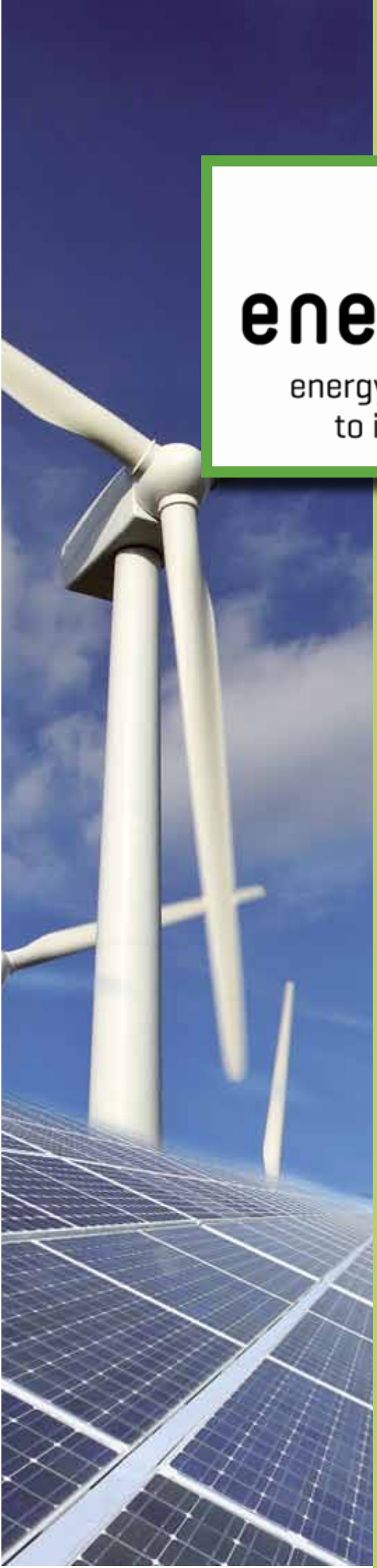

energy research to innovation

Belarus ENERGY Sector: the Potential for Renewable Energy Sources and Energy Efficiency

Analytical Review

The Review has been developed and funded within the FP7 project ENER2I — "ENErgy Research to Innovation: Reinforcing cooperation with ENP countries on bridging the gap between energy research and energy innovation" supported by the European Commission under the grant agreement № 609532.

CONTENT

Chapter 1

INTRODUCTION

Nowadays, increasing efficiency of energy supply and usage is a burning challenge both for the European Union and the countries bordering the EU in Eastern Europe. Reducing conventional energy sources is urging today's society to use the energy resources much more carefully and efficiently, to look for and use alternative energy sources more actively, to control climate changes and environmental pollution, etc. Using the latest technologies and innovative approaches is vital for these areas; consequently energy is one of the priorities of science and technology development in most countries inside and outside the EU, including Belarus.

In order to strengthen the connections between science and innovations in Eastern Partnership countries (EaP) for developing business in energy efficiency (EE) and renewable energy sources (RES), the European Union has supported the ENER2I project ("ENErgy Research to Innovation: Reinforcing Cooperation with ENP Countries on Bridging the Gap between Energy Research and Energy Innovation"). The project is funded by the European Commission under the 7th Framework Programme for Research, Technology and Development (FP7) from October 2013 to September 2016. The ENER2I consortium is composed of 11 partner organisations from the EU member states (Austria, Germany, Hungary) and the EaP countries (Armenia, Belarus, Georgia, Moldova). The project is coordinated by the Centre for Social Innovation (ZSI), Austria. Belarus is represented by the two organizations — Belarusian Institute of System Analysis and Information Support of Scientific and Technical Sphere (BelISA) and Belarusian Innovation Fund (Belinfund).

This Review resultsfrom the first, analytical phase of the ENER2I project in Belarus and has a two-fold objective. First, it helps the project consortium to identify the challenges in implementing the innovation activities in EE/RES sector in Belarus, and select those of them which can be solved with the support of the ENER2I partners. This will be achieved via strengthening cooperation between science and industry at the national and international level. For that, such innovation promoting instruments as innovation vouchers, brokerage events, twinning schemes, etc. will be implemented. Moreover, the Review provides an opportunity to identify the needs of various stakeholders' groups and provide them with a targeted

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support. In other words, it helps to understand who needs assistance, what exactly one misses and how the ENER2I project and similar support actions can serve the needs.

Second, together with the similar documents developed in Armenia, Georgia and Moldova,the Review will serve as a basis for framing recommendations for the governments and policymakers in the focus countries on promoting research and innovation activities for strengthening business in EE/RES and developing and appropriate action plan.

The Review also may be of interest for a wide range of readers interested in Belarus and its economy and energy sector current trends. This information can be used in decision-making on capital investment and innovation cooperation.

The Review provides a general description of the national energy sector and examines its potential with a focus on EE/RES. Chapter 1 describes objectives, goals, methods and performers of the research. Chapter 2 contains a brief analysis of current situation in the national energy sector and the main tasks of the state energy policy. Chapter 3 gives a more detailed insight onthe situation in RES (hydro energy, wood fuel, biogas, wind and solar energy, and etc.) and main activities undertaken to increase EE of the country as a whole and its dominant branches in particular. Furthermore, Chapter 3 examines the role of domestic and foreign businesses in developingthe renewable energy, as well as the measures implemented by the Government in order to increase the role of business in EE/RES. Chapter 4 considers the innovativeness of the energy sector: how the Belarus Government promotes innovation in the EE/RES sector?howactively business uses the results of domestic R&D?whether technology transfer takes place?whether FDI is promoted?how well international cooperation in science and technology is developed, including that with the EU? Finally, Chapter 5 contains assessment of the situation in the EE/RES sector and its innovation development including the international cooperation with the EU presented in the Chapters 2–4 (SWOT-analysis).

The Review is based on general research methods (analysis, synthesis, comparison, modelling) and SWOT-analysis. The data sources include the International Energy Agency, the National Statistical Committee, the Ministry of Energy, the National Agency of Investment and Privatization of

the Republic of Belarus,as well as the State Register of R&D projects and the database of international S&T projects administered by BelISA.

The Review was prepared by the group of the ener2i project partners from the BelISA and Belinfund with the active involvement of national and international experts in the field of energy. At the expert workshop held in Minsk on March 17, 2014, comments and suggestions to the document were submitted by Dr. Valery Sudilovskiy, Dr. Denis Rimko and Dr. Sergey Vasilevich (Institute of Energy of the National Academy of Sciences of Belarus), Mr. Kyril Levkov (Scientific and Technological Park of the BNTU "Polytechnic"), Ms. Alla Minko (Belinfund), Mr. Vladimir Nistsiuk (Belarusian Renewable Energy Association), Prof. Tatyana Pospelova (Belarusian National Technical University), Mr. Boris Rubenchik (Association of Energy Engineers), Dr. BronislavTauroginsky (Ataev Institute of Housing "NIPTIS"), Dr. Jürgen Schenk (International Sakharov Environmental University), as well as by Dr. Manfred Spieseberger (ZSI). Later on, Dr. Anatoly Suturin (BelISA) provided his input for Chapter 2 and contributed to editing of the Review. The authors deeply appreciate the cooperation with the involved experts and their efforts.

Chapter 2

CURRENT SITUATION IN THE ENERGY SECTOR OF THE REPUBLIC OF BELARUS

2.1 Background

Belarus is located in the center of Europe. The territory accounts 207.6 thousand km2 and the population is 9.46 million people (2013). The country has a common border with Latvia in the north, Russia in the north and east, Ukraine in the south, Poland in the west and Lithuania in the north-west. Belarus is divided into 6 regions ("oblasts") and 118 departments ("rayons"). Minsk, the capital of Belarus is a separate administrative unit. The population of 7 cities numbers from 200 to 500 thousand people.Over 1.9 million people live in Minsk (2013).

Figure 1. Map of Belarus

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Climate of Belarus is moderately continental and has warm summers with mild and humid winters. Winter and summer periods last 105–145 and about 150 days respectively. Average temperatures in January and February, the coldest months range from 18 °F to 25 °F(–8 °C to –4 °C), while temperatures in July and August are around 65 °F (18 °C). The period with temperatures above zero (32 °F) lasts about 230–260 days. The average rainfall is 600–700 mm. Snow period lasts 75 days in the southwest and 125 days in the northeast of the country and average snow depth ranges from 15 cm to over 30 cm respectively[1]. Heating season starts when the average daily temperatures is 8 °C and less (10 °C and less — in hospitals, schools and preschool institutions) and lasts 198 and 216 days respectively (the averages for the six regions).

There are more than 20,800 rivers and streams with a total length of approximately 90,800 km and about 11,000 lakes in Belarus. Three major rivers flowing through the country are the Dnieper (length within the country is 700 km and catchment area is 118,360 km^2), the Pripyat' (495 km, 50,900 km^2) and the Neman (436 km, 34,610 km^2).

Over 4,000 mineral deposits have been explored in Belarus. The main mineral resources are peat, potassium salts, granite, dolomitic limestones, marl, chalk, sand, gravel and loam. The stock of mineral resources of the country is limited, so the country has to import oil, gas, coal, combustible shale, etc. More than 80 oil deposits have been explored in Belarus and most of them are located in the Gomel region, in the northern part of the Pripyatdownwarp. There is a tendency towards reducing the oil and petroleum gas reserves: if oil production is maintained at the level of 2010 (1.7 million tons), its reserves in Belarus will be enough for 30 years.

There are more than 9,000 peat deposits in Belarus with the total area of 2.4 million hectares, of which 25 % are included in the nature conservation fund. The total amount of peat deposits is estimated as 4.0–4.2 billion tons. The average peat production is about 2.5 million tons (0.8 Mtoe) per year in the last five years (Table 1). If the current level of peat production is maintained[2], the exploitation of reserves will be maximized by 2015 and can stay effective for 20–30 years.

Belarus was one of the USSR's major industrial republics specialized in theproduction of machinery and agriculture. Nowadays, the industrial production continues to play an important role in the national economy.

[1] *The Republic of Belarus: An Encyclopedia,* ed. Gennady P. Pashkov (Minsk: BelEN, 2007), vol. 4, pp. 75–76 (in Russian).

[2] See Ivan Lishtvan, "Local energy sources for energy problems solving", *18th Belarusian Energy and Ecology Forum on 16–19 October, 2013,* http://www.tc.by/download_files/energy2013/lishtvan.pdf, 12.01.2014 (in Russian); Valery Kovalev, "Peat Sector, its current state and prospects of development", *18th Belarusian Energy and Ecology Forum on 16–19 October, 2013,* http://www.tc.by/download_files/energy2013/kovalev_2.ppt, 12.01.2014 (in Russian).

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Table 1

Intramural production of selected fuels in Belarus

	1990	1995	2000	2005	2010	2011	2012
Crude oil (million tons)	2.05	1.93	1.85	1.78	1.70	1.68	1.66
Natural gas (billion m^3)	0.29	0.26	0.25	0.22	0.21	0.22	0.21
Fuel peat of standard humidity (million tons)	3.43	3.14	2.00	2.30	2.35	2.70	2.67

Source: Statistical Yearbook 2013 and 2011

The main sectors of industry are metallurgy, mechanical engineering, metalworking, chemical and petrochemical industries, light and food industries. After the collapse of the USSR, all sectors of Belarusian economy were affected by the profound economic crisis. Since 1996, the economy of Belarus has been steadily growing annually at an average rate of 7 %. During 2001–2008, GDP grew on average by 8.3 % annually, more rapidly than in Europe and Central Asia region (5.7 %) and the CIS (7.1 %). Growth slowed down substantially due to the global economic crisis of 2008–2009: it dropped to 0.2 % in 2009. Tight monetary and fiscal policy in late 2011 and through 2012 helped to restore the macroeconomic stability in the country by 2013[3]. "The influence of the government over the economy remains extensive, including not only direct ownership of enterprises but also administrative intervention in credit allocation and widespread subsidies"[4].

According to the World Bank's income classification, Belarus belongs to the group of upper middle-income countries and has $6,530 GNI per

[3] "Belarus", *World Bank*, http://www.worldbank.org/en/country/belarus, 20.12.2013.

[4] United Nations Economic Commission for Europe, I*nnovation Performance Review of Belarus* (New York and Geneva, 2011), p. 4.

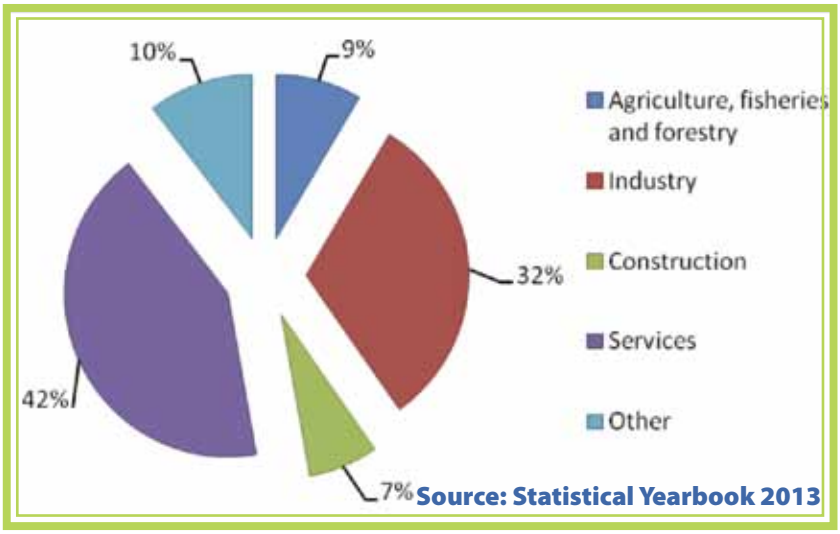
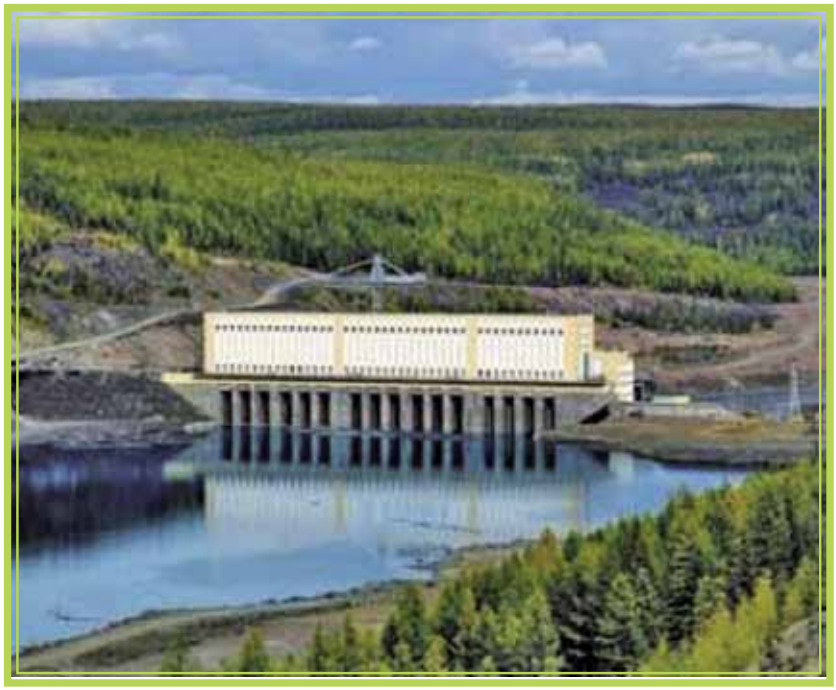


Figure 2. GDP of Belarus: composition by sector of origin (in current prices)

capita (2012). GDP is $63.27 billion and its growth is 1.7 % (2012). R&D expenditures are 0.67 % of GDP (2012)[5].

Belarus has trade relations with over 180 countries in the world and, within the Custom Union and the Common Economic Space, free access to the market of Russia and Kazakhstan (over 170 million people). The main trade partners of Belarus by exports of goods are Russia, the Netherlands, Ukraine, Latvia and Germany.



[5] National Statistic Committee of the Republic of Belarus, *Science and Innovation Activities in the Republic of Belarus: Statistical Book* (Minsk: Belstat, 2013), p. 41 (in Russian).

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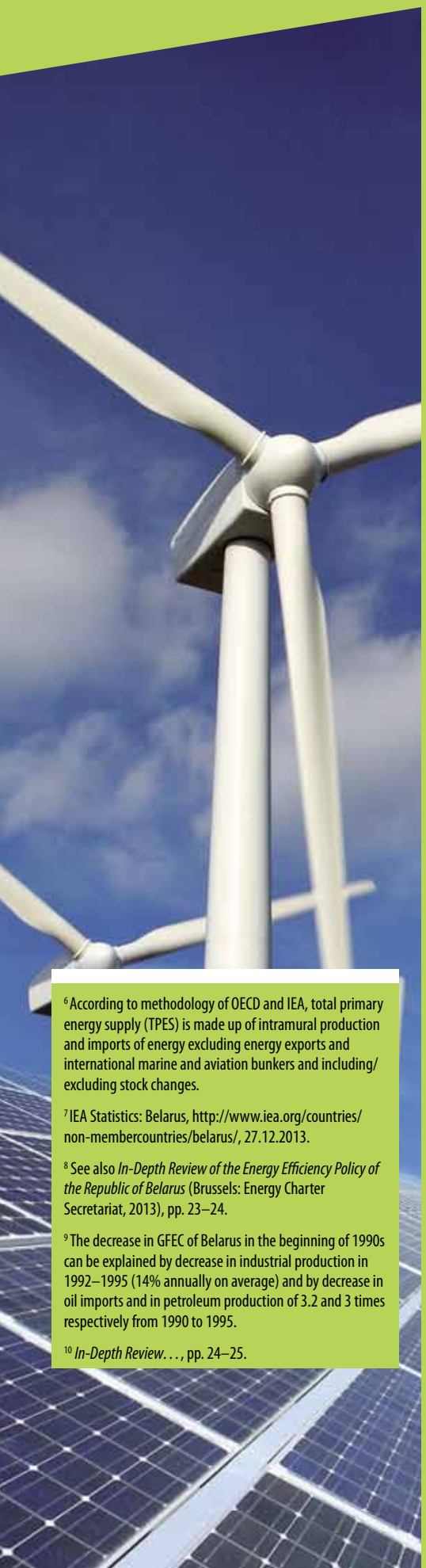


2.2 Energy consumption

From 1990 to 2011, total primary energy consumption (TPES)[6] of Belarus decreased 1.54 times, from 45.49 Mtoe to 29.50 Mtoe[7]. It promoted the average annual decrease in the energy intensity of GDP of 4.3 %. In 2011, energy intensity of Belarusian economy was 0.23 toe per thousand of 2005 $ GDP PPS (3 times less than in 1990)[8]. Gross final energy consumption (GFEC) was 21.15 Mtoe (2011) and decreased 1.6 times in comparison with 1990. The most significant decrease in GFEC was in 1990–1994: 13.3 % annually on average[9] (Figure 3).

From 1990 to 2011, the average annual decrease in energy intensity of GDP of Belarus was 4.7 % (6.3 % in 1997–2000). Energy intensity of Belarusian economy by 2011 was lower than those of leading CIS countries (Russia, Ukraine and Kazakhstan) but it was still higher than average energy intensity of the European OECD countries: 0.15 toe per thousand of $ 2005 GDP PPS[10] (Figure 4).

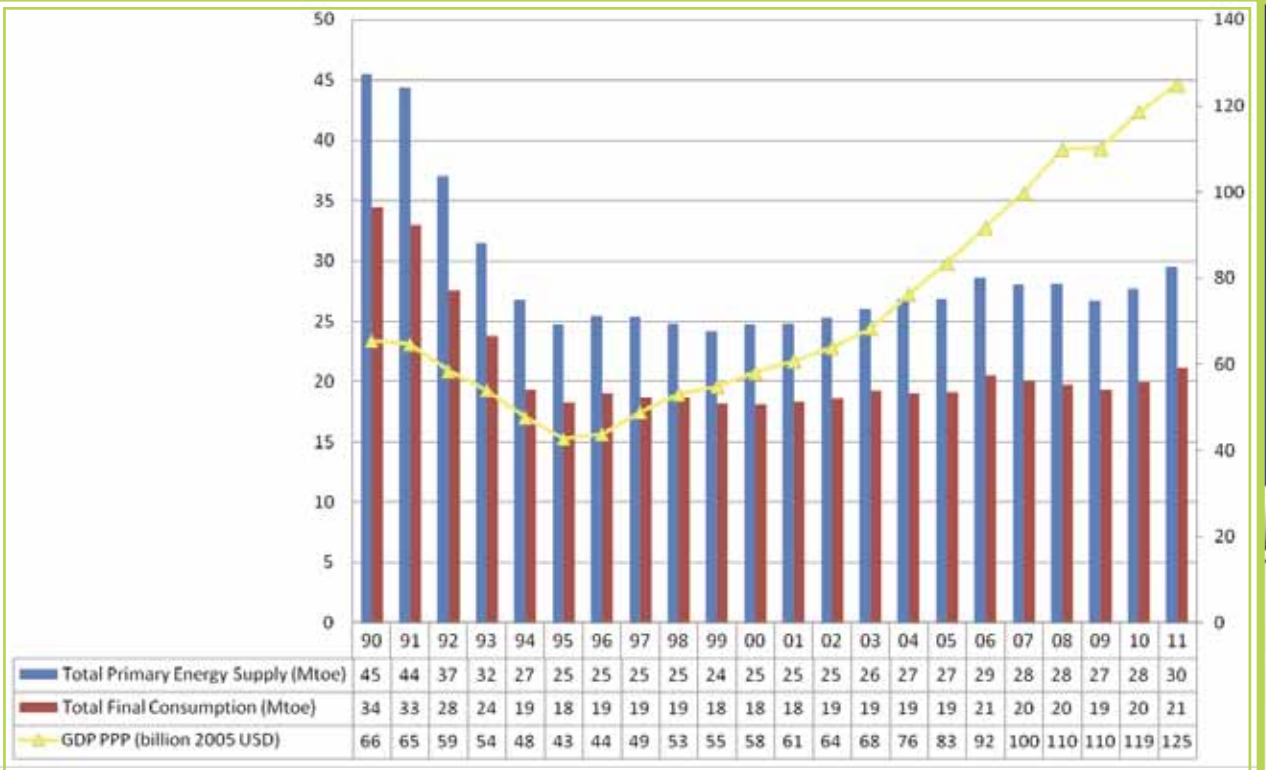
[6] According to methodology of OECD and IEA, total primary energy supply (TPES) is made up of intramural production and imports of energy excluding energy exports and international marine and aviation bunkers and including/excluding stock changes.

[7] IEA Statistics: Belarus, http://www.iea.org/countries/non-membercountries/belarus/, 27.12.2013.

[8] See also *In-Depth Review of the Energy Efficiency Policy of the Republic of Belarus* (Brussels: Energy Charter Secretariat, 2013), pp. 23–24.

[9] The decrease in GFEC of Belarus in the beginning of 1990s can be explained by decrease in industrial production in 1992–1995 (14% annually on average) and by decrease in oil imports and in petroleum production of 3.2 and 3 times respectively from 1990 to 1995.

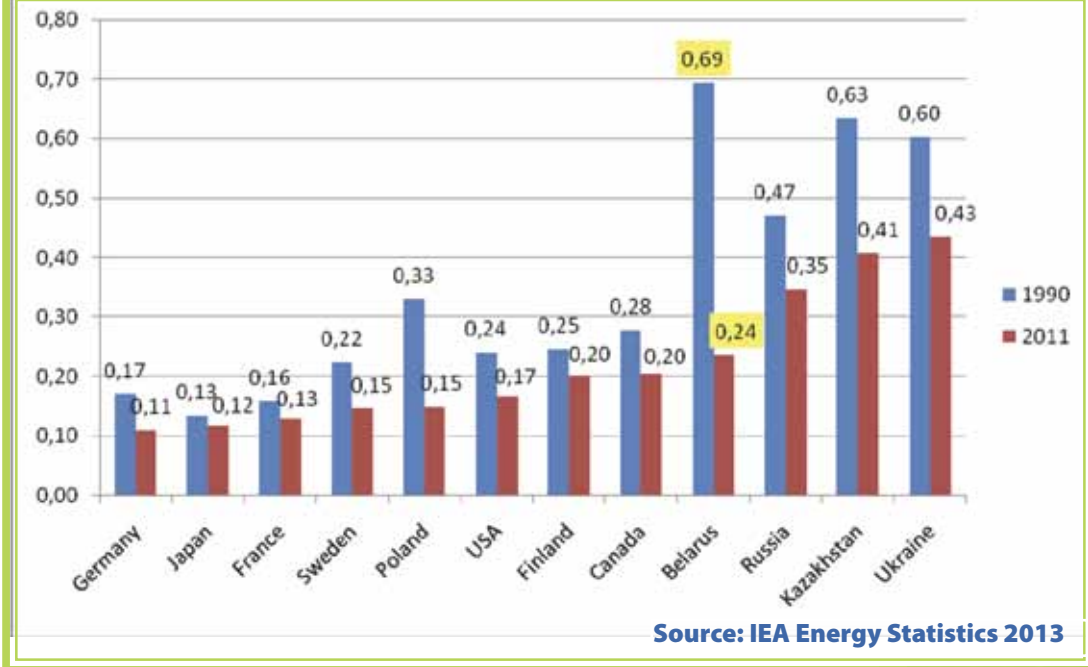
[10] *In-Depth Review*. . . , pp. 24–25.



	90	91	92	93	94	95	96	97	98	99	00	01	02	03	04	05	06	07	08	09	10	11
Total Primary Energy Supply (Mtoe)	45	44	37	32	27	25	25	25	25	24	25	25	25	26	27	27	29	28	28	27	28	30
Total Final Consumption (Mtoe)	34	33	28	24	19	18	19	19	19	18	18	18	19	19	19	19	21	20	20	19	20	21
GDP PPP (billion 2005 USD)	66	65	59	54	48	43	44	49	53	55	58	61	64	68	76	83	92	100	110	110	119	125

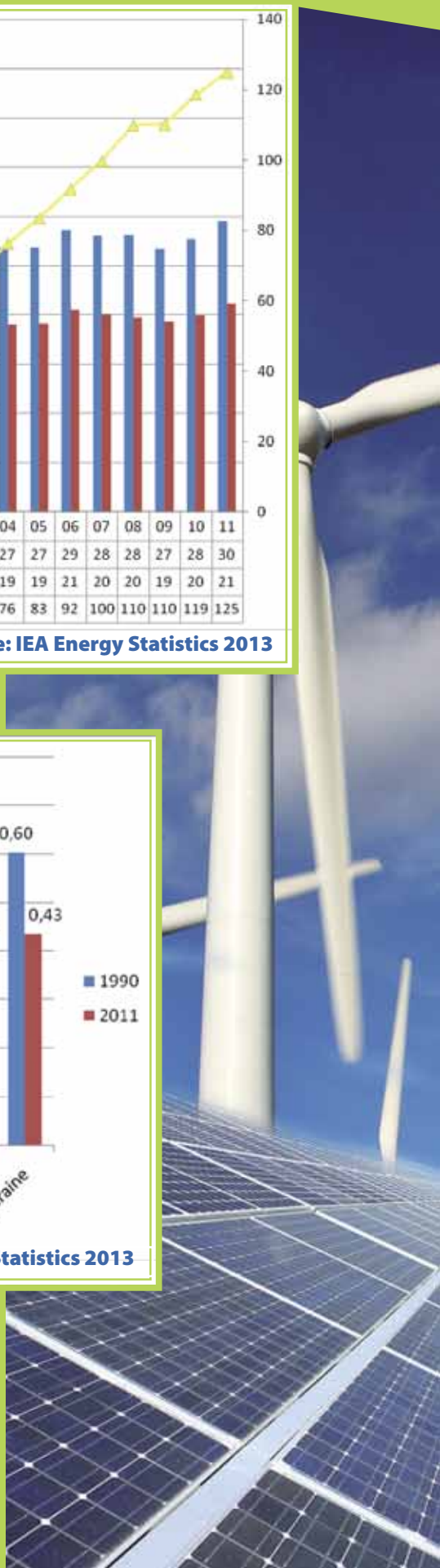
Source: IEA Energy Statistics 2013

Figure 3. TPES, GFEC and GDP PPS of Belarus, 1990–2011



Source: IEA Energy Statistics 2013

Figure 4. Energy intensity of Belarus and selected countries (toe per thousand of 2005 GDP PPS)



2.3 Energy and fuels balance

Domestic energy sources of Belarus are divided into two main categories:

1) Mineral sources such as crude oil and oil shale, natural gas, peat;

2) Renewable energy sources (wood, wood chips and waste wood, biomass, hydro and wind energy, etc).

Belarus cannot cover its demand for energy with domestic sources because its mineral resources and RES are quite limited. The country has to import fuels and energy, mainly from the Russian Federation. The share of the net import of total primary fuel and energy consumption is about 85 %. The structure of energy balance of Belarus is presented in Figure 5.

According to IEA Statistics for 2011, TPES of crude oil is 20.6 Mtoe[11] however most of the oil is refined by the national petrochemical industry (75.2 %) or re-exported (8.1 %). Only 8.2 % of intramural oil demands are covered through domestic production. TPES of natural gas is 17.18 Mtoe (19.99 billion m^3) of which domestic production is only 1%.

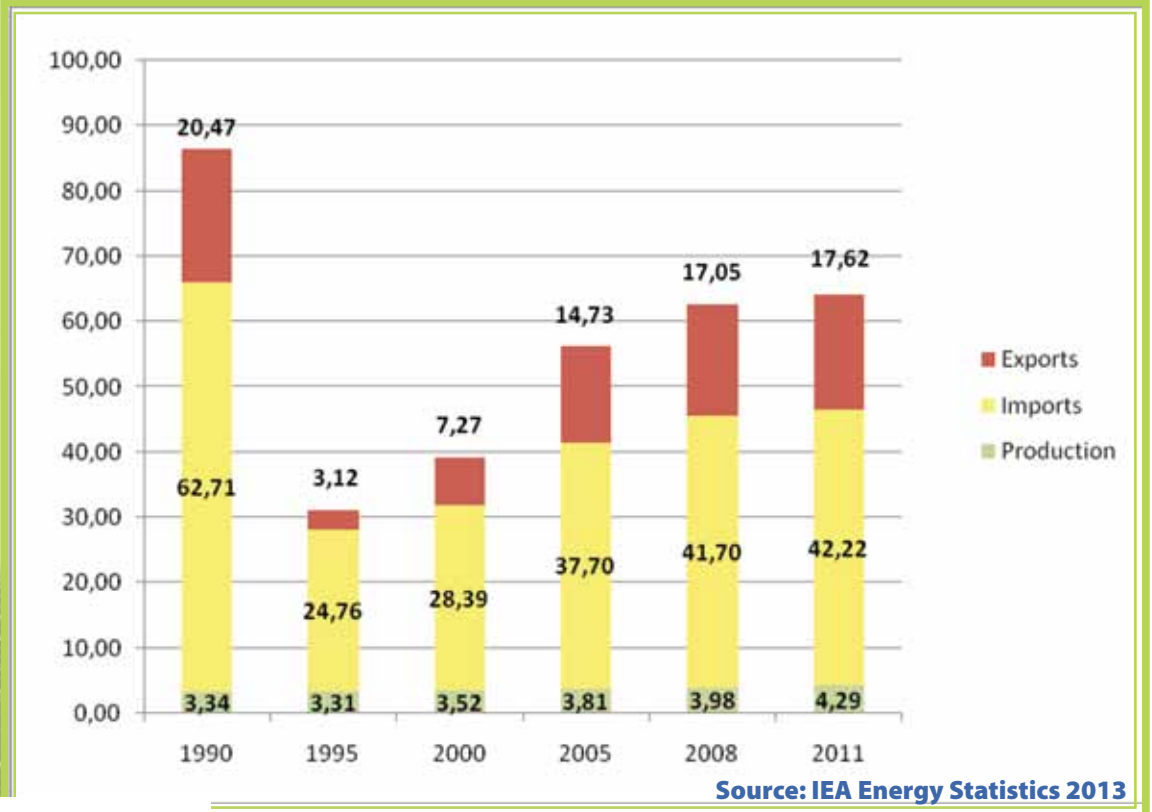
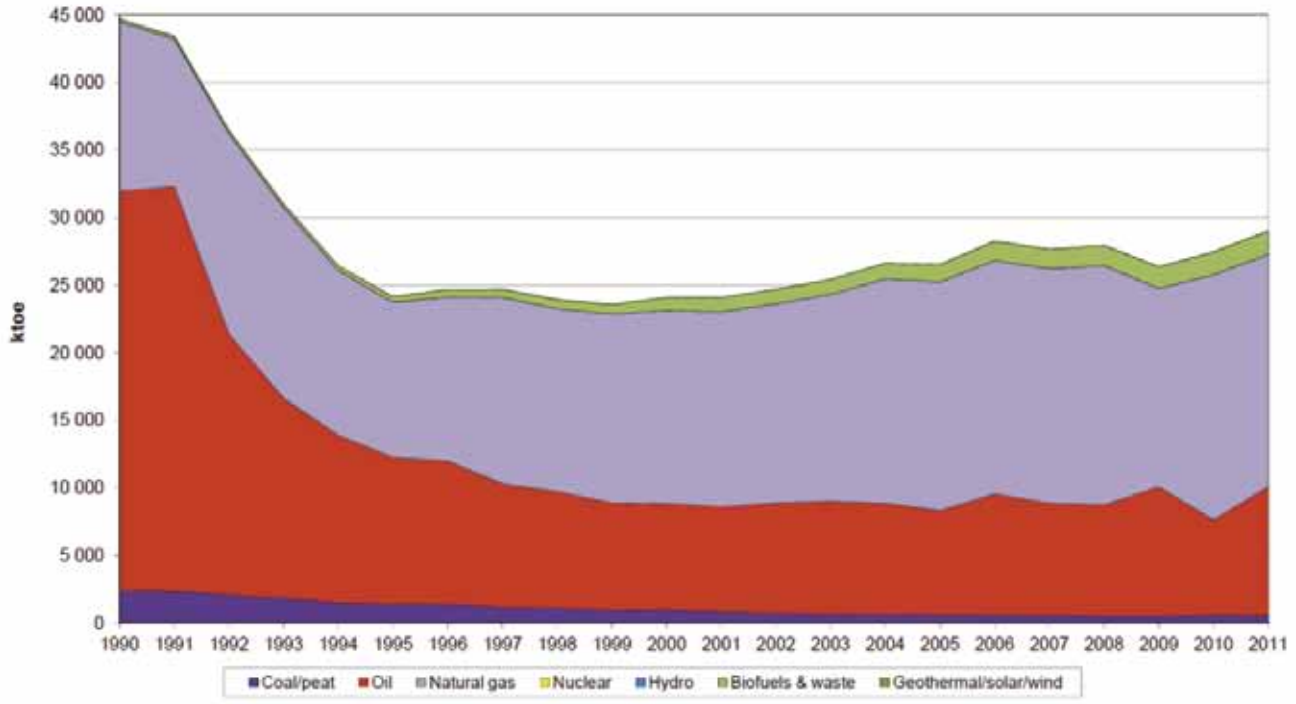


Figure 5. Energy balance of Belarus, mtoe

[11] *IEA Statistics: Belarus*, http://www.iea.org/countries/non-membercountries/belarus/, 27.12.2013.

TPES of peat and coal is 0.58 Mtoe and includes the following items: peat and peat briquettes (95.4 %), coal and coke (4.6 %). According to the State Program "Peat" for 2008–2010 and until 2020, the annual production of fuel peat should reach 0.7 Mtoe in 2015 and 0.84 Mtoe in 2020[12].

From 1990, there is a tendency towards decreasing of the share of oil and increasing of the share of natural gas, biofuels and wood waste in TPES (Figure 6). Thus, one can note **a disproportion in Belarusian energy sector in which the largest part of TPES is provided by imported oil and gas (more than 90 % in total), while domestic resources (primarily, peat, wood and wood waste) provide about 8 % of TPES only.**



Source: IEA Energy Statistics 2013

Figure 6. TPES of Belarus, 1990–2011 (excluding electricity trade)

In order to improve this situation, the Government of the Republic of Belarus has decided to **concentrate efforts on the construction of a nuclear power plant** (NPP).In 2011, its construction started near the town of Astravets in the Hrodna region. The Belarusian NPP will consist of two units with VVER-1200type reactor each. The combined capacity of the two

[12] *State Program "Peat" for 2008–2010 and until 2020,* http://www.topgas.by/node/233, 01.04.2014.

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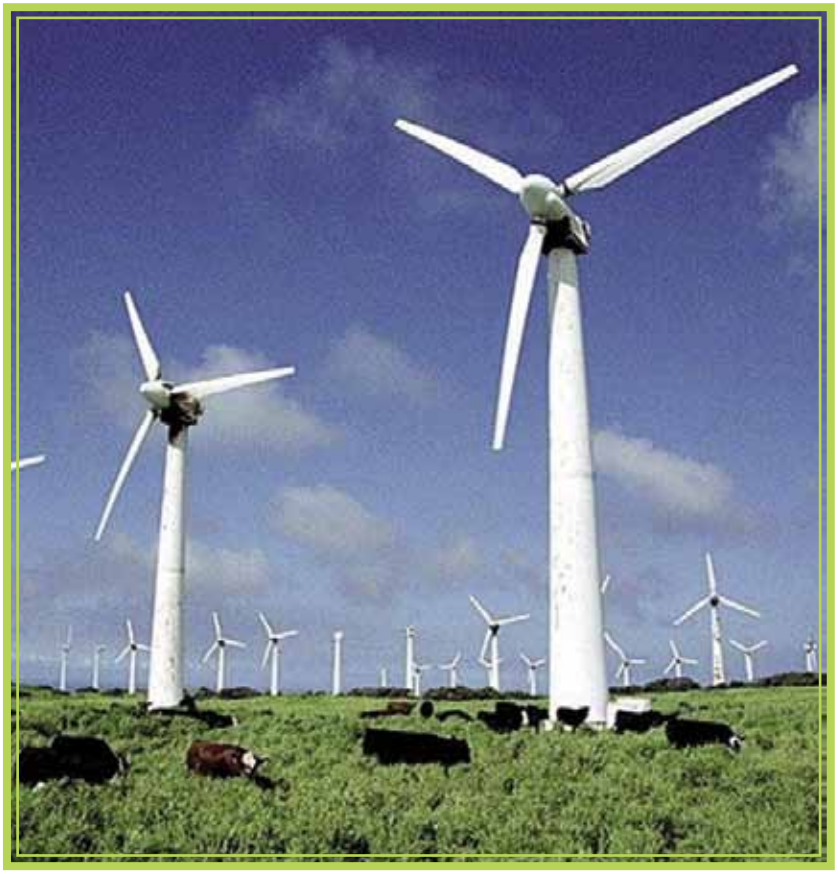

reactors will be 2400 MW. The first reactor of the NPP is expected to be operational by 2018, and the second one by 2020.Total cost of the construction is about $ 9 billion provided as a loan by the Russian Federation for 25 years. Once the Belarusian NPP is commissioned, the country will be able to save energy up to 5.6 Mtoe (>$1.7 billion) and replace almost 25 % of consumed natural gas per year[13].

2.4 Relationship between electricity and heath energy

According to the data of IEA for 2011, the total annual production of electricity in Belarus is 32,192 GWh. The share of energy generated by large condensation electric power plants is 41.9%, by large thermal power plants — 53.0 %. The largest share of electricity is generated by natural gas (98.2 %), Table 2.The annual electricity import is 9,289 GWh.

The total annual production of heat is 260,446 TJ. As in case of electricity, natural gas is a main source of heat generation (88.6 %). According to

[13] "Belarusian NPP construction project was presented at a session of the IAEA in Vienna", *BelTA: News from Belarus,* http://atom.belta.by/ru/belaes_ru/view/proekt-stroitelstva-belorusskoj-aes-prezentovali-na-sessii-magate-v-vene-1570/, 15.01.2014 (in Russian); "European consulting for Belarusian nuclear power plant construction", *BelTA: News from Belarus,* http://atom.belta.by/en/press_en/view/european-consulting-for-belarusian-nuclear-power-plant-construction-2083/t_id/1, 15.01.2014.

Table 2

Electricity and heat production in Belarus by fuels, 2011

Fuel	Share (%) in total production of:	
	electricity	heat
Coal and peat	0,06	1,44
Oil	1,06	2,83
Gas	98,28	88,57
Biofuels	0,33	6,79
Waste	0,14	0,38
Hydro*	0,14	0,00
Wind	0,003	0,00

* The share of hydro sources in total production of electricity has actually increased after the Hrodna hydropower station with the total capacity of 17MW was launched in 2012.

Source: IEA Energy Statistics 2013

Ministry of Energy of the Republic of Belarus[14], from 2010 to 2015, the estimated natural gas consumption will decrease of 8.4%, from 12.03 billion m^3 to 11.03 billion m^3. The largest consumer of electricity (46.77 %) and heat energy (42.48 %) is the industrial sector (Figure 7).

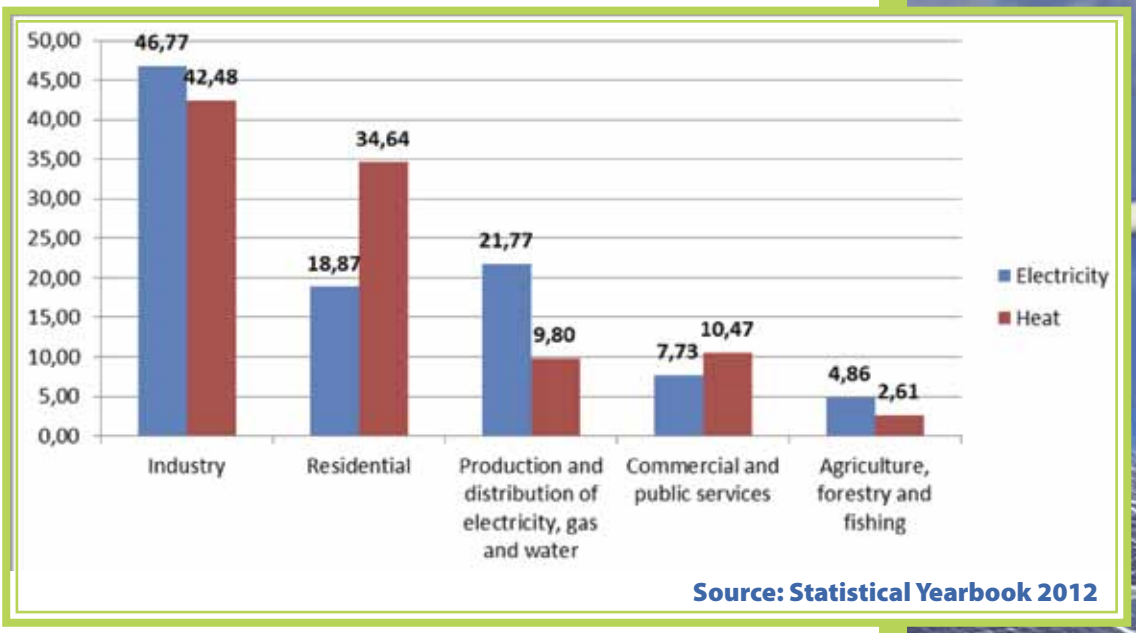

Figure 7. Total consumption of electricity and heat in Belarus, by sectors (%)

[14] Ministry of Energy of the Republic of Belarus, *Statistics*, http://www.minenergo.gov.by/ru/statist, 13.01.2014 (in Russian).

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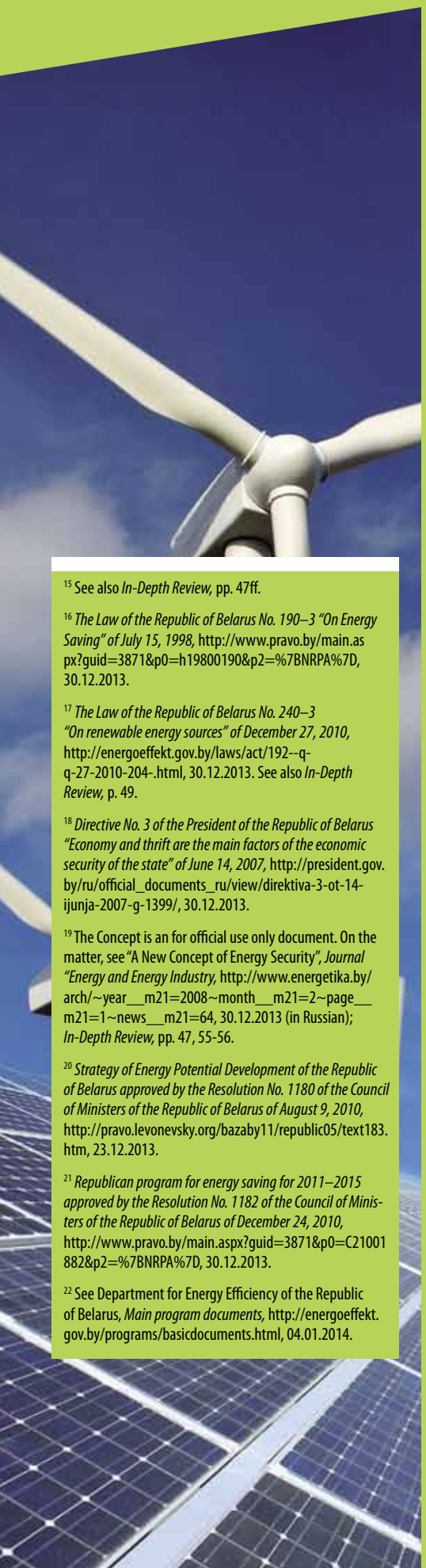


2.5 State Energy Policy[15]

ГThe main goal of state energy policy in Belarus until 2020 is to modernize the national economy on the basis of energy efficient technologies and to provide national security in the energy sector. The legal framework for energy policy includes the Law of the Republic of Belarus "On energy saving"[16] (approved on 15 July, 1998, the last amendments were adopted on 31 December, 2009),the Law of the Republic of Belarus "On renewable energy sources" (approved on 27 December, 2010)[17] and some other laws.

The current national policy for developing the energy sector is determined by the following official documents:

- Directive of the President of the Republic of Belarus № 3 "Economy and thrift are the main factors of the economic security of the state"[18] (2007, hereafter referred to as Directive № 3);
- Concept of Energy Security of the Republic of Belarus (approved in 2007, second edition was adopted in 2014)[19];
- Strategy of Energy Potential Development (2010)[20];
- Republican Program for Energy Saving for 2011–2015[21] (approved in 2010);
- other sector and regional programs[22].

Directive № 3 sets up the main areas of activities in the energy sector. According to this document, the key objective is to ensure the energy security and independence of the country. To achieve this objective, the Directive № 3 formulates the following tasks:

- Saving and thrifty use of energy sources in the energy sector and in the housing and utilities services;
- Technical modernization of production based on energy and resource saving technologies;
- Increase of effectiveness of science, technology and innovation activities in the energy sector, forestry and extraction of fuel and energy natural resources;
- Increase of public awareness of the need for saving and thrift;
- Increase of control of the effective use of fuel, energy and material resources.

[15] See also *In-Depth Review,* pp. 47ff.

[16] *The Law of the Republic of Belarus No. 190–3 "On Energy Saving" of July 15, 1998,* http://www.pravo.by/main.aspx?guid=3871&p0=h19800190&p2=%7BNRPA%7D, 30.12.2013.

[17] *The Law of the Republic of Belarus No. 240–3 "On renewable energy sources" of December 27, 2010,* http://energoeffekt.gov.by/laws/act/192--q-q-27-2010-204-.html, 30.12.2013. See also *In-Depth Review,* p. 49.

[18] *Directive No. 3 of the President of the Republic of Belarus "Economy and thrift are the main factors of the economic security of the state" of June 14, 2007,* http://president.gov.by/ru/official_documents_ru/view/direktiva-3-ot-14-ijunja-2007-g-1399/, 30.12.2013.

[19] The Concept is an for official use only document. On the matter, see "A New Concept of Energy Security", *Journal "Energy and Energy Industry,* http://www.energetika.by/arch/~year__m21=2008~month__m21=2~page__m21=1~news__m21=64, 30.12.2013 (in Russian); *In-Depth Review,* pp. 47, 55-56.

[20] *Strategy of Energy Potential Development of the Republic of Belarus approved by the Resolution No. 1180 of the Council of Ministers of the Republic of Belarus of August 9, 2010,* http://pravo.levonevsky.org/bazaby11/republic05/text183.htm, 23.12.2013.

[21] *Republican program for energy saving for 2011–2015 approved by the Resolution No. 1182 of the Council of Ministers of the Republic of Belarus of December 24, 2010,* http://www.pravo.by/main.aspx?guid=3871&p0=C21001882&p2=%7BNRPA%7D, 30.12.2013.

[22] See Department for Energy Efficiency of the Republic of Belarus, *Main program documents,* http://energoeffekt.gov.by/programs/basicdocuments.html, 04.01.2014.

According to the Directive № 3, the main practical results of activities in the energy sector should be areduction in the energy intensity of GDP; diversification of energy imports; reconstruction of existing underground storages of natural gas, oil and fuel oil and construction of new ones; construction of aNPP; more intensive construction of coal-fired TPPs, small and medium HPPs, CHPs, biofuel plants, WPPs, biogas plants, municipal solid waste power plants.

The provisions of Directive № 3 were extended in the Concept of Energy Security of the Republic of Belarus, Strategy of Energy Potential Development of the Republic of Belarus andRepublican Program for Energy Saving for 2011–2015. Analysis of these documents allows us to identify the priorities of the national energy policy until 2020.

The strategic goal for Belarus is a reduction ofthe energy intensity of GDP of 50 % by 2015 and of 60 % by 2020 (from the level of 2005) and providing the energy security of the country. To reach this goal, the Concept of Energy Security of the Republic of Belarus defines 12 energy security indicators, the thresholds and 3 checkpoints for monitoring (2010, 2015, 2020). 10 indicators should reach a value which is classified as "normal" for providing national energy security while 2 indicators will stay at "pre-critical" level. Table 3 contains the most important of these indicators.

Table 3

Selected indicators of efficiency of the national energy system of Belarus

Indicator	Checkpoint		
	2010 r.	2015 r.	2020 r.
Energy intensity of GDP, toe per $ 1000 GDP PPS	0.29	0.21	0.17
Share of domestic energy sources in the balance of boiler and furnace fuels mix, %	22.5	27.5	32–35
Share of motor fuel produced from domestic oil, %	19.5	17.9	15.2
Share of natural gas in production of electricity and heat, %	68–54	64–58	57–43
Share of natural gas in the consumption of boiler and furnace fuels, %	72–75	64–58	61–51
Share of a main supplier in total consumption of fuel and energy resources,%	77–75	71–70	64–57

Source: Concept of Energy Security of the Republic of Belarus

Chapter 2

The implementation of these goals of the national energy policy as well as achievement of corresponding indicators' values should be reached by executing the following tasks:

- Improvement of economic and organizational policy of energy saving;
- Increase of energyefficiency of production and energyconsumption, introduction of new technologies and upgrade of the current ones;
- Increase of energy efficiency in all stages of production, transportation and consumption;
- Diversification of fuel and energy balance of Belarus, increase of share of domestic fuels, waste and renewable energy sources;
- Reconstruction and modernization of national energy system to increase its reliability.

According to the international experts[23], **Belarus energy sector as whole is a powerful system which can successfully develop its components and have a sufficient level of reliability and a certain level of sustainability. However, it is characterized by serious disproportion in energy prices.** They consider such state to be a good basis for reforms similar to the ones that have been undertaken or are being undertaken in many countries under transition in America, Asia and former USSR. The reforms should be aimed at increasing of economic efficiency and reliability of supply.

[23] EuropeAid/129710/C/SER/BY project "Support for implementation of complex energy policy in Belarus", final conference, 27 November 2012, Minsk.

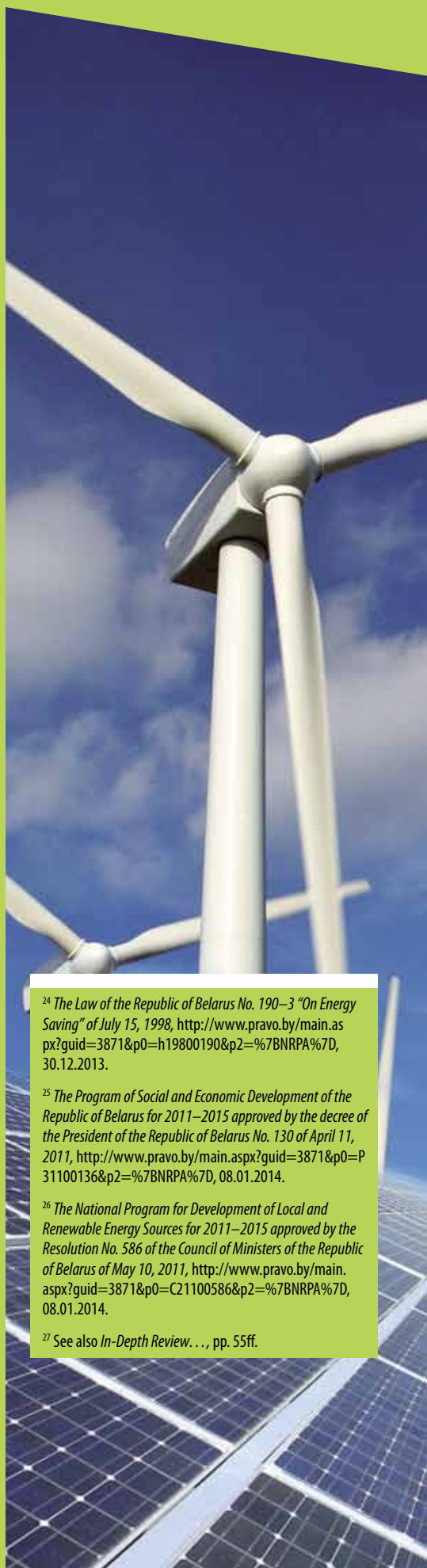
ENERGY EFFICIENCY AND DEVELOPMENT OF RENEWABLE ENERGY

3.1 State Policy in Energy Efficiency

According to the Law of the Republic of Belarus "On Energy Saving"[24], energy efficiency, or efficient use of energy resources, is defined as "using of all types of energy sources by cost-efficient and progressive methods within the framework of currently available equipment and technology and in compliance with national laws". The indicator of EE is a scientifically sound volume (absolute or specific) of energy resources consumption. This indicator is based on normative legal acts on technical regulation and standardization and includes the normative energy losses per unit product.

The strategic documents on energy efficiency have been listed in the previous chapter. One has to add to them the Program of Social and Economic Development of the Republic of Belarus for 2011–2015[25] and the National Program for Development of Local and Renewable Energy Sources for 2011–2015[26].

The analysis of these documents[27] brings to a conclusion that **the main objectives of national policy in EE are reduction in the energy intensity of GDP and providing the saving and thrifty use of energy, fuels and material sources in all industry sectors, as well as in the housing and utilities services.** Table 4 contains indicators corresponding to these objectives.



[24] *The Law of the Republic of Belarus No. 190–3 "On Energy Saving" of July 15, 1998,* http://www.pravo.by/main.aspx?guid=3871&p0=h19800190&p2=%7BNRPA%7D, 30.12.2013.

[25] *The Program of Social and Economic Development of the Republic of Belarus for 2011–2015 approved by the decree of the President of the Republic of Belarus No. 130 of April 11, 2011,* http://www.pravo.by/main.aspx?guid=3871&p0=P31100136&p2=%7BNRPA%7D, 08.01.2014.

[26] *The National Program for Development of Local and Renewable Energy Sources for 2011–2015 approved by the Resolution No. 586 of the Council of Ministers of the Republic of Belarus of May 10, 2011,* http://www.pravo.by/main.aspx?guid=3871&p0=C21100586&p2=%7BNRPA%7D, 08.01.2014.

[27] See also *In-Depth Review. . .*, pp. 55ff.

Chapter 3

Table 4

The main indicators of EE of the Republic of Belarus

Indicator	Checkpoint		
	2006–2010	2011–2015	2016–2020
Reduction in the energy intensity of GDP, % from the level of 2005	31	50	60
Savings of energy and fuels, Mtoe	at least 5.3	at least 4.9	at least 3.6
Share of domestic energy sources in the fuel and energy balance, %	26–27	28–30	32–34

Today, there is a need in Belarus in adopting a series of laws on energy saving, including a new Law "On energy saving" (under development), a Law "On electricity generation" (the concept of the Law has been developed), a Law "On heating". Another direction of the state policy in EE is a development of technical norms and standards harmonized with the EU and international requirements[28].

The list below includes the main measures to improve EE in different sectors of the national economy:

1) Diversification of fuel and energy balance:

- decreasing share of natural gas in fuel and energy balance upon the launching the Belarusian NPP with a total capacity of 2,400 MW and involvement of nuclear fuel in the energy balance of Belarus[29];
- construction of the HPSs on the West Dvina and the Neman, increasing a total capacity of small HPPs up to 250 MW by 2020;
- increasing the use of local fuel and energy resources (oil, associated gas, peat, wood, etc.) and construction of 160 local-fuel-fired power plants with total electric and heat capacity of 32.65 MW and 1023.33 MW respectively in 2010–2015;
- launching 32 biogas plants with a total capacity of 34.71 MW in 2013–2015[30];
- increasing the total electric capacity of WPPs up to 162 MW by 2016 and, if investments are sufficient, up to 300 MW[31];
- increasing the volume of imported fuels substituted by solar and geothermal energy, municipal solid waste, standing crops, crop production waste, etc. up to estimated 70 ktoe.

[28] See also *In-Depth Review…*, pp. 61–62.

[29] It will allow substituting 5 billion m3 of natural gas or 25 % of imported natural gas annually. Consuming the nuclear fuel, the country plans to substitute about 5 million toes of organic fuels by 2020.

[30] *Program of construction of biogas plants for 2010–2015 approved by the Resolution No. 1885 of the Council of Ministers of the Republic of Belarus of June 9, 2010,* http://pravo.by/main.aspx?guid=3871&p0=C21000885&p2=%7BNRPA%7D, 01.04.2014.

[31] As national experts note, the biogas and wind measures probably will not be fully implemented by 2015–2016.

2) Increasing the reliability of national energy system:

- reconstruction of current electricity infrastructure (power plants, electricity lines, distribution systems with capacity of 330 kV);
- decentralization of electric and heat supply systems by launching mini-CHPs at industry enterprises and in small towns;
- introduction of modern automated control systems of electricity and heat supply, including individual ones.

3) Modernization of electricity and heat production:

- introduction of new technologies of electricity and heat generation (co-generation) and modern vapor-gas, gas-turbine and compression units with the efficiency of not less than 57 %;
- optimization of the heat supply system (liquidation of long heating mains, development of autonomous heat supply stations) and decrease of losses in the heat supply networks of 8.0 %.

4) Modernization of industry:

- decrease in specific energy losses per unit product of 15–20 % by introduction of new technologies and equipment and by use of waste energy sources;
- saving of energy resources and use of local and renewable fuels (e.g., substitution of natural gas by peat in production of cement).

5) Measures in the housing and utilities services:

- introduction of new technologies (biogas plants, energy efficient pumps, etc.);
- thermal modernization of dwelling houses (after the capital repair and reconstruction of building, consumption of heat for heating and ventilation should be not more than 60 kW/h per m^2);
- introduction of individual automated control systems of heat supply in apartments, energy efficient lighting, co-generation;
- increase of share of local and renewable fuels in total fuel consumption up to 54.5 % by 2015;
- reduction in specific fuel consumption for production of heat of 5.0 % by 2020;

• use of municipal solid waste and sludge in the volume of 56–70 ktoe in 2020.

6) Measures in construction:

• promoting energy efficient technologies in production of construction materials;

• increase of the share of energy efficient dwelling houses[32] in the total amount of newly-erectedones up to 60.0 % by 2015 and up to 100 % in 2020.

7) Measures in agriculture:

• introduction of local-fuel-fired power plants;

• use of straw for energy production (up to 162 ktoe);

• introduction and wider use of biogas plants.

8) Measures in forestry:

• setting up new enterprises for production of wood granules (pellets) and wood briquettes;

• introduction of equipment for production of chip fuel from the fuel wood and wood waste.

9) Measures in food industry:

• implementation of vinasse treatment for producing biogas;

• construction of sewage treatment plants with new technologies of producing biogas.

10) Education and public awareness:

• introducing the discipline "Basics of Energy Efficiency" in Belarusian universities;

• introducing the specialty "Energy Efficiency Technologies and Energy Management" in four universities of the country[33];

• conductinga wide awareness-raising public campaign on saving and thrifty use of electric and heat energy.

[32] The energy efficient dwelling house is a house with specific heat consumption for heating and ventilation of no more than 60 kW/h per m^2 for middle- and multi-stored buildings (more than 3 stores) and no more than 60 kW/h per m^2 for low-rise buildings (1–3 stores).

[33] See V. Pashinsky, S. Kundas, "Training of masters of science in Management of renewable energy resources", *18th Belarusian Energy and Ecology Forum on 16–19 October, 2013,* http://www.tc.by/download_files/energy2013/pashinskiy.pdf, 14.01.2014. (in Russian)

11) Measures in all sectors:

- reduction of unproductive electricity consumption for water pumping;
- introduction of energy efficient equipment in compressed air and cold production, creation of interconnected complex of technological sub-systems in joint system of centralized heat and cold supply for big consumers;
- introduction of energy efficient lighting systems in all industrial sectors and in the housing and utilities services;
- consumption of biodiesel and ethanol fuels should be increased at least up to 2 million tons by 2020 (including technologies for adapting internal combustion engines to use a petrol with more than 10 % of ethanol);
- introduction of equipment for joint electricity and heat generation (co-generation).

3.2 Main renewable energy sources in the Republic of Belarus

3.2.1 Water

After the launch of Hrodna HPP with a capacity of 17 MW in 2012, there are 42 operating HPPs in Belarus, although their total capacity (33.1 MW) does not correspond to the potential of national hydro sources (see Table 5).

Table 5

Potential total capacity of hydro energy sources of Belarus

Potential capacity, MW	The International Journal on Hydropower & Dams[34]	Strategy of Energy Potential Development[35]
Theoretically possible	856	850
Technically possible	342	520
Economically viable	148	250

According to the State Program of Construction of HPPs in 2011–2015[36], Belarus is planning to construct 33 HPPs with a total capacity of 102.1 MW in 2011–2015, four of which will provide 97.0% of total declared capacity and the remaining ones will be mini- and micro-HPPs. In 2016–2020, Belarus is planning to construct another 6 large HPPs with a total capacity

[34] *International Journal on Hydropower & Dams,* http://www.hydropower-dams.com/ (05.07.2009).

[35] *Strategy of Energy Potential Development of the Republic of Belarus approved by the Resolution No. 1180 of the Council of Ministers of the Republic of Belarus of August 9, 2010,* http://pravo.levonevsky.org/bazaby11/republic05/text183.htm, 23.12.2013. See also *In-Depth Review. . .*, p. 86.

[36] *State Program of construction of HPPs in the Republic of Belarus for 2011–2015 approved by the resolution of the Council of Ministers of the Republic of Belarus No. 1838 of December 12, 2010,* http://pravo.levonevsky.org/bazaby11/republic03/text681.htm, 08.01.2014.

of 70.3 MW (excluding mini- and micro-HPPs). These measures will allow the country to set up 3 cascade systems of HPPs by 2020:

1) the Neman cascade system with the total capacity of 37 MW (Hrodna and Neman HPPs);

2) the West Dvina cascade system with the total capacity of 112 MW (Polotsk, Bitsebsk, Beshenkovichy and Verkhnedzvinskaya HPPs);

3) theDniper cascade system with the total capacity of 20 MW (Orsha, Retchitsa, Shklov and Mogilev HPPs).

As a result, Belarus will be able to fully use the potential of its hydro energy sources by 2020.

3.2.2 Wood fuels

Belarus has a significant opportunity for producing wood fuels. Forests cover about 40 % of country's territory and are the main sources of natural energy resources. Standing wood resources are estimated to be 1.5 billion m^3 and the growth of wood resources is about 30.3 million m^3 annually. Production capacity of wood and wood waste fuels is estimated to be 11.65 million m^3 annually (2.2 Mtoe). Belarus is planning to reach this figure in 2020. In 2015, wood fuel production should reach 10.56 million m3 (1.9 Mtoe)[37].

3.2.3 Biogas

At the beginning of 2014, there were 23 biogas plants with a total capacity of 24.33 MW in Belarus[38]. The annual estimated capacity of biogas production is 2.3 Mtoe. The main sources of biogas are agricultural farms (cattle- , pig- and poultry-breeding complexes) and sewage treatment plants, municipal waste and food industry waste (actually, treatment of vinasse). Belarus is planning to launch a number of new biogas plants with a total capacity of 34.71 MW by 2015.

3.2.4 Wind

There are three regions with the largest potential to produce electricity from wind turbines in Belarus: Hrodna, Minsk and Mogilev regions[39]. At the beginning of 2014, there were 28 operating wind turbines with a total capacity of 6.57 MW.[40] Belarus is planning to launch a number of wind turbines with a total capacity from 162 MW to 450 MW (depending on related factors) by 2016.

[37] *In-Depth Review. . .*, pp. 27–28.

[38] *RES Cadaster of the Ministry of Natural Resources and Environmental Protection of the Republic of Belarus,* http://194.158.214.59:8080/apex/f?p=105:2:6746860687717032::NO, 05.04.2014.

[39] It should be noted that today the best places to produce electricity (e.g., places in Dzerzhinsk district) cannot be used to put wind turbines due to the lack of permission from the Ministry of Defense of the Republic of Belarus.

[40] *RES State Cadaster of the Ministry of Natural Resources and Environmental Protection of the Republic of Belarus,* http://194.158.214.59:8080/apex/f?p=105:2:6746860687717032::NO, 05.04.2014.

3.2.5 Solar energy

Today, Belarus does not use its potential to produce solar energy. The duration of sunny period exceeds 3 month annually. The areas with the best prospects for producing solar energy are located in the south and south-east of the country. The average annual power density of solar radiation is 120 W/m^2 however this figure can be increased up to 150 W/m^2, if solar elements are installed at an angel of 30–40° to the south. A solar element with an efficiency of 10% and an area of 1 m^2 permits to generate energy equal to 54 kWh.

Taking into account local climatic conditions, the main areas of solar energy development in Belarus are as follows (in order of priority):

1) solar collectors for hot-water supply and heating;

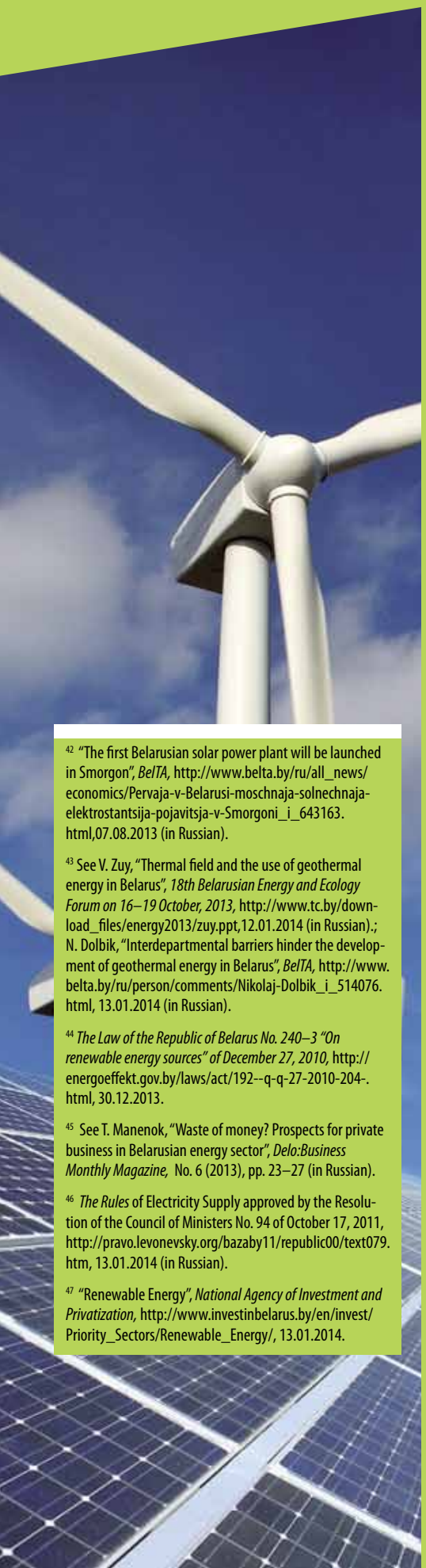
2) "solar houses";

3) photovoltaic transducers for electricity generation.

The efficiency of solar installations for electricity generation is 6–17 % and this figure can be increased to 30–45 % by using solar installations with concentrators. At the beginning of 2014, there are 24 solar power installations with a total capacity of 51.75 MW in Belarus.[41] According to the National Program for Development of Local and Renewable Energy Sources for 2011–2015, 125 solar water heaters and 47 solar installations are planned to be launched at public organizations and enterprises during this period.

A solar power plant with the total capacity of 17 MW is being constructed in Smorgon. It will be a solar plant of the highest performance in Belarus. The investment project "Construction and maintenance of electric power plants using renewable energy sources (solar energy)" is being implemented LLC "Ecological Energy". The first phase of the project (5 MW)

[41] *RES Cadaster of the Ministry of Natural Resources and Environmental Protection of the Republic of Belarus,* http://194.158.214.59:8080/apex/f?p=105:2:6746860687717032::NO, 05.04.2014.



is planned to be finished before June, 2015 and the second one (6 MW) will — by December, 2016. The additional capacity of 6 MW will be built by July, 2018. Total planned investment is BLR 375 billion[42].

3.2.6 Geothermal sources[43]

Use of heat pumps is at the initial stage. At the beginning of 2013, there were about 100 geothermal installations with heat pumps in the county (a total capacity is about 5.5 MW). These installations are used for heating water-supply and sanitary system, cottages and hospitals (e.g., in Nesvizh). Belarus is going to launch 126 heat pumps with a total capacity of 8.9 MW in 2011–2015. The undoubted advantage of heat pumps is an ability to provide heating to objectswhich are not connected to a district heating system. However, implementation of heat pumps in Belarus is complicated by the fact that groundwater used in the geothermal heat pump has a high salinity, thus heat pumps require more frequent and expensive cleaning.

3.3 Preferences for business

According to the Belarusian legislation, legal entities and individual entrepreneurs can act as free agents in RES sector of the country. This means they can manufacture RES equipment (power installations) as well as generate electricity from RES for their own needs or for sale.[44] Moreover, foreign and joint companies also can build up and operate local-fuel-fired power installations.[45]

Since 2012, private companies in Belarus can generate and re-sell electricity using existing electricity grids. According to the "Rules forElectricity Supply", a wholesale consumer/reseller of electricity is "a legal entity which has electricity grids in private property, lease or operating management and performs power-purchase-agreement-based wholesale buying, transportation and contract-based selling electricity to consumer".[46] Before 2012, energy supply functions were performed only by organizations of the Ministry of Energy of the Republic of Belarus.Despite these measures, national business is significantly underrepresented in the national energy sector.

At the same time, there are some visible results of the Government attempts to attract foreign investment in the energy sector, mainly in RES where Belarus offers foreign investors a set of benefits:[47]

[42] "The first Belarusian solar power plant will be launched in Smorgon", *BelTA,* http://www.belta.by/ru/all_news/economics/Pervaja-v-Belarusi-moschnaja-solnechnaja-elektrostantsija-pojavitsja-v-Smorgoni_i_643163.html,07.08.2013 (in Russian).

[43] See V. Zuy, "Thermal field and the use of geothermal energy in Belarus", *18th Belarusian Energy and Ecology Forum on 16–19 October, 2013,* http://www.tc.by/download_files/energy2013/zuy.ppt,12.01.2014 (in Russian).; N. Dolbik, "Interdepartmental barriers hinder the development of geothermal energy in Belarus", *BelTA,* http://www.belta.by/ru/person/comments/Nikolaj-Dolbik_i_514076.html, 13.01.2014 (in Russian).

[44] *The Law of the Republic of Belarus No. 240–3 "On renewable energy sources" of December 27, 2010,* http://energoeffekt.gov.by/laws/act/192--q-q-27-2010-204-.html, 30.12.2013.

[45] See T. Manenok, "Waste of money? Prospects for private business in Belarusian energy sector", *Delo:Business Monthly Magazine,* No. 6 (2013), pp. 23–27 (in Russian).

[46] *The Rules* of Electricity Supply approved by the Resolution of the Council of Ministers No. 94 of October 17, 2011, http://pravo.levonevsky.org/bazaby11/republic00/text079.htm, 13.01.2014 (in Russian).

[47] "Renewable Energy", *National Agency of Investment and Privatization,* http://www.investinbelarus.by/en/invest/Priority_Sectors/Renewable_Energy/, 13.01.2014.

- a guaranteed connection of RES installations to the state electricity grids;
- a guaranteed purchase of all proposed energy produced from RES by the state energy supply organizations and guaranteed payment of all energy produced from RES at preferential tariffs (see Table 6);
- protection against unfair competition, in particular from legal entities with dominant position in energy production;
- development (reconstruction, modernization) of RES power installations;
- opportunity to independently identify the most promising places to install the RES objects;
- exemption from import duties and VAT on imported equipment for its use within the framework of an investment project;
- exemption from land tax or rent payment for the land plots being the state property, provided for the construction of the RES objects.

Table 6

High feed-in-coefficients for electricity produced from RES in Belarus

RES	Operation period of RES installation	
	first 10 years	next 10 years
Wind, biogas, wood fuels, hydro energy, geothermal energy	1.3	0.85
Solar energy	3.0	0.85

Source:National Agency of Investment and Privatization

National enterprises and, in particular, SMEs in the energy sector are mainly involved in such areas as energy consulting, dealership of big energy brands, production of local fuels (primarily wood and agricultural waste fuels). The most important reasons of this situation are the following:

- There is no developed energy market in Belarus. "Belenergo" still holds a monopolist role in national energy sector. Recent reforms have touched upon only electric power industry and RES sector;
- Such negative factors as high costs and limited access to finance (e.g., high interest rate on loans) hinder the development of private business in RES sector;

- There is no modern legislation on energy market in Belarus (e.g., a new law on electricity) which could further develop the national energy system according to the market rules;
- Government continues its interventions in setting up electricity tariffs (e.g., cross-subsidies).

Some energy projects with the participation of foreign companies and investors are listed in the Table 7.

Table 7

Energy projects with the participation of foreign companies

Project and end date	Foreign participant(s)	Role in a project Extent
Biomass-fired mimi-CHP with the total capacity of 3.7 MW (Pruzhany, 2009)	MW BiopowerOy (Finland)	General contractor and creditor
Wind power installation (Grabniki, 2011)	China National Corporation for Overseas Economic Cooperation	Creditor ($ 4 million)
Reconstruction of the CHP-2 (Mibsk, 2011)	China National Corporation for Overseas Economic Cooperation	Creditor ($ 46 million)
Construction of vapor-gas unit at the CHP-5 (Minsk, 2011)	China National Corporation for Overseas Economic Cooperation	Creditor ($ 260 million)
2 wind power installations with a capacity 1 MW each (Smorgon district, 2013)	LLC «AeroStream» (Russia)	Investor(BLR 3 billion)
Neman HPS with the total capacity of 45 MW (Hrodna region, 2014/2015)	Finest S.p.A., PVB Group, Energy T.I.EST (Italy)	Investors (€ 110 million)
Vitsebsk HPS (Vitsebsk, 2015)	China National Electric Equipment Corporation, China Development Bank	General contractor, creditor ($ 189 million and $ 289 million respectively)
Beshenkovichy and Verkhnedzvinskaya HPPs (Vitsebsk region, 2015)	CetInsaatMuhendislikTicaret Limited Sirketi (Turkey)	Investor ($ 300 million) by BOT system for 30 years
Solar power plant with the capacity of 28 MW (Gomel region, 2015/2016)	Pure Energy Intelligence (Ireland)	Investor (€ 40 million)
Vapor-gas CHP (Brest, 2016)	LLC «Belenergiya» (Italian capital)	Investor (€ 415 million) with the participation of investments from Russia, Switzerland and Poland

Source: T. Manenok, "Waste of money? Prospects for private business in Belarusian energy sector"; tut.by; belta.by

3.4 Information support for renewable energy

In order to provide complete and accurate information about the development of alternative energy in Belarus, a State Cadaster of RES has been developed.[48] It contains information about operating RES in Belarus and is updated by the staff of the Ministry of Natural Resources and Environmental Protection of the Republic of Belarus.

One can obtain access to the Cadaster at the special information resource of the Ministry of Natural Resources and Environmental Protection.[49] The cadaster provides the following information: places to install the RES objects; potential of the Republic of Belarus in RES; laws and regulations on RES in force; maximum level of electricity and heat generation from RES; cartographic and hydro-meteorological data; other useful information on RES.

Registered users of the Cadaster can add information about newly launched RES installations. The information system provides legal entities and individual entrepreneurs (owners of RES installations) with the following opportunities:

- to add information about their RES places and installation into the Cadaster;
- to update current information about their RES places and installations;
- to use the e-service for obtaining the certificate confirming the origin of energy (anadministrative procedure № 6.23 "Issuing certificate confirming the origin of energy or its duplicate and making changes and amendments"[50]).

[48] "State Cadaster of RES", *Ministry of Natural Resources and Environmental Protection of the Republic of Belarus,* http://www.minpriroda.gov.by/ru/actual/new_url_19948904.17.04.2014 (in Russian).

[49] *RES Cadaster of the Ministry of Natural Resources and Environmental Protection of the Republic of Belarus,* http://194.158.214.59:8080/apex/f?p=105:2:6746860687717032::NO, 05.04.2014.

[50] *Resolution of the Council of Ministers of the Republic of Belarus No. 156 of February 17, 2012 "On approval of the single list of administrative procedures carried out by state bodies and other organizations concerning legal entities and individual entrepreneurs",* www.pravo.by/pdf/2012-35/2012-35(010-398).pdf, 05.04.2014.

INNOVATIONS IN THE ENERGY SECTOR

Developing of a competitive, innovative, high-tech, resource- and energy-saving, environmentfriendly economy is a priority for Belarus. One of the tasks on this way is the increase of the production of alternative fuels and energy resources[51]. Involvement of the science in this process is provided by the inclusion of the energy and energy saving in thelist of priority areas of scientific and technological activities in the Republic of Belarus for 2011–2015[52]. The same goes to research priorities for 2011–2015: here, the energy-related set of topics (energy supply, energy conservation, energy efficiency and energy-efficient technologies[53]) is placed on the top position.

According to these priorities,various level national R&D programs are developed. They are funded, completely or partly, from the national budget. In 2011–2015, the following programs are being implemented in the country[54] (table 8).

Table 8

S&T programs in Energy for 2011–2015

Program	Public procurement authority	Main contractor	Supported types of activities
State research program "Energy security, energy efficiency, energy conservation and nuclear energy" (2013–2015)	NAS of Belarus Ministry of Education	A. V. LuikovHeat and Mass Transfer Institute, Joint Institute for Power and Nuclear Research – "Sosny"(NAS of Belarus) Belarusian National Technical University Belarusian State University	Research
State Scientific and Technical Program "Energy 2015" (2011–2015)	Ministry of Energy	A.V.LuikovHeat and Mass Transfer Institute (NAS of Belarus)	Research, development and testing
The State Program for Innovative Development of Belarus for 2011–2015	Council of Ministers, Ministry of Energy	Research organisations and enterprises	Innovative activity, modernization

[51] *RegulationoftheCouncilofMinistersof 26 May 2011 № 669 "On the State Program of Innovative Development of the Republic of Belarus for 2011–2015",* http://www.pravo.by/main.aspx?guid=3871&p0=C21100669&p2={NRPA}, 26.01.2014.

[52] Priorities of S&T development for 2011-2015, appr.by the Decree of the President of Belarus of 22 July 2010 № 378.

[53] List of priority areas of basic and applied research for 2011-2015, appr.by the Regulation of the Council of Ministers of 19 April 2010 № 585.

[54] *RegulationoftheCouncilofMinistersof15 August 2013 № 719 "On amendments and additions to the Regulation of the Council of Ministers of the Republic of Belarus of 1 February 2011 № 116",* http://www.pravo.by/main.aspx?guid=3871&p0=C21300719&p1=1, 26.02.2014.

The Department for Energy Efficiency of the State Committee for Standardization, the Ministry of Energy, the National Academy of Sciences of Belarus, the Ministry of Education, the State Committee on Science and Technology and the Ministry of Industry are responsible for science, technology and innovation activities in the fields of EE and RES at the state level. Research institutes, universities, public and private companies are involved in the actual implementation of projects.

Programs are developed in such a way that they cover the whole innovation cycle from ideas to their embodiment in a particular product or service. The results of the state research programs formthe scientific basis for technological developments within the state S&T branch and regional programs while it is expected that the results of the state S&T(branch and regional) programs would be transferred in innovation projects, either individual ones or those included in the State Program of Innovative Development.

Moreover, it is expected that a product (service) which is going to be developed within the framework of the state S&T (branch, regional) program is demanded by business. The evidence of business interest towards results of R&D project is confirmed by its commitment to co-finance projects within the state scientific and technical programs for up to 50 % of their value, in the framework of research programs — up to 15 %.

In addition to participating in the R&Dprograms, there is a possibility of receiving funding for the implementation of individual projects fromseveral funds. Thus, the **Belarusian Republican Foundation for Fundamental Research** supports fundamental research projects in engineering, natural and other sciences, including those performed in collaboration with researchers from foreign countries. It provides grants for experienced and young scientists.

The **Belarusian Innovation Fund** which provides budget funds on a repayable basis for implementation of innovation projects and setting up ofproductions at quite favorable conditions has a visible role in supporting close-to-market science-intensive projects through:

- funds availability period — up to 5 years;
- repayment calculation at 0.5 refinancing rate;
- referral on interest and capital repayments;
- no security interest and insurance.

Chapter 4

Since 2001, the Belinfundhas supported several projects in the field of energy saving, EE and RES, including:

- a series of projects on producing various types of air conditioning, ventilation and heating installations with heat recovery on heat pipes and fans at LLC "Innovation Enterprise "Alternativa" in Brest. The first project started in 2010. The total cost exceeds 5 million EUR, of which 3 million EUR are provided by the Belinfund;

- a project by the Scientific and Production Republican Unitary Enterprise "Unichimprom BSU[55]" on developing a technology of biodiesel production from rapeseed oil and constructing biofuel installations at JSC "HrodnaAzot" in Hrodna and JSC "Chimvolokno" in Mogilev, the largest chemical plants in Belarus (2003–2006);

- a project by the same company, SPRUE "Unichimprom BSU" on developing a technologybacked by a set of equipment,and also on setting up a production of composite solid biofuel (pellets) based on rape straw and other garden wastes (2009–2014). The total project cost is 500 thousand EUR, half of which is provided by the Belinfund. Payback period from the start of the project implementation is 4 years. The period from the retention time of pilot production to designed capacity is 2 years.

Another financial instrument is **innovative funds in the ministries and local authorities**, which are financed from the profit tax payable to the republican budget by subordinate organizations of the relevant ministry or companies operating in a given region. Support for innovation projects

[55] BSU = Belarusian State University

through innovation funds is subject to their compliance with the following criteria:

- technological organization, providing an average level of value added per worker similar to the EU level on the corresponding economic activity or exceeding this level;
- export orientation (export surplus) of a project;
- development and implementation of technologies and (or) productsnew for Belarus and (or) global economy.

It is important to emphasize that research, technology and innovation projects implemented in Belarus regardless of their funding sources are **exempt from VAT (20 %)**. For that a project has to be registered in the State Register of RTD projects in accordance with the procedure,[56] established by the President of Belarus upon the results of the appropriate examination. RTD which fit the priorities of social and economic development and aimed at creating new processes and knowledge-based competitive products, as well as on opening up promising research directions are subject to state registration.

Enterprises producing innovative products and those which areresidents of technology parks have **tax incentives**. They also have an opportunity for preferential rent and receipt of consultancy services provided by business support centers and business incubators.

[56] Presidential Decree of May 25, 2006 № 356 «On State Registration of research, development and technological works.» (National Register of Legal Acts of the Republic of Belarus, 2006, № 86, 1/7622).

Another form of support for innovation in the country is providing **research organizations, universities and small and medium enterpriseswith financial support for engaging in international cooperation**. Annually, 3–4% of the total budget expenditures for science and innovation are allocated for this purpose in a special budget line.

Over 1,000 international projects are implemented in the country every year. The leading partner countries by the number of projects are Russia, Ukraine, Germany, Poland, Lithuania, and France.

Notwithstanding its merits, the system of support to science and innovation in Belarus (program targeted management) has several disadvantages:

1) Being bounded mainly with budgetary support, the system disregards risks associated with the commercialization stage: a project contracting organization is obliged to return the invested funds in the state budget, if within 3 years after completion of a project it was not able to commercialize its results. This stimulates contractors to endlessly carry out research that is completed in scientific reports and publications, and limits their willingness to promote their ideas to the market because of a fear of failure. Hence - a serious imbalance in funding: in 2011–2015, the budget of the state S&T program "Energy – 2015" is about 1 million EUR, while 13 million EUR are allocated for the state research program "Energy security, energy efficiency, energy conservation and nuclear energy", which purpose is just to feed the abovementioned SSTP.

2) Furthermore, the budget per project is on the average of 9–12 thousand EUR/year that leads to "narrowing down" of a project frame and goals and inability to present a significant result. If such a financing scheme is more or less acceptable for public research organizations (e.g. they can implement many small projects), for SMEs it doesn't workas the project budget is too small. As a result, business is involved in only 13 % of all research and technology projects in the energy sector[57].

3) Not only participation in research, but also the involvement of business in financing R&D remains low. Business angels and venture capital still only make their first steps. This especially reflects the new businesses - spin-off and start-up companies.

[57] Sampling from the RDTW State Register of 31.10.2013. Ongoing projects and those completed before 2010 were taken into account.

4) The mentioned above challenges are typical for the national science and innovation system as a whole. However, they are particularly evident in the energy sector due to the "weight" of the energy as a priority area: the share of financing for R&D in the field of energy and EEin the total funding for research and development is just 5.4 %[58] (2012), and it is one of the two "low-funded" priorities.

Despite the priority of EEand RES for the national economy, the availability of sufficiently coherent system of funding for research and innovation, the relative success in attracting FDI (see Chapter 3) and the possibility to mobilize government support for international cooperation, research organizations, universities and innovative business are rather weakly integrated in the international and, in particular, in the European research area. This is evidenced by the lack of ongoing and completed projects in energy implemented jointly with foreign partners in the above mentioned State Register of RTD projects, as well as by the low involvement in international R&D programs. In 2007–2013, the number of applications to the 7th EU Framework Programmein EE and RES did not exceed 3 % of the total number of applications involving Belarus partners. A project for automation of "smart" grids with two Belarusian teams — the A. V. Luikov-Institute of Heat and Mass Transfer of NAS Belarus and "Minskenergo" — pulled the only winning ticket. Support capabilities for cooperation between Belarus and the EU member states through other EU programs, for example, within the European Neighborhood Policy Instrument in 2007–2013 were very limited, as the issues of democratization and human rights dominated in the activities of the latter in relation to Belarus. The opportunities for cooperation can significantly expand with the introduction of the task to create a common knowledge and innovation spacethat is a new priority for 2014–2020.

Cooperation through the TAIEX is on the way. Capacity building is being implemented in two dimensions — in energy-related issues (sector approach; in recent years activities related to harmonization of legislation of Belarus in EE and "green" economy according to the EU rules) and in innovation (developing a competitive business environment, commercialization of research results). The relatively small number of TAIEX projects at the moment are outperformed by the substantial volume of technical assistance provided in the past 10 years for Belarus by international donors (World Bank, EU, the UN family and GEF). Energy saving issues became a

[58] On the state and prospects of thescience development in the Republic of Belarus in 2012.Minsk. 2013. P. 23.

priority in the EU Annual Action Plan in favor of Belarus in 2010[59] and were further developed in a similar vein in 2011, which put an emphasis on the sustainable development of the regions.

Table 9

Technical aid projects in the energy field implemented in the Republic of Belarus

Project	Completion period	Budget, mln, $
Projects funded by the World Bank		
Rehabilitation of areas affected by the Chernobyl disaster	2007–2011	50,0
Rehabilitation of areas affected by the Chernobyl disaster	2011–2013	30,0
Increasing the energy efficiency in Belarus	2009–2014	125,0
Projects supported by UNDP/GEF/UNECE		
Using biomass for heating and hot water supply	2003–2008	3,1
Removing barriers to energy efficiency improvements in the state sector enterprises in Belarus	2007–2011	1,4
Improvement of energy efficiency in residential buildings	2011-2015	4,5
Development of wind energy in Belarus	2011–2015	3,5
EU funded projects		
Supporting the implementation of a comprehensive energy policy in Belarus	2010–2013	5,0

It has to be noted however that these projects **do not involve or involve a to a small extent the issues of scientific support and innovation development of EE and RES**. This is largely due to the neglect by the potential recipients of technical assistance in Belarus at the stage of formulating queries and/or drafting technical specifications for such projects and lack of consultation with the government authorities responsible for science and innovation (lack of horizontal cooperation between different government bodies). The new EU technical assistance project "Capacity Development Facility to support the implementation of sector programs under the ENPIAAPs for Belarus 2009"" (2013–2015) is designed to train the ministries and departments on how to plan and prepare the competent applications for technical aid.

[59] Annual Action Programme 2010 in favor of Belarus to be financed under Article 19 08 01 03 of the general budget of the European Union.

Chapter 5

ANALYSIS OF ADVANTAGES AND DISADVANTAGES OF ENERGY SECTOR IN BELARUS. RECOMMENDATIONS

Over the past 10–12 years, the energy intensity of GDP of the Republic of Belarus has considerably decreased and came out on top among the CIS countries. At the same time, it continues to be 1.4–1.7 times higher than in the industrialized countries, although the specific and absolute energy consumption in the industrial sector is 3–4 times lower in comparison with them. As of today, the electric power supplied to the Belarusian industry is less than 30 billion kW/h, which is not enough for introducing modern electrical technologies in engineering, petrochemistry, production of construction materials, etc. According to some national experts, it is necessary to ensure the production of 70–80 billion kW/h of electricity in the country annually (currently, 38.4 billion kW/h are produced), and its price for industrial enterprises should be 4–6 U.S. cents per 1 kW/h (at the moment — 13.6 U.S. cents).

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In this situation, EE is a prerequisite for ensuring the competitiveness of Belarusian products in the short and long term perspective. However, frequently despite the declaration of objectives to improve the EE by government authorities, the actuakmodernization of companies does not benefit from state support and, moreover, faces with the noncompliance and incoherence of legislation.

The most acute challenges in Belarus energy sector are the following:

1) The lack of systemic approach and consistency in the EE policy and general economic policy of the Government;

2) The current tariff policy does not stimulate the development of modern and effective tariffregulationsseeking cost reduction and efficiency of accounting procedures;

3) The tariffs for electricity and heat are significantly higher than in foreign countries. That certainly hinders the attraction of foreign high-tech manufactures in Belarus;

4) The interests of institutional and individual consumers are not sufficiently safeguarded in legislation and tariff policy;

5) National industrial and business enterprises lack the financial resources for the implementation of energy-efficient modernizationprojects. The high interest rates of banks is an obstacle to the investments in profitable projects;

6) For the same reason, and also due to the lack of recognition of the right to take risk in the policy instruments supporting research and innovation activities, business is not active in implementing and financing research and development;

7) Long-drawn-out underfunding of research and innovation leads to the degradation and isolation of human capacity in science.

The SWOT-analysis carried out at the preparatory phase of the analytical report allows us to determine strengths and weaknesses of the national energy sector.

STRENGTHS:	WEAKNESSES:
1) Over 50% TPP have low specific fuel consumption (160-180 g / kW • h) 2) The power system has electrical power reserve of 43% of its current actual loads 3) The country has established a strong network of trunk transmission lines of 330 kVvoltage 4) Availability of a significant resource base for the development of RES 5) Availability of three engineering design and research institutes and other specialized organizations for construction, installation and commissioning works.	1) The energy losses in electric grids account for 11%, and taking into account the transit and flows — about 20 % 2) "Belenergo"monopoly at the national energy market 3) High electricity tariffs, which are formed on a "cost plus" method and excess similar rates in other countries (13.6 U.S. cents per kW•h for industry) 4) Availability of cross-subsidization duringsetting up of tariffs for electricity for the population and industrial companies 5) Low purchase prices for surplus electricity from private and public producers, as well as energy flows set up by the Ministry of Economy
PERSPECTIVES:	**BARRIERS:**
1) Currently there is an opportunity to buy cheap electricity generated at nuclear power plants in Russia and Ukraine 2) Belarusian NPP launch 3) The growth of FDI in the energy sector 4) Ability to obtain loans from the Russian Federation 5) Availability of technicalinfrastructure fortheexportofelectricitytoLithuaniaand Poland (it is limited inthelattercase) 6) There is an opportunity to expand exports of services by national engineering design and research institutes and other specialized organizations. 7) Development of cooperation with theEU under the Framework Programme for Science and Innovation "Horizon 2020" and the programmes focused onneighboring countries	1) A high degree of energy dependence on the Russian Federation and slow diversification of energy supply 2) Growing costs of imported fuels and energy equipment 3) The high cost of construction of the Belarusian NPP that inhibits the growth of public spending on RES 4) The downward trend in purchase prices for electricity from RES 5) Lack of own funds in companies for modernization, high interest rates on bank loans 6) Underfunding of the national science, especially for applied research and innovation 7) Insufficient use of up-to-date developments in the field of modern electrical technologiesfor the needs of industry 8) Weak links of the national science and innovation business with the international community 9) Reduction in international technical aid due to mismatch of views on the development of internal policies of the Belarusian leadership[60]

[60] For example, in 2009 the European Bank for Reconstruction and Development introduced an "adaptive" strategy for the Republic of Belarus. However, upon the last President's elections in December 19, 2010 the EBRD refused to cooperate with the public sector of Belarus in several areas: in particular, the Bank refused to invest in energy projects in the state sector, as well as from the direct interaction with the public sector of Belarus in the field of sustainable energy. For details, see European Bank for Reconstruction and Development, Strategy for Belarus, http://www.ebrd.com/russian/pages/country/belarus/strategy.shtml, 29.03.2014.

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Based on this analysis, one can identify the most important areas of activities focused on modernization of the national energy system and promotion of RES.

1) Implementation of the systemic policy in EE:

- establishment of a clear management system and coordination between different ministries and departments,
- elimination of the "Belenergo" monopoly in the energy market,
- development and adoption of a new legislation in the energy sector (primarily, it is the law "On Energy Saving" [under development] and such laws as "On Electric Power" [a concept of the law has been designed] and "On Heat Supply"),
- development of modern technical norms and standards, their harmonization with European and international standards.

2) Upgrade of the existing tariff policy in the energy sector:

- development of mechanisms for identifying and accounting the underlying actual costs,
- elimination of cross-subsidization,
- reduction of tariffs for electricity and heat for industrial companies to the level of foreign countries.

3) Improvement of economic incentives in EE:

- preserving increasing tariffs for energy produced from RES,
- increase of purchasing prices for the excess of electricity produced,
- applying public procurement mechanisms for the purchase of the most energy efficient equipment for public purposes.

4) Support to the private sector in the field of EE and RES:

- decrease of interest rates on bank loans for private businesses,
- providing support by innovation funds,
- promoting public-private partnership,
- support to start-ups, expansion of the financing of high-rick innovative projects,
- active attraction of FDI to the national energy sector.

5) Timely construction and ensuring reliability and safety in operation of Belarusian nuclear power plant

6) Wider exploitationof the potentialof "Belenergo" TPPs and cogeneration installations in industrial enterprises. The technically available potential of annual heat supply in Belarus is 84 million Gcal produced by 20.000 of boilers, dryers and heat generators with direct and inefficient combustion of natural gas. The introduction of of modern cogeneration installationsin these processes would allow producing 72–75 billion kWh • h per year. At the current rate of fuel consumption for the production of 1 kW • h and natural gas price (U.S. $ 220 per 1.000 m^3), the net cost of electricity will be 4.7–4.9 U.S. cents per 1 kW • h that is 2,8 times lower than the current price, and import substitution of natural gas will be 11–13 billion m^3 annually[61].

7) Support for energy research:

- improvement of the financing system,
- increase in spending on energy research in the total R&D funding,
- recognition of the right of researchers to take risk, providing financial support for risky projects,
- encouraging business participation in financing and implementation of R&D in the energy sector, introducing support instruments to facilitate cooperation between academia and business in the national practice of R&D funding,
- facilitating the international cooperation and in particular participation of national research centers and companies in prestigious EU-funded programs.

8) Considering the interests of consumers and in particular ofbusiness, including the private one while developing the legislative and tariff policies. This could be implemented, e.g. through setting up of Advisory Board on Energy at the national level, which would include representatives of the widest circles of society: business people, scientists, environmentalists, NGOs, etc.

[61] These calculations are supported by more than 20 years of experience in the West and over 10 years of experience in Belarus itself. For example, currently, the co-generation plants at "Polymir" (32 MW), "Grodno Chimvolokno" (36 MW) and JSC "Naftan" (32 MW) have been installed and are functioning effectively. JSC "Belaruskaliy" own co-generation program of total capacity of 180 MW is on track.

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