Conference Proceedings

Solar World Congress 2015
Daegu, Korea, 08 – 12 November 2015

Renewable Electricity Production Effect on the Energy Balance of Latvia

Peteris Shipkovs[1], Galina Kashkarova[1], Kristina Lebedeva[1], Janis Shipkovs[1], Lana Migla[1]

[1] Institute of Physical Energetics, Riga (Latvia)

Abstract

The paper presents current situation in the Latvian Energy sector, the place and the role of renewable energy resources in the Energy and Electricity production. The dynamics of the energy consumption and production is described along with evaluation of the environmental, legislative, and economic aspects of renewable energy use.

Keywords: *Renewable Energy Resources, Renewable Electricity, Energy Consumption, Energy Balance*

1. Introduction

The climate changes, pollutions, and energy insecurity are among the greatest problems of our time. According to the EU directives, the Energy sector is one of the areas in which the EU Member States have been sharing competence. The time span from 2014 to 2020 is a transitional phase for the EU's Energy policy, when the relevant objectives set for 2020 are to be achieved, with future objectives elaborated.

In particular, by 2020 the EU has to achieve the following climate and energy policy objectives set by the European Council of March 2007:

- to reduce greenhouse gas (GHG) emissions by 20% relative to the 1990 level;

- to increase the share of renewable energy resources (RES) in the energy consumption by 20%;

- to improve the energy efficiency by 20%.

In compliance with the EU legal acts on the climate and energy, the Latvian objective by 2020 is to ensure 40% of RES share in the final energy consumption.

Latvia has already made substantial improvements in the energy balance owing to the diversion from the use of fossil fuels (especially fuel oil or solid fuel) to that of wood biomass. In the time span from 1990 to 2013, the use of fossil fuels rapidly decreased – of liquid fuels by 59.7%, of solid fuels by 82.3%, and of natural gas by 49.6%, while the total wood biomass, biogas and biofuel use increased by 105%. According to the EuroStat, Latvia is currently holding the second place among the EU 28 Member States as to the RES share in the final energy consumption, and in 2013 reached 37.10% of the total gross final consumption.

2. Strategy and Policy Targets on Renewable Energy Use

The key directions of the efficient, well-balanced, market-oriented energy policy of Latvia set forth in the informative report "Long-Term Energy Strategy 2030 – Competitive Energy for Society" (Energy Strategy 2030, approved by the Cabinet of Ministers at the meeting of 28 May 2013) are aimed at the

doi:10.18086/swc.2015.04.31 Available at http://proceedings.ises.org

development of the state economy's competitiveness, promoting welfare of the society.

The main task of Energy Strategy 2030 is to ensure a positive impact of the energy sector on the national economy of Latvia, at the same time striving to achieve secure and sustainable energy supply, i.e.:

– secure energy supply – a stable energy supply and developed infrastructure provided for energy consumers;

– sustainable energy supply – reduced dependence on the imported energy resources; implementation of new and efficient technologies for the RES use and of the measures for improvement of energy efficiency.

The Energy Strategy 2030 envisages a 50% decrease in the energy import from non-EU suppliers, with a half of the total final energy consumption in the state ensured by RES, which is to be achieved by increasing the RES share in the heat, electricity and transport sectors.

Currently, in order to increase the energy production from domestic energy resources, to decrease the use of fossil fuels as well as to reduce the GHG emissions, different renewable energy sources (RES) are used for energy production. As shown in Table 1, the RES (the **bold text**) use has a stabile tendency for growth in general and, in particular, for electricity production.

Table 1: Dynamics of Primary Energy Resource Consumption (PJ).

	2010	2011	2012	2013	2014
Natural gas	61.3	54	50.8	50.3	45.4
Oil products	64.6	59.5	58.4	59.3	59.7
Coal and coke	4.5	4.6	3.8	3	2.5
Electricity (imported)	14.3	14.4	17.8	18	19.2
Hydro energy	**12.7**	**10.4**	**13.3**	**10.5**	**7.2**
Fuel wood	**45.6**	**46.9**	**52.5**	**53.1**	**55.9**
Wind energy	**0.18**	**0.26**	**0.4**	**0.43**	**0.5**
Biogas	**0.56**	**0.92**	**2.2**	**2.7**	**3.1**
Others	0.07	0,08	0.07	0.14	0.13
Total	203.81	191.06	199.27	197.47	193.63

The National strategy as well as plans and programs have been developed in view of reducing the negative environmental impacts of the energy sector, promoting the use of Renewable Energy Sources.

The RES segment in the electricity production comprise hydropower plants, wind power plants, biogas power plants and biomass power plants, as well as cogeneration stations utilizing RES (Table 1, Table 2).

Table 2 illustrates the share of RES in the total energy consumption and its share in the electricity production (Shipkovs *et al*., 2014).

Table 2: Share of RES.

	2000	2010	2013	2014
Share of RES in the total energy consumption, %	29.5	35	37.1	34.0
Share of RES in the electricity production, %	47.7	49.3	56.9	42.6

The main RES types in our country are the fuel wood and hydro resources, which in 2014 accounted for 34% of the total consumption of energy resources.

Over the last ten years (2004-2014) the total consumption of RES has increased by 12%.

Fuel wood is the most commonly used RES in Latvia, and its share in the total energy consumption in the time from 2010 to 2014 increased from 23.4% to 30.2%. In 2014, the share of fuel wood in RES consumption was 82.1%, which is 3.4 PJ or 4% more than in 2013 (Fig. 1).

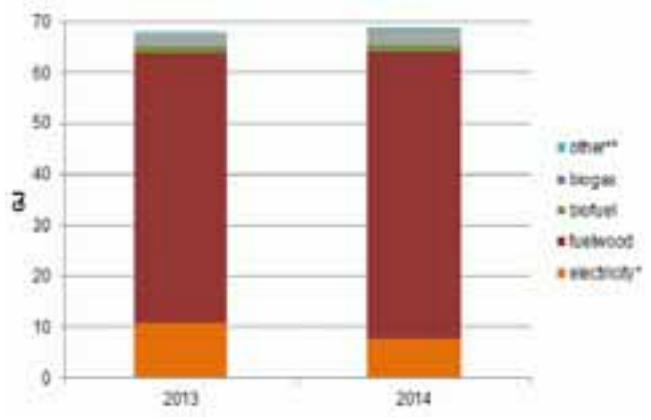

Fig. 1: Consumption of renewable energy resources in 2013 and 2014, GJ.

In 2014 the total consumption of fuel wood grew by 6% as compared with 2013 (see Fig. 1); consumption changes are also seen in the breakdown by sectors. The share of fuel wood increased both in households and in transformation sector for heat and electricity production. The main fuel wood consumers are households, which mostly use firewood (85%). In 2010, the share of consumed fuel wood in households was 42.9%, in 2013 – 45.4%, and in 2014 – 46.3%. The fuel wood consumption by sectors is shown in Fig. 2.

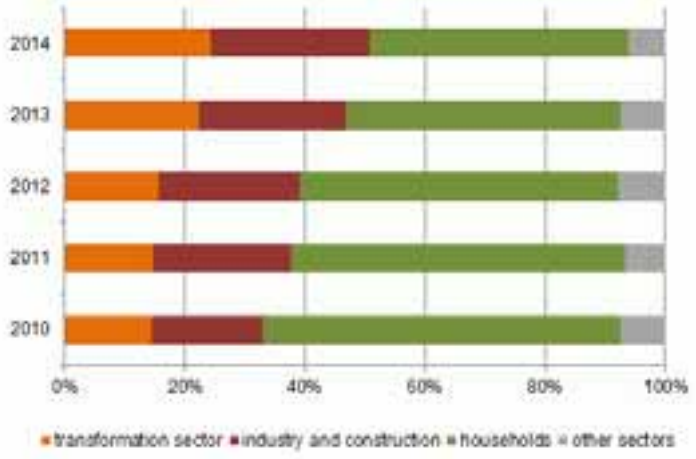

Fig. 2: Fuel wood consumption in Latvia, %.

Over the time span 2010-2014 the share of fuel wood in transformation sector increased by 9.8%, in 2014 reaching 24.3% of the total consumption in Latvia. In the transformation sector mainly wood chips are used (86.5%). The greatest growth in consumption of fuel wood in the transformation sector was recorded in 2014, when the share of wood chips grew by 25.1% as compared with 2013. This was due to the new CHP plants which started their operation in 2014, and to the annually increasing RES share along with reduced share of natural gas. Since 2007, the installed electrical capacity of RES CHP plants by 2014 had increased 12 times, reaching 121 MW; the electricity production increased 16 times, reaching 669 GWh, which accounts for 22% of the total electricity produced in CHP plants.

Directive 2009/28/EC of the European Parliament and of the Council on the promotion of the use of energy from renewable sources stipulates that the share of energy from RES by 2020 must account for at least 40% of the final energy consumption. In 2008, this share in Latvia was 29.81%, in 2010 – 35%, in 2013 – 37.1%, and also in 2014 this percentage slightly rose, reaching 34 %. Each Member State is obliged to ensure that by 2020 the share of electricity produced from RES (biofuel, biogas) and consumed in transport is at least 10% of the final consumption of energy in transport (in 2013 Latvia reached 3.08%).

In Latvia, current legislation foresees promotion of purchasing the energy produced from RES, namely, the electricity produced by the cogeneration plants using local energy sources.

The next planned steps in order to promote further use of RES in Latvia are as follows:

- Participation in the EU Emission trading.
- Introduction of energy tax (CO_2 tax).
- Setting the overall RES target in the primary energy supply, with sectoral and type breakdown.
- Implementation of pilot projects.
- Organization of public awareness campaigns about RES.

3. Electricity Market

The electric energy makes the basis for economic development of every country, and the global demand for this energy is constantly growing. As of now, the use of fossil or nuclear sources for energy production becomes problematic for many reasons. The only real environment-friendly way of producing electric power is the use of renewables, which are considered as the main energy source in the future.

In Latvia, the shortage of local energy creates dependence on electricity importers (see Table 3 for the electricity supply dynamics). Therefore, to reduce this dependence, it is necessary constantly to increase power generation capacity, which in turn contributes to an increase in hazardous emissions and greenhouse effects reinforcement.

Table 3: Electricity Supply in Latvia (GWh).

	2000	2005	2009	2010	2011	2012	2013	2014
Total electricity supply	5922	7053	7223	7500	7340	7859	7564	7457
Gross electricity generation including:	4136	4905	5569	6627	6094	6167	6209	5140
from renewable energy resources:	2824	3414	3555	3635	3078	4109	3534	2803
large HPPs*	2794	3263	3391	3445	2823	3627	2852	1925
small HPPs	25	62	66	75	64	80	60	68
biomass power plants	–	6	4	9	13	65	215	319
biogas power plants	–	36	44	57	107	223	287	350
wind power plants	5	47	50	49	71	114	120	141
from fossil energy resources:	1312	1492	2014	2992	3017	2059	2675	2337
large CHPs**	1163	1278	1476	2402	2425	1409	1957	1648
other CHPs	149	214	538	590	592	650	718	689
Net electricity imports	1786	2148	1654	873	1245	1691	1355	2317

* Daugava cascade – Riga HPP, Kegums HPP, and Plavinas HPP
** Riga CHP-1 and Riga CHP-2, source: JSC "Latvenergo"

One of the ways to reduce the electricity imports might become additional sources of energy, especially clean ones. Increase in the electricity production from different renewable sources is shown in Table 4.

The electricity market in Latvia has been open since 1 January 2015. Pursuant to the amendments to the Electricity Market Law of 18 September 2014, households have an opportunity to freely choose the provider and agree on the electricity price based on an agreement just like legal entities. The amendments to the Electricity Market Law of 18 September 2014 further envisage special tariffs for the protected consumers.

Along with complete opening of the electricity market as of 1 January 2015, a support instrument for protected consumers was introduced.

Table 4: Increase in the electricity production from different RES.

Energy sources	Installed capacity, MW		Electricity production, GWh		Electricity production increase from 1995 to 2013
	1995	2013	1995	2013	
Wind	1	67	0	120	× 120
Hydro (big)	1504	1560	2934	2912	× 0.99
Hydro (small)	3	29	3	60	× 20
Solar batteries (PV)	0	0,1	0	0,056	× 0.056
Biomass (total)	0	55	0	215	× 215
Biogas	0	53	0	287	× 287
TOTAL			2937	3534,056	× 1.21
Electricity consumption			5193	4 387	
RES-e part			56.50%	80.56%	× 1.43

Table 5 presents the dynamics of installed electric capacity of power plants and combined heat and power (CHP) plants which use renewable energy sources for electricity production.

Table 5: Installed electric capacity of power and CHP plants using RES (MW).

	1990	1995	2000	2010	2011	2012	2013	2014
Hydropower plants	1 487	1 507	1 513	1 576	1 576	1 576	1 589	1590
Wind power plants	-	1	2	30	36	59	67	69
Biomass power plants and CHP plants	-	-	-	5	5	23	55	63
Biogas CHP plants	-	-	-	11	25	43	53	58
Total	1 487	1 508	1 515	1 22	1 642	1 701	1 764	1780

Over the last years the capacity of hydropower plants did not change much; in turn, the electric capacity of other power and CHP plants grew significantly. For instance, capacity of wind power plants in 2014, as compared with 2013, rose by 3%, and compared with 2012 – by almost 17%. The electric capacity of biogas CHP plants in 2014 grew by 9.4% as compared with 2013, while this indicator for biomass power plants and CHP plants was 14.5% greater in 2014 than in 2013, and 174% greater as compared with 2012. One of the factors promoting RES development is the State support, which allows selling electricity within the mandatory procurement framework.

In 2014, the energy production from RES promoted the mandatory procurement of electricity and investment support from the EU Cohesion Fund, the Climate Change Financial Instrument, and the European Agricultural Fund for Rural Development. Renewable energy is closely linked to the country's energy independence, environmental protection and climate change, as well as to its impact on the competitiveness of the economy. Now it is vitally important to increase the independence of Latvian energy sector. For this purpose serves the use of RES which increases a positive impact on reducing the energy dependence on imported energy and the share of RES in final energy consumption.

As shown in Fig. 3, the greatest share (over 70%) of electricity from RES is produced by hydropower plants. In 2014, hydropower plants with the capacity >10 MW (Plavinas Hydropower Plant, Riga Hydropower Plant and Kegums Hydropower Plant) produced 1 925 GWh of electricity, or 68.7% of the total electricity produced from RES.

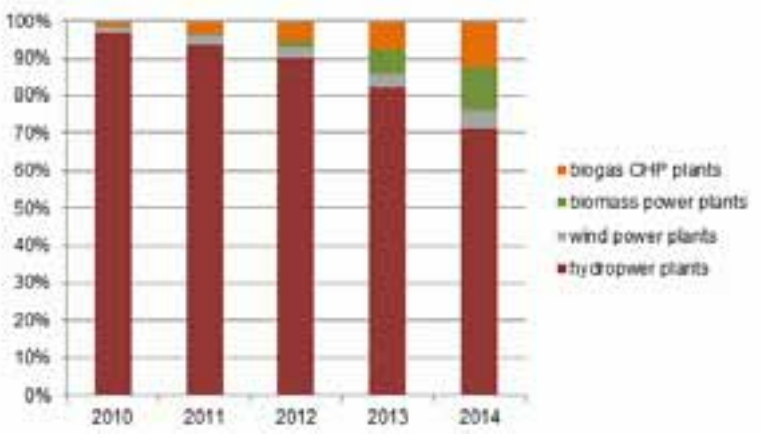

Fig. 3: Electricity produced from renewable energy resources, %.

Important contribution to the total renewable energy balance is being made by three large hydro stations: Kegums Hydroelectric Power Plant (HPP) – 264.1 MW, Plavinas HPP – 884 MW, Riga HPP – 402 MW. To increase the installed capacity of hydropower, reconstruction of the hydro generation units is underway (see Table 6).

Table 6: Planned reconstruction of Hydro Power Plants.

	Year	Number of turbines	Increase of utilization rate	Increase in generation
Plavinas HPP	2014-2016	2	5% ... 9%	+18 GWh
Kegums HPP	2014- 2017	3	5% ... 6%	+22 GWh
Riga HPP	2017- 2021	6	3.5%... 5%	+25 GWh

Small hydropower plants had played a special role at the beginning of Latvian electrification and local electricity grid development. This was worth expanding, so at the end of 1926 there were installed 26 HPPs with the total capacity of turbines 1.5 MW and of power generators 1.26 MW. The Latvian hydro resource potential was first analyzed in 1931. Small hydropower development continued until the beginning of 70-ies. At that time, construction of large power plants and transmission lines was developed. With time, the operation of small HPPs became unprofitable, and from 1963 to 1977 they were decommissioned. In turn, from 1992 to 2012 there were put into service 143 small HPPs, 91% of which were restored or reconstructed and only 9% rebuilt (Shipkovs *et al*. (2013)).

The theoretical potential of Latvian small and medium-sized rivers as energy sources is calculated to be ~ 900 million kWh. Technically achievable potential of hydro energy resources (taking into account mining and processing facilities and technological transformation capabilities) is 150-300 million kWh per year. Currently, only 20-40 % of the real small river resource potential is utilized. This potential can be increased by improving the existing HPP technologies and power generation efficiency.

With a greater than 40% share of cogeneration in the total gross electricity production, Latvia is among the top three member states in the EU, as all thermal electricity is produced by CHP plants (Shipkovs *et al*., 01.2013). The total installed CHP capacity more than doubled from 2006 and reached 1.252 MWe in 2013, with the number of CHP plants increased from 43 to 166 and the electricity generation increased by 60% reaching 3.2 TWh in 2013. The combined cycle turbine operating on natural gas is a prevailing technology at four largest public district heating CHP plants, with ~ 85% share in the total CHP capacity and > 60% – in the CHP electricity and heat generation in 2013. Gas engines are most often used at smaller CHP units (<20 MW) where among the 162 existing CHP plants there are only 46 autoproducers CHP plants. The CHP generation is concentrated in a small number of major CHP units, which is the main reason for rather big fluctuations in the CHP electricity and heat generation (see Fig. 4).

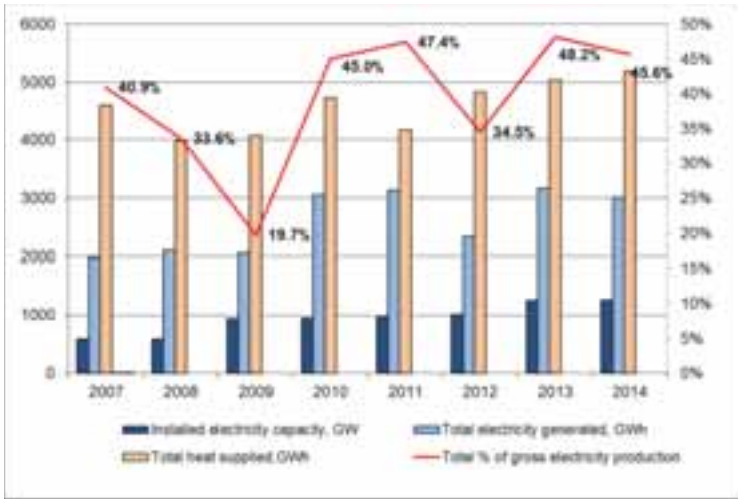

Fig.4: CPH installed capacity and generation.

With a greater than 78.9 % share, the natural gas is the major fuel used at CHP plants, followed by wood biomass and biogas (see Fig. 5) whose share is ever growing.

In 2014, CHP plants supplied almost 60% of the total produced heat to widespread district heating systems, covering ~ 70% of the households' heat demand and approx. 22% of the total heat demand in Latvia.

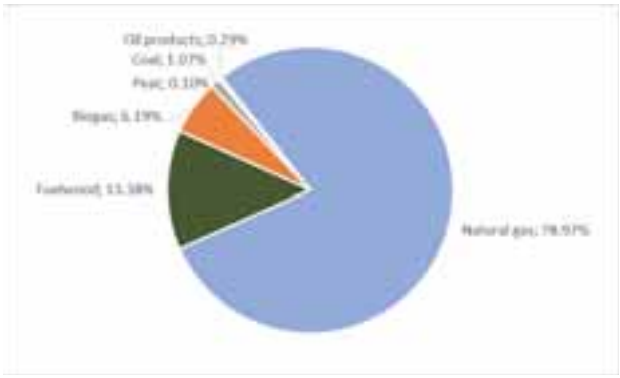

Fig.5: Structure of fuel consumption by CHP plants (2014).

Until the beginning of the year 2009, biogas was produced by "Riga Water Ltd." at its water purification plant (capacity of 2 MWe), with the resulting electricity spent for their production needs at Riga landfill "Getlini Eco" (installed capacity of 5 MWe), LAU Study and Research Farm "Vecauce" (total capacity 270 kWe, and two plants at Liepaja landfills (total capacity of 1 MWe) In 2009, Latvian entrepreneurs (58 in number) received a quota for biogas production with a total installed capacity of ~ 54 MWe. In the same year, one unit of the North landfill Daiba was put into operation with a capacity of 170 kWe, and a number of biogas plants (the total installed capacity of 10-12 MWe) was launched. In March, 2010, the "MC" Ltd. biogas plant was put into operation. In 2014, already 54 biogas plants were operating, of which: at domestic landfills – 7, operating with domestic waste water – 1, with food production residues or waste water – 2, in agricultural sector – 44 (the total installed capacity 58 MW, with 350 GWh of electricity produced).

The estimates obtained for the biogas potential are shown as related to agricultural and industrial branches (Fig. 6); also, the technically achievable potential of biogas that could be obtained from household waste was estimated to be 0.3 TWh.

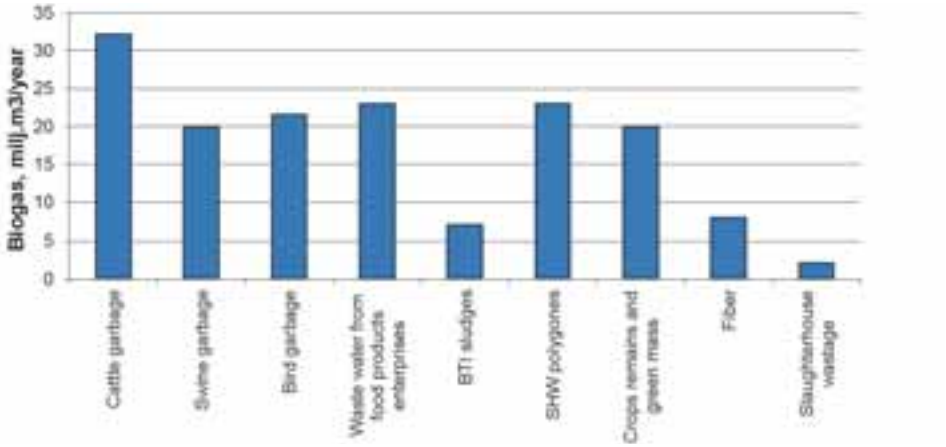

Fig.6: Biogas production potential.

As concerns wind energy, Latvia possesses a very good potential for its development along the Baltic Sea coastline, especially owing to a high voltage transmission line running there (see Fig. 7). Accordingly, the wind power plants are installed mostly in the seaside area, with totally produced electricity of 140 GWh.

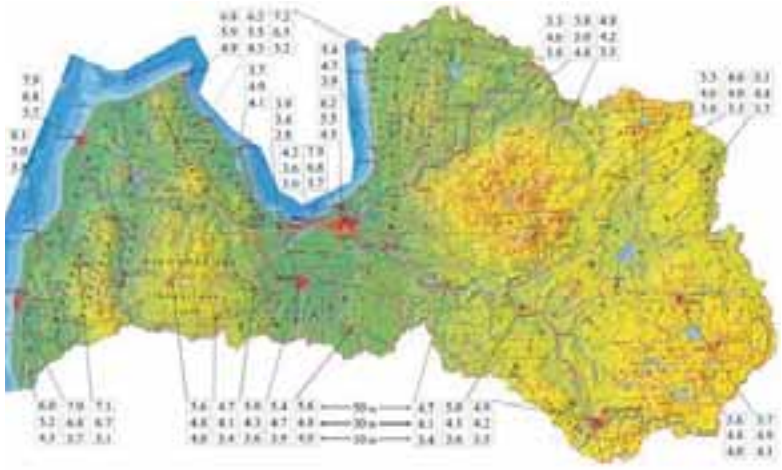

Fig.7: Wind map (on 10 m, 30 m, and 50 m heights).

Wind power output rose quickly, from 2 MW in 2000 to 69 MW in 2014; in particular, when the wind power farm "Pope" had been built in 2012, the country's installed wind power capacity was doubled (up to 68 MW). So far Latvia uses only 5 % of its wind power potential. The wind map in Fig. 7 made up for the whole country shows that wind farms could be constructed along practically all its coastlines. The related branch should continue the development at a steady pace, given the fact that the renewable energy action plan envisages increasing the wind turbine fleet's capacity to 416 MW by 2020 (180 MW offshore included).

Latvia is firmly embarked on the electricity supply source diversification process, which will enable our country to gradually wean itself off the electricity imports and even eliminate the impact of hydropower's up-and-down performance on the renewable energy share of its electricity mix.

Concerning the use of solar energy for electricity generation in Latvia, it is insignificant up to now; still, in 2013 solar energy (PV solar panels) came in sight, with the produced electricity of 0.2 TJ.

4. Conclusions

In Latvia, the potential for RES use development in high in terms of all factors: technical, social, and the market.

Firewood and wood waste will remain the most important source of bio-energy in the future. However, contribution of bio-energy is closely associated with possibility of using it not directly as fuel for electricity and heat generation but also for production of fuel for transport, with reducing the costs of RES use technologies.

Today, many problems in the RES use area exist – e.g. high costs of equipment, low interest among the policy makers, and, as a result, deficiency of national support; still, despite these problems, there are also opportunities for development, namely: liberalization of energy supply, focussing on the decentralized energy production, higher prices for fossil fuels, etc.

The progress in developing the energy production technologies using renewable energy resources has been made in many countries; however, there is a need to make the results widely known, to transfer and exchange technologies and practices. Recent development of different technologies for this purpose opens new possibilities for RES use also in small countries such as Latvia.

Availability of the economic instruments for promotion of RES in the electricity market and for heat generation would help Latvia in its search for the opportunities to encourage RES application through Kyoto mechanisms and building up the required legal and administrative framework. The combination of the mentioned measures should create necessary operating conditions for new RES power plants (especially for large-scale wind farms) and conversion of the existing power stations on biomass to cogeneration plants. In Latvia, economic stimuli have been established for construction and operation of small HPPs, WPPs and CHP plants. In particular, power plants using RES for electricity production have priority access to the transmission and distribution systems in Latvia.

In Latvia, renewable electricity generation is stimulated through a complex support system based on a feed-in tariff, which also includes elements of a quota system and tenders. The existing state support mechanisms for energy production from renewable energy resources are being assessed and revised by The Ministry of Economics. Stringent supervision of subsidized electricity producers, and stricter controls with limited timeframe for the implementation of RES projects have been introduced. In January 2014, a new tax for subsidized electricity producers was introduced, which should be paid by the companies receiving financial support for power generation from RES or from combined heat and power plants. Although the access of renewable energy plants to the grid is subject to the general legislation on energy, the electricity from renewable sources is not given priority. Also, devices for heat production from RES are not given priority connection, and there is no special legislation promoting the connection of RES heating devices to the heat transmission network at the national level.

Scanning of current energy strategies shows that Latvia has its energy strategy and plans while generally no specific strategies regarding solar power. Another major effort is to identify and analyze the supportive structures that exist for those who intend to invest in the solar power and to investigate it.

The structure of the modern energy supply systems in combination with renewable energy resources is promoted by new progressive technologies that increase the efficiency of renewable energy utilization and pledges support for a wider RES use.

The review of all renewable energy resources which could be more or less used for electricity production shows that Latvia has real possibilities for achieving its targets for the future. Latvia has already a 20-year experience of creating a viable energy policy to provide the State with stable energy supply and promote effective and rational energy utilization. Progressing in the relevant technologies and developing the State laws will lead to creation of a stable energy sector that in turn will promote rational and effective RES use.

Acknowledgements

This work has been supported by the State Research Program "LATENERGI".

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