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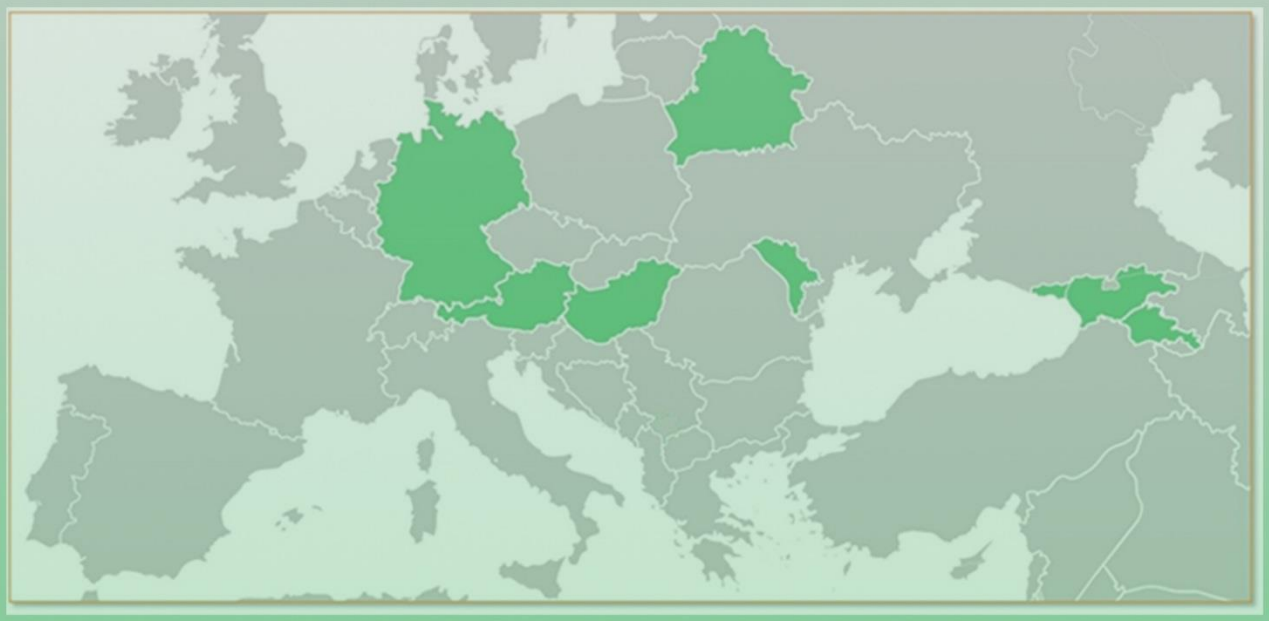
Reinforcing Cooperation with Eastern Partnership Countries on Bridging the Gap Between Energy Research and Energy Innovation



Recommendations, Roadmap & Policy Brief on Energy Efficiency and Renewable Energy Use

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Angyal, Zsuzsanna
Buday, Zita
Csondor, András
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1. European Neighbourhood Policy (ENP) and Energy innovation policy

Innovation is the driver of sustainable economic development and contributes to well-being of people. This message is brought by the World Commission on Environment and Development in the 1980s and is repeated throughout the last decades. Innovations in energy, herewith, are necessary to eradicate energy poverty, mitigate climate change, reduce risks of conflicts and meet other societal challenges. Within this framework, the European Union has adopted the European Neighbourhood Policy (ENP) with the aim to support the non-Member countries in achieving their aspirations and peaceful co-existence with inclusion of the energy issues.[1] It is not solely altruism of the EU but also self-interest because environmental risks do not respect political borders, cross-cultural exchange generates innovations and international trade fosters mutual economic development. Moreover, support for energy efficiency measures and renewable energies help the partner countries save resources, which are beneficial for their economies, and reduce energy imports and related political dependencies.

Realized through the funds of the 7th Framework Programme of the European Union, the project ENER2i is executed within this policy framework with the focus on energy efficiency and renewable energy. Its objective is to foster development of sustainable energy systems in several neighbouring countries which were part of the Soviet Union: Armenia, Belarus, Georgia and Moldova. The aim is to is assist development of policies on innovations in energy efficiency and renewable energy through cooperation between actors in research and innovation across the EU and the ENP countries.

Several partners on the EU and ENP side were involved during the period 2013 - 2016.

The following partners participated on the EU side:

- The Zentrum fuer Soziale Innovation in Austria (ZSI) – the project leader
- The Regionalis Informacios Es Fejleszto Tudaskozpont in Hungary (RCISD)
- Energy Engineers in Germany (EE)
- The European Sustainable Energy and Innovation Association (ESEIA) in Austria with its partners
  - The University of Hamburg in Germany
  - The University of Brasov in Romania
  - The University Twente in the Netherlands

The following partners participated on the ENP side:

- Technology Transfer Association (TTA) of Armenia
- The National Academy of Science (NAS) in Armenia
- The Institute of System Analysis and Information Support of Scientific and Technical Sphere (BelISA) of Belarus
- The Innovative Fund in Belarus (BIF)
- The Registered Union Energy Efficiency Center in Georgia (EEC)
- The Agentia Pentru Inovare Si Transfer Technologic (AITT) of Moldova

[1] Sevilay Kahraman, 2005, The European Neighbourhood Policy, Perceptions, Winter 2005 p. 1-28

- And the Organizatia Pentru Dezvoltarea Sectorului Intreprinderilor mico si mijlocii in Moldova (ODIMM). [2]

The present publication tries to give an overview of Energy innovation and energy research in the ENP countries by providing a compilation of the main results of the ENER2i project. This document will be complete with a set of recommendations for future policy actions in ENP countries in relation to EU policies.

This publication is built upon the following deliverables of the project:

- The ENER2i Countries Report[3] that is also an annex of this publication.
- The cross countries report titled reinforcing cooperation with ENP countries on bridging the gap between energy research and energy innovation.
- Expert opinions from ENP countries visited the EU countries and vice versa.
- Lessons learnt from brokerage events that were executed in connection with conferences and business fairs in the ENP countries, as well as training and twinning events in the ENP countries were organized with participation of large audience.

The present energy efficiency and renewable energy in the ENP countries was assessed and the countries' institutional framework for energy is indicated largely based on the countries and the cross-countries reports. The policy recommendations were drafted using theories and experiences in the EU and ENP countries with consideration of differences in culture and geography of the participating ENP countries (e.g. distance of 3 000 km from Minsk in Belarus to Yerevan in Armenia is similar to Vienna - Yerevan).

Section 2 of this report reviews the present situation of energy efficiency and renewable energy in the ENP and EU countries, section 3 addresses the institutional framework and challenges in the ENP. Section 4 provides a roadmap on innovating in energy efficiency and renewable energy in the ENP countries. Section 5 assesses the activities and a lesson learned from the ENER2i project and provides recommendations on this basis.

A few definitions were introduced to avoid misunderstanding. Energy efficiency is about cost-effective energy use, meaning high energy output at low costs. This can be achieved through better performance in processing, distribution, transformation and storage, as well as more effective use of resources, for example reuse of heat. The renewable energy resources are considered biomass, waste, hydro, geothermal, wind and solar energy. The fossil fuels are coal, oil, gas and nuclear energy. The term innovations is used in a broad sense of "doing things differently" (after Schumpeter, (1939, 1989:59),[4] which covers new uses of new and available

[2] Zsuzsanna Angyal, Anna Bognár, Béla Kardon (RCISD), Manfred Spiesberger (ZSI), Tigran Arzumanyan (NAS RA), Mikael Abovyan (TTA), Olga Meerovskaya, Yauhen Hurynau (BelISA), Anatoly Hryshanovich, Alla Minko (BIF), Elene Gvilava, Liana Garibashvili (EEC), Ana Ciofu, Igor Plamadeala (AITT), Olga Popa, Sergiu Luchian (ODIMM).

[3] Arzumanian, T., M. Abovyan, Country Report Armenia, Ener2i, 2014; Meerovskaya, O., Y. Hurunyau, A. Hryshanovich, A. Minko, Country Report Belarus, Ener2i, 2014; Gvilava, L., L. Garibashvili, Country Report Georgia, Ener2i, 2014; Ciofu, A, I. Plamadeala, O. Popa, S. Lucian, Country Report Moldova.

[4] Schumpeter, J.A. ((1939) 1989), *Business cycles*, 4th Edition, Porcupine Press, Philadelphia.

technologies embracing machines, products, services, models, brands, and so on. Innovating is primarily a business-wise activity with the aim of profitable results. The conventional (demand pull) model on the innovation process was considered. Given the external demands and internal knowledge a capability, a successful research and development generates novelties (inventions), followed by market introduction of the invention (innovation), entailing dissemination of innovation called diffusion. Research and development is an investment cost, which can be covered through sales of licenses, products and services but these sales are uncertain at the moment of the investment decisions (Stoneman, 1983).[5] Research and development are done in private and public institutes and firms as well as in small companies and social organizations based on formal and tacit know-how, which is generated due to interactions between tinkerers and with experts. Social capabilities of the tinkerers and experts in societies, therefore, are essential for innovation (Freeman, 1996).[6] The innovation potential in energy is a term comprehended as being factors that enable innovations in energy business, such as good economic position and natural resources (market factors), available energy business structures (firm factors) and institutional conditions (system enabling factors) (Jacobsson and Johnson, 2000)[7]. Herewith, the institutional conditions are usually comprehended in the sense of organizational and political relations.

2. Current situation

This section indicates possibilities of innovating energy efficiency and renewable energy in the ENP and EU countries which participate in the ENER2i project. It is assessed using indicators for innovations in general followed by indicators for the energy business.

2.1 Innovation potential

Several factors indicate the innovation potential of a country, in this case possibilities for innovations in energy efficiency and renewable energy. Table 1 shows several indicators of the ENP and EU countries:

- Gross Domestic Product (GDP) per capita indicates economic capabilities for generation and absorption of innovations: high income – high capability,
- energy use per capita indicates value addition: low use – high value added energy use,
- population density indicates natural endowments because renewable energy needs space: low population density – much space,
- the average altitude indicates possibilities for the hydropower production possibilities: high altitude – good possibility,

[5] Stoneman, P. (1983), *The Economic Analysis of Technological Change*, 1st Edition Oxford University Press, Oxford.

[6] Freeman C., (1996), The greening of technology and models of innovation, *Technological Forecasting and Social Change* 53, p. 27–39.

[7] Jacobsson, S., A. Johnson (2000), The diffusion of renewable energy technology: an analytical framework and key issues for research. *Energy Policy*, 28 (9), p. 625-640.

- annual average irradiation indicates the solar power productions possibilities: high irradiation – good possibility
- Research and Development (R&D) as percentage of the GDP shows knowledge capabilities: high R&D – much capability,
- Given unemployment rate, percent students of the secondary education that enter the tertiary education shows the potential know-how resources: high percentage - high human resources,
- Ranking in convenience of doing business indicates attractiveness of making business: high rank means attractive for business.
- Global Innovation Index 2015, which compounds input indexes (indicators of institutions, human capital and research, infrastructure, market sophistication, business sophistication) and output indexes (indicators of knowledge and technology outputs and creative outputs) – high index and rank means highly innovative
- Innovation efficiency, which means index of the outputs divided by the index of the inputs – high index means high efficiency.

Herewith, It should be noted that the indicators mentioned above are only imperfect expressions of the countries' innovations systems but used to compare the countries' opportunities and barriers for innovations though not specifically on energy efficiency and renewable energy.

Table 1 Innovation potential in energy efficiency and renewable energy in a few ENP and EU countries

Indicators for the innovations potential		ENP countries				EU countries		
		Armenia	Belarus	Georgia	Moldova**	Austria	Germany	Hungary
Income[1]	GDP/cap	3873	8040	3670	2237	51190	47822	13585
Energy use[1]	t.o.e./GNP	997	3223	825	920	3928	3874	2313
Density[2]	cap/km2	280	47	64	105	259	593	280
Height av.[2]	m altitude	1792	160	1432	139	910	263	143
Solar irra*[3]	kWh/m2.a	1700	900	1500	1300	1100	1100	1300
Know-how	R&D % GDP	0.24	0.67	0.16	0.35	2.83	2.85	1.41
Education[1]	Students to pupils	0.46	0.93	0.33	0.41	0.81	0.6	0.57
Doing bus.[4]	In rank of 100	74.22	72.33	77.45	70.97	78.38	79.87	72.57
Innovation[5]	Index 2015 (rank)	37.31 (61)	38.23 (53)	33.83 (73)	40.53 (44)	54.07 (18)	57.05 (12)	43.0 (35)
Efficiency ratio[5]	Output/Input index (rank)	0.79 (34)	0.70 (73)	0.62 (107)	0.98 (5)	0.77 (33)	0.87 (13)	0.78 (35)

* the lowest average of solar irradiation is considered, ** Wikipedia income data in USD/cap is 4 973

[1] World bank statistics, 2013 [2] Wikipedia, [3] Solar Maps, [4] doingbusiness.org/rankings [5] Global Innovations Index 2015; it should be noted that the index is composed on many indicators that are not observed statistically and subject to interpretations

- The ENP countries' per capita average economic output is about 6 to 20 times lower than in Austria and Germany and about 2 to 5 times lower than in Hungary. The ENP countries have low economic capabilities in innovations.
- The ENP countries use five times more energy per value unit than Austria and Germany, except Belarus. Not only energy efficiency and renewable energy but also higher valued activities are needed. Innovations that generate value adding activities in the ENP countries are needed in Armenia, Georgia and Moldova.
- The natural conditions in the ENP countries are suitable for renewable energy. Aside Armenia, the ENP countries have 2 to 5 times lower population density than the EU countries. Belarus in particular has large potential (for instance the neighbouring Latvia with the similar population density and climate is an EU leader in bioenergy).
- There is high hydropower potential in Armenia and Georgia whose average altitude is nearly twice higher than the Austrian one; Belarus and Moldova have lower hydropower potential. This potential is only partly used.
- There is high solar power potential in Armenia and Georgia. Their annual irradiation is on average about 1.5 times higher than in Germany, which has already installed much solar power capacity.
- A major barrier for innovations in the ENP countries is 5 – 15 times lower R&D effort per GDP compared to Austria and Germany and 2 – 5 times lower than in Hungary. The R&D in the ENP countries is low even after correction for the lower GNP per capita.
- The ENP countries, except Belarus, experience much higher unemployment rate than the EU countries[8] Although its population is educated, the percentage of pupils that go on with learning are low, except in Belarus with nearly all pupils going on with a study. Students that enter universities can develop capabilities that enable innovations after some time. The human capabilities development is low.
- The conditions for doing business are reasonable in the ENP according to indicators of the World Bank doing business ranking. However, individual indicators show more nuances. For example it is difficult to get electricity in Armenia, to get credit in Belarus, to resolve insolvency in Georgia, or to deal with construction permits in Moldova. Other institutional factors also influence the business climate, such as the level of corruption, degree of democratic development, stability of government and strong state control over policy and economy.
- The innovations capabilities of the ENP countries are substantially lower than the ones of the EU countries. The lower capability is mainly caused by their lower innovation inputs

[8] ILO unemployment rates in percent of all willing and able to work: Armenia, 17.3, Belarus 0.7, Georgia 13.7, Moldova 9.1 in the ENP countries and Austria 5.6, Germany 4.5, Hungary 6.5 in the EU countries (found in en.wikipedia.org/wiki/List_of_countries_by_unemployment_rate) visited 29-2-2016

(ranking of the input-indicators is: Armenia 69, Belarus 55, Georgia 67, Moldova 74 in the ENP, and Germany 18, Austria 19, Hungary 42 in the EU)

- The scarce innovation inputs in the ENP countries are used rather efficiently in Moldova and Armenia but inefficiently in Belarus and Georgia compared to the EU countries.

In sum, the natural resources of the ENP countries enable and even facilitate innovations in energy efficiency and renewable energy but development of human capabilities and R&D entailing value adding activities is needed. The Belarus position, herewith, is somewhat better though its use of the innovation resources can be much improved.

2.2 Energy business

Energy innovations are generated mainly within the energy business. An important question is, if this business is capable to generate and adopt innovations. Herewith, innovations in energy efficiency and renewable energy usually need a distributed system of energy production and transmission because the resources are scattered in space and across various organizations. However, in the EU and ENP countries the centralized energy systems are vested by the large scale (and often public) energy companies. The competing distributed (network) energy systems emerge. Studies pinpoint that new energy companies emerge independent of the vested energy businesses in a few EU countries but they hardly exist in the ENP countries (Bertoldi et al, 2014)[9]. These energy service companies (ESCO) are energy producers and services companies that usually deliver renewable energy and generate higher energy performance. The ESCO generate income based on management contracts with customers that include division of revenues from energy saving and value adding services. . On average in the period 2008 and 2012, which is after the financial crisis, about 3 600 ESCO's a year enter the European markets, which involves annually 23 000 new jobs. The vested energy businesses are generally obstacles to the innovative distributed systems (Krozer, 2015).[10] Conditions for the energy innovations in the ENP countries are indicated in Table 2. These indicators are:

- energy use per person indicates whether it is economic to innovate for energy efficiency: low energy use implies rather uneconomic innovations because little can be gained,
- a low share of the domestic production in consumption shows high energy dependency, which can be an incentive to innovate for more energy independence because it improves countries' balance of trade: high dependence is incentive for innovations
- scale of the energy business is indicated by the share of exports in the domestic production, whereby the large energy businesses can hinder innovations: high exports indicates large scale of the vested energy business;
- Share of renewable energy in total production indicates the present involvement and interest of the countries' business and policies in renewable energy: large share means much interest in innovations (or high capacity in the more traditional renewable hydropower, as is the case in Georgia).

[9] Bertoldi P., B. Boza-Kiss, S. Panev, N. Labanca, 2014, ESCO Market Report 2015, Joint Research Centre, report number 26691 EN

[10] Krozer, Y, 2015, Theories and Practices on Innovating for Sustainable Development, Springer, Heidelberg/New York.

These indicators are shown in Table 2. All data is based on the IEA balances. The ENER2i countries reports and the cross country provide much useful and detailed information about the individual countries but they are less useful for the cross-countries comparisons including the EU countries.

Table 2 Possibilities of the energy business to innovate in energy efficiency and renewable energy

Indicators for the energy business		ENP countries				EU countries		
		Armenia	Belarus	Georgia	Moldova	Austria	Germany	Hungary
Energy use	t.o.e./cap	0.96	2.88	0.86	0.86	3.89	3.93	2.29
Local producer	% of consumed	28%	15%	36%	10%	38%	38%	45%
Scale energy business	export/import+ domestic product.	5%	37%	3%	2%	22%	16%	18%
Renewables	share renewable resource in total	6.8%	5.8%	31.1%	9.6%	32.0%	11.8%	8.6%
All data based on IEA statistics: iea.org/statistics/statisticssearch/								

- Energy consumption in the ENP countries is 3 – 5 times lower than in the EU countries, except in Belarus where this consumption is similar to the EU countries. That low energy consumption per capita implies that innovating for energy efficiency is generally uneconomic. Energy efficiency innovation can be economic in selected energy-intensive industries (which are few in the ENP countries, except in Belarus).
- The ENP countries are highly dependent on energy imports as their local production and energy consumption is low. The energy independency is lower than in the EU countries whose policies aim at more energy independence. Georgia is as energy independent as the EU countries, which is achieved due to the local biofuel and hydropower production. The Armenian local energy production largely depends on an ageing nuclear power plant, which may have to be shut down in the coming years. For more energy independence innovations in renewable energy are important.
- The energy businesses in Armenia, Georgia and Moldova are rather small scale compared to the businesses in the EU countries. These businesses could be attracted by the distributed energy systems. This is different in Belarus where the energy businesses are large and can be an obstacle for this kind of energy innovations.
- The share of renewable energy in the ENP countries is similar to the EU countries. It suggests sufficient interest for the local renewable energy production. The low percentage in Belarus is similar to the EU laggards, such as the Netherlands, whereas the high share in Georgia is similar to one of the EU frontrunners.

In sum, possibilities for energy-efficiency innovations in the sense of lower energy use per person are modest because the present energy use is low. However, higher value production is essential for the energy-efficiency. Belarus has a higher energy use per capita but the large scale energy business can obstruct these innovations because it impedes their sales. In all ENP

countries, there are ample possibilities for the local renewable energy production with regard to their high energy dependency and sufficient interest in renewable energy.

3. Institutional conditions

The institutional conditions in the ENP countries are largely based on the ENER2i countries report and the cross-countries report. This section addresses the institutional conditions for innovations in energy efficiency and renewable energy. The institutional conditions are considered organizational and political possibilities throughout the innovation process.

3.1 Innovation capabilities

Innovation processes in energy are assumed to evolve in phases. They start with goal definition. In case of energy efficiency and renewable energy, the goal definition addresses societal challenges because not solely the private interests are considered but also the social goods. After the societal goals are defined, which is usually done by a national authority, the necessary social capabilities for innovative activities can be developed. These are primarily related to education and know-how building. Good education and know-how are necessary for research and product development entailing market introduction of products and services if all previous phases are successful. This presentation is only a model because in reality there are already pre-existing goals, capabilities, research and development and markets, as well as many interactions during these phases. The model is helpful to discuss the existing institutional framework and the needs.

An appropriate institutional framework, herewith, embraces in particular: regulation of property rights and investments, institutions for education, for know-how and non-profit research, as well as technical and organizational facilities and infrastructure for product development and market introduction. What is the appropriate framework and what public interventions are precisely needed is much debated. These debates are beyond the scope of this report. Herewith, it is solely indicated if there is sufficient attention to these institutional conditions. The indications are based on the Countries Reports for ENER2i. Table 3 summarizes the institutional conditions per phase in innovation processes.

Table 3 Institutional conditions for innovating in energy efficiency and renewable energy; EE means energy efficiency, RE means Renewable energy, general means not specifically EE or RE (based on ENER2i Country Reports).

Phases	Armenia	Belarus	Georgia	Moldova
Energy policy	Energy (market) law, EE&RE law aim at local resources with funds, program, roadmap	Energy Saving Law, RE Law for diversification & modernization (EE, hydro, bio)	No specific energy policy, focus on hydro and transmissions	National Agency on Energy Regulation, EE Fund, Energy Strategy 2030, Law on RE promotion
Education	EE&RE in High Educat. Ministry Education & Science aim at talents	Academic courses on EE basics, EE Tech.& Manag. Awareness	-	-
Know-how	Nat. Center Innovation and Entrepreneurs to	EU ass. for authorities on project proposals	External support (general)	Energy & Biomass Project, credit for residents

	foster ideas and young researchers (general)			
Research	EE&RE in the National Academy of Science (2000 persons)	Foundation for fundamental research (general)	External support, Rustaveli foundat.	Moldovan Academy of Sciences
Development	SME Development Nat. Center, Technopark, Venture capital firms, Patent Office (general)	Department funds	Technol. & Innov. Agency (general)	EE Fund, Agency for Innovation and Technology Transfer-
Market entry	Armenia EE&RE Fund, Free Economic Zones, External support (e.g. REP project)	Loans Innovation fund (Belinfund) , 3-4% of national budget for intern. Cooperation	External support low local business interest in EE&RES	Financing facility (MOSEFF), Organisation for SME development (ODIMM)

- Reliable policy goals reduce uncertainties about the future energy markets, which enables to take risk of innovations. Comprehensive legal frameworks with laws, programs and roadmaps on energy efficiency and renewable energy are elaborated in Armenia, Belarus and Moldova. It is hardly elaborated in Georgia where high renewable energy production is found. However, a complex legislation reduces transparency and invokes irregularities, which impedes innovations. The policy transparency in the ENP countries is low.[11] Presumably it poses major barriers to the innovators in energy efficiency and renewable energy.
- A broad educational structure is available in all ENP countries. However, the educational quality and the links between educational levels can be much improved as none of the ENP countries is in the top 30 of math, reading or science.[12] Also, many pupils of the secondary schools do not enter the tertiary education and appropriate vocational education is not in place, which leads to a huge loss of human capabilities. The specialized courses on energy efficiency and renewable energy are rare. Such courses are mentioned in Belarus. Scouting and supporting young talents is addressed in Armenia.
- Know-how capabilities on energy efficiency and renewable energy seem hardly being under development in the ENP. Insofar it is under development and largely driven by the external assistance. Armenia has developed a national center on innovations with facilities for young researchers, which include the energy topics. Belarus fosters the policymakers' know-how through energy courses. Civil society initiatives on energy efficiency and renewable energy are apparently intangible or hardly observed, with the Energy Efficiency Centre Georgia being an exception and good practice example. Only Moldova provides policy instruments in support of the citizens' initiatives. Armenia mentions some civil organizations involvement.

[11] The ranking of Transparency International is: Germany 81 points, Austria 76, Georgia 52, Hungary 51, Armenia 35, Moldova 33 and Belarus 32 (transparency.org/cpi2015).

[12] businessinsider.com/pisa-rankings-2013-12?IR=T

- Research on energy efficiency and renewable energy in the ENP is largely based on external financial assistance. It is fundamental by approach and rarely specific on energy efficiency and renewable energy. Research is usually linked to the National Academy of Science and not many innovations oriented research programs are observed, which underpins the low level of R&D in the countries.
- Armenia has elaborated an institutional framework for technology development with centers for small and medium sized enterprises, techno parks, venture capital, and patent offices and so on but it is short of intermediary organizations for operating these institutions. Similar frameworks are introduced in Georgia and Moldova though not specialized in energy efficiency and renewable energy. The Belarus approach relies on the ministerial institutes and their funds.
- All ENP countries have established institutions for co-financing market entry of the innovative businesses, often with external assistance. Various approaches are applied. Armenia has a free economic zone. Belarus has allocated a few percent of the ministerial budget for international cooperation. Moldova supports initiatives of businesses and residents with credits. Georgia also uses external funds but there is low business interest in energy efficiency and renewable energy.

In sum, the ENP countries generally address the policy formulation and market entry phases. The ENP countries have legal frameworks on energy efficiency and renewable energy. The policy formulation provides a basis for innovations but the implementation may lack transparency. These frameworks are hardly reflected in the institutions for education, know-how, as well as research and product development. Development of human capabilities on energy efficiency and renewable energy can be improved, which can also be observed in many EU countries but the EU has introduced instruments for capacity building and civil society, such as Horizon 2020, regional and structure funds and so on.

Vital is the business interests in innovations. Interests of small and medium sized enterprises in energy efficiency and renewable energy in the ENP countries are reflected in the business proposals for innovations vouchers. Within the ENER2i project vouchers of € 4 000 were awarded to the best evaluated proposals. The vouchers scheme produced 89 voucher applications that competed for the vouchers. Out of these 25 vouchers have been awarded, plus 5 additional from external funds, which is 34% of all applications. Table 3 shows the results per country (all funded projects are on web ener2i.eu/innovation_vouchers/funded_projects). The recipients underline that the vouchers are useful tools for starting business and linking with research (ener2i.eu/innovation_vouchers/testimonials).

Table 4 Distribution of vouchers applications and funding across the ENP countries

Vouchers	Armenia	Belarus	Georgia	Moldova	Total
Submitted applications	14	23	18	34	89
Eligible proposals (quick check)	10	20	18	29	77
Successful evaluated proposals	8	7	17	23	55
Funded projects	6	7	6	11	30

The proposals submitted to the competition are divided into several subjects: energy efficiency in production, energy efficiency in consumption and the renewable energy production in biofuel, hydro, geothermal, wind energy and solar energy. The entrepreneurs in Armenia are focused on the solar energy technologies (7 out of 10), in Belarus on the energy efficient production (6 out of 7), in Georgia on the energy efficient production and consumption (8 and 4 out of 18), which is also found in Moldova (23 out of 29). By far, the most entrepreneurs aim at cost-saving in business and in household. Only a few businesses addressed the renewable energy technologies aside solar (7 out of 64). Hardly any entrepreneur proposed products and services that add value to customers. Such value addition is generated through linking various technologies (for example information and communication technologies for energy efficiency called "smart"), adding services to the energy technologies (e.g. electric car sharing and leasing), integrating of the energy expertise in other technologies (e.g. passive buildings), integrating management in energy practices (e.g. heat loss prevention), designing energy products (e.g. efficient lighting) and other cross-overs. It is observed that such cross-overs often generate successful innovations. Presumably the limited human capabilities in businesses pose severe constraints to the value adding energy innovations though precisely these are necessary in the ENP countries.

3.2 SWOT

The institutional capabilities are assessed in the ENER2i Countries Reports. The SWOT framework is used, which requires indicating the Strength, Weakness, Opportunities and Threats of energy efficiency and renewable energy in the ENP countries. These assessments are done by the ENP partners. Table 5 compiles the findings in these reports.

Table 5 SWOT assessment of the institutional capabilities for innovating in energy efficiency and renewable energy; EE means energy efficiency and RE renewable energy (based on ENER2i Country Reports)

	Armenia	Belarus	Georgia	Moldavia
Strengths	Legal framework, policy documents, promotion institutions	Effective power plants, reserve in production & transmission, good knowledge base	Much hydro, solar & bio; International cooperation	Long term strategy, EU harmonization, Promotion EE/RE
Weaknesses	Poor infrastructure, low R&D expenditures, low incentive for businesses	High grid losses (up to 20%), costly power, cross-subsidies, low grid feed-in tariffs	Low technology & policy experience, high interest rate for loans	Low feed-in, poor information, laws, firm-academia link, investment climate, inefficient banking
Opportunity	Solar potential, plans for launching, the diaspora expertise,	Launching national plan, foreign investors, loans of Russian Fed., export technical know-how and engineering	Projects in pipeline, IFI support, EE/RE developers, Spatial plan with RE for buildings	EU association & funding, electricity transit corridor, cross border infra, High potential RE
Threats	Policies without economic support, environmental laws with no incentives	Monopoly position of the Belenergo because weaknesses remain	Poor infrastructure, scarce capacities, low R&D	Political instability, bureaucracy, import dependence

Per country, it is combined what strength entails opportunities, as well as weaknesses cause threats. This way, improvements of the institutional capabilities can be specified.

- The Armenian strength is the institutional framework, which can be improved due to expertise of diaspora and external assistance. The weaknesses are mainly poor know-how and incentives for businesses, which cause that various institutional initiatives have little innovation incentives. The institutional capabilities are largely developed and formalized but their implementation across society can be improved.
- The Belarus strength is modern power production and good knowledge, which can be improved through national development programs with external assistance and international exchange of the technical know-how. The weakness is poor network infrastructure and low incentives for renewable energy, among others caused by the monopoly structure of the energy market. The challenge is the resolving of institutional barriers posed by the monopolized energy market.
- The Georgian strength is internationally funded projects on natural resources for renewable energy. This can be enhanced through sound infrastructure for energy transmission and projects aiming at the residential energy efficiency. The weaknesses are little experiences with modern technologies and low incentives for innovations. This is aggravated by poor infrastructure, low human capabilities and research and development. The institutional capabilities can improve through know-how development and incentives for energy business.
- The Moldovan strength is planning in line with the EU harmonization. It can be strengthened due to the association agreements with external assistance and development of the electricity transit corridor and other transnational infrastructure. The weaknesses are deficient incentives and intermediary organizations, such as poor links between academia and firms and inefficient banking. This can be aggravated by the political instability and bureaucracy. The institutional capabilities can improve through incentives and stakeholders networks for energy business.

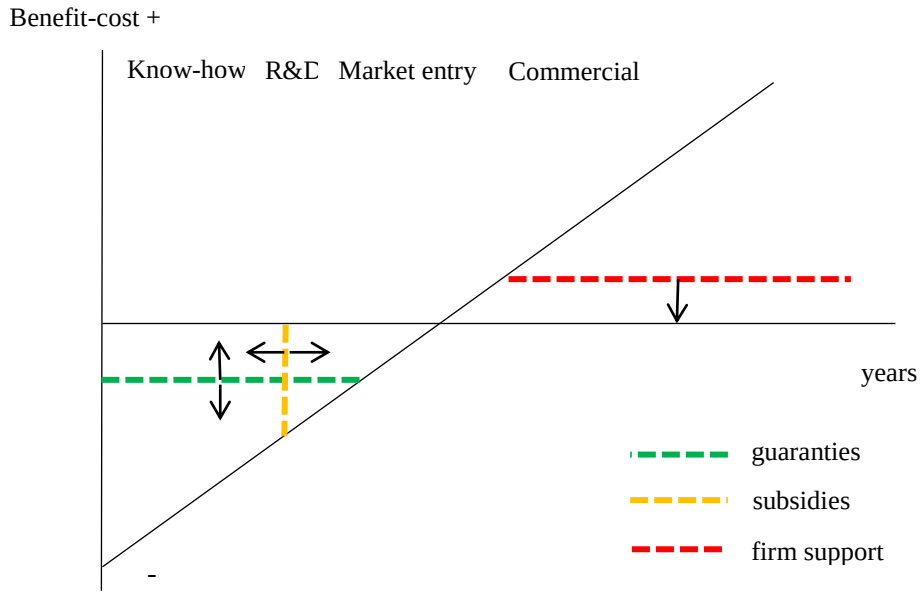
In sum, the formal institutional framework for energy efficiency and renewable energy is available in the ENP countries. The challenge is institutional capability for the implementation, which needs upgrading and scaling up of education, know-how, research and development. Belarus and Georgia are focused on technical infrastructure and know-how for energy transmission, Armenia and Moldova on incentives for and stakeholder's involvement in energy efficiency and renewable energy.

4. Roadmap for Innovation

Innovating is a risk-taking endeavour. The risk is that costs are made but benefits are missed because know-how is insufficient, research fails, development delivers deficient qualities, market introduction is not appreciated by customers, and so on. Usually, the risks decrease but the costs increase per phase. Public interventions are indispensable because the total costs usually exceed wealth of individual innovators and high risks discourage lenders. A model that reflects costs and benefits of (aggregated) innovations processes in a region or country is helpful

to draw the roadmap with recommendation for policies on energy efficiency and renewable energy. The model is schematically presented in Figure 1.

Figure 1 Schematic presentation of a country's innovation process



The net benefits (benefits – costs) or profits are shown vertically. The innovation processes in time is put horizontally. The capacity building, which covers education, know-how and basic research, is a cost with little or insufficient income to cover all costs. Public funding is necessary, which is justifiable because the benefits are accrued by various sections of society and used for different purposes, including the energy-efficiency and renewable energy innovations. As the innovation processes approaches the market entry more costs can be covered by the innovators and investors because they can benefit directly from the eventual profit making. The investors, herewith, are considered the innovators, as well as the suppliers of private equity and public funding. The commercial activities can be financed privately. The public support of the commercial activities should be avoided because it distorts the role of prices as signals of resource scarcity and it undermines the position of innovators because it reduces costs of the vested technologies.

The challenge in the ENP countries is development of the human and institutional capabilities in the early phase of the innovation process in energy efficiency and renewable energy. According to the global innovation ranking all ENP countries allocate very low resources for innovations but some ENP countries operate efficiently with the scarce resources. The challenges in all ENP countries is generate more resources for innovations and do it a way that generates successful innovative results. Given their low value added of energy use and low energy use per capital the focus should be on generating energy efficiency and renewable energy that increase value added of products and services. Solely locating more resources for the existing institutions does not help much because not necessarily foster innovators but on the contrary may hinder them.

A roadmap with policy recommendations is presented aiming to foster this institutional capability along with elevating of the value of produced products and services given energy use. Per phase, a few main tasks are specified taking into consideration the low value added of energy

use in the ENP countries, as well as the low level of R&D and the scarce governmental resources. It means that the low-cost policies that generate innovations are envisaged.

4.1 Know-how

A lot of know-how, the formalized educational knowledge and tacit skills embedded in individuals, is needed for any innovation processes. This is also in the ENP countries that spend little on the R&D but have very reasonable international performance in the European projects. The countries score in the EU FP7 projects is between 20% and 23% (out of total 222 to 328 proposals), which is well in line with other EU countries.[13] Apparently, the ENP countries possess tacit capability that can be used for innovations. Experiences in energy efficiency and renewable energy are that know-how is generated on the specific regional locations during many decades due to the outstanding natural qualities and a socio-cultural environment of diversity and tolerance because these facilitate human interactions about know-how. Policies can foster an environment for such interactions through encouragement of the non-governmental (civil society) initiatives, because these initiatives often evolve into stakeholders' networks with links to businesses and institutions entailing creation of novel firms and institutions.[14] The following tasks can be defined:

Task 1: assess civil society initiatives that (can) champion energy efficiency and renewable energy.

Task 2: facilitate the stakeholder networks on energy-efficiency and renewable energy in these regions.

Task 3: generate proposal for education, innovation and policy based on the stakeholders' networks.

Task 4: develop capacity building programs with projects based on the generated proposals.

4.2 R&D

All countries struggle with barriers in linking researchers, businesses and investors because the interests and dynamics of these stakeholders are different, often opposite. These links need improvement in the ENP countries because of poor relations between the universities expertise and firms and weak venture investors, as being assessed in the Global Innovations Indexes. The ENP countries, however, cannot pay large R&D expenditures spent by some countries (e.g. per capita about USD 1100 in the US and Japan, half of it in the EU and even less than half of the latter in China or Russia; roughly half of these are the public expenditures. The expenditure are divided across more than 160 types of financial policy instruments (Ermen, 2007)[15], such as subsidies, soft loans and tax exemptions. The instruments support researchers and developers that are selected because it is assumed they generate net benefits. But if they fail these public

[13] Gheorghe Duca, Chair of the National Committee for the Association to Horizon 2020, 13 March 2014, H2020 Regional Launch event.

[14] Krozer Y., 2012, Renewable energy in European regions, International Journal on Innovation and Regional Development, Vol. 4, No. 1, pp. 44-59.

[15] Ermen van R. (2007), Comparison and Assessment of Funding Schemes for Development of New Activities and Investments in Environmental Technologies, Fundetec, rapportnummer 044370, Brussels.

funds are lost. Various methods are tested to reduce this public risk, such as funding of the potential customers rather than the developers, support cooperation in value chain, subsidies with repayment in case of profits and so on. Also, the private investors are encouraged through tax exemptions. The ENP countries must assess bout how to create the links given their specific innovations systems because the silver bullet is not available. The tasks can be defined:

- Task 1: Assess policy instruments in use for innovations in energy efficiency and renewable energy,
- Task 2: Assess effectiveness, efficiency and coherence (integrity) of the instruments in use,
- Task 3: Given the capabilities and scarce resources select a few most promising instruments,
- Task 4: Establish a Task Force that defines the instruments, monitors effects and evaluates results,
- Task 5: Periodically, e.g. every 5 years, update the instruments and excludes the redundant ones.

4.3 Market entry

The main barriers of entry for innovators are high costs of technology development, in particular proof of concept through demonstration plants and policy support of the rival vested interests because such support reduces costs of the non-innovators and increases competition to the innovators. The former can be tackled through change of focus in innovation support. Instead of focus on the costly technology development one can address higher value products and services based on the available technologies, which is usually lower cost but it needs high value expertise and creative environment. The policy support of the vested interests is often counterbalanced through the innovators supported with the innovator-specific instruments such as credits, tax exemptions and facilities called incubators, economic zones and so on. This is done despite observations that effects of such specific instruments on market entry are insignificant and they need huge budgets. Generic instruments are alternatives, which are often price, volume or quality guarantees. A guarantee for renewable energy that has gained popularity in the EU called feed-in tariff is an obligation imposed on the power networks to accept the renewable energy deliveries to grid at the guaranteed prices or volumes. It provides a stable market without policy interference (other guarantees are quality certificates, product warranties, guarantees for return of goods, and so on). The following tasks are envisaged:

- Task 1. Assess the main barriers of entry for innovators in energy-efficiency and renewable energy,
- Task 2. Develop policy that cuts subsidies for the energy use along with eradication of energy poverty,
- Task 3. Develop policies that reallocate subsidies for the vested energy interests towards feed-in tariffs,
- Task 4. Establish a reliable institution that is capable of controlling fair play on the energy markets.

In sum, the ENP countries have opportunities to lead in energy-efficiency and renewable energy when they can generate value adding activities without much additional energy use and tune their energy policies to the local natural resources. The presented Roadmap can help in this direction.

A few country-specific recommendations are presented with the aim to upgrade the value of energy use and generate renewable energy in the ENP countries based on the SWOT analyses. Armenia can strengthen their research capabilities on renewable energy in relation to business development. With regard to the natural environment and businesses interests this can be particularly attractive on the value adding, solar power-based products. The major challenge in Belarus is upgrading of the electricity network, which needs large investment. These must be funded with funds that are external to the energy business, which is feasible only in case the cross-subsidization of the energy infrastructure is substantially reduced. Large opportunities for hydro, wind and solar exist in Georgia if more capital is attracted. Given the political uncertainties and scare capital, the local business capabilities in the project preparation and development can be strengthened because it can attract the external capital for such investments. Development of incentives for renewable energy, such as feed-in tariffs, and stakeholders'' arrangements that attract foreign capital foster the Moldovan energy efficiency and renewable energy.

5. Learning and Recommendation

The ENER2i project has generated when measured by involvement of stakeholders and businesses in the ENP countries. The training and brokerage events have contributed to exchange of ideas and creations of the cross-countries contacts albeit too early for tangible impacts on the countries innovation systems. The vouchers are successful because enabled the ENP entrepreneurs to generate new business ideas and foster contacts with expertise centers in the ENP countries and across Europe. The key factor for the results is high motivation and capability of people involved because the early phases in this cooperation depend on the individual efforts. Getting reliable partners that can fulfil the outstanding tasks in the ENP and EU countries should be considered a key learning for the early stage international cooperation.

Training and brokerage is often executed as stand-alone activities. In the ENER2i, however, the training and brokerage events were linked to exceptional events in the ENP countries, such as a conference and business fair. Such links enabled to generate stakeholders' interest and attract large audience. The links also supported participation of businesses in competition for vouchers and promotion of the winners in this competition many people noticed them. The challenges are management of interactions with the event organizers and the project activity, in particular marketing and promotion of the project activities amid the event, and dissemination of materials about ENER2i and the business winners because a lot of other items are presented. The organizational capabilities of the local partners, therefore, are essential for the successful training and brokerage.

Awarding winners in a competition is a popular instrument to attract businesses. The ENER2i vouchers as a financial reward of the best business proposals in the ENP countries has also been successful. The number of participants in the competition, however, varies too much across countries and this variety does not reflect the scale of energy business in a country. Other reason could impede the participation, such as insufficient promotion of the vouchers or institutional

impediments in absorbing the funding. The applications hardly addressed the value adding products, which is an omission in the ENP countries that need higher value of energy use. An awarding system of vouchers based on competition for value adding business models is an excellent instrument in promoting energy efficiency and renewable energy innovations.

Follow up is the Achilles heel of any project. The ENER2i project enabled to establish contacts. These can evolve into partnerships if there is project follow up through tailor-made studies modules, training and capacity building. These need to be organized based on other EU funded projects. Participation of the ESEIA network in the ENER2i can provide an umbrella for such partnership and project-wise cooperation (e.g. the Belarus partner has entered into another project). Given that the ENER2i partners are involved in several EU project there is chance for such partnerships. However, this partnership does not emerge automatically because requires participants' commitments in the partnership and tangible proposals for the mutually beneficial actions. It is recommendable that ESEIA provides an umbrella for the follow up and the project partners provide commitment on actions.

The ultimate goal of the ENER2i project is contribution to sustainable socio-economic development and good governance through mutually beneficial cooperation between the ENP and EU countries on energy efficiency and renewable energy. The ENER2i project can be considered a stepping stone towards more systematic international cooperation with various neighbouring countries to the EU. Follow up strategies on joint fundraising for the energy efficient and renewable energy business and governance models are necessary. These strategies should be geared to the countries' innovations systems, which implies that positive political decision about fostering such cooperation is needed.

6. Country Report of Armenia

Authors:

Tigran Arzumanyan

Mikael Abovyan

Lead by NAS RA, with the support of TTA

List of Tables and Figures

Abbreviations

CDM = Clean Development Mechanism
EaP = Eastern Partnership countries
EBRD = European Bank for Reconstruction and Development
EE = Energy Efficiency
GWh = Gigawatt Hour
HPPs = Hydro Power Plants
IFC = International Finance Corporation
IMF = International Monetary Fund
KTOE = Kilotonne of Oil Equivalent
NPP = Nuclear Power Plant
R&D = Research and Development
RES = Renewable energy sources
RTD = Research and Technological Development
S&T = Science and Technology
SMEs = Small and medium enterprises

6.1 Introduction

The objective of this Country Report is to conduct the analysis of the energy sectors in Armenia and the identification of stakeholders as basic information for the initiation and stimulation of further innovation and research support activities for energy efficiency (EE) and renewable energy sources (RES) to be carried out within ener2i project. It will focus on existing potential in EE/RES and provide overview of available technologies and technology providers, opportunities and barriers and address relevant policies and energy strategies. This analysis will also constitute the basis for the formulation of policy recommendations and the definition of a joint roadmap to be addressed to the responsible public institutions. The analysis is carried out on the basis of common methodology developed within WP2 of ener2i project also to allow conducting a comparative analysis focused on the local energy innovation systems in Armenia, Belarus, Georgia and Moldova.

6.2 Current energy situation in the country

Armenia, officially the Republic of Armenia, is a landlocked mountainous country in the Caucasus region of Eurasia. Located at the crossroads of Western Asia and Eastern Europe, it is bordered by Turkey to the west, Georgia to the north, the de facto independent Nagorno-Karabakh Republic and Azerbaijan to the east, and Iran and the Azerbaijani exclave of Nakhijevan to the south. A former republic of the Soviet Union, Armenia is a unitary, multiparty, democratic nation-state with an ancient and historic cultural heritage.

Armenia has no indigenous sources of oil, coal or natural gas. It imports and consumes 47,000 barrels a day of oil, most of which is imported from Russia. It also imports and consumes about 9 mln cubic meters of natural gas of which two-thirds is imported via pipelines from Russia that runs through Georgia and one-third comes from Iran. In 2008, Armenia imported 2.2 bn cubic meters of gas from Russia. On December 23, 2009, Iran and Armenia reached an agreement for Armenia to import about 150 mln cubic meters of natural gas from Iran. Armenia was importing 1-1.5 mln cubic meters, which it paid for by exporting electricity to Iran. Natural gas from Iran is imported via a 140 km pipeline that was completed in 2008. The pipeline is controlled by ArmRosGazprom (ARG), a Russian-Armenian joint venture that up until 2013 was 80% owned by Gazprom of Russia. In autumn 2013, Armenian Government announced about the decision to hand over the state's remaining 20% stake in joint venture to Gazprom thus ceding almost total control of energy supplies to Russia.

Heavy reliance on imported fuels and the old and under-maintained transmission and distribution assets put Armenia at risk of supply interruptions, price fluctuations, and possible outages. The average age of the transmission lines is around 45 years and the transmission company did not make any substantial investments in rehabilitation of the lines. Moreover, Armenia is dependent on the imports for gas and nuclear fuel used to generate over two-third of the country's electricity.

Armenia currently has sufficient capacity to meet its demand. However, depending on the power demand growth scenarios, generation capacity shortage of 520-920 MW to meet the peak electricity demand is estimated to emerge after the planned shutdown of the nuclear power plant (if construction of new nuclear power plant not implemented), and the phasing out of inefficient and old (>40 years) thermal power plants. The shortage is expected to reach 1,150 – 2,270 MW by 2020.

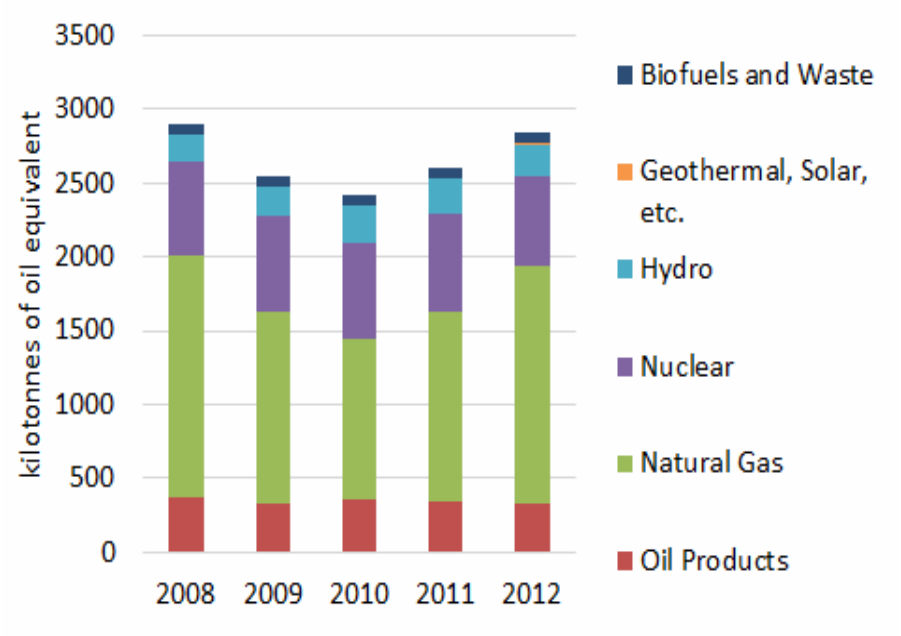


Figure 1. Primary Energy Supply in Armenia, 2008-2012

Source: Preparation of SREP Investment Plan for Armenia, Task 1 and 2 Report, 26 September 2013[16]

Electricity consumption grew by an annual average of 2% from 2008-2012, with the share of consumption by customer class remaining largely the same. Out of a total annual primary energy supply of 2,586 thousand tonnes of oil equivalent (ktoe), 1,372 ktoe are from natural gas, 688 ktoe are from nuclear power, 394 ktoe from petroleum products, 157 ktoe from hydroelectricity plants, and 1 ktoe from RES. Wind power from Lori-1 WPP and other renewable energy projects such as the Lusakert biogas plant represented around 0.03% of electricity production in 2012. Although Armenia imports nearly all its primary energy needs, it is a net exporter of electricity, with net exports of 27 ktoe. Primary energy supply chart of the country is given in the Figure 1.

Hydropower and nuclear power are the main indigenous sources of energy. There are 9 major hydro power plants. The largest is the Sevan Hrazdan Cascade plant, which is 90% owned by United Energy System (UES) of Russia. The second largest hydro plant, the Vorotan facility, was acquired by US energy company in January 2014. Under the takeover agreement signed with the Armenian government, the New York-based group Contour Global is to pay $ 180 million and invest $ 70 million in the three plants making up the Vorotan Hydro Cascade. [17]

The Meghri hydropower plan, a joint project of Iran and Armenia, is currently under construction. The USD 2.3 bn plant will have a capacity of 130-140 MW and will be built by Iranian companies. Construction

[16] r2e2.am/en/2013/08/3253-2/
[17] azatutyun.am/content/article/25246857.html

was expected to be completed in 2015. According to the agreement it will be included into the Armenian energetic system in 2033.

There is one nuclear power plant (NPP). The Metsamor NPP was built in 1979 and has an installed capacity of 815MW but only 1 of its 2 units is operational and stands for 407.5MW. Nuclear fuel is flown in from Russia. Although the government owns the plant, UES signed an agreement in 2003 to operate the facility. The plant was scheduled to close in 2016, but in September 2013 Russia announced an agreement to extend the life of the plant by ten years, and in May 2014 Russia agreed to a $300 million loan for upgrading the plant to enable life extension to 2026.

In 2007, Armenia adopted a new energy strategy focusing on security of supply through diversification and the use of nuclear energy as well as renewable energy sources. Later in 2007, the energy minister announced a feasibility study for a new unit at Metsamor, the investigation being carried out with assistance from Russia, the USA and the International Atomic Energy Agency. The new plant was then expected to go on line about 2016.

In February 2009, the government announced a tender for a new 1000 MWe unit, the Armenia New Nuclear Unit (ANNU). In May 2009, Australian company Worley Parsons was chosen to administer the project, and a $460 million management contract was signed in June. Legislation providing for construction of up to 1200 MWe of new nuclear capacity at Metsamor from one or more reactors was passed in June 2009.

In December 2009, the government approved establishment of Metzamorenergoatom, a 50-50 Russian-Armenian joint stock company set up by the Ministry of Energy and Natural Resources with Atomstroyexport, with shares offered to other investors. This is to build a 1060 MWe AES-92 unit (with a VVER-1000 model V-392 reactor) with a service life of 60 years at Metsamor. It would have two natural-draft cooling towers. In March 2010 an agreement was signed with Rosatom to provide the V-392 reactor equipment for it. In March 2011 the environmental assessment report was presented to the Ministry of Nature Protection, and in October 2012 Revision 1 following public consultation is available.

In August 2010, an intergovernmental agreement was signed to provide that the Russian party will build at least one VVER-1000 reactor, supply nuclear fuel for it and decommission it. Construction was to commence in 2013 and was expected to cost US$5 billion. The customer and owner of new reactors, as well as electricity generated, will be Metzamorenergoatom, and Atomstroyexport will be the principal contractor. Armenia undertakes to buy all electricity produced at commercial rates, enabling investors' return on capital, for 20 years. CJSC Metzamorenergoatom is to fund not less than 40% of the construction, and early in 2012 Russia agreed to finance 50%, though in late 2013 this was reported as 35%.

In May 2014 the government approved construction of the new reactor, starting 2018.[18]

6.2.1 Legal Framework in the field of Energy

Energy Law[19]

[18] world-nuclear.org/info/country-profiles/countries-a-f/armenia
[19] parliament.am/law_docs/210301HO148eng.pdf

"Energy Law of the Republic of Armenia" was adopted by the Armenian Parliament in April 2001, to regulate interrelations between legal entities involved in the energy sector, electricity, heating and natural gas consumers pursuant to the law and the state bodies. Currently, the Law guarantees the market for electricity produced by all small hydropower plants (SHPPs, total capacity up to 10 MW per plant) in Armenia. According to this Law (Article 59, Clause 1.c), "*All electricity (capacity) generated at small hydro power plants, as well as from renewable sources of energy within the next 15 years shall be purchased pursuant to the Market Rules*".

Some of the basic principles of the state policies for energy sector stated in the Law are as follows

- Enhancement of competition and efficient operation in the energy sector.
- Regulation on energy sector operations.
- Protection and balance of interests between consumers and economic entities.
- Efficient use of domestic and alternative sources of energy, and the creation of economic and legal mechanisms to serve that purpose.
- Encouragement of investments, safety and environmental protection in the energy sector.
- Encouragement of scientific-technical progress and employment of new energy-efficient and energy-saving technologies, as well as encouragement of personnel training and re-training.
- Separation of the generation, transmission, and distribution system operators, etc.

Energy Efficiency and Renewable Energy Law[20]

According to the Energy Efficiency and Renewable Energy Law, ratified in December 2004, the principles of Armenian policy in energy saving and renewable energy are:

1) Increasing the level of supply of indigenous renewable energy carriers to satisfy the energy demand of the economy,
2) Implementation of energy saving strategies, as well as development and enforcement of legal and economic mechanisms for the promotion of renewable energy,
3) Ensuring increasing usage of renewable energy resources as well as the application and development of new renewable energy technologies aimed at its promotion,
4) Ensuring competitiveness of renewable energy resources and protection/enforcement of the rights of businesses engaged in the area of renewable energy,
5) Ensuring high priority of issues of environmental protection and efficient (economic) usage of natural resources while implementing measures/activities aimed at the development of energy saving and renewable energy, etc.

Water Code[21]

This Code, which has been adopted on 4 June 2002, establishes procedures to obtain water permit for hydro power plants. According to this Code water permit for a hydro power plant is given for 3 years at the first, but once the plant is operational or even it is under construction, then the permit is extended for a much longer period. The purpose of this provision is to prevent people getting a water permit and then not proceeding to construct the project. However, land lease for the project outlined in the Land Code dated 2 May 2001 is not in synch with this provision because there are not such time limits for the land lease.

[20] parliament.am/legislation.php?sel=show&ID=2119&lang=eng
[21] parliament.am/legislation.php?sel=show&ID=1310&lang

Energy Security Concept[22]

The Energy Security Concept of the Republic of Armenia was approved by the President in October 2013, outlining the main directions of energy security arrangements and stipulating the development of 2014-2020 Action Plan within a short period of time. The document mentions development of renewable energy sources and increasing energy efficiency as one of the directions of ensuring energy security in the country.

RA Energy Sector Long-Term (up to 2036) Development Concept[23]

Energy Sector Long-Term (up to 2036) Development Concept was developed and approved by the Government in December 2015 which is aimed to highlight midterm and long-term implementing measures towards the preservation and continuous enhancement of energy security and reliability in Armenia. According to it the main energy strategy pillars are:

- Development of Nuclear Energy
- Development of Renewable Energy, Energy Efficiency and Energy Saving Programs
- Regional Integration
- Diversification of Primary Energy Sources and Supply Routes

Energy debates

In Armenia, Japan's nuclear accident has raised a debate over the safety of Metsamor nuclear power station which is also situated on an earthquake-prone zone, and prompted the Armenian government to invite the IAEA inspection to the plant. Metsamor currently provides more than 40% of electricity in Armenia. The country suffered from severe electricity shortages during the time Metsamor was closed. Therefore, the nuclear plant is very important for Armenia in terms of energy production. Armenia plans to replace Metsamor with a new nuclear power plant at the same location. Since 2007, the EU provides assistance in nuclear safety through the Instrument for Nuclear Safety Co-operation (INSC), and the Armenian Ministry of Energy receives Commission assistance for the decommissioning of the ageing Medzamor nuclear plant. Projects range from "on-site assistance" – for example, making sure the plant operates safely until shutdown – to the development of alternatives to nuclear energy, such as hydro-electricity and gas.

6.3 Current situation with EE/RES

Armenia passed through an energy crisis in 1991-1995 in the result of its energy security loss what was the consequence of a conflict in the region and following economic and fuel blockade by Azerbaijan and Turkey, as well as low self-sufficiency by Armenia's own energy resources. This has caused an economic decline, environmental disruptions, and decrease of live quality. In order to overcome the created situation, the re-opening of the Armenian Nuclear Power Plant, which was decommissioned after the 1988 earthquake, was necessary.[24]

Generally, Armenia can meet only 35% of the total demand for energy with its domestic resources and it is thus highly dependent on imported energy resources. It produces, however, a significant share of about

[22] minenergy.am/en/en/2013-12-18-11-49-40
[23] minenergy.am/page/493
[24] lumes.lu.se/database/alumni/01.02/theses/hovhannisyan_karen.pdf

40% of the annual production of electricity from hydropower (2010). Energy efficiency within the Armenian economy is much lower than that of developed countries in the region. Therefore, in order to secure the sustainable development of Armenia, priority has to be given to the development of domestic energy resources and widespread implementation of energy efficiency throughout the economy. During last decades a number of studies, strategy papers and legal documents were adopted in Armenia to ensure sustainable development of the economy and energy sector based on increasing energy efficiency and renewables.[25]

Armenia's **Energy Law**, which was enacted in 1997 and revised by the National Assembly in 2001 states among others (Article 5) that the main principles of the state policy in the energy sector are:

- Efficient use of local energy resources and energy renewables and the application of relevant economic and legal measures for that purpose;
- Ensuring energy security;
- Promotion of the energy independence of the republic, including the diversification of local and imported energy resources and ensuring maximal use of capacities; and
- Ensuring environmental security.

Armenia's commitment to promote renewable resources relates to its need to diversify its energy resource base and reduce energy imports. The country has taken concrete steps to make renewable energy development part of its energy law and energy strategy. In 2004 legislation was passed on the Law of the Republic of Armenia on Energy Efficiency and Renewable Energy. The Public Services Regulatory Commission of Armenia has set high tariffs for newly constructed small hydro power plants operating on natural water flows and other renewables.

Law on Energy Efficiency and Renewable Energy was adopted on November 9, 2004. It was amended in 2011, and another round of amendment is currently underway. The objective of this law is identification of mechanisms of state policy principles for development of energy efficiency and renewable energy and the mechanisms of their implementation, targeted at:

- Strengthening the economic and energy independence of the RA,
- Raising the economic and energy safety, energy system reliability of the RA,
- Creation of new industries and organization of services to promote development of the energy efficiency and renewable energy.
- Decrease negative impact on environment and health of people.

Towards implementation of the provisions of the Law on Energy Efficiency and Renewable Energy, **Armenian Renewable Resources and Energy Efficiency Fund** was created in 2006 with a main mission to facilitate investments in energy efficiency and renewable energy and provide an array of comprehensive assistance to project developers, investors, banks, condominiums, researchers and other stakeholders. It provides professional expertise to the government in issues related to green energy development strategies and legislation. The Fund continuously analyses situation identifying barriers and proposing solutions to relevant government agencies. It also established financing mechanism through a revolving

[25] r2e2.am/wp-content/uploads/2011/07/National_Program_eng.pdf

lending tool, which finances energy efficiency and renewable energy projects through the banks and credit organizations.

National Programme on Energy Saving and Renewable Energy of the Republic of Armenia was developed in 2007 by the Research Institute of Energy within USAID funded project with the main aim of setting the targets for the energy saving and renewable energy development in the country and outlining mechanisms of its implementation.[26]

Renewable Energy Roadmap for Armenia was developed in 2011 by Danish Energy Management A/S within Global Environmental Facility (GEF) and World Bank (WB) funded project to identify the economically and financially viable potential of renewable energy (RE) in Armenia. It defines short (2013), mid-term (2015), and long-term (beyond 2020) targets for the development of RE as well as outlines specific steps towards achieving those targets. It includes milestones to allow regular tracking of progress towards the established goals.

According to the main results of the Armenian RE Roadmap project, the contribution of the renewable electricity in Armenia can increase by fivefold in 2020 in comparison to the present energy production from RE. In 2010, RE production generated 310 GWh, and it is forecasted to generate 740 GWh in 2015, and 1500 GWh in 2020. It is important to emphasize that the achievement of targets is much more dependent on politically implemented measures than on technical capabilities.

The findings of a comprehensive review of RE potential in Armenia have ranked electricity from small hydropower plants (SHPP, up to 10 MW) and solar hot water heaters as the most advanced renewable energy technologies (RET) and the most economical for Armenia in the short to medium-term, followed by grid connected wind farms and the use of heat pumps.

Photovoltaics, geothermal power, and biofuels, especially bioethanol from cellulosic feedstock, are ranked as more costly in today's prices and are not expected to be commercially viable in the short to medium-term, but may play a more important role in the longer term, and in the development of RE high-tech industry.

Biomass was also considered for both heat and electricity production for the short term, under several conditions, including replanting of harvested trees and biofuels using fractionation process. In addition, hydrogen was considered as a possible fuel for transportation in the longer term. Finally, although not strictly a renewable resource, municipal solid waste in landfills was considered a practical source for generating methane for power production near municipalities.[27]

The 2013 **National Energy Security Concept** outlines the governments' strategies for achieving energy security through fuel diversification, building up fuel reserves and reserve generation capacity. The Concept identifies the promotion, development and investment in renewable energy technologies as critical to Armenia diversifying its energy supply and achieving energy independence.

The **Armenian Development Strategy** (ADS) and **National Security Strategy** (NSS) also emphasize the importance of renewable energy and energy efficiency in addressing energy security. The ADS and the

[26] r2e2.am/wp-content/uploads/2011/07/National_Program_eng.pdf

[27] r2e2.am/wp-content/uploads/2012/07/Renewable-Energy-Roadmap-for-Armenia.pdf

NSS outline the GoA strategic objectives for economic growth, poverty reduction, and national security. Both policies highlight the fundamental importance of the energy sector in achieving these objectives.[28]

Energy Sector Long-Term (up to 2036) Development Concept approved by the Government in December 2015 includes Renewable Energy, Energy Efficiency and Energy Saving Programs as main directions of energy sector development in long-term perspective.

All these activities are indicative of prioritization of EE/RES issues in the country at the highest decision-making level. It is also to be mentioned that in May 2010 the government adopted a resolution on Science and Technology Development Priorities for 2010-2014 where Renewable Energy & New Energy Sources is one of the 6 priority fields.

Below is the brief description of the situation and development potential in separate RES sectors.

Hydropower

The hydro potential of Armenia has been evaluated to be about 21.8 billion kWh/year, including 18.6 billion kWh from large and medium rivers and 3.2 billion kWh from small rivers. According to the Renewable Energy Armenia webpage, the economically feasible hydropower potential is about 3.6 billion kWh, with 1.5 billion kWh already utilized. The remaining hydropower potential is to be developed during the next 15 years. As of 2013, there were 136 commercial size small hydropower plants (SHPP) operating in Armenia with a total capacity of 221 MW and annual generation of 665 GWh. About 60 of these have been developed and constructed in the past decade. Additionally, the PSRC has licensed the construction of 77 new projects, which could potentially add approximately 168 MW of SHPP capacity and 592 GWh of annual generation. There are also numerous small units that are operated by individuals to satisfy their own electrical needs.[29]

Wind

The average annual wind velocity in Armenia is distributed unevenly in the range of 1.0 to 8.0 meters per second. In some regions, particularly in the Ararat Valley, strong mountain valley winds are quite common. For instance, during the summer months the velocity of these winds often reaches 20 m/s or more. Despite a relatively attractive wind regime in many parts of the country, the only operational wind power facility in Armenia today is the 2.6 MW Lori-1 pilot wind power project comprised of four 660 kW Iranian-assembled Vestas wind turbines. A second, the Iran-Armenia Wind Farm, is under construction.

Biomass

Biomass energy in Armenia has the potential to provide significant power, if utilized. Armenia has reasonable areas of land covered by forests and lands for agricultural industry, including farming of plants and animals. These areas can potentially produce residues which could be used as fuel for biomass combustion or gasification, as well as biogas production through anaerobic digestion. Forest residues (slash from forest thinning or waste wood from sawmills) can provide a concentrated resource to be used as fuel for energy production. Agricultural residues can provide a range of residues, including crop

[28] Scaling Up Renewable Energy Program (2014) *Investment Plan for Armenia.* Available: climateinvestmentfunds.org/cif/sites/climateinvestmentfunds.org/files/Armenia%20SREP%20Investment%20Plan_final.pdf.

[29] armenianweekly.com/2013/07/25/electricity-production-in-armenia/

residues (corn stover, nutshells, fruit tree branches, etc.) and animal wastes. Lusakert Biogas Plant (LBP) is the first industrial size state of the art biogas plant based on organic wastes from animal farming constructed at 26 km distance from Yerevan under the loan from the Danish Industrialization Fund for Developing Countries. It can process up to 220 ton per day of liquid poultry manure coming from nearby Lusakert Pedigree Poultry Plant.

Solar

Armenia is rich in solar energy resources, the utilization of which will reduce the need for imports of other energy sources. The average annual solar radiation is approximately 1,720 kWh/m2 compared to the average annual European solar radiation of 1,000 kWh/m2. Over a quarter of the territory of the country has solar resources with an intensity of 1,850 kWh/m2.

Solar PV deployment in Armenia to date has been limited to relatively small-scale rooftop-based installations at schools, hospitals, office buildings and municipal sites throughout Armenia. It is estimated that less than 100 kW of solar PV is currently operational.

Geothermal

Armenia has no installed geothermal power plants, but comprehensive geo-technical studies suggest that geothermal resources suitable for power production may exist at a number of sites, including the most promising Karkar, Jermaghbyur, and Grizor sites, as well as along the Armenian-Georgian border. In 2009-2011, comprehensive surface investigation works were conducted for Karkar site. Results of the above studies indicate that a geothermal resource exists at the site, and can only be confirmed through exploratory drilling. The key conclusions and recommendations of those studies were also reviewed by a third party – Iceland Geosurvey (ISOR), which confirmed the robustness of the methodology for the above studies and the key conclusion that exploratory drilling is needed to confirm the resource and its characteristics. The World Bank/ESMAP Global Geothermal Development Plan TA Program supported the Government to prepare a drilling program for Karkar site, including test well options, drilling and associated consulting services required, contracting arrangements, and costs.

The total geothermal resource potential of three geothermal sites that were explored to some extend has been estimated to be at least 150 MW. However, it is important to note that because of the limited exploratory activities and information about Armenia's geothermal resources, this is a very rough estimate, which relates only to three potential sites for which information was available, and the actual geothermal resource potential could be much larger.

Energy Efficiency

The need to promote EE in Armenia is going to increase due to the fact that the upcoming decommissioning of the nuclear power plant requires the country to develop RE. Additionally, Armenia has been associated to the Copenhagen Accords under UNFCCC, and has committed in increasing energy production based on RE sources and improving EE in all sectors of the economy, including buildings and construction. Better use of the potential of EE will limit the dependency of the country on imported fuel and will significantly contribute to energy security of the country.

According to the National Program on Energy Saving and Renewable Energy (ESRE), the potential for energy efficiency (EE) savings in Armenia is large, including 40% in building sector, 35-40% in food industry, while optimization of lighting was estimated to save 475 million kWh over the next 10 years.

Under the project financed through the Asian Development Bank loan (2013) it is planned to rehabilitate and upgrade four of seven HPPs in Sevan-Hrazdan Cascade Hydropower System, rehabilitation of water outflow canals in three plants and replacement of electrical equipment in the plants respectively.

Under the Power Transmission Rehabilitation Project (2012) financed by the Asian Development Bank loan it is intended improving the efficiency and power supply reliability of power system of Armenia. The project includes two major components: extension of dispatching control and data collection system (SCADA), and rehabilitation of eight existing 220 kV substations with respective replacement of aged transformers, circuit breakers and other equipment.

6.4 Innovation situation in the energy sector

In the 1950-80s, the powerful scientific-technical and industrial potential was established and functioned in Armenia practically in all basic industrial branches of the former Soviet Union: chemistry and chemical technologies, electrical engineering, radio electronics, machine-tool industry, instrumentation technologies, construction industry, textile industry, and also rock mining industry and metallurgy. By its production volumes, assortment and extensive cooperation networks Armenia was among the four most industrial republics of the former Soviet Union.

After the collapse of the Soviet Union as a common economic area, transport blockade and energy crisis, the basic components of Armenian industry have been destroyed except for a few factories of chemical profile, mining and processing industry, electrical engineering and construction industry (cement plants, natural stone, copper and molybdenum mining, and ferroconcrete structures manufacturing, etc.).[30]

After several years of double-digit economic growth, Armenia faced a severe economic recession with GDP declining more than 14% in 2009, despite large loans from multilateral institutions. Sharp declines in the construction sector and workers' remittances, particularly from Russia, led the downturn. The economy began to recover in 2010 with 2.1% growth, and picked up to 4.6% growth in 2011, before slowing to 3.8% in 2012. Under the old Soviet central planning system, Armenia developed a modern industrial sector, supplying machine tools, textiles, and other manufactured goods to sister republics, in exchange for raw materials and energy. Armenia has since switched to small-scale agriculture and away from the large agroindustrial complexes of the Soviet era. Armenia's geographic isolation, a narrow export base, and pervasive monopolies in important business sectors have made it particularly vulnerable to the sharp deterioration in the global economy and the economic downturn in Russia. Armenia has only two open trade borders - Iran and Georgia - because its borders with Azerbaijan and Turkey have been closed since 1991 and 1993, respectively, as a result of ongoing conflict of Azerbaijan with Armenian populated Nagorno-Karabakh region. Armenia is particularly dependent on Russian commercial and governmental support and most key Armenian infrastructure is Russian-owned and/or managed, especially in the energy sector. The electricity distribution system was privatized in 2002 and bought by Russia's RAO-UES in 2005. Natural gas is primarily imported from Russia but construction of a pipeline to deliver natural gas from Iran to Armenia was completed in December 2008, and gas deliveries expanded after the April 2010 completion of the Yerevan Thermal Power Plant. Armenia's severe trade imbalance has been offset somewhat by international aid, remittances from Armenians working abroad, and foreign direct investment. Armenia joined the WTO in January 2003. The government made some improvements in tax and customs administration in recent years, but anti-corruption measures have been ineffective and the economic downturn has led to a sharp drop in tax revenue and forced the government to accept

[30] reegle.info/countries/armenia-energy-profile/AM

large loan packages from Russia, the IMF, and other international financial institutions. Armenia will need to pursue additional economic reforms and to strengthen the rule of law in order to regain economic growth and improve economic competitiveness and employment opportunities, especially given its economic isolation from two of its nearest neighbors, Turkey and Azerbaijan.[31]

Armenia has a very liberal economy. According to the Heritage Foundation Index of Economic Freedom, Armenia's economic freedom score is 67.1, which ranks it 52nd in the 2015 index. Compared to the 43 countries in the European region, Armenia is ranked 23rd, putting its score above the world and the regional averages. Its overall score has declined by1.8 points from last year, reflecting considerable deterioration in property rights, labor freedom, and monetary freedom.[32] According to the World Bank, Armenia is ranked 45th out of 189 economies in Doing Business 2015. The Doing Business indicator sheds light on how easy or difficult it is for a local entrepreneur to open or run a small to medium-size business when complying with relevant regulations.

The 2015 Global Innovation index ranks Armenia 61sth among 141 countries.[33]

Innovation infrastructure is among the least competitive dimension of Armenia's overall competitiveness performance. According to the World Economic Forum *Global Competitiveness Report 2013-2014* Armenia ranks above 100th place among 148 economies in terms of quality of research institutes (106), company spending on R&D (109), university industry collaboration in R&D (107) and government procurement of advanced technology products (111).

By government resolution as of September 2006, the Ministry of Economy was recognized as authorized body responsible for development and implementation of innovation policy, in co-operation and coordination with other concerned ministries and organizations. On 17 February, 2011, RA Government approved the Concept Paper on the Initial Strategy of the Formation of Innovation Economy which is based upon the projects implemented by the Ministry of Economy of RA directed to the development of the sphere, as well as legal, business, educational, financial and innovation infrastructure building measures aimed at developing the national innovation system.

"National Center of Innovation and Entrepreneurship" (NCIE) among the operating organizations in the system of the Ministry of Economics plays an important role in the formation of an innovative policy of economy of the Republic. The NCIE realizes the incubation process of innovative ideas development, supporting to the realization of necessary preparatory works for their commercialization, also provides scientific-technical information and library services.[34]

The Ministry of Education and Science of RA elaborates and implements the policies of the Republic of Armenia Government in the education and science sectors.[35] To improve the policy-making and better coordination in the field of S&T, in October 2007 the government made a decision on creation of the State Committee of Science empowered to carry out integrated S&T policy in the country. This structure is subordinated to the Ministry of Education and Science, but with wider power of independent activity.[36]

In May 2010, the Government adopted the Strategy on Development of Science in Armenia, which outlined the state policy towards development of science in 2011-2020.

[31] cia.gov/library/publications/the-world-factbook/geos/am.html
[32] heritage.org/index/country/armenia
[33] globalinnovationindex.org/content.aspx?page=GII-Home
[34] mineconomy.am
[35] edu.am
[36] scs.am/eng.php

Based on this strategy, the Action Plan 2011-2015 was approved by the government in 2011 on the development of science in Armenia which incorporates the following targets for the stated period as follows:

- Improving the S&T management system and ensuring adequate conditions for the sustainable development;
- Measures on increasing the number of young and talented specialist involved in research, education and technological development, upgrading of research infrastructure;
- Creating adequate conditions for the development of integrated science, technology and innovation system
- Developing international cooperation in RTD.

One of the main positive aspects in the latest adopted policy documents is the existence of quantitative targets to measure the success of implementation of envisaged measures.

In December 2014, the Government approved new science and technology development priorities for 2015-2019 which are stated to be:

- Armenian Studies
- Life Sciences
- Secure and Efficient Energy
- Key Enabling Technologies, Information and Communication Technologies
- Space, Earth Sciences, Sustainable Use of Natural Resources
- Basic Researches for Key Problems of Scientific and Socio-Economic Development [37]

The total number of Government's Resolutions approved during 2008-2014 and concerned to R&D is about 20.

The National Academy of Sciences of Armenia (NAS RA) with affiliated around 35 research institutes and centers, and around 2000 research staff remains to be main R&D performing organization in Armenia. The Academy promotes and carries out fundamental and applied research in different scientific fields, as well as coordinates basic research carried out throughout Armenia.

The new Statute of the National Academy of Sciences of Armenia was approved by the government in May 2011, based on the Law on the National Academy of Sciences of Armenia, allowing the Academy to carry out wider business activities towards commercialization of R&D outcomes and creation of spin-offs. Decision was made on optimization of the NAS structure and creation of scientific/technological/production centers through amalgamation of institutes involved in close research activities to promote innovation.

In 2007, Science Development Foundation was created within the NAS RA with the main objectives:

- Supporting research projects with innovative potential;
- Supporting commercialization of research outcomes
- Supporting infrastructure modernization projects

In total there are around 90 research institutes in Armenia subordinated to the Academy and various ministries.

The higher education system in Armenia consists of 22 public institutions of higher education (IHEs) and over 70 private IHEs. From 2000 on, the system of higher education in the country started to reform itself along the lines of the European models as per the Bologna agreement. Unfortunately, there are no statistical data on the dynamics of R&D intensity in the university sector to analyze trends during recent years. However, based on general observations and personal interviews, it can be stated that university R&D, particularly in leading state universities, is increasing. The universities are more flexible in redirecting revenues from tuition fees to modernization of research laboratories and funding research activities.

Dramatic downsizing of R&D intensity, starting from the early-1990s after the collapse of the former Soviet Union, mostly affected branch and enterprise research institutes, which were mostly involved in applied research and were subordinated to local or Moscow-based industries or ministries. The vast majority of these enterprises have been privatized during last decades, and stopped or reoriented their activities by shutting down RTD divisions.

[37] scs.am/

There are also a number of small enterprises involved in innovative R&D and high-tech production activities. Such enterprises could play an essential role in economic development of the country, but they face a number of problems, such as: 1) shortage of qualified specialists in the field of technology transfer, commercialization, and management, and lack of innovation support intermediary organizations; 2) low awareness in intellectual property related issues among businessmen involved in technological development; 3) lack of financial institutes and venture capital funds providing loans on acceptable conditions.[38]

The Ministry of Energy and Natural Resources of RA is the highest executive authority to elaborate and implement the policies in the energy sector. The Ministry includes in its structure the Research Institute of Energy with the main activity directions to be as follows:

- Research and development in power engineering,
- Design Engineering,
- Design of occupational safety laboratories,
- Development projects on operation of power systems,
- Development of optimization methods for power network and energy system operation,
- Development of power supply plans,
- Energy loss calculation in power networks,
- Energy saving projects,
- Forecast services for power engineering development of Armenia,
- Preparation of standard documents in power engineering,
- Research in power engineering,
- Research in renewable energy.

By the decision of the government, Armenian Renewable Resources and Energy Efficiency Fund was created in 2006 with a main mission to facilitate investments in energy efficiency and renewable energy and provide an array of comprehensive assistance to project developers, investors, banks, condominiums, researchers and other stakeholders.

During last years the Armenian Government adopted several conceptual and legislative documents directed to creation of the innovation system, though these measures can be considered as initial steps towards the development of a legislative framework and improvement of the information support and institutional basis of the innovation system. The issues of effective management of innovative resources, modernization of S&T basis, introduction of incentives for innovative companies, and attraction of private investments need to be still addressed adequately. The adopted legislative measures need to be supported by adequate concrete actions and programmes directed towards forming the national innovation system. Up until recently they had more of a declarative and fragmented character and were not supported by adequate financial commitments and tailor-made decisive actions consistent with general economic development trends.

[38] INNO-Policy TrendChart - Policy Trends and Appraisal Report, Armenia, EC

It is to be mentioned that R&D intensity (GERD/GDP ratio) has decreased dramatically in Armenia since the collapse of the former Soviet Union, dropping from 2.5% in 1990 to around 0.27% in 2014. This decline is reflected also in the number of researchers and research institutes, which decreased nearly four-fold and two-fold, respectively. Though, while speaking about last years it can be mentioned that some stabilization and diversification of R&D funding has taken place via implementation of the following national funding mechanisms, implemented via State Committee of Science:

- Basic funding
- Thematic (project based) funding
- Goal oriented project funding

Among recent initiatives to promote research-industry cooperation, it could be mentioned a new funding programme for research projects, launched by the SCS RA in 2011, with a requirement for research institutes to build partnership with an industrial enterprise in a project proposal and 15% co-funding by this industry partner. In 2015, the industrial partner co-funding was increased up to 25%.

New Young Researchers Support and Infrastructure Programmes have also been launched recently which reflect the positive tendencies in S&T and Innovation system.

Unfortunately, no statistics is available on business expenditure on R&D in Armenia, though from personal considerations and various reports it can be estimated to be very low and insignificant.

There are no specific progrmmes focusing only on energy sector, but all these programmes are open for energy research as well, including RES. Screening of funded national research projects for 2010-2013 showed that there have been very few projects in energy field which is indicative that prioritization of RES as research topic doesn't imply any specific support mechanism.

Amongst other government initiatives towards creating favorable business environment it can be mentioned establishment of the Small and Medium Entrepreneurship Development National Centre of Armenia (SME DNC of Armenia) in 2002. The SME DNC of Armenia was the first national body created to implement state support to small and medium-sized enterprises (SME) and programs directed towards the development of the sphere, as well as to facilitate links between SMEs and other state support organizations. The main goals of the SME DNC are as follows:

- Providing support to start-up and operating SMEs
- Increasing the efficiency and competitiveness of SMEs
- Expanding the financing opportunities for SMEs
- Promoting innovations and support to new technologies introduction
- Encouraging external economic activities of SMEs

SME DNC of Armenia provides support to SMEs through the following programs: 1) Loan guarantees provision; 2) Partial subsidizing of credit interest rates; 3) Information and consulting support; 4) Goods and services market promotion; 5) Start-up business support; and 6) Program for implementation of R&D activities for introducing innovations, new technologies and products.

As a private initiative, it can be mentioned the establishment of Viasphere Technopark, a state-of-the-art technology park, operating in Yerevan since 2001. It provides infrastructure to technology companies worldwide looking to extend their core development offshore. Viasphere Technopark is currently hosting

several successful US-based subsidiaries developing advanced software in a variety of fields. In Armenia, Viasphere Technopark interacts with technical universities and institutes in areas of advanced research.[39]

The shortage of intermediary organizations - such as technology transfer centers, business incubators and technoparks aiming to bridge public RTD and business communities as well as support knowledge commercialization activities - is one of the major bottlenecks of the Armenian innovation system. The existing scientific system of Armenia does not encourage scientific research outcomes to be utilized. Some technology assessment and offer development activities are carried out by NAS RA and SME DNC. Starting January 2015 NAS RA and SME DNC joined the European Enterprise Network (EEN) as EEN Business Cooperation Centers providing innovation, technology transfer and business support to all SMEs in Armenia. A few technoparks have been created and decisions have been adopted to create further ones during recent years under state or private initiatives, which mainly provide infrastructure for start - ups and do not focus on support to commercialization of R&D outcomes.

A number of civil society organizations, including non-governmental organizations and various associations, try to get involved and influence innovation policy development activities. Amongst the most active ones it can be mentioned the Union of Manufacturers and Businessmen (Employers) of Armenia, whose mission is to represent and protect the collective interests of businessmen, and improve the business and legal environment in the country.

The Intellectual Property Agency of the Republic of Armenia was established in 2002 through the merger of the Patent Office and the National Copyright Agency. Currently, intellectual property related matters in Armenia are regulated by the Civil Code, law on copyright and neighboring rights, law on patents, law on trademarks, service marks and appellations of origin, law on protection of topographies of integrated circuits, law on protection of the economic competition as well as by a number of international treaties. Armenian legislation on intellectual property has been harmonized with the requirements of the Agreements on Trade Related Aspects of Intellectual Property Rights (TRIPS Agreements). Since 2003, Armenia is a member of the World Trade Organization (WTO).

A further instrument to support innovation in a broader sense is the approach of Free Economic Zones (FEZ). The overall aims of the FEZ is the promotion of foreign investments, the development of new and advanced technologies, the increase of exports from Armenia, and the generation of employment and economic growth. Armenia's first FEZ opened in July 2013 based in the Yerevan Computer Research and Development Institute (YCRDI) and the Mars motors manufacturing company. The FEZ is an example of a combined approach of supporting inward-investment, export-orientation and high-tech development. A special technological focus of FEZ Mars and YCRDI is on R&D and innovation in the fields of electronics, precision engineering, pharmaceutics and biotechnology, ICT, alternative energy, industrial design, and telecommunications. "One-stop-shop" services are offered to all zone residents who can enjoy tax benefits, exemption from import and export duties, profit tax, property tax, etc. As far as this is a relatively new approach in Armenia, it would be difficult to assess the economic effects of this initiative.

Granatus Ventures (GV), the first venture capital fund in Armenia, was launched in 2013. It is focused on investing in and helping start-ups achieve success by leveraging international value chains, the Armenian diaspora, and a global network of advisors, mentors, and partners.

All these innovation support initiatives and structures are also not energy specific but surely cover energy, and in particular, EE/RES priorities as well.

All the policy and strategy documents adopted during last decades directed to the regulation and the development of S&T and Innovation in Armenia, stress the importance of the development of international cooperation in the field of sciences and technology, and better positioning of the country in the international research and development environment.

[39] viasphere.com/technopark/tenants.htm

In particular, the Law on Scientific and Technological Activity, the Strategy on Development of Science and Action Plan 2011-2015 on the development of science in Armenia include the development of international cooperation in RTD as one of main challenges.

According to FP7 statistics, a total of 146 eligible proposals were submitted in response to 381 EU FP7 calls for proposals involving 159 applicants from Armenia. A total of 45 proposals were retained for funding from Armenia requesting EUR 3,2 million EC financial contribution. None of these projects were in the field of energy. Within FP7 Research to Innovation call for proposals another project focusing on energy efficiency was retained for funding (INNOVER-EAST: Building a more effective pathway leading from research to innovation through cooperation between the European Union and Eastern Partnership countries in the field of energy efficiency) where Science Development Foundation of NAS RA is a partner from Armenia. Surely, there are good opportunities for synergy and cooperation between ENER2I and INNOVAR-EAST Projects.

During the last decade a number of EE/RES oriented projects have been implemented in the country by various stakeholders in partnership with international organizations. Below are brief descriptions of such projects:

The Renewable Energy Project (REP), bearing TF-053910 index of Global Environmental Facility (GEF) and World Bank (WB), started in 2007 by Renewable Resources and Energy Efficiency Fund. REP consisted of two main components – credit and grant components. REP financial funds were provided for supporting the construction of Small scale Hydro Power Plants (SHPP-s) in Armenia. The total REP credit package made about USD 15 mln. of which WB portion made USD5 mln. Another USD 3 mln. amount made the portion of Gafeschyan Family Fund (USA) and USD 7 mln. was the portion of EBRD. At the expense of these funds 26 SHPP construction projects have been carried out with 43 MW total capacity and about 160 thousand kWh annual production. Already 12 power plants out of the mentioned are in operation at present and the rest are in construction and licensing stages. The successful implementation of REP credit component set a good example for the start of several similar projects in Armenia: Armenian-German Fund, ArmCEEF European Project, IFC Project and etc., studies of fundamental importance in RE sector, studies on resources, evaluation of various RE technology potentials and perspective availability, etc. Upon the start of the works about 20 separate expensive international projects and special studies have been implemented within the frame of REP for most various directions of renewable energy (RE) in Armenia. Around 124 leading experts, of which 105 local and 19 foreign experts (from USA, Denmark, Switzerland, Sweden, Russia) have participated in these works. The conducted studies include such RE sectors like: SHPP-s, solar photovoltaic energy, bio-ethanol production, geothermal energy, development of norms and standards for some technologies of this sector, development of RE geographical-informative system, assessment of peak electricity potential and hydro-accumulative station perspective availability for Armenian and regional markets, etc. The following studies implemented within REP framework were of special applicative importance, such as: development of the microprocessor-based relay protection system for energy absorption increase from RE sources, development of its estimated methodology and norms/standards (Project "Support to energy system regulation and protection in Armenia for energy absorption from RE sources"), as well as development of the Project for Emergency systemic automatics securing the safety of RE stations and reliability and efficiency of the works in the Armenian 2010-2016 energy system.[40]

Armenia Renewable Resources and Energy Efficiency Fund started the WB supported Energy Efficiency Project since August 10, 2012, the objective of which is reducing energy consumption in public and municipal buildings and in street lighting systems. Within the project energy saving measures have been

[40] r2e2.am/en/2011/06/potential-by-regions/

implemented in schools and other educational institutions, kindergartens, hospitals, administrative, cultural and residential buildings.

The Fund is involved in BSBEEP-Black See Buildings Energy Efficiency Plan Project (2013-2015) within EU funded Black See Joint Operation Programme with overall objective to strengthen the administrative capacity of local authorities and exchange good practice knowledge in energy efficiency in buildings.[41]

The European Bank for Reconstruction and Development (EBRD) initiated Armenian Sustainable Energy Financing Facility (ArmSEFF) project to assist in realization of renewable energy project ideas. This credit line is meant for Armenian private businesses of all scale and sectors as well as individuals who intend to invest in EE/RE projects.[42]

Since November 2010, a four-year East-Invest project has been under implementation which is a regional investment and trade facilitation project for the economic development of the Eastern Neighborhood region, launched in the framework of the European Eastern Partnership initiative. It targets Business support organizations and SMEs from the 6 Eastern Partnership countries (Armenia, Azerbaijan, Belarus, Georgia, Republic of Moldova, Ukraine), who have potential for developing mutual cooperation and investment relations with the European Union. One of six thematic focuses of the initiative is the alternative energy. Its main objectives are:

- To promote and facilitate investment and economic cooperation at large between the EU and Eastern Partnership countries, and also between the 6 target countries.
- To create the "East Alliance", mobilizing business organizations from both sides to engage in a sustainable partnership and dialogue both within the private sector and towards the public authorities.
- To develop concrete activities that will generate immediate results for SMEs in the region.[43]

The Institute of Geological Sciences of NAS RA is a partner in "CO2 Capture and Storage" Caucas-CCS Project together with Karlsruhe Institute of Technology (Germany) and Tbilisi State University (Georgia) which started in 2012. The project was funded within FP7 BS-ERA Net Project Pilot Joint Call for proposals.

UNDP is supporting the Ministry of Nature Protection in preparation of the National Communications under UN Framework Convention on Climate Change including the development and publication of Greenhouse gases inventory of Armenia, which is essential for assessment of mitigation potential and attraction of foreign investments and technology transfer in energy sector. UNDP supported Ministry in calculation and publishing the national electrical grid emission factor for 2009, 2010, 2011, 2012, which is important data for Clean Development Mechanism Projects under implementation in Armenia (3 small hydroelectric plants, biogas plant, and landfill gas)[44].

UNDP assisted Ministry of Energy and Natural Resources in assessment of national needs and gaps under "Sustainable Energy for All" Initiative of UN Secretary General thus allowing Armenia to join this Initiative among other 58 countries before Rio+20 Summit.

[41] bsbeep.com/activities/ga-2/
[42] armseff.org/
[43] east-invest.eu/en/about-east-invest

[44] nature-ic.am

Starting from 2005 UNDP is assisting Ministry of Nature Protection in implementation of three large scale projects with Global Environment Facility funding (USD 5,75 mil.) aimed at promotion of energy efficiency in heating, building and lighting sectors. More than 12 million direct foreign investments were attracted in the energy efficiency projects initiated so far.

Starting from 2010 under coordination of the RA Ministry of Nature Protection and RA Ministry of Urban Development the GEF financed "Improving Energy Efficiency in Buildings" Project. Project has supported Armenia in development and promotion of the energy efficient building technologies, building materials and construction practices. The support being provided by the project aims at development of new regulations (EE building codes and standards) the training of professionals, demonstration of integrated building design approach and stimulating manufacturing of new EE materials and equipment.

Benefits of energy efficient design were demonstrated on the example of 3 pilot buildings. Energy efficiency and building thermal physics laboratories were established in Armenia as well as support was provided for testing and certification of the locally produced insulation materials.

The UNDP-GEF "Green Urban Lighting Project" started in 2014 is aimed on state of art technology transfer to Armenian municipalities and demonstrating benefits of modern illumination technologies and contributing to the reduction of municipal energy costs related to street lighting. UNDP in cooperation with other donors assisted the **Energy Strategy Center** of the Research Institute of Energy in organization of International Conferences on Renewable Energy and Energy Efficiency. Starting from 2002 five conferences were organized and the last one organized in October 2013. The Conferences provide opportunity to scientists, business and policy makers to exchange opinions and present developments in the sector. The Proceedings of the Conferences were published.

Several EE/RES projects have been implemented through EU funded INOGATE Programme – an international energy cooperation programme between the EU and partner countries of Eastern Europe, the Caucasus and Central Asia. The partners involved agreed to work together toward achieving the following four major objectives:

1. Converging energy markets on the basis of the principles of the EU internal energy market taking into account the particularities of the involved countries
2. Enhancing energy security by addressing the issues of energy exports/imports, supply diversification, energy transit and energy demand
3. Supporting sustainable energy development, including the development of energy efficiency, renewable energy and demand side management
4. Attracting investment towards energy projects of common and regional interest.

Below is the list of INOGATE Projects implemented during the last years with Armenian participation:

Project Title	Project Period	Energy Theme	Countries
Energy Saving Initiative in the Building Sector in the Eastern European and Central Asian Countries (ESIB)	01/01/2010 - 01/02/2014	Renewable Energy, Sustainable Energy Development, Investment Attraction	Armenia, Azerbaijan, Belarus, Georgia, Kazakhstan, Kyrgyzstan, Moldova, Tajikistan, Turkmenistan, Ukraine, Uzbekistan

Supporting Participation of Eastern European and Central Asian Cities in the 'Covenant of Mayors'	20/09/2011 - 20/07/2015	Energy Efficiency, Renewable Energy	Armenia, Azerbaijan, Belarus, Georgia, Kazakhstan, Kyrgyzstan, Moldova, Russian Federation, Tajikistan, Turkmenistan, Ukraine, Uzbekistan
INOGATE Technical Secretariat and integrated programme in support of the Baku Initiative and the Eastern Partnership energy objectives	01/02/2012 - 31/01/2015	Oil, Gas, Electricity, Energy Efficiency, Renewable Energy, Climate Change, Convergence of Energy Markets, Energy Security, Sustainable Energy Development, Investment Attraction	Armenia, Azerbaijan, Belarus, Georgia, Kazakhstan, Kyrgyzstan, Moldova, Tajikistan, Turkmenistan, Ukraine, Uzbekistan

Table 1. INOGATE Projects

*Source: **inogate.org***

Generally, lack of financial resources restricts mobility programmes for Armenian researchers, as well as the attraction of foreign scientists. Weak infrastructure is another major barrier, both from the point of view of up-to-date research equipment, and housing and working conditions for researchers from abroad. Many Armenian researchers and innovators have also emigrated, attracted by access to modern infrastructure and higher salaries. While this weakens the innovative capacities in the country, it also creates opportunities for cooperation between the scientific diaspora and researchers in Armenia. Language is to some extent still a barrier, but the younger generation possesses the required language skills for international cooperation.

6.5 Overview of critical stakeholders

The **Ministry of Energy and Natural Resources of RA** is the highest executive authority to elaborate and implement the policies in the energy sector including system planning and investment planning for state-owned entities. The Ministry objectives include also provision of energy efficiency and renewable energy sector policy development and implementation, provision of the state policy of state technical control in the power sector and energy consumption, conducting supporting research, and obtaining and facilitating support from international organizations. minenergy.am

The **Public Services Regulatory Commission (PSRC)** performs regulatory operations in energy, water and telecommunication sectors, including:

- Regulating tariffs, service quality and licensing
- Overseeing compliance with licensee obligations
- Mediating disputes between licensees and customers
- Defining electricity market rules
- Setting, monitoring and enforcing service quality standards

(psrc.am/am)

The **Ministry of Nature Protection of RA** is the highest executive authority for coordination of implementation of the activities aimed at meeting the commitments of the Republic of Armenia under UN Framework Convention on Climate Change.

As a Non-Annex I party to the UNFCCC Armenia does not have quantitative commitments for reducing GHG emissions. However, being a party to the convention and supporting its objectives, as well as taking into account that the mitigation activities are in line with the economic, energy and environmental objectives of the country, Armenia has declared willingness to take certain quantitative limitations in greenhouse gas emissions by consistently reducing energy intensiveness of its GDP in case adequate financial and technical assistance will be provided under Convention mechanisms. mnp.am

The **Armenian Renewable Resources and Energy Efficiency Fund** was created in 2006 with a main mission to facilitate investments in energy efficiency and renewable energy and provide an array of comprehensive assistance to project developers, investors, banks, condominiums, researchers and other stakeholders. r2e2.am/enversion

The Ministry of Energy and Natural Resources includes in its structure the **Research Institute of Energy** with the main mission carrying out applied and analytical studies. The **Energy Strategy Center within the Institute** aims to promote and expedite the implementation of projects and activities in the energy sector. Areas of expertise: Advice on specific energy issues, energy auditing, promotion of technology, dissemination of information, implementation of RES projects, consulting, support in project implementation for energy efficiency, CHP, small wind farms, solar energy, biomass. energinst.am/eng/enrazkentr.htm

The **National Academy of Sciences of Armenia** (NAS RA) with affiliated around 35 research institutes and centers is the main R&D performing organization in Armenia. The Academy promotes and carries out fundamental and applied research in different scientific fields, as well as coordinates basic research carried out throughout Armenia. Renewable and alternative energy related research is being carried out in several research institutes of the NAS RA. sci.am

Energy related research is being carried out in some departments and laboratories of **Yerevan State University** (Department of Physics of Semiconductors and Research Center of Semiconductor Devices and Nanotechnologies), **State Engineering University of Armenia**, **American University of Armenia**, and **Armenian-Russian (Slavonic) University.**

The **National Competitiveness Foundation of Armenia** is a public-private partnership (drawing on international business executives of Armenian descent) with the objective to attract FDI supporting economic development and international competitiveness. cf.am/eng/index.php

The main mission of the **Chamber of Commerce and Industry of Armenia** is the activities towards improving general business environment, promotion of export and investments, as well as competitive product manufacturing, and support to SMEs. armcci.am/

The activities of the **Union of Manufacturers and Businessmen (Employers)** of Armenia are directed to promotion of the private sector, creation of favourable conditions for business development, and support to creation of market infrastructures. umba.info.am/

Republican Union of Employers of Armenia is another business support non-governmental organization aiming at improving the business environment and advocacy of business community. employers.am/

Armenian Development Agency (ADA) acts as "one-stop-shop" agency for investors assisting them in setting up their business in Armenia, helping in project implementation, performing a liaison role with the Government, providing information on investment opportunities in the country, as well as investment related regulations and laws. In its export promotion activities, ADA helps to find markets for products, undertakes market studies and seeks out partners for joint ventures aimed at increasing the volume of exports and development of Armenian enterprises. ada.am/

Small and Medium Entrepreneurship Development National Centre of Armenia (SME DNC) provides support to SMEs through the following programs: 1) Loan guarantees provision; 2) Partial subsidizing of credit interest rates; 3) Information and consulting support; 4) Goods and services market promotion; 5) Start-up business support; and 6) Program for implementation of R&D activities for introducing innovations, new technologies and products. smednc.am/

Engineering Academy of Armenia (EAA) was established in 1992 and is a non-governmental organization with a main mission to promote research and innovation in applied science fields including energy. eaa.academy.am

ECOATOM LLC is a company created in 1991 involved in research and development of industrial technologies in various fields, including renewable energy sources, hydrometallurgy, processing of nuclear wastes and the recycling of industrial wastes.

CONTACT-A LLC is a private renewable energy company, established in 1993 on a basis of former Yerevan Solar Institute having experience in research, development and implementation of various photovoltaic (PV) cells, modules, and systems for autonomous and grid connected applications as well as in manufacturing of solar collectors and implementation of solar water heating systems. contact-a.am/index.html

BARVA Innovation Center was established in 2005 specializing in R&D and manufacturing of various high-tech innovative products for different industry sectors, including agriculture, energy, utilities, etc. The Center is involved in R&D and manufacturing of renewable energy systems such as biomass briquetting equipment (straw, cane, wood chips, etc.), high efficiency biomass boilers, mini thermal co-generation power plants on syngas from biomass, parabolic trough concentrated solar power systems for waste heat applications and generation of electricity and heat. barva.am/

Transistor Plus Ltd, an engineering company involved in clean energy technologies. It carries out design, installation and maintenance of renewable energy systems including bioenergy, solar thermal and PV. It also manufactures components for solar energy systems (PV modules, DC to AC power inverters, solar tracking systems, UPS).

Viasphere Technopark is a state of the art commercial technology park in Yerevan, providing infrastructure to local start-ups and companies worldwide looking to extend their core development

offshore. In addition to providing a vital bridge to Silicon Valley, USA, Viasphere Technopark provides the facilities, infrastructure and support services to companies for cost effective speed-to-market and scalability.

6.6 Analysis

Armenia has adopted a policy of sustainable economic development, which assumes harmonized growth for each branch of the economy. Under these conditions, the energy sector is the most important sector for growth of the society as its qualitative and quantitative development determines the degree of Armenia's level of development and wellbeing of citizens.

Armenia can meet only 35% of the total demand for energy with its domestic resources, thus it is highly dependent on imported energy resources. In addition, energy efficiency within the Armenian economy is much lower than that of developed countries. Therefore, in order to secure the sustainable development, priority must be given to the development of domestic energy resources and widespread implementation of energy efficiency throughout the economy.

Under these circumstances, the government's strong interest in developing renewable sources of energy is natural. Renewable energy cannot completely substitute for the contributions of nuclear and thermal energy, but they can be an increasingly important component of the electricity mix. As such the Law on Renewable Energy and Energy Efficiency established a legal framework to facilitate development of RES, and specified that all renewable energy produced is to be purchased by the electricity distribution company. The regulator for the power industry, the Public Service Regulatory Committee (PSRC) has set attractive tariffs for newly constructed SHPPs, and wind and biomass plants, and has stipulated that the electricity off-take and these tariff rates will apply for 15 years from the date of issue of an operating license for a new plant.

Armenia has renewable energy resources that can already compete with conventional resources in the generation of electricity. Most of the viable projects implemented so far are in small hydropower sub-sector. As of 2013, there were 136 commercial size small hydropower plants (SHPP) operating in Armenia with a total capacity of 221 MW and annual generation of 665 GWh. About 60 of these have been developed and constructed in the past decade. Additionally, the PSRC has licensed the construction of 77 new projects, which could potentially add approximately 168 MW of SHPP capacity and 592 GWh of annual generation.

Despite a relatively attractive wind regime in many parts of the country, the only operational wind power facility in Armenia today is the 2.6 MW Lori-1 pilot wind power project comprised of four 660 kW Iranian-assembled Vestas wind turbines. A second, the Iran-Armenia Wind Farm, is under construction. The national target for wind power is 500MW of grid connected capacity by 2025.

Lusakert Biogas Plant (LBP) is the first industrial size state of the art biogas plant based on organic wastes from animal farming constructed at 26 km distance from Yerevan under the loan from the Danish Industrialization Fund for Developing Countries. It can process up to 220 ton per day of liquid poultry manure coming from nearby Lusakert Pedigree Poultry Plant. Total energy production can amount for up to 14 GWh per year. It is one of few projects in Armenia formally certified by UNFCCC under the Clean Development Mechanism (CDM).[45]

[45] lbp.am/index.php

Innovative research in the field of development of new energy sources is underway in several Armenian institutions.

At Yerevan State University (Department of Physics of Semiconductors and Research Center of Semiconductor Devices and Nanotechnologies-DPS&NT) a team of scientist has been involved in photovoltaic research for many years and manufactured a PS layer as the appropriate antireflection coating (ARC) on common (industrial) solar cells instead of conventional ZnS ARC and compared their parameters.[46]

Improved hydro-wind power system with higher efficiency is suggested by the researchers at the Institute of Radio-Physics and Electronics (IRPhE) of NAS RA. Researchers of the IRPhE also carry out research on development of thin film CIGS solar cells on specially synthesized non-conducting perlite glass-ceramic substrates.

The Institute of Geological Sciences and the Institute of Geophysics and Engineering Seismology of NAS RA are involved in studies on identification of geothermal sites in Armenia. Researchers at the Institute of Geological Sciences have started studying the possibility of using the method of biodiesel production from microalgae.

In the Institute of Chemical Physics of NAS RA high efficiency technological processes for synthesis of hydrides of transition metals are developed. Self-propagation high-temperature synthesis (SHS) method of hydride production has essential advantages: it is low-energy consuming, quick, single stage, wasteless, safe and environmentally pure process.

"Ecoatom" Company developed a simple method for obtaining hydrogen to be used in car engines by magnesium and water. A chemical reaction of mixing magnesium and water results in the production of hydrogen, magnesia and heat. This method is well known, but the revolutionary difference is relatively low cost of magnesium produced by a new technology.[47]

Specialists of BARVA Innovation Center and Engineering Academy of Armenia (EAA) are involved in research to develop a co-generation plant using syngas produced from biomass or other organic wastes. It makes possible to re-purpose the carbon content in biomass and conventional solid waste products into syngas, and then it can be turned into electricity at the low cost with zero CO_2. Research is also underway on development of parabolic trough concentrated solar thermal (CSP) power station (150-300KW). CSP plants use steam to produce energy like conventional steam power plants. The difference is that CSP plants use emission-free clean solar radiation to produce heat instead of fossil or nuclear fuel.

Among other innovative research projects suggested by EAA it could be mentioned design and construction of solar pond for sun energy storage with application of new method of thermal energy conversion into electric power which has been elaborated and patented by the authors.

The study carried out by Danish Energy Management in the frame of GEF funded Renewable Energy project "Development of PV Industry Potential in Armenia" (August 2008) states that there is an extent experience in PV technology in Armenia but at the moment there is no significant practical activity in this area.

[46] r2e2.am/documents/english/solar_task1_eng.pdf

[47] ada.am/files/98/publications/Armenwal.pdf

A large number of R&D tasks have to be undertaken to meet the common targets across all PV technologies for the short term (up to 2013) and medium term (up to 2020).

Short-term: In the present economical and global PV market situation Armenia should exploit business opportunities along the supply chain, e.g. gases (trichlorsilane and others) or parts for equipment manufacturers. In parallel Armenia has to develop their human basis, especially on the R&D side to sustain future local business development in PV. Establish collaboration through joint activities with European partners from R&D and industry to develop a local industry. By joining forces and competencies the collaborations enable a critical mass for manufacturing and surviving in the PV business.

Mid-term: In the next two to four years Armenia can gather important know-how and collaborations to understand and identify their position for establishment of the future highly profit and fast growing PV business.

Long-term: PV should become part of the future national energy policy, with respect to its future contribution to energy security and environmental and social benefits. A commitment from the Government and a clear long-term strategy will develop a local market and create locally business opportunities, which help to learn and build up the capacity for the local enterprises.

Most importantly should be following addressed:

- involve all relevant stakeholders and decision makers;
- have continuity and long-term action plan;
- improve technology transfer;
- focus and coordinate R&D efforts in a national PV R&D roadmap;
- roll out a capacity building program to emphasize on manufacturing issues and market development;
- develop human resource basis through dedicated education programs;
- improve funding/incentives for R&D and PV business start-ups;
- provide attractive incentives for PV business start-ups; and
- establish a National PV Industry Association responsible for lobbying with Government
- and coordinate a national PV industry and market roadmap.[48]

At present, the existing support mechanisms for EE/RE projects are mainly funds provided by donor agencies for on-lending to small hydro or wind power facilities.

Based on the aforementioned, below we tried to make a SWOT analysis of the innovation system with some focus on local energy sector and of its innovative capacities.

Strengths	**Weaknesses**
• Adoption of several legal and strategic documents towards creation and development of innovation system and promotion of EE/RES • Creation of innovation and EE/RES promotion structures (SME DNC, RREEF, etc.)	• Poor development of innovation support infrastructure and intermediaries • Extremely low level of R&D expenditure and negligible level of share of business sector in it • Limited role of business subsystem in the innovation process • Lack of incentives for stimulation and growth of innovative and science-intensive SMEs and spin-offs
Opportunities	**Threats**
• Launching of new programmes to promote research-industry cooperation • Strong Diaspora ready to bring new knowledge and investments in case of favourable conditions	• Adopted innovation policy documents and measures are not based on strategic economic development priorities of the country • R&D system and infrastructure remain nearly unchanged and far away from real economic and social needs of the country • Environmental regulation and enforcement is not uniform for all RE technologies

Table 2. SWOT analysis of innovation system in Armenia

Ener2i project with planned wide range of activities, including analytical reports on the research and innovation situation and players in EE/RES in EaP countries and further expert workshops with participation of representatives of concerned stakeholders are surely to contribute to highlighting the existing barriers and derive recommendations for tackling them. Moreover, the innovation voucher

[48] r2e2.am/documents/english/solar_task1_eng.pdf

scheme, brokerages, expert workshops and twinning between EaP and EU partners could be a good tool for local start-ups and innovative SMEs to raise awareness on available innovative research/technologies, to find partners for joint projects and to make a step forward to commercialization of available research outcomes.

6.7 Annex: critical stakeholders

A mapping of critical stakeholders (including contact persons and e-mail) in the national energy sector will be performed (nuclear energy sector representatives/organisations to be included where relevant):

- Research institutes dealing with EE/RES
- Universities/higher education institutions – their departments dealing with EE/RES
- Businesses: main EE/RES related businesses per country(manufacturers, start-ups, technology providers, etc.), regional businesses
- Business interest organisations: Chambers of commerce, employers organisations
- Support structures: research and innovation funds, SME support funds, intermediaries (e.g. TTOs,), relevant incubators and S&T/technoparks
- political stakeholders, representatives of National Authorities, Ministries
- local and municipal authorities (depending on whether they can make decisions, lead activities, or have capacity/budget)
- NGOs dealing with EE/RES (platforms, associations, etc.)

Structure, how to prepare the information – a table template will be provided, which will need to be filled in, so that it can be easily transferred in the database at the ener2i website:

- Name of organisation
- Address
- Contact person & contact details of organisation& website (contact details have to be updated regularly)
- Type of organisation: PRO/HEI/BES/PUB/NGO (plus department level, if applicable/relevant)
- No of overall staff and No of staff dealing with EE/RES (department level, if applicable)
- Function/Capacities of organisation (research/research or innovation funding organisation
- Keywords (drop down menu
- Relevant output of organisation: publications, products, promotion tools, technologies developed, etc.

6.8 References

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2. National Program on Energy Saving and Renewable Energy of Armenia, USAID, Yerevan, 2007
3. Renewable Energy Roadmap for Armenia, Task 4 Report, Danish Energy Management A/S, May 2011
4. Report on Development of PV Industry Potential in Armenia, Renewable Energy Project, GEF Grant # TF: 056211, “Assistance to the Modern Solar PV Industry Development in Armenia”, 2008
5. Preparation of SREP Investment Plan for Armenia, September 2013

7. Country Report of Belarus

ener2i - ENErgy Research to Innovation:

Reinforcing cooperation with EAP countries on bridging the gap between energy research and energy innovation

Authors:

Belarusian Institute of System Analysis and Information Support of Scientific and Technical Sphere (BelISA):

Olga Meerovskaya, Yauhen Hurynau

Belarusian Innovation Fund:

Anatoly Hryshanovich, Alla Minko

Abbreviations

CHPs = *Coal* Handling Plants
CIS = Commonwealth of Independent States
EaP = Eastern Partnership countries
EE = Energy Efficiency
EAP = European Neighbourhood Policy
GFEC = Gross final energy consumption
HPPs = Hydro Power Plants
IEA = International Energy Agency
KTOE = Kilotonne of Oil Equivalent
MTOE = Million Tonnes of Oil Equivalent
NGOs = Non-Governmental Organizations
NPP = Nuclear Power Plant
OECD = Organisation for Economic Co-operation and Development
R&D = Research and Development
RES = renewable energy sources
RTD = Research and Technological Development
S&T = Science and Technology
SMEs = Small and medium enterprises
TPES = Total Primary Energy Supply
TPPs = Thermal Power Plants
VAT = Value-Added Tax
WPPs = Wind Power Plants

7.1 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 sources 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 – the Belarusian Institute of System Analysis and Information Support of Scientific and Technical Sphere (BelISA) and Belarusian Innovation Fund (Belinfund).

This Review results from 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 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 an 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 into the situation in RES (hydro energy, wood fuel, biogas, wind and solar energy, 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 developing the 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 Belarusian Government promotes innovation in the EE/RES sector? How actively 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 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 Power Engineering of the National Academy of Sciences of Belarus), Mr. Kyril Levkov (Scientific and Technological Park of the BNTU "Polytechnic"), Mr. Vladimir Nistsiuk (Belarusian Renewable Energy Association), Prof. Tatyana Pospelova (Belarusian National Technical University), Mr. Boris Rubenchik (Association of Energy Engineers), Dr. BronislavTauroginsky (Institute of Housing – NIPTIS named after S.S. Ataev), 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 while Dr. Tatsiana Zoryna (Institute of Power Engineering of the National Academy of Sciences of Belarus) contributed to updating and editing of the Review. The authors deeply appreciate the cooperation with the involved experts and their efforts. All errors and inaccuracies are those of the authors.

7.2 Current Situation in the Energy Sector of the Republic of Belarus

7.2.1 Background

Belarus is located in the center of Europe. The territory occupies 207.6 thousand km^2 and its population is 9.46 million people (2014). 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 (2014).

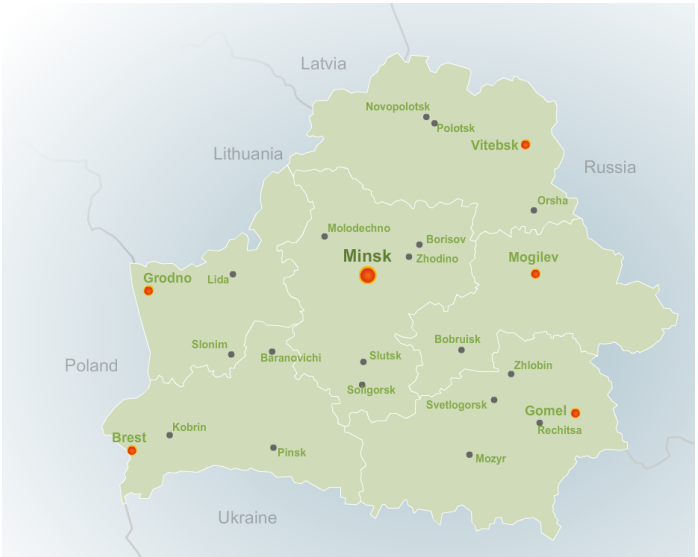


Figure 1 - Map of Belarus[49]

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

Source: belarus.by

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[50]. Heating season starts when the average daily temperatures is 8°C and less (10°C and less for 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 sources are peat, potassium salts, granite, dolomitic limestones, marl, chalk, sand, gravel and loam. The stock of mineral sources 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 Pripyat downwarp. 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 2.28 million tons (0.8 Mtoe) per year in the last five years (Table 1). If the current level of peat production is maintained, the exploitation of reserves can stay effective for 20-30 years.[51]

	1990	2005	2010	2011	2012	2013	2014
Crude oil (million tons)	2.05	1.78	1.70	1.68	1.66	1.64	1.65
Natural gas (billion m^3)	0.29	0.22	0.21	0.22	0.21	0.22	0.22
Fuel peat of standard humidity (million tons)	3.43	2.30	2.35	2.70	2.67	2.26	1.43

Table 1. Intramural production of selected fuels in Belarus

Source: Statistical Yearbook 2015, 2013 and 2011

Belarus was one of the USSR's major industrial republics specialized in the production of machinery and agriculture. Nowadays, the industrial production continues to play an important role in the national economy. The main sectors of industry are metallurgy, mechanical engineering, metalworking, chemical and petrochemical industries, light and food industries. "The influence of the government over the

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

[51] See Ivan Lishtvan, "Local energy sources for energy problems solving", *18th Belarusian Energy and Ecology Forum on 16–19 October, 2013*, 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*, tc.by/download_files/energy2013/kovalev_2.ppt, 12.01.2014 (in Russian).

economy remains extensive, including not only direct ownership of enterprises but also administrative intervention in credit allocation and widespread subsidies."[52]

After the collapse of the USSR, all sectors of the 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. However, in the late 2014 – early 2015 the country faced a new financial crisis which is still continuing. By the beginning of 2016, the Belarusian economy is in recession, with stagnation projected over the medium term, and the Government is developing a series of anti-crisis measures.[53]

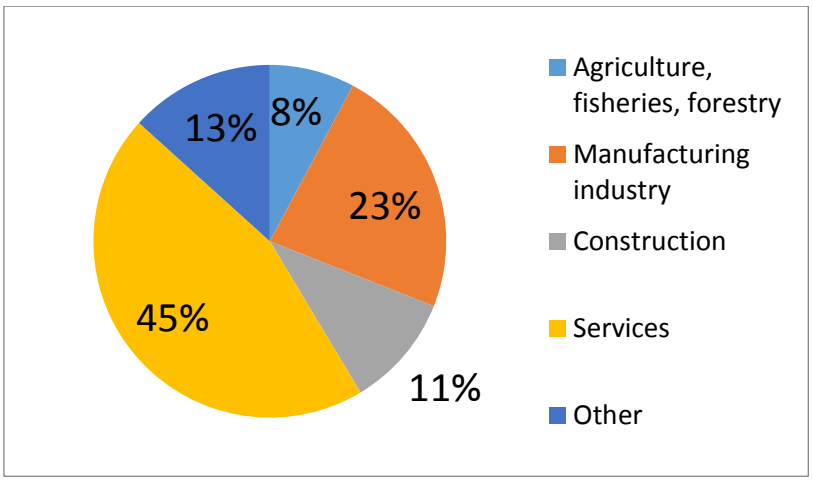


Figure 2 – GDP of Belarus: composition by sector of origin (in current prices), 2014

Source: Statistical Yearbook 2015

According to the World Bank's income classification, Belarus belongs to the group of upper middle-income countries and has $7,340 GNI per capita (Atlas methodology, 2014).[54] GDP is $76.14 billion and its growth is 1.6% (2014). R&D expenditures are 0.52% of GDP (2014) – the worst result for all the period from 1990.[55]

Belarus has trade relations with over 180 countries in the world and, within the Custom Union and the Common Free Market Zone, 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.

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

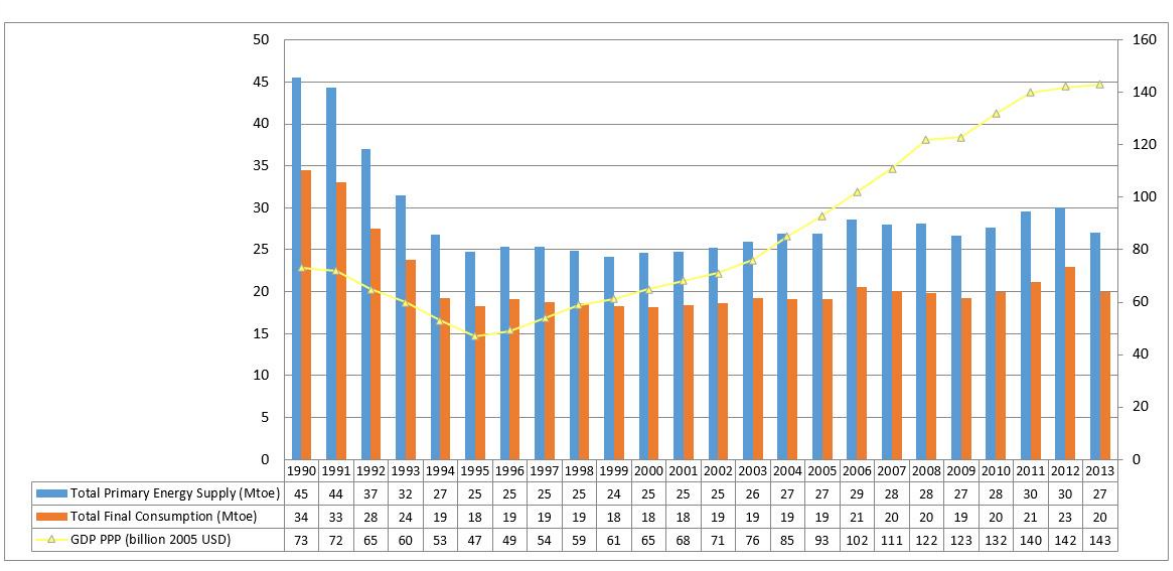
[53] Consult "Belarus", *World Bank*, worldbank.org/en/country/belarus, 18.01.2016.

[54] "Updated Income Classifications", *World Bank*, data.worldbank.org/news/2015-country-classifications, 18.01.2016.

[55] National Statistic Committee of the Republic of Belarus, *Science and Innovation Activities in the Republic of Belarus 2015: Statistical Book* (Minsk: Belstat, 2015), p. 60 (in Russian).

7.2.2 Energy consumption

From 1990 to 2013, total primary energy consumption (TPES)[56] of Belarus decreased 1.67 times, from 45.50 Mtoe to 27.28 Mtoe.[57] It promoted the average annual decrease in the energy intensity of GDP of 4.77%. In 2013, energy intensity of Belarusian economy was 0.18 toe per thousand of 2005 $ GDP PPP (3.4 times less than in 1990). Gross final energy consumption (GFEC) was 19.85 Mtoe (2013) and decreased 1.71 times in comparison with 1990. The most significant decrease in GFEC was in 1990–1994: 13.3% annually on average (Figure 3).[58]



	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
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	30	27
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	23	20
GDP PPP (billion 2005 USD)	73	72	65	60	53	47	49	54	59	61	65	68	71	76	85	93	102	111	122	123	132	140	142	143

Figure 3. TPES, GFEC and GDP PPP of Belarus, 1990–2013

Source: IEA Energy Statistics 2015

From 1990 to 2013, the average annual decrease in energy intensity of GDP of Belarus was 4.77% (6.3% in 1997–2000). Energy intensity of Belarusian economy by 2011 was lower than those of the 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 PPP[59] (Figure 4).

[56] 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.

[57] *IEA Statistics: Belarus*, iea.org/countries/non-membercountries/belarus/, 10.01.2016.

[58] 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.

[59] *In-Depth Review of the Energy Efficiency Policy of the Republic of Belarus* (Brussels: Energy Charter Secretariat, 2013), pp. 24–25.

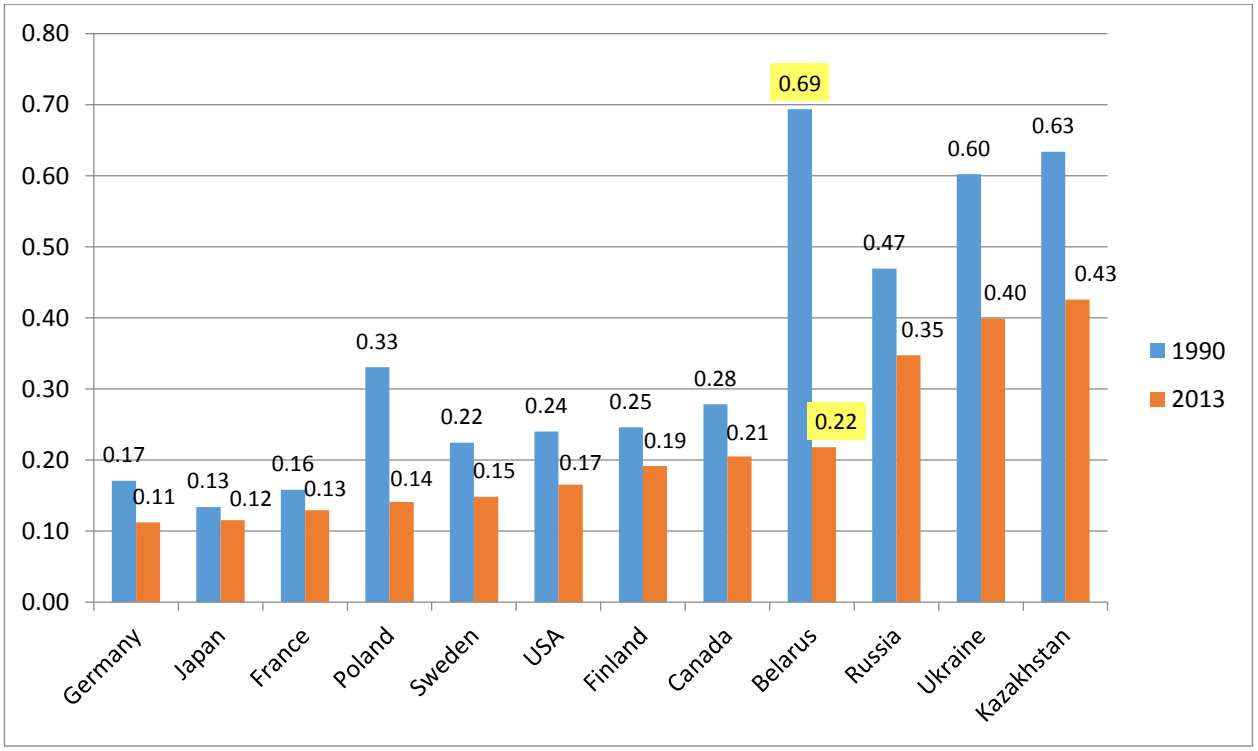


Figure 4. Energy intensity of Belarus and selected countries (toe per thousand of 2005 GDP PPP)

Source: IEA Energy Statistics 2015

7.2.3 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 sources and RES are quite limited. The country has to import fuels and energy, mainly from the Russian Federation (90% of total energy imports). 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.

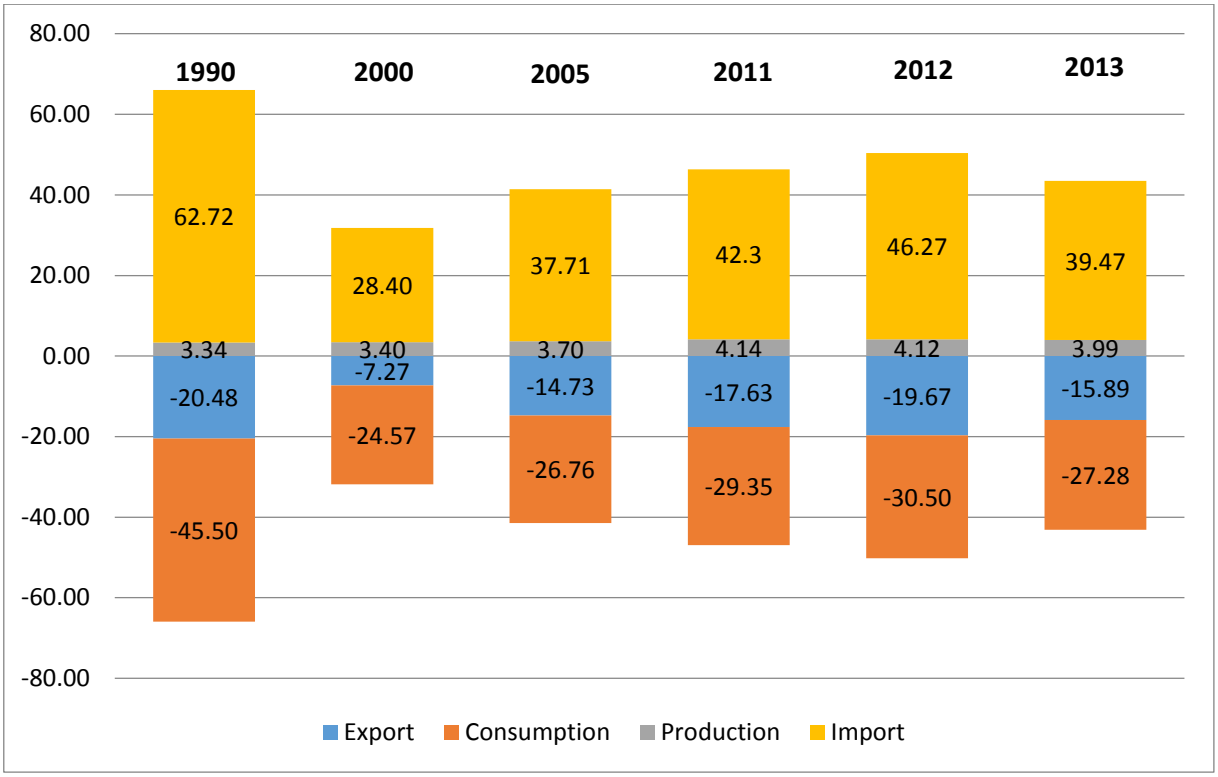


Figure 5 – Energy balance of Belarus, mtoe

Source: IEA Energy Statistics 2015

According to IEA Statistics for 2013,[60] TPES of crude oil is 21.29 Mtoe.Most of the oil is refined by the national petrochemical industry (65.89%) or re-exported (7.64%). Only 7.76% of intramural oil demands are covered through domestic production. TPES of natural gas is 17.07 Mtoe (19.98 billion m^3) of which domestic production is only 1.11%.

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.[61]

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 (90% in total), while domestic sources (primarily, peat, wood and wood waste) provide about 8% of TPES only**.

[60] "Belarus", *IEA Statistics*, iea.org/countries/non-membercountries/belarus/, 10.01.2016.
[61] *State Program "Peat" for 2008–2010 and until 2020*, topgas.by/node/233, 01.04.2014.

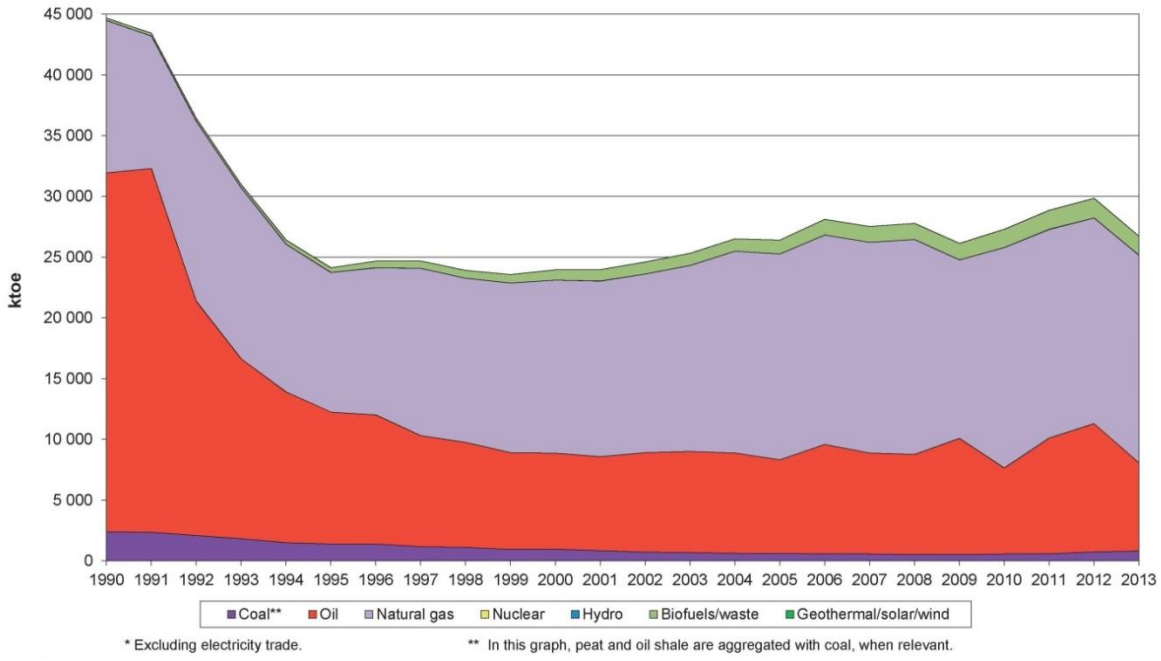


Figure 6. TPES of Belarus, 1990–2013 (excluding electricity trade)

Source: IEA Energy Statistics 2015

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 Grodna region. The Belarusian NPP will consist of two units with VVER-1200 type reactor each. The combined capacity of the two 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 $ 10 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 (more than $0.75 billion) and replace almost 25% of consumed natural gas per year.[62]

[62] "Belarusian NPP construction project was presented at a session of the IAEA in Vienna", *BelTA: News from Belarus*, 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*, atom.belta.by/en/press_en/view/european-consulting-for-belarusian-nuclear-power-plant-construction-2083/t_id/1, 15.01.2014.

7.2.4 Relationship between electricity and heath energy

According to the data of IEA for 2013, the total annual production of electricity in Belarus is 31,507 GWh. As of January 2015, total installed capacity of national energy system was 10,035 MW, including 2 by large condensation electric power plants (4,305 MW) and 39 thermal power stations (4,994 MW). The largest share of electricity is generated by natural gas (98.4%; see Table 2). The annual electricity import is 9,289 GWh.

Fuel	Share (%) in total production of:			
	Electricity		Heat	
	2011	2013	2011	2013
Coal and peat	0.06	0.07	1.44	1.37
Oil	1.22	0.57	2.92	2.14
Gas	98.26	98.41	88.63	89.04
Biofuels	0.30	0.38	6.73	7.26
Waste	0.03	0.10	0.29	0.20
Hydro	0.13	0.44	0.00	0.00
Wind	0.003	0.03	0.00	0.00

Table 2. Electricity and heat production in Belarus by fuels, 2011 and 2013
Source: IEA Energy Statistics 2015

The total annual production of heat is 263,853TJ (2013). Natural gas is a main source of heat generation (89.04%). According to Ministry of Energy of the Republic of Belarus[63], from 2010 to 2015, the estimated natural gas consumption will decrease of 8.31%, from 12.03 billion m^3 to 11.03 billion m^3. The largest consumer of electricity (47.33%) is the industrial sector and transport sector, of heat (44.62) – the residential sector. (Figure 7).

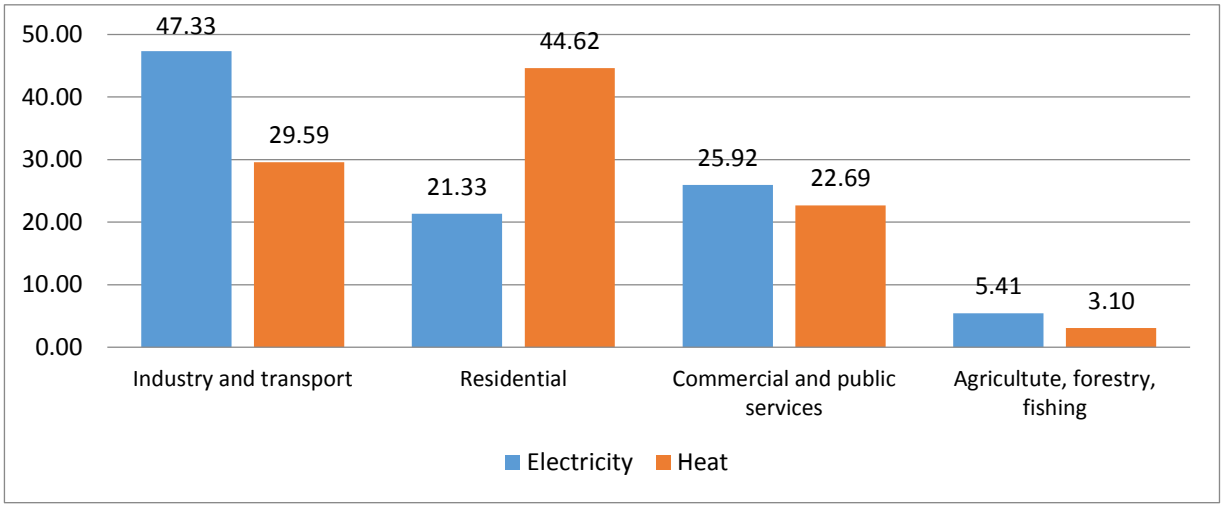


Figure 7. Total consumption of electricity and heat in Belarus in 2013, by sectors (%)
Source: IEA Energy Statistics 2015

[63] Ministry of Energy of the Republic of Belarus, *Statistics*, minenergo.gov.by/ru/statist, 13.01.2016 (in Russian).

7.2.5 State Energy Policy[64]

The legal framework for energy policy includes the Law of the Republic of Belarus "On energy saving"[65] (approved on 15 July, 1998, the last amendments were adopted on 8 January, 2015), the Law of the Republic of Belarus "On renewable energy sources" (approved on 27 December, 2010)[66] and some other laws, including bylaws for stimulating an increase of EE in enterprises and organizations.

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"[67] (2007, hereafter referred to as Directive № 3),
- Strategy of Energy Potential Development (2010),[68]
- National Strategy for the Sustainable Social and Economic Development of Belarus for the Period till 2030 (approved in 2015),[69]
- Concept of Energy Security of the Republic of Belarus (approved in 2005, the second and third editions were adopted in 2007 and 2015 respectively),[70]
- other sector and regional programs[71].

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 sources;
- Increase of public awareness of the need for saving and thrift;
- Increase of control of the effective use of fuel, energy and material resources.

According to the Directive № 3, the main practical results of activities in the energy sector should be reduction 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 the NPP; more intensive construction of coal-fired thermal power plants (TPPs), small and medium HPPs, CHPs, biofuel plants, WPPs, biogas plants, municipal solid waste power plants.

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

[65] *The Law of the Republic of Belarus No. 239–3 "On Energy Saving" of 8 January, 2015*, minenergo.gov.by/dfiles/000437_303862__ob_energosberezhenii_2015.pdf, 07.04.2015.

[66] *The Law of the Republic of Belarus No. 240–3 "On Renewable Energy Sources" of December 27, 2010,* energoeffekt.gov.by/laws/act/192--q-q-27-2010-204-.html, 30.12.2013. See also *In-Depth Review*, p. 49.

[67] *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*, president.gov.by/ru/official_documents_ru/view/direktiva-3-ot-14-ijunja-2007-g-1399/, 30.12.2013.

[68] *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*, pravo.levonevsky.org/bazaby11/republic05/text183.htm, 23.12.2013.

[69] "National Strategy for the Sustainable Social and Economic Development of Belarus for the Period till 2030," *Economic Bulletin of NIER of the Ministry of the Republic of Belarus*, No. 4 (2015) (in Russian).

[70] *The Concept of Energy Security of the Republic of Belarus approved by the Resolution No. 1084 of the Council of Ministers of the Republic of Belarus of December 23, 2015*, government.by/ru/solutions/2337, 12.01.2016.

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

The provisions of Directive № 3 were extended in above-mentioned strategies and concepts. Analysis of these documents allows us to identify the priorities of the national energy policy. The main goals of state energy policy in Belarus are. from the one hand, to increase energy efficiency of heat electronic stations and the share of non-carbon energy in the period of 2015–2020 and, from the other hand, to increase energy independence of the country through the more intensive use of such primary energy sources as nuclear energy and RES in the period of 2021–2030.

The strategic goal for Belarus is a reduction of the energy intensity of GDP of 30% by 2035 from the level of 2015 and providing the energy security of the country. To reach this goal, the Concept of Energy Security of the Republic of Belarus defines 11 energy security indicators for monitoring regularly every five years till 2035. By 2035, 7 indicators should reach a value which is classified as "normal" for providing national energy security while4indicators will stay at "pre-critical" level. Table 3 contains the most important of these indicators.

Indicator	Checkpoint					
	2010	2015	2020	2025	2030	2035
Energy intensity of GDP, toe per $ 1000 GDP 2005	0.642	0.570	0.558	0.532	0.478	0.404
Share of domestic energy sources in total primary energy consumption, %	14	14	16	17	18	20
Share of RES in total primary energy consumption, %	5	5	6	7	8	9
Share of dominating energy source (natural gas) in production of electricity and heat, %	91.4	90	70	60	50	<50
Share of a dominating energy supplier in total energy imports,%	96	90	85	80	75	70
Share of total energy imports in GDP, %	21.7	20	19	18	17	15

Table 3. Selected indicators of efficiency of the national energy system of Belarus
Source: Concept of Energy Security of the Republic of Belarus 2015

The implementation of these goals of the national energy policy as well as achievement of corresponding indicators' values should be reached by implementing series of actions in nine focus areas:

1. Energy independence, i.e. increasing the share of national energy demands covered from domestic energy sources including renewable energy sources up to 20% in 2035 (14% in 2015),
2. Diversification of energy sources (local and renewable energy sources, nuclear energy) and suppliers, decreasing the share of dominating energy supplier in total imports of energy sources from 90% in 2015 to 70% in 2035,
3. Reliability of energy supply, storage and processing of fuel and energy sources,
4. Increasing the energy efficiency of end-consumption of fuel and energy sources through the introduction of new technologies and materials in manufacturing and service sectors, construction and housing; reduction of the energy intensity of GDP of approximately 30% by 2035 from the level of 2015,

5. Effectiveness and efficiency of energy generation and distribution (creation of favorable economic and legal framework for energy sector development, modernization and reconstruction of energy grids and infrastructure),
6. Affordability of fuel and energy sources for consumers, elimination of cross-subsidization of electricity and heat tariffs,
7. Integration into global energy system, development of international cooperation with the Eurasian Economic Union, the EU and leading energy organizations, such as the International Energy Agency and International Uranium Enrichment Center, expansion of energy exports to the EU countries,
8. Improving the management system in national energy sector, creating the wholesale national electricity market, developing the law "On electric power industry",
9. Providing a scientific and technology support for development of the energy system focusing on such areas as energy efficient technologies, nuclear technologies, local fuel and energy sources and RES, environment protection, intellectual management of fuels and energy generation and consumption.

According to the international experts[72], **Belarus energy sector as a 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.

7.3 Energy Efficiency And Development Of Renewable Energy

7.3.1 State Policy in Energy Efficiency

According to the Law of the Republic of Belarus "On Energy Saving",[73] energy efficiency (EE), or efficient use of energy sources, is defined as "ratio of outputs from the using fuel and energy sources to the costs for generation of these sources." The indicator of EE is a scientifically sound volume (absolute or specific) of energy sources 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. The analysis of these documents 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.**[74] Table 4 contains indicators corresponding to these objectives.

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

[73] *The Law of the Republic of Belarus No. 239–3 "On Energy Saving" of 8 January, 2015.*

[74] Consult 'National Strategy for the Sustainable Social and Economic Development of Belarus for the Period till 2030," p. 52 ff. (in Russian).

Indicator	Checkpoint			
	2015	2020	2025	2030
Energy intensity of GDP, toe per $ 1000 GDP 2005	0.570	0.558	0.532	0.478
Share of primary energy generated from RES in total energy consumption, %	5	6	7	8
Share of primary energy generated from domestic sources in total fuel and energy consumption, %	14	16	17	18

Table 4. The main indicators of EE of the Republic of Belarus

Currently, there is a need in adopting a series of laws on energy saving in Belarus. Some new bills in this field are being debated, e.g. draft laws "On Power Generating Industry", "On State Regulation of Electricity and Heat Energy Tariffs", "On Heat Supply", "On electricity generation" (the concept of the Law has been developed). Harmonisation of current regulations and standards with European and international requirements is another important task of the state policy in EE.

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

1) Diversification of fuel and energy balance:

- Increasing the share of domestic energy sources (oil, associated gas, peat, wood, etc.) in total primary energy consumption from 14% in 2015 to 20% in 2035 (share of RES should reach 9% of total primary energy consumption by 2035).
- Launching the Belarusian NPP with a total capacity of 2,400 MW and involvement of nuclear fuel in the energy balance of Belarus. These measures will allow substituting 5 billion m^3 of natural gas (25% of imported natural gas) annually. Consuming the nuclear fuel, the country plans to substitute about 5 million toes of organic fuels by 2020.
- Construction of the HPSs on the West Dvina and the Neman, increasing a total capacity of small HPPs up to 250 MW by 2020. Development of micro-small HPSs, construction of pumped-storage hydroelectricities for load electricity balancing.
- Construction of wind farm near at the village of Grabniki, Grodno region, with total capacity of 7.5 MW and further construction of large wind farms with capacity of at least 1 MW for each unit.

2) Increasing the reliability of the 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:

- Construction of complexes for heavy oil residue hydrocracking (JSC "Mozyrshkiy NPZ") and delayed coking of petroleum residues (JSC "Naftan"). Increase of crude oil refining depth from 73.7% in 2014 to 92.0% in 2020.
- 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 sources 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:

- 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 m2.
- Introduction of individual automated control systems of heat supply in apartments, energy efficient lighting, co-generation.
- Introduction of solar water heaters as well as micro-CHP using local energy sources.
- 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 houses75 in the total amount of newly-erectedones up to 60.0% by 2015 and up to 100% in 2020.

7) Measures in agriculture, forestry and food industry:

- Launching biogas plants in cattle-breeding complexes, food industries, solid waste landfills and in big cities. Development of domestic technologies and components for biogas plants.
- 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.

8) 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;[76]
- Conducting a wide awareness-raising public campaigns on saving and thrifty use of electric and heat energy.

11) Measures in all sectors:

- 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.

[75] 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).

[76] 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*, tc.by/download_files/energy2013/pashinskiy.pdf, 14.01.2014. (in Russian).

- 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).

7.3.2 Main renewable energy sources in the Republic of Belarus

Water

After the launch of Grodna 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).

Potential capacity, MW:	The International Journal on Hydropower & Dams[77]	Strategy of Energy Potential Development[78]
theoretically possible	856	850
technically possible	342	520
economically viable	148	250

Table 5. Potential total capacity of hydro energy sources of Belarus

According to the State Program of Construction of HPPs in 2011–2015,[79] 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 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 (Grodna and Neman HPPs);
2) the West Dvina cascade system with the total capacity of 112 MW (Polotsk, Bitsebsk, Beshenkovichy and Verkhnedzvinskaya HPPs);
3) the Dniper 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.

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 sources. Standing wood sources are estimated to be 1.5 billion m^3 and the growth of wood sources is about 30.3 million m^3 annually. Production capacity of

[77] *The International Journal on Hydropower & Dams*, hydropower-dams.com/, 05.07.2009.

[78] *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*, pravo.levonevsky.org/bazaby11/republic05/text183.htm, 23.12.2013. See also *In-Depth Review*…, p. 86.

[79] *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*, pravo.levonevsky.org/bazaby11/republic03/text681.htm, 08.01.2014.

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.[80]

Biogas

At the beginning of 2014, there were 23 biogas plants with a total capacity of 24.33 MW in Belarus.[81] 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).

Wind

There are three regions with the largest potential to produce electricity from wind turbines in Belarus: Grodna, Minsk and Mogilev regions.[82] At the beginning of 2014, there were 28 operating wind turbines with a total capacity of 6.57 MW.[83] Belarus is planning to launch a wind farm with total capacity of 7.5 MW near the village Grabniki, Grodno region, in 2016.[84] Number of wind turbines with a total capacity from 162 MW to 450 MW (depending on related factors) by 2016. The next steps include construction of large wind farms with capacity of at least 1 MW for each unit.

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^2however 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.[85] A big investment project for constructing solar power plant with the total capacity of 17 MW was launched by LLC “Ecological Energy” in Smorgon, Grodno region, in 2013. It was planned to construct the first unit with capacity of 5 MW by June, 2015 and the second unit with capacity of 6 MW by July, 2018.[86] As of beginning of 2016, any information about current status of the project is missing.

[80] *In-Depth Review*…, pp. 27–28.

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

[82] 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.

[83] *RES State Cadaster of the Ministry of Natural Resources…*

[84] “Construction of wind farm near Hrabniki, Novogrudokraino”, *Grodno Republican Unitary Enterprise “Grodnoenergo”*, energo.grodno.by/node/1684/, 15.01.2016.

[85] *RES State Cadaster of the Ministry of Natural Resources…*

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

Introducing solar water heaters in housing and agriculture sector is viewed as one of the tasks of national energy policy for the period 2015–2030.

Geothermal sources[87]

Use of heat pumps is at the initial stage. In 2013–2014, there were about 100 geothermal installations with heat pumps in the county with a total installed capacity of 6.5 MW.[88] These installations are used for heating water-supply and sanitary system, cottages and hospitals (e.g., in Nesvizh). The undoubted advantage of heat pumps is an ability to provide heating to objects which are not connected to a district heating system. Belarusian Government is planning to enhance introducing heat pumps and geothermal installations in 2015–2030 despite the fact that groundwater used in the geothermal heat pump has a high salinity, and thus heat pumps require more frequent and expensive cleaning.

7.3.3 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.[89] Moreover, foreign and joint companies also can build up and operate local-fuel-fired power installations.[90]

Since 2012, private companies in Belarus can generate and re-sell electricity using existing electricity grids. According to the "Rules for Electricity 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".[91] 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:[92]

- 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 (tariffs are indexed to the USD exchange rate, using multiplying factors, 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;

[87] See V. Zuy, "Thermal field and the use of geothermal energy in Belarus", *18th Belarusian Energy and Ecology Forum on 16–19 October, 2013*, 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*, belta.by/ru/person/comments/Nikolaj-Dolbik_i_514076.html, 13.01.2014 (in Russian).

[88] *UNECE Renewable Energy Status Report 2015* (Paris: UNECE, 2015), p. 33.

[89] *The Law of the Republic of Belarus No. 240–3 "On renewable energy sources"…*

[90] 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).

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

[92] "Renewable Energy," *National Agency of Investment and Privatization*, investinbelarus.by/en/invest/opportunities/directions/renewable-energy-and-new-materials/, 13.01.2016.

- 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.

Type of RES	**Operation period of RES installation:**	
	first 10 years	*next 10 years*
Wind, including plants with the age of equipment:		
less than 5 years,	1.2	0.75
more than 5 years	1.05	
Water and geothermal energy, including plant with connected capacity of:		
up to 300 kW,	1.2	0.75
301 kW – 2 MW,	1.15	
more than 2 MW	1.1	
Wood, biogas and other RES, including plants with connected capacity of:		
up to 300 kW,	1.3	0.85
301 kW – 2 MW,	1.25	
more than 2 MW	1.2	
Solar energy, including plants with connected capacity of:		
up to 300 kW,	2.5	0.75
301 kW – 2 MW,	2.3	
more than 2 MW	2.1	

Table 6. High feed-in-coefficients for electricity produced from RES in Belarus
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 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 Table 7.

Project and end date	Foreign participant(s)	Role in a project Extent
Biomass-fired mini-CHP with the total capacity of 3.7 MW (Pruzhany, 2009)	MW Biopower Oy (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 (Minsk, 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 (Grodna region, 2014/2015)	Finest S.p.A., PVB Group, Energy T.I.EST (Italy)	Investors (€ 110 million)
Vitebsk HPS (Vitebsk, 2015)	China National Electric Equipment Corporation, China Development Bank	General contractor, creditor ($ 189 million and $ 289 million respectively)
Beshenkovichy and Verkhnedzvinskaya HPPs (Vitebsk region, 2015)	Cet Insaat Muhendislik Ticaret 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
Biogas boiler with the capacity of 20 MW (Cherven, Minsk region, 2017)	Enerstena Group (Lithuania)	General contractor, investment (€ 6 million) from the World Bank

Table 7. Energy projects with the participation of foreign companies
Source: T. Manenok, “Waste of money? Prospects for private business in Belarusian energy sector”; tut.by; belta.by

7.3.4 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. It contains information about the 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 source of the Ministry of Natural Resources and Environmental Protection. [93] 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 (an administrative procedure № 6.23 "Issuing certificate confirming the origin of energy or its duplicate and making changes and amendments"[94]).

7.4 Innovations In The Energy Sector

Developing of a competitive, innovative, high-tech, resource- and energy-saving, environmentally friendly economy is a priority for Belarus. In this connection, innovations are viewed as one of the key pillars of prosperity and sustainable development of Belarusian economy in the next fifteen years as well as the base for integrating national science into global science and technology system.[95]

One of the main tasks on this way is the development of energy efficient technologies and increase of the production of alternative fuels and RES. Energy, energy efficiency, nuclear energy, domestic energy sources and RES have been included in the list of the priority areas of science and technology activities in Belarus for 2015–2020[96] and in the list of priority areas of scientific research.[97]

According to these tasks, some national R&D programmes have been developed for the period of 2016–2020 (table 8). The State Programme of Innovative Development for 2016–2020[98] is aiming among other at developing national fuel and energy sector and meeting the needs of industry and households in energy sources. Priority areas of programme activities in the section concerning energy are as follows:

- energy efficiency in industry and housing sector,
- reduction of costs of fuel for generation of heat and electricity,
- reduction of fuel and electricity transportation losses,

[93] *RES State Cadaster of the Ministry of Natural Resources…*

[94] *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"*, pravo.by/pdf/2012-35/2012-35(010-398).pdf, 05.04.2014.

[95] Consult 'National Strategy for the Sustainable Social and Economic Development of Belarus for the Period till 2030," p. 32 ff. (in Russian).

[96] "List of priority directions of scientific and technical activities in the Republic Belarus for 2016–2020 approved by the Decree of the President of the Republic of Belarus No. 166 of April 22, 2015," *National Scientific and Technological Portal of the Republic of Belarus*, scienceportal.org.by/upload/2015/April/SandT.pdf, 11.01.2016.

[97] "List of priority areas of scientific researches approved by the Resolution No. 190 of the Council of Ministers of the Republic of Belarus of March 12, 2015," *National Legal Internet Portal of the Republic of Belarus*, pravo.by/main.aspx?guid=12551&p0=C21500190&p1=1, 20.01.2016.

[98] "Concept of the State Programme of Innovative Development of the Republic of Belarus for 2016–2020," *State Committee on Science and Technology of the Republic of Belarus*, gknt.gov.by/opencms/export/sites/default/ru/Documents/GPIR_2016_2020.doc, 11.01.2016 (in Russian).

- integration of the Belarusian NPP into the national energy system,
- introducing biogas plants at water treatment facilities,
- development of new energy-efficient technologies of heat recovery ventilation,
- construction of photovoltaic plants, wind plants, HPPs.

The State Programme of Innovative Development for 2016–2020 as well as the State research programme "Energy Systems, Processes and Technologies for 2016–2020"[99] are funded from the national budget.

Program	Public procurement authority	Main contractor	Supported types of activities
State research programmmes "Energy Systems, Processes and Technologies for 2016–2020"	NAS of Belarus Ministry of Education	A.V.Luikov Heat and Mass Transfer Institute, the Belarusian National Technical University,	Research
State Program of Innovative Development of the Republic of Belarus for 2016–2020	Council of Ministers, Ministry of Energy	Research organisations and enterprises	Innovative activity, modernization

Table 8 — S&T programmes in Energy for 2016–2020.

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.

Programmes 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 form the scientific basis for technological development 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 programmes is in demand by business. In addition to participating in the R&D programmes, there is a possibility of receiving funding for the implementation of individual projects from several 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 production at quite favorable conditions has a visible role in supporting close-to-market science-intensive projects through:

- funds availability period - up to 5 years;

[99] Detailed information on the programme is still missing in open sources. On its short summary, see "List of State Research Programmes for 2016–2020 approved by the Resolution No. 483 of the Council of Ministers of the Republic of Belarus of June 10, 2015," *National Legal Internet Portal of the Republic of Belarus*, pravo.by/main.aspx?guid=12551&p0=C21500483, 11.01.2016.

- repayment calculation at 0.5 refinancing rate;
- referral on interest and capital repayments;
- no security interest and insurance.

Since 2001, Belinfund has 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 Belinfund;
- a project by the Scientific and Production Republican Unitary Enterprise "Unichimprom BSU"[100] on developing a technology of biodiesel production from rapeseed oil and constructing biofuel installations at JSC "GrodnoAzot" in Grodno 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 technology backed 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 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 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) products new 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,[101] established by the President of the Republic 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 are residents 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.

Another form of support for innovation in the country is providing **research organizations, universities and small and medium enterprises with financial support for engaging in international cooperation.** Annually, 3-5% of the total budget expenditures for science and innovation are allocated for this purpose in a special budget line.

[100] BSU = Belarusian State University

[101] 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, No. 86, 1/7622.

From 600 to 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 the 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 the fear to fail. 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 above mentioned 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 work as 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.[102]
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.
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 EE in the total funding for research and development is just 5.4 % (2012),[103] and it is one of the two "low-funded" priorities.

Despite the priority of EE and 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. The evidence of this is 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 programmes. In 2007-2013, the number of applications to the 7th EU Framework Programme in 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 programmes, 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

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

[103] *On the State and Prospects of the Science Development in the Republic of Belarus in 2012* (Minsk, 2013) p. 23.

with the introduction of the task to create a **common knowledge and innovation space** that 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 (the World Bank, the EU, the UN family and GEF). Energy saving issues became a priority in the EU Annual Action Plan in favor of Belarus in 2010[104] and were further developed in a similar vein in 2011, which put an emphasis on the sustainable development of the regions.

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

Table 9. Technical aid projects in the energy field implemented in the Republic of Belarus

It has to be noted however that these projects **do not involve or involve 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). One of the latest horizontal EU technical assistance projects, "Capacity Development Facility to support the implementation of sector programs under the ENPIAAPs for Belarus 2009" (2013–2015) was implemented to train the ministries and departments on how to plan and prepare the competent applications for technical aid.

[104]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.

Another EU funded project, MOST is aimed at enhancing people-to-people-contacts for promoting mutual understanding and exchange of best practice between Belarus and EU MS. It has been launched for 3 years from 2015 to 2017. The name of the action comes from Russian "мост" that means "bridge". With a 5 million EUR budget, the project is going to cover professional exchange and mobility opportunities between Belarus and the EU for about 1,500 Belarusians. MOST core sectors are culture, education and youth, *science and technology*. Applications from other sectors (i.e. economy, public health, energy, public administration etc.) are welcome. The project may partly compensate the lack of nationally supported international mobility of researchers and promote international cooperation with EU and its MS in research and innovation.

7.5 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 decreased. Although Belarus is among leading CIS countries in terms of intensity of GDP, this indicator 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 (current price is 10.5 U.S. cents as for early 2015).

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 actual modernization 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 tariff regulations seeking 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 modernization projects. The high interest rates of banks is an obstacle to the investments in profitable projects. As a results, the volume of RES investment in Belarus in last ten years (2004–2014) totaled only 0.5 billion USD;[105]

[105] *UNECE Renewable Energy Status Report 2015* (Paris: UNECE, 2015), p. 62.

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 source 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 during setting 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 6) Decrease of feed-in coefficients for electricity produced from RES (for example, for hydro sources the coefficient was decreased from 1.3 to 1.1; for solar energy - from 3 to 2.7)
Opportunities:	**Threats:**
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 for the export of electricity to Lithuania and Poland (it is limited in the latter case) 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 the EU under the Framework Programme for Science and Innovation "Horizon 2020" and the programmes focused on neighboring countries. 8) Creation of the united wholesale energy market of the Republic of Belarus, the Russian Federation and the Republic of Kazakhstan.	1) A high degree of energy dependence on the Russian Federation and slow diversification of energy supply 2) Growing costs of energy equipment 3) The high cost of construction of the Belarusian NPP that inhibits the growth of public spending on RES 4) Lack of own funds in companies for modernization, high interest rates on bank loans 5) Underfunding of the national science, especially for applied research and innovation 6) Insufficient use of up-to-date developments in the field of modern electrical technologies for the needs of industry 7) Weak links of the national science and innovation business with the international community 8) Reduction in international technical aid due to mismatch of views on the development of internal policies of the Belarusian leadership.[106]

[106] 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

Table 10: SWOT Analysis

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, the laws "On Power Generating Industry", "On State Regulation of Electricity and Heat Energy Tariffs", "On Heat Supply", "On electricity generation" [the concept of law has been designed]),
- 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,
- introduction of the effective system of electricity and heat differentiated tariffs.

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-risk innovative projects,
- active attraction of FDI to the national energy sector.

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

6) Wider exploitation of the potential of "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 modern co-generation installations in these processes would allow producing 72-75 billion kWh 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 m3), 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 m3 annually[107].

Bank for Reconstruction and Development, *Strategy for Belarus*, ebrd.com/russian/pages/country/belarus/strategy.shtml, 29.03.2014.

[107] 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"

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 of business, 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.

(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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8. Country Report of Georgia

ener2i - ENErgy Research to Innovation:

Reinforcing cooperation with EAP countries on bridging the gap between energy research and energy innovation

Authors:

Energy Efficiency Centre Georgia (EEC):

Elene Gvilava

Liana Garibashvili

Abbreviations

ADB = Asian Development Bank

CDM = Clean Development Mechanism

CIS = Commonwealth of Independent States

CoM = Covenant of Mayors

EaP = Eastern Partnership countries

EBRD = European Bank for Reconstruction and Development

EE = Energy Efficiency

EIB = European Investment Bank

EAP = European Neighbourhood Policy

GNEWRC = Georgian National Energy and Water Supply Regulatory Commission

GoG = Government of Georgia

GRDF = Georgian Research & Development Foundation

GWh = Gigawatt Hour

HPPs = Hydro Power Plants

IEA = International Energy Agency

IFC = International Finance Corporation

IMF = International Monetary Fund

ISTC = International Science and Technology Center

KFW = Kreditanstalt für Wiederaufbau

KTOE = Kilotonne of Oil Equivalent

MDSPPSG = Main Directions of State Policy in the Power Sector of Georgia

MTOE = Million Tonnes of Oil Equivalent

NGOs = Non-Governmental Organizations

PEEREA = Protocol on Energy Efficiency and Related Environmental Aspects

RES = renewable energy sources

SEAP = Sustainable Energy Action Plans

STCU = Science and Technology Center in Ukraine

USAID = United States Agency for International Development

VAT = Value-Added Tax

8.1 Introduction

The presented report has been developed within ENER2i project financed by EU Commission aiming to analyze the local energy sectors in Georgia and various players and stakeholders acting not only in traditional energy sectors but also acting in Renewable and Energy Efficiency filed. More specific in below presented chapters in detail is considered current energy situation in the country started from its collapse at the end of 1990s till its renovation. In the report is presented the main energy sources and suppliers for the Georgia, its total consumption by sectors with consideration of economical development in Georgia as well as energy prices for a generation, transmission dispatch, distribution, import and consumption of electricity and for the transport, distribution and consumption of natural gas. Also, current situation in terms of legal basis and policy related to energy sector in Georgia.

In the report is described the current situation related with renewable energy sources and energy efficiency, its potential and capacities as well as bottlenecks and barriers for development of innovative technologies. Also, how far these are already relevant and applied in the business sector along with existing linkages between energy research institutes, higher education institutions and business sectors.

At the end of the report is identified and analyzed the strengths and weaknesses of the local energy sectors and of its innovative capacities in Georgia and the needs to be done to improve the EE/RES situation in the business sector and linking research and business better. In the report is outlined the cooperation opportunities between EU and ENP partners on innovations in EE/RES and the projects and programmes implemented at present in Georgia by various local and international organizations.

Also, how and by whom the development of innovative technologies is supported in the economy and energy sector, what kind of support for energy efficiency and renewable energies are available in the Georgia. in detail is represented the main players and stakeholders acting in RE/EE filed from different sectors such as governmental, non-governmental, research organizations and business in Georgia. How are the energy sector and the energy research community linked internationally; especially focused on cooperation with international partners.

8.2 Current energy situation in the country

8.2.1 Geographical and climate characteristics of the republic of Georgia

Georgia since 1991 is an independent country in the South Caucasus region. It is located at the crossroads of Western Asia and Eastern Europe, bounded to the west by the Black Sea, to the north by Russia, to the south by Turkey and Armenia, and to the southeast by Azerbaijan. The capital of Georgia is Tbilisi. Georgia covers a territory of 69,700 km², and its population is about 4.4 million. The capital, Tbilisi has population of about 1.15 million. Georgia is divided into 9 regions, 1 city (capital), and 2 autonomous republics. These in turn are subdivided into 60 districts.

Picture 1: Map of Georgia

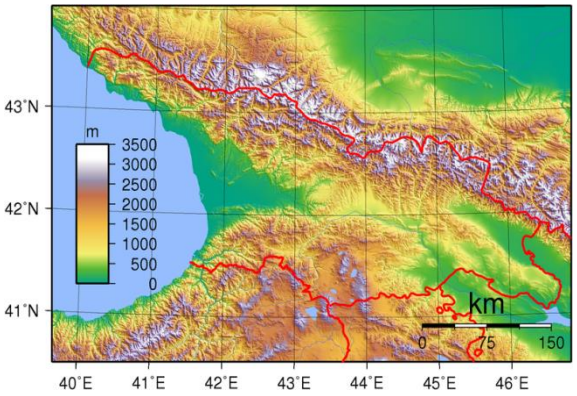
A mountainous landscape determines the variety of Georgia's physical geography: there are mountains, valleys, plains, lowlands, glaciers, wetlands, arid lands, lakes, rivers and even 18 geysers. Mountains cover a significant part of the territory: 54% of it is located at an altitude of 1,000 m above sea level. In addition

to the Great Caucasus range, there are several other mountain ranges in Georgia. The most important is the Likhi Range, running from the North to the South and dividing the country into its Eastern and Western parts.

Almost every climatic zone is represented in Georgia except for savannas and tropical forests. To the North, the range of the Great Caucasus protects the country from the direct penetration of cold air. The circulation of these air masses has mainly determined the precipitation regime all over the territory of Georgia. The climatic picture totally differs in both parts of Georgia as divided by the Likhi Range.

The climate in Western Georgia is highly diverse, altering in certain areas very sharply from humid subtropical to permafrost. The climate is determined by the Black Sea coast to the West, and by the amphitheatre of three big mountain ranges (the Great Caucasus, the Likhi and the Meskheti), in addition to the surrounding Kolkheti lowland (wetland) in the very centre.

The Black Sea coastal zone has a humid subtropical climate. The average annual temperature there is 14-150C, with extremes ranging from +450C to -150C, and annual amounts of precipitation vary between 1,500 mm and 2,500 mm. The Black Sea influences the climate of West Georgia, resulting in mild winters, hot summers and abundant precipitation. Here in the mountainous and high mountainous areas, the annual air temperature ranges from 6-100C to 2-40C with an absolute minimum between -300C and -350C, and annual amounts of precipitation range between 1,200-1,600 mm and 2,000 mm.



Picture 2: Topography of Georgia

The climate in the plains of East Georgia is dry: in the lowlands, it is a dry subtropical climate, and in mountainous areas it is alpine. The average annual temperature is 11-130C in the plains, and 2-70C in the mountains. The absolute minima are -250C and -360C respectively. The absolute maximum reaches +420C, and the absolute minimum falls to -420C in the high mountains (the slopes of Mount Kazbegi). The annual amounts of precipitation vary in the range of 400-600 mm in the plains, and 800-1,200 mm in the mountains.

Georgia is rich in fresh water: rivers, lakes and springs. The rivers are not large enough to be navigated but they are fairly potent for the purposes of hydro energy and fishery, owing to their fast and sloping run. The largest river is the Mtkvari (Kura), which originates in Turkey and, crossing through almost all Georgia, flows into the Mingechaur Reservoir (in Azerbaijan). Two other rivers also flow here – the Alazani and the Lori, originating in the mountains of the Great Caucasus, and running down the Kakheti region. The other important rivers of Eastern Georgia are the Liakhvi, the Khrami, and the Aragvi.

Western Georgia is even richer in rivers than Eastern Georgia. Most of these have their origins in the mountains of the Great Caucasus. The rivers Rioni, Enguri, Tskhenistskali, Natanebi, and Supsa, all flow into the Black Sea. In South Georgia, on the Javakheti Highland, at an altitude of 2,100 m, lies Georgia's largest lake, Paravani (37.5 km2). Other lakes include Paliastomi (18.2 km2), Tabatskuri (14.2 km2), Jandari (10.6 km2), and Bazaleti 12 km2). There are also over 20 reservoirs of fresh water formed by different rivers.

Georgia is rich in various ecosystems. The Kolkheti lowland stretches over 600 km2 of Western Georgia and is a vast wetland; in Eastern Georgia, the Kakheti region is the arid area of the Gareji semi-desert (70 km2), and glaciers along the Great Caucasus occupy an area of about 500 km2. Forests cover 43% of the total area of the country. Georgia's magnificent forests, abundant in rare species of wood, are the true wealth of the country. The rich nature, diverse climate and large variety of healing geothermal and

mineral waters in the country have resulted in a number of resorts being established, some of which are world famous. Georgia possesses certain reserves of various mineral resources, the most important of which are manganese, iron, copper, coal and marble[108].

8.2.2 Georgian Energy Sector characteristics

Before consideration of energy supply and consumption by sectors in Georgia it should be noted that annual energy consumption has been significantly reduced in Georgia compared with data of last century of 1990s. Along with collapse of USSR a sharp drop of energy reduction consumption was caused by economic and social crisis in the first years of country's independence and occupation (about 20%) of the country's territory.

In the Soviet period Georgia imported most of its energy resources, including power, natural gas and oil from former Soviet republics. Accordingly, the Georgian power system was once part of an integrated regional system of the South Caucasus that allowed for the balancing of seasonal deficit in hydropower in winter with power imports, and the export of surplus power in spring and summer due to the seasonal nature of production from Georgian hydropower plants.

Following the breakup of the USSR, the energy sector in Georgia and its capital Tbilisi suffered a catastrophic collapse in the early 1990s. Power, oil and gas import and supply to industries and households dropped dramatically. At that time, no customer in Georgia had uninterrupted power supply. The regions of Georgia as well as a capital had a scheduled power supply, there were daily blackouts, and in winter periods some areas of Georgia had no power for a number of days, weeks and even the months. Power sector assets were dilapidated and theft of electricity and corruption were rampant. Due to a lack of financial discipline in the sector, only a fraction of fees paid by customers were collected, resulting in a massive debt accumulation by sector companies, making them unable to import needed power for the country from neighboring countries' systems, which in turn led to more power shortages. Deficits in management, financial control, maintenance and timely rehabilitation works on the energy infrastructure played a significant role in the near collapse of the power and gas systems. The disintegration of the centralized economic system and the drastic increase in prices for energy resources after the collapse of the former Soviet Union were followed by a serious energy crisis in Georgia.

Since 2004 with support from the International Development Association (IDA) in the Electricity Market Support Project, the new government transformed the power sector into a financially viable, modernized, and functioning sector. For the last few years, this sector has delivered 24-hour uninterrupted power supply to its customers including households, the public sector, industry, transport and commercial entities.

Currently Georgia is a net importer of natural gas and petroleum products, which are, with hydropower and biomass for residential heating, the main energy sources. Much of its electricity and gas infrastructure is scheduled for refurbishment but the costs of the necessary rehabilitation are large, considering the timeframe available. Acute situations have developed over the high rates of electricity losses and gas leakage and the non-collection of bills precipitated a crisis in the power supply. Reform efforts in power sector regulation and governance are well underway and large-scale refurbishment and the renewal of critical infrastructure is high on the government's list of priorities.

From the early 1990s through to 1996 primary energy demand was in free fall. This is illustrated in the figure below, where by 1996 energy demand was at one third of that at the beginning of the decade.

[108] unfccc.int/resource/docs/natc/geonc2.pdf 2nd National Communication to UNFCCC

Primary energy demand broadly reflects the fortunes of the economy and it only resumed growth in 2002, having bottomed out at 25% of the demand 12 years earlier.

8.2.2.1 Oil and Gas

Georgia is a net importer of fuels and energy products. The country relies on imports of natural gas, oil products and some hard coal and bio-fuels to meet most of its energy needs. Net imports represent 77.4% of total primary energy sources (TPES), and this share has increased from 47.2% in 2002 as Georgia has had to increase its reliance on imports to meet robust demand. Georgia also exports modest quantities of feedstock and oil products, which account for less than 2% of total TPES. Azerbaijan is the largest trading partner with Georgia in energy, and is the main source of imports of natural gas and oil. Gas imports were 2 billion cubic metres (bcm) in 2013, and around 88% was from Azerbaijan. However, gas trade with Azerbaijan only began in 2009. Previously, all gas was imported from Russia, and Russia is still the source of 10% of gas imports, mainly through transit fees for gas transit to Armenia. Oil product imports were 1 Mtoe in 2013 and came from Azerbaijan (48%) and other non-specified countries. Total primary energy supply (TPES) was 3.7 million tonnes of oil-equivalent (Mtoe) in Georgia in 2012. Energy supply has increased by 45.7% compared to 2002, growing every year since, apart from in 2008 when TPES declined by 10.1%. Energy per capita was 1.04 tonnes of oil-equivalent (toe) in 2012, also up by 48.2% since 2002.

Natural gas is the main fuel in Georgia's energy mix, accounting for 44.5% of TPES in 2012. The supply of natural gas has increased at a faster rate than overall energy supply, growing by 142.6% since 2002. Demand from the residential and commercial sectors has driven this growth. Oil, including oil products, is also a significant fuel in Georgia, and it represents 27.1% of TPES. The supply of oil has increased by 76% since 2002, mainly driven by growing demand from the commercial and industrial sectors. The supply of coal has had resurgence in the past five years, with its share in the energy mix increasing from 0.5% in 2002 to 2.9% in 2012. Graph below refers total primary energy supply of Georgia in 1990-2012[109].

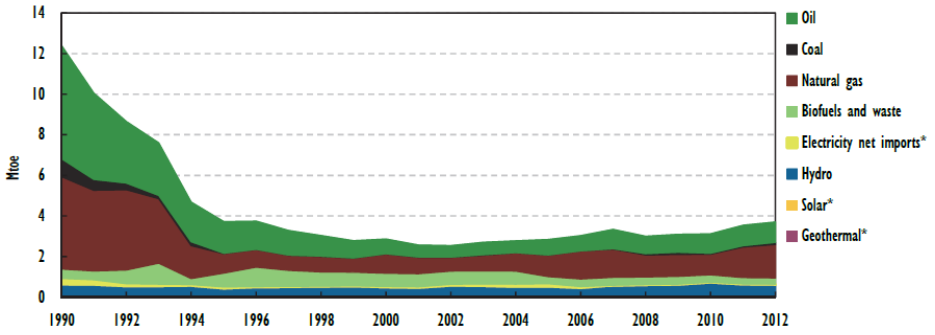


Figure 1: Total Primary Energy Supply of Georgia

Georgia's proven oil and gas resources are modest. The country's 15 oil fields have confirmed reserves of about 8.3 million tons but larger oil reserves are assumed to exist. The oil potential of the Black Sea shelf is estimated at 70 million to 1.3 billion barrels (GTZ, 2009). Oil extraction and exploration works are conducted by Georgian and foreign companies. In 2012[110] in Georgia the total crude oil production was 48977 tons, while the average annual natural gas production for the period 2009-2013 totaled 16,5 6,3 mlm^3.

[109] Source: IEA (2014), Energy Balances of Non-OECD Countries, OECD/IEA, Paris
[110]"In-Depth Review of Energy Efficiency Policies and Programmes" – page 33

	RESERVE	RESOURCE
Coal, (Mtoe)	185	300
Brown Coal (Mtoe)	20	-
Oil (Mtoe)	42.5 (8.3+23.7+10.5)	850
Natural Gas (bcm)	8.4 (2.9+5.3+0.24)	180
Hydro (TWh)	32 (maximum economic potential)	80 (technical potential)

Table 1: Energy Resources of Georgia[111]

Although Georgia has no proven large-scale oil and gas resources or production, it can generate revenues from oil and gas transit because of its geo-strategic location. Despite its lucrative location, Georgia has struggled to secure a basic energy supply for its citizens since independence.

Georgia remained a reliable energy partner for the EU in developing the Southern Corridor. Georgia and Ukraine are working on a new multilateral inter-governmental agreement to develop the Euro-Asian Oil Transportation Corridor (EAOTC). In June, the Shah Deniz II (SD II) shareholders' consortium selected the Trans-Adriatic Pipeline as the European supply route for SD II gas. In September, long-term gas sales agreements were signed with nine European companies to supply 10 bcm/year of SD II gas to Italy, Greece and Bulgaria. The signature of these agreements marked an important step towards the Final Investment Decision, which was concluded in December at a ceremony attended by Commissioner Oettinger and several heads of state and government.

8.2.2.2 Natural Gas Supply in Georgia and Tbilisi Capital

Despite the fact that Georgia more or less has significant potential of internal energy resources, energy supply of national economy largely depends on the import of primary energy resources, especially such as oil and gas. The fuel and energy complex is composed of natural gas transportation and distribution sectors, power generation plants, state electro system of Georgia, up to 50 natural gas distribution companies and 4 large power distribution companies[112].

Imported gas is mainly used for heating and cooking by households and power generation. In rural area of Georgia the main primary energy used for heating and cooking is local bio-fuels mostly firewood. Most of Tbilisi is covered with natural gas distribution network. In Tbilisi natural gas is distributed by the Ltd "Kaztransgas". Natural gas consumption in Tbilisi was more than 2.05 billion m^3 in 1989. Gas import and consumption dropped dramatically in the 1990s. The natural gas supply has improved in recent years. Currently annual consumption is about 500 million cubic meters. There is a trend of increasing gas consumption in the city. The major consumer is the household sector[113]. The central heating system in Tbilisi and main cities of Georgia collapsed in the 1990s due to the fuel shortages and lack of maintenance on the distribution network. At present the central heating system does not exist in Georgia and households usually use individual heating (gas heaters and/or firewood stoves) equipments.

The total final consumption (TFC) by energy source for 2013-14 is illustrated in the Table 2: Total Consumption by energy source below, which show the dominance of oil and gas in the total final energy consumption[114].

[111] Georgian Oil and Gas Trunk Pipelines by T. Gochitashvili, T. Javakhishvili – page 24

[112] Energy Balance of Power Sector of Georgia – page 5

[113] GEO-Cities Tbilisi: an integrated environment assessment of state and trends for Georgia's capital city – prepared with project of UNEP and OSCE

[114] Source: Energy Efficiency Center Georgia data

Total final energy consumption/ Products	2013		2014	
	(1000 toe)	%	(1000 toe)	%
Coal	315.1	8.5	290.4	9.7
Oil	1077.6	28.9	113.2	3.8
Natural Gas	1058.7	28.4	1277.9	42.6
Geothermal/Solar	13.5	0.4	14.9	0.5
Bio-fuel/Waste	481.1	12.9	465.0	15.5
Electricity	780.3	20.9	841.4	28.0
Total	**3726.3**	**100 %**	**3002.8**	**100 %**

Table 2: The total final consumption (TFC) by energy source for 2013-14

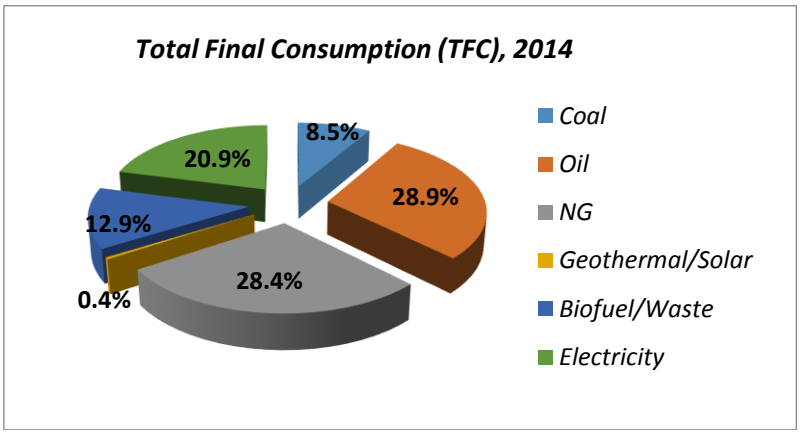


Figure 2: Total Energy Consumption for 2014

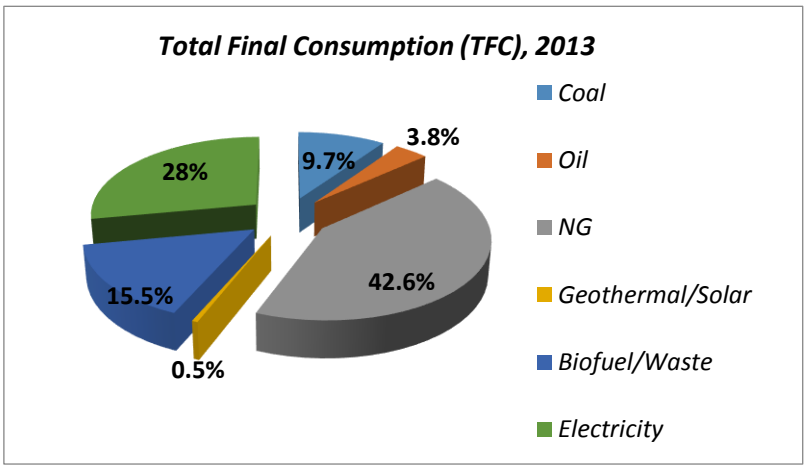


Figure 3: Total Energy Consumption for 2013

Georgia's strategic location makes it a transport corridor for natural gas and crude oil supplies to European markets. The transport corridor through Georgia allows the EU to diversify its supply, increasing energy security. In addition, Georgia is the only route for the transportation of Russian natural gas to

Armenia. Georgia's favorable location has prompted significant investments into its oil and gas sector. Georgia's main natural gas pipelines are:

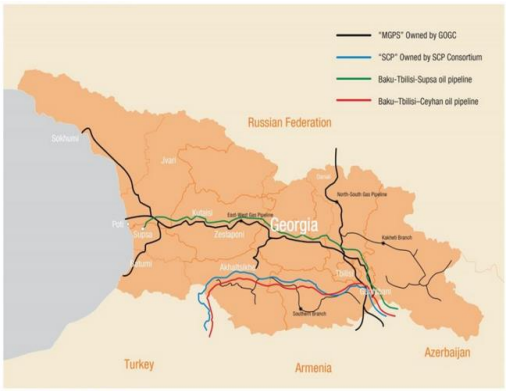
- Main Gas Pipeline System (MGPS) that stretches across the country and is comprised of:
  - North-South Gas Pipeline (NSGP), extending 235km and transporting gas from Russia to Armenia;
  - East-West Gas Pipeline (EWGP);
  - Southern branch;
  - Kakheti branch;
- South Caucasus Pipeline (SCP) that stretches 692km (249km in Georgia) and transports natural gas from Azerbaijan to Turkey through Georgia and from Turkey further to the EU. The Southern Gas Corridor project, aimed at improving the security and diversity of EU energy supply, will bring additional volumes of natural gas from the Caspian region to Europe. It is comprised of several separate energy projects, including the expansion of the SCP pipeline.

Georgia's main oil pipelines are:

- Western Route Export Pipeline (WREP) that stretches 833km (375km in Georgia) and transits crude oil from Azerbaijan to the Black Sea coast (Supsa) for onward shipping to global markets;
- Baku-Tbilisi-Ceyhan Pipeline (BTCP) that stretches 1,768km long (249km in Georgia) and transits crude oil from Azerbaijan to Turkey on the Mediterranean Sea;

Georgian Oil and Gas Corporation (GOGC) is a state-owned company (under the Partnership Fund). GOGC holds the legal status of a National Oil Company (NOC) and represents the state's interests in upstream crude oil and natural gas projects in Georgia. GOGC was established to consolidate Georgia's energy assets under single management.

To guarantee uninterrupted gas supply in the critical situation and significantly improve Georgia's energy security as well as manage seasonal supply/demand misbalances Georgia plans the construction of the underground gas storage reservoir in Samgori. The storage capacity would be 230-250 mmcm, about 10-15% of current annual consumption. Georgia is currently the only country in the region with no gas storage. A feasibility study is currently underway. The estimated project cost is around US$ 250mn[115]. 2014 was characterized with high demand on natural gas which was increased by 15% compared to the previous year and basically it was conditioned by the increased demand in gas filling stations. They consumed 80 mln m3 more natural gas compared to the previous year. The volume of consumed natural gas by the Thermal Power Plants was increased by the 70 mln m3 in the reporting year compared to the previous year.



Picture 3: Pipelines in Georgia

Gasification activities were actively carried out across the country. Connection of new customers to the distribution network was especially accelerated after adoption of the "Rules and procedures for the connection on new customers to the natural gas distribution network" by the Commission.

At the end of the 2014 the gasification coefficient reached the 73 %. The volume of consumed natural gas by the household sector was 597mln m3 which is 4% more than similar indicator of the previous year.

[115]Source: Georgian Oil and Gas Corporation/GOGC

The average annual consumption of natural gas by the one household customer (gasified household) was 697m3 in Georgia.

The devaluation of Georgian Lari became a significant challenge for the main actors of the market as far as Georgia is almost fully dependent on the imported resources and therefore prices on natural gas was increased in national currency for certain suppliers.

Natural gas market of Georgia represents a market of direct contracts. Both long-term and short-term contracts are drawn between the suppliers. Affiliated companies of 'Socar' (Azerbaijan Compnies) dominate on the market which participate in both retail and wholesale market. They supply the imported natural gas to the suppliers and final customers. Natural Gas market is comprised of two different segments from the wholesale level to the customer level. Households and Thermal Power Plants are consuming cheaper natural gas. Accordingly, these two customer categories are represented as a social segment. The other customers buy natural gas through the direct contracts with different commercial prices and therefore they represent a non-household segment.

Existing structure and organization of Georgian natural gas market is conditioned by the proportion of natural gas supplied from South Caucasus Pipeline in cheaper prices and imported commercial gas. The volume of natural gas delivered from South Caucasus Pipeline (SCP) is not enough to satisfy the total consumption of the country. Therefore special customer categories are defined by the Government of Georgia (part of household customers and TPPs) for whom the natural gas supplied from SCP and North South Main Gas Pipeline (NSMGP) is available. Respectively, natural gas market of Georgia is divided into the regulated and deregulated segments. Wholesale and retail market prices, except for the regulated part of household customers8 and TPPs, are deregulated and natural gas is supplied to them without setting the consumer tariff.

Option and additional gas from SCP and natural gas received as Armenian transit fee are transferred by JSC "Georgian Oil and Gas Corporation (GOGC)" through LLC "Socar Gas Export-Import" to the natural gas regulated segment (TPPs) and natural gas wholesale and retail traders who are delivering the natural gas to the distribution licensee which are represented as the suppliers for the household sector.

It should be noted that the division of suppliers as wholesale and retail suppliers is conditional as in most cases wholesale suppliers are carrying out the retail supply as well. Subsidiary companies of Socar almost fully supply the natural gas to the deregulated segment of market on the wholesale level, which is imported from the Republic of Azerbaijan. They supply natural gas to the distribution licensees to meet the needs of the deregulated customers (non-household sector).

Suppliers on the wholesale market supply the natural gas to the retail suppliers and retail suppliers - to end-users. Companies participating in wholesale market in some cases also provide retail supply. For the analytical purposes the wholesale supplier is a supplier who supplies at least little amount of natural gas to another supplier. Total volume of natural gas entered the Georgian natural gas transportation system was 4.26 billion m3 from which 48.4% was transit in the Republic of Armenia[116].

8.2.2.3 Electric Power Supply of Georgia and Tbilisi Capital

Currently the installed generation capacity in Georgia totals 3700 MW of which 75% (2786 MW) is Hydro Power Plants. The installed capacity of four thermal power plants is 913 MW. In 2014 HPPs accounted for 80% (8.3TWh) of total electricity produced, with TPPs accounting for the remaining 20%. The state-owned Enguri and Vardnili HPPs, which are partially located on territory occupied by Russia, (According to an agreement between the Government of Georgia and the *de facto* government of Abkhazia, ~60% of the electricity generated by the Enguri and Vardnili HPPs is supplied to Georgia; the remaining 40% goes to Abkhazia) are the largest HPPs in the country They account for 38% of total electricity generation.

[116] Source: Georgian National Energy and Water Supply Regulatory Commission/GNERC Annual report, 2014

In 2015 231,2MW capacity combined cycle Thermal Plant in Gardabani was commissioned. The plant efficiency is 1.5 times higher than that of existing thermal plants working on natural gas. Electricity generation in M KWh in Georgia in 2011-2014 is presented in Table 3 below[117].

	2011	2012	2013	2014
Electricity generation	10104.51	9694.72	10058.8	10369.6
Thermal plants	2212.05	2472.1	1787.71	2035.9
Hydro Plants	7892.46	7222.62	8271.04	8333.7
Import	**470.98**	**614.59**	**484.11**	**851.9**

Table 3: Electricity generation and import in GWh in Georgia in 2011-2014

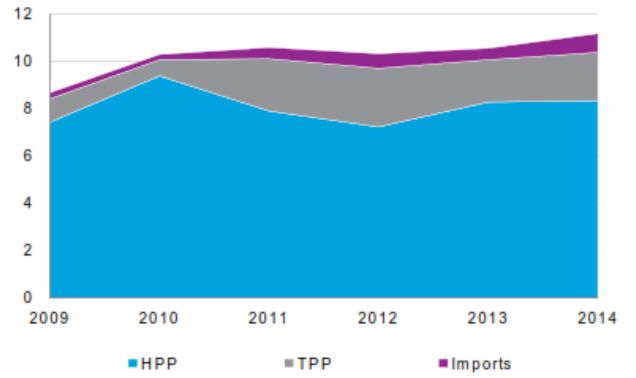


Figure 4: Electricity Supply Structure in TWh

Over the last 5 years electricity generation has grown 23% to 10.4TWh in 2014, while consumption increased 27% to 10.2TWh. Growth in electricity consumption is largely driven by economic growth. In general, a 3% increase in GDP translates into a 1% rise in electricity consumption. Since reforms began domestic electricity demand and electricity use per capita have been relatively stable in the face of growing GDP and per capita income, reflecting in part improved efficiencies in the delivery and use of electricity. Annual electricity use per capita averages 1,780 kWh from 1995 to 2009. Annual per-capita electricity consumption in Georgia (2,260 kWh in 2014) is below OECD levels (around 8,000 kWh)[118].

[117] Source: Electricity System Commercial Operator of Georgia (ESCO)
[118] Source: Electricity System Commercial Operator of Georgia (ESCO)

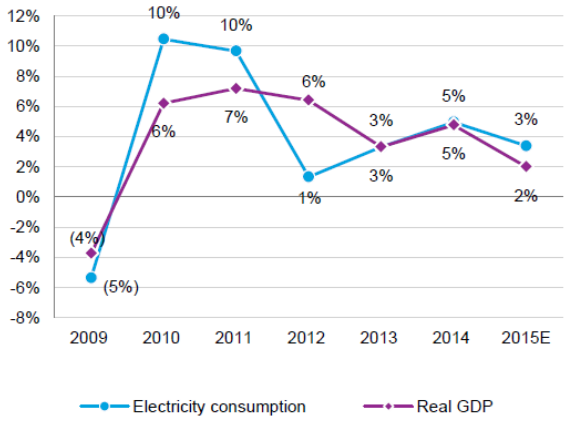


Figure 5: Electricity consumption vs. GDP growth

In 2010 and 2011, demand for electricity grew as much as 10% annually, although in 2012 and 2013, the increases tapered off to 2% annually. As only hydropower will not meet the increased demand import of electricity and natural gas for thermal power will be needed to balance supply and demand[119].

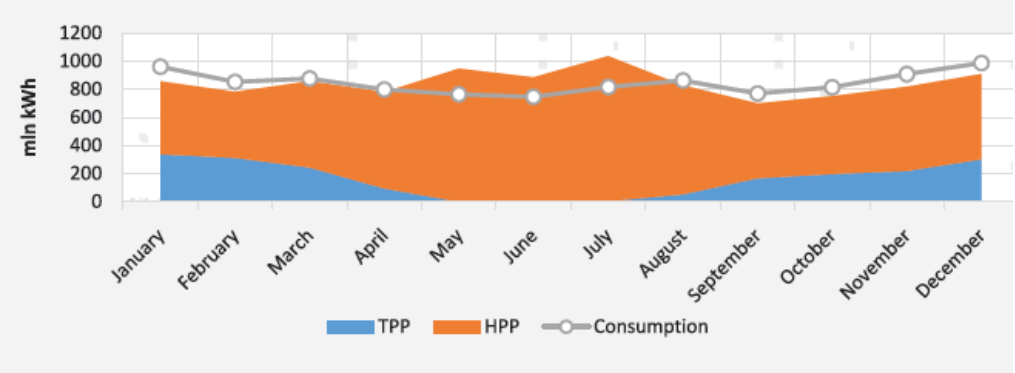


Figure 6: Electricity Consumption and Generation in 2014

Balance of electricity generation and consumption in 2014 has been negative and almost twice as much as in previous year.

[119] Georgian National Energy and Water Supply Regulatory Commission

	2010	2011	2012	2013	2014	2015
Import from Turkey	0.00014	0.0028	0.006			
Export to Turkey	-303.37	-218.63	-79.01	-0.005	-236.49	-349.858
Import from Azerbaijan	10.14	23.42	97.54	23.56	184.23	101.694
Export to Azerbaijan	-14.34	-5.92	-11.79	-6.61	-8.03	-0.03
Import from Armenia			0.0004	0.001	2.1	23.2
Export to Armenia	-89.45	-117.47	-67.92	-73.16	-140.46	-70.847
Import from Russia	211.94	447.54	517.05	460.55	607.01	264.542
Export to Russia	-1117.12	-588.58	-369.44	-370.61	-160.08	-169.574
Total Import	**222.08**	**470.96**	**614.59**	**484.11**	**793.34**	**389.44**
Total Export	**-1524.28**	**-930.6**	**-528.15**	**-450.39**	**-545.06**	**-590.31**

Table 4: Electricity Import/Exports Statistics, 2010-2015 (Mln.kWh)

In 2014 balance of electricity import and export was still negative (see Table 4). Import of electricity has reached 793, 33 million kWh, which is 64 % more than it was in 2013 and 29% more than in 2012. As for the export, 646,06 million kWh electricity was exported from Georgia that is 21% more than 2013 indicator and 3% more than 2012.

According to consumption scenarios (growth 2-5%) by 2020 the consumption will reach 12-14 TWh and existing hydro generation units will not meet such demand. The deficit will be covered by more expensive thermal plants and imports. If no new generation capacity is added to the system, and because of the seasonal nature of hydropower generation, power shortages could occur at least in winter, although power may still be exported during summer months.

According to Ministry of Energy 22 HPPs with total installed capacity of 1,550 MW are either under construction or at licensing stage and will be in operation by 2020. If 702 MW Khudoni HPP project is excluded from forecasted estimations (due to financial problems, social and environmental concerns) the hydro generation will increase by 2020 by 848 MW from current 3,000MW.

In addition Ministry of Energy has signed 72 MoUs with investors for construction of HPPs with total installed capacity of 2,600 MW. Output at HPPs is seasonal with peaks in summer and falls in winter. In winter to balance deficit Georgia depends on thermal plants and imports. Since 2012 Georgia has become net electricity importer after being net exporter over 2006-2012 which can be explained by increased consumption and insufficient generation. In 2014, Georgia imported 793 GWh, while exported 545 GWh. As new generation units come on the pipeline Georgia will boost exports during the summer months. Georgia's long-term energy policy goal was 100% reliance on hydropower; however, this approach was changed with the construction of a new thermal power plant and exploration of the possibilities for the utilization of wind energy for power generation.

The power grid consists of a network of 6-, 10-, 35-,110-, 220-, 330-, 500-kilovolt (kV) lines covering almost all of Georgia, except for some remote mountainous villages, and is interconnected with Armenia, Azerbaijan, the Russian Federation (through Abkhazia), and Turkey. The transmission system belongs to three companies—JSC Sakrusenergo, Georgian State Electrosystem (GSE), and JSC Energo-Pro Georgia. JSC Sakrusenergo, 50% owned by the Georgian government and the other half by the Russian company Inter RAO UES, owns 330-kV to 500-kV lines. Its main function is to transmit electricity through interconnected lines with neighboring countries, except Armenia. GSE owns and operates 110-, 220-, and 330-kV lines, and several facilities down to 35-kV lines (in Kakheti Region). It also owns all substations and holds the license for the Dispatch Center. GSE transmits domestic electricity. All power transmitted within Georgia through JSC Sakrusenergo goes through GSE network. The company is responsible for controlling the power system, to ensure overall system reliability and proper operation of the transmission network under both normal and emergency modes. In 2013, Energotrans, a subsidiary of the GSE, completed the Black Sea Transmission Line that connects Georgia and Turkey. It owns and operates the 500-kV Vardzia and Zekari lines and 400-kV Meskheti line. Georgia is the first country in the region to install HVDC back-to-back links, with guarantees a stable exchange of electricity without disturbances to or contingencies within the Turkish high voltage power system. They also improve the stability of the national electricity network and strengthen country's potential to be a hub for electricity transits. Energy transfer between Georgia and the demanding markets of Turkey started through the new 700MW HVDC converter station and related 500/400kV lines, with total 278,09 million kW/hrs transmitted in 2014.

Under the law GSE became a Transmission System Operator (TSO) authorized to operate and plan the development of entire transmission grid of Georgia; New tariffs established for transmission and dispatch services enables GSE to operate and maintain the sustainability of the system in a more effective manner; GSE prepared and the Government approved 10-Year Transmission Grid Development Plan for the period up to 2025 with the focused approach to the current developments in the sector.

JSC Energo-Pro Georgia has been involved with transmission since late 2014 with the completion of the 110kV Nigvziani line, which serves Poti and Ureki regions and low-voltage transmission lines. It is also constructing the Batumi-Muratli transmission line to Turkey, with commissioning expected in 2016.

The distribution network consists of 6-, 10-, 35- and110-kV lines and substations, supplying electricity to about 1.45 million consumers. Power is suppliedto small residential and commercial consumers at 220/380 volts and to large consumers at higher voltage. Power is distributed by three distribution companies.

JSC Energo-Pro Georgia is the largest distribution company, with high (35–110 kV), medium (6–10 kV), and low (0.4 kV) networks throughout most of the country (except in Tbilisi and the Kakheti region)[120]. JSC Energo-Pro Georgia provides distribution services, power supply, and wheeling to about 952,228 customers, serving about 43% of total electricity demand. JSC Energo-Pro Georgia bought the assets of the United Electricity Distribution Company of Achara and of six medium size hydropower plants. Thus, JSC Energo-Pro Georgia nowowns 15 hydroelectric power stations, with a total installed capacity of more than 469 megawatts—about 18% of the country's hydropower capacity.

[120] Source: web-site of 'Eenergo-pro Georgia' / energo-pro.ge).

JSC Telasi is the second largest distribution company in Georgia, and owns high (35–110 kV), medium (6–10 kV) and low (0.4 kV) voltage networks in Tbilisi and surrounding areas, supplying about 2 billion kWh per year to its 492,813 customers. Under a memorandum of understanding with the government, JSC Telasi has an assured long-term tariff until 2026. JSC Kakheti Energy Distribution is a distribution company operating in the Kakheti region, providing 200 gigawatt-hours of electric energy annually to its 138,872 consumers (GNERC 2014). The three companies currently serve almost 99%of Georgia, except for the disputed territories and a small population in remote mountain villages. All three distribution companies also buy electricity and sell it to their customers; under present legislation, distribution and supply are not unbundled.

8.2.3 Basic Description of the Economic Situation related to the Energy Sector; GDP per capita and its development

Georgia's macroeconomic performance and general progress with reforms in the past years have been strong. Georgia has achieved significant economic growth, mainly driven by large foreign capital inflows. Foreign investments across different sectors of the economy have contributed to broadening the economic base. Domestic credit has grown rapidly, supported by increased confidence in the banking sector and access to international financial markets. The level of dollarization in the sector has gradually decreased and progress with structural reforms has been significant. Reforms include the regulatory framework for business, free industrial zones, reduced corruption, a simpler tax system and large-scale privatization in critical sectors of the economy.

However, the Georgian economy was greatly affected by both the Russian – Georgian conflict in August 2008 and the international financial crisis. The August conflict undermined investor and consumer confidence, put stress on public finances and damaged the physical and other infrastructures. The intensification of the international financial crisis has put further pressure on Georgia's currency and foreign investments and affected the quality of its loan portfolios and the recovery of bank deposits. Remittances from workers living abroad have declined since the beginning of 2009 due to the global economic slowdown, in particular those from Russia, which is the source of two-thirds of remittances. This negative impact has been partly offset by large-scale international financial support, amounting to about $4.55 billion over three years, pledged in October 2008. The IMF emergency 18-month stand-by programme of $750 million that started in mid-September 2008 (augmented by an additional $424 million and extended by 14 months in August 2009) also helped with the stabilization process.

Georgia made a peaceful transition of power following the 2012 and 2013 presidential and parliamentary elections, further demonstrating its commitment to a democratic process. Corruption and ease of doing business indices continue to be favorable. An Association Agreement and a Deep and Comprehensive Free Trade Area agreement was signed with the European Union in 2014. Trade with Russia opened up in 2013 and has since grown significantly.

Georgia handled the difficult 2008–2009 period well, including through the support of an IMF program. Following the dramatic slow-down of the economy—with a contraction of 3.7 percent in 2009—growth returned, reaching 4.8 percent in 2014. Fiscal deficits averaging close to 7.5 percent of GDP in the period 2008–10 were reduced to 2.9 percent of GDP in 2014. Inflation—which reached 10 percent in 2008—has remained in recent years. However, the current account

deficit has remained stubbornly high, reaching close to 10 percent of GDP in 2014. External debt is also high at around 80 percent of GDP.

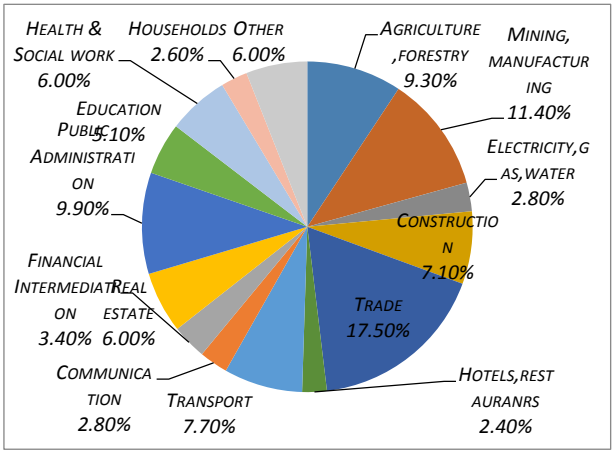


Figure 7: Georgia's GDP Structure[121]

In 2014, the largest share in GDP formation had trade (17.4%), manufacturing (17.1%), transport and communication (10.5%), state government (9.9%) and agricultural (9.2%) sectors. In this period, the structure of GDP is similar to the structure in 2013.

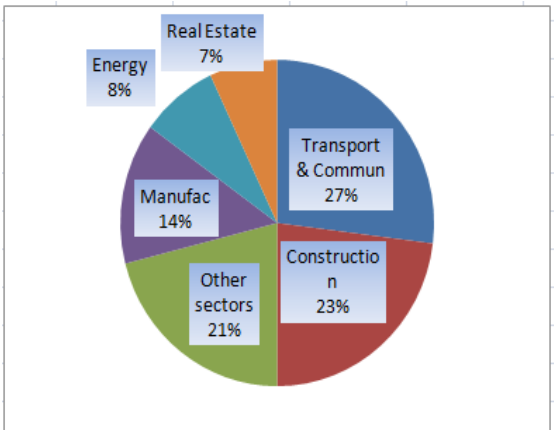


Figure 8: Foreign Investments 2014

In 2014, the economy of Georgia grew by 4.8%. The indicator of real GDP growth rate exceeded (1.5% points) the corresponding indicator of 2013 (3.3%). In the first quarter of 2014, the real GDP growth rate was quite high (7.2%), while it slowed down during the next three quarters. In the fourth quarter of 2014, the economic growth was 1.8%.

In 2014, the volume of FDI increased by 35.1 % compared to 2013 and was 1272.5mln.USD. The foreign direct investment increased significantly in the third (99.16%) and fourth (54%) quarters of 2014.

[121] Source: National Statistics Office of Georgia/GeoSTAT

In 2014, the top three economic sectors in terms of the largest FDI flow were: transport and communication (27%), construction (23%) and manufacturing (14%), while in 2013, the FDI structure by economic sectors was the following: energy (26%), financial services (18%) and transport and communication (17%).

The bulk of the energy FDI falls on the electricity generation sector. Over the past three years, US$ 283mn was invested in HPPs through which an additional 170MW of installed capacity was added to the grid, according to the Ministry of Energy. Commercial banks are actively involved in the development, with over US$ 100mn of financing made available over the past three years[122].

The figures (table 5 & figure 9) below are illustrating the energy consumption for 2013-14 by the various sectors of the economy.

Sectors	**2013**	**2014**
	Thousand Tonnes of Oil Equivalent	
Industry	654.1	612.7
Transport	963.1	1328.1
Commercial & public services	192.9	431.8
Residential	1467.9	1190.09
Agriculture/forestry/fishing	13.7	12
not elsewhere specified	138	140.9
non-energy use	296.6	306.4
TOTAL	**3726.3**	**4021.99**

Table 5: Energy Consumption for Various Sectors in 2013-2014

[122] Source: Galt & Taggart

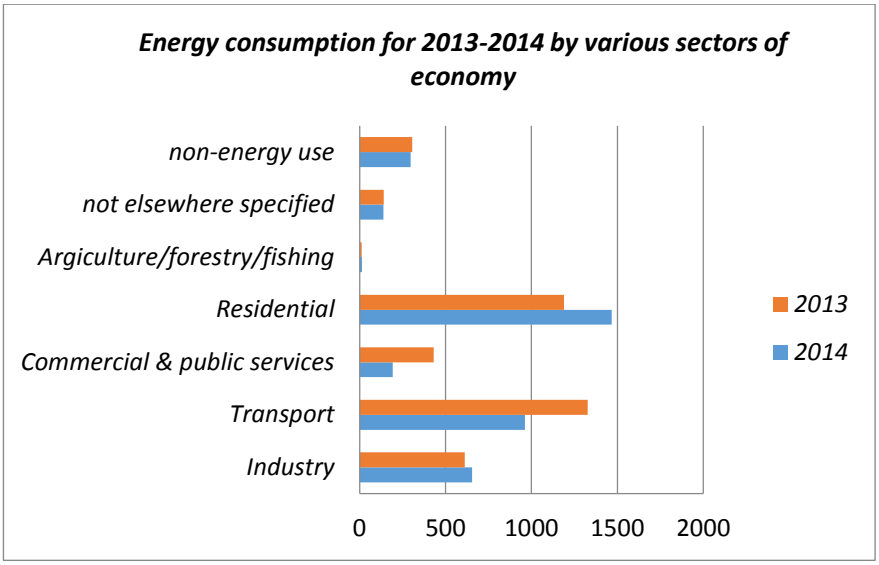


Figure 9: Energy Consumption for Various Sectors in 2013-2014

Residential sector stands first in energy consumption which could be mainly attributed to the heating of living spaces. Georgia is dependent on imported natural gas and oil from Russia and Azerbaijan, and as a result, economic growth and resulting increases in energy demand indicate that the need in energy efficient improvements in industrial sector is of high importance.

Georgia has one of the most energy-intensive economies when compared with similar size countries. Only Azerbaijan and Armenia consumes more energy per U.S. dollar of gross domestic product adjusted to purchasing power parity in the region. The chart below presents the energy intensity of Georgia, its close neighbor countries and the Baltic States.

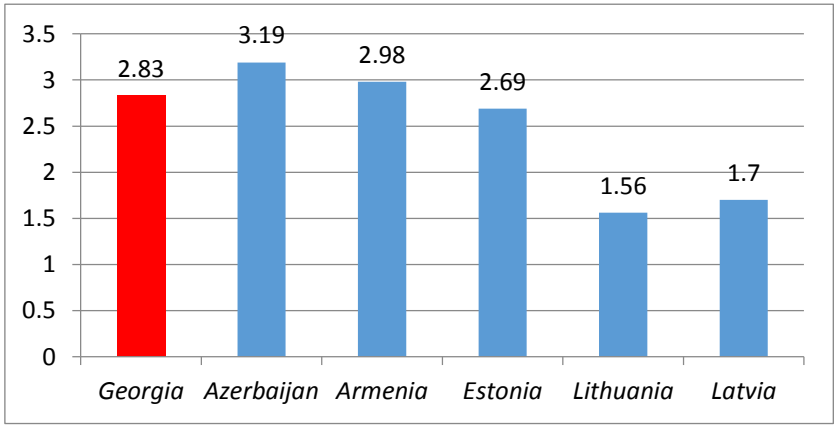


Figure 10: Energy Intensity 2013, kWh/USD[123]

The IMF explains the decline in economic growth in Georgia by slower private investment, weak credit growth, and budget under spending. The IMF recommends the Georgian government to timely diffuse internal political tensions in order to restore investors' trust towards the country.

[123] Source: International Energy Agency, iea.org

Heavy investments in infrastructure, both external and domestic, are positioning Georgia better to realize its potential in transport, tourism, energy and agriculture.

Electricity exports will become a strong contributor to GDP growth once major hydropower projects are completed. Georgia is a regional energy transit corridor for gas and crude oil. Although energy and water supplies account only for about 3% of 2014 GDP, electricity generation might become the fastest growing GDP components in future. After being electricity importer for more than a decade beginning from 2007 Georgia exported on average 0.9TWh annually; the country has the potential to produce 5 times more electricity, which is the cheapest in the region. There are significant export opportunities to neighboring countries, especially Turkey. With the completion of the transmission line between two countries the export potential to Turkey has increased.

Georgian regulation of the hydropower sector offers potential investors ownership advantages- newly built HPPs will remain property of the investors, HPPs with installed capacity under 13MW have the right to operate without a license and sell electricity to consumers. After 2008 tariffs are deregulated and Electricity System Commercial Operator (ESCO) guarantees purchase of electricity at market price if sold locally in winter.

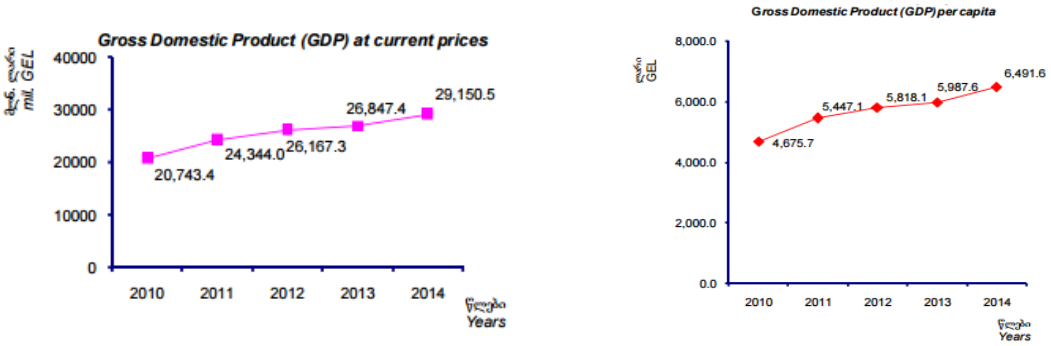


Figure 11: National Accounts of Georgia, 2014[124]

The Government forecasted a 5% GDP growth rate in 2014 and IMF 6%, respectively; Georgia's economy increased by 3.3% by the end of 2013 and by 4.6% in 2014. For comparison in 2014 GDP growth in Armenia was 3,7% and Azerbaijan only 1,5%[125].

[124] Source: National Statistics Office of Georgia/GeoSTAT
[125] Source: ADB-Key Indicators for Asia and the Pacific 2015

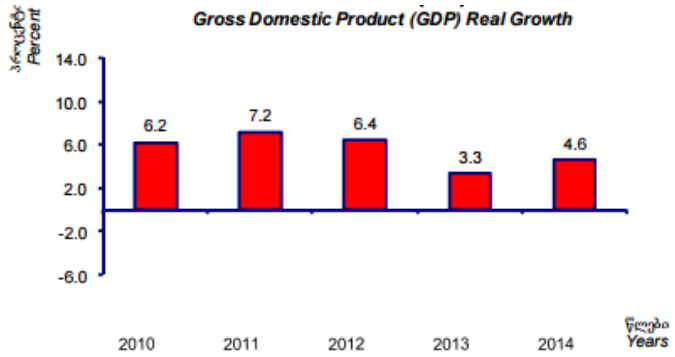


Figure 12: Gross Domestic Product (GDP) Real Growth

In 2014 the annual unemployment rate in Georgia declined by 2.2 percentage points and equaled 12.4 percent. As indicated in the Figure 15 & 16 with regards to unemployment rate the situation in Georgia is better that in its neighbour Armenia.

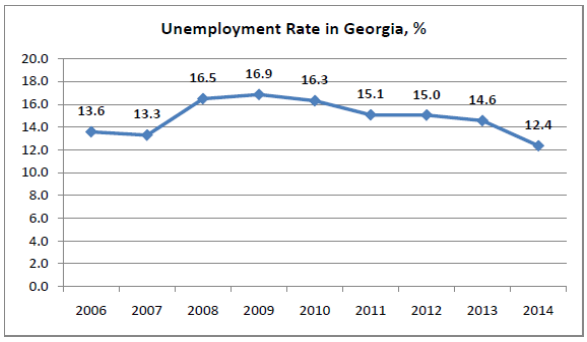


Figure 13: Unemployment Rate in Georgia, %

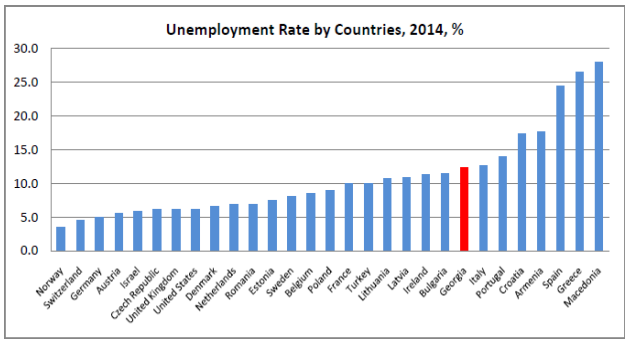


Figure 14: Unemployment Rate by countries, 2014, %[126]

In 2014 the average monthly salary of those employed has increased as compared to 2013 by about 6%. Agriculture is the largest employer, accounting for 51% of the workforce of about 1.8 mln people.

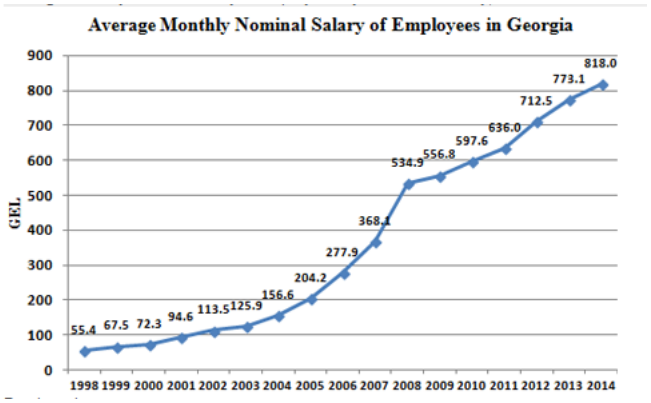


Figure 15: Average Monthly Nominal Salary of Employees in Georgia

[126] Source: International Labor Organization

The salaries were higher in energy, transport and communication and public administration sectors.

Years	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2014*
Total	**368.1**	**534.9**	**556.8**	**597.6**	**636.0**	**712.5**	**773.1**	**818.0**
Agriculture, hunting & forestry	184.9	299.3	264.4	279.2	392.6	424.6	495	504.3
Fishing	168.8	211.1	257.2	341.4	271.1	388.9	587.1	503.3
Mining & quarrying	657.7	808.9	677.7	812.3	838.6	874.5	893.1	902.8
Manufacturing	357.7	510.5	447.9	510.6	552.2	623.0	683.0	714
Water	533.8	738.3	766.8	822.9	877	919.9	967.6	1039.1
Construction	494.5	597.3	626.1	671	738.5	890.8	868.2	942.8
Wholesale & retail trade; repair of motor vehicles & personal & household goods	355.5	510.6	517.7	583.6	548.9	650.0	692.5	702.1
Hotels & Restaurants	238.4	33.6	364.4	377.5	342.4	397.5	437.1	477.5
Transport & Communication	492.3	667.7	729.3	787.6	873.8	943.4	1058.6	1074.7
Financial Intermediation	1014.5	1343.5	1319	1276.7	1386.3	1402.3	1505.8	1590.3
Real Estate, Renting & Business activities	405.8	540.1	640.3	596.5	674.3	843.5	848.2	911.2
Public Administration	585.4	869.5	888.8	973	998.8	1031.2	1152.1	1232.2
Education	153.0	243.7	269.3	205.1	319.6	355.1	422.9	456.7
Health and social work	206.4	305.8	366.7	446.8	522.9	599.5	667.9	741.8
Other community, social & personal Service activities	260.6	408.7	411.1	460.1	511.5	602.1	680.8	687.2

Tax collection is the main revenue source of total revenues in 2014. There are following taxes in Georgia

Standard tax rates 2014

- Personal income tax 20% (If an individual's taxable employment income during the calendar year does not exceed GEL6,000, he/she is entitled to deduct from this income a personal allowance of GEL1,800;
- Personal income tax for micro business- exempt;
- Personal income tax for small business 3% or 5%;
- Personal income tax for fixed taxpayer- GEL1 to GEL2,000 or 3% (The exact fixed rate is set by the Government of Georgia for each territorial unit and activity type within the range of GEL1 to GEL2,000;
- VAT- 18%;
- Social tax-nil;
- Corporate Profit tax-15%;
- Dividend & Interest Income Tax-5%;
- Property tax- up to 1%[127].

Exchange Rates 1 EUR-GEL	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
	2.28	2.40	2.06	2.45	2.34	2.22	2.13	2.20	2.15	2.33

Table 7: Exchange Rate EURO to GEL

8.2.3.1 Energy Prices and Their Development

The Georgian National Energy and Water Supply Regulatory Commission (GNEWRC) sets tariffs for the generation, transmission dispatch, distribution, import and consumption of electricity and for the transport, distribution and consumption of natural gas. Electricity consumption tariffs for electricity in Georgia are regulated by the GNEWRC. Large consumers can be supplied through direct contracts with generators in the bi-lateral market.

The tariff policy methodology is based on a full cost recovery principle for production and supply, stipulated by the law and tariff methodology. Regulated tariffs for electricity consumers are based on supply-distribution costs and totaled approximately 0.06–0.07 EUR/kWh for 6/10 kV consumers and 0.07 – 0.08 EUR/kWh for consumers supplied with 380/220 V electricity in 2012-2014.

In order to create additional guarantees for social protection and for the promotion of the rational consumption of electricity, rigid step tariffs were introduced: for the consumption of up to 100 kWh and 101-300 kWh, and for more than 301 kWh. These values have to be compared with average prices in the European Union of 0.173 EUR/kWh for households and 0.105 EUR/kWh for industry (source EUROSTAT 2010).

The electricity tariff was unchangeable since 2006 despite an overall inflation of about 35% in the relevant period. Electricity bills of households amounted to 3% of all total expenditures according to analysis conducted by World Experience for Georgia[128]. Depreciation of the Georgian lari since November 2014 up to 33% influenced tariffs as share of imported natural gas for electricity generation at thermal plant and electricity import is high and is carried out in foreign currency. By the decision of Georgian National

[127] Source: Pocket Tax Book Georgia 2014

[128] Source: weg.ge

Energy and Water Supply Regulatory Commission (GNEWRC) beginning from August 2015 the electricity tariffs have increased on average by 32%. As could be seen in the table below the average tariff for residential consumers in foreign currency is 0.07 – 0.08 EUR/kWh.

Companies	For Residential Customers			For Commercial Customers		
	<101 kWh	101-301 kWh	>301 kWh	110-35 kW	10–6–3.3 kW	0.4 kW
Telasi	0,0497	0,0650	0,0822	0,0536	0,0584	0,0756
Energo-Pro	0,0496	0,0650	0,0821	0,0519	0,0543	0,0757
Kakheti	0,0497	0,0632	0,0670	0,0289	0,0366	0,0532

Table 8: the average electricity tariff for residential consumers

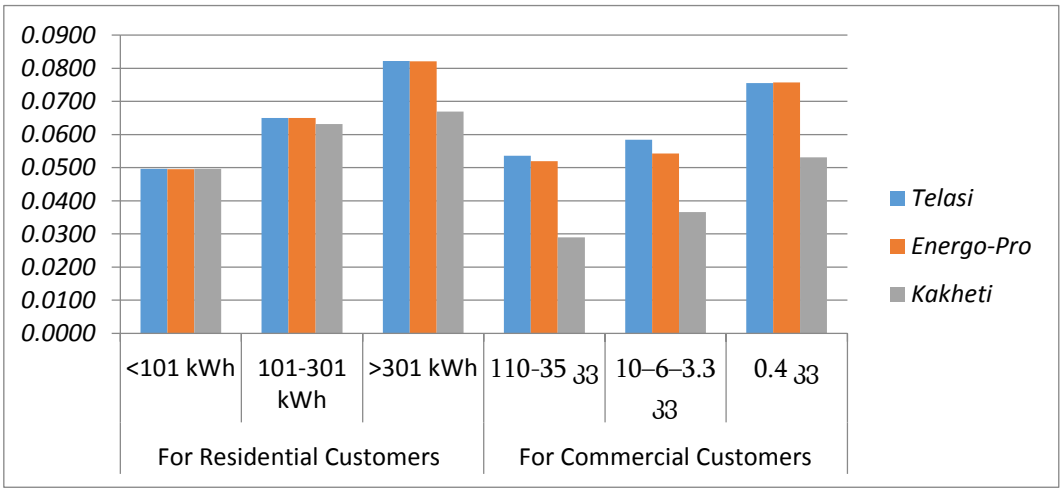


Figure 16: the average electricity tariff for residential

The metering system is based on individual meters installed in each household or commercial entity, though in some rural areas there are still communal meters. The system for electricity bill payment includes service centre payment points: dedicated bank branches or post offices.

Current tariffs for natural gas consumption have to be differentiated between residents of Tbilisi and other residents. Residents of Tbilisi, who consume low pressure gas, pay 0.17EUR/m³. Beginning from March 2015 the natural gas tariff for commercial consumers (besides bakeries) has increased by 20% and the cost of consumed 1000 m3 of gas became 900 GEL (earlier 750 GEL). Those, who consume average pressure gas (mostly bakeries), pay 0.28 EUR/m³, while consumers of high pressure gas (large enterprises) pay 0.33 EUR/m³, including VAT. Residents of various regions of Georgia pay as average 0.2 EUR/m³ of gas. In winter period the government subsidies the natural gas consumed by the population in Kazbegi Municipality and several villages in Dusheti municipality.

The cost of firewood used mainly in the regions for heating and cooking is in the range 80-100 GEL (30-37 EUR for 1 m3. The coal production in Georgia is very low, in 2013 only 0,4 mil. tons was produced (source energy balance of Georgia 2013), from which only 1200 tons was used by residential and commercial sector. The coal for heating is mainly used in high mountainous villages in Southern Georgia. The cost of 1 ton of coal is about 150-170 EUR.

8.2.4 Energy Policy

Until 2015 Georgia did not have officially developed energy policy and/or energy strategy. Georgia was pursuing market-orientated policies to promote its economic development and where possible to better align its prospects for trade with neighbouring markets. As was above mentioned after political-economic crisis in 1990s the Georgian energy sector was failed in poor condition. Since 2004 a restoration/rehabilitation actions of energy sector were identified as a top objective which itself would promoted the economic recovery as well. In 2006 the Parliament of Georgia approved Main Directions of State Policy in the Power Sector of Georgia (MDSPPSG) on which was started full utilization of energy resources and diversification of imported supply energy carriers and promoted the achievement following objectives: full energy demand of industry and household sector, achievement of economic independence and provision security (technical, economic and political) of energy sector.

In the beginning of 2012, Ministry of Energy of Georgia approved Georgian Electricity market Model 2015 9GEMM 2015) and Electricity trading Mechanism (ETM) as a core strategic document[129]. GEMM and ETM envisages development of Georgian electricity sector in line with EU competitive market principles and movement toward the convergence of regional energy markets with required modifications

In 2015 the parliament of Georgia approved new main directions of the state policy in energy sector of Georgia and invalidated old one approved in 2006. Main objective of new approved energy policy is to raise country's energy security, which serves as a tool for ensuring national interests through uninterruptable supply of various energy products under acceptable quantity, quality and price. The Energy Policy for Georgia sets out strategic directions that address the priorities and development opportunities in the energy sector of Georgia also considers main directions towards energy security. The policy intents is to develop a long-term comprehensive state vision, which will later become the basis for the development of short, medium and long term strategies in the energy sector serving as the basis for energy sector programs and further development of the regulatory legal basis of the sector. Accordingly the core national energy policy directions include:

- Diversification of supply sources, optimal utilization of local resources and reserves;
- Utilization of Georgia's renewable energy resources;
- Gradual approximation of Georgia's legislative and regulatory framework with the EU's Energy acquis;
- Energy market development and improvement of energy trading mechanism;
- Strengthen Georgia's role as a transit route in the region;
- Georgia – regional platform for generation and trade of clean energy;
- Develop and implement an integrated approach to energy efficiency in Georgia;
- Taking into consideration environmental components in the implementation of the energy projects;
- Improving service quality and protection of consumer interests.[130]

Besides, the aim of the new Energy Policy is to develop a long-term comprehensive state vision, which will later become the basis for the development of short, medium and long term strategies for 2030, with special implication on utilization of Georgia's renewable energy resources;

In 2015 the Ministry of Energy of Georgia along with energy policy has started working on Georgia's Energy Sector Development Strategy. It reflects an existent situation of energy sector, visions, priorities, challenges and its solutions. The strategy covers the period of 2016-2025. It is in line with Georgia's social-economic development strategy - "Georgia 2020" developed in 2014 and also takes into account the long-term prospective of the country's economic development. The main priorities of strategy along with

[129] GEMM 205 & ETM was developed by the Hydropower Investment Promotion Project (HIPP) under financial support of USAID
[130] energy.gov.ge/projects/pdf/pages/MAIN%20DIRECTIONS%20OF%20THE%20STATE%20POLICY%20IN%20ENERGY%20SECTOR%20OF%201047%20eng.pdf - (Ministry of Energy of Georgia)

improvement of energy law, the promotion of investment environment, strengthening a role of transit, construction of gas storage systems and etc includes as well the promotion of energy efficient measures and utilization of renewable energy sources. Currently, both of political documents are under development process.

8.2.5 LEGAL BASIS

The principal energy sector's primary legislation is the "Law on Electricity and Natural Gas" (1997), which incorporates elements of energy regulation and market rules in line with EU principles. This law also stipulates the establishment and functioning of the energy regulator. The law has been amended many times (over the last years) to include regulations and decrees improving the market rules, etc. in line with the EU model. The law prescribes the roles and functions of the two main state institutions responsible for the development and operation of the electricity and gas markets: the Ministry of Energy and the National Energy Regulatory Commission. The Law of Oil and Gas that was passed in 1999 and later amended is the legal basis for the development of the oil and gas resources of Georgia. The main objectives are to:

- Support and promote investments in the oil and gas sector of Georgia;
- Protect the legal interests of the investors engaged in oil and gas operations (exploration and production) in Georgia;
- Create an effective legal basis for the state supervision and control of oil and gas operations in Georgia (Georgian Oil and Gas Regulatory Agency) with the inter alia establishment of a relevant state body and the determination of functions of the National Oil Company of Georgia.

Approved resolution on the Main Directions of Energy Sector is addressed to Georgian legislative and executive bodies, and power, oil and gas national regulatory commissions. They are to be given expression through legislative and normative acts, the implementation of state programmes and state-funded projects, participation in international actions, privatization and other actions foreseen by Georgian legislation.

The intent is to provide for the efficient utilization of power resources and energy security as well as third-party access to the electricity transmission and distribution networks. Wider goals include:

- Attracting local and foreign investments and privatization;
- The economic sustainability of the sector;
- Bilateral and regional cooperation;
- The liberalization of the energy markets. Key to sustainability is provision for a tariff policy and metering;
- Secondary legislation comprises different statutory acts, such as government resolutions, ministerial orders and the GNEWRC (Georgian National Energy and Water Supply Regulatory Commission) resolutions. The latest include the methodology for electricity and natural gas tariff approval and setting (1998, 1999), various amendments in the period 2002-2010 and also supply and consumption rules that determine the retail market and power supply conditions for consumers[131].

Despite the fact that Georgia did not have yet energy policy and/or energy strategy even the legislation related to the energy policy/strategy including renewable energy and energy efficiency policy it has signed various international, multilateral and bilateral agreements that require concrete development and establishment actions in terms of renewable energy sources and energy efficiency from Georgia:

[131] In-Depth Review of Energy Efficiency Policies and Programmes: Georgia – prepared by Energy Chapter Secretariat , 2012

- Energy Charter Treaty and Energy Charter Protocol on Energy Efficiency and Related Environmental Aspects (PEEREA);
- Framework Convention on Climate Change and the Kyoto Protocol;
- Clean Development Mechanism (CDM) under the Kyoto Protocol;
- European Neighborhood Policy;
- EU Green paper;
- MoU signed with Kingdom of Denmark in 2004;
- Covenant of Mayors;

All above international agreements obliged Georgia to implement following actions:

- Harmonize with EU legislation;
- Enact the Laws;
- Law on Energy Efficiency;
- Law on Renewable Energy Sources;
- Enact of Climate Development Mechanism;
- Enact of building standards and codes;
- Enact the Standards on Energy Efficiency and Renewable Energy;

After the adoption of the new energy policy the Georgian Government continues working towards improvement of self-sufficiency with utilization of local renewable energy resources by constructing of new generation units (HPPs, WPPs, CHPs, etc.) and reduction of dependency on import. For the purpose of supporting the construction of new generation units the Government of Georgia has adopted state programs and several sub-laws in particular:

- Resolution No.107 on the “Approval of the National Program “Renewable Energy 2008”, which define procedure for initiating and implementing renewable energy projects in Georgia. Although it does not contain renewable energy targets or a national action plan in the field;
- Resolution No. 214 on the “Approval of Rules for Expressing Interest in Conducting Technical and Economic Feasibility Studies for the Construction, Ownership and Operation of Power Plants in Georgia” effectively replaced the resolution No.107 for a new power plant projects and at the same time it somewhat modifies the approach introduced by the 2008 resolution;
- Decree No40 of Minister of Energy of Georgia, regulates the rules for construction own and operation of Wind Power Plant and other Renewable Energy Resources;
- To this end implementation of above-mentioned regulations simplified regulatory regime for small and medium-sized HPPs and wind power plans as well.

Despite the existing regulations, Georgia is still missing the renewable energy law or a strategy that would cover the entire legal framework for effective utilization of all kind of renewable energy resources.

Some of changes related to legal basis are expected as far as Georgia started negotiations for joining the Energy Community in February 2014. Joining the Energy Community requires, among others, the candidate to implement the European Acquis Communautaire in the energy sector, among them “Third Energy Package” which sets the legal background for the functioning of the integrated, competitive electricity and gas markets.

By signing the 'EU-Georgia Association Agreement", the country took obligations to cooperate with the EU, including the energy sector. The agreement includes a list of the EU directives and regulations, the implementation of which will contribute to intensification of its energy market integration process to the EU's common energy market. These directives are: Directive 2009/72/EC concerning common rules for the internal market in electricity, DIRECTIVE 2005/89/EC concerning measures to safeguard security of electricity supply and infrastructure investment, DIRECTIVE 2008/92/EC concerning a Community procedure to improve the transparency of gas and electricity prices charged to industrial end-users (recast), Regulation (EC) No 714/2009 on conditions for access to the network for cross-border exchanges in electricity.

An important requirement of Directives is effective separation of transmission system operation from other non-network activities (unbundling), set the common rules for the usage of the networks with an objective to facilitate cross-border trade and reduce transaction costs for all customers. Regulations set important rules for regional trade in electricity: on charges for access to the networks, on congestion management, on the inter-transmission system operators compensation mechanisms and so on.

Over the last decade Georgia's electricity sector has undergone significant reforms. It has been transformed from a dysfunctional vertically integrated system operated by state-owned SakRusEnergo into a well-functioning, largely liberal market structure. In 2013 the government started a new stage of development that aims to develop a fully competitive market structure and synchronize regulation with EU standards. The Government has already implemented several regulatory/legislative amendments, but reforms are still underway.

8.3 Current situation with EE/RES

Despite a fact that Georgia since its independence signed different international agreements including the Energy Charter Treaty, the Framework Convention on Climate Change and the Kyoto Protocol, the Energy Community Treaty, the European Neighbourhood Policy which binds to develop RES/EE in Georgia there was no State policy and/or legislation advancing RES/EE development. Such kind of approach is explained with Georgian government's free economic development course when the market itself regulates the economic principles in energy sector. Consequently, the absence of a general vision and/or realistic targets, the fragmentary legislative (Law on Electricity and Gas, Main Directions of State Policy in the Power Sector of Georgia) initiatives did not fully addressed the needs of EE/RES development. Georgia signed above-mentioned agreements that are both voluntary and in some cases mandatory which itself offer some financial incentives and project financing opportunities for Georgia to develop innovative EE/RES projects and undertake energy sector reforms to harmonize its energy legislation with international standards.

Georgia still remains the only country in the region, which has not adopted energy efficiency and renewable energy laws yet, and this is more a sign of under development, rather than of economic policy. Indeed, this field is related to modern technologies, research and development, advanced institutions, commercial, and banking systems and commercial companies. Its implementation requires a high energy consciousness and the subtle mechanisms of economic incentives, which are characteristic of a highly developed society. This is one of the essential elements for European energy cooperation and refusing it means rejecting development and international technological and financial assistance.

The first positive changes in terms of development and implementation of EE/RES policy have taken place from 2010 when thirteen (13) Georgian municipalities and cities (Self-governing Tbilisi City, Self-governing Rustavi City, Self-governing Batumi City, Self-governing Kutaisi City, , Self-governing Gori City, Self-governing Telavi City, Zugdidi municipality, Telavi municipality, Akhaltsikhe municipality, Mtskheta municipality, Kazbegi municipality, Tianeti municipality, Bolnisi municipality) have joined EU initiative and signed of Covenant of Mayors taking the commitments to reduce CO2 emissions by 20% by 2020. As

Covenant of Mayors Georgian signatories some of them (Self-governing Tbilisi City, Self-governing Rustavi City, Self-governing Batumi City, Gori Self-governing, Self-governing Kutaisi City, Self-governing Telavi City, Zugdidi municipality) elaborated the Sustainable Energy Action Plans (SEAP) which envisages the implementation of EE/RES measures in various sectors. So, it could be said that at present these (SEAPs) are the only real political documents which reflect EE/RES policy on local municipal level.

Although as it was mentioned in above some positive changes are also observed on state/governmental level as well; in 2014 at the Ministry of Energy of Georgia the department of Energy Efficiency and Renewable Energy responsible for the development of EE/RES policy for the country has been created.

Specific active changes in this direction can be observed since after EU and Georgia has signed an Association Agreement in 2014, which includes a deep and comprehensive free trade area (AA/DCFTA). The Agreement significantly deepens political and economic ties with the EU in the framework of the Eastern Partnership that it itself implies the harmonization and aligning Georgia's laws with EU legislation across all sectors including the energy.
In 2015 Ministry of Energy of Georgia along with international and local experts as well as other stakeholders (Ministry of Economy and Sustainable Development of Georgia in close cooperation with Energy Community) is actively involved in developing of National Energy Efficiency Action Plan (NEEAP). Despite government's awareness of the need for introducing EE standards and measures to improve the energy supply and security situation in the country, little was done in the field. A dedicated policy approach is needed to promoting EE in the country, which would include an assessment of EE potential and would set EE policy targets in various sectors.

To help Georgia ensure that it can successfully improve the EE standards and performance of the economy, the EBRD retained a consultant - Eco Ltd to assist the Ministry with the preparation, drafting, adoption process and publishing of the country's first NEEAP. The NEEAP shall identify significant EE improvement measures and expected energy savings in all sectors (e.g., buildings, transport, power, products, processes and services) taking account of the country's potential and national EE targets, with a view to achieving high EE performance of the economy.

The first step would be the adoption of the country's first National Energy Efficiency Action Plan (NEEAP), which is a requirement both for European Union (EU) Member States under the EU Energy Efficiency acquis and for the Energy Community Contracting Parties. The NEEAP is a strategic policy document that sets the country's overall and intermediate national indicative energy savings targets for the public and private sectors and proposes concrete measures and actions to meet these targets.

Till today the major encouraging and leading role in the development of EE/RES in Georgia is played by the international institutions & donors (EU Commission, USAID, the United Nations Development Program (UNDP), BP to Georgia, the German development Bank of KfW, the Global Environment Facility (GEF), EBRD, the Norwegian Government and etc.) which ensure financial support for various EE/RES programmes and projects. Nowadays, almost every EE/RES innovative projects and/or programmes in Georgia are implemented by local and/or international non-governmental organizations with the support of foreign international financial institutions or private companies. Most popular EE/RES innovative projects are solar, hydro and biogas technologies and various weatherization measures in the buildings, etc.

Since 2000, a new phase of the energy sector rehabilitation started and at all rehabilitated HPPs new modern equipment, control systems were introduced. According to Ministry of Energy currently 13 hydro plants are under construction. The installation of modern equipment is envisaged for these plants.

One of the most interesting developments is natural gas starting to substitute diesel and gasoline in the transportation sector. O&G is adopting a lot of new technologies, and a lot of funding is going into innovations that can help oil and gas companies work smarter.

Private investments made by gas distribution companies in construction of new equipped with up to date equipment and devices, introduction of modern metering systems for consumers has positive impact on both supplied gas pressure and improvements in accounting.

As to EE/RES technology market in Georgia it is under developing process. Most of EE/RES innovative technologies are imported to Georgia from Turkey, China, Ukraine and Germany. The imports and/or exports are not regulated due to the absence of relevant legislation. Accordingly the energy market in terms of EE/RES in Georgia is a bit chaotic and free, represented by various types of technologies with and/or without relevant certifications. A small number of locally produced EE materials/technologies are available on the local market. In general, Georgian producers cover some areas of production of energy efficient construction materials and light construction materials. Along with EE technologies there are a number of companies which provide innovative RE technologies and its service as well. As estimated by private sector representatives, currently only about 10-15% of market potential is absorbed. New market players are welcome in these areas for further growth of already existing capacity and launching of the new EE/RES productions lines.

Quite an interesting picture is unfolding in terms of consumers' attitude towards EE/RES technologies on the market. More specific, at present there is interest to EE/RES innovative products but there is still lack of demand for them from any sector, such as household or business. Mentioned situation could be explained by several factors: firstly, due to the absence of EE/RES legislation there is no obligation for any sector to develop and establish EE/RES initiatives, secondly, low awareness of society and thirdly, high cost of EE/RES on the market. Accordingly at present its development fully depends on customers' willingness, knowledge and financial abilities. At the same time despite of the current situation by personal initiatives both in business sector & households EE/RES innovative projects are being implemented in the country. Nowadays most popular in rural areas of Georgia are solar systems (solar water heating systems) and biomass applications (EE stoves, biogas and etc) while in urban areas EE technologies (EE construction materials and heating systems). As to business sector recently a special the local banks started financing energy efficient measures in newly constructed buildings. The example of such commitment is JSC '$m^{2'}$ Real Estate is wholly owned subsidiary of JSC Bank of Georgia. The company is among pioneers in introducing energy efficient technologies in residential building construction. Another example is also bank supported – new environmentally friendly 'Green LISI Town'. 'The Green Lisi Tow' will occupy area of about 400 acres around the Lisi Lake in Tbilisi and besides residential buildings include big recreational zone. The construction works started in the autumn of 2011 and only the first phase of works has been completed. Within the framework of the Project "LISI Veranda" particular attention is paid to the quality of the construction materials, its ecological properties and energy saving properties. Based on the research and recommendations of invited European experts the following construction brands were selected: "SCHUCO" aluminum stained-glass windows of German origin, Leegwater Houtbereiding bv, S.ANSELMO for façade finishing, etc. Another example of energy efficient building is American Academy in Tbilisi (GZAAT). The building is constructed with a green principle and uses the energy-efficient elements: natural lighting, geo-thermal heating, special control and regulation systems, energy-efficient materials. Pro-credit Bank has also established green loans for its customers willing to introduce RE/EE technologies in their homes or businesses.

8.4 Innovation situation in the energy sector

8.4.1 General description of economic situation related to EE/RES

For Georgia, innovative economy means opening its rich natural capital to new business opportunities that drive economic growth and development while simultaneously ensuring that these assets continue to provide the resources and environmental services on which our well-being relies. Accordingly, developing of innovative economy especially in energy sector for Georgia is a step forward to sustainable energy development, which itself will facilitate the economic growth and create new jobs.

In the past years Georgia's macroeconomic performance and general progress with reforms has been strong. Georgia has achieved significant economic growth, mainly driven by large foreign capital inflows. Foreign investments across different sectors of the economy have contributed to broadening the economic base. Domestic credit has grown rapidly, supported by increased confidence in the banking sector and access to international financial markets. Though significant shits/changes in terms of developing of innovative mechanisms in economy does not take place especially in energy sector excluding the rehabilitation works.

In Georgia during the soviet epoch a number of research institutions acting in various fields including 'the Institute of the Energy of Georgia' worked very actively. But after the USSR collapse some of them was abashed and/or affiliated to the universities as a research centers. Accordingly, due to the reorganization of the research centers their activities and scale of financial support was reduced and their work is presented in small-scale studies which are mainly funded by international foundation organizations.

It should be noted that some university based research centers are trying individually to establish innovative technologies in the Georgian market. Mentioned tendency is observed especially in EE technologies/innovations for the building sector. The linkages between energy research institutions/centers and business is very weak and almost no cooperation between them. The reason of this could be explained by some reasons:

- No interest in EE/RES innovations from the side of local business sector;
- No incentive measures for supporting EE/RES development on the market;
- No sufficient supporting of research centers from the government side;

Although the Georgia government declared that development EE/RES innovations is one of the priority, before the development and approval of EE/RES strategy and/or legislation some specific changes are not expected as well as any kind of support from government for development of EE/RES innovations.

Until now the changes that occurred in energy sector of Georgia were supported by international organizations. Energy issues are important component of the EU's cooperation with Georgia. Within the framework of the Eastern Partnership launched in 2009, the policy cooperation between the EU and the partner countries was enhanced in several fields of importance such as energy efficiency, renewable energy and support for infrastructure development, interconnection and diversification of supply; regulatory framework and approximation of EU energy policies.

The projects that EU implements in Georgia aim at improvement within these fields. The EU supports the Black Sea Transmission line between Turkey and Georgia with € 8 million, which will facilitate future electricity exports. The EU support aimed at preparing the tender documentation and to enable an alternative routing of the line which mitigated the environmental impact on the national parks in Georgia (Borjomi-Khalagauri national park). The EU has also granted €11.5 million for the refurbishment of turbines of the Enguri hydro power plant.
Under the regional INOGATE programme, the EU has financed numerous projects – mainly on technical assistance. In Georgia, one of them supports the Tbilisi Municipality's participation in the Covenant of Mayors, which is a European movement involving local and regional authorities, voluntarily committing to increase energy efficiency, reduce CO2 emissions and to increase Renewable Energy. Specifically, this

project will deliver solutions to increase energy efficiency in public buildings and disseminate the experience to other cities of Georgia. The support from the EU amounts to € 500 000.

With an INOGATE technical secretariat having opened in Tbilisi at the beginning of 2012, the process of identifying further relevant projects in Georgia will be facilitated.

The EU recently extended financial support to strengthen the capacities of the Georgian National Electricity Regulatory Commission (GNERC) in updating its incentive based electricity tariff methodology. This aims at promoting long term investments and functions in line with EU standards and best practices. The total budget of the project is € 1 million.

Georgia remained a reliable energy partner for the EU in developing the Southern Corridor. In the electricity sector, work on the Georgian side of the Black Sea Energy Transmission Network (Azerbaijan-Georgia-Turkey) is progressing well. The construction of an electricity interconnection with Azerbaijan and related infrastructure were completed. Renovation of the large Enguri hydro power plant progressed. In January, Georgia and Turkey signed a cross-border agreement on electricity trade across new interconnections between them. Georgia remained an active observer in the Energy Community. In January 2013 it submitted an application to become a full member. Georgia is encouraged to strengthen the energy regulator's independence and capacity and to continue working on gas market reform, including unbundling. It is also encouraged to step up efforts on renewable energy and energy efficiency including by adopting legislation in these areas.

Investment in research and innovation continued to remain at a relatively low level. Georgia ranked 71 out of 141 countries on the Global Innovation Index in terms of its innovation capabilities and results. Its expenditure for research and innovation over the last few years remained below 1% of GDP. Based on the Georgia ENP Progress report for 2012 since 2008, Georgia has become increasingly involved in the FP7 through 31 projects covering infrastructural and networking measures and to a lesser degree, pure research, in the areas of health, information technology and communication, the environment, social sciences and humanities. A total EU contribution to these projects amounts to EUR 156 million, more than EUR 3 million of which is given to the 26 Georgian public and private institutions participating in these projects.
As stated in Georgia ENP Progress report for 2013 in the field of research and innovation, cooperation with the EU progressed. Georgia increased its participation in the Seventh Framework Programme (FP7), being involved in 63 projects with a total EU contribution of EUR 5.4 million. Six new FP7 projects (R2I-Research to Innovation) involving Georgian stakeholders were launched with EU funding of around EUR 6 million, aiming at fostering research-industry partnerships, supporting Georgian capacities in the innovation domain and facilitating the commercial exploitation of research results. A new FP7 regional project, the INCONET EaP, involving the Shota Rustaveli National Science Foundation, was launched in September 2013 for three years with a view to preparing the transition to Horizon 2020 and promoting the cooperation opportunities this new programme will bring.

The most popular partners for Georgia in international cooperation activities except EU are:

- United States Agency for International Development (USAID);
- International Finance Corporation (IFC);
- European Bank for Reconstruction and Development (EBRD);
- Asian Development Bank (ADB);
- Kreditanstalt für Wiederaufbau (KFW);
- European Investment Bank (EIB) and others.

8.5 Overview of critical stakeholders

When talking about stakeholders acting in EE/RES field in Georgia the following sectors could be emphasized: international and local non-governmental sector, international financial institutions, governmental sector, local and municipal authorities, business sector, household sector, educational sector (universities, research institutions).

In 2010-11 as a result of reorganization a number of scientific-research institutions in subordination of the Ministry of Education and Science were affiliated to higher education institutes and universities as independent research units. The main aim of mentioned policy was to promote a gradual integration and to increase the effectiveness of activities of scientific-research and high educational institutions. In addition the reorganization of high education institutions was aimed to facilitate the development of science and capacity building of scientific researchers in high educational institutions and to improve the cooperation with international scientific community. Thus currently at some universities the scientific research institutes conduct their research work in Georgia. In the below listed universities various scientific researches in EE/RE field is conducted:

- *Science Department at the Technical University (GTU)* - is a structural unit of technical university, with core activity to promote and develop the latest fundamental and applied research of engineering problems at the university departments and scientific-research centres. This at large determines education focused on new, up to date scientific achievements Several scientific research centres and institutes at GTU work in the field of EE/RE innovations like Thermal and Hydro Energy, Thermal Power Plants, Renewable Energy and Energy Efficiency;
- *Faculty of exact and natural science at the Tbilisi State University (TSU) is* known for its outstanding scientific activities. 39 scientific directions comprise wide range of research activities. The faculty undertakes number of scientific projects funded by national and international foundations. Lots of scientific-technological innovations are patented. The Research Management in TSU is carried out by the Department of Scientific Research and Development (R&D). Department helps Faculties/Institutes staff secure external funding to support their research, promotes, supports and administers quality research activity at TSU. Nowadays TSU combines and provides basic financing to 16 scientific-research Institutes, which operate under the aegis of Department of Scientific R&D. The main source of financing of research is external grants.

Ilia State University (ISU) is a higher education institution that strives for academic excellence and integrity in teaching and research. ISU's recognition at home and abroad, amongst many of its partners worldwide is due to ISU's unique institutional capacity that is reflected primarily, in the quality of academic staff recruited successfully throughout Georgia and beyond. Secondly, in the strong focus on and commitment to research conducted in the areas relative to Georgia's geopolitical standing and social, political and cultural development, and in its distinctive ability to initiate an open, unbiased public policy discussion. Over a short period of time, ISU has emerged as one of the leading reformers in Georgian higher education system and has managed to evolve into one of the most selective universities and prestigious study destinations in the country.

ISU was established in 2006 as a merger of six different institutions, each having a long history and a diverse institutional profile. With its over 800 academic staff, the university strives to provide excellence in all areas of academic practice and scientific research in Georgia. Four Schools – Arts and Sciences, Business, Law and Engineering - each offer distinctive training in their respective direction.

Ilia State University unites 25 Research Institutes, Centers and Laboratories dispersed across the country. The diverse profile of these research institutions and laboratories create a unique opportunity for research and practice on the topics relevant to Georgia's role and contribution to international community.

Currently, Ilia State University has:

- Reached the highest research citation index in Georgia; fourteen percent of ISU's annual budget is allocated for research and ISU is the first University in Georgia to use international peer reviewing in its publications;
- One of the top positions among Georgian HEIs in Webometrics Ranking Web of World Universities that ranked 12,000 HEIs worldwide indicating performance and visibility;
- Academic and research infrastructure in every region of Georgia (25 large and small research centers and stations);
- 10,000 student places: strong competition in the university entry examinations is rising and/or the demand has been maintained in spite of an increased intake of student body each year;
- Pioneered to transform itself into the first Liberal Arts Educational Institution[132].

There are also scientific foundations that support various innovative researches and projects in EE/RES:

- Shota Rustaveli National Science Foundation;
- Georgian Research & Development Foundation (GRDF);
- Science and Technology Center in Ukraine (STCU);
- International Science and Technology Center (ISTC);
- Scientific and technological research council of turkey (TÜBİTAK);
- Centre National de la Recherche Scientifique (National Center for Scientific Research).

As it was mentioned above nowadays in Georgia majority of EE/RES innovative projects are actively financed by international financial institutions. International financial institutions (EBRD, KFW, IFC, USAID, UNDP, etc.) usually finance projects both in state and private sectors. Georgian banks, basically 'Bank of Georgia' and 'TBC Bank' have been main financial intermediaries of those funding, which normally are with low interest rates, generally distribute the loans among large-size participants of the system. Private companies which mainly adopt the funding are local generation, distribution or transmission companies. Usually for those companies the procedures of loans are more or less simplified and out of the typical rules.

Unless the International Financial Institutions (IFI) active support in energy investments projects, the situation with financing of such project would have been even worse. Among the large infrastructure projects IFI funding involves energy projects such as power transmission, power generation and energy efficiency issues.

The most active IFI community in Georgia is represented by the following institutions:

- International Finance Corporation (IFC);
- European Bank for Reconstruction and Development (EBRD);
- Asian Development Bank (ADB);
- Kreditanstalt für Wiederaufbau (KFW);
- European Investment Bank (EIB);

Asian Development Bank (ADB) financed the large scale projects and basic stakeholder has always been a Government of Georgia (GoG). Among the energy loans can be emphasized Regional Power Transmission projects with 350 and 48 million USD to GoG.

[132] iliauni.edu.ge/index.php?lang_id=ENG&sec_id=3

In terms of government organizations in EE/RES innovations' sector important role plays the Ministry of Energy of Georgia. It is responsible to develop EE/RES policy and strategy for country as well as is a country coordinator of Covenant of Mayors (CoM) related issues along with Ministry of Environment and Natural Resources Protection of Georgia.

Ministry of Economy and Sustainable Development of Georgia is responsible for EE innovation policy. In February 2014, at the Government meeting was made the decision to establish "the Technology and Innovation Agency of Georgia" (GITA). The aim of the agency is to create innovative ecosystem, promote the use of innovation and technologies in various field in Georgia and promote commercialization of innovative research and development.
GITA implements the specific projects and programs in order to support the innovation and technology adoption in the country. Also it is aiming to promote the commercialization of the research and development, IT business, distance employment and creation and implementation of Georgian program software. A special attention is paid to the formation of the export oriented IT industry, as well as innovative start-ups and creation of technology companies and the increase of the effective use of innovation and technology. Both financial and non-financial institutions are being created in order to achieve the agency goals[133].

The Agency is actively involved in technology parks, innovation centers, innovation labs, accelerator and business - incubators for the creation and development. In this regard in December of 2015 the first Technology Park (Tech Park)[134] was launched by Georgia's Innovation and Technology Agency aiming to support start-ups and make peoples' ideas a reality. More specific the new facility is expected to promote scientific research and innovative ideas in Georgia as well as create a partnership between innovation and technology. The new complex provides resources for start-up and small-sized companies that has not been accessible before. It will play an important role in the creation of new companies, current business development, commercialization of innovations and creation of high-paid jobs as well as give an opportunity to create local branches of international companies and attract foreign investments in Georgia.

The Technology Park is consisted with small incubators, educational centers and laboratories, large offices for companies, co-working spaces, conference rooms, recreational areas and etc. Also provides Business Incubator participants with expert consultation in the field of management, marketing, financial management and more, as well as connect them with necessary personnel and investors.

As for EE/RES policies in local municipalities those ones which joined EU initiative of Covenant of Mayors by taking commitments to reduces by 20% CO2 emissions by 2020 develop, plan and implement EE and RE projects. In Georgia, 8 self-governing cities and 5 municipalities are CoM signatories. Especially, it should be noted local non-governmental organizations' role in promotion and popularisation of RES/EE technologies in Georgia. At present there are some organizations that implement various RES/EE related projects including practical demonstration projects as well as energy audits, policy research papers, consultancy, trainings, workshops and etc financed mainly by different international donor organizations. Thus, below is presented most active local NGOs in Georgia working in RES/EE field:

- "Sustainable Energy Centre – Sun House";
- Greens Movement of Georgia/FoE;

[133] economy.ge/en/media/news/technology-and-innovation-agency-of-georgia-will-be-established-according-to-the-decision-of-the-government-of-georgia
[134] Source: techpark.ge/#gaxsna

- Sustainable Development and Policy Centre;
- World experience for Georgia;
- Caucasus Environmental NGO Network;
- Rural Communities Development Agency (RCDA);
- Union for Sustainable Development – Ecovision;
- Regional Environmental Centre for the Caucasus (REC Caucasus);
- Union "Energy Efficiency Centre Georgia"
- And etc.

One of the important stakeholders in implementation of EE/RES innovations is the business sector represented by two types of stakeholders: companies importing the EE/RES innovative technologies and companies producing local EE innovations mainly for building sector. Also, it should be noted that companies that local companies producing EE innovative products at the same represents the research centres.

8.6 Analysis

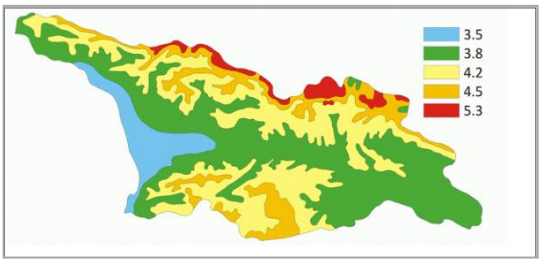
8.6.1 General information of Renewable Energy Sources in Georgia

Georgia has considerable resources of almost all types of renewable energy sources (RES) - solar, wind, geothermal, hydro, and biomass. The achievable annual potential of all RES can be estimated at 10-15 terawatt hours (TWh). This is enough energy to meet a third of Georgia's annual energy needs. Although only a very small part of this potential is used currently. The share of renewable energy in Georgia's energy balance is approximately 1%. Currently apart from large hydro power, the amount of electricity generated from renewable energy source is approximately 3% of the total amount of electricity produces.

8.6.1.1 Solar Energy Capacity

The climatic conditions of Georgia are favorable for utilizing solar energy. Most regions of the country have 250–280 days of sunshine per year. Direct and global radiation reaches daily values from 3.5 to 5.3kW/m² and an annual average about 1,550kW/m². The potential of solar energy, however, is strongly seasonal and varies by a factor of more than four from mid-summer to mid-winter. The achievable potential of solar energy in Georgia is estimated at 60–120 GWh annually. Based on these estimates, one can calculate that on average about 190 kWh of electric energy can be annually obtained from one m² surface of solar PV panels and 1,200 kWh of thermal energy (hot water) from solar water heating panels.

Based on above-stated, the development of solar photovoltaic systems is important for Georgian electricity system for several reasons. Solar provides households and businesses with micro level solution for electricity supply security. Through diversification of power supply sources and improvements in storage technologies solar contributes even more to increase of electricity supply security. Connection of many small scale solar PV systems to the grid will both contribute to grid, as well as market electricity market development. Renewable and carbon free nature of solar power will create at least a partial substitute to polluting thermal power generation.



Picture 4: Average daily solar radiation in kWh/m2; Source: the solar energy cadastre of Georgia.

The using of solar energy in Georgia is still low, but during the last 10-15 years, mainly solar water heaters systems became increasingly popular in the regions of Georgia. Mostly, solar systems are exported from China, Turkey, and Germany. Based on the offered price most widespread are Chinese solar water heaters. Several private companies are specializing in import and installation of the solar systems as well. Popularity of solar water heating systems compared with PV system is explained from its price affordability. The 180 l/day systems cost approximately 1,000–1,500 USD. Currently there are no legal acts or tax benefits supporting the development of solar energy use in Georgia. For water heating systems, the investment payback period is about 3–9 years; these are most profitable in applications where hot water expense is high and the main load is in summer (swimming pools, hotels). Although more than 70 % of this potential is realizable in the months of April through September, solar power can contribute to reducing energy dependence by almost completely replacing the need for gas currently used for hot water supply throughout the year.

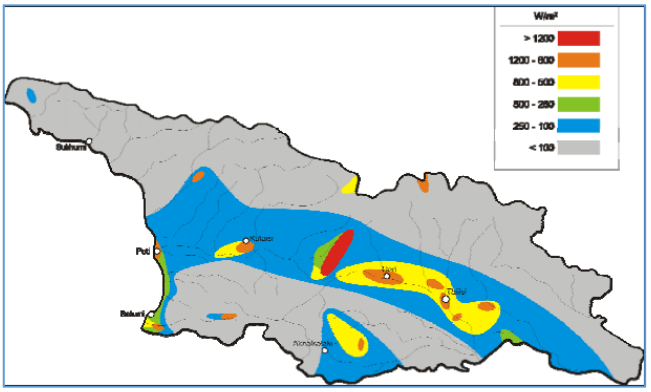
As to solar PV panels due to their very high prices they are less common and basically their installation is justified in off grid high mountains villages of Georgia. It should be noted that such kind of projects are mainly supported and financed by international organizations within the various projects and programmes.

Currently there are no legal acts in support of development of solar energy use in Georgia. Until recently the solar systems received tax benefits and were exempt from the VAT. However the new tax code has eliminated these and other benefits. As a result, the price of solar panels in Georgia has increased by 35-40% due to transportation and the taxation costs after importing[135].

[135] "Renewable Energy Potential in Georgia and the Policy Options for Its Utilization" -2008

8.6.1.2 Wind Energy Capacity Of Georgia

The wind potential capacity for Georgia is studied by the Wind Energy Research Center of Kanergo. Measurements of wind speed have been carried out in Georgia on 165 meteorological substations during several decades. Based on processing and analysis of these data, it has been proven that the total theoretic wind energy potential amounts to 1300 gigawatt hours (GWh) and exceeds the total theoretic river energy potential (135 GWh) almost ten times. The wind energy research center "Karenergo" has developed the "Georgian Wind Energy Atlas," as well based on existing meteorological data and their own perennial measurements using the contemporary measurement equipment. Based on the wind energy potential, the technical potential of wind power has been assessed with the use of analytical methods and specialized software. The calculations showed that annual power generation might reach 4 GWh.



Picture 5: Average annual wind energy distribution on the territory of Georgia at the height of 50 m. above ground level

By wind speed the territory of Georgia is divided into four zones:

- A high speed zone – mountainous regions of Southern Georgia, Kakhaberi Vake and the Central region of Kolkheti Vally. The working duration period is more than 5000 hours per year;
- A partly high speed and low speed zone - the Mtkvari gorge from Mtskheta to Rustavi, Southern part of Javakheti, Black Sea line from Poti to Kakhaber Vake. The working duration is 4500-5000 hours per year;
- A low speed mountain range effective exploitation zone - Gagra mountain range, Kolkheti Valley and Eastern Georgian lowlands;
- And a low speed mountain range limited exploitation zone - Iori Zegani and Sioni water reservoir. The rest of the mountain ranges on the territory of Georgia cannot be used for exploitation by wind power stations.

Based on the research conducted on the territory of Georgia several prospective sites for the wind farm construction have been identified. The total installed capacity of these potential wind farms is 1450 MW with annual generation of about 4160 mln.kWh.

In 2013 Ministry of Energy together with "Georgian Energy Development Fund" started the development of the project for the pilot wind farm "Qartli"with the installed capacity of 20 MW.The project investment cost is about 30mln.USD.

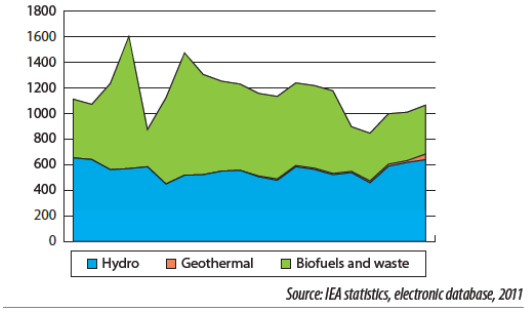
8.6.1.3 Geothermal Energy Capacity of Georgia

According to modern hydro-geological studies, the Georgian geothermal water forecasted reserves reach 250 mln m3 annually. At present there are more than 250 natural and artificially drilled water channels where the average temperature of geothermal waters ranges from 30 to 110^{0}C, located in 44 deposits throughout Georgia with the total daily debit is 160 000 m3.

About 80% of this geothermal potential is located in West Georgia. The total theoretical thermal capacity of all geothermal sources at t 0-250^C was estimated at 300 MW of thermal capacity. Total achievable

potential is estimated at 30% or 100MW of thermal capacity (N. Tsertsvadze, G. Buachidze, O.Vardigoreli "Thermal Waters of Georgia", Tbilisi, 1998). The temperatures of geothermal deposits are not very high and are mostly suitable for heating and hot water supply[136].

The use of geothermal sources is already developed to a considerable extent. In capital Tbilisi, the output of geothermal water of 4,000 m³ per day is used to supply around 100 residential blocks. The prices are not regulated and are determined by the supplier. In other locations the geothermal water is used by the neighboring population in an unorganized way. There are projects in the planning stage to better utilize and expand the use of thermal waters from the existing wells. The feasibility of these and other projects requires further study in order to determine economically viable options and volumes of geothermal energy utilization. In order to promote the use of geothermal energy in other locations it is necessary to implement a number of policy measures including:



Picture 6: Renewable Sources in Primary Energy Supply

- Transparent rules for obtaining licenses for geothermal wells;
- Clear regulations on land use and property rights for wells and pipe routes;
- Clear definitions on price regulations and subsidies for different groups of consumers[137];

8.6.1.4 Biomass Energy Capacity of Georgia

Georgia has a considerable potential of biomass resources. It is conditioned by its geographical position and a favorable climate for growing forests and agricultural products. In some regions, it is even possible to have two yields per year. Unfortunately, the current use of biomass in Georgia is rather inefficient and unsustainable. Firewood consumption is estimated at 8 million m³ per year, which covers almost 50 % of the population's energy demand. This consumption is far above sustainable forest development level, which should not exceed 1 million m³ per year. Therefore, the RE potential of forest and forest residues must be set to 1 million m³ of bark energy, amounting to approximately 2,700 GWh. Residential waste is another type of biomass. 900,000 tons of waste per year accumulates in the Tbilisi and Kutaisi dumps according to municipal data. An estimated 90 million m³ biogas can be obtained by re-treating these residues; this would equal 64 million m³ of natural gas. Approximately 160 million m³ of biogas can be annually obtained from the sewage water cleaning station of Tbilisi (serving 1.2 million). The resulting biogas energy is estimated to be 1,000 GWh/year equaling 100 million m³ of natural gas. Therefore, the technical potential of the major biomass sources in Georgia amounts to 12, 5 TWh/year. The achievable potential is estimated at 3-4TWh/y. This estimate does not incorporate the potential of farming energy crops. For comparison, one can note that total annual electricity generation in Georgia is in the range of 8,000 GWh. Apart from firewood, which is used for cooking and heating, and a few donor supported biogas initiatives, the biofuel potential remains untapped[138].

The last three years some of important projects have been implemented in terms of study of biomass production and with its related wastes. In 2013 Ministry of Environment and Natural Resources Protection of Georgia and UNDP in cooperation with Global Environment Facility started a new project – 'Promotion of Biomass Production and Utilization in Georgia'. The overall objective of the project is to promote sustainable production and utilization of the upgraded biomass fuels to meet municipal services

[136] "Renewable Energy Potential in Georgia and the Policy Options for Its Utilization" -2008
[137] Renewable Energies in Central Asia - Country Chapter: Republic of Georgia
[138] Renewable Energies in Central Asia - Country Chapter: Republic of Georgia

sector's heating needs in a sustainable and efficient way thereby reducing dependence on fossil fuels and avoiding GHG emissions. To achieve the objective, a comprehensive strategy is proposed, including promotion of demand for and supply of upgraded biomass fuels, establishment of both biomass financing mechanism and an investment grant mechanism to deliver pilot biomass projects and ensure sustainability of the project's approach.[139] The project is ongoing that will be ended in 2016.

In 2014 the "Assessment of Wood and Agricultural Residue Biomass Energy Potential in Georgia" was performed by "World Experience for Georgia" (WEG). The study describes annual and perennial crop residues. According to the study findings the highest potential energy from biomass is forestry amounting to 40 PJ (31.3 PJ already accumulated wood energy value and 8.7-annual potential) or more than 11 TWh exceeding current annual electricity consumption in Georgia. The study indicates also that wood biomass and sawdust is more concentrated and commercially interesting than other types of agricultural biomass. Very big potential has unused residues from vineyard pruning (2PJ/a) though this potential needs more detailed research. Totally, 37.4PJ energy can be theoretically generated from wood and agricultural crop residues. For comparison, total gas consumption in Georgia is 70 PJ[140].

Also at the end of 2014 the "Detailed feasibility Assessment of Pilot Biomass Plant in Tbilisi and Complete Feasibility Study for Installing Biomass Boilers in Tbilisi Municipal Facilities" was performed by "the New Technology Center". The study provides information on viable biomass types, research of biomass sources, description of bio-fuel production and utilization technologies, production scenarios for efficient conversion of biomass into fuel for Tbilisi municipality through mechanical and chemical transformation[141].

8.6.1.5 Hydro Energy Capacity of Georgia

Hydro resources take the first place among the natural riches of Georgia. There are 26 000 rivers with a total length of about 60 000 km on the territory of the country. Approximately 300 rivers are of significance in terms of energy production; their total annual potential capacity is equivalent to 15000 MW, while the average annual production equals to 40-50 TWh.

Considering peculiarities of Georgian rivers, which are characterized by distinct seasonality, these resources can be distributed only by building hydro power stations with regulating water reservoir in the short and long term perspectives. However, from the ecological point of view, such kind of constructions is difficult. That's why hydro power stations with small reservoirs are more common. The Government of Georgia has approved the State Program – "Renewable Energy 2008" which includes the list of potential green-field projects and rules for construction of new renewable energy sources. In the scope of the above-mentioned program memorandums of understanding are signed between the Government of Georgia and investors on such projects as: Khudoni HPP–with the installed capacity of 750 MW and generation of 1,5 bln KWh; Cascade of Namakhvani HPPs - with the installed capacity of 450 MW and generation of 1 670 mln KWh; Faravani HPP - with the installed capacity of 78 MW and generation of 425 mln KWh; Cascade of HPPs on the rivers: Chorokhistkali, Lukhuni, Tekhura, Gubazeuli, Mtkvari, Bakhvistskali da etc. totally 21 HPPs (total installed capacity of 1 583 MW and generation of 5,5 bln.KWh) are under construction agreements. Besides tendering a number of new large HPPs, the Ministry of Energy has sought foreign investments for the development of new small and medium HPPs. As a result of rehabilitation activities carried out on large HPPs, the hydro generation of electricity increased up to 9.7 TW/h.

[139] ge.undp.org/content/georgia/en/home/operations/projects/environment_and_energy/promoting-the-production-and-use-of-biomass-in-georgia.html (Web-page of UNDP in Georgia)

[140] Source: biomass.ge/en/studies

[141] weg.ge/wp-content/uploads/2014/12/Biofuel-Feasibility-Study-Eng.pdf

At present time hydro is the main renewable resource contributing to energy supply in Georgia and accounts for the major part of electricity generation. Consequently, Georgian government's main approach is to create attractive conditions for the capital and to facilitate large-scale investment, more specific:

- To renew and extend current electricity infrastructure;
- To renovate existing hydro generation plants;
- To develop the small and medium-sized hydro resources;
- To provide the access to the markets in neighboring countries (turkey) for power exchange;
- To reform Georgian energy sectors into a net electricity exporter;

Hydroelectric power plants provide almost 92% of Georgia's electricity with natural gas combustion generating the remaining 8%. Georgia has been the main exporter country in the region from 2007 and delivers the electricity to all neighboring countries throughout the year.

Thus the Georgian government's one of the top priority remains maximum utilization of the abundant hydro resources. More specific, the main objective of the long-term energy policy is attraction of foreign investments for the construction of the countries demand with its own resources, which should be implemented in the stages: first, the import, and then the thermal generation replacement.
According to the potential of the high-capacity power generation and the increasing demand, the main objectives of the energy policy were identified:

- Rehabilitation of the infrastructure connecting to the neighbor countries' energy systems;
- Construction of the new transmission lines and substations;
- Export of the surplus power generated in new and existing power plants142;

In general, the main objective for the long term policy of the country has been to fully satisfy the country's overall demand for electricity with domestic hydro resources. Besides tendering a number of new large HPPs, the Ministry of Energy has sought foreign investments for the development of new small and medium HPPs. As a result of rehabilitation activities carried out on large HPPs, the hydro generation of electricity increased up to 9.7 TW/h.

In addition, the Georgian government plans to facilitate further development of new renewable sources by creating favorable conditions for the development of micro electric power plants up to 100 MW. Currently there are a number of medium and small hydro facilities totaling approximately 1,540 MW providing domestic power, either on a regular basis or seasonally.

Thus the estimated potential of different types of RES in Georgia could be summarized in such way:

RES Type	Theoretical Potential	Technical Potential	Achievable Potential	Economical Potential
Small Hydro	40 TWh	19.5 TWh	5TWh	
Wind	1300TWh		5TWh	
Bio Mass		12.5 TWh	3-4TWh	
Solar	1550 kWh/m^2			60-120GWh
Geothermal	300MW	100MW	700-800 GWh	

In Georgia almost all RES technologies are imported and accordingly Georgian market is provided various RES technologies by various companies. Below a short overview of current RES market in Georgia is presented.

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Solar energy (solar water heaters & PVC panels) – Georgia is sunny country and the potential of using solar energy is very high. Solar energy transforms into heating energy (solar water heating system) and electric energy (solar power station). Solar water heating systems (collectors) are produced in Georgia (price of 2 sq.m. – US$ 400-500) and are imported as well (price – US$ 500-1,000). The price of 50 W solar power station (module, accumulator, electric equipment) with surface area 2 sq/m is about 700-800 US$; 500 W (4 sq/m) –7,000-8,000 US$; 1,000 W (8 sq/m.) – US$ 15,000; 3,000 Wt (25 sq.m.) – US$ 45,000. The following companies are working in this field:"Solar Energy Georgia Ltd.", Association Sustainable Energy Center "Mzis sakhli", "Sichinava da Kompania Ltd.", "Technoimporti Ltd.", "Therma Arsenali Ltd.".

Wind energy – The potential of wind energy is used insignificantly in Georgia yet. Only some small (100-400 watt) plants are working. In the last period because of improvement of technologies, the price of electric energy manufacturing on wind power plants approaches to the price of electric energy on hydroelectric power plants. It increases the perspective of using wind energy in the country. The component parts of wind power plants are imported. The price of turbines of wind power plants is: 450 watt – US$ 1,000, 750 watt – US$ 1,350. Ltd "Qarenergo" (Research and design works for using wind energy) and "Mzis sakxli" (equipment for wind power plants) are working in this sphere.

Hydro energy – Hydro energetic has a big potential in Georgia. 85% of electric energy is generated on hydroelectric power plants. During the last years the quantity of small hydroelectric power plants reduced from 400 to 50, but theoretical is possible to build 1,000 small hydroelectric power plants. The turbines for receiving hydro energy are imported. Water wheels with simple machinery are made by local resources. JSC "Saqhtskalproeqti", JSC "Saqhidroenergomsheni", "Soreli Ltd." are engaged in construction of hydro objects, research and design works on hydro energy objects.

Biogas – There are about 400 biogas plants in Georgia. Wide-spread are such constructions:

- Plant with hard dome;
- Gobari type plant;
- Plant made from polymer-fibrous;
- Over-ground methyl tank working in thermophilic regime.

The price of locally manufactured bio digester with volume 4-6 cubic meter is US$ 2,000 – 3,000. The construction of bio digester needs skill technician. Bioenergy Ltd and "Global Energy Ltd." are working on a turn-key basis in this sphere, though in various regions of Georgia there are individual entrepreneurs who specialize on construction of bio-digesters.

8.6.2 General information on Energy Efficiency Materials in Georgia

Georgian energy efficient construction materials sector is under development process, with high growth potential supported by a strong and competitive construction industry. The market in Georgia is represented by perlite, glass wool, rock wool and polystyrene. Perlite and polystyrene insulation materials are produced locally as well as imported from Iran, Czech Republic, Italy, France and Turkey. Glass wool and rock wool are imported to Georgia from Turkey, Russia and Germany. The most frequently used local natural resources for production of construction materials are perlite, basalt, pumice, slate and tuff, the vast reserves of which are owned by Georgia. During the last 4-5 years the using of energy efficiency

building materials was growing up by 30-35% per year. Currently most common EE materials on Georgian constructive market are:

- **Pearlite** – is amorphous volcanic glass with high content of water. Pearlite manufactured in Georgia is imported in Azerbaijan and Russia. In Georgia there is only one undertaking which manufacturing pearlite – ltd "Samto Kompania Paravanperliti". The pearlite blocks/bricks are producing by ltd "Semi" and ltd "HB";
- **Polystyrene** – is a polymer produced from liquid hydrocarbon. Polystyrene more often is used in pressured kind. It is imported by ltd "GRC" from Turkey, Russia, Poland and Finland. There are some companies which are importing polystyrene with other building materials, because polystyrene is very light, not compact and only its import is not profitable. The local producers of polystyrene are ltd "Kemkheli" and ltd "Interplasti";
- **Glass wool** – it imported to Georgia from Turkey, Iran and Russia. The demand on wool glass is higher, than on mineral wool, because it is cheap thermal isolation material. The importers of glass wool are ltd "GRC" and distributors of "Knauf". Price of 1 square meter glass wool in Georgia is US$ 1.75 (with foil) and US$ 1.45 (without foil);
- **Mineral wool** – also is imported to Georgia from Turkey, Iran and Russia. Demand is growing up. The price of 1 square meter mineral wool is about US$ 8-10. The main importers are ltd "GRC" and ltd "Knauf Marketing";
- **Aluphom –** heat, steam and noise insulating material composed of 1 or 2 layers of special clean (99.4%) aluminum and foamed polyethylene. It keeps insulating state in moist environment. This material is ecological clean, light and keeps at least 25 years. The similar state has the other insulating material **Terraphom.** Those materials are imported from Ukraine;
- **Sandwich-panels –** are imported in Georgia from Turkey and Germany, the local producer is "Interplasti" Ltd;
- **Pumice blocks –** pumice blocks are traditional building material in Georgia. The demand on pumice blocks is higher, than on other light building materials (pearlite blocks, foam concrete). In different regions of Georgia, with pumice stocks, some manufacturing units producing pumice blocks ("Geokabadoki Ltd.", "Delta Ltd.", "Karieri Ltd.") are working;
- **Foam concrete** – is produced in different regions of Georgia by a few production units, but their work is not stable. The general consumers of foam concrete are big building companies. Foam concrete is 20 times lighter than traditional concrete and 8 times lighter than silicate brick. The main producers of foam concrete are ltd "Dugabi +", ltd "Porobetoni", ltd "Evrobloki".

8.6.3 Mounting of energy efficient heating and water supply systems

In the regions of Georgia where population generally uses firewood for heating a utilization of energy efficiency firewood stoves is very important. Energy efficiency firewood stoves use less firewood for receiving the same quantity of warmth (price: 200-250 USD). There are number of local manufactures producing such stoves as well as a number of local companies importing EE stoves to Georgia, for example from Turkey.

For water heating two types of systems either storage or water flows working on electricity or natural gas is used. These devices as well as other systems used for HVAC are imported from Turkey, Germany, Italy, China, Russia, and Ukraine. Locally manufactured natural gas space heaters are also popular as their price is relatively lower of imported ones. The "KERA" gas space heaters are manufactured by "Tam Kera" Ltd.

It is noteworthy that there are various insulating materials available on the local market without any information about insulating properties, producers and consequently of doubtful quality. Therefore, it is desirable to acquire insulating materials with all above mentioned information on labels.

8.6.4 EE windows and Doors

As a mean of improving energy performance of buildings installation of double glazed PVC windows and doors became very popular in Georgia in recent years. The production units for such windows and doors are almost in every town/district centre in Georgia. These production units import all necessary supplies and accessories mainly from Turkey & Germany.

8.6.5 Use of lighting energy saving systems

Due to the absence of lighting energy saving technologies' production in Georgia the EE bulbs (diode & fluorescent lamps) mostly is imported mainly from China, Turkey, Germany, Czech Republic, and Poland. Their prices in accordance with quality and lighting power are from 6 to 20 GEL. Principal importers are: ltd "Akhali Nateba", ltd "Insta", OSRAM and others.

Although in 2014 the Company "AG Telekom" through investment made by the Georgian businessmen has opened the plant "AG Microelectronics". The plant is specialized in the production of wide range small household electronic devices (television receivers, modems, smart phones, tablets, netbooks, TV sets), including the LED light bulbs. The company is constant supporter of innovation and technology development in the country[143]. The company aims to be the market leader in the region. For this reason the company is planning to develop enterprise and create its neighboring enterprises that will facilitate the creation of a complete cycle of production and to increase of products' competitiveness in the world market.

As it was mentioned above after the breakup of the USSR, the energy sector in Georgia fell down a catastrophic collapse in the early 1990s. Consequently, when the Georgian government decided to restore the Georgian energy sector it was revealed that existing energy infrastructure needed full rehabilitation and equipment with innovative technologies. And in 2004 Georgian government with support of the International Development Association (IDA) transformed the power sector into functioning sector. The rehabilitation process of energy sector included technical equipment of existing thermal and hydro power plants and transmission lines with modern innovative technologies.

It should be noted that renovation of the energy sector is ongoing process especially in hydro power sector with consideration of construction of the new hydro power plants, transmission lines and substations as one of the main objective of the Ministry of Energy of Georgia.

In terms of implementation of technical and social innovations in energy field it has to be noted significant share contribution of international and local non-governmental organizations. Most of these projects were implemented in rural area of Georgia.

One of the most active bodies on the ground in Georgia appears to be USAID-sponsored Winrock International which runs a range of RES/EE programs. Winrock Georgia is an official representative of Winrock International in Georgia, carrying out USAID projects since 2005. Winrock Georgia has accomplished several projects 1) Rural Energy Program144, 2) New Applied Technologies Efficiency and

[143] Source: agmicroelectronics.com/#!shesaxeb-eng/cqo5

[144] The Georgia Rural Energy Program (REP), implemented by Winrock International, was a four-year (2005-2009) project designed to develop the basic regulatory, technical, financial and operational building blocks for commercial generation of small hydro power and other renewable power sources in rural Georgia.

Lighting Initiative - NATELI 1 , NATELI 2 and just recently started Enhancing Capacity for Low Emission Development Strategies (EC-LEDS) supported by US Agency for International Development (USAID).

The Rural Energy Program stretched renewable energy and energy-efficiency procedures in rural Georgia. Technical assistance and training helped rehabilitate small hydropower plants, introduced and promoted renewable energy and energy efficiency technologies, increased access to financing for small hydropower and strengthened the capacity of the energy sector in Georgia.

The program NATELI 1 that was financed by USAID program was intended to support energy efficiency and renewable energy (but with lesser scope) usage in Georgia. The main objective of the program was to promote energy efficiency to the Georgian public and business sectors, and to design financial, technical and operational frameworks to foster the development and implementation of energy efficiency projects.

The main objectives of the NATELI project were to help large institutions reduce their energy consumption with a special focus on hospitals. The work activity consisted: energy audits; examination of financial costs and benefits of various energy efficiency improvements; assistance to hospitals with implementation on a limited basis; teaching the local stakeholders how to manage their energy consumption; evaluation the financial viability of energy efficiency improvements, facilitated access to financing, and promoted results to the public.

The second tasks of the project encompassed support to pilot projects that promote residential energy efficiency. The projects stakeholder in which Tbilisi Municipality was involved has been condominium associations. The separate project was accomplished with Georgian State Technical University (GTU) to incorporate energy efficiency matters into their curriculum, and to implement energy efficiency retrofitting in several GTU buildings.

Innovative approach for raising public awareness was EEC Georgia initiated and BP & partners and USAID/Winrock Georgia funded a 3-year project which was focused primarily on rural communities. The Energy Bus toured Georgian communities and educated Georgian citizens about energy efficiency and renewable energy in general, as well as their practical application. Energy Efficiency Centre (EEC) deals with energy efficiency issues having its representation in Georgia since 1998 after it was funded by the EC's TACIS Program. EEC studies being delivered as recommendations have always emphasized the lack of institutional and legal framework that turns out to be the main obstacle for realization of energy efficiency policy.

Projects implemented by EEC include feasibility studies, technical and economic studies, comprehensive market research, pilot and demonstration projects, trainings in various RE & EE technologies, promotion and dissemination, project financing, as well as a deep understanding of the wider policy and investment issues facing the energy sector. In addition, EEC has become a Covenant Supporter to Georgia which leverages along with another covenant supporter to Georgia (NGO "National Association of Local Authorities") to lobby, communicate and make a networking activities to promote the Covenant of Mayors initiative and support the commitments of its signatories.

Another USAID-sponsored firm, Advanced Engineering Associates International (AEAI), was running (2008-2011) an energy capacity initiative to further enhance energy policy analysis capacity within Georgia, promote stakeholder dialogue on policy issues and support higher education programs in energy.

Local NGO "Sustainable Energy Centre-Sun House" with financial support of various international organizations has been implementing innovation projects in order to promote solar systems. The main aim of the organization is to research and promote the practical applications of solar, wind water and biogas applications in Georgia. In various rural areas of Georgia the organization installed mainly solar

applications (solar water heaters & solar PV panels) supported with wind systems. The applications were installed mainly in high mountains regions of Georgia for various beneficiaries such as individuals (sheppards) living in high mountains throughout the years, churches and monasteries, administration buildings of protected areas managed by agency of protected areas, the public buildings located in various regions of Georgia.

Georgia does not have programs or developed strategy in place to jump start EE/RES market development. These instruments should incorporate realistic numerical parameters for EE/RES capacity and output and have clear and achievable benchmarks. The document of "Main Directions of State Policy in Energy Sector" provides some targets, but only for small hydro power and wind power development. Furthermore, these numbers are already outdated and need to be reviewed based on realistic assumptions and using sound planning methodology and analytical tools. Finally, given that the government is very keen to attract new investments, it would be very beneficial for a government program to provide information on EE/RES innovations possibilities and optimal locations.

The main bottlenecks and barriers for developing of EE/RES innovations in Georgia are

- Insufficient capacity of the government and business sector which does not allow properly address all the challenges facing RES/EE innovations development;
- The taxation system is no longer supportive of RES/EE innovation development. In 2005 Georgia abolished tax benefits for RES/EE investment in the country's new tax code. Tax reductions or local tax exemptions the main tools that will promote to encourage RES/EE development;
- Absence of the legislation related to the development of EE/RES innovations. Some legal initiatives in support of RES/EE introduced is scattered in various legal documents;
- Public awareness on EE/RES innovations potential and opportunities is low. There are not efficient information campaigns or analytical research projects to promote EE/RES;
- Low interest of local energy sector to invest in the development of EE/RES innovations especially in solar, wind, biomass energy sector;
- Low capacity of research centers to establish local EE/RES innovations on local market;
- Lack of effective cooperation between local business sector and research institutions;
- Difficulties of connection of produced renewable electricity to the national grid;
- Absence and/or insufficient financial support to research centers/institutions from government side for developing of EE/RES innovations;
- High cost of EE/RES innovations on Georgian market.

SWOT analysis of Georgian energy field and EE/RES:

Strengthens	Weaknesses
❖ High RES/EE potential especially water, solar and biomass; ❖ Declared objective of Government to develop small and medium hydropower plants; ❖ Member of international agreements (Covenant of Mayors) to develop and establish sustainable energy policy; ❖ Energy policy and/or strategy that is currently under development process; ❖ EU funds available for such projects;	❖ The local experience in EE & RE projects is not sufficient. The lack of technology experience in Georgian makes the technology investment cycle long and as a result early technology development must be subsidised early adaptation, well ahead of commercialization. So far, there is no special VAT exemption incentives (green certificates) for the consumers to purchase this type electricity are not working; ❖ High interest on loans to industrial or households projects related to energy efficiency and renewable energy;
Opportunities	**Threats**
❖ Several EE/RES innovations have been implemented and other projects are in the line; ❖ With support of IFI through local banks credit lines opened for EE/RES innovations; ❖ Growing market for EE/RES developers; ❖ Newly developed low on Spatial Planning and Construction Code including EE/RES components in the building sector; ❖ Renewable Energy Sources can comprise a large stake in Georgia's total Primary Energy Supply; ❖ Renewable Energy Sources can be price-competitive with traditional energy sources; ❖ Creating a favorable investment environment which will set Georgia on an easy, self-propelling EE/RES development path;	❖ Stricter conditions relating to the connection of electricity generation facilities using RES to the transmission or distribution system; ❖ The technical capacity of the Georgian electricity grid needs some upgrading for the development of RE generation facilities;

Table 9: SWOT Analysis

First of all government should initiate such encouraging initiatives as listed below to develop EE/RES innovations:

- VAT exemption, low loans, legal regulations on EE/RES, capacity building of business sector and/or research centres in the field of EE/RES innovations;
- Support the research and development in the field of EE/RES in order to support the activities in this sector with sound information and the analytical base;
- Develop and approve the law and/or policy on EE/RES;
- Develop long term and short term EE/RES plans;
- Expand and strengthen the activities of specialized institutions such as research centers

- To promote the specific incentives of EE/RES for business sector;
- To strengthen of cooperation between business sector and research centers.

In the development of EE/RES innovations in ENP countries cooperation and experience sharing with EU is very essential. Accordingly, ongoing ENER2i project will strengthen cooperation between research and business actors in EE/RES in the participating countries and at the same time facilitate the cooperation between EU and participating EaP countries. All this will encourage improvement of knowledge transfer and innovation support in the field of EE/RES through a comprehensive trans-national cooperation.

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9. Country Report of Moldova

ENERGY SECTOR IN THE REPUBLIC OF MOLDOVA

Authors:

Agency for Innovation and Technology Transfer (AITT):

Vadim Iatchevici, Doinita Ulinici,

Organization for the Development of Small and Medium Entreprises (ODIMM):

Olga Popa

Assistance:

Institute of Energy of the Academy of Sciences of Moldova

Dr. Natalia Timofti

ABBREVIATIONS

CIS = Commonwealth of Independent States

EBRD = European Bank for Reconstruction and Development

EE = Energy Efficiency

GWh = Gigawatt Hour

KTOE = Kilotonne of Oil Equivalent

NEEAP = National Energy Efficiency Action Plan

NGOs = Non-Governmental Organizations

OECD = Organization for Economic Co-operation and Development

PNEE = National program for energy efficiency

PPP = Purchasing Power Parity

RES = renewable energy sources

SMEs = Small and medium enterprises

9.1 Introduction

As part of a wider /research, the Moldova Country Report will consist of two parts, analysis of local energy sectors, and stakeholder identification. The Report will analyse the local energy sectors of the Republic of Moldova and will describe the current energy and technology resources. The paper will identify the local strengths and weaknesses with regards to the application of energy efficiency and RES in the business and enterprise sector. It will provide an overview of available technologies and technology providers, of social innovations achieved, and address the relevant local policies and energy strategies. Another important focus of analysis will be the national innovation systems, including funding possibilities and innovation support services concerning EE/RES. Linkages between research and business in the energy field will be investigated and existing bottlenecks highlighted. Cooperation opportunities between EU and ENP partners on innovations in EE/RES will be outlined. On the basis of these current snapshots of the local energy innovation systems, potentials and opportunities for EE/RES applications will be outlined and outlooks for future developments in the sector provided. The country report will identify the relevant stakeholders in EE/RES (research institutes, manufacturers, technology providers, start-ups, innovation support providers, incubators, funding agencies, etc.). The identification of stakeholders is a necessary precondition for fostering research-business collaboration.

Geography And Demographics

Moldova is lies in south eastern Europe, at the junction of Eastern, Central and Southern Europe. The territory is crossed, in the middle by 28˚ 50' long. E and 47˚ latitude N.. Moldova is a country located in the Black Sea and in the Danube River Basins. Danube is the second largest river in Europe, but the first by its role in trade between European countries. The potential of this river is not yet exploited by Moldova.

Moldova is bordered by Ukraine and Romania. The border with Romania follows the river Prut and a small area of about 900 meters, on the Danube. At the North, East and Southeast, Moldova borders with Ukraine. The total area of the Republic of Moldova is approximately 33,800 square kilometers.

Total population of the Republic of Moldova on January 1, 2012 was 3.5595 million people. About 2 million people live in rural areas, and a million and a half - in urban areas. The population is devided in the following way: in the capital city Chisinau live 794.800 people, in the northern districts of the country - 1.0026 million people, in the central districts - 1.062 million people and in the southern districts - 538 900 people. These numbers do not include the population living in the Transnistria region which in 2013 consisted of 506 900 inhabitants.

Most of the eastern territory of Moldova is occupied by an integral relief unit, the Moldavian Plateau, which extends from the piedmont of Bukovina and the Moldavian Subcarpathian mountains in the west to the Dniester River in the east. On the left branches of the river Dniestr we have the Southwest Podolia Plateau. Within these major units, in addition to the relief of the plateau, there are hills and plains. In the Prut-Dniester interfluve, Moldova Plateau is between 429 m (Hill Bălăneşti) and 4 m high in the meadow Dniester (Palanca).

The Republic of Moldova has a moderate continental climate that is characterized by short and mild winters, with little snow and warm summer, with a low amount of precipitation. These conditions also have a negative effect as they are responsible for long dry periods and the changing nature of weather. Basic features of the climate of Moldova are formed under the influence of the influx of solar radiation, atmospheric circulation and the character of the active surface.

Due to its position in the South-East of Europe, atmospheric circulation in Moldova is characterized by the action of specific priority centers of air pressure, specific to south and south-eastern Europe. Air masses that move between the main centers of air pressure over the country arrive over Moldova with modified physical characteristics due to their transformation, determining the sequence of weather conditions in the country. In conclusion, most air masses arriving ton the country are largely dry. This explains the frequency of drought in almost all seasons.

Insolation during the course of the year ranges from 1940 to 2180 hours, 60-70% in summer and 20-30% during the winter. Solar energy reserves expressed by the size of the radiation balance, constitutes about 2100 MDj/m2 a year. It is the basic energy source which provides the heating of the soil, evaporation, and the average temperature of the air.

Moldova's climate is moderately continental: The summers are warm and long, with temperatures averaging about 20 °C (68 °F), and the winters are relatively mild and dry, with January temperatures averaging −4 °C (25 °F). The annual average air temperature is 8-10°C and 10-12°C on the surface of the soil. The frost-free period averages 170 days in the north and 190 in south, but in some years its duration can reach 200-230 days. Moldova belongs to an area of insufficient humidity. Rainfall decreases from northwest to southeast, from 620 to 490 mm per year. Precipitation are falling primarly during the warm season as rain showers and only about 10% of yearly precipitations are in the form of snow.

Wind regime is characterized by the winds coming from northwest and southeast, in terms of frequency (12 to 35% and 15 to 25% respectively). Average wind speed varies from 2.5 to 4.5 m/s.

9.2 Current Energy Situation In The Republic Of Moldova

Moldova has minor reserves of coal, petroleum and natural gas and moderate hydroelectric potential. This has led to a high dependence on energy imports (mainly from Russia, Ukraine and Romania) – with imports of 2,084 ktoe in 2013, or 87% of the total energy supply of 2,391 ktoe. In 2013, total energy imports were comprised of: 44.7% natural gas, 34.1% petroleum products, 7.5% coal and 13.7% electricity.

The past decade has brought about changes in the fuel mix. A fivefold increase from 2005 to 2013 in average annual natural gas import prices from 76.1 $/1000m^3 in 2005 to 379.6$/1000m^3 in 2013 resulted in a sharp increase in tariffs for gas supply, but also in tariffs for locally produced electricity and heat.[2] These price increases served as the main driving force in the search for alternative energy resources, and also for optimisation of energy consumption in all sectors of the national economy. The final use of natural gas, almost 100% of which is imported from Russia, decreased from 2005 to 2013 by 28%. As per 2013, 100% of coal and 99% of petroleum products were imported and more than 80% of electricity supplied to consumers was provided from sources defined as external, including from Ukraine.

Main macroeconomic and energy data	Unit	2010	2011	2012	2013	2014 (f)	2015 (f)	CAGR 2010-13
Total Population	Thousands	3,562	3,560	3,560	3,559	3,558	3,557	0.0
GDP (constant, 2005 prices)	Million Lei	44,119	47,126	46,780	50,944	52,723	55,095	4.9
Primary Energy Production	ktoe	189	238	245	283	323	371	14.4
Net Energy Imports	ktoe	1,800	1,923	1,813	1,889	1,906	1,930	1.6
Net Energy Imports (inc. other sources)	ktoe	2,058	2,136	2,022	2,051	2,044	2,049	-0.1
Total Primary Energy Supply (TPES)	ktoe	2,294	2,353	2,267	2,318	2,356	2,407	0.3
Total Final Energy Consumptio(TFEC)	ktoe	2,006	2,083	2,007	2,055	2,096	2,148	0.8
Electricity Consumption	ktoe	282	291	298	300	310	318	2.1
Electricity Consumption	GWh	3,280	3,384	3,466	3,489	3,608	3,696	2.1
Per Capita Indicators	Unit	2010	2011	2012	2013	2014 (f)	2015 (f)	CAGR 2010-13
Primary Intensity - TPES/ population	toe/capita	0.644	0.661	0.637	0.651	0.662	0.677	0.4
Final Intensity - TFEC/ population	toe/capita	0.563	0.585	0.564	0.577	0.589	0.604	0.8
Electricity/ population	kWh/capita	921	951	974	980	1,014	1,039	2.1
Energy Intensity	Unit	2010	2011	2012	2013	2014 (f)	2015 (f)	CAGR 2010-13
TPES/ GDP	toe/ Million LEI of 20005	52.0	49.9	48.5	45.5	4.7	43.7	-4.4

TFEC/ GDP	toe/ Million LEI of 20006	45.5	44.2	42.9	40.3	39.8	39.0	-3.9
Overall efficiency of the trans- formation sector	**Unit**	**2010**	**2011**	**2012**	**2013**	**2014 (f)**	**2015 (f)**	**Δ 2010-13**
Total Transformation Output/ Input	%	80.7	80.9	80.4	80.2	79.5	78.2	-0.6
TFEC/ TPES	%	87.4	88.5	88.5	88.7	89.0	89.2	1.2
Energy Dependency (Net Imports/ TPES)	Unit	2010	2011	2012	2013	2014 (f)	2015 (f)	Δ 2010-13
Net Imports/ TPES	%	78.5	81.7	80	81.5	80.9	80.2	4.9
Heating Degree Days	Unit	2010	2011	2012	2013	2014 (f)	2015 (f)	1994-2014 average
HDDs for Chisinau	-	3,144	3,147	3,145	2,883	2,975	n.a.	3,083

Table 1: Main macroeconomic and energy data

During the last few years, solid biofuels have had a growing share in total primary energy sup-ply (TPES) and total final consumption (TFC) has. In 2013, solid biofuels accounted for 11.6% of TPES and 12.6% of TFC.

The process of revision and improvement of national energy statistics is on-going. This has resulted in a number of discrepancies in the latest and in previous official data provided by the National Bureau of Statistics of Moldova. In the current review for all presented data the official sources of data are provided. Keeping in mind that all national strategies, laws, programmes and action plans are based on the local official data, in the following text preference was given to the national statistical data rather than other sources like IEA, etc. The existing discrepancies in the local official statistical data should be seen as part of the on-going process of improvement of local energy and other statistics.

Data provided by the National Energy Regulatory Agency for 1997 to 2013 show that local power production in Moldova accounted for about 25% in 1997 and 18.3% in 2013 of the total. The rest of the electricity came from sources defined as external, including Ukraine.

9.2.1 Main energy sources and energy suppliers in the Republic of Moldova

The main sources of the energy sector can be observed in the table 1 and are: supply of natural gas, electricity, and thermal energy and oil products.

Resources	2005	2006	2007	2008	2009	2010	2011	2012
Total	**2463**	**2430**	**2358**	**2410**	**2312**	**2401**	**2442**	**2358**
Internal Sources	87	92	88	110	124	104	116	123
Liquid fuel	10	7	16	26	38	31	31	29
Solid fuel	70	78	69	77	81	66	78	91
Hydroelectricity	7	7	3	7	5	7	7	3
Import	2185	2157	2115	2104	1973	2071	2150	2041
Liquid fuel	622	603	643	668	659	666	740	675
Natural gas	1205	1201	1110	1057	977	1033	1015	971
Solid fuel	103	105	110	124	84	112	125	113
Electricity	255	248	252	255	253	260	270	282
Stocks of fuel beginning of the year	191	181	155	196	215	226	176	194
Distribution – total	**2463**	**2430**	**2358**	**2410**	**2312**	**2401**	**2442**	**2358**
Internal consumption	2278	2271	2160	2191	2071	2209	2237	2145
transformation in other types of energy	842	817	767	764	716	737	717	704
production-technological needs of which:	1436	1454	1393	1427	1355	1472	1520	1441
industry and construction	161	163	156	142	85	107	118	125
Agriculture	61	59	52	51	46	48	45	44
Transport	267	285	325	336	291	358	383	369
trade and communal facilities	120	123	119	120	172	157	157	156
sold to population	704	691	598	632	660	689	708	639
Other	123	133	143	146	101	113	109	108
Export	3	4	7	5	15	18	14	27
Stocks of fuel end-year	182	155	191	214	226	174	191	186

Table 2. ENERGY BALANCE (thousand tons of oil equivalents)[145]

[145] *Source: National agency of statistics*

Electricity: The main normative act regulating internal electricity sector today is the Law on electricity adopted in 2009. In Moldova there are 4 major electricity producers, 1 state enterprise for electricity transport and 3 electricity providers. Beside the 3 providers with regulated tariffs, Moldova also has 9 companies with unregulated tariffs. Electricity production in the Republic of Moldova covers about 25% of its consumption, with a decreasing trend.

Figure 1: Electricity and gas network of Moldova

Source: *Energy Community (2013), Study on the Implementation of the New Regulation (EU) 994/2010 Concerning Measures to Safeguard Security of Gas Supply in the Energy Community, Energy Community, September, Energy Community, Vienna.*

Therefore, the data shows that the volume of electricity produced in 2014, comparing to the last year, increased with 40.2 mln. kWh (aprox. 5.1%), constituting a total amount of 788.1 million kWh. However, even if the amount has increased comparing to the previous two years (2012 and 2013), it remains with 100.3 million kWh (aprox. 11.3%) below the average of the annual electric energy production which were registered in the period 2001-2014. It should be mentioned that the amount of energy produced in 2014 was 32.3% lower comparing to the maximum volume produced in 2001 (1 42.9 mln kWh).

In 2014, there were registered a significant increase, 2.9 times compared with the previous year, of the amount of electricity generated and delivered in the network of other domestic producers such as factories for the production of sugar within their own sources of generation, production of electricity in the different renewable energy sources. Thus, the production of this type of energy within wind power, solar power and biogas installations has increased by 64.3%, from 1.9 mln. kWh in 2013 to 3.1 mln. kWh in 2014.

Natural Gas: Moldova is dependent on natural gas imported from abroad. This dependence increases the vulnerability of the economy and increases the price of the purchased natural gas.

In 2014, the Chain Corporation "Gazprom" from Russian Federation continued to be the only source of natural gas for the Moldovan's market. The total purchases of natural gas amounted 1 53.1 thousands m3. Comparing with 2013, it was registered an increase of 2.1%.

All activities, import, supply, cross-border and national transmission, distribution and retail in Moldova's gas market, are performed by vertically integrated company Moldovagaz. The company acts as an importer and a wholesale and (in Chisinau) retail supplier. The legislative framework is set by the Natural Gas Law adopted in 2009 and amended in 2014. The Law transposes the provisions of Directive 2003/55/EC and Directive 2004/67/EC. The secondary legislation includes technical standards for natural gas transmission and distribution networks, regulations on the quality of natural gas transmission and distribution services and a regulation on the provision and use of natural gas. In 2014, Moldova started to develop a new Gas Law with the aim to transpose the Third Package and to rectify breaches of Energy Community Acquis in the existing legislation.

The law considers efficient utilization of assets and differentiation of tariffs per level of pressure but not specific incentives for customers to achieve savings are yet in place.The gas tariff stimulates savings by providing a threshold of 30 m^3, the price for consumption higher than 30 m^3.

In August 2014, the Ungheni-Iasi gas pipeline from Romania was completed, 43 km long with a potential capacity of 1.5 bcm. The pipeline runs 10 km on Moldovan territory. The government is currently making plans to build a 100 km extension of the pipeline to Chisinau by end-2016.

Thermal Energy: The market of thermal energy is covered by three thermoelectric plants CHPs and the main provider is "TERMOELECTICA" and CET-Nord. Production of thermal energy in the Republic of Moldova has a decreasing trend. Thus, according to the energy balance, in 2011 generation of thermal energy decreased by 5.3% compared to 2010 and by 11.5% compared to 2008.

In 2014, the total amount of thermal energy purchased from CETs and produced by thermal power plants of the businesses which are under the regulation of thermal energy sector (excluding own and technological consumption) constituted 1 819.6 thousand Gcal. This means that it was registered a decrease of 1.7 thousand Gcal (aprox. 0.1%) comparing to the previous year and a decrease with 189.7 thousand Gcal (aprox. 9.4%) comparing with 2012.

District heating is provided through centralized systems and during 2013 were provided by 14 operators carrying out activities to provide thermic energy in cities and towns. Service tariffs are regulated by ANRE.

Indices	2001	2005	2009	2010	2011	2012	2013	2014
Electricity production (delivered from the outgoing power lines) total mil.kWh	**1042,9**	**999,8**	**856,8**	**888,1**	**854,3**	**776,1**	**747,9**	**788,1**
Incl: CET –1	115,4	128,9	116,7	82,0	59,8	47,7	53,3	44,0
CET –2	812,8	724,7	639,2	665,4	655,9	636,6	594,0	616,4
CET – Nord	31,5	55,5	53,5	57,1	57,8	54,5	49,4	50,1
NHE Costești	72,2	83,8	54,0	78,3	75,5	33,5	44,6	58,3
Other internal producers	11,2	6,9	2,4	5,3	5,3	4,0	6,6	19,3
Purchasers of electricity - total, million kWh	**3194,8**	**3465,1**	**3799,6**	**3915,6**	**3993,7**	**4050,3**	**4071,9**	**4.122,3**
Incl. RED Nord	569,7	588,1	638,6	651	662,9	663,9	662,0	689,7
RED Nord - Vest	314,9	287,1	330,6	342,4	344,1	353,0	355,8	363,3
RED Union Fenosa	2310,2	2484,3	2749,2	2842,2	2902,5	2949,2	2941,9	2.981,7
		105,6	81,1	80,0	84,2	84,2	112,2	87,6

Table 2 : Structure of electricity generation by producers and breakdown of consumption by supplier

Oil and Liquefied gas: Currently, there are 10 importers of liquefied gas and 24 importers of gasoline and diesel. There are 71 companies operating as distributors of liquefied gas and 80 companies as distributors of gasoline and diesel.

The largest companies in the oil market are "Lukoil-Moldova" SRL, "Petrom Moldova" and "Rompetrol Moldova".

The volume of all petroleum products imported in 2013 increased was 640 843 tons, showing an increase of 10.9%, compared to the volume imported in 2012. The largest increase in imports was experienced in the fields of diesel (17.6%), liquefied gas (1.4%) and gasoline (0.4%) compared to 2012. In addition to imported fuel, oil products processed from oil extracted in Moldova were also marketed in the domestic market. The "Arnaut-Oil" company has produced 1 231 tons of diesel, which is 724.4 tons less than in 2012. For the first time, the same company produced gasoline, in a total amount of 159 tons.

9.2.2 Legislation and institutional framework in energy sector

Energy institutions of the Republic of Moldova have been undergone a substantial restructuring process during the period from 1998 to 2014. In the energy sector the Ministry of economy is responsible for:

- Participation in the development and implementation of measures concerning energy security;
- Development of technical requirements;
- Organization and coordination of drafting legislative and normative acts;
- Developing programs on medium and long term and investment projects for the development of the energy sector and its segments, in cooperation with energy companies and other interested parties;
- Developing and monitoring concepts and strategies, and the implementation of the program in the energy sector at national and regional levels;
- Development policy of gas pipelines;
- Defining the general rules concerning the import, export and transit of electric energy, gas, petroleum products and other fuels;
- Coordinating the activities on the field of energy efficiency and renewable energy and supervision of responsible authorities;
- Promoting international cooperation in the energy sector.

The energy policy of Moldova is based on national priorities and international commitments, notably since 2009 when Moldova acceded to the Energy Community Treaty. In the period be-tween receiving full membership of the Energy Community (2010) and before signing and ratification of the EU-MD Association Agreement (2014), several policy documents were adopted in Moldova, including but not limited to:

- National Development Strategy ‘Moldova 2020', adopted by Law nr. 166 of 11 July 2012, and
- Energy Strategy of Moldova until 2030, adopted by Government Decision nr. 102 of 5 February 2013.

As stated in the National Development Strategy ‘Moldova 2020', energy efficiency and security have a direct impact on economic development and social welfare. Among the eight priority objectives for long-term development of Moldova, as defined in this policy document, one objective (nr.5) comprises: ‘. decrease in energy consumption through increased energy efficiency and use of RES'.

As stated in the Strategy, the achievement of these strategic objectives is based on two pillars, namely:

- ensuring national energy security, and
- improving energy efficiency.

Energy efficiency improvement is expected to be attained by:

- energy intensity reduction in residential, industry, transport and agriculture sectors;
- modernisation of the energy system;

- implementation of energy-efficient technologies;
- development of local energy resources, including RES;
- public awareness-raising regarding the need for energy savings (including public utili-ties, building materials, housing, household appliances, etc.).

The government's commitment to achieving these strategic goals is attested by:

- strengthening the sector reform, including adoption of new and EU-aligned energy leg-islation;
- implementation of energy efficiency promotion measures;
- attracting investments in the sector;
- strengthening institutional capacity in this field.

Among the specific targets set out in this Strategy are the following:

Indicator	2015	2020
Energy security		
New interconnections:		
• electricity transmission grids, km		**139**
• natural gas pipelines, km		**40**
Increase of local power generation, MW		**800**
RES share in annual electricity production, %		**10**
Energy efficiency		
Decrease in energy intensity by, %		**10**
Decrease of electricity losses in transmission and distribution networks to, %	**13**	**11**
Decrease of natural gas losses in transmission and distribution networks by, %	**20**	**39**
Decrease of heat losses in transmission and distribution networks, %	**2**	**5**
Decrease in greenhouse gas emissions by (compared with 1990 level), %		**25**
Decrease in buildings' energy consumption by, %		**10**
Share of retrofitted public buildings, %		**10**

Source: National Development Strategy Moldova 2020

The legislation of the Republic of Moldova in energy sector is based on the following laws:

Currently the main policy document is the Energy Strategy 2030 approved by Government Decision no. 102 of 05th of February 2013.

The objective of the Strategy is to provide a practical guidance for the development of the energy sector in the Republic of Moldova in order to support economic growth and social welfare. Thus, the Strategy

has identified strategic vision and strategic opportunities in the country's rapidly changing energy environment, in the Central, Eastern and Southern regions.

Priority strategy aims are directed to overcoming the country's energy problems that require quick solutions and rescheduling/resizing objectives, with prudent reconciliation between: resources currently available, the EU aims/objectives of the Energy Community and national agreements, international obligations and programs (including also towards neighbouring countries), and emergency needs of the country.

The strategy is based on three objectives: energy security; creating competitive markets and regional and European integration; environmental sustainability and combating climate change.

Moldova's energy sector development in the decade of 2020-2030 will be based on the successful implementation of measures and actions planned for the previous period of 2012- 2020. At the beginning of this new phase, the energy sector will benefit from planned improvements to diversification of the energy mix, reduce consumption and higher efficiency in generation, transmission, distribution and consumption. It will also benefit from stronger inter-connections, more diversified sources of supply, effective competition in the supply of energy, and lower market concentration. Another set of advantages will be obtain from the implementation of the mechanisms of a competitive and transparent market price, responsible, honest management, and a high level of professionalism and increased social accessibility. All these achievements will form a sustainable platform to begin a new stage in the development of Moldova.

Other legislation related to energy sector is:

a. Law Nr. 1525 of 19th of February 1998 on Energy

The purpose of this law is to create a legal framework to ensure energy efficiency, reliable supply of the national economy and the population with energy resources.

b. Law Nr. 461 of 30th of July 2001 on the petroleum products market

The purpose of this law is to form an organizational, legal and economic framework, in order to ensure the economic security of the country and regulate the import, transport, storage and marketing of petroleum products on the domestic market, considered as strategic products, with a special regime of activities.

c. Law Nr. 160 of 12 of July 2007 on renewable energy

The purpose of this law is the legal operation of the renewable energy sector, economic and social relations that constitute the process of exploitation of renewable energy sources, ways of organizing production and bringing renewable fuel and energy sources to the market.

d. Law No. 117-XVIII of December 23, 2009 for Moldova's accession to the Treaty establishing the Energy Community.

This law refers to Moldova's accession to the Treaty establishing the Energy Community. As a consequence, Moldova enjoys all rights guaranteed to the parties and is subject to all the obligations imposed by the treaty, by all procedural decisions and acts adopted in the context of the treaty after its entry into force.

e. Law Nr. 123 of 23rd of December 2009 on natural gas

The purpose of this Act is to establish a legal framework for the effective functioning of the gas market and gas sector activities, in terms of accessibility, availability, reliability, continuity, competitiveness, transparency, compliance with quality standards, safety and protection of the environment.

f. Law Nr. 124 of 23rd of December 2009 on Electricity Law

The purpose of this Act is to establish a legal framework for the efficient operation of the electricity market. Establish measures to ensure security of electricity supply in order to ensure the proper functioning of the electricity market, an adequate level of generation capacity, an appropriate balance between supply and demand, and an appropriate level of interconnection systems with neighboring countries for the development of electric power market.

g. Law Nr. 142 of 2rd of July 2010 on Energy Efficiency

This law regulates the activities aimed at increasing the energy efficiency and renewable energy sources of the national economy.

Other relevant normative acts are:

- **Decision of the National Agency for Energy Regulation Nr. 321 of 22nd of January 2009 on approval of the Methodology of determination, approval and application of tariffs for electricity produced from renewable energy and biofuel.**
- **Government Decision no. 833 of 10th of November 2011 "National Program on Energy Efficiency 2011-2020;**
- **Government Decision no. 113 of 2nd of July 2013 on the approval of the National Action Plan for Energy Efficiency for 2013-2015;**
- **Government Decision no. 1073 of 27th of December 2013 on the approval of the National Action Plan on the RES for the period 2013 – 2020.** The purpose of this Decision is to develop an action plan to promote the use of renewable energy.
- **On 7th of February 2014, at the initiative of the Ministry of Economy of the Republic of Moldova, the Government approved the draft law on the promotion of renewable energy sources (RES). This normative act aims at diversification of primary energy sources; achieve at least a 17% share of energy from renewable sources in gross final consumption of energy by 2020.** The main purpose of the law is to encourage and protect investors, to ensure the continued development of technologies, which generate energy from renewable sources, to provide free and non-discriminatory access for manufacturers to the energy grids, access for producers of biogas to the natural gas network, ensuring mandatory purchase of electricity produced from renewable sources, biogas and biofuels.

In the context of Moldova's dependence on imported energy sources up to 95% of the country's energy consumption and an energy intensity of about 3 times higher than in developed countries, capitalizing RES will enhance the energy security of the country. The project also aims to promote technological development and innovation, providing opportunities for employment and regional development, especially in rural areas.

Using renewable resources such as solar, wind, biomass, and other debris and waste to produce electricity, biofuel and biogas provides significant environmental benefits, given the strong potential for achieving greenhouse gas reduction, both in the production of energy and in the their use as biofuel.

The law creates the framework for attracting foreign investments in the production of electricity from renewable sources as well as a mechanism to protect the consumer in order to obtain fair prices for electricity from renewable energy sources.

The elaboration of the draft law on the promotion of renewable energy, is driven by the need to harmonize the legislation of the Republic of Moldova with the principles of the legal system of the European Union.

The the draft Law on the promotion of renewable energy sources (RES) was formally announced in the Parliament in 2014 and it is not adopted yet.

- **Government Decision no. 141 of 24th of February 2014 on the establishment of an energy statistic system**

This decision provides for the establishment of an action plan on creating and implementing an efficient energy statistical system in accordance with European Directives. It provides for the introduction of specific indicators of energy efficiency and renewable energy, as well as the production of energy statistics for reporting to stakeholders and international organizations.

9.3 Current situation with energy efficiency and renewable energy sources

The Republic of Moldova almost entirely depends on imported fuels; dependence on imports is estimated to be around 88%. Shortage of internal capacities to generate energy, increasing energy intensity of the economy, and a low level of RES usage (solar, wind, hydropower, and biomass) are other significant challenges for the Moldovan energy sector. In this situation, it is necessary for national and local public authorities to undertake concrete actions for increasing energy efficiency and the energy supply through RES, as an essential condition for the sustainable development of the economy. Moldova has indeed great potential to produce energy from its own renewable sources (e.g. biomass), which have not yet been exploited. The country's energy intensity is around 3 times higher than in the EU and the use of renewable energy is still limited. Recent policy and legal developments directly related to renewable energy sources (RES) include, but are not limited to, the following documents: National Development Strategy 'Moldova 2020' (adopted in 2012); Energy Strategy 2030 (2013); Energy Strategy of the Energy Community (2012); EU-MD Association Agreement (2014); Law on renewable energy (2007); National Energy Efficiency Program 2011-2020 (2011); National Renewable Energy Action Plan 2013-2020 (2013); Regulation on solid biofuels (2013); Regulation on the guarantee of origin for electricity produced from RES (2009);

Two new draft laws are now in the adoption process:

- on the promotion of use of energy from renewable sources
- on biofuels, biofuels for transportation and bio-oils, approved by Parliament at the first reading in 2007.

The draft law on the promotion of use of energy from renewable sources aims at transposing into national legislation Directive 2009/28/EC of 23 April 2009 on the promotion of the use of energy from renewable energy sources, as resulting from the Energy Community and EU-MD Association Agreement commitments.

In 2009, Moldova became a member of the Energy Community, which extends the EU internal energy market to South East Europe and beyond through a legally binding framework. In the period 2010-2014, the EU allocated €14 million for the production of renewable energy from local biomass (e.g. straw) as part of a EuropeAid project, helping to reduce the greenhouse gas emissions and the dependency on imported fuels. In 2015, the project entered the 2nd phase with an extension timeframe until November 2017 and was allocated another €9,46 million. The energy sector is vital for the economic development of the country. The Government of the Republic of Moldova has undertaken a series of actions to optimize and streamline the energy sector, by creating prerequisites for strengthening energy security, diversification of energy sources and attracting investments in the sector. According to the energy strategy of Moldova for 2030, the amount of energy produced from renewable sources should increase to 20%. Moldova has a large potential for energy production from renewable sources. Studies have shown that the most reliable and affordable are alternative sources of energy such as those obtained from straw and other waste. Each year, our country produces on average over 700 tons of straw. This volume rises to about 250 million cubic meters of natural gas, which is about 25% of the annual consumption in the Republic of Moldova. This quantity of straw is sufficient to warm the 9 million square meters or 100 thousand houses with an average area of about 80 square meters.

9.3.1 Electricity production from renewable sources

Tariffs for the electricity produced from renewable sources were approved in 2014 for 6 new manufacturers: S.R.L. „G&G Solar 1”; Î.C.S.”Covoare Lux” S.R.L; Î.M. „Sudzucker Moldova”; G.Ţ. ”Duca Vitalie Mihail”; S.R.L. ”Sadisal Auto” and S.R.L. ”Auto-Mar”. Rates approved for already existing producers, installed capacity of power plants, the type of sources and volumes of electricity produced from RES in the previous year are shown in the table 2.1.

Name of the company	Type of RES	Capacity, kW	Approved tariff, MDL/k	No. of guarantees of origin issued by the network in	Total electricity produced and delivered to the electrical	
					2013	2014
G.T. "Morari	Biogas	85	1,73	12	324.4	318.6
SRL "Solotrans Agro"	Solar energy	95	1,92	12	89.9	99.9
SRL "Tasotilex"	Energy	18	1,88	12	11.3	17.65
SRL "Elteprod"	Energy	1100	1,24	12	979.8	1481.2
SRL "Tevas Grup"	Biogas	320	1,73	12	502.5	956.8
S.R.L. „G & G Solar 1”	Solar energy	333	1,90	9		260.1
G.Ţ. "Duca Vitalie Mihail"	Solar energy	20	1,88	1		0.14
Total				**47**	**1907.9**	**3134.39**

Table 3. Electricity production from renewable sources in 2014

Source: National Agency for Energy Regulation, Annual report, 2014

During 2014, a total of 70 guarantees of origin were issued for a total volume of electricity produced from renewable sources of 3,1 GWh. The volume of electricity increased comparing with 2013, when 1,9 GWh of total volume of electricity from renewable sources was delivered to the electricity grid.

9.3.1.1 Renewable energy sources (RES) and biofuel

In the field of biofuels and other renewable fuels, efforts have been made in the past by now defunct the Ministry of energy, to adopt specific legislation on the use of biofuels and their use in the transport sector, as well as promoting energy generation from biomass. However, although some projects have been

prepared for this purpose, these efforts have not been successful no law of this kind has been approved by the Moldovan Parliament yet.

Currently, main primary legislation that supports the use of biofuels is the 2007 Law on renewable energy, in which is expressly stipulated that one of the main objectives of the State policy in the field of renewable energy is to increase the yearly share of renewable fuels produced and consumed in Moldova. It also puts emphasis on the creation of a system of production, distribution, marketing and rational consumption of such fuel. This law also provides for the confirmation of the origin and authenticity of such fuels by means of a certificate of compliance to be issued in accordance with the law and for the establishment of a certification system as with regards to equipment and technical devices, which operate on the basis of renewable fuel.

The Republic of Moldova disposes the following forms of Renewable Resources: wind, solar, biomass and hydraulic.

Despite the ambitious targets set at national level, the proportion of renewables in the total energy mix in 2012 was only about 4%. According to NES and NREAP, 400 MW of additional renewable energy capacity is planned before 2020. It is assumed that investment in renewable technologies will come from the private sector.

	Technical potential		
	PJ		**million toe**
Solar	50.4		1.2
Wind	29.4		0.7
Hydro	12.1		0.3
Biomass	Agricultural wastes	7.5	
	Firewood	4.3	
	Wastes from wood processing	4.7	
	Biogas	2.9	
	Biofuels	2.1	
	Total biomass	**21.5**	**0.5**
	Total RES potential	**113.4**	**2.7**
Low energy potential sources, including geothermal		*> 80,0*	*> 1,9*

Table 4. Technical potential of the main types of renewable energy sources in Moldova

Source: Strategia naţională de dezvoltare 'Moldova 2020' (2012)

As of today, hydro energy and biomass are predominantly used, but there has been a number of recent developments in biogas (including landfill gas), solar, wind, bioethanol and geothermal. In the past Moldova had numerous small and micro hydro and wind farms, but most of them do not exist now.

9.3.1.2 Wind Energy: Current Status and Potential

Today, Moldova does not dispose of any modern wind installations, and there is only some small power wind equipment (with capacity from 1 to 2.5 kW), designed and exploited by amateurs. Unextensive studies developed at the beginning of the 1990s concluded that Moldovan geography is not favorable for the use of wind installations. Negative appraisals were based on meteorological data of the Chisinau Weather Station. These studies did not take into account the poor geographic positioning of the Weather Station (obstacles and rugged terrain). In fact, further scientific researches and measurements revealed that Moldova has some favorable zones for wind installations. Thus, measurements taken between years 1990 and 1999 at a weather station located in the south of the country showed that, at 10m above ground, average wind currents are 3-7 m/s. This speed allows efficient operation of modern wind installations. Moreover, wind speed increases with height and would make more efficient the use of wind installations, at a typical construction height of 60-70 m above ground.

In 2001, Technical University started a research project having the goal to prepare a Wind Atlas of the Republic of Moldova. Financed by the Supreme Council for Research and Technological Development and the Technical University, the project was estimated to take 3 years. However, due to the limited number of measurement systems available, the schedule for calculations over 50 m above ground required 2 additional years. Partial available results show that there are favorable zones for wind installations, with wind speeds equal to or exceeding 7 m/s at 50 m and more above ground.

9.3.1.3 Solar Energy Current Status and Potential

In Moldova, solar energy is used for:

- ***Drying medicinal plants and tobacco***. According to the Ministry of Agriculture and Food Processing Industry, approximately 80% of annual tobacco harvest is dried traditionally, using solar heat. Taking tobacco production in 2002, i.e. 14,000 t as reference, , the annual quantity of substituted fuel is estimated at 7,400 toe. In addition, approximately 1,500 t/year fruits and medicinal plants are dried using solar energy. In fact, estimated potential for this procedure is ten times higher. Primary energy sources used to dry fruits and medicinal plants are wooden biomass and solar energy (no data on the consumed quantities);
- ***Heating water for domestic use*.** First Moldovan research on solar energy used to heat water was carried out in the middle of the last century. But low energy prices at that time and lack of policy to promote renewable resources stopped implementation of this kind of equipment. Later, in the ninth decade of the last century, three Moldovan institutions designed and built solar installations to heat water. Fifteen houses, public institutions and companies were equipped with their solar equipment. At present, due to the components' bad quality and lack of maintenance, solar equipment's installed between 1982 and 1990 are not functional. Continuing the tradition, two other Moldovan companies have designed solar installations since 1993 to heat water. It has to be noted that in 2006-2007, several solar batteries were installed with the support of the World Bank for heating and hot water supply in certain Moldovan hotel complexes;
- ***Producing electricity by photovoltaic installations***. There are a few existing experimental installations to supply water pumps and weather station communication systems. the As electrical supply network is available to all consumers, PV development is limited to certain sectors, like

small power irrigation or supply-isolated consumers.

The quantity of solar energy reaching the Earth depends on several factors, among others on the Sun's brightness and current distance from our planet. For the Republic of Moldova, theoretical (maximum) sun brightness period is 4450 h/year. In fact, the real value is 2100-2300 h/year, approximately 50% of the maximum theoretical value. The brightest Moldovan period is from April to September, representing more than 75% of the total annual brightness period. Solar radiation is 3.5% more significant in the central than in northern region, and 2.6% in the southern than in the central region. In order to achieve the Energy Strategy's aim concerning Solar Energy, it is necessary to install through 2010 one million m2 of solar installations for water heating and 80 thousand m2 of solar installations for drying agricultural products. The potential of PV Solar Energy utilization was investigated as well. It was estimated that 5850 isolated consumers might be supplied by PV Solar.

9.3.1.4 Biomass Energy: Current Status and Potential

In the Republic of Moldova biomass – fuel wood, wooden wastes and agricultural residues - is burned mainly for heating and cooking purposes. To be noted that in the Republic of Moldova, the areas covered with forests varied considerably over time but in 2005 we were close to the level of 150 years ago: from 366.2 thousand ha in 1848 to 362.7 thousand ha in 2005 or circa 10.7 percent of the country's territory.

The total volume of standing wood mass in the forests of the Republic of Moldova is circa 45 million m3, on average 124 m3 per hectare. The average forest increment is 3.3 m3/yr/ha, and the total average increment is circa 1085 thousand m3/yr. The structure by age in the case of all forest species are misbalanced, in particular in those of low productivity.

The volume of commercial timber, as well as the quantity of fuel wood gathered in Moldova, were identified based on statistical data and reports on commercial deforestation in managed forest land, provided by the Forestry Agency "Moldsilva", and the State Ecological Inspectorate, on authorized fellings and illegal logging in forests and other woody vegetation areas managed by local public authorities. Data on the volume of fuel wood gathered also include the volume of twigs, boughs, branches, etc., which are also used as fuel.

Within the last 10 years, the Forestry State Agency 'Moldsilva' provides circa 300-400 thousand m3 of fuel wood annually. The price of one m3 of fuel wood, including transport, is approximately US $15. According to available statistical data, in 2005, a conventional family living in the rural sector used approximately 2.3 m3 of fuel wood. In reality, average family consumption is much more significant, but no coherent data are available because of the lack of detailed studies.

A certain amount of biomass is harvested also from protected forest strips and other types of forest vegetation. Local public authorities manage 95 percent of these resources but this data not statistically confirmed either, as the available national records for this type of vegetation are insufficient. Biomass is harvested from orchards and vineyards too, in particular during the cleaning cuttings, as well as from the trees growing in private rural orchards (the traditionally used average was 10 trees per household).

In order to achieve the Energy Strategy's aim concerning combustion of fuel wood, wooden wastes and agricultural residues as resources, it is necessary to increase the consumption of respective RES to 300 thousand tons.

It has to be mentioned, that early in 1999, Moldova implemented his first experimental installation producing briquettes from agricultural residues, like sunflower and corn stalk and straw. The installation, financed by the Netherlands Government and managed by 'AGROBIOENERGIA' Company, produces 250 kg briquettes per hour, for US $20-25 per briquettes ton operation cost. In 2012, in Moldova we had more than 40 producers of pellets and briquettes. The branch is evolving and is characterized by sporadic strong motivation of producers to learn production technologies and assess the profitability of the activity. The branch is characterized by a lack of homogeneity in terms of technologies used by manufacturers, geographical distribution, and biomass used in the production process.

Another specific domain is Biogas obtained by fermentation from animal and poultry manure. In the early 2000s, two projects were developed with the assistance of the Netherlands:

In 2000, Dutch NGO Novib and Moldovan NGO Agroeco developed an individual anaerobic fermentation installation with 10 m3 installed capacity, for the Grigoras family farm in Soroca district.

In 2002, within the framework of the Netherlands Programme for cooperation with Central and Eastern Europe, an installation was put into service intended for the fermentation of 700 m3 of waste from a poultry farm. Located in the Vadul-lui-Voda region, the installation produces biogas for a cogeneration engine with an installed capacity of 87 kWe and 116 kWt;

In 2005, with technical assistance from the Netherlands, a project to construct a power plant in Colonita village was launched, which was based on the consumption of biogas obtained from manure coming from a cattle breeding farm (the generator capacity is 100 kW, which is sufficient to cover the farm's in-house needs in electricity).

The potential for biogas production in the Republic of Moldova is estimated at 3700 thousand m3. In order to achieve the Energy Strategy's aim concerning Biogas Resources, it is necessary to increase the fermentation installation capacity to 7100 m3.

In the Republic of Moldova there are five wastewater treatment plants provided with anaerobic treatment tanks and biogas collecting equipment. However, the respective installations, built more than 20 years ago, are not operational because of their degraded status, lack of use, reparation and maintenance. Limited financial resources and unrewarded competence and legislation in this field, also contribute to the poor condition of respective equipment for biogas production.

9.3.1.5 Hydro Power Energy: Current Status and Potential

Hydro Power Plants are associated with electricity production. Generally, is the factor that assigns a Hydro Power Plant to the category of Renewable Energy Sources.

The Republic of Moldova has two Hydro Power Plants: one at Dubasari (48 MW installed capacity 30 MW available) and another at Costesti (16 MW installed capacity 10 MW available). There are 6 micro Hydro Power Plants, built by individuals or economic agencies and placed on already existing accumulation systems of lakes and drainage. Their total installed power is 141 kW. Hydro potential

in Moldova is estimated at 3 billion kWh/year, including potential of large rivers (1.9 billion kWh/yr.) and small rivers (1.1 billion kWh/yr.).

9.3.2 Energy Efficiency

The 2010 Law concerning energy efficiency partially transposes Directive 2006/32/EC on energy efficiency and services to final consumers. The Law has also created the institutional framework for energy efficiency, introduced the concept of energy audit and imposed energy management obligations on local public authorities. In addition, it provides for the establishment of energy service companies (ESCO) and allows financing third parties (TPF) and contracting energy efficiency projects.

National program for energy efficiency (PNEE) and energy labeling have been addressed as part of the assistance offered by the project "support for the implementation of the agreements between the Republic of Moldova — EU". The programme was elaborated by the Government, with the support of the project of draft proposals on the formulation of PNEE and energy labeling.

The national program for energy conservation for the period 2003-2010 stated a low level of energy efficiency in the Republic of Moldova and aimed at reducing energy intensity by 2-3% annually. However, at the practical level, there were no measurements for monitoring its implementation.

This program is expected to be replaced by the above mentioned 2011-2020 PNEE, which proposes the national goal of 20% saving by the year 2020, with an intermediate target of 9% by the year 2016. PNEE project, to be formally adopted in the very near future, also lists the activities in each sector on the basis of EU directives, suggests a national communication strategy in sensitizing public opinion and identifies the measures, funding sources and institutions responsible for implementation, as well as specific terms to be respected in its action plan.

Despite this large decrease, Moldova's economy still has a high level of primary energy consumption per unit of GDP compared to averages for countries in the OECD. According to IEA, in 2005, the energy intensity of Moldova (energy use compared to GDP at purchasing power parity (PPP)) is 0.45 toe/US$ 1000 at PPP, nearly three times higher than the EU-27 average.

The residential sector is the greatest energy consumer (40% of total final consumption), followed by industry (21%) and transport (15%). Agriculture, although dominating the economy of the country, has a small share in the final consumption of commercial energies (4%).

The economic and structural reforms implemented in the country resulted in substantial reduction of industrial production, which in turn resulted in reduced energy consumption. However, the energy efficiency of the industrial sector is low. The specific energy consumption of industrial processes is high and energy loss is substantial. Energy audits and implemented energy efficiency projects demonstrate high energy efficiency potential in all sub-sectors of industry. Nonetheless, energy efficiency is still not a matter of great concern in industry. For instance, in 2007 the energy intensity of industrial production was 0.118 t.c.e./thousand MDL, almost twice lower than in 2001.

9.3.2.1 Energy Losses from Electricity, Gas Transmission and Distribution Grid

In 2014, about 4.1TWh of electricity was transported through the transmission system of Moldova, operated by the state-owned TSO Moldelectrica. As of today, the average level of technological consumption and technical losses in transportation network, as approved by ANRE, is 3.0% of the electricity supplied to transmission networks. For comparison, as included in approved tariff calculations, in 2010 this level was 3.5%, in 2009 it was 2.94% and in 2007 it was 3.5%.28

In 2012, a project for rehabilitation of the transmission network in Moldova was launched. The project includes the design and modernisation of a number of substations and transmission lines. The rehabilitation will improve the energy efficiency of Moldelectrica network, strength-en the stability of power supply and improve the overall operation of TSO Moldelectrica, a prerequisite for Moldova's integration into the European transmission network ENTSO-E. The project is financed through soft loans provided by EBRD (€15.5 million) and EIB (€17 million) for 2012 to 2019 and a grant by NIF (€8 million) for 2013 to 2019.

Regarding electricity losses in distribution networks, and as presented in Table 7, these losses are steadily decreasing and in 2014 they accounted for between 9.2 and 11.58% of the electric-ity supplied to the distribution grids.

DSOs	Technologic consumption and de facto losses (as % of electricity metered at the exit points from transportation network)									Electricity purchased by DSOs in 2014	Electricity supplied to		Nr. of consumers, 2014	
	2001**	2005	2010	2011	2012	2013		2014			GWh	%		%
RED UF	28	21.44	13.68	13.11	12.39	10.75	10.86*	9.45	9.54*	2,981.70	2,626.10	72.0	856,489	64.2
RED Nord	28.4	14.39	10.43	9.89	9.89	9.83	10.5*	8.53	9.2*	689.7	613.7	16.8	294,645	22.1
RED Nord-Vest	39.9	20.07	12.98	12.39	11.9	11.7	12.01*	11.3	11.58*	363.3	313.5	8.6	183,963	13.8

* as % of electricity supplied to the distribution grids

** this includes commercial losses (commonly defined as thefts, non-metered and non-paid electricity consumption)

Table 5: Electricity distribution losses in Moldova 2001-2014.

Sources: Raport privind activitatea Agenţiei Naţionale pentru Reglementare în Energetică în anul 2014, anre.md/files/raport/RAPORT%20%20de%20activitate%20%202014.pdf

As provided by the NEEP 2011-2020, DSOs should achieve reduction of losses from 13% in 2011 to 7-10% in 2020. The latest data of ANRE, as of April 2015, indicate the progress of all DSOs since 2011 towards achieving this target. In 2013, as provided by ANRE, heat losses in distribution and supply systems were 22% of the total heat supplied to the network, increasing from 2011 to 2013. These data differ from the national statistical data, where the share of losses in 2012 was of 16%, but both sources indi-cate a significantly decreasing level of centralised heat power supplies, regardless of weather conditions during the heating season. Thus, the final consumption of heat in 2012 was almost 30% lower than in 2005 and heat production, during the same period of time, decreased by 27.7%.xx In 2013, 1,420,400 Gcal of heat was supplied to consumers, or 18.8% (328,000 Gcal) less than in 2010. From 2011 to 2013 the amount of heat delivered to the network decreased by 12.4% and the amount of heat delivered to consumers decreased by 15.1%.

Company	Heat supplied into the network, 1000 Gcal			Heat losses, 1000 Gcal			Heat losses , %			Heat supplied to consumers, 1000 Gcal			Share in total supplies, %		
	2011	2012	2013	2011	2012	2013	2011	2012	2013	2011	2012	2013	2011	2012	2013
Termocom, Chisinau	**1,770.9**	**1,717.7**	**1,577.2**	**355.2**	**359.2**	**358.9**	**20.06**	**20.91**	**22.76**	**1,415.7**	**1,358.5**	**1,218.3**	**84.60**	**85.40**	**85.80**
Apa-canal, Chisinau	27.30	26.80	23.70	2.60	3.10	2.50	9.52	11.57	10.55	24.80	23.70	21.20	1.50	1.50	1.50
CET-Nord, Balti	**214.90**	**213.30**	**183.10**	**41.10**	**49.10**	**35.10**	**19.13**	**23.02**	**19.17**	**173.90**	**164.20**	**148.00**	**10.40**	**10.30**	**10.40**
Termogaz, mun. Balti	12.70	12.80	10.90	1.20	1.30	1.10	9.45	10.16	10.09	11.40	11.50	9.80	0.70	0.70	0.70
Comgaz Plus, Ungheni	14.90	10.90	8.00	2.80	2.30	1.10	18.79	21.10	13.75	12.10	8.60	6.90	0.70	0.50	0.50
Retelele Termice Calarasi	8.00	6.20	4.10	2.60	2.00	1.30	32.50	32.26	31.71	5.40	4.20	2.80	0.30	0.30	0.20
Servicii Publice Cimislia	1.20	0.90	0.70	0.10	0.10	0.00	8.33	11.11	0.00	1.10	0.80	0.70	0.10	0.10	0.10
Retelele Termice mun. Comrat	7.10	6.60	6.00	0.20	0.20	0.20	2.82	3.03	3.33	6.90	6.40	5.80	0.40	0.40	0.40
Antermo, Anenii Noi	2.30	2.00	1.50	0.20	0.20	0.10	8.70	10.00	6.67	2.10	1.80	1.40	0.10	0.10	0.10
Retelele Termice Stefan Voda	1.30	1.20	1.00	0.10	0.10	0.10	7.69	8.33	10.00	1.20	1.10	0.80	0.10	0.10	0.10
Retelele Termice Cahul	7.40	5.10	0.70	0.20	0.20	0.00	2.70	3.92	0.00	7.30	4.90	0.70	0.40	0.30	0.00
Retelele Termice Glodeni	3.30	2.10	0.00	0.20	0.20	0.00	6.06	9.52	0.00	3.10	1.90	0.00	0.20	0.10	0.00
Retelele Termice Criuleni	1.90	1.30	0.40	0.30	0.40	0.20	15.79	30.77	50.00	1.70	0.90	0.30	0.10	0.10	0.00
Centrale si Retele Termice, Orhei	6.60	2.20	3.90	0.30	0.10	0.20	4.55	4.55	5.13	6.30	2.10	3.80	0.40	0.10	0.30
Total per regulated companies	**2,079.90**	**2,009.30**	**1,821.3**	**407.10**	**418.6**	**400.90**	**19.57**	**20.83**	**22.01**	**1,672.9**	**1,590.7**	**1,420.4**	**100.0**	**100.0**	**100.0**

Table 6: Centralised heat supply and losses in Moldova 2011-2014.

Sources: Raport privind activitatea Agenţiei Naţionale pentru Reglementare în Energetică în anul 2014, anre.md/files/raport/RAPORT%20%20de%20activitate%20%202014.pdf

The ***Energy Strategy of Moldova until 2030*** provides guidelines for national energy sector de-velopment, in order to ensure necessary grounds for economic growth and social welfare. Through this document, the government presented its vision and identified strategic national opportunities in a rapidly changing energy context. The Strategy highlights the priority prob-lems of the country, which require rapid solutions and the re-dimensioning of objectives in order to provide an optimal balance between local resources (those currently used, but also projected ones) and the emergency needs of the country, the objectives of the European Un-ion and Energy Community and national targets, international commitments resulting from treaties, agreements and programmes to which Moldova is party. The Strategy defined general policy goals for 2013 to 2030 as well as specific policy objectives for 2013 to 2020 and 2021 to 2030, specifying measures for their implementation. As stated in this Strategy, from 2013 and 2020 the first results are expected in the implemen-tation of less expensive energy efficiency measures aimed at a 20% reduction in energy con-sumption by 2020. The evolution between 2021 and 2030 of the energy sector of Moldova will be determined by the national policy implementation success rate between 2013 and 2020.

9.3.2.2 Electricity prices (households and industry)

Since 1998, the National Energy Regulatory Agency (ANRE) has set tariffs for electricity, heat and natural gas in the regulated market. Later on, based on the provisions of the law on renewable energy of 2007, ANRE was authorised to develop a methodology for tariff calculation and to set tariffs on electricity and fuels produced from RES. Since 2009, ANRE has also been responsible for approval of tariffs for centralised heat supply.

The law on electricity of 2009 required that regulated tariffs on electricity and heat produced by CHPs, electricity produced from RES, tariffs for electricity transportation and distribution services, tariffs for electricity supplies at regulated prices, etc. should be calculated by licence. holders and approved by ANRE based on existing methodologies. Methodologies for calcula-tion and application of regulated tariffs, as listed above, are approved by ANRE.

From 2005 to 2014 all tariffs set by ANRE were marked by major increases. As mentioned ear-lier, electricity and heat generation in Moldova are predominantly based on natural gas. Until March 2015, natural gas was imported from a single source and average import prices in-creased five-fold from 2005 to 2014, from 76.1 $/1000m3 in 2005 to 377.1 $/1000m3 in 2014.. The highest average annual price for natural gas in 2012 was 394 $/1000m3. Average tariffs for natural gas, expressed in USD, supplied to consumers in Moldova increased between 2005 and 2014 6.1 times: from 72 $/1000m3 in 2005 to 436 $/1000m3 in 2014, or 6.9 times from 2005 to 2012.33 Tariffs for heat produced by CET-2 and CET-1 increased more than five-fold. These two companies provide over 80% of district heating in Moldova. Local electricity production covers only about 20% of total consumption, and thus the increase of electricity tariffs for consumers was more moderate than that of gas and heat tariffs, because of the significant proportion of more stable electricity import prices. Tariffs for electricity produced by local CHPs increased over three-fold, whereas tariffs for electricity supplied by DSOs to consumers approximately doubled.

9.4 Innovation Situation In The Energy Sector

9.4.1 Describing the situation with EE/RES, in particular to what extent these are currently relevant and applied in the business sector

The Republic of Moldova depends heavily on energy imports; thus, 95 % of its energy needs are

covered by imports. The dependence on external energy sources has led to constant price increases and accumulation of huge debts towards foreign suppliers. The energy sector is vital for the country's economic development. The Moldovan Government committed itself to reform the energy sector through enhancing the energy security, diversifying the energy sources and attracting investments to this area. By 2020, the authorities opt to increase the share of renewable energy up to 20% of the country's total energy consumption – an objective stated in the Energy Strategy of the Republic of Moldova.

The Moldovan Sustainable Energy Financing Facility provides a unique opportunity to realize energy savings potential. It provides not only loan financing and grants for this kind of projects, but also technical assistance by international experts who help to optimize the project.

Among the well-known Moldovan companies who implemented projects with the assistance of MoSEFF are Orheit Vit, Macon, Covoare Ungheni and others. But also a range of small companies implemented projects from loans ranging from EUR 10,000 to 2 million.

The Moldovan Sustainable Energy Financing Facility (MoSEFF) was launched by the European Bank for Reconstruction and Development (EBRD) in order to support energy efficiency investments of Moldovan enterprises. Under MoSEFF, the EBRD made a total of € 42 million available for on-lending through local partner banks. To make investments into energy efficiency projects even more attractive, MoSEFF contains a grant component for eligible projects. Depending on the energy savings and CO2 emission reductions achieved, the grant may reach 5% to 20% of the loan amount.
To facilitate and speed-up investments in energy efficiency, MoSEFF provides technical assistance and advice on the optimization of energy consumption and supply. MoSEFF's technical assistance is financed by the European Union and is available free of charge for eligible projects.

Also the country has a pretty high potential for the production of renewable energy, which is so far unexploited. Biomass is the most abundant alternative energy source in the Republic of Moldova. In general, we can say that biomass covers a wide range of materials, such as: agricultural and technical crops, agricultural and forestry residues, etc.

According to the definition provided in the European Directive 2003/30/EC, biomass is the biodegradable fraction of products, waste and residues from agriculture, forestry, and industrial and municipal waste. In this context, biomass is the main fuel used in rural areas. As an agricultural country, the Republic of Moldova faces a major challenge - the use of its existing potential of biomass.

The energy produced from own sources are beneficial for several reasons: it reduces the dependence on imports, enhances the country's energy security, has lower costs, and enables the development of new businesses and creation of new jobs. Moreover, it reduces the GHG emissions and air pollution.
The Moldova Energy and Biomass Project provides support to public institutions from rural communities to have access to renewable energy sources, ensure energy independence, and community development. With the help of the financial support, modern biomass-fired heating systems – an alternative to the ones currently in place – will be installed by 2014 in more than 130 rural schools, kindergartens, and community centers across the country. The Energy and Biomass Project will cover the majority of costs related to the installation of alternative heating systems, while the villages are expected to contribute with at least 15% of the total investment value.

The Energy and Biomass Project Beneficiaries:

- District Councils;
- Local Public Authorities;
- Local public institutions;
- NGOs and community centers;
- Local and regional entrepreneurs, biofuel producers.

The expected impact resulting from the implementation of biomass processing is the possibility to enhance energy safety of rural communities throughout the country, to foster the development of enterprises for processing locally available biomass, and to set up sustainable partnerships, that contribute to the economic development of villages and regions.

9.4.2 Are there relevant (EE/RES-specific) strategies available?

The Republic of Moldova adopted multiple strategies and policies, which influenced, directly or indirectly, the energy sector's performance. The evolution of energy consumption and forecasts concerning the energy and energy resources consumption have been used as a basis for the current political decisions of the Republic of Moldova oriented towards providing the users with energy under safe conditions, for minimal prices and in compliance of the environment protection requirements.

The Energy Complex is one of the main branches of the national economy and plays an important role in successful implementation of economy development programmes and maintaining social stability. Thus, the Moldovan Energy Complex, pursuant to the National Development Strategy "Moldova 2020", approved by the Law No, 166 dated 11 July 2012, has got the basic objective to provide high-quality energy at affordable prices to all consumers and support the implementation of the sustainable development of the national economy. This target is attainable on the basis of competitiveness and liberalised energy market.

The aforementioned analysis of energy resources and energy consumption was and is useful to forecast and devise energy sector plans and development strategies. The most relevant plan is: "**The National Energy Efficiency Action Plan for 2013-2015"** (NEEAP) developed by the Agency for Energy Efficiency in co-operation with the Central and Local Public Administration Authorities, intended to provide assistance as per its functional competences. The NEEAP has been developed in compliance with the national legislation in this area, with the commitments of the Republic of Moldova as a Member of the Energy Community Treaty, the provisions of the Law on Adherence of the Republic of Moldova to the Treaty establishing the Energy Community No. 117- XVIII dated 23.12.2009.

The purpose of the NEEAP relates exclusively to efficient energy consumption and reduction of greenhouse gas emissions. The objective of the NEEAP is to reduce the energy end-use in all sectors of the national economy by 428 ktoe, and cut the emissions of CO2 by 962 848 tons during 2013-2015. Similar to the EU Member States aiming to achieve an overall national indicative energy savings target of 9% during 2008-2016, the Republic of Moldova also has set up an intermediary energy savings target of 9%, to be reached by 2016, compared to 2009.

Most savings would be achieved through the establishment of development conditions and the introduction of energy services on the market, the allocation of additional earmarked funds and

credit lines to those sectors. Thus, domestic and foreign financial efforts have been consolidated in order to implement the present NEEAP, including:

- credit line for small and medium-sized enterprises and the Moldovan Sustainable Energy Financing Facility (MoSEEF) II in the total amount of 352 million MDL (22 MEUR);
- credit line for the residential sector (MoREEF) in the total amount of 560 million MDL (35 MEUR);
- Energy Efficiency Fund in the total amount of 520,107.6 thousand MDL for the NEEAP timeframe, with resources coming from the direct budget support provided to the energy sector;
- energy sector budget support provided by the EU Delegation in the amount of circa 640 million MDL (40 MEUR);
- technical assistance in the total amount of 35.2 million MDL (2.2 MEUR) provided by the EU Delegation for the implementation of the Energy Sector Budget Support Policy Matrix;
- technical assistance provided by the Global Environment Fund to support the energy efficiency growth in the industrial sector in the total amount of 12.8 million MDL (0.8 MEUR), etc.

9.4.3 Is it a priority in the country concerned?

In order to diminish dependency on imported energy resources and the energy sector's impact on climate changes, the National Energy Efficiency Programme 2011-2020, which serves as a starting point for this NEEAP, pursues the accomplishment of the following objectives, relative to 2009 baseline:

- Increase the efficient use of overall primary energy by 20% by 2020;
- Cut the greenhouse gas emissions by at least 25% by 2020, relative to the 1990 baseline.

By improving the energy efficiency in different national economy sectors, it would be possible to exploit the energy savings potential in a cost-efficient manner. The set of measures outlined in the national policies pursue the goal to create significant benefits for each sector of the national economy, including:

- Energy transformation sector, including all related activities: production of electricity and heat, transportation and distribution of electricity, heat and natural gases, and the final use of all types of energy resources;
- Industry sector;
- Construction sector;
- Transport sector;
- Public sector.

The main document dealing with the issues in question is the National Energy Efficiency Programme for 2011-2020, approved by the Government Decision No. 833 dated 10 November 2011; Moldova's strategic objectives for 2013-2020 are as follows:

- Safety of natural gas supply, by diversifying the supply routes and sources, carrier types (conventional, non-conventional gas, LNG) and storage facilities, together with strengthening Moldova's role as a natural gas transmission corridor;
- To strengthen Moldova's role as a power transmission corridor, by building new interconnectors, connected to the ENTSO-E system, and by consolidating the internal power transmission network;
- To create a strong power and heat generation platform, through retrofitting, efficient district heating and advanced marketing;
- To improve the energy efficiency and increase the use of renewable energy sources (RES);
- To provide legal, institutional and operational framework for a real competition, to effectively open the market, set up energy prices in a transparent and fair way, integrate the Moldovan energy market into the EU internal market;
- To provide a modern and competitive institutional framework for the energy industry's development.

9.4.3.1 Institutional Framework for the EE and RES sector implementation

During 2001-2010, the institutional framework responsible for the energy sector was subject to essential amendments. The Ministry of Energy was dissolved, while the competence in energy policy was assigned to the Ministry of Industry and Infrastructure. Subsequently, the latter was also dissolved, and the energy sector divisions were assigned to the Ministry of Economy.

The National Agency for Energy Conservation, which is a body charged with the energy conservation tasks, being a self-financed body, failed to cope with financial challenges, and was subject to reorganisation in late 2006 as per the Government Decision No. 1452 dated 21 December 2006 on the activity performed by the National Agency for Energy Conservation.

Since energy efficiency is not a separate sector, the Government of the Republic of Moldova established the Agency for Energy Efficiency (AEE) through the reorganisation of the National Agency for Energy Conservation to promote and implement energy efficiency policies and implement the use of renewable energy sources in all sectors of the national economy. AEE is first mentioned in the Renewable Energy Law No. 160-XVI dated 12th of July 2007, although it was established only in 2010 by the Government Decision No. 1173 dated 21st of December 2010 on the Agency for Energy Efficiency, based on Article 8 of the Energy Efficiency Law No. 142 dated 02 July 2010.

9.4.4 Energy Efficiency – is it an issue among businesses?

The aspect of sustainable development should not be a secondary one in Moldova, especially considering the great potential that the country has for developing some sectors of the "green economy".

An important indicator is the level of the country's overall energy-efficiency, which is very low but similar to the CIS countries. The objective of Moldova is to get closer to the energy efficiency levels of the Central and Eastern European Countries that show a 40% higher EE.

Another specific indicator that reflects the reduced concern of Moldovan companies to capitalize strategic opportunities offered by the "green economy" is the very low penetration of ISO 14001 certificates (only 0.3 certificates / 1 billion of GDP, compared to 0.4 in CIS and 8.4 in CEE countries).

Energy efficiency is not at the top of the priority list of Moldovan enterprises. Most people and enterprises use old equipment and technologies resulting in energy intensity about 3 times higher than in EU. Since 2010, when the AEE was founded, things are gradually changing because the Agency, through its activities, aims at drawing attention to this fact and involve both public and private companies and institutions.

Another reason that raised the level of attention to EE in Moldovan enterprises is the considerable increase in the price of natural gas and oil. In the first quarter of 2010, the estimated price for gas imported by Moldova was 231.71 dollars per thousand cubic meters and the price gradually increased until it reached the level of 374.38 dollars per 1000 cubic meters in the first quarter of 2014[146]. With the skyrocketing heating bill in winter, the number of those who replace gas heating with biomass boilers is growing. Many entrepreneurs have found that EE offers excellent earning potential, and today it is a growing industry, so even if EE does not have a major impact within companies, there is an increasing number of companies that produce biogas, fuel pellets and solar energy.

What hampers investment in EE is the insecurity of entrepreneurs, who often purchase equipment based solely on their price, usually choosing the most economic option and neglecting their ability to use energy more efficiently. This attitude is partly due to the lack of knowledge in energy management, the lack of capital in businesses and the reduced availability of loans, but also an administrative command of Soviet type that persists even today.

9.4.5 How far energy innovations have been implemented in the country?

Renewable energy and energy efficiency became a topic of national importance only in the last few years as the price of the usual energy sources rapidly increased and started to menace Moldova's energy security. Under the pressure and urging of the government, some innovations in the energy sector were introduced by small enterprises and also at an industrial scale. Innovations are intended as elements of novelty at country level, as the solar batteries, windmills and some biogas equipment, already present for some time in most developed countries.

There is always a greater emphasis on energy efficiency of households and public buildings as it is the sector that consumes the most of the energy introduced in the grid. Because of rising housing prices, this sector is very active, and materials of latest generation that can greatly enhance the energy efficiency of buildings have recently become available on the market.

[146] moldovagaz.md/menu/ro/about-company/transportation

9.4.6 Are there any relevant renewable energy sources installed or companies active in RES?

Considering the willingness of the Moldovan government and the help from the European community, solar energy as well as other renewable resources, like biomass or wind turbines, probably will be part of the daily life of the Moldovan citizens in the next decade.

According to the radiation levels studied by the Technical University, solar energy has a great potential in the Republic of Moldova. The energy needs of the country and the rising energy price provide the push to make renewable energy production units grow within the next years. Solar energy production is very limited, as the price of solar energy is higher than that of generated from traditional resources. In 2013, the amount of solar energy delivered to the grid was 101218 kWh, and its use is rather limited. It is mainly used by households, but the first Solar Farm in Moldova is already built, which generates 350 kW of power, based on amorphous panel technology. In 2009, the Institute of Oncology started a project aimed at generating photovoltaic solar energy, with a significant financial support from the Government of Japan (5 million USD). The phase of installation of the equipment was finalized in September 2013, and the solar energy plant, which covers an area of 8000 m[147] generates savings that are directed to enhance the quality of medical care.

Other relevant solar installations are placed on commercial buildings like Bucuria factory, the roof of the office building of Porsche, and some institutional buildings. There are several companies which provide the equipment and installation services, but there are no companies producing solar energy for commercial use. There are some programs (Green House, MOSEFF) that support the purchase of photovoltaic systems by covering part of the costs, and this makes the solar energy more competitive, but these contributions are not sufficient to switch to a solar energy production at national scale.

Wind installations producing energy in Moldova reach a total capacity of 979807 kWh^3. In Moldova, there are over 25 wind mills and turbines, 20 of them with a small installed capacity and in the ownership of Mr. Nicolai Constantinov, president of the Wind Energy Association. These turbines are installed at small farms, vineyards and sheep farms. Another important institution that installed 10 units of wind turbines, is the Technical University of Moldova. These installations are part of a an experimental project supported by Ion Bostan, the rector of UTM. Some of these units were installed in Chisinau, and Cahul.

The amount of energy delivered to the grid by biomass power producers is 826843 kWh[148]. It appears that the energy produced from biomass is less than the wind energy but this can be explained by the fact that biomass is used primarily for the production of thermal energy. "Energy and Biomass" project, which should be implemented in 2011-2014 and has a budget of 14.56 million euros, granted by the EU (14 million) and UNDP (560000 EURO), plays a very important role in the formation of a local market for biomass energy. This project aims to:

[147] aee.md/energie/energia-eoliana/analiza/254-statistic-energie-eolian

[148] aee.md/energie/biocombustibil/analiza/255-statistic-bioenergie

- Improve quality assurance of heating energy of public buildings in beneficiary villages, using wheat straw and other grain waste supplied by local agricultural businesses;
- Stimulate the development of production market of heating energy for individual households, production of biomass briquettes and creation of industrial CHP plants;
- Increase the capacity of key stakeholders in the biomass sector, ensuring durability and further replication of technologies based on biomass;

Another important project in this area was announced by the Ministry of Agriculture and Food Industry. It will be funded by the Government of Japan and implemented during 2012-2014. The project provides for the procurement and installation of the social institutions of rural settlements and agricultural enterprises that require thermal heating boilers that work on biomass (straw and other crop residues).

In 2013, the first biogas plant at industrial level in Moldova was built by the German company Südzucker in Drochia. Sudzucher Moldova S. A. processes about 300 tons of sugar beet. As a result of the technological process, it produces 80 thousand tons of dehydrated pulp. This amount of pulp is not requested on the market and therefore accumulates at the factory in the form of waste, which in turn creates problems for the environment. The company invested 7.5 million euros in the construction of the biogas factory. The projected annual processing capacity of the plant is around 7.3 million cubic meters of biogas, containing 51% methane, produced from 55 000 tons of pressed sugar beet, the main waste resulting from the process of obtaining sugar beet., Compressed sugar beet waste will be processed only in the first two years, and after this period the factory will use all organic waste resulting from the processing of sugar beet.

MolFarm Group plans to build its own biogas factory in 2014, that will process animal manure. The company has a farm with around 1000 head of cattle, which translates in 60 tons of biomass daily. The total capacity of the factory will be of 1000 kWh.

Moldova does not possess deposits of fossil fuels, but rivers such as Nistru and Prut, and a number of smaller rivers are of interest. We cannot talk about the erection of large hydroelectric power plants, but it is possible to build smaller power generating units, even on streams with low flow. They are a local use and importance, but if we are able to strengthen this network, the cumulative effect will improve the energy security of the country.

Currently, hydropower is produced by two hydroelectric plants in Moldova: CHE Dubosari, with an installed capacity of 48 MW, and HPP Costeşti - 16 MW. There are several micro hydro power plants built by individual producers and operators. All generating units are built on the basis of existing dams on small reservoirs. Statistics show that the total amount of energy produced from this source reached almost 80000 kWh in 2000-2011, being by far the most important source of renewable energy in the Republic of Moldova.

9.5 Overview Of Critical Stakeholders

We can consider the stakeholders of the energy sector in Moldova on 5 different levels:

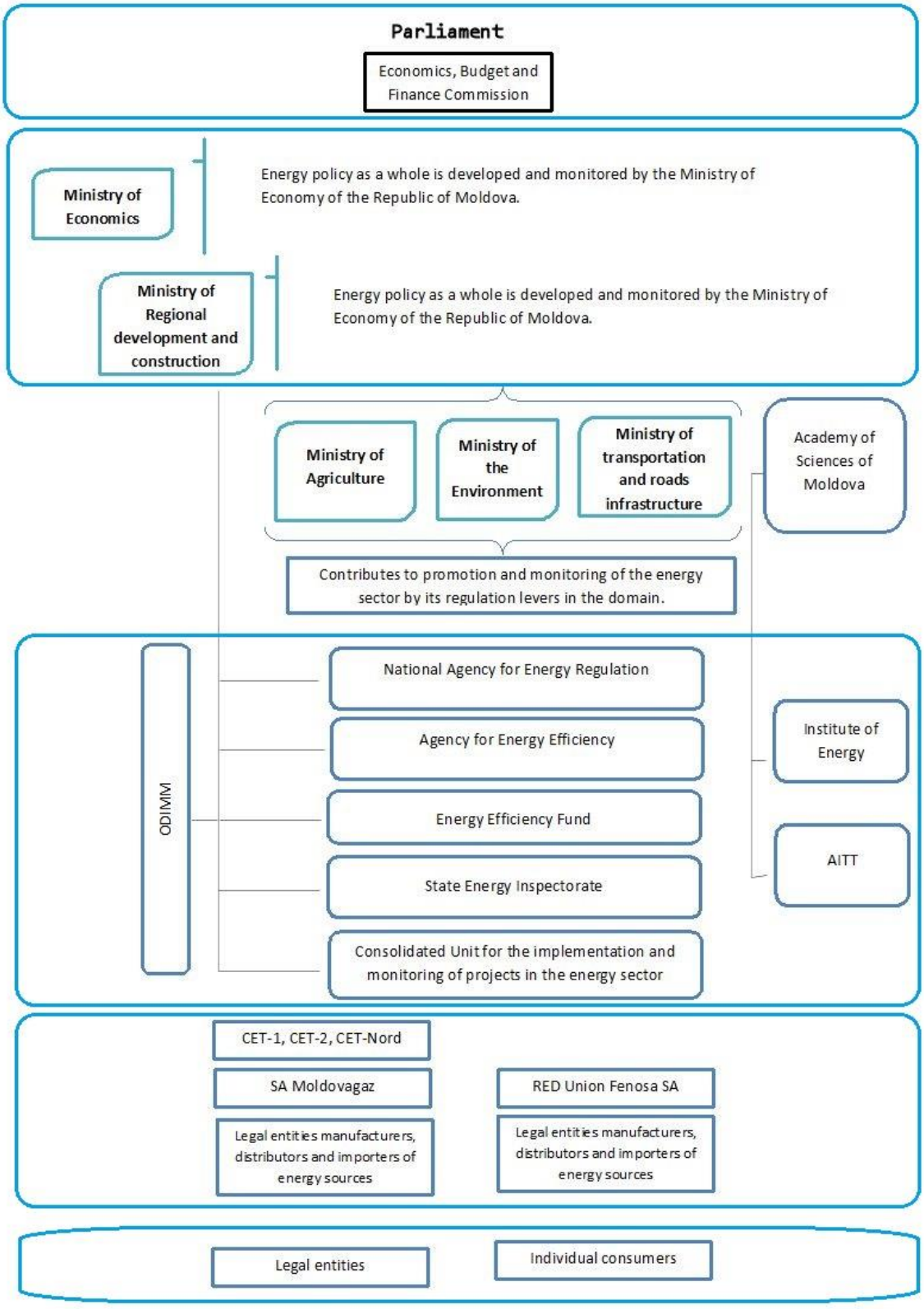

Figure 1: Political or legislative level

1st - Political or legislative level

The Parliament and the Parliamentary Standing Committee "**Committee on Economy, Budget and Finance**" discusses and approves the draft laws and other legal documents related to the energy sector.

2nd - The operational level

The Ministry of Economy of the Republic of Moldova is the main regulatory body in the field of energy. It contributes to the development and promotion of energy policy based on principles ensuring energy security of the state, and increasing energy efficiency, by diversifying energy sources and the use of renewable energy. As a result, it helps to create a competitive and efficient energy complex to provide consumers with quality energy resources that are affordable and reliable.

The Ministry of Regional Development and Construction creates the legal framework and mechanisms to encourage improvements in the energy performance of buildings in the country. Taking into consideration the fact, that buildings currently consume 45% of total energy, this occupies a special place in the policy of the Republic of Moldova.

The Ministry of Agriculture and food industry develops policies to promote the use and exploitation of the energy potential of biomass. It aims at gradually substituting fossil fuel consumption by processing the plant biomass into briquettes and pellets, in terms of durability, efficiency and competitiveness.

The Ministry of Environment promotes the state policy to assure ecological security by reducing greenhouse gas emissions. However, the Ministry of Environment contributes through its policies to expanding access to clean energy, improving energy efficiency and promoting green industry as an integral component of the transition to a green economy.

The Ministry of Transport and Road Infrastructure regulates and mitigates the emissions of greenhouse gases in the transport sector and promote the use of biofuels.

The Academy of Sciences promotes the state policy in the field of research and development. ASM performs a series of activities in the field of CD and innovation, including funding and implementation of projects in the energy sector.

3rd - "Execution and monitoring of public policy"

The National Agency for Energy Regulation regulates economic and commercial activities in electricity sectors, natural gas and oil products through licensing, promotion of adequate tariff policy and consumer rights protection.

The Energy Efficiency Agency's mission is to oversee developments in energy efficiency and renewable energy sources, ensuring the preparation and submission of program summaries, evaluation of investment projects, drafting of legislation and the creation of an information base in its areas of activity.

The Energy Efficiency Fund: The primary activity of the fund is to attract and manage financial resources for funding and implementing projects in the field of energy efficiency and renewable energy recovery in accordance with the strategies and programs developed by the Government. This objective will be provided by:

- promotion of investment projects in energy efficiency and exploitation of renewable energy sources;
- technical assistance for projects development in energy efficiency and renewable energy;
- providing financial assistance to projects;
- direct financial contributions;
- acting as the agent or mediator for other sources of financing;
- providing full or partial guarantees for bank financing;
- assistance in identifying the optimal combination of project financing.

The State Energy Inspectorate monitors the power system development in Moldova and has the following functions:

- Control for the rational use of electricity and thermal energy in all spheres of the national economy and implementing measures to achieve energy saving;
- monitoring consumers' compliance to the discipline and regime of consumption limit of electricity and thermal energy;
- organization and optimization of the quality of the flow of electricity and thermal energy delivered to consumers;
- enhancing consumer requirements for the exploitation of technical and safety operation of electrical installations, identify wasteful, inefficient and unsatisfactory processes in the context of reliability and safety of operation of electrical installations;
- increase control while reducing the costs of electricity consumption used for heating supply, thermal and energy-technological processes, public lighting and advertising panels in all spheres of the economy and in the context of household needs.

The Consolidated Unit for the implementation and monitoring of projects in the energy field was created by Government Decision no. 1276 of 21st of December 2000 in order to improve efficiency of investment projects, financial and technical assistance in the energy sector provided by the World Bank and other donors.

The Organization for Development of Small and Medium (ODIMM) - contributes to enhancing the competitiveness of the national economy by supporting the development of SMEs sector. Elaborates and implements programs and projects including in energy development.

The Institute of Power Engineering of the Academy of Sciences is an institution working in the field of research and aims to promote the following strategic directions:

- energy security and efficient functioning of the energy complex
- innovative solutions to build power lines, equipment adjustment for the realization of the concept of intelligent energy networks;
- new methods of calculation and analysis of transient processes and stationary circuits (lines) with heterogeneous distributed and focus parameters;
- rational use of electricity and thermal energy;
- conversion plants and systems for renewable energy sources in the conditions of the Republic of Moldova.

The Agency for Innovation and Technology Transfer - was created to coordinate, stimulate and implementing mechanisms for innovation and technology transfer activities. One of the strategic

direction it supports is the optimization of the energy complex and assurance of energy security by financing projects that aim at improving the use of renewable energy sources.

4th - "production, import and distribution of energy resources"

Moldovan-Russian Joint Stock Company "Moldovagaz" is a distributor of natural gas. As of 1st of January 2009, it exploits approximately 1800 km of gas pipelines and gas pipelines connections, 92 gas distribution stations, five compressor stations, one gas measuring station and other accessories, which form the country's gas transportation system. The organization also operates more than 17000 km of gas distribution network, 20475 plants and installations for the regulation of the gas pressure of all types and categories (from single ones up to those located in separate buildings), 290 gas measuring points and other accessories that work in a single gas distribution system of the country. In the country there are 552 790 gasified apartments and houses, including 388 130 in the cities and 164 660 in rural areas.

RED Union Fenosa SA is the largest private distributor of electricity in Moldova. RED Union Fenosa SA serves over 835,000 clients, individuals and legal entities, it distributes electricity in 21 out of the 37 districts, including in the capital, Chisinau, which overall constitutes two-thirds of the country.

S.A. Termocom is a production company in Chisinau, under the control of the mayor's office and the City Council. The activity of the company aims at the production, transportation and distribution of thermal energy (hot water and heating) to consumers: municipal housing organizations, state institutions, budgetary and socio-cultural organizations, economic agents, the private sector and individuals.

Other legal entities that are producers and distributors of energy are energy companies in all sub-sectors of the energy sector - holders of licenses for regulated activities of generation, transmission, distribution and supply of electricity at regulated tariffs.

5th - "Consumers"

Legal entities and individual consumers of energy resources in Moldova.

9.6 Analysis

Promoting energy efficiency in the Republic of Moldova is a must but also proves to be a challenge. However, since 2010, with the approval of the primary regulatory framework for energy efficiency, a number of actions/activities have been launched based on an intention to improve efficient energy consumption and at the same time educating Moldovan society to the importance of energy efficiency.

The first law drafted under the Law no. 142 of 2nd of July 2010 on energy efficiency is the National Energy Efficiency Programme 2011-2020, approved by Government Decision no. 833 of 10th of November 2011. The program comes with a strategic vision, especially in terms of energy efficiency, aiming to take a stand in the following sectors:

- Energy transformation sector (electricity, thermal energy, natural gas, etc.).
- Industry sector;
- Construction sector;
- Transport sector;
- Public sector.

The program comes with a set of objectives and specific measures for each of the aforementioned sectors, to ensure energy savings of about 14.2 PJ and a volume reduction of greenhouse gas emissions of around 760 kt of CO2 by 2020. To achieve the program goals, several measures and activities were formulated. Some of them have already started by being placed on the agenda of the authorities in the field, and also on the agenda of the local government.

To support the program, the National Action Plan for Energy Efficiency for 2013-2015 was developed and approved. This action plan sets intermediate targets, intended to be achieved through making a list of measures. Some of them are:

- Promoting energy auditing;
- Promoting voluntary agreements;
- Creating necessary conditions for market development of energy services;
- Develop and implement various incentive instruments for both the private and the public sectors, etc.

However, the National Action Plan for Energy Efficiency sets an intermediate target of 9% for energy savings by 2016. The action plan sets the objective to save energy of a total of 428 ktoe in absolute value cumulatively for the period 2013-2015. The realization of the objectives stated in the law have to be treated in other reports, prepared in accordance with the terms and conditions predetermined by the law. With the same purpose, the Agency will report progress summaries on the base of action plans and will create a knowledge base in the field of energy efficiency. These materials will contain information about the implementation of the actions included in the plans developed by all relevant actors.

The estimated energy economy target for 2020 compared to actual consumption of primary energy resources is very ambitious. Setting such targets requires the development of a list of measures/activities, with the setting of responsibilities and identifying the sources of financial

coverage. To achieve the values specified in the objectives, a monitoring mechanism should be applied.

OBJECTIVES OF RENEWABLE ENERGY - National Targets for 2030

According to the decision D/2012/04/MC-EnC of the Ministerial Council of the Energy Community, the Republic of Moldova has committed to achieve a share of renewable energy sources in the gross final energy consumption of 17% by 2030.

Implementing the above mentioned decision takes place through several policy documents, among them:

- Energy Strategy of the Republic of Moldova until 2030;
- Renewable Energy Law Nr. 160-XVI of 12th July 2007;
- Draft law on the promotion of renewable energy, approved on February 27th, 2014 in Government meeting;
- National Development Strategy of the Republic of Moldova 2012-2020;
- National Action Plan on energy from renewable sources for the years 2013-2020.

(NAPERS), approved by Government Decision no. 1073 on 27th of December 2013.

Sectorial targets and trajectories related to renewable energy sources

In accordance with the aforementioned primary and secondary legislation, Moldova is committed, to achieve the following sector objectives up to the 2020 time horizon: The share of biofuels in the total consumption of fuels used in the transport sector is expected to be at about 10%. Simultaneously, the National Development Strategy 2012- 2020 reiterates Moldova's overall national target for renewable energy use of 20%, and supplements it by a midterm objective - 10% renewable energy in gross final energy consumption by 2015. The strategy also sets a target sector for producing electricity from RES to 10% by 2020. It needs to be mentioned that the national target for the consumption of electricity produced from RES can be achieved without "green" energy imports.

Consequently, the share of RES in total thermal energy consumption has to be very huge in order to achieve the global target of 17%. Thus, the contribution of the "thermal energy from RES" should be about 28% by 2020.

Objectives for energy efficiency

Promoting energy efficiency and setting goals for the efficiency of energy consumption are addressed in the following regulations:

- Energy Strategy of the Republic of Moldova until 2030;
- National Energy Efficiency Programme 2011-2020;
- Government Decision no. 102 of 05.02.2013 on the Energy Strategy of the Republic of Moldova until 2030, Official Gazette no. 27-30 of 08/02/2013, Article number: 146
- Government Decision no. 833 of 10.11.2011 on the approval of the National Energy Efficiency Programme 2011-2020 Official Gazette. 197-202 of 18.11.2011, Article number: 914
- National Action Plan on energy efficiency for the years 2013 - 2015 (NAP);

- National Development Strategy "Moldova 2020".

Therefore, the overall objective for energy efficiency is set out in the NPEE and states an improvement of efficient global primary energy consumption of 20% by 2020. The National Action Plan in this field, as mentioned above, comes with an intermediate target fixed for the year 2016, and at the same time traces the trend of primary energy consumption optimization. In this sense, the goal is to reduce the annual consumption by 1.8%.

With regards to the Strategy “Moldova 2020”, it establishes a number of sectorial targets for the horizons 2015 and 2020, for the electricity sector, thermal, natural gas, construction, public sector, etc.. The final and the intermediate targets are shown in the table below.

Energy-consumption optimization

As a general approach to energy consumption optimization, we can mention that Moldova is an energy intensive country with efficiency three times below the average of EU member countries. Large domestic consumption, characteristic to the subjects operating on the internal market, appears on the background of using old technology and obsolete equipment. This occurs due to the fact that energy conservation is a subject ignored at all levels. In addition to the reasons stated above, we may add the lack of information or simply the poor information that flows to the society and the private sector pertaining to the benefits gained from the implementation of energy efficiency measures.

Today we may observe an insistent demand made by the society for the demonstration of good practice in the field of energy consumption, which in tandem with financial instruments, special funds, credit lines available on the market today, are able to make an important shift towards the implementation of measures that would optimize consumption efficiency. The first steps in this direction have already been taken, including the support of the administrative body in the energy efficiency and renewable energy domain - the Energy Efficiency Agency.

SWOT Analysis:

Strengths	Weaknesses
Long term energy sector strategy (2030) Harmonization of Moldovan legislation with EU standards Implementation of projects for the assistance of the development of the energy sector High potential for the use of renewable energy sources Implementation of investment programs to promote energy efficiency	Low rates on energy delivered in the grid Lack of information about the benefits deriving from EE and RES Incomplete and incoherent legislative framework Financing concentrated on projects Weak interaction between the research and the business sector Poorly developed infrastructure in the energy sector Low public and private expenditures in R&D Poor valorization of RES The lack of an attractive investment climate for foreign and local investors in the energy sector Low energy efficiency in the production- distribution-transportation chain Inefficient banking system in the investment field Lack of qualified human resources
Opportunities	**Threats**
Association agreement with the EU Unexplored capacity Different and diversified EE funding sources and support structures (FEE, MoSEFF, AITT, AEE...) Strengthening the role of the Moldovan electricity transit corridor through the construction of new interconnection lines, ENTSO-E connection to the internal network and strengthen the electricity transmission Gradual internationalization of companies in the energy sector Investments in cross-border energy infrastructure	Political instability in the region Excessive bureaucracy Government underfunding in research, innovation and technology The high degree of dependence on energy imports The rising costs of energy resources

Table 7: SWOT Analysis

9.7 References

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