



# The electricity transmission and distribution network as a barrier to the development of renewable energy sources in Poland

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## ABSTRACT

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One of the major goals that Poland is aiming at nowadays is ensuring the country's energy security together with limiting harmful gas and dust emissions into the atmosphere. Therefore, the government puts a lot of pressure onto low emission economy development. This means, among other things, the necessity of consistent increase in the renewable sources energy production. Poland has a high potential with this respect, however, there are difficulties in creating the economy's output potential. The following paper is aimed to analyze synthetically the transmission grid infrastructure which is one of the most significant obstacles in the development of the country's renewable energy sources.

## 1. Introduction

Poland, while considering further economic development, the increase in innovation in industry, ensuring energy security and realizing obligations in terms of the environment protection (especially those taken with respect to the European Union regulations) needs to bring about the changes in the energy industry. One of the key elements of these changes should be increasing the supply of electrical energy generated by renewable energy sources (RES). This will make it possible to diversify the energy structure and to diminish the country's reliance upon fossil fuels, to increase the country's economic innovation (by means of research and development and investment in new technologies) and to increase employment. Due to the fact that such units are mainly of local character they are of great significance for the country's sustainable development. Moreover, local production and connected with that local consumption make it possible to limit investment and to diminish grid losses during the electricity transmission and distribution.

The development of the renewable energy sources has become one of the strategic aims of the country's economic policy presented, for example, in Polish Energy Policy until 2030 and National Action Plan for Energy from Renewable Sources.

Apart from the positive influence that RES will have onto Polish economy (including the pace of its development) their introduction constantly faces numerous barriers and obstacles which are mainly connected with:

- The number and quality of administrative regulations (regulation risk). Some of them are connected with the absence of the true competition in the given sector. However, the existence of many of them cannot be justified. Moreover, introducing new regulations is quite often postponed, there is little transparency and no analysis of the effect of introducing them, and we also face inconsistency of various executive acts and the interpretation of the law. This concerns both the functioning and support for RES. Public Procurement Law can be mentioned here as an example, as it creates problems concerning price optimization and, because of that, delays the investment process. Another example could be a very strict Building Law and environment protection regulations.
- Insufficient transmission infrastructure.

- Maintaining the state's dominant position in the energy sector. Therefore, it is subjected to the election cycle and immediate budgetary purposes (such as dividend draining of state-owned enterprises).
- Financial, social, localization and infrastructure issues.
- The purpose of the following paper is to present a synthetic analysis of the transmission grid influence onto the development of RES in Poland. It is one of the basic investment limitations into such units. Simultaneously, it is not met with sufficient interest on the part of public administration (contrary to coal or nuclear energy).

## 2. Energy from renewable sources as a significant factor of the power industry development in Poland

Technology concerning renewable energy sources is characterized by rapid development, which influences constant increase in the number of power plants of this type and the diversification of the facilities size [4]. It is both the space for investment and the number of potential investors, (nowadays households as well) that are increasing. The result is the increase in the potential energy supply.

RES are nowadays one of the most significant elements of strategy of all developed countries of the world. For that reason, the European Union has introduced so called Package Climate and Energy which is supposed to increase the share of renewable energy sources in generating energy, together with ensuring sustainable development and stimulating the EU innovation. A number of regulations which are aimed at „enforcing” or facilitating the realization of established guidelines have been introduced, the most important of which are as follows:

- Directive 2009/28 / EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77 / EC and 2003/30 / EC , Journal of Laws L 140 of 5 June 2009.
- Directive 2009/29/EC of the European Parliament and of the Council of 23 April 2009 amending Directive 2003/87/EC on the facilitation and expansion of the EU trade in greenhouse gas emissions, Journal of Laws L 140 of 5 June 2009.

- Decision 2009/406/EC of the European Parliament and the Council of 23 April 2009 regarding the efforts undertaken by the member states aimed at the reduction of greenhouse gas emissions in order to realize the EU obligations regarding the reduction of greenhouse gas emissions until 2020, Journal of Laws L 140 of 5 June 2009.
- Directive 2009/31/EC of the European Parliament and the Council of 23 April 2009 regarding geological storage of carbon dioxide and amending the Directive of the Council 85/337/EWG, Euratom, Directives of the European Parliament and the Council 2000/60/CE, 2001/80/CE, 2004/35/CE, 2006/12/CE, 2008/1/CE and Regulation (CE) No. 1013/2006, Journal of Laws L 140 of 5 June 2009.

Rational exploitation of the energy from renewable energy sources (that is river, wind, solar, geothermal or biomass energy) is one of the most significant elements of sustainable development in Poland as well.

The significance of RES results in the fact that the European Union is planning to spend 23 billion EURO on low-emission economy in the New Financial Perspective for the years 2014-2020. These resources might be spent on:

- renewable energy sources,
- decreasing the use of energy,
- intelligent energy grids.

In terms of wind power the best conditions for its use in the European Union can be found in countries located on islands, that is: Great Britain and Ireland, and in those with a long coastline, that is France, Germany, Belgium, Scandinavian countries or the Netherlands. It is also Spain that has favorable conditions in some areas (especially on the Canary Islands). Poland, situated in the north and central Europe has Poland, situated in the north and central Europe has favorable wind conditions over some part of its territory. It is true that there are no precise measurements of the wind speed in particular periods. However, according to the estimates made by the Polish Wind Energy Association, good wind conditions can be found in about 30% of the country's territory and the areas characterized by exquisite potential with this respect account for about 5% of the territory [6].

As far as photovoltaic cells are concerned the most favorable conditions can be found in the countries of Southern Europe. However, together with the technology development the profitability edge of the installation of such devices is moving more and more to the north. In theory, the potential solar radiation in Poland is estimated to be at the level of 3 – 4 GJ/m<sup>2</sup> annually. The proper conditions for the use of solar energy can be found in only 0,5% of Poland's territory.

Biomass as a resource for making energy consists of plant or animal-based materials which are biodegradable and whose use for the energy production is not limited by law. It constitutes the third in terms of size natural source of energy. In Poland the basic materials that can be used as biomass are wood, straw and biogases.

In Poland a dynamic increase in the use of biomass for electrical energy generation (especially in the process of co-combustion in high capacity coal boilers) was observed. This was due to the support system which promoted production of electrical energy from renewable sources. The real economic biomass potential in Poland is estimated to be at the level of 600 168 TJ in 2020, while the market potential is estimated to be at 533 118 TJ [7].

Due to the controversy of co-combustion as RES, Poland is currently considering the limitation of support for such installations. It is regarded that biomass should be used by small energy sources, similarly to what is happening in Denmark, Sweden or Austria, where distributed power industry is widely developed.

Proper conditions for geothermal energy can be found in over 60% of Poland's area. Polish geothermal waters have the temperature between 30°C – 120°C, which makes them especially suitable for heat energy generation.

Polish supplies of water energy are relatively small, which is due to the country's lowland character. Nowadays, large power stations (with a total power output of 5 MW and owned by large power companies) generate over 90% of electrical energy from falling water.

source type	biogas power plants	biomass power plants	solar power plants	wind power plants	water power plants	Total
year	(in MW)					
2005	32.0	189.8		83.3	852.5	1 157.5
2006	36.8	238.8		152.6	934.0	1 362.1
2007	45.7	255.4		287.9	934.8	1 523.8
2008	54.6	232.0		451.1	940.6	1 678.3
2009	70.9	252.5	0.001	724.7	945.2	1 993.2
2010	82.9	356.2	0.033	1 180.3	937.0	2 556.4
2011	103.5	409.7	1.1	1 616.4	951.4	3 082.0
2012	131.2	820.7	1.3	2 496.7	966.1	4 416.1
2013	162.2	986.9	1.9	3 389.5	970.1	5 510.7
2014	188.5	1 008.2	21.0	3 833.8	977.0	6 028.6

Source: Energy Regulatory Office.

To sum it up it might be stated that Poland has a relatively large potential as far as RES are concerned. It is estimated to be 90% of our country's energy demand. The most affluent renewable energy sources in the country are:

- geothermal energy (1,512 PJ/year),
- solar energy (1,340 PJ/year),
- biomass energy (619 PJ/year).

Moreover, Poland has also wind (43 PJ/year) and water supplies (36 PJ/year). Specificity of renewable energy sources (for example changeability resulting from different seasons or twenty-four hours' cycle) limits their use mainly to solving local and regional energy problems.

According to the forecast until 2020 RES share should be about 20%. It is definitely the wind energy that should prevail (about ¼ of all renewable sources power). However, the increase in the RES installations requires, apart from capital demand and financial support, the existence of transmission networks which will be able to take over and transmit the generated energy.

### 3. Transmission and distribution infrastructure in Poland

Energy transmission grids condition in Poland cannot be characterized as satisfactory. The most important prerequisite for the network modernization (both energy and gas) should be the life cycle of the infrastructure. Moral assets depreciation also needs to be taken into consideration. However, due to the fact that the subjects responsible neglected the standards, the majority of the transmission and distribution infrastructure is in a very bad technical condition. Most transmission lines were built in the 70s and 80s of the 20th century. Therefore the average age of the network assets for the power industry is 40 years, so it is close to the technical wear. Moreover, the infrastructure comes from the times when other technical standards were applied. The lines were not designed for such big energy transmission and for distributed generation sources.

M. Kleiber, J. Steinhoff, K. Żmijewski estimate that transmission lines are depreciated in 71%, and distribution lines – in up to 70-80%. Z. Maciejewski presents more favorable estimates, assuming 51% of technical depreciation of fixed assets for transmission networks and 59% for distribution networks. Ministry of Economy states that in the case of high voltage networks when it comes to:

- 220 kV lines: 82% is over 30 years old, 17% is between 20 and 30 years old, 1% - is less than 20 years old.
- 400 kV lines: 25% is over 30 years old, 56% is between 20 and 30 years old, 19% is less than 20 years old.

Eurostat data show that Poland is not an exception in Europe in this regard. Electrical grid in the European Union is also obsolete and the companies do not have sufficient resources for the necessary investment. Similarly to Polish grids they were also constructed for the purpose of large power plants. Apart from similar problems with depreciation of transmission infrastructure the countries of Western Europe have an advantage due to the density of transmission grids which in Poland is much lower. In Poland there are 41km of grids (similarly to Hungary) for 1000 km<sup>2</sup>. This ratio is much higher in other countries of the European Union. For example, there are:

- over 161 km in Switzerland,

TABLE 1. INSTALLED CAPACITY CONCERNING RES AS FOR 2014 (IN MW)

- 120 km in Greece,
- 100 km in Germany,
- about 90 km in France,
- 80 km in the Netherlands,
- over 70 km in Italy.

It is also Spain, Belgium, Portugal, Slovakia or the Czech Republic that have higher density of transmission grids.

Moreover, Poland suffers also from insufficient cross-border connections which do not allow for higher power transfer between Poland and other countries. There is also a quality difference. In Poland there are mainly overhead power lines, while in Europe there are often underground power lines.

One should also bear in mind that each new generation source will require building new connections, that is construction grid investments, which makes the situation of transmission grids even worse.

In Poland distributors are obliged to sign contracts with subjects applying for grid connection. It results from art. 7 sec. 1 of the Act of Energy Law of 10 April 1997 (Journal of Laws No. 89, item 625, as amended, 2006r.). Moreover, the legislator obliged the operators of transmission systems to create the instruction of traffic and exploitation of the electric grid (art. 9 sec. 1 of the Act of energy Law), which was supposed to enforce, among other things, the proper use and development planning of the electric grids considering the necessary related facilities. However, the connection dependence of the existence of suitable technical and economic conditions and the energetic company's compliance with the legal conditions for connection and load created the loophole that makes it possible not to give the permit or to protract the connection procedure. This happens especially with respect to RES.

Therefore, it is necessary to implement the investment strategy regarding energy grids. It should apply to both high voltage grids 400 kV and 220 kV, and also 15 kV and 230 V grids (that is medium and low voltage grids) and regard trans-border connections, loop closures and creating rings around large cities in order to ensure the proper quality of electric energy (especially for business). While operating investments one should consider the integration of transmission and distribution grids at the international, national and local level [8]. The strategy should also take into consideration the issue of connecting distributed energy sources, including RES.

In order to improve the situation at least PLN 200 billion should be invested in energy industry up to 2030. This cannot be done instantaneously due to high costs and the technological process. Other requirements are as follows:

- Finding solutions to the financing sources problems. Although the rate is constructed in such a way that it is the receiver who pays for the investment, but the needed resources are so high that it would involve increasing the prices to the level impossible to accept by households (due to low income level) and businesses that would suffer from lower price competitiveness (that is the fundamental factor). Capital market due to the risk cannot provide such high financing at the acceptable price. The solution could be allocating some of the European funds connected with RES for building the connections.
- Changes in law. Firstly, so called transmission corridor act regulating the process of establishing the ancillary nature of transmission and introducing parametric system of payment to the owners of property through which transmission corridors go needs to be introduced.

Moreover, the changes in Building Law, environmental conditioning and streamlining of planning processes are necessary. Nowadays, acquiring a building permit can take even 12 years, and the building process itself – 25 or more years. That is why the average time of building a complex transmission grid is 7-15 years.

- Beginning of a real restructuring process of the companies dealing with energy distribution. The present overstaffing and high operation costs result in frittering away the resources and have unfavorable effect onto the quality and the size of the infrastructure.

While taking into consideration long-term country development and making a good use of the advantages of renewable energy sources we need to eliminate the major barriers in this sector's development, including those connected with transmission and distribution grids. However, one needs to bear in mind that even if we succeed in eliminating the barriers we will need to wait for the results for the next 25 years.

#### 4. Conclusions

As far as RES are concerned, Poland has a large unused potential. As the extension of the existing infrastructure requires a lot of time and is very costly it needs to be dealt with immediately. It is necessary to use the money from the next EU financial perspective and spend it on transmission lines and changes in law. The introduction of corridor act and changes in law connected with the environment also need special attention. It does not, however, concern diminishing the harshness of the existing law and neglecting the environment protection, but it is about eliminating pathology, such as blocking the investment by pseudo ecological organizations. Without those changes which should be implemented immediately the RES development will be stopped and the energy security of the country can be endangered. This will also influence the pace of the country's economic development.

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