

Analysis of potential of renewable energy in the Lithuania

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Abstract. Lithuania is a country highly dependent on energy imports. The most energy raw materials such as oil and gas are imported from Russia. It is however, the only Baltic state to own a refinery that makes it an exporter of petroleum products. Renewable energy sources (RES) are available to a larger extent. Good potential for wind energy exists along the shores and geothermal sources are located in the western part of the country. But the largest and still widely unused potential lies in biomass. The hydroelectric potential is rather low and already largely utilized. The purpose of this article is to investigate the potential of RES and its usage in Lithuania and to analyze the evaluation features of effectiveness of investment in RES.

Keywords – renewable energy, effectiveness of investment in RES, potential of renewable energy.

I. INTRODUCTION

Demographic situation that is growing globally, recovering purchasing power, fosters greater production of good and services for which to create it is necessary to use more and more power.

There are no more doubts that traditional energy sources like oil, gas, coal and peat are running out inexorably. Therefore to ensure both – the conservation of non-renewable energy sources and willing to get cheaper energy there is necessary to use and develop renewable energy such as solar energy, wind energy, hydropower, biofuels and geothermal energy.

Relevance of this topic cannot be unambiguous, since this question is miscellaneous. After signing the Kyoto protocol and other important documents related with climate changes, all European countries, including Lithuania, are focused on energy produced from renewable energy sources, particularly in transport sector.

The promotion in biofuel sector is influenced by following reasons [12]:

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- Low level of fossil fuel, especially oil, reserves, influence rising prices and political dependence on fossil fuel exporters;
- The excess of agricultural production of food market in European Union and other developed countries that could be unprofitable to reduce in other means (organic farming, early withdrawal from agricultural production and ect.);
- Social issues in agriculture, caused by rising productivity and limited food demand, that requires support grants from government and EU funds;
- Changing usage amount between different fuels and its kind.

Currently there are various researches held in different fields to solve the most important challenge in global renewable energy market – the energy price reduction produced from RES. However, evaluating all the external costs caused by currently used dominating energy sources and gathering together the positive effect which is influenced by uptake and utilization of RES, the economical competitiveness of some RES already can be seen. [1, 2, 17]

RES inside accumulates the essential qualities like [11]:

- The use of renewable energy means that energy is easy to recover or it never ends;
- Technological advances have focused on the human activities in harmony with the natural circulation of natural processes;
- The technical progress made in this field is huge, but due to the expensive energy produced from RES it cannot break through to the larger scale in energy market. RES energy is still too expensive comparing to conventional oil, gas and coal-based energy.

To compete with conventional technologies, such as the use of fossil fuels, RES has to overcome two major commercial barriers - poor infrastructure and lack of economies of scale in production, which is usually used by traditional technologies. The development of new renewable energy sources requires high initial investment for its infrastructure development. Those investments enlarge energy cost produced by RES, particularly in the initial year.

Energy produced from RES makes us solve some important issues such as competitive energy markets, energy security and environmental protection.

The measures used to achieve these three goals often are in conflict with each other. Especially big difficulties are caused by the problem solving of competitiveness in energy market and energy supply reliability [6].

Fisher and Rothkopf identify these market barriers which causes difficulties to the development of renewable energy resources [9]:

- Commercial (Trade) barriers caused by the competitiveness between new and ordinary technology.
- Price distortions caused by existing subsidies and unequal tax burden on RES technologies comparing with normal prices.
- Market failure evaluating the social benefits of RES and negative external effects of traditional energy resources;
- Market barriers, such as inadequate information, access to capital constraints, change of initiatives, high transaction costs of making small purchases and institutional barriers.

The purpose of this article is to investigate a potential of RES and it's usage in Lithuania and to analyze the evaluation features effectiveness of investment in RES.

II. THE USE AND DEVELOPMENT OF RENEWABLE ENERGY SOURCES IN LITHUANIA

Every year, more and larger amounts of energy are produced from renewable energy resources. According to 2010 statistics of the European Union in 2010 the leading country that produced the biggest amounts of energy from renewable energy sources was Norway making 42.4% of energy from RES, then comes Latvia with 36.2% and Sweden - 34.4% of energy producing. Meanwhile in Lithuania renewable energy sector is in a significant lag - in total energy production only 10.5% of total amount generated from renewable sources [7].

Recently, in Lithuania energy produced from renewable energy resource is increasing every year (Table I). The increase is not only in energy plants, but also in produced energy amount.

Renewable energy development and its use in Lithuania is a great opportunity to reduce environmental pollution, to receive financial benefits to the country's, to ensure economic stability and reduce unemployment. According to studies, Lithuania has considerable potential for developing renewable energy projects because it has resources such as geothermal energy, also there is huge potential of biomass production development.

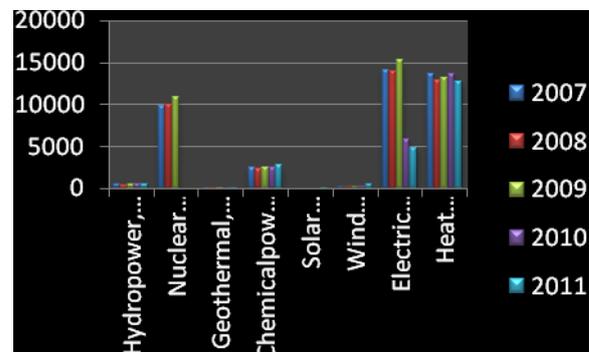
Furthermore, Lithuania is committed to increase biofuels in total transport fuel in country's balance sheet by 15 percent, and by 2025 – up to 20 percent, also the share of renewable energy in primary energy balance has to be increased at least 20 percent [5].

According to the newest data from Lithuanian Department of Statistics [16], currently the most used RES types in Lithuania are timber and hydropower, but other types of energy sources such as wind energy, biofuels, geothermal energy and etc. has also huge development potential (Table II).

Table I. Share of renewable energy in gross final energy consumption [7]

	2006	2007	2008	2009	2010	Target
EU (27 countries)	9	9.9	10.5	11.7	12.4	20
Belgium	2.7	3	3.3	4.6	No Data	13
Bulgaria	9.6	9.3	9.8	11.9	13.8	16
Czech Republic	6.5	7.4	7.6	8.5	9.2	13
Denmark	16.5	18	18.8	20.2	22.2	30
Germany	6.9	9	9.1	9.5	11	18
Estonia	16.1	17.1	18.9	23	24.3	25
Italy	5.8	5.7	7.1	8.9	10.1	17
Latvia	31.1	29.6	29.8	34.3	32.6	40
Lithuania	16.9	16.6	17.9	20	19.7	23
Hungary	5.1	5.9	6.6	8.1	No Data	13
Malta	0.2	0.2	0.2	0.2	0.4	10
Netherlands	2.7	3.1	3.4	4.1	3.8	14
Austria	26.6	28.9	29.2	31	30.1	34
Poland	7	7	7.9	8.9	9.4	15
Finland	29.9	29.5	31.1	31.1	32.2	38
Sweden	42.7	44.2	45.2	48.1	47.9	49
United Kingdom	1.5	1.8	2.3	2.9	3.2	15
Norway	60.6	60.5	62	65.1	61.1	67.5

Table II. Energy balance in Lithuania (prepared by authors using data of Lithuania Statistic Department [16])



Energy produced from all types of renewable energy sources can be used for electricity generation, heat production and energy production. Table III identifies the usability of main RES.

Table III. Usability of renewable energy sources (prepared by authors using statistical data [15, 16])

Renewable energy source	Electricity generation	Heat production	Energy (fuel)
Wind energy	✓		
Water energy	✓		
Biomass	✓	✓	
Biogas	✓	✓	✓
Biofuel	✓	✓	✓
Geothermal energy	✓	✓	
Solar photovoltaic	✓		✓
Solar collectors		✓	

A. Solar energy

Solar energy is one of the most used renewable energy source not only in Lithuania but also in neighboring countries. The main use of solar energy is to convert it either into heat or electricity. In Lithuania maximum duration of solar radiation is at the seaside – about 1840-1900 hours per year, the lowest is in the eastern part of the country – less than 1700 hours per year. In neighboring countries, the duration of solar radiation is relatively similar [15].

Solar energy is a very perspective area and lots of investments are made for its development and innovations and therefore it reduces its technology price and also photo elements cost. The use of solar energy in Lithuania is a big possibility for the water heating (solar thermal energy). Those projects still need significant investments for solar collectors to absorb solar radiation and transmit it to heating system.

To summarize the solar energy area, some advantages can be made: this type of energy is environmentally friendly, solar energy is constant, and there is possibility to produce energy even during cloudy day.

However solar power has negative side such as: energy gain from sun is directly related to the time of a day and nature conditions. Currently it also make doubts about solar energy production feasibility (the payback of that kind of investment is very long) and without government grants and subsidies this energy industry is hardly possible. Moreover, some researches show that solar energy efficiency is relatively small, so in order to produce enough energy a large area of land is needed to install the equipment [2, 18].

In fact, it should be mentioned that in Germany, that presents similar number sunny days per year, solar energy production and development is significantly higher than in Lithuania and what is more, Germany is mentioned to be among the most contributing countries in the development and use of solar energy worldwide.

B. Wind energy

Lithuania is considered to be weak wind country, however the largest volume of wind is from September to December when strong winds prevail.

In Lithuania's territory non-effective land for developing wind power is about 30% but the most efficient and the greatest economical benefits are from offshore wind farms. For development of wind energy there are some problems such as lack of available land, environmental requirements and others. Also Lithuania does not use offshore wind power reserves, that could bring greater economic benefits, but the relevant legislation and environmental requirements for offshore energy activities are not permitted [4, 15, 19].

As wind energy is unstable, its usage requires energy storage equipment – electricity networks, or local batteries. There are horizontal and vertical wind turbines. Vertical – does not make so much sound like horizontal, it works also with not that strong wind, but their efficiency is also lower.

Scientists highlights the following benefits of wind energy – it does not distinguish hazardous materials, wind energy is a constant, the innovation of wind energy decreases cost of power and at the same price of electricity [8, 4, 19].

As the main disadvantage of wind energy it is mentioned its instability, which is required for the power connection to the electric grids.

C. Biomass

Biomass - a plants or animals biomass (organic material) which they receive from the photosynthesis of solar energy. Plants accumulate so many reserves of energy that they even can exceed the annual amounts of global energy demand. As an energy source, biomass is used for solid fuel or biogas form. The largest amounts of biomass derived from forests, but not the all kinds of biomass plants are used to produce energy. To produce biomass energy it is also used timber industry waste, agricultural waste, specially grown corps, also food and animal wastes are converted into biogas during special processes. According to statistics, Lithuania is the leader among European Union countries, according to the use of biomass potential [12].

It is important to note that biomass energy can be produced not only for heat and electricity, but it may be also used for production of biofuels that can be applied in conventional diesel engines. Lithuania has especially high potential for extraction of biofuels from sugar industry. Using wastes from this industry, such as sugar cane and sugar beet, biofuels can be successfully developed.

Biomass energy's main advantages are: constant energy production, the energy extraction method is less expensive than fossil fuels, the use of domestic resources, preventing the movement of money to other countries, also the organic waste can be used for energy production, which reduces landfill area, positively affects the environment, and it can reduce unemployment by creating new jobs.

On the opposite side, biomass energy can present disadvantages such as: some of the raw materials (energy crops) are seasonal; their preparation process is long, because the process includes the planting and growing period of the crops, and also the conflict with the food industry, when farmers start to grow energy crops instead of food. That could lead to food crises. What is more, biomass industry release CO₂ by burning biomass, but of course not that much as burning fossil fuels. [1]

D. Hydropower

Hydropower - the energy of the water, which consists of potential and kinetic energy. In practice, the most commonly used potential energy of water flow due to higher plant productivity. The Earth's gravitational force is considered to be the most constant, which allows successfully develop hydro-electricity. Energy from hydro power usually is produced from dammed rivers, waves and tidal energy (in Lithuania, this type is not developed due to natural conditions) [15]. Lithuania, as well as neighboring



countries – Latvia and Estonia, has adequate water resources, which can be used to produce hydropower.

Lithuania is covered 4% with water, 3.9% in Latvia and Estonia – 6.3%. Another important issue is that in Lithuania, without its three longest rivers Nemunas (475km), Neris (234km) and Venta (161km), there are 758 rivers longer than 10 km, while in Latvia is 880 km, while in Estonia the 525 km. Not forget to mention that Nemunas, in comparison with neighboring countries, has the largest water-flowing stream in cubic kilometers per year. However, to develop hydro energy from rivers in Lithuania is quite hard due to the prevailing plains. According to experts, in Lithuania the most worthy development is for small hydropower plants, which would bring the greatest economic benefit because of the lower investment required for construction, pond design and installation [2].

Hydropower, in large scale hydro plants, main disadvantage is during the construction stages, it affects the environment in large scales – it often floods meadows and fields and destroys ecosystems. Investments needed for large scale power stations are in the range of 2\$/W [14].

E. Geothermal energy

Geothermal energy is a kind of energy that is obtained from the depths of the Earth, by radioactive processes. Geothermal energy variety of use in Lithuania as well as in the all world is quite wide - from the heat and electricity generation, to treatment, recreation, agriculture or industry.

However, worldwide geothermal resources are used not developed enough – energy produced from geothermal sources is less than 1%. The biggest producer of this type of energy worldwide is United States, Mexico and Iceland, in Europe - Italy, Turkey and Switzerland. In Lithuania geothermal resources in the most distinguished coastal region.

In the most prospective zones there are 300 million tons of hydrothermal water in Lithuania that can be used to produce energy and over 300 billion tons of water in layer deeper than 6 km [15,16].

Geothermal energy utilization in the neighboring countries, in comparison with Lithuania, is underdeveloped, because of the lack of knowledge and of studies needed for the application of this energy source.

The literature identifies the following advantages of geothermal energy: energy production is constant, energy production does not pollute the nature and geothermal energy raw materials are considered inexhaustible [13].

Anyway this energy resource has negative sides – first of all geothermal layers are very unevenly dispersed, often are difficult to access and it requires big investment. It also meets such problems as technical power operations [3,14].

Although RES has many advantages, such as it saves inexorably depleting energy sources, but it should be mentioned that it has some disadvantages, like wind turbines causes inconvenience by making noise, their visibility and landscape spoilage, large areas of land

exploitation, bird deaths caused by spinning blades of wind turbines. For example solar power plants, although they are said to be clean, but a lot of pollution is created by their production technologies, what is more it causes environmental damage by its implementation and realization [3].

While burning biomass, it emits harmful substances, but on the other hand that kind of pollution with carbon dioxide is natural process. Especially, the use of biomass emits 90% less dioxide than fossil fuels [13].

Overall, it is expected that installation and operation costs of renewable energy sources will reduce, when vast majority of consumers will understand advantages of RES, and it lets not only to protect nature, but also allows to save non-renewable sources such as coal, oil and wood.

The initial investment required for renewable energy projects are much higher comparing to fossil energy projects, as a consequence RES energy cost is higher, while its resources (solar, wind, water) is free, or less expensive than fossil fuels (biomass).

III. ASSESSMENT FEATURES OF INVESTMENTS IN RENEWABLE ENERGY SOURCES

In order to invest to RES projects it is necessary to make its analysis based on economic, social, technical and financial issues, particularly when a bank or other institutional financial assistance is needed.

There are four key characteristics that help to define the RES projects scope and its objectives [10]:

- Scope. The funding especially depends on project's scope and capacity.
- Customers. Projected customers help to identify problems and potential risk of projects revenues.
- Technology. To get easier and greater financing it is much easier while using market-proven technology then new experimental.
- Weather. RES projects mainly dependents on the weather issues. It should be a very good analysis of the country's weather conditions, in order to predict the weather, thereby reducing project risk, while increasing access to finance.

However, analysis of the RES projects must be carried out in the feasibility assessment, i.e. analyse and evaluate such items as electricity demand, technology, financial conditions, economic conditions, institutional resources, infrastructure, the risks (technical, financial and institutional), sensitivity (the viability of the selected design parameters) [2, 13].

While investing in renewable energy projects, its establishment or development, there are number of ways to assess the attractiveness of the project. The way of evaluation depends on purpose of the analysis. However, the assessment usually begins with the project capital costs, projected energy production volumes, annual revenue and expenditure.

In additional, not only financial performance, such as NPV, IRR, payback period, should be analysed, but also

great attention should be given to the ecological, social, political, technological and other benefits assessment techniques. That is why in those cases many scientists propose to apply multicriterial performance evaluation techniques that allow to gain the most efficient investment of the project and to optimize it [2, 14, 17, 18].

IV. CONCLUSIONS

The development of renewable energy resources is becoming more important every day because of the commitment with European Union, for energy independence, in order to promote innovation, reduce energy isolation and so on.

To choose the most appropriate type of renewable energy power plant it is necessary to assess the operational capabilities of the project, energy use and energy production capacity.

As RES projects are very expensive, so it is very important to get government support that requires giving clear facts and figures showing the benefits of the project.

In the case of Lithuania, almost all renewable energy sources are possible to extent, but it is very important to pay attention to power efficiency factors in individual cases.

To identify the most useful and most economically viable project there must be made a multiple criteria evaluation of the project, which encompasses economic, social, technological, environmental, political, legal aspects.

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