two-part tariffs apply:

- the main charge per 1 kWh of maximum load power; and
- an additional charge per 1 kWh of the consumed energy.

For all other consumers of electric energy a uniform charge per 1 kWh of consumed energy is applied depending on a consumer group (industry, transport, budget organization, rural and urban population, etc.).

The heat energy charge depends on following factors:

- a region;
- a consumer group;
- technical characteristics of the coolant – select pairs of different levels of pressure, sharp and reduced steam, hot water.

For all consumers of heat energy a single tariff per 1 Gcal of heat energy consumption is applied, accounted for by commercial metering devices.

Industry and government customers have to subsidize residential consumers to meet the production cost of the respective regional/district utility or boiler to which they are all connected. In fact tariffs for the residential customers, set by the Council of Ministers, do not cover the energy production costs (Table 1.12). The main reason is that the degree of increasing prices for natural gas imported into Belarus was over governmental tariffs.

Table 1.12. Development of electricity and heat tariffs for residential customers and production costs in 2006–2009.

Electricity			Heat		
Tariff Br/kWh	Production cost, Br/kWh	%	Tariff 1,000 Br/Gcal	Production cost 1,000 Br/Gcal	%
			2006		
88.3	95.5	92.5	29.144	41.536	70.2
			2007		
107.7	135.3	79.6	33.878	59.863	56.6
			2008		
130.2	159.1	81.8	34.551	70.595	48.9
			2009		
160.2	215.8	74.2	40.780	88.947	45.8

Source: Belenergo 2010

2 Renewable Energy

2.1 Potential, actual and projected use

Belarus is poorly endowed with fossil resources. Fossil resources have met only about 7% of the country's primary energy consumption in past years. These resources can hardly be increased because of geological conditions. However, Belarus has significant renewable energy resources. The total renewable energy potential in Belarus is about 12 million tons of oil equivalent (Mtoe) per year (Table 2.1). Estimates of the potential should be interpreted with caution, because they can vary widely depending on the assumptions made. This potential can be realized by introducing new technologies. According to the Local Fuels Programme (2004) the priority should be given to expand the use of wood, peat, and hydropower resources for small-scale energy generation, as well as sustaining oil production. The wide-scale use of other renewable options such as wind, solar, and geothermal energy seem to be less attractive from an economic standpoint because of Belarus' geographical and geological conditions. Table 2.1 presents information on the projected use of various types of sources in Belarus in 2012, as well as the actual use in 2006.

Table 2.1. Renewable energy potentials, actual and projected use, Mtoe per year.

Energy source	Potentials	Actual use in 2006	Projected use in 2012
Woody biomass from forests	4.6	1.46	2.2
Woody biomass from plantations	0.9		0.05
Peat	1.0	0.52	0.8
Biogas from animal waste	1.0		0.03
Crop residues	1.0		
Hydropower	0.2	0.006	0.08
Wind	1.4	0.001	0.002
Solar	0.4		
Geothermal	1.2		
Total	11.7	1.99	3.17

Source: Ermakovich et al 2006, Local Fuel Programme 2004

2.1.1 Woody biomass

Harvesting of energy wood and generation of by-products from wood processing are concentrated at enterprises of the Ministry of Forestry and the concern "Bellesbumprom". The total annual use of woody biomass is about 1.46 million toe. The volume of woody biomass which comes to rural households through own harvestings is estimated to be 0.2–0.3 million toe. The potential use of wood as fuel can be determined from the natural annual increment of forests (28.6 million m^3), which is roughly estimated at 4.6 million toe per year, including contaminated areas in the Gomel region (3,700 toe). Special technologies and equipment for gasification and deactivation have to be developed and deployed in order to use woody biomass from contaminated areas as fuel (Woodfuels Programme 2009).

In Belarusian climatic conditions 1 ha of energy wood plantation (fast growing trees) is able to produce up to 10 tons of dry wood, equivalent to about 3.5 toe. By using better technology, the energy production per hectare can be doubled. Old peat deposits, where the conditions are not suitable for growing crops, are the most appropriate objects for energy plantations. The area of these deposits in Belarus is about 180,000 hectares, which can become a stable, environmentally

clean source of woodfuels producing 0.9 million toe per year. Lack of experience in using energy plantations for energy purposes does not allow the assessment of costs and future woodfuel prices, because the growing of energy plantations will require the development of special equipment, road infrastructure, processing plants, etc. However, the estimated cost is about US$ 50 per toe. More information about prices and volumes may be received after the development of experimental plots of grey alder that are planted in the Gomel region.

More detailed information about woody biomass resources and production of woodfuels in Belarus is given in chapter 3.

2.1.2 Peat

Belarus has about 4 billion tons of peat reserves. It would allow to increase the extraction of peat for energy up to 1 million toe per year (Peat Programme 2008). In order to use this annual volume it is necessary to increase the consumption of fuel peat in Belarus by 0.51 million toe per year (2.2 million tons) by 2020 compared to 2006 by constructing boilers and CHP plants operating on peat fuel. To perform this task about 8,500 hectares of peat land should be taken for the extraction of peat and an investment of €306 million would be required into infrastructure and equipment, including:

- € 115 million for the construction of mining and railroad tracks;
- € 127 million for purchasing equipment for the extraction and transport; and
- € 28 million for retooling pellet plants.

The main source of financing is the Innovation Fund of the Ministry of Energy, plus own funds of peat enterprises, bank loans and the budget of the country.

The development of peat briquette prices in Belarus in 2000–2009 is shown in Table 1.5. More detailed information about peat resources and production of peat fuels in Belarus is given in chapter 4.

2.1.3 Biogas from animal waste

Agricultural sector of Belarus includes about 6,300 big cattle breeding and dairy farms, 100 big pig-breeding farms and 48 big poultry farms (Renewable Energy Association 2010). There are 4.15 million cattle, 3.79 million pigs, 52,000 sheeps, 75,000 goats, 125,000 horses and 34.1 million poultry (Poleschuk 2010). The potential for obtaining commercial biogas from livestock farms is 1 million toe per year (Ermashevich 2006). The main advantage is that, without additional energy costs, livestock farms can get a clean high-quality organic fertilizer and therefore proportionately reduce the energy-intensive production of mineral fertilizers. The use of biogas plants will significantly improve the environment near large farms, livestock farms, and crop areas, where the animal waste is discharged.

Three biogas projects have been implemented in Belarus: “Western” farm (РУСН СГЦ “Западный”) in Brest region (0.5 MW of electrical power), Gomel poultry farm (ОАО “Гомельская птицефабрика”) in Gomel region (0.3 MW of electrical power) and “Belarusian” poultry farm (племптицезавод “Белорусский”) in Minsk region (0.3 MW of electrical power). Nine projects are in the planning phase with the total electrical power of 12 MW (Renewable Energy Association 2010).

2.1.4 Crop residues

The use of crop residues as a fuel is a new direction of energy conservation in Belarus. The total potential of crop residues is estimated to be 1 million toe per year. Suitable amounts of combustion for fuel purposes should be addressed in relation to the specific needs of households on an individual basis (Kuznich and Usova 2006).

2.1.5 Hydropower

The potential capacity of all the watercourses of Belarus is 850 MW, of which technically available are 520 MW and economically viable 250 MW (Renewable Energy Association 2010). The installed power capacity of 30 hydropower plants (HHP) in Belarus is 12 MW. Annual electricity generation is 28 million kWh. One project, namely Grodno hydropower plant at Neman river (power capacity 17 MW), is under implementation. New projects include:

- 4 hydropower power plant cascades at Dvina river (power capacity 120–140 MW);
- 2 hydropower power plant cascades at Dnepr river (power capacity 20–30 MW);
- construction of Neman hydropower plant at Neman river (power capacity 20 MW);
- construction of small and micro hydropower plants (7 HPP in total, power capacity till 1,8 MW);
- rehabilitation of small and micro hydropower plants (5 HPP in total, power capacity till 1,4 MW).

2.1.6 Wind power

There are 1,840 identified sites for wind turbines with a theoretically possible energy potential of more than 1,600 MW in Belarus (Voytekhovich 2008). Wind electricity generation potential is 6.5 billion kWh. In 2009 the total installed capacity of 4 wind power plants amounted to 1.3 MW (Renewable Energy Association 2010), equal to 334 toe. The locations of wind power plants are Zanaroch in Minsk region (250 kW and 600 kW), Korelichi in Grodno region (200 kW), and the international ecological park “Volma” (200 kW). There are 5 projects under implementation with the total power capacity of 177.5 MW. New projects are located in the following places (Shenets 2009):

- Lyozno district in Vitebsk region (60 MW);
- Dzerzhinsk district in Minsk region (60 MW);
- Novogrudok district in Grodno region (17.5 MW);
- Oshmyany district in Grodno region (25 MW);
- Smorgon district in Grodno region (15 MW).

Until recently, the conversion of wind energy into electricity has been done by using traditional bladed wind turbines, which are ineffective in Belarus. However, modern technical solutions allow the creation of wind power to start with the wind speed of 3 m/s the nominal operating speed being 7–8 m/s. Rising prices of imported natural gas willsignificantly increase the economic viability of even existing wind technologies (Ermashevich et al. 2006).

2.1.7 Solar energy

Meteorological data of the Republic of Belarus shows an average of 150 cloudy days per year, with 185 days of variable cloudiness and 30 clear days (Voytekhovich 2008). The average annual

amount of solar energy at the Earth's surface is 243 calories per 1 cm² per day, equivalent to 2.8 kWh per km²/day, and taking into account the efficiency of converting 12% – 0.3 kWh per m² per day. The potential of solar energy for hot water provision is estimated at 0.88 – 1.23 Mtoe per year, and for production of electricity – at 0.7–0.88 Mtoe per year (Kuznich and Usova 2006, Yermashkevich and Rumantseva 2004). The solar power sector has no industrial significance at the moment. Only several experimental systems exist at present. No use of solar energy on a wider scale is planned in Belarus in the nearest future due to the high cost of electricity production is solar systems at the moment. Technical progress in this area will, of course, help to reduce costs, but in the conditions of Belarus electricity production using solar energy will be almost unprofitable for the considered period. The main areas of use for solar energy will be solar energy water heaters and a variety of solar systems for the intensification of drying and heating of water in agriculture and other domestic purposes. Under favourable economic and operating conditions it can be expected that during the forecasted period about 0.35–0.53 Mtoe per year may be replaced through the use of solar energy (Ermashevich et al. 2006).

2.1.8 Fuel ethanol and biodiesel

A special state programme for biodiesel production in Belarus (Biodiesel Programme 2007) has been developed for the "Belneftekhim" concern (Belneftekhim 2010). Measures to ensure the achievement of the goals and objectives of this programme should be carried out in 2007–2010. Implementation of this programme in full will help to solve the energy supply problems of in the country's economy using its own sources of renewable energy. Annually this will be no less than 100,000 tons of biodiesel and 2 million tons of a mix of biodiesel, which will reduce the country's need for oil refining by about 300,000 tons per year and save the country approximately US$ 100 million.

2.2 Renewable energy policy

The access to cheap gas from Russia and lack of energy diversification policies have prevented Belarus from developing its potential of renewable energy resources for energy generation. However, in 2005 the government adopted a programme "Target Programme of Ensuring Generation of at least 25% of Electricity and Heat from Local Fuels and Alternative Energy Sources in Belarus for the Period up to 2012" (Local Fuels Programme 2004). This programme set a target of nearly doubling the power and heat production from renewable energy resources by 2012. The available woody biomass and peat deposits are the main sources to meet this target. However, there is a risk that the targeted increase in the production of fuel wood may cause a raise in the use of high-quality logs as fuel wood, which will have negative environmental implications and result in a suboptimal exploitation of forest resources.

Simultaneously, the government has developed a series of regulatory documents to create a legislative, economic, financial, organizational and technical framework for the use of renewable energy, including:

- State Integrated Programme for Modernization of Basic Production Assets of Belarus Energy System, Energy Saving and Enhanced Use of Local Fuel and Energy Resources for 2006–2010 (Modernization Programme 2007).
- Policies designed to provide incentives for economic entities to save energy, through which enterprises can create "energy saving funds". Savings obtained due to energy efficiency

measures are accumulated in this fund and can be used for further activities in savings as well as for bonuses (up to 50% of this fund).
- New regulations related to providing incentives for budget institutions to save energy are under design in the Committee for Energy Efficiency.

The development of small-scale power generation using biomass and hydropower calls for enacting policies to facilitate investments in these types of renewable energy. The most critical barriers to small-scale power generation in Belarus include (Department for Energy Efficiency 2010):

depressed prices for competing fuels (namely natural gas);
unfavourable power pricing rules;
an incomplete legal framework for independent power producers; and
transmission access and interconnection requirements.

Many of these issues are not unique to Belarus and are being faced by several countries planning to promote renewable energy.

3 Woody Biomass and Woodfuels

Belarus has significant forest resources. Forests cover 8.6 million ha, or 39% of its territory with a growing stock of 1.57 billion m³. The annual increment of the forests is 28.6 million m³. Actual harvesting of timber in 2008 was 15.1 million m³ of which 6.6 million m³ final felling, – 5.7 million m³ thinnings, and 2.7 million m³ other fellings. About 80% of the annual allowable cut from final felling was realized (Shatravko 2010, Gerasimov and Karjalainen 2010).

The relatively low degree of harvesting of forest resources can be attributed to a number of reasons, namely:

- The structure of the forest industry. Belarus has a relatively low demand for pulpwood, especially deciduous tree species (birch, aspen, alder).
- The proportion of protected forest areas and specifically the proportion of special protected forest areas. About 18% of forest area is fully or partly restricted to wood harvesting.
- Radioactive contamination on 22% of forest area. Wood harvesting is permitted in forests having contamination up to 185 kBq/m² (5 Ci/km²).
- Inaccessibility of peat land forests. The wood harvesting in 17% of the forest area is directly linked to weather conditions and only possible on frosty winters and dry summers.

3.1 Woody biomass

The following woody biomass can be used in Belarus for the production of woodfuels:

- energy logs, harvested during scheduled harvesting (low-quality roundwood);
- logging by-products (branches, tops etc.);
- energy plantation trees (grey alder);
- energy short rotation trees (fast-growing over-mature deciduous tree species such as black alder, aspen);
- energy forest trees (dead-felled and dead-standing trees);
- wood processing industry by-products (saw dust, wood shavings, bark, cross-cut ends etc.).

3.1.1 Energy logs

The main source of woodfuel in Belarus is energy logs (low-quality, roundwood not suitable as a raw material of forest industry), harvested during scheduled harvesting. The output of energy logs from final fellings is 27%, from thinnings 55%, and from other fellings 58% (Belstat 2010, Forestry Programme 2006). On average the share of energy logs is 41% of the total harvest. In 2008, about 6.2 million m³ of energy logs was harvested. According to the forecast calculations made for the period up to 2015 taking into account the changing age structure of forests in Belarus, the volume of energy logs will reach 7.8 million m³ (Lobas 2008).

3.1.2 Logging by-products

Logging by-products (branches, tops etc.) are formed during felling, delimbing and bucking of trees at harvesting sites. Almost all wood harvesting by-products are left in the forest, and are frequently burned directly in the forest. Use of tree stumps and roots is not acceptable at the moment due to tree species composition, technological and economic conditions. The annual volume of logging by-products is estimated to amount to 2 million m³. Part of the residues from wood har-

vesting is used for improving the technological conditions of wood harvesting (building of skid trails). Nevertheless, abound 0.5 million m³ could be used as woodfuels annually (Woodfuels Programme 2009, Lednitsky 2009, Vasilenko 2007).

3.1.3 Energy plantations

One of the governmental priorities of increasing the extracted volume of woody biomass for woodfuel production in Belarus is the use of low-grade grey alder plantations. Grey alder plantations occupy 184,000 ha or 2.4% of the forest lands with 22.6 million m³growing stock. The average stock of these plantations is 122 m³ per 1 ha. Over 90% of plantations are located in the Vitebsk region, where 11% of forest lands are occupied by them. Grey alder is one of the fastest growing tree species in Belarus, and differs from other species by rapid growth and high productivity, especially at a young age. The rotation time of alder is short, and therefore the culmination of the growth is observed at the age of about 20 years. Then the growth slows down somewhat, and by 25–30 years it sharply declines. At the age of 30–40 years, alder becomes damaged by rot and natural mortality increases. In order to maximize the involvement of alder plantations for the woody biomass procurement the cutting age of grey alder was set at 21 years in 2008 (Age of Felling 2008). The annual volume of extraction of grey alder for woodfuels could be about 1 million m³ (Woodfuels Programme 2009, Rusalenko 2008).

3.1.4 Short rotation energy wood

Considerable forest area in Belarus (2.8 million ha, or 36% of stocked forest land) is represented by deciduous tree species (birch, black alder, aspen), growing in their typical growing conditions – in low-lying places with excessive moisture. Drainage of lands which they occupy has been prohibited on environmental reasons. Therefore, replacing these species with coniferous species in the process of forest harvesting and reforestation does not seem possible. At present, the current structure of the forest industry in Belarus does not allow complete processing of deciduous tree species. As a result, more and more deciduous tree stands are falling into the category of overmature stands. As a result, the relatively fast-growing deciduous tree species should be treated as a long-term resource for woodfuels.

According to the inventory of the forest fund of Belarus (1 January 2009) 19 300 ha of overmature deciduous forests belonging to the Ministry of Forestry with the total growing stock of 4.6 million m³ are available for harvesting. The annual harvesting potential of overmature deciduous species for producing woodfuels (pellets, briquettes and chips) could be up to 1 million m³ (Woodfuels Programme 2009, Lednitsky 2009).

3.1.5 Dead felled and dead standing trees

More than half of the annual mortality (dead felled and deadstanding trees) is harvested in scheduled harvesting and the other part is left in the forest for biodiversity conservation in accordance with the requirements of normative legal acts and forest certification. The current volumes of deadfelled and deadstanding trees in the forests belonging to the Ministry of Forestry are 0.7 and 7.2 million m³ respectively. Part of the mortality could be used for energy. However, the procurement of which would require creation of additional harvesting capacity, acquisition of equipment, vehicles, and construction of roads. Therefore, the mortality should be considered as a reserve of woodfuel resources; possible annual procurement could be approximately 0.6 million m³ (Woodfuels Programme 2009).

3.1.6 Wood processing industry by-products

The most efficient production of woodfuels can be organized by using sawmilling and woodworking by-products (sawdust, wood shavings, lump, cross-cut ends etc). Currently, a large portion of wood processing by-products (about 1.8 million m³) is used as boiler and furnace fuel to produce heat and electricity, and is also used as a raw material in the woodworking industry. Some part of the wood processing by-products could be processed to higher grade woodfuels (pellets or briquettes). With the current amount of wood processing by-products, the potential for production of wood pellets and briquettes could be about 0.5 million m³.

3.1.7 Potential for energy use

The forecast of average annual harvesting of woody biomass by source and region in Belarus in 2010–2015 is shown in Table 3.1. Annual harvesting potential of woody biomass in Belarus in 2010–2015 is 12.9 million m³. The Vitebsk region has the richest potential (3.3 million m³ per year), while Grodno and Brest regions have the lowest (around 1.5 million m³). The average consumption of woodfuels both for energy use and technological needs is 8.2 million m³. The projected balance of woody biomass resources is 4.7 million m³, which is possible to use at the newly established power plants both for the production of wood pellets as well as briquettes (Woodfuels Programme 2009). The woody biomass potential in the Belarus regions is also presented in Figure 3.1.

Table 3.1. Forecast of woody biomass harvesting (in million m^3 per year) in Belarus for 2010–2015.

Woodfuels source	Belarus	Region					
		Brest	Bitebsk	Gomel	Grodno	Minsk	Mogilev
1. Total energy logs from scheduled harvesting, including	7.8	1.0	1.7	1.6	0.8	1.6	1.1
1.1. Final fellings	2.5	0.3	0.7	0.6	0.2	0.4	0.3
1.2. Thinnings	3.6	0.5	0.7	0.7	0.4	0.7	0.6
1.3. Other fellings	1.7	0.2	0.3	0.3	0.2	0.5	0.2
2. Wood processing by-products	2.0	0.3	0.3	0.3	0.2	0.5	0.4
3. Grey alder plantations	1.0		0.8		0.1	0.1	
4. Overmature deciduous tree species forests	1.0	0.1	0.3	0.2		0.1	0.3
5. Wood harvesting by-products	0.5	0.05	0.1	0.1	0.05	0.1	0.1
6. Mortality (dead-felled and dead-standing trees) – 50%	0.6	0.1	0.1	0.1	0.1	0.1	0.1
Total woodfuels potentials	12.9	1.55	3.3	2.3	1.25	2.5	2.0
Use of woodfuels by energy plants, mills, private households	8.2	1.0	1.6	1.6	0.8	1.9	1.3
Balance of woodfuels, potentials for development	4.7	0.55	1.7	0.7	0.45	0.6	0.7

Source: Woodfuels Programme 2009

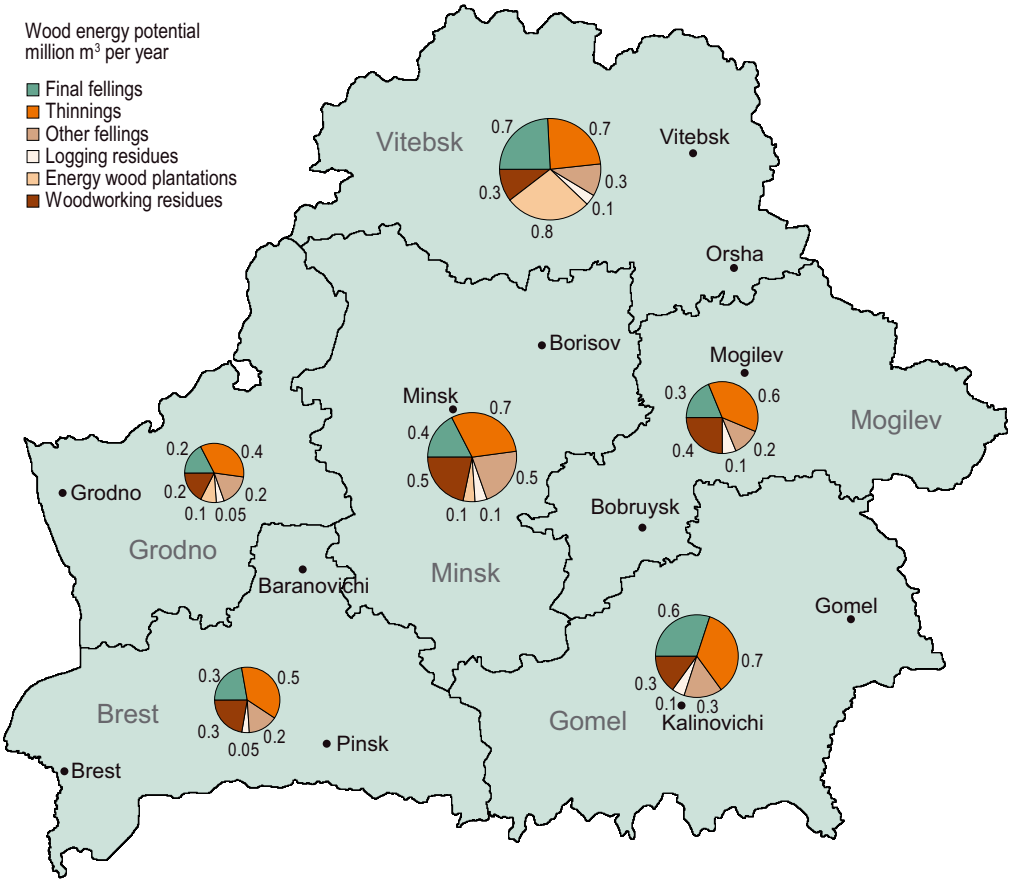

Figure 3.1. The woody biomass potential in the Belarus regions.

3.2 Supply for woody biomass

A number of mechanisms already exist in Belarus for the supply of woody biomass of 9 million m³ per year including 6.2 million m³ of energy logs and 2.8 million m³ of wood processing by-products. Almost all wood harvesting by-products (2.0 million m³) are left in the forest, and are frequently used for slash reinforcement or burned directly in the forest. The main capacities for woody biomass supply are located in wood procurement enterprises belonging to the Ministry of Forestry (43%) and the "Bellesbumprom" concern (24%), and fuel enterprises belonging to the "Obltop" at the regional administrations (6%). Moreover about 27% of total woody biomass in Belarus is harvested by private SMEs and the local population. About 8.5 million m³ (1.58 million toe) of woody biomass is available for energy production and the rest (0.5 million m³) is used for the production of wood-based panels and agriculture.

Belarusian machinery industry produces a range of equipment for woody biomass harvesting (Gerasimov and Karjalainen 2010): woody biomass forwarders (Figure 3.2), chippers (Figures 3.3 and 3.4), chip trucks and trailers (Figure 3.5). Depending on equipment used, the wood chip production is done at the road side (Figure 3.6), or at the cutting area (Figure 3.7) or at the mill gate (Fyedorenchik and Lednitsky 2008, Fyedorenchik and Zhary 2009, Shatravko 2009).

Figure 3.2. Belarus MPT-461 forwarder for woody biomass.
Source: www.mozyrmash.by

Figure 3.3. MR-40 mobile chipper
Source: www.mozyrmash.by

Figure 3.4. MRN-1Mobile chipper
Source: www.mozyrmash.by

Figure 3.5. PK-12 chip semi trailer
Source: www.mozyrmash.by

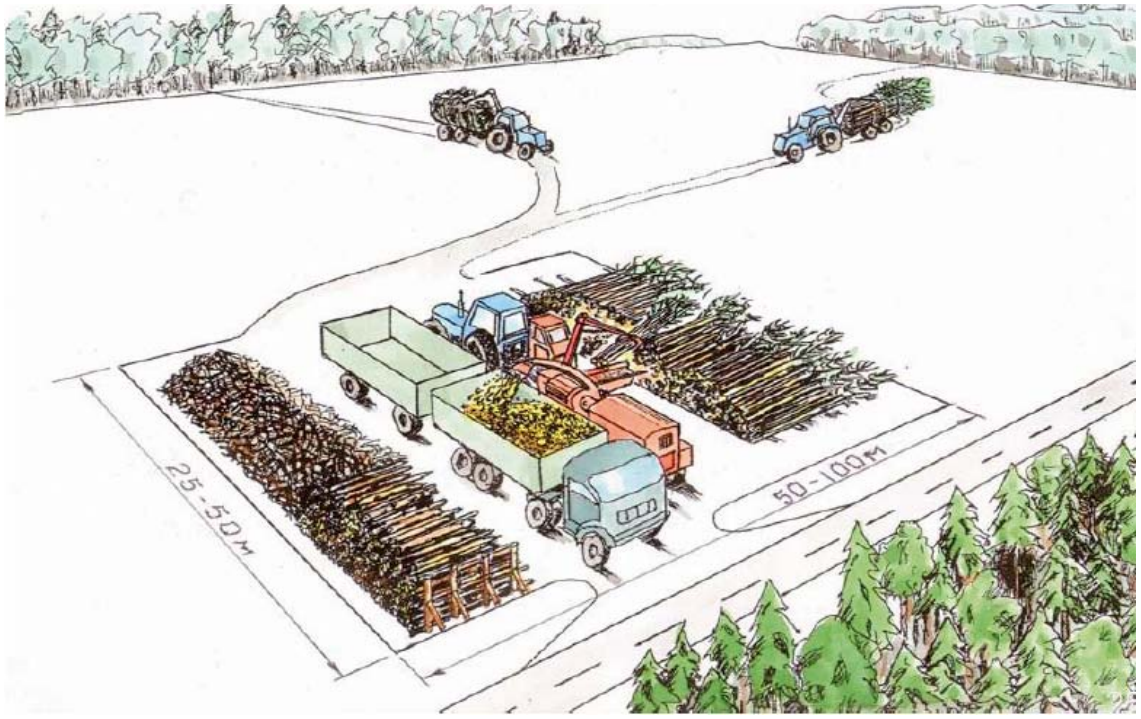

Figure 3.6. Wood chip production at the road side using a woody biomass forwarder and a mobile chipper.
Source: Shatravko 2009, Wood Harvesting... 2010

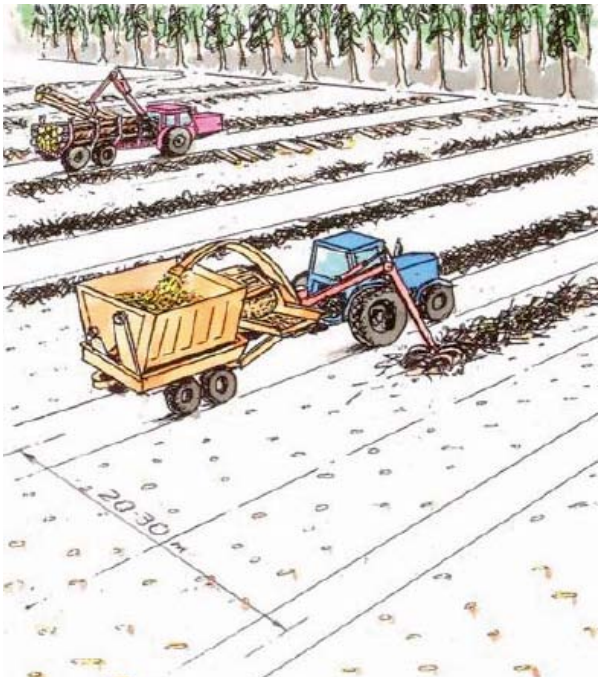

Figure 3.7. Wood chip production at the cutting area using a mobile chipper and a chip semi trailer.
Source: Shatravko 2009

3.2.1 The Ministry of Forestry

Over 90 forestry enterprises (лесхоз) belonging to the Ministry of Forestry (Figure 3.1) control the cutting permissions for 12.6 million m³ of annual harvest or about 84% of the total annual harvest in Belarus. The forestry enterprises undertake own harvesting operations providing about 7.7 million m³ per year or half of the total annual harvest in Belarus. This volume includes 2.0 million m³ from final felling, 4.5 million m³ from thinning and 1.2 million m³ from other felling.

In terms of industrial wood (4.5 million m³), around 1 million m³ are processed, 2.3 million m³ are sold to the domestic market and 1.2 million m³ are exported.

In terms of woody biomass, the total harvested volume of woody biomass is about 3.9 million m³ per year (43% of the total woody biomass available annually for harvest in Belarus) including 3.3 million m³ of energy logs and 0.5 million m³ of wood processing by-products. Most energy logs are sold to local power stations, boilers and households, 2,900 m³ are exported, 0.2 million m³ are processed to wood chips and 7,300 m³ are processed to wood pellets and briquettes.

Most of the forestry enterprises (73) have small sized sawmills with a processing capacity of around 1,000 m³ per month. In 2009 the volume of processed industrial wood was 885,900 m³ and the volume of produced lumber 361,200 m³.

The machinery fleet of forestry enterprises belonging to the Ministry of Forestry included 78 forwarders, 21 harvesters and 286 short-wood trucks, and 785 Belarus MPT-461 tractors in 2009. In 2009, 407 units of forest machinery were purchased, including 16 forwarders, 12 harvesters, 72 short-wood MAZ trucks, and 19 hydraulic cranes (Minleshoz 2010). According to the Wood Harvesting Development Programme (2010), 1462 units of forest machines should be purchased for forestry enterprises belonging to the Ministry of Forestry in 2010–2015 (Table 3.2) including 260 short-wood trucks, 55 harvesters for final felling, 29 harvesters for thinning and 93 forwarders.

Table 3.2. Purchasing of wood harvesting machinery for forestry enterprises belonging to the Ministry of Forestry.

Machine	Year											
	2010		2011		2012		2013		2014		2015	
	pcs	Br billion	pcs	Br billion	pcs	Br billion	pcs	Br billion	pcs	Br billion	pcs	Br billion
Short-wood truck with trailer	80	24.80	34	10.54	31	9.61	35	10.85	38	11.78	42	13.02
Harvester for final felling	12	9.24	10	7.70	6	4.62	7	5.39	9	6.93	11	8.47
Harvester for thinning	4	4.00	2	2.00	5	5.00	6	6.00	6	6.00	6	6.00
Forwarder	25	11.50	12	5.52	11	5.06	12	5.52	15	6.90	18	8.28
Belarus MPT-461.1	70	9.80	65	9.10	43	6.02	42	5.88	46	6.44	49	6.86
Tractor “MTZ”	50	5.00	46	4.60	42	4.20	51	5.10	58	5.80	62	6.20
Crane	15	1.13	15	1.13	16	1.20	21	1.58	22	1.65	21	1.58
Semi-trailer with craine for tractor	20	1.40	20	1.40	14	0.98	15	1.05	17	1.19	16	1.12

Source: Wood Harvesting Development Programme 2010

According to the Innovation Forestry Programme (2007) the government should invest Br 87.6 billion for the modernization of woody biomass procurement machinery and purchased 70 chippers, 145 chip trucks and 24 chip loaders in 2007–2011 (Table 3.3).

The Council of Ministers approved a set of measures to improve forest operations in 2010–2015 on 26 July 2010. The whole Forestry Development Programme for 2011–2015 has been submitted in the Council of Ministers in November 2010 (Forestry Programme 2010).

According to the programme, the use of the annual allowable cut on final felling should be increased to 95% until the end of 2015 (the current use is 72%). Br 683 billion will be invested for the purchasing of modern logging equipment, including harvesters and forwarders. Modern harvesting equipment will increase the volume of harvested wood in all types of cuttings from 7.7 million cubic m³ in 2009 to 9 million m³ in 2015. The brand new machines will provide an opportunity to introduce modern technology of final felling and thinning, no less than 70% of the total harvest by forestry enterprises belonging to the Ministry of Forestry.

Table 3.3. Investments in domestic machinery for woody biomass supply.

Name	Unit	2007	2008	2009	2010	2011	Total
Chip loader	pcs	1	3	7	7	6	24
Chip truck	pcs	3	22	40	40	40	145
Chipper	pcs	2	11	19	19	19	70
Short-wood truck	pcs	2	5	12	12	12	43
Tractor TTP-401	pcs		35	61	61	61	218
Loading and transport machine	pcs	5	16	36	36	36	129
Investments	Br billion	2.6	12.3	24.3	24.3	24.1	87.6

Source: Forestry Programme 2006

The establishment of forestry enterprises is envisaged with 180 separate structural harvesting units in which the total volume of harvested timber to the end of 2015 will be at least 1 million

m³ per year. Possible options will be developed to improve the current system of forest management by separating the activities on forestry and raw material production (wood harvesting and processing).

At least Br 20 billion will be invested annually in the modernization of existing wood production of forest enterprises in order to enhance the quality of products and degree of processing. There would be 28 new plants, which are planned to produce 25,000 tons of pellets and briquettes, and 36,000 m³ of chipped wood annually. A new facility for the production of 1.5 million m³ of wood chips per year will be established. For this purpose forestry enterprises will be equipped with modern technology from leading countries, such as Finland, Sweden and Germany.

A further Br 85 billion will be invested on the development of forestry infrastructure, including construction of buildings, garages, fire and chemical plants, and repair and renovation of existing facilities. Until the end of 2015, 500 km of forest roads and 6 road repair enterprises (one in each region) for the maintenance and repair of roads are planned to be built using budget funding. Joint venture logging companies with the total harvesting capacity of at least 2 million m³ per year will be established for the provision of services for wood harvesting.

3.2.2. The "Bellesbumprom" concern

The majority of wood processing in Belarus is carried out at the 20 companies belonging to the Belarusian wood and paper industry concern "Bellesbumprom". The concern is operating allover Belarus, but is mainly concentrated in the Minsk and Gomel regions (Bellesbumprom 2010). Logging companies of the concern harvest annually about 2.6 million m³ of timber including 1.1 million m³ of energy logs. Adding to this the 1.1 million m³ of wood processing by-products, the concern harvests annually about 2.2 million m³ of woody biomass (24% of the total harvested woody biomass in Belarus).

According to the Forestry Programme (2006) 545 units of harvesting machines should be purchased for logging enterprises belonging to the "Bellesbumprom" concern (Table 3.4) including 190 short-wood and length-tree trucks with cranes, 6 harvesters, 22 forwarders and 43 skidders.

Table 3.4. Purchasing of wood harvesting machinery for logging companies belonging to "Bellesbumprom".

Machine	Year										Total	
	2007		2008		2009		2010		2011			
	pcs	Br billion	pcs	Br billion	pcs	Br billion	pcs	Br billion	pcs	Br billion	pcs	Br billion
Truck with crane	47	4.27	54	4.66	31	3.54	31	3.54	31	3.54	194	19.55
Harvester			1	0.326	1	0.326	2	0.326	2	0.326	6	1.30
Forwarder	6	1.64	7	2.01	3	1.01	3	1.01	3	1.01	22	6.68
Cable skidder	1	0.095	2	0.19	2	0.19	2	0.19	2	0.19	9	0.86
Skidder	5	0.74	5	0.74	5	0.74	5	0.74	5	0.74	25	3.70
Tractor-skidder	37	1.88	38	1.93	38	1.93	38	1.93	38	1.93	189	9.60
Crane	20	0.64	20	0.64	20	0.64	20	0.64	20	0.64	100	3.20
Total	116	9.3	127	10.5	100	8.4	101	8.4	101	8.4	545	44.89

Source: Forestry Programme 2006

Wood processing by-products are also made available through the "Bellesbumprom" concern, which covers about 80% of all wood processed in Belarus. About 1.1 million m³ by-products come from their wood processing activities, 0.3 million m³ of this volume is used for the production of wood-based panels, 0.5 million m³ as fuel for boilers at woodworking mills within the "Bellesbumprom" concern, and 0.3 million m³ sold to households and collective farms.

Given the existing balance, formation and consumption of wood residues, and prospects for their use in the coming years (rawmaterial for new wood-based panel industry and power plants using wood fuel), wood residues will not be an available raw material for new production of wood pellets and briquettes at the enterprises within the "Bellesbumprom" concern.

3.2.3 The Ministry of Communal Services

The regional fuel enterprises "Obltop" (Облтоп) are situated in each region and are operated by the regional administration as a part of the Ministry of Communal Services. Every "Obltop" manages approximately 20 district fuel enterprises "Raitop" (Райтоп) or city fuel enterprises "Gortop" (Гортоп) which are located in district centres. These district fuel enterprises are operated both by the regional administration and by the corresponding "Obltop". District fuel enterprises have 1–2 teams of workers who carry out logging and transport to supply fuel wood for rural or town households, commercial and budget (state) institutions. Taken together, approximately 120 regional enterprises supply about 0.5 million m³ of energy logs, approximately 6% of the total woody biomass harvest in Belarus (Novitskaya 2008, Zhibul 2007, Department for Energy Efficiency 2010).

3.3 Woodfuels

Annually about 5.6 million m³ of energy wood in the rough, 1.5 million m³ of wood chips and offcuts, 57,000 tons of pellets and briquettes with a total energy content of approximately 1.58 million toe are produced from woody biomass in Belarus.

Table 3.5. Use of woody biomass in Belarus.

Products		Woody biomass supply, million m^3 per year		
		Energy wood logs	Wood processing by-products	Total
Woodfuels	Energy wood in the rough	5.6		5.6
	Wood chips and offcuts	0.2	1.3	1.5
	Wood pellets and briquettes		0.2	0.2
Non-energy and losses	Wood chips for wood-based panels, export, agriculture	0.7	1.0	1.7
Total		6.5	2.5	9.0

3.3.1 Production of energy wood in the rough

About 5.6 million solid m³ of energy wood in the rough per year is produced in Belarus (Shatravko 2010, Lednitsky 2009). The most common raw material for split energy wood (so called firewood) is low-quality roundwood not suitable to be utilized as a raw material in the forest industry. Pulpwood and rotten logs are also used to some extent.

The method of making split energy wood is very simple, only a chain-saw for cross-cutting and an axe for splitting are needed. Some enterprises belonging to the Ministry of Forestry (Buda-Koshelevo, Yelsk, Rechitsa, Dyatlovo) and the Ministry of Communal Services use more advanced firewood processors and dryers (Zhibul 2009).

3.3.2 Production of wood chips

Most of the wood chips are produced by forestry enterprises belonging to the Ministry of Forestry (лесхозы), logging companies of the "Bellesbumprom" concern and enterprises belonging to the Ministry of Communal Services.

Wood chips for energy use are produced in 33 forestry enterprises belonging to the Ministry of Forestry since 2007 with the total capacity of 511,000 tons per year (Shatravko 2010, Figure 3.8).

There are four ways to organize wood chip production depending on customer and equipment used. The first approach is based on an existing customer and an existing modernized mobile chipper in forest. This type of production has been organized at Telehany (Brest), Begoml (Vitebsk), Borisov, Uzda and Pukhovichi (Minsk) forestry enterprises.

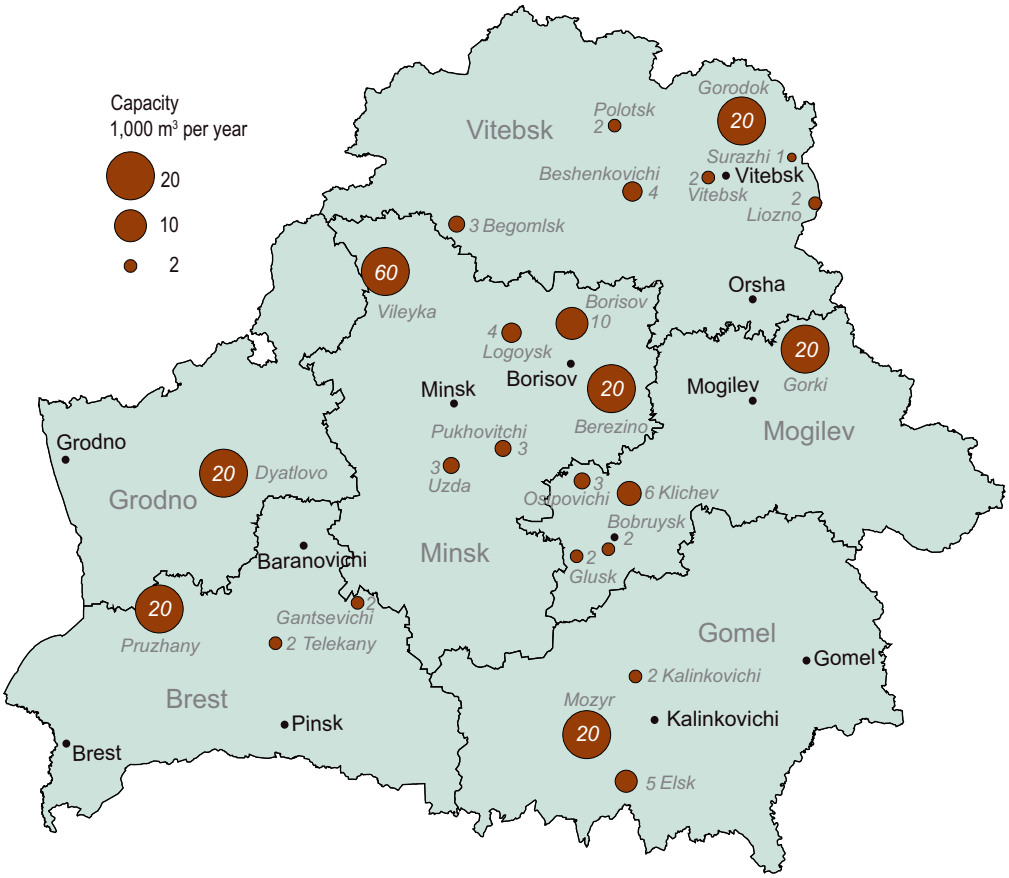

Figure 3.8. Capacity of wood chip production at forestry enterprises belonging to the Ministry of Forestry.

The second approach is based on an existing customer and an existing modernized stationary chipper at sawmill. This type of production has been organized at Gantsevichi (Brest), Polotsk, Beshenkovichi, Vitebsk, Liozno (Vitebsk), Kalinovichi, Yelsk (Gomel), Glussk, Osipovichi and Klinovichi (Mogilev) forestry enterprises.

The third approach is based on a brand new power plant and a brand new mobile chipper in forest. Several pilot projects have been set up to compare different technologies from Russia, Finland Austria and the Baltic countries. Cases are Vilejka with an annual capacity of 60,000 m³, and Gorodok, Mozyr, Dyatlovo, Logoyka, and Berezin each with an annual capacity of 20,000 m³. After the analysis, the best technology option will be chosen for other district capitals of Belarus.

The fourth approach is based on a brand new power plant and a brand new yard machine chipper. This type of approach is used in the Pruzhany mini-CHP. Woodfuel supply of the plant (20,000 m³ of wood chips per year) is based on energy log transport from harvesting areas of Pruzhany forestry enterprise to the central processing yard. The woody biomass is chipped by the MR-40 chipper (made by Minsk Tractor Plant) and transported to mini-CHP by chip trucks (made by Minsk Automobile Plant) at a distance of 30 km. In the future, wood harvesting by-products will be processed into wood chips. The price of the wood chips is about Br 73,000 per m³ (Zhibul 2010). Thus, a new woody biomass supply system based on domestic machinery and equipment has been organized. Currently, attention is focused on reducing the cost of woodfuel production and increasing its competitiveness relative to fossil fuels by developing the most effective systems of machines, optimizing the location of yards and logistic solutions for woody biomass delivery.

The total wood chip capacity in the Ministry of Forestry was 398,000 m³ in 2008. However, only 204,800 m³ of wood chips were sold in 2009. This means the capacity of wood chip production is not fully utilized due to low price. In 2007, the price of wood chips sold to the heat and electrical stations belonging to state production association “Belenergo” was US$ 117 per 1 toe (without VAT); the price for 1 solid m³ was US$ 21.8.

About 331,000 m³ of wood chips are produced at the “Bellesbumprom” concern for industrial purposes, mainly for the manufacture of wood-based panels.

Concerning the Ministry of Communal Services about 69 chippers, 68 short-wood trucks, 112 tractor-based loaders, 39 chip trucks and tractors are involved in wood fuels production (Novitskaya 2008, Zhibul 2007).

3.3.3 Production of wood pellets and briquettes

Wood pellets and briquettes in Belarus are produced by 29 companies with a total capacity, as of 1 May 2009, of 133,000 tons per year (Figure 3.9). Approximately half of these facilities started during the second half of 2008 or the first half of 2009. In 2008, 57,000 tons of wood pellets and briquettes were produced. The major producers (about 70% of production of these products) are legal entities without departmental affiliation. The largest production capacity within the “Bellesbumprom” concern has the largest woodworking enterprises JSC “Pinskdrev” (25,000 tons pellets per year), and “Mozyrles” (10,000 tons briquettes per year). Pellets are produced at Zhitkovichi, Stolbtsy, Tolochin and Bogushevsk forestry enterprises belonging to the Ministry of Forestry with a total capacity of 12,000 tons per year. Briquettes are produced at Zhitkovichi, Klichev and Ostrovets forestry enterprises belonging to the Ministry of Forestry with a total capacity of 10,000 tons per year. The list of companies, producing wood pellets and briquettes, is given in Table 3.6.

Table 3.6. Production of wood pellets and briquettes in the Republic of Belarus.

Name	Capacity in 2009 1,000 tons	Production in 2008 1,000 tons	Comments
The Ministry of Forestry			
Zhitkovichi forestry enterprise – Житковичский лесхоз	2.9	1.43	Established in 2008, pellets
Stolbtsy forestry enterprise – Столбцовский лесхоз	2.9	1.06	Established in 2008, pellets
Bogushevsk forestry enterprise – Богушевский лесхоз	3.0		Established in 2010, pellets
Tolochin forestry enterprise – Толочинский лесхоз	3.0		Established in 2010, pellets
Klichev forestry enterprise – Кличевский лесхоз	4.0		Established in 2010, briquettes
Ostrovets forestry enterprise – Островецкий лесхоз	3.0		Established in 2010, briquettes
Zhitkovichi forestry enterprise – Житковичский лесхоз	3.0		Established in 2010, briquettes
The “Bellesbumprom” concern			
Luninetsles – ОАО «Лунинецлес»	0.9	0.18	Established in 2008
Mozyrles – ОАО «Мозырьлес»	10.0	–	Established in 2009
Borisov woodworking mill – ОАО «Борисовский ДОК»	3.8	2.8	Reconstruction in 2008
Lidastroymaterialy – ОАО «Лидастройматериалы»	2.0	1.9	Established in 2008
Pinskdrev – ЗАО «Холдинговая компания Пинскдрев»	25.0	8.5	Established in 2008–2009
Brest			
Profit system, Ivantsevichi – СООО «Профитсистем» Ивацевичский филиал	5.8	4.8	
Lihtarik – ООО «Лихтарик»	0.72	0.05	Established in 2008
Pillet-Master – ИП «Пиллет-Мастер»	2.4	1.3	Lack of raw material
Vitebsk			
Quantum – ОДО «Квант»	2.0	2.0	
Postavy furniture centre – ЧПУП «Поставский мебельный центр»	6.0	1.22	Established in 2008
Farm Zhingel – Крестьянское (фермерское) хозяйство Жингель	1.2	0.15	Established in 2008
Interforest – СП ЗАО «Интерфорест»	0.5	0.34	Lack of raw material
Vittopgran – ОДО «Виттопгран»	2.0	1.0	Established in 2008
BelLatGaz – СООО «БелЛатГаз»	1.8	0.15	Established in 2008
Gomel			
Biovtorresurs – СООО «Биовторресурс»	10.0	9.6	Lack of raw material in winter
BelAvantik – СП ЗАО «БелАвантик»	5.0	0.41	Limited demand
Ekoformresurs – ОДО «Экоформресурс»	2.4	1.0	Limited demand
Grodno			
Granuldrev – ООО «Гранулдрев»	4.0	3.4	
Regional Environmental Company – ЧПТУП «Региональная экологическая компания»	1.05	0.25	Limited demand
Leader-Ritual – ЧПТУП «Лидер-Ритуал»	0.3	0.26	
Grandor – ИООО «Грандор»	6.0	4.56	Lack of raw material
Minsk			
Ekolin and K – СООО «Эколин и К»	4.8	1.2	Lack of raw material
Profitsystem – СООО «Профитсистем», Филиал №3 «Плещеницлес»	2.6	2.4	
Mogilev			
Ecogran – ООО «Экогран»	12.0	4.6	Lack of raw material
Belbiotop – ИЧПТУП «Белбиотоп»	5.4	2.6	Lack of raw material
Topgran – ООО «Топгран»	4.8	–	Established in 2009
Yugum – ООО «Югум»	4.8	–	Established in 2009
Belarus	133.07	57.16	

Source: Woodfuels Programme 2009, Minleshoz 2010, company information

Figure 3.9. Annual capacity of wood pellet and briquette companies.

For most companies the wood pellet and briquette business is a secondary activity aimed to use the residues from their own sawmilling and wood processing (mainly in the form of sawdust). The relatively simple technological equipment, minimal costs for pre-preparation (drying) of raw materials and reasonable export prices (€80–100 per 1 ton) ensure the profitability of production. However, the capacity is not fully utilized due to a lack of raw materials (Figure 3.10). This is largely due to the implementation of the tasks of the State Programme of Modernization of Basic Production Assets of the Belarusian Energy System, Energy Efficiency and Increasing the Share of the Country's Own Energy Resources for the Period up to 2011 (approved by the Presidential Decree of 15 November 2007 № 575) and the implementation of big energy projects in the framework of the National Energy Conservation Program for 2006–2010 (approved by the Council of Ministers on 2 February 2006 № 137).

Thus, 1.2 million solid m³ of woody biomass was produced by companies belonging to the "Bellesbumprom" concern in 2008. 319,000 m³ (27.7%) was used for industrial purposes (chips for the wood-based panels manufacture), 331,000 m³ (28.8%) was sold to the residential customers and the collective farms, and 500,000 m³ (43.5%) was used for own boilers at woodworking mills, including new boilers replacing natural gas on sawdust and wood shavings (Woodfuels Programme 2009).

The existing balance between production and consumption of wood processing by-products and prospects for their use in the coming years (as rawmaterial for new wood-based panel industry

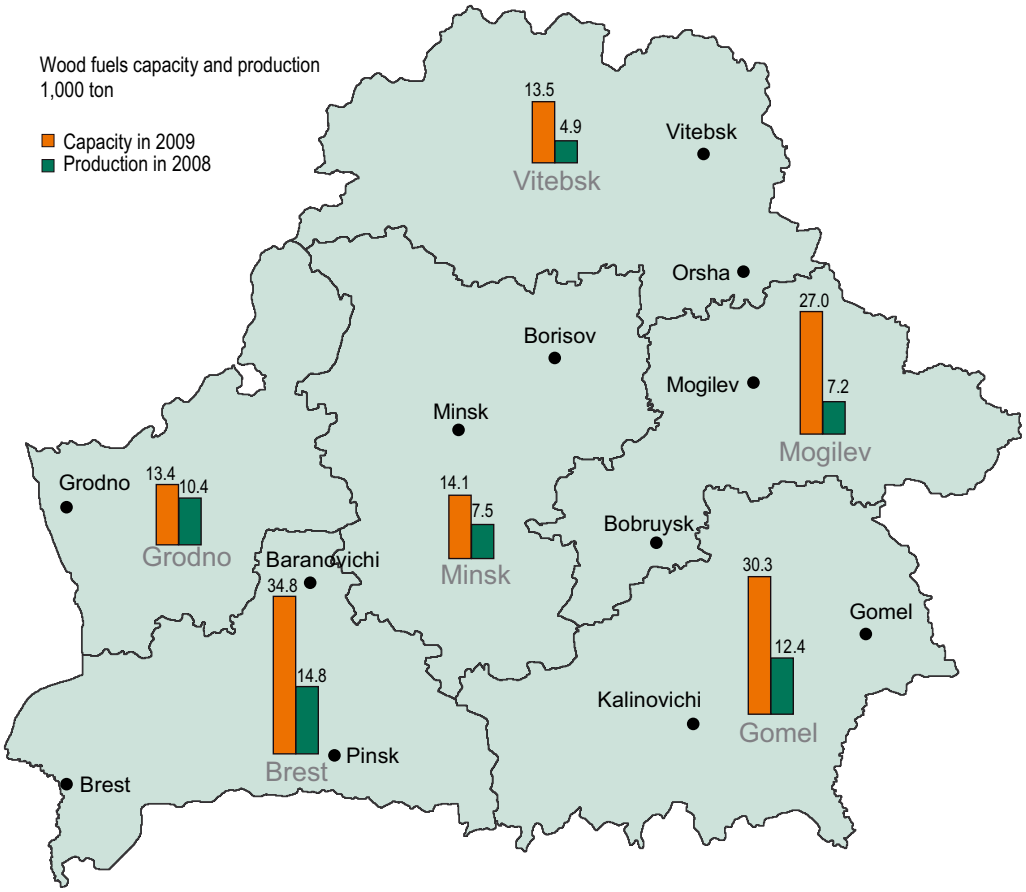

Figure 3.10. Capacity and production of wood pellets and briquettes by region.

and power plants using wood fuel) shows a lack of raw materials for new production of wood pellets and briquettes at the enterprises belonging to the “Bellesbumprom” concern.

The availability of wood processing by-products is currently the main condition for profitable production of woodfuels. Proposals for the establishment of new facilities have been made to enterprises which usually have a guaranteed source of residues from woodworking. In particular, the Administration of the President of the Republic of Belarus has proposed the state enterprise ”Belarustorg” to establish a large wood pellet production plant (with a capacity of 40,000 tons per year) in Petrikov (Gomel region). The mill would be the largest in Belarus. The wood processing by-products and energy logs (low-quality round-wood) of 120,000 m³ would be received from the National Park “Pripyat”.

Six private organizations have announced their intention to build similar production plants based on their own sources of financing and loans from banks. The total planned capacity in 2009–2010 for the new production (the list is given in Table 3.6) is estimated at 70,100 tons of wood briquettes and pellets per year (except for the Ministry of Forestry which has its own development programme). Thus, the total capacity of existing and brand new mills will be approximately 203,000 tons per year. The brand new production capacity of wood pellets and briquettes, planned to be established in 2009–2010 in Belarus is shown in Figure 3.11.

Table 3.7. The plan of establishing the brand new mills for the production of wood briquettes and pellets (except the Ministry of Forestry).

Name	Year	Capacity, 1,000 ton/yr	Raw material
Administration of the President "Belarustorg" ГП «Беларусьторг» (пеллеты)	2009	40.0	Residues from sawmilling and woodworking National Park "Pripyat" – 120,000 m^3
Brest			
"Basic Timber Company" СООО «Бейсик Тимбэ Компани»	2009	2.4	Own residues – 5,600 m^3
Belchekhstav – ЗАО «Белчехстав»	2009	0.5	Own residues – 1,000 m^3
Divstroy – ОДО «Дивстрой»	2009	1.2	Purchased raw material – 2,500 m^3
"Pillet-Master" (ext.) – ИП «Пиллет-Мастер» (расширение)	2010	9.6	Purchased raw material – 23,000 m^3
Vitebsk			
"Orsha combine of building materials" ОАО «Оршанский комбинат строительных материалов»	2010	4.0	Own residues
Gomel			
"Ecoformresurs" (2nd line) ОДО «Экоформресурс» (2 линия)	2009	2.4	Own residues
Grodno			
"Ecoenergogroup" ЧПУП «Экоэнергогрупп»	2010	10.0	Own and purchased residues
Belarus		70.1	

Source: Woodfuels Programme 2009

Figure 3.11. Projected annual consumption of woody biomass in wood pellet and briquette companies.

Based on the availability of wood fuel resources, the Ministry of Forestry has scheduled 22 brand new production facilities for wood pellets and briquettes, including 15 mills for production of pellets and 7 production facilities for manufacturing wood briquettes, as shown in Table 3.7 and Figure 3.8.

Table 3.8. Creation of production facilities for the manufacture of wood pellets and briquettes in 2009–2011.

Region Forest unit	2009	2010	2011	Capacity, ton/h	Raw material consumption, 1,000 m^3
Wood pellets	3	8	4	23.5	423
Vitebsk					
Begomol	1			1.0	18
Verkhnedvinsk		1		2.0	36
Gorodok		1		2.0	36
Disna			1	1.0	18
Surazh	1			1.0	18
Tolochin	1			1.0	18
Ushachy			1	1.0	18
Gomel					
Mozyr			1	1.5	27
Petrikov		1		1.5	27
Rechitsa		1		3.0	54
Svetlogorsk		1		1.5	27
Minsk					
Berezino		1		2.0	36
Luban			1	2.0	36
Mogilev					
Bykhov		1		1.5	27
Chaussy		1		1.5	27
Wood briquettes	1	6	1	3.3	58
Brest					
Luninets		1		0.4	7
Vitebsk					
Beshenkovichi		1		0.4	7
Gomel					
Zhitkovichi		1		0.6	11
Grodno					
Ivye			1	0.3	5
Ostrovets	1			0.3	5
Novogrudok		1		0.3	5
Mogilev					
Klichev		1		0.45	8

Source: Woodfuels Programme 2009

The total woody biomass consumption of existing and projected mills for the production of wood pellets and wood briquettes can be estimated at about 0.8 million m^3 per year and is shown in Figure 3.12.

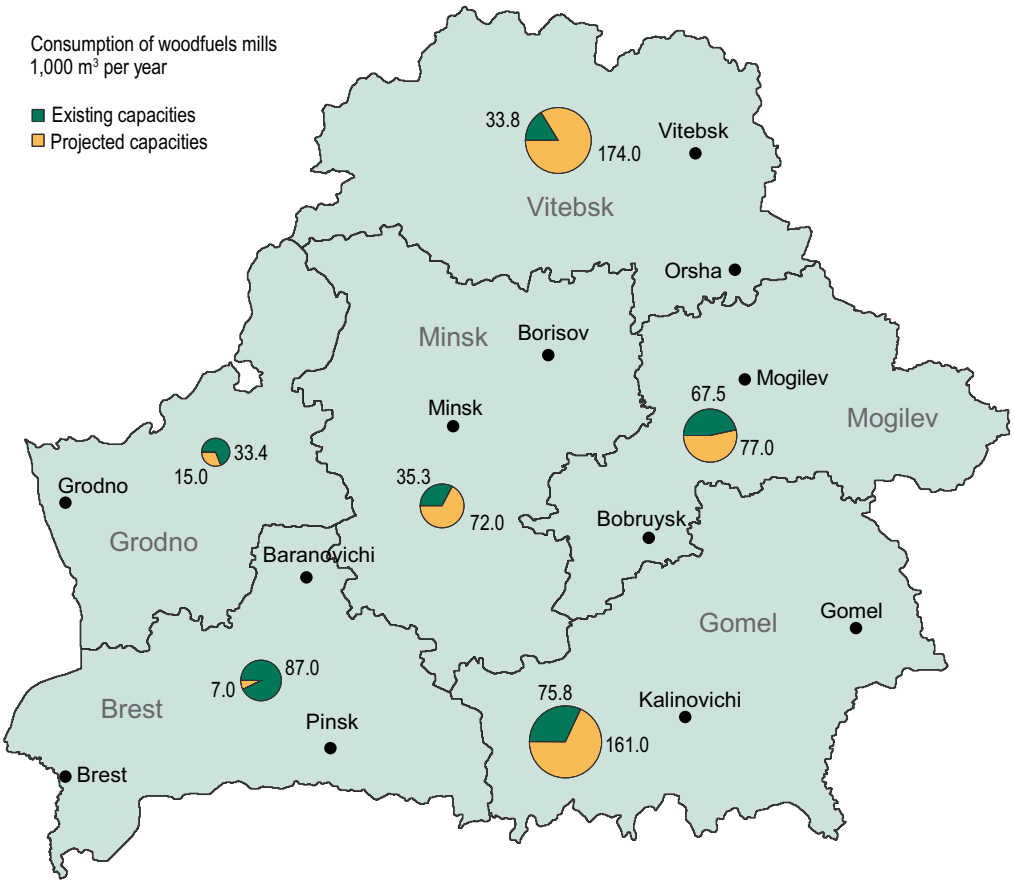

Figure 3.12. Consumption of woody biomass in existing and projected wood pellet and briquette companies.

3.4 Domestic use of woodfuels

The average annual primary consumption of energy in Belarus is about 25.3 million tons of coal equivalent (toe) and only 6% is covered by own wood resources. Belarus as a whole uses currently woodfuels equal to 1.5 million tons of oil equivalent (Mtoe). The majority of this is for heating individual rural households (about 0.8 Mtoe), a lesser amount is used in small boiler houses (0.5 Mtoe) and the remainder (0.2 Mtoe) is used within the wood processing industries (in the form of off-cuts and sawdust).

In terms of volume the production of woodfuels in recent years has been about 7 million m³, including 5.7–5.9 million m³ from companies and 1.0–1.3 million m³ from own production by private households. A substantial portion of the woodfuels produced by industry was provided to the population and budgetary organizations. Thus, according to data reported in 2008, 3.7 million m³ of woodfuels or 62% of the produced woodfuel was sold to residential customers. Thus, the remaining 2.2 million m³ of woodfuels was used by boiler-generation plants for the production of heat and electricity (Minleshoz 2010, EXPORT.BY 2010). At the moment 10 power plants (Figure 3.13) and 104 boilers with a capacity of over 1 MW use woodfuels.

In order to improve woodfuels supply, harvesting units for the production of wood chips have been created within the existing forestry enterprises under the Ministry of Forestry and the "Belesbumprom" concern. The pilot energy supply system for the Vileika mini-CHP was implemented

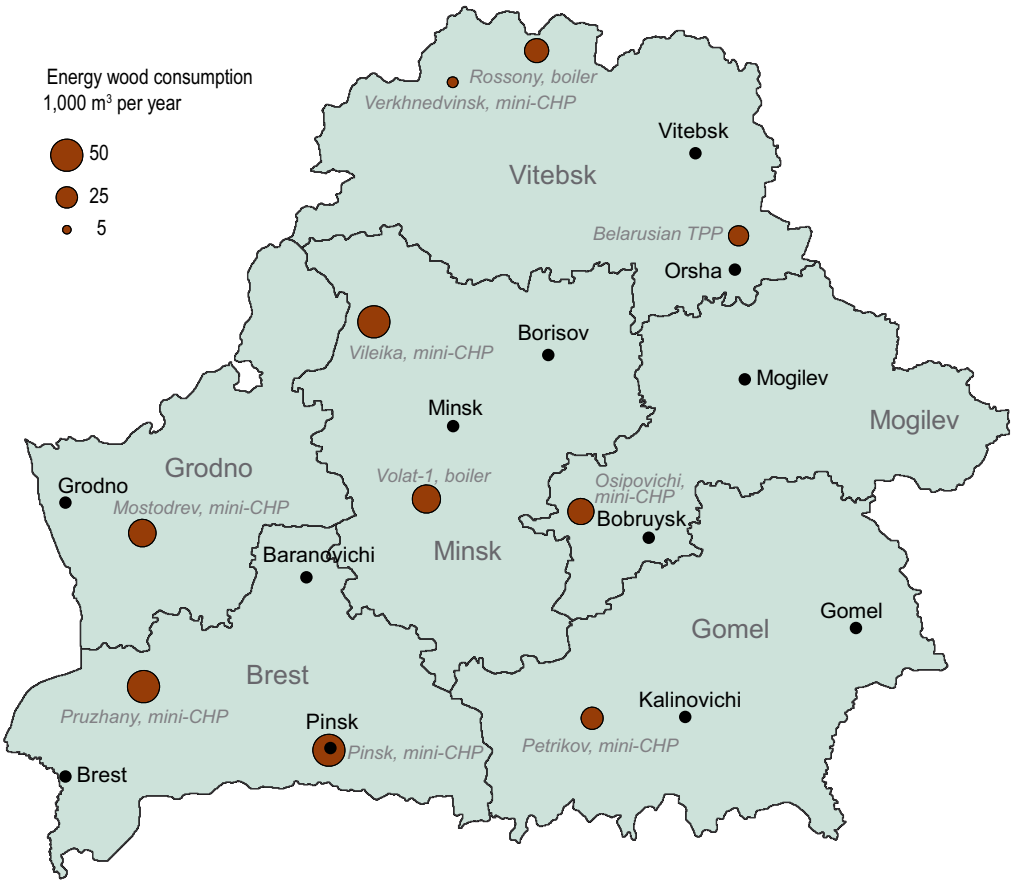

Figure 3.13. Largest power plants using wood.

under the project of the Government of Belarus and the UN Development Programme, ”Biomass Energy for Heating and Hot Water Supply in Belarus” (Fedoseev et al. 2004).

In accordance with the ongoing state programmes (Local Fuels Programme 2004, Energy Modernization Programme 2005) at least 25% of the energy in Belarus should be produced from local fuels by 2012 and 16 mini-CHP using woodfuels should be constructed with an annual woodfuel consumption of 1.2 million m³.

The domestic consumption of woodfuels in recent years will be reduced by the ongoing work on the gasification of rural settlements which are the main consumers of local fuels. According to the Ministry of Energy and the Department of Energy of Gosstandard, this reduces the possibility and prospects for the use of wood pellets and briquettes by private households and power plants in Belarus. Rural population traditionally use non-industrial roundwood as a fuel. Firewood prices are governed by the regional executive committees taking into account the purchasing possibilities of the rural population.

In the framework of regional energy saving programmes in Belarus (mainly communal organizations) over 230 boilers using wood fuel were installed in 2006–2009. Typically, the work of these boilers is designed for the burning of wood processing by-products, the price of which is currently significantly below the value of wood pellets and briquettes.

Against this background, it should be noted that capacity for the production of wood pellets is dependent on the potential resource of wood processing by-products, and total production of these products can be about 200,000 tons per year. On the basis of elaboration of the existing woody biomass source only the Ministry of Forestry has decided to create a number of brand new production facilities for wood pellets and briquettes at the subordinate enterprises.

3.4.1 Export

Woodfuels export in 2008 (Table 3.5) as compared with 2004 has increased in terms of volume by 78,100 tons (or 63%) and in terms of value by US$ 11.6 million (4.1 times). The growth in exports is due to a change in its structure. Cause for the structural change was the adoption of the Council of Ministers' decision (dated 15 February 2005 № 159) to impose an export duty on round energy wood (€10 per 1 m³). This customs duty was retained by the Presidential Decree of 5 December 2006 № 717 and 31 December 2007 № 700. As a result, the export of woodfuels in the form of chips, pellets and briquettes has increased, and in the form of roundwood has decreased from 112,000 tons in 2004 to 2,300 tons in 2008. The analysis of volume and value of woodfuels export in 2006–2009 is given in Table 3.9.

Table 3.9. Export of woodfuels in 2006–2009.

Fuel type	Unit	Year				
		2004	2005	2006	2007	2008
Total	1,000 ton	123.3	56.9	94.2	134.5	201.4
	US$1,000	3,724	2,462	5,191	9,271	15,329
	US$/ton	30.2	43.3	55.1	68.9	76.1
Energy wood in the rough	1,000 ton	112.0	12.8	5.3	0.8	2.3
	US$1,000	3,209.9	381.8	256.0	62.8	189.7
	US$/ton	28.7	29.8	48.2	80.4	82.2
	Share in term of volume, %	90.9	22.5	5.6	0.6	1.1
	Share in term of value, %	86.2	15.5	4.9	0.7	1.2
Wood chips, shavings	1,000 ton	3.3	12.5	30.1	55.8	92.9
	US$ 1,000	56.0	207.2	418.6	2,064.2	3,927.2
	US$/ton	17.1	16.6	13.9	37.0	42.3
	Share in term of volume, %	2.7	22.0	32.0	41.5	46.1
	Share in term of value, %	1.5	8.4	8.1	22.3	25.6
Sawdust and wood waste in the form of logs, briquettes, pellets	1,000 ton	7,974	31,595	58,733	7,758	106,139
	US$ 1,000	457.8	1,873.4	4,516.1	7,143.7	11,211.7
	US$/ton	57.4	59.3	76.9	91.6	105.6
	Share in term of volume, %	6.5	55.5	62.4	58.0	52.7
	Share in term of value, %	12.3	76.1	87.0	77.1	73.1

Source: Woodfuels Programme 2009

4 Peat and peat-based fuel

4.1 Potential and projected use

Peat resources are exploited intensively in Belarus and are used in agriculture, energy, chemical technology, spa facilities, and protection of the environment. After hydro-technical reclamation many of the peat deposits are used as farmland. As a result of the peat extraction, salinity, wind and water erosion, contamination and fires the industrial stocks of peat have decreased by some 1.4 billion tons. Natural growth of peat resources during the same period has amounted to 60–70 million tons.

The total area of peat deposits is 2.4 million ha with geological reserves of peat of about 4 billion tons. However, these reserves can not be considered as possible for energy use, as they are composed of an "ash" type of peat, small peat deposits and peat deposits that provide significant environmental impacts. Currently only 13,900 ha are suitable for the extraction of peat with a stock of 22.2 million tons. These resources will provide the current level of production for 5–7 years, and without involving new areas many peat companies will cease to exist due to the depletion of peat resources.

According to the Concept of Energy Security of Belarus peat and wood fuels are most in demand in the energy sector. By 2020, the amount of peat extraction for energy should increase to 1 million toe (4.4 million tons of peat), and the share of peat in total fuel consumption should be no less than 4.3%.

According to the Scheme of Rational Use and Protection of Peat Resources (Схема рационального использования и охраны торфяных ресурсов) the peat deposits (4.4 billion tons, Table 4.1) are distributed between target groups (environmental, reserve, land, developing, unused and developed funds) (Scheme of Peat Resources 1991). Due to cheap energy resources at the time of the adoption of the scheme, the land and environmental use of peat has been a priority. The developing fund is about 7.4% of the existing peat stock (323.4 million tons for 18–20 years of exploitation). However, since the scheme was approved, the recoverable fund has been substantially used/exploited. All the big deposits are distributed between target funds, and without reviewing the Scheme of Rational Use and Protection of Peat Resources the increase of peat extraction is not possible.

Table 4.1. Distribution of peat potentials by funds in 1988.

Fund	Area, 1,000 ha	Stock, million ton
Environmental	312.6	771
Reserve	31.1	103.4
Land	963.1	1,575.3
Developing	109.0	323.4
Unused	797.5	1,478.9
Developed	183.4	145.8
Total	2,400	4,400

Source: Scheme of Peat Resources 1991

Given the use of environmentally friendly technologies, the negative influence of peat extraction on the environment could be minor and short-term. The environmental, land and unallocated funds have to be reviewed and reallocated. It is predicted that the recoverable fund will be approximately 400 million tons (Peat Programme 2008).

4.2 Peat industry

As part of the state production association of fuel and gasification "Beltopgaz" (ГПО "Белтопгаз") there are 34 enterprises in the peat industry, of which 31 enterprises extract and process peat, 22 produce fuel briquettes, and 3 enterprises produce engineering products for the peat industry. The state enterprise "Belniitopproekt" (РУП "БелНИИтоппроект") provides development services for the construction and reconstruction of peat extraction and processing, development of design documentation for the manufacture of machinery for the production of bog-preparatory work, and peat extraction and the implementation of complex research projects to introduce new technology. The state enterprise "Beltoplivostroy" (ПРУП Строительно-монтажный трест "Белтопливострой") carries out construction of mining and processing peat. Most of the peat enterprises were established more than 40 years ago.

The peat reserves in 46 developing peat deposits are estimated to be 101.8 million tons within the area of 37,400 ha. Table 4.2 and Figure 4.1 show the distribution of peat reserves in developing peat deposits by regions in 2007. Annual production of peat is about 3 million tons. Table 4.3 and Figure 4.2 show the distribution of peat production in developing peat deposits by regions in 2007.

Table 4.2. Distribution of peat reserves in developing peat deposits by regions in 2007, 1,000 tons.

Region	Total	For energy	For agriculture
Belarus	101,803	77,125	24,678
Brest	12,580	11,762	818
Vitebsk	15,791	5,547	10,244
Gomel	7,195	7,195	0
Grodno	12,699	10,754	1,945
Minsk	48,348	38,337	10,011
Mogilev	5,190	3,530	1,660

Source: Peat Programme 2008

Table 4.3. Development of peat production in developing peat deposits by regions in 2008–2020, 1,000 tons.

Region	2008	2009	2010	2015	2020
Belarus	3,028	3,385	3,781	4,505	5,128
Brest	615	690	732	845	863
Vitebsk	281	336	374	596	855
Gomel	338	364	453	545	567
Grodno	526	614	640	681	868
Minsk	1,085	1,151	1,339	1,580	1,704
Mogilev	183	230	243	258	271

Source: Peat Programme 2008

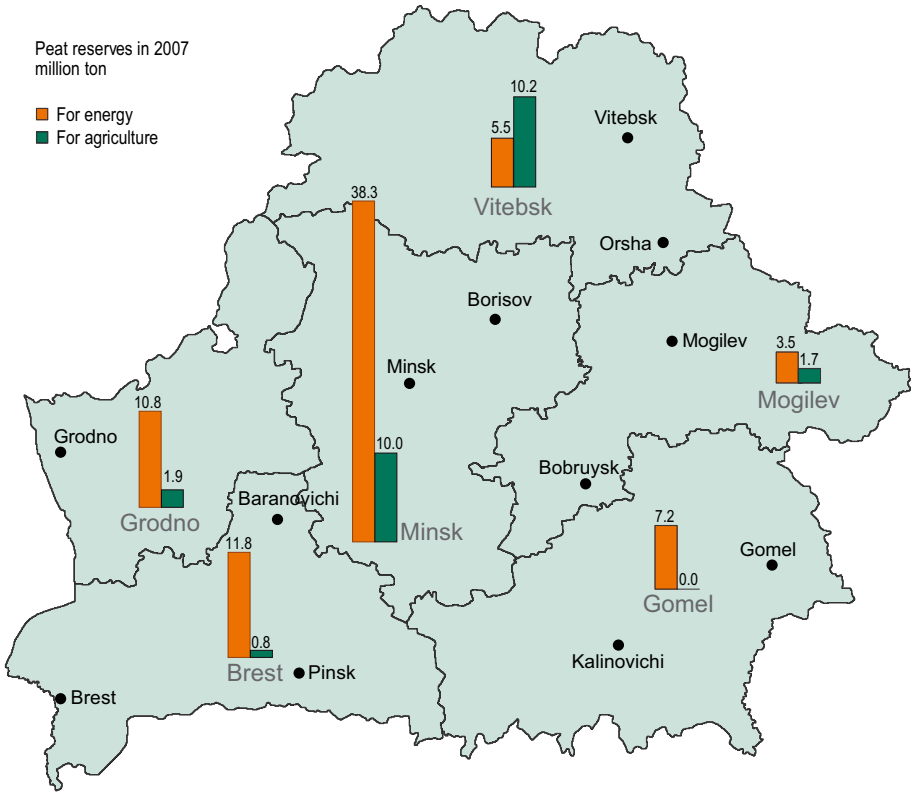

Figure 4.1. Distribution of peat reserves in developing peat deposits by regions in 2007.

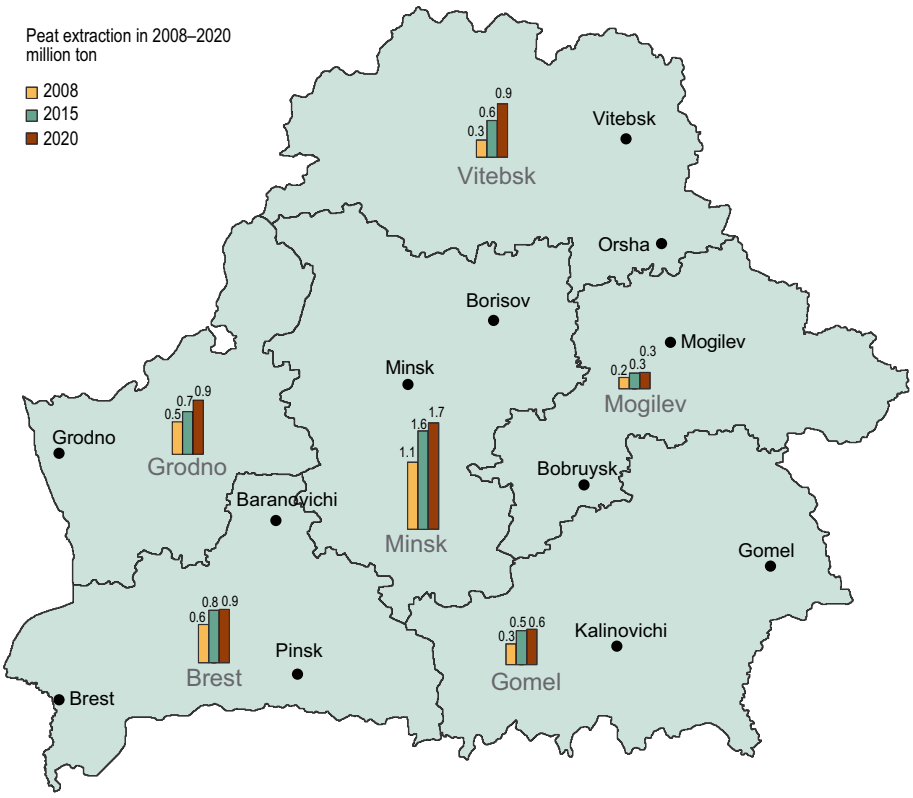

Figure 4.2. Distribution of peat production in developing peat deposits by regions in 2007.

The main method of peat extraction in Belarus is the milling method. The milling method for production of peat products was designed by the Soviet specialists from the Research Institute of Peat and has been used in the industry since 1930.

The development of peat is preceded by drainage and surface preparation. Preparation of the surface field is performed after the construction of a drainage network and the end of the preliminary drainage of peat. Trees and moss vegetation are removed. The drainage system consists of a network of channels which contributes to lowering ground water and reduces the moisture of the peat deposits. When the surface of the field is ready, the peat is loosened to a depth of 11–13 mm using a tractor mounted with a milling drum (Figure 4.3). Mills, revolving around the drum axis and moving into peat, remove the small layer of peat and turn it into crumbs. Thus loosened peat dries in the sun. During the drying process, the peat is turned 2–3 times by harrow, which is also installed on a tractor (Fig. 4.4).

Figure 4.3. Milling drum
Source: negonki.ru

Figure 4.4. Harrow
Source: FART 2010

Figure 4.5. MTF-43 harvesting machine
Source: www.parovoz.ru

Figure 4.6. MTF-71 stacking machine
Source: www.parovoz.ru

Once milled peat reaches the desired humidity, it goes into a roller directly on the field. And further harvesting machines (Figure 4.5) move along the roller, collecting peat into a bunker and transporting it to a stack, located at the end of the rolls, where the peat is unloaded from a hopper in bulk on the side slope stacks and is allocated to an even layer on the surface by the stacking machine (Figure 4.6).

All stacks are temperature controlled, to avoid self ignition. This procedure is important because an increase in temperature in the stacks can lead to the formation of spots of spontaneous combustion, which leads to loss of peat. Peat becomes toxic to plants and is not suitable for further use in production. Milling, tedding and harrowing, followed by harvest into stacks constitute the so-called "cycle of harvesting". Immediately after the end of one cycle of harvesting, a new process of milling the surface of the swamp begins. During the summer a layer of peat of 20 cm is removed within up to 23 cycles of harvesting.

Milled peat can be dried only in dry sunny weather, so its production is only possible in the summer for a very short period of time.

The following equipment is used in the production of milled peat in Belarus:

- milling, 123 units of machine MTF-13, -14, -18;
- tredding, 96 units of machine MTF-21, -22;
- harrowing, 64 units of machine MTF-31, -33;
- harvesting, 227 units of machine MTF-41, -43, PPF-5; and
- stacking of milled peat, 60 units of machine MTF-71, -71A.

The sod peat method of peat extraction has been introduced in Belarus, but it plays a minor role at the moment.

The tracked crane КПТ-1, МТТ-16 (84 units) and wheeled loader ТО-7, -18, -28, -30 (54 units) are used for loading. The locomotive ТУ-4, -6, -7, -8 (124 units) and wagon ТСВ-6 (1823 units) are used to transport peat by railway (Figure 4.7). Most peat equipment, except sod peat machinery and wheeled loaders, are outdated.

Figure 4.7. Tracked crane, wagons and locomotive are used for peat transport.
Source: www.parovoz.ru

4.3 Peat fuels

In order to achieve the goals of increasing the use of local fuels, projections of peat extraction (Table 4.4) and the use of peat fuel in the country for the period up to 2020 (Table 4.5) are formulated in the Peat Programme (2008).

Table 4.4. Projected fuel peat extraction in Belarus for the period up to 2020.

	2006		2008		2009		2010		2015		2020	
	1,000 ton	1,000 toe	1,000 ton	1,000 toe	1,000 ton	1,000 toe	1,000 ton	1,000 toe	1,000 ton	1,000 toe	1,000 ton	1,000 toe
Total production	2,143	510.4	2,700	644.0	2,990	714.0	3,341	805.0	4,100	980.0	4,377	1,050.0
for briquettes	2,109	502.0	2,536	603.4	2,791	664.3	2,927	700.0	3,047	725.2	3,079	732.9
for customers	24	5.7	140	33.6	146	35.0	344	84.0	921	219.1	1081	257.6
lump	9.5	2.7	22	6.3	50	14.0	66	20.3	85	24.5	165	47.6
for pellets	–	–	2	0.7	3	0.7	4	0.7	47	11.2	52	12.6

Source: Peat Programme 2008

Table 4.5. Projected use of peat fuels in Belarus for the period up to 2020.

	2008		2009		2010		2015		2020	
	1,000 ton	1,000 toe	1,000 ton	1,000 toe	1,000 ton	1,000 toe	1,000 ton	1,000 toe	1,000 ton	1,000 toe
Total consumption		626.5		665		734.3		907.2		972.3
Domestic consumption		538.3		610.4		679.7		882		972.3
briquettes	1,042	437.5	1,190	499.8	1,242	521.5	1,367	574	1,442	605.5
pellets	1	0.7	1	0.7	2	0.7	23	9.8	26	10.5
for customers	126	30.1	131	31.5	310	73.5	829	197.4	973	231.7
lump peat	21	6.3	48	13.3	63	18.2	81	23.1	157	44.8
for peat fuel production		62.3		65.1		65.8		77.7		79.8
Export	210	88.2	130	54.6	130	54.6	60	25.2	–	–

Source: Peat Programme 2008

4.3.1 Production of fuel briquettes

The main product of the peat industry is peat fuel briquette. In 2006 “Beltopgaz” produced 1.24 million tons (0.52 million toe) of briquettes, from which 210,900 tons (88,600 toe) was exported (17% of the total supply of peat briquettes in Belarus) (Table 4.6). Key importers are Sweden, Germany, Poland, Latvia, and Lithuania (Figure 4.8). According to the Peat Programme (2008) the production of peat fuel briquettes should be increased by up to 1.47 million tons per year (Table 4.7, Figure 4.9).

Table 4.6. Supply and consumption of peat fuel briquettes in 2006, 1,000 toe.

Region	Supply	Consumption	Balance
Belarus	519.8	510.7	9.1
Brest	113.1	106.5	6.6
Vitebsk	56.6	59.8	-3.2
Gomel	49.0	46.2	2.8
Grodno	60.2	51.0	9.2
Minsk	105.6	103.7	1.8
Mogilev	46.8	54.9	-8.1
Abroad	88.6	88.6	

Source: Peat Programme 2008

Table 4.7. Projected volumes of the production of peat fuel briquettes in 2008–2020, 1,000 tons.

Region	2008	2009	2010	2015	2020
Belarus	1,270	1,347	1,400	1,456	1,471
Brest	294	307	318	318	326
Vitebsk	50	70	75	85	85
Gomel	136	139	145	170	170
Grodno	268	275	279	280	280
Minsk	472	493	518	538	545
Mogilev	58	63	65	65	65

Source: Peat Programme 2008

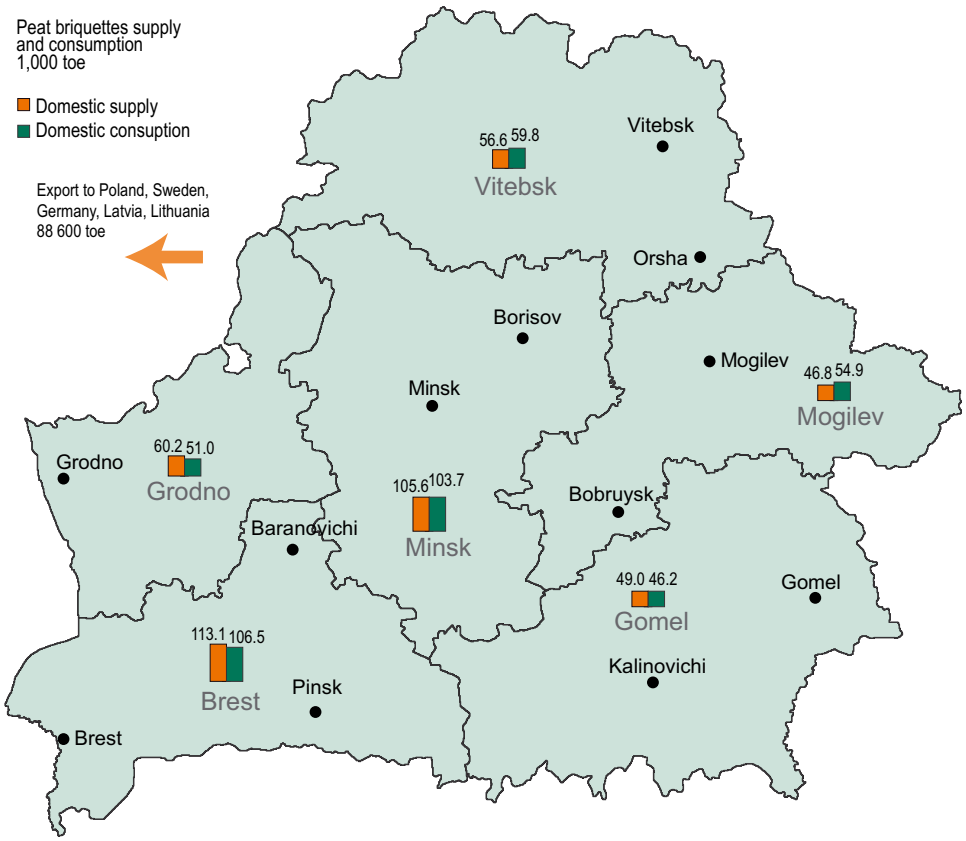

Figure 4.8. Supply and consumption of peat fuel briquettes in 2006, 1,000 toe. KUVA: Domestic consumption

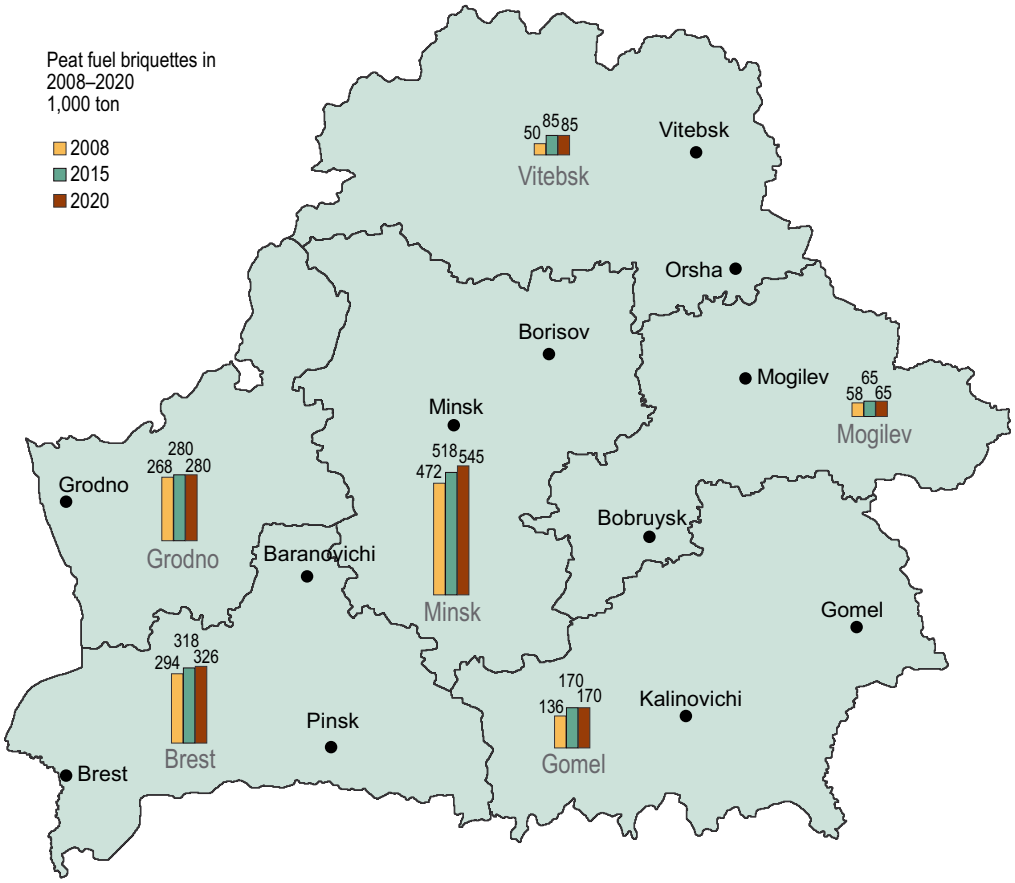

Figure 4.9. Projected volumes of the production of peat fuel briquettes in 2008–2020, 1,000 tons.

The production of peat fuel briquettes is carried out on the pneumatic steam dryer "Peco" (2 units), the tubular steam dryers by the German company "Tsemag" (26 units) and briquette press BPD-2, B 8232, B 9032, "Bukkau-Wolf" (103 units). Most of the equipment is outdated.

4.3.2 Production of fuel pellets

Since 2008 the "Zelenoborskoye" enterprise in the Minsk region has been realizing a pilot project on the production of a new type of peat fuel pellets with a 12,000 ton capacity per year by 2020. In 2011–2014 the "Vitebskoye" enterprise in the Vitebsk region plans to introduce pellet production with a capacity of 40,000 tons per year by 2020.

4.3.3 Production of sod peat

Production of this type of peat fuel is less energy-intensive than briquettes. The production of sod peat should be increased from 22,000 tons in 2008 to 66,000 tons in 2010 due to the introduction of the high-performance equipment for mining, loading and transportation of sod peat at the enterprises "Vitebskoy" and "Osintorf" in the Vitebsk region. In case of positive results the further development of sod peat will be extended with a target of 165,000 tons production in 2020. Due to the significant increase in the production of sod peat (more than 17 times compared with 2006) it is necessary to solve the issues of increasing its use in Belarus.

4.4 Re-equipment of the peat industry

The tasks of the technical re-equipment of peat enterprises are formulated in the Peat Programme (2008).

The main tasks for peat harvesting are: the introduction of wide working peat harvesting machines which reduce fuel consumption; the domestic production of wheeled harvesting machines; the introduction of resource-saving technologies; and chain of machines for the extraction of peat with a separated harvest. Application of this technology can reduce fuel consumption by 15%, create an annual economic effect of at least Br 15 million per chain, improve the technological reliability of machines and reduce production losses due to weather conditions. Increasing sod peat production is possible by introducing high-efficiency equipment.

In peat transport, the existing tracked loading cranes are replaced with domestic wheel loaders; railway locomotives are modernized; master production of railway rolling stock for peat transportation are organized by the domestic machine-building enterprises.

In peat fuel production, 26 steam tube dryers “Tsemag” are in operation at the peat plants of the Ministry of Energy. The fleet of the equipment is over 25 years old, and it is practically depleted. The main goal in the future is to maintain their functionality.

Capital expenditures in carrying out activities on peat in 2008–2020 at 2007 prices should be about Br 1.2 trln. Areas of use of these investments are as:

- Br 436 billion 345 million for the construction of mining and railroad tracks;
- Br 483 billion 348 million to purchase equipment for the extraction and transport;
- Br 105 billion 599 million for the technical renewal of the pellet plants;
- Br 84 billion 221 million for the reproduction of new peat;
- Br 32 billion 232 million for renewal of the constructon organization;
- Br 21 billion 976 million to organize the production of new products;
- Br 1 billion 963 million for the purchase of firefighting equipment.

5 Conclusion

The energy sector makes up approximately 30% of the industrial structure of the country. The role of the sector is large both in exports (36% of the total export value) and imports (39% of the total import value). Previously access to cheap gas from Russia and lack of energy diversification policies prevented Belarus from developing its potential local energy resources for energy generation. The cost effectiveness at a certain level of reliability was a key performance criterion in Belarus when planning power systems at national level. Nowadays energy security is the top priority. Energy independence is determined primarily by the share of local energy resources in the overall energy balance. Currently, the share of local fuels is about 16% of the gross consumption of primary energy and 17% in the use of boiler and furnace fuel. According to the concept of energy security of Belarus the latter figure must be increased to 25% by 2012 (Local Fuels Programme 2004).

Belarus is poorly endowed with fossil resources, which have met only about 7% of the country's primary energy consumption in recent years. The most valuable Belarusian fossil energy resource is high quality oil, but its residual reserves are estimated at only 55 million tons.

The total reserves of peat in the country are identified as 4 billion tons, but most of them are in agricultural land, or assigned to environmental areas.

The natural conditions of Belarus do not allow a large-scale use of all renewable energy resources. Economically viable hydropower potential of rivers is about 250 MW. Taking into account the seasonality, hydropower stations can provide about 2% of current electricity consumption. Wind and solar potential in Belarus has not been studied (Mihalevich 2009). Preliminary theoretical predictions based on single measurements in the field of the so-called "wind corridor" show the maximum possible power output using all sites to be at the level of 2.8 billion kWh, or about 8% of today's consumption. However, these estimates and the size of the expenditure required for the development of wind power need to be clarified. Modern technology allows to consider solar energy in the temperate latitudes as a possible source of heat energy, since the efficiency of the solar-electrical converters is still low. The greatest potential sources of renewable energy in Belarus are the forests. The annual increment of forests is about 28.6 million m^3, which can provide approximately 4.6 million toe per year.

Therefore, wood and peat will be the main sources of growth the share of local energy resources in the energy balance of Belarus until 2020. The government has developed a series of regulatory documents to create a legislative, economic, financial, organizational and technical framework in the use of wood and peat fuels (Local Fuels Programme 2004, Woodfuels Programme 2009, Peat Programme 2008, Forestry Programme 2006). However, there is a risk that the targeted increase in the production of woodfuels may result in an extensive use of high-quality logs as woodfuel, which will have negative environmental implications and cause a suboptimal exploitation of the forest resources. Many of these issues are not unique to Belarus and are being faced by several countries who plan to promote renewable energy.

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