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Research article

The renewable energies as a vector of growth in Poland?

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Abstract

Under the EU climate-energy package (the so-called "3x20%," i.e. reducing greenhouse gases emission by 20% of 1990 levels, reducing energy consumption by 20% of the projected 2020 levels and increasing the share of renewable sources of energy to 20% of total energy generation, including an increase in the use of renewables in transport to 10%), Poland is committed to reduce its greenhouse gas emissions by 14% in 2020 compared to its 2005 level, and to increase the RES (Renewable Energy Sources) to a level of 15% in the Polish finale energy use. Between its interest to maintain its energy independence thanks to its coal resources which generate 93% of the Polish electricity and the requirement to implement the European priorities, the Polish energy sector is facing a several drastic challenges. The main aim of this paper is to assess if the renewable energies can be a real vector of growth in Poland and which parameters have to be fulfilled in the next decade to diversify the Polish energy mixt as well as to respond to the European requirements. The paper focuses on the electricity market and shows that the renewable energy sources, generally, and the wind power, particularly, can play a role in the Polish growth, The research is based on the data and performance of Polish energy sector, the European energy package, the theoretical approaches underlining social costs, the availability of the European funds to promote renewable energies. By presenting the current Polish climate-energetic situation and taking into consideration the theory of social costs, the challenges that the Polish electricity production sector will have to face on, the paper concludes that the wind technology can impact positively the Polish growth and competitiveness in a 2020 perspective.

Keywords: renewable energies, environment and growth, natural resources, energy.

JEL codes: P28, Q20,Q42, Q52

Introduction

The first section will present the current climate-energetics situation of Poland. Then the second section will show the challenges the Polish electricity production sector will have to face, taking into consideration the theory of social costs. Finally, we will analyse how the wind technology can impact positively the Polish growth and competitiveness in a 2020 perspective.

Section 1: a low carbon economy in Poland? – How the EU climate-energy policy influences the Polish policy.

Poland committed itself to reducing greenhouse gas emissions by ratifying the Kyoto Protocol in 2002 and by participating in the European Union's climate policy. These obligations impact on many areas of the Polish policy, including in the sphere of environmental, energy and economic policy. The EU law has a particular binding impact on all Member States. This concerns particularly the EU regulation known as Energy and Climate Package (ECP) which was negotiated in 2008 and gradually introduced into the EU legal order. It has a stronger impact in Poland than the United Nations Framework Convention on Climate Change, adopted in Kyoto. In matter of environment protection, the EU law is stronger than other international obligations. Furthermore, the ECP introduces much stricter requirements for reducing greenhouse gas emissions and imposes higher costs on the adjustment of the Polish energy sector and other sectors of Polish economy to reach the requirements of EU law[1]. The EU's Energy and Climate Package is based on 3 points:

- A reduction in EU greenhouse gas emissions of at least 20% below 1990 levels,
- 20% of EU energy consumption to come from renewable resources,
- A 20% reduction in primary energy use compared with projected levels, to be achieved by improving energy efficiency.

The fulfillment of the EU's Energy and Climate package is particularly difficult to reach in Poland[2]. Several factors can explain the Polish specificity.

1.1 / The obsolescence of the Polish infrastructure

Firstly, experts' estimations[3] show that approximately 40% of the energy power units installed have more than 40 years, 15% are over 50 years and 70% is over 30 years old. Spoilage exceeds 73% for power centrals, 71% for transmission network, 75% for distribution network, and damage for heating energy is higher than 63%. The poor level of infrastructure is widening steadily due to lack of preventive actions in matter of privatization of the energy's sector either of public and commercial investments during the last recent years. The Polish government estimates that in the coming years, it will be necessary to double the capacity of existing utilities. Modernization investments and new capacities should reach 86 billion złoty (around 21.5 billion €) by 2015 and 49 billion złoty added (around 12.2 billion €) by 2030. Without this necessary investment, an energy deficit already appeared in 2011. (graph 1)

Graph 1: *the estimated Polish energy deficit*

Source: *Polska 2030*, Kancelaria Prezesa Rady Ministrów, Warszawa 2009, p. 180.

[1] Społeczna Rada Narodowego Programu Redukcji Emisji, *Zielona Księga Narodowego Programu Redukcji Emisji Gazów Cieplarnianych*, , Warszawa 2010, s. 29; McKinsey&Company, *Ocena potencjału redukcji emisji gazów cieplarnianych w Polsce o roku 2030*, , Warszawa 2009; International Energy Agency, OECD, *Energy and CO2 emissions scenarios of Poland*, 2010; World Bank, *Transition to a Low-emissions Economy in Poland*, Washington 2011; K.Żmijewski: *Zagrożenie problemem carbon leakage w Polsce*, Instytut im. E.Kwiatkowskiego, Warszawa 2011.

[2] Grosse T.G. (2011), *Analizy natolińskie*, Polityka energetyczno-klimatyczna - Pominięte wyzwanie dla polskiej prezydencji w UE, 2 (50) 2011, Centrum Europejski Natolin, Warszawa.

[3] *Zielona Księga Narodowego Programu Redukcji Emisji Gazów Cieplarnianych*, p. 32–35. (*Green book of the National Program for greenhouse gas emission's reduction*). Source: http://www.rada-npre.pl/; Institute for Public Policy Research, *Europe's next economy, The benefits of and barriers to the low carbon transition*, London, May 2012, p.39.

Moreover, spoilage of energy infrastructure means that the potential emission reductions in Poland until 2020 will be only 3% compared to 2005. The possibilities to increase the emission reductions can appear only after 2020, until conditions that needed investments will be fulfilled on time.[4]

1.2 / A production of electricity based on a very high energy intensity

Secondly, the problem of the Polish power sector is not only an exceptionally high degree of depreciation. An even greater problem is the negative rate of inefficiency or a very high energy intensity in carbon (graph 2). In addition, this applies to the entire infrastructure.

Graph 2*: intensity of energy use 2000-2009 (%)*

1.3 / A strong carbon-based economy

Thirdly, nearly 93% of energy in Poland is derived from coal and lignite (the EU average is less than 30% - Map 1). This is due to fact that Poland has relatively large natural resources of coal. This makes carbon-based economy in Poland an important issue to ensure the country's energy security. However, it is an emitting energy source, generating two times more CO2 than natural gas. That is why the implementation of the ECP is much more expensive in Poland than in other EU countries, where energy sources are based on gas (the Netherlands, Italy, Ireland, Great Britain), on nuclear (France, Belgium, Lithuania, Slovakia) or on renewable sources of energy (Austria, Latvia, Sweden, Finland). The share of renewable sources of energy (RES) in Poland in 2008 accounted for only 7.6% when the EU average was approaching at this time to 18%.[5] According to government experts, it will be difficult to achieve the objectives of ECP in this field (15% of sources of energy should be from RES in 2020). Poland is not among the largest emitters of greenhouse gases globally, but its economy is

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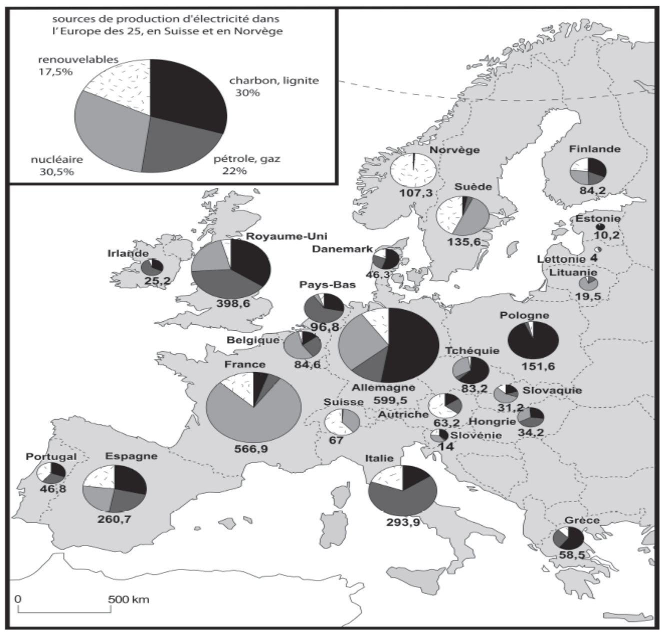
[4] Kancelaria Prezesa Rady Ministrów, , *Polska 2030,* Warszawa, 2009, p. 172.
[5] Główny Urząd Statystyczny, *Energia ze Źródeł odnawialnych w 2009 r.*, Warszawa 2010, p. 18.

among the least carbon-efficient in the EU[6]. In relation to the potential of the domestic economy (measured by purchasing power parity GDP), Poland is among the countries with the greatest needs for investments in energy and weakest possibilities for their implementation. Most countries in a such situation are new EU members from Central Europe.

Map 1 ***:*** *production of electricity in TWh (billions kWh) per sources of energy for UE-25, Norway and Switzerland*



Source : I.E.A. Energy Statistics

Source : I.E.A Energy statistics

1.4/ The influence of European policies

The process related to climate and energy policy undertaken in the European Union forces then Poland (and other Central European countries) to high adjustment costs. Those can have serious consequences on the Polish economy and its competitiveness on the EU's and global market. For example, introduction of the EU ETS[7] in the distribution of emission allowances assumes that only 10% of them will be distributed on the basis of GDP per capita[8]. This is a fundamental difference compared to the Kyoto Protocol, where the former socialist countries were partly exempted and had to reduce their greenhouse gas emissions by 6% compared to year 1988 level. According to experts, Poland reached this goal by reducing emissions by about 30% compared to the base year[9]. Climate and energy package not only introduces a higher obligation, but does not consider the reduction of

[6] World Bank, *Transition to a Low Emission Economy in Poland*, February 2011. Available on: http://web.worldbank.org/WBSITE/EXTERNAL/COUNTRIES/ECAEXT/0,,contentMDK:22839437~pagePK:146736~piPK:146830~theSitePK:258599,00.html -

[7] EU ETS : European Union Emissions Trading Scheme or System. Directive 2003/87/EC. More information on: http://ec.europa.eu/clima/policies/ets/index_en.htm

[8] For the period 2013-2020, Poland can account on only for 30 million permissions, which is less than one percent of the total number of allowances during this period. R. Jeszke, A. Błachowicz, E. Smol, P. Sikora, S. Lizak, M. Pyrka: *Wybrane aspekty wdrażania Pakietu energetyczno- klimatycznego*, p.9.

[9] Z.M. Karaczun, A. Kassenberg, M. Sobolewski: *Polityka klimatyczna Polski – wyzwanie XXI wieku*, Polski Klub Ekologiczny, p. 44.

emissions made by the post-socialist countries in the nineties. This is due to the fact that firstly the EU system of management of greenhouse gas emissions adopted the year 2005 as the reference point and secondly the EU Emissions Trading Scheme is calculated on the base of emission allowances (and the associated reduction) for the entire European Union. For the period 2013-2020, Poland is among the countries benefiting of the legal derogation regarding payable emission allowances. Poland will receive up to 70% free emissions allowances in 2013, gradually decreasing in subsequent years. It will probably weaken the increase process of energy prices for industry and consumers. But in the same time, the European Commission presses on Poland to use as little as possible those free emissions allowances[10]. Poland could be then interested by the derogation in additional investment in CCS (carbon capture and storage), under pressure of European Commission. But it should be noted that CO2 carbon capture and storage technology may not be safe for the environment in the event of leakage of stored gas[11]. It is also very expensive[12], which discourages potential investors. Paradoxically, a more rational attitude is to buy emission allowances. CCS technology can be operated if associated with a significant increase in energy consumption and a decrease of productivity. An additional problem is the early stage of development of this technology. In conclusion, it should be noted that the costs of ECP implementation are particularly high in countries with poorly diversified structure of energy sources and with a weak economy. In the Polish case, the needed investments are calculated on the amount of 92 billion € by 2030[13]. According to the experts from the International Energy Agency, the total costs of ECP implementation and the modernization of Polish energy infrastructure are estimated at 195 billion €[14] for the same period. Finally national experts assume even greater costs: from 265 to 320 billion €[15]. The scale of these investments is not proportional to the level of economic development. Indeed, the growing collapse of the energy infrastructure in Poland did not make successive governments to take appropriate strategic actions. This demonstrates the weakness of the long-term Polish economic policy[16].

Climate policy in Poland came under the influence of the Kyoto Protocol ratification. But it should be noted however that it did not contain a real active economic policy, because emission reductions were automatically decreased by industrial restructuring during the transformation and privatization period. This has even motivated the Polish government to adopt an ambitious target and to reduce emissions by 40% in 2020 compared with base year 1988[17]. Poland started a homogeneous planning works, which initially concentrated on the ecology sphere and later on the economy (mainly energy sector). The decisions of the Polish authorities are thus taken as a reaction to European regulations and policies. First of all, they have to implement the requirements of European policies. The primary strategic documents in the last few years were the National Development Strategy (2007-2015), the National Reform Programme (NRF) (2008-2011) and the National Strategic Reference Framework 2007-2013 (NSRF). Those two last documents were prepared under the EU's influence and on the base of political' and funds' needs. The aim of NRF was to implement the Lisbon strategy in Poland while the NSRF had to achieve the implementation of the cohesion policy.

Among the priorities, three appear as the most important: (1) development of an innovative economy, (2) infrastructure for economic competitiveness and (3) human capital. All the 3 analysed documents mention the EU' Energy and Climate Package. But they refer very generally to the objectives of a low carbon and energy development's policy. They focus on the protection of the environment, and do not really support the national economy in order to facilitate the implementation of the European policies' requirements. By reading these documents, it is difficult to speak of a "green" industrial policy or a low-carbon economic policy of the Polish government.

[10] Rzeczpospolita, *Bruksela utrudnia darmową emisję CO2*, 24.01.2011. Available on: http://www.rp.pl/artykul/599228.html
[11] A. Serzysko: *Koszty i finansowanie CCS w Polsce*, Analizy i Opinie nr 5, Centrum Stosunków Międzynarodowych, Warszawa 2009.
[12] Rzeczpospolita, *Unia uderzy w inwestycje w polskich elektrowniach*, 15.02.2011. Available on: http://www.rp.pl/artykul/612502.html
[13] McKinsey & Company, *Oce na potencjału redukcji emisji gazów cieplarnianych w Polsce do roku 2030*, Warszawa, 2009,p. 17
[14] IEA, *Energy and CO2 emissions scenarios of Poland*, p. 4. Available on: http://www.piio.pl/dok/Warsaw_24_May_PressConference_2010.pdf
[15] *Zielona Księga Narodowego Programu Redukcji Emisji Gazów Cieplarnianych*, p. 31.
[16] Klonowski D., *The Effectiveness of Government- sponsored Programs in Supporting the SME Sector in Poland*, „Post-Communist Economies", 2010, vol. 22, nr 2: 229–245
[17] Ministerstwo Środowiska, *Polityka klimatyczna Polski. Strategie redukcji emisji gazów cieplarnianych w Polsce do roku 2020*, Warszawa, dokument przyjęty przez Radę Ministrów dnia 04.11.2003 roku, p. 14.

1.6 / A lack of tradition to prepare combined policies

An additional problem is that there is no tradition in Poland to prepare policies to solve a specific problem, which simultaneously would combine the activities of several ministries. For example, there is no low-carbon industrial policy strategy, which would coordinate the activities of various ministries, and in the same time which would ensure the implementation of the most important priorities of the government's economic policy. In 2010, the Ministry of Economy published a new report named "Assumptions for a National Programme for reducing greenhouse gas emissions"[18], but this was a very general document. It was then replaced on the 16th of August 2011 by the programme called "Assumptions for a National Programme of a low carbon emissions economy"[19]. Experts point out that in Poland there has been no integration of the economic climate policies. Strategy, which indicates the greatest priorities of the government in matter of low-carbon economy, is in the document "Polish energy policy until 2030"[20]. In general, however, the policy framework to support emissions reductions and low-carbon development in Poland is relatively immature.

Section 2: the challenges and different scenarios for electricity production sector towards the RES in Poland

This section presents the main economic notion of the "social costs", and briefly introduces the role of RES and the Polish electricity sector challenges.

2.1 / The social costs or internalizing the negative external costs

2.1.1 / Definition of social costs

The notion of social costs is strictly linked to the negative externality or external effects. Arthur Cecil Pigou in 1920[21], considered as a precursor of the environmental economics, defines the externality as costs or benefits arising from an economic activity that affect somebody other than the people engaged in the economic activity and are not reflected fully in prices. We can then distinguish negative and external externalities. The externality is called positive when the effect provides an improvement in the welfare of the other agent (see the example of the beekeeper Maede[22]), and negative when the other agent sees its welfare decrease. Negative externalities (also called "external costs" or "external diseconomies") result in an outcome that is not socially optimal. From the perspective of those affected, a negative externality is a problem (pollution from a factory), or a gain (honey bees that pollinate the garden)[23]. In the first case, the person who is affected by the negative externality in the case of air pollution will see it as lowered utility: either subjective displeasure or potentially explicit costs, such as higher medical expenses. Thus, an external cost may pose an ethical or political problem. Alternatively, it might be seen as a case of poorly-defined property rights, as with, for example, pollution of bodies of water that may belong to no-one. In the second case, a person or a third party affected by a positive externality (also called "beneficial externality", "external benefit" or "external economy") can improve and increase its utility at no cost. Education, public health initiatives as well as renewable sources of energy for electricity can be considered as positive externalities on the society. The externality concept is a controversial one regarding the government or state intervention in the form of regulation in case of free market failure. In practice, it is used to characterize and formalize the problems of pollution, finding an interest in environmental economists. In our case, the production of coal-based electricity has contributed and contributes to degrade the environment and the air in Poland, which also affect the health of the population, the deterioration of the vegetation, etc. This is then a negative externality because we can easily imagine that the Poles did not choose specially (the population has to bear the political decisions) to destroy at long terms their own health to have electricity in short terms. Facing this situation, Pigou says that if a company creates negative externalities as pollution, then the social cost of production is higher than the private marginal cost of production. To return to an optimum as defined by Pareto,

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[18] Ministerstwo Gospodarki, *Założenia Narodowego Programu Redukcji Emisji Gazów Cieplarnianych*, Warszawa 2010.
[19] Ministerstwo Gospodarki, *Założenia Narodowego Programu Rozwoju Gospodarki Niskoemisyjnej,* Warszawa 2011.
[20] Ministerstwo Gospodarki, *Polityka energetyczna Polski do 2030 roku,* Warszawa 2009.
[21] Pigou, C.A, *The Economics of Welfare*, Macmillan and Co, 1920.
Available on: www.econlib.org/library/NPDBooks/Pigou/pgEW.html
[22] Meade J. E., *External Economies and Diseconomies in a Competitive Situation*, The Economic Journal, Vol. 62, No. 245, 1952, pp. 54-67
[23] Ibidem

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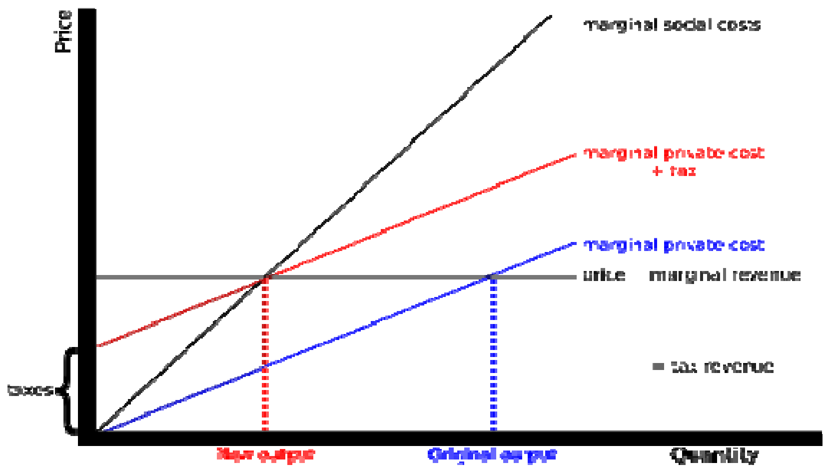
the gap between private and social cost has to be filled thanks to a state intervention, which would sanction the economic agent who caused the negative externality. By integrating the social cost not included in the initial calculation, the state is then internalizing the negative external cost. That's what the graphic 4 shows.

Graph 4: *Illustrated and adapted graph of the marginal social and private costs*



Source : Pigou, C.A, *The Economics of Welfare - Appendix III A Mathematical and Diagrammatic Treatment of Certain Problems of Competition and Monopoly*, 1920

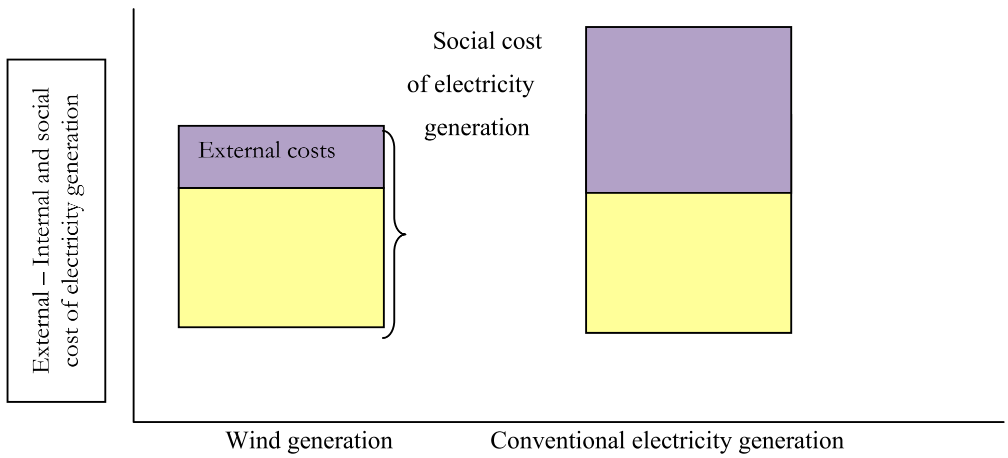
Foreshadowing of the economy of the environment, it creates the notion of "polluter pays" well known later in the form of so-called **Pigouvian tax.** The state intervention would then correct market imperfections. This approach is very strongly criticized by classical and liberal's economists, including Ronald Coase[24] whose theorem, initially mentionned by G.Stigler in 1966[25], is the following: "if transaction costs are zero and if property rights are well defined, it results in an efficient allocation." The market can regulate itself and there is no need of State intervention. In 1963, K.William Kapp[26] critized also Pigou and gave us another definition of the social costs that share of the total costs of production that is not born by producers but is shifted to 3[rd] parties, future generations or society at large. Kapp rejected Pigou's confusing terminology of externalities and supports the assumption that social costs are systemic and an enormous problem of modern civilization. In the reality, it's very difficult and even impossible to internalize the social costs which have to be considered more than accidental minor aberration from the "optimal norm" that can be fixed by ad hoc measures. Finally, the European Commission in 1994 developed the following generic definition "*benefits and costs which arise when the social or economic activities of one group of people have an impact on another, and when the first group fails to fully accounts for their impacts*"[27]-[28] (European Commision, 1995).

[24] Coase R-H, *The problem of social cost*, Journal of Law and Economics (October 1960)
[25] Coase accepted the paternity of this theorem stated by Reference G.Stigler in his book "The problem of social cost"
[26] K.W.Kapp, *Social Costs of Business Enterprise*, Asia Publishing House, 1963 – French version published in 1976, *Les coûts sociaux dans l'économie de marché*, Flammarion, p.49-54
[27] European Commission (1995): *ExternE Externalities of Energy. Vol. I-IX.;* European Commission, DG Environment, *A Study on the Economic Valuation of Environmental Externalities from Landfill Disposal and Incineration of Waste, Final Main Report,* October 2000, p.ii.
Available on: http://ec.europa.eu/environment/waste/studies/pdf/econ_eva_landfill_report.pdf
[28] The most noted project on determining the external cost of energy is the ExternE (Externalities of Energy) project, which attempted to develop a consistent methodology to assess the externalities of electricity generation technologies. Extern methodology is a bottom-up approach.

2.1.2 / The impact of social costs on the production of electricity

Analysing external costs is not an easy task. Science (to understand the nature of the impacts) and economics (to value the impacts) must work together to create analytical approaches and methodologies, producing results upon which policymakers can base their decisions for appropriate measures and policies. Subsequently, the question arises whether the internalisation of externalities in the pricing mechanism could impact on the competitive situation of different electricity generation technologies, fuels or energy sources. As graph 5 illustrates, a substantial difference in the external costs of two competing electricity generating technologies may result in a situation where the least-cost technology (where only internal costs are considered) may turn out to be the highest-cost solution to society if all costs (internal and external) are taken into account.

***Graph 5**: Social Cost of Electricity Generation*[29]



Source: Auer et al. (2007)

It is difficult to determine correctly the external costs related to feeding and utilization of energy. For simplicity, we classify them into three broad categories:

- Costs hidden by the government (for example, hidden subsidy in the case of the French nuclear industry where the state would offset the direct and indirect damages of any serious accident. This transfer of responsibility is not compensated by an insurance premium or a tax, and therefore nuclear energy has a hidden subsidy)

- Costs of damages created to health and environment due to GHG emissions

- Costs of global warming due to CO_2 emissions

[29] Auer, Obersteiner, C., Pruggler, W., Weissensteiner, L., Faber, Y., Resch, G., *Action Plan, Guiding a Least Cost Grid Integration of RES-Electricity in an extended Europe*, 2007

Table 1 *: external costs caused by the production of electricity*

Local costs	*Global costs*
Deposit of dirt or soot	Damages du to acid rain
Sun obscured by smoke	Damages to trees and crops
Noise of power plant, coal handling	Damages to buildings
Noise du to supply of fuel	Damages to human health
Discharges in rivers	Damages to fisheries
Accidents in power plants, human costs	Damages to animals
Bad smells	Fuel spill – cleaning costs
Dust and smoke	Accident in the elimination of ash
Deposit of heavy metals	Deposit of heavy metals
Maintenance of emergency evacuation procedures (nuclear)	Leakage of radioactive wastes (nuclear)

Source : Les Energies renouvelables pour la production d'electricite[30]

External costs have been already studied several times and can be estimated according the type of energy, with more or less significant impact according the selected categories. The table 2 summarizes and compares value of different external costs.

Table 2*: Estimation of external costs in Euro cents / kWh for production of electricity*

Category	*Coal*	*Fuel*	*Gas*	*Nuclear*	*Wind*
Human wealth and accidents	0.7 - 4	0.7 - 4.8	0.1 - 0.2	0.03	0.04
Forest and cultures	0.07 - 1.5	1.6	0.08	Low	0.08
Buildings	0.15 -5	0.2 - 5	0.05 - 0.18	Low	0.1-0.33
Disasters	-	-	-	0.11-2.5	-
Total of damages	0.7 - 6	0.7 - 6	0.03 - 0.7	0.2 - 2.5	0.2 - 0.5
Estimation of global warming	0.05-24	0.5-1.3	0.3-0.7	0.020	0.018
Total amount (€/kWh)	**1.7 - 40.5**	**3.7-18.7**	**0.83-1.86**	**0.36-5.05**	**0.4-1.0**

Source : Les Energies renouvelables pour la production d'electricite[31]

Those external costs should be added to costs of production of electricity. In calculating the cost of production of electricity (CpE) expressed in €/kWh, we should take into account :

- The cost of capital (Cc) : it includes the installation and acquisition of land (except in the case of an annuity where it is considered as a cost of operation), the main connections and the initial financial costs. - The costs of operation and maintenance (Com) consisting of the payment of labor and equipment expenses required for plant's maintenance, including assurance, annuities and local taxes to pay for local authorities.
- The price of fuel (Cf).

[30] Freris L, Infield D., *Les Energies Renouvelables pour la production d'electricite*, Dunod, Paris, 2009, p.230
[31] Ibidem, p.232

- The cost of CO2 emissions (as given by the European Trading System for CO2, ETS). We can write : CpE = Cc+Com+Cf+Ce+ETS

This indicative cost depends on the type of energy and its own performances. The table 3 presents the current situation.

Table 3: *indicative costs and comparative data related to different sources of energy*

Technologies	***Wind onshore***	***Wind offshore***	***Gas***	***Coal***	***Nuclear***
Costs of capital Capex (€/kWh) – Cc **(A)**	1 000 – 1 500	1 500 – 2 000	450 – 1 300	1 000 – 1 100	1 700 – 2 300
Cost of maintenance (cents €/kWh) – Com **(B)**	0.9 – 1.5	1.5 - 3	0.3 – 0.8	0.8 – 1.5	0.5 – 1.2
Rate of inefficiency **(Rie) (%)(C)**	50-80% *(65%)*	60-70% *(65%)*	10-30% *(20%)*	20-25% *(22.5%)*	10-15% *(12.5%)*
Price of fuel – Cf (cents €/kWh) **(D)**	0	0	2.3-3	1.5-2.3	0.6-1.1
External costs – Ce (E)	0.4-1	0.4-1	0.83-1.86	1.7-40.5	0.36-5.05
F = B+D	**0.9 – 1.5**	**1.5-3**	**2.6 – 2.66**	**2.3 – 3.8**	**1.1 – 2.3**
G = F pondered by the average of Rie (C)[32]	**1.49 – 2.48**	**2.48 – 4.95**	**3.12 – 3.19**	**2.82 – 4.66**	**1.24 – 2.59**
Average G	**1.99**	**3,72**	**3.16**	**3.74**	**1.92**
H = B+D+E	1.3 – 2.5	1.9 - 4	3.43 – 5.66	4 – 44.3	1.46 – 7.35
I = H pondered by the average of Rie (C)	**2.15 – 4.13**	**3.14 – 6.6**	**3.95 – 6.51**	**4.9 – 54.27**	**1.64 – 8.27**
Average I	**3.14**	**4.87**	**5.23**	**29.57**	**4.96**
Cost of CO2 (cents €/kWh)	0	0	0.0053	0.01	0
C02 emissions (t/kWh)	0	0	350	700	0

Source : Les Energies renouvelables pour la production d'electricite[33] - adapted by the author

The costs for CO2 emissions was not included in the case of electricity production based on coal or gas, as the impact is not significant due to very low price of EU-ETS and free allowances in Poland. This should change and will impact even more negatively the electricity production based on coal and gas. This table shows that:

a) the price per kWh is very favorable to nuclear and gas if the external costs are excluded from the costs of production of electricity (average G). The capital for wind power is higher than for thermic power plant but cheaper than for nuclear while its energy efficiency is relatively low (35%) compared to nuclear (88%), gas (80%) or coal (78%).

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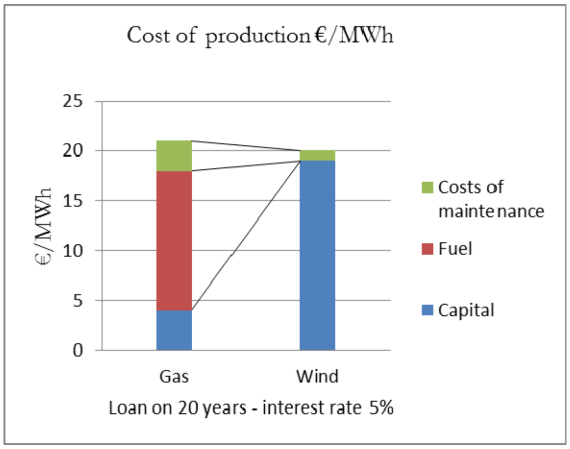
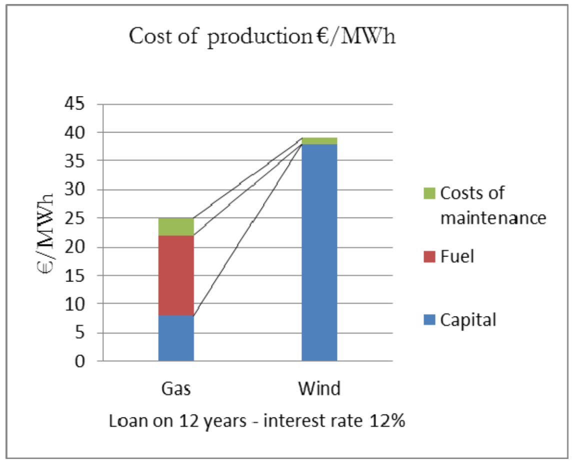
32 [(1 +(X Rie)) * lower total cost or higher total cost]
33 Ibidem, p.218

b) if external social and environmental costs are taken into consideration into the costs of production of electricity (average I), the costs of production of electricity based on coal is then prohibitive, while wind power becomes the most competitive source of energy.

c) the capital CAPEX , which is not taken into consideration in the analysis, is a key factor depending on whether interest rates are low or high and the loan's duration is short or long. We can illustrate the assumption as follows :

Graph 6 *: impact of financing conditions on cost of electricity production*





Source : *Les Energies renouvelables pour la production d'electricite*[34]

Depending on the duration of loan and the interest rate, the wind power can be competitive or not compared to other technologies (graph 6). That's why the Polish preferential loan programmes offered by the National Environmental Protection and Water Management Fund (NFOŚiGW) or its regional subsidiaries are very important. The aid is granted in the form of a preferential loan that can be written off under certain conditions. The loan amount may range from 4 million PLN to 50 million PLN, and it may cover as much as 75% of the eligible investment costs. The interest on the loan is variable and it amounts to WIBOR 3M + 50 base points. The loan term is up to 15 years starting from the first disbursement of funds.

2.2 / Challenges for the Polish electricity production and the role of RES

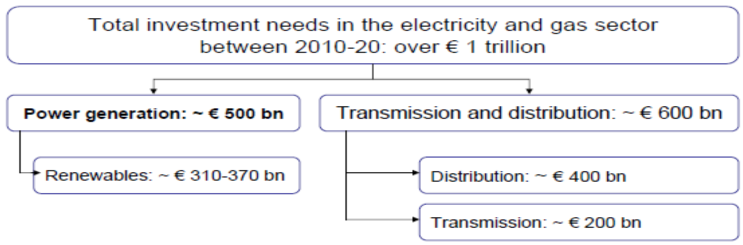
If we already mentioned some challenges in the first section mainly linked to the past of Poland, several others can be mentioned for the Polish electricity sector, making the situation quite complex. Those can be politics or techno-economics. They can be linked to a process intern or semi-extern to Poland.

2.2.1 / Investments needed and how to finance them

Globally, in EU an amount of 1 trillion euros will be needed for the period 2010-2020 to replace obsolete power plants, to modernize and adapt infrastructure to the latest technologies and to cater for demand for low carbon energy. For renewable sources of energy, a budget of around 350 billions euros will be needed to reach the European climate and energy package goals.

34 Ibidem, p.221

Graph 7*: total European investments needs in the electricity and gas sector for 2010-2020*



Source: Background on energy in Europe – European Council of the 4 February 2011 – Commission calculations

At the Polish level, according the Poland's alternative energy policy until 2030, "*the total investments in electricity networks by 2020 can be estimated at about EUR 11 billion. This represents about 1/3 of the investments in the production capacity in this period. About EUR 3 billion of the systemic costs of the promotion of energy efficiency should be added to this. Hence, the total amount needed for investments in 2010–2020 to ensure the safe functioning of the electricity sector is about EUR 50 billion, representing about EUR 5 billion/year – without capital costs. A similar amount will have to be invested in 2020–2030. As a total, in 2010–2030 investments at a level of EUR 103 billon will be necessary, including EUR 67 billion worth investments in plants, EUR 22 billion worth of network investments and at least in EUR 14 billion worth investments in the efficiency of the entire system, primarily on the use side. The financial costs should be added to these costs, depending on the adopted financing model and the market-based capital costs. It should be emphasized that with debt-based financing the financial costs will exceed 100% of the investment costs even when the credit interest rate falls to 6% in the nearest years."*[35](Polish Institute of Sustainable Development, 2009). Additionally, the underdevelopment of the transmission network and the 110kV distribution networks is now the major barrier to the development of dispersed generation facilities, particularly those using wind. The right of access to the network has become subject to commercial trading. As indicated by the data of PSE-Operator, the achievement of the target 15% share of RES in the national electricity balance would require the construction of about 1,220 km of transmission lines and at least 5 new extra high voltage stations. The estimated cost of these investment projects is about PLN 3.3 billion.[36] Considering that the Operational Program for Infrastructure and Environment for 2007-2013 reaches 37.7 billion euro (28.3 billion euro from the European structural funds and 9.4 billion from national contribution)[37] and that only 3.096 billion euro are really dedicated to the energy efficiency and diversification of energy sources[38], we can just confirm that the modernization of the Polish electricity sector will be very difficult and will take more time than the EU or even than the Polish government would like. It will be an economic challenge but also and mainly a question of civilization's choice to which lot of Poles are opened but are not still prepared to pay for.

2.2.2 / Still no legal framework for the RES - Implementation of the directive 2009/28/EC

Till today, the law in force for the energy sector is the energy law of the 10 April 1997, which also applies to the RES development.[39] In April 2009, the new directive 2009/28/EC on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC[40] and 2003/30/EC[41] was

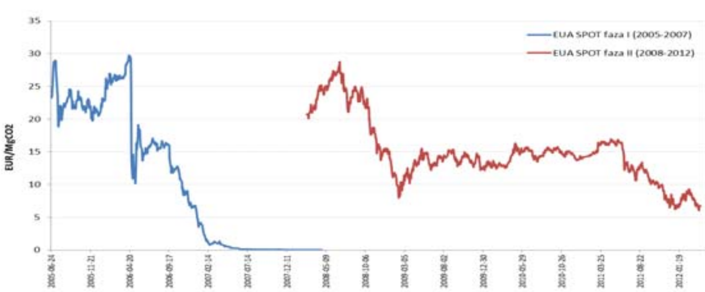
[35] Instytut na rzecz ekorozwoju, *Poland's alternative energy policy until 2030 (AEP) – Final report*, Warsaw, December 2009, p.44.
[36] Ibidem – 3.3 billions PLN =
[37] Data available on http://www.pois.gov.pl/WstepDoFunduszyEuropejskich/Strony/o_pois.aspx
[38] Operational Program for Infrastructure and Environment – Priority 9: *Energy infrastructure and energy efficiency* - 1 403.0 million (EUR 748.0 million including the Cohesion Fund); Priority 10: *Energy security, including diversification of energy sources* - 1 693.2 million (including EUR 974.3 million from the European Regional Development Fund);
[39] Energy law (10.04.1997) - Dz.U. 2006 r. Nr 89, poz. 625 and modifications
[40] OJ L283 - 27/10/2001- promotion of electricity from renewable energy sources in the internal electricity market.

voted by the European Parliament and the Council. If the Polish government submitted on time its National Renewable Energy Action Plan (NREAP)[42] according the article 4-paragraphe 2, there is strongly delay to transpose it into the Polish law. According article 27, all Member States had to the 5th of December 2010 to transpose the directive at a national level. The first law's project was submitted to the civil society by the Ministry of Economy only in December 2011, jeopardizing strongly the Polish credibility and effigy towards the other Member States but causing also an internal controversy during the 1st semester 2012.[43] In July 2012, the Ministry of Economy published a second edition, better than the previous one, but still criticized mainly by actors of the renewable energy market.[44] Even if the new law will help to adjust the level of support for the technology to its cost and its expected change in time and will reduce support for the co-incineration, a risk can come from the proposal to remove the replacement fee. That's why it should be important to create a level statutory mechanism that allows adjusting the value of future replacement fee to current market conditions and macroeconomic situation. Indeed, the delay of more than two years to transpose the European Directive to the Polish law is considered as one of the main causes of the low share of the RES in the production of electric energy in Poland. The Ministry of Economy clearly wants to bring it into force by the 01st January 2013. The lack of clear rules and government intervention, at least at the beginning, is clearly a handicap for making play investors on the RES's market. The slower the transposing process will be into the Polish legislation, the more expensive it will cost to Poland in the near future.

2.2.3 / The influence of EU ETS on the electricity prices

The basic legal regulation for the EU ETS is the Kyoto Protocol (1997), ratified by 141 countries, which entered into force on 16 February 2005. Year 2011 is the fourth year of trading in CO2 emissions under the second phase of the Kyoto Protocol. Interdependence of electricity prices and of CO2 emissions is observed despite the fact that in the current situation the EU ETS has excessed allowances which were granted in free allocation system. (for example, the correlation coefficient from BASE Y-12 with SPOT EUA[45] (BlueNext)[46] is approximately 0.7, whereas the German BASE Y-13-13 and EUADEC are correlated more than 94%). This situation indicates a high probability of increasing the dependency in a situation of allowances' deficit and increase weight of the auction system.

Graph 8: *Prices of CO2 emissions allowances on the market SPOT (BLUENEXT) for the period 2005-2012 (phase 1: 2005-2007 – phase 2; 2008-2012)*



Source : Towarzystwo obrotu energią (*Rynek Energii Elektrycznej w Polsce)* – 31.03.2012

41 OJ L 123, 17.5.2003 - promotion of the use of biofuels or other renewable fuels for transport: the Directive sets a target of 5.75% of biofuels of all petrol and diesel for transport placed on the market by 31 December 2010
42 Available for each Member States on: http://ec.europa.eu/energy/renewables/action_plan_en.htm
43 Newspaper Gazeta Prawna, *Projekt ustawy o odnawialnych źródłach energii niejasny i z błędami,* 23/01/2012
44 Newspaper Gazeta Prawna, *Eksperci o projekcie ustawy o OZE: Dobra dla energetyki odnawialnej, ale...*, 13/08/2012 ; *Kilian: Projekt ustawy o odnawialnych źródłach energii do poprawki*, 10/08/2012.
45 EUA = European Union Allowance is a permit to emit one metric tonne of CO2 under the European Union Emission Trading Scheme (EU ETS). EU ETS is the first international trading system for CO2 emissions. National Allocation Plans (NAPs) determine the total quantity of EUAs that Member States grant to their companies, which can then be sold or bought by the companies themselves.
46 BlueNext : BlueNext is the world's leading environmental trading exchange. It was founded by NYSE Euronext and Caisse des Depots, in December 2007. In 2010, CDC Climat, took over CDC's shareholding in BlueNext.

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Available online www.ajeepr.com

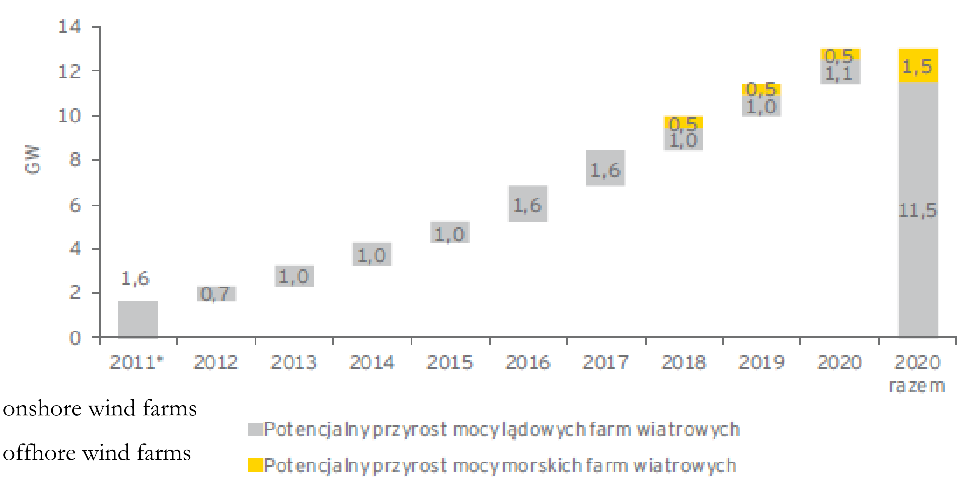
Despite significant development of renewable energy sources according the 2010 targets, in the perspective of the next few years the Polish energy mix will undergo a significant change, which will induce after 2012 an increase of electricity prices due to the purchase of additional CO2 emission allowances at a price strongly dependent on EU's action and regulation. The impact of CO2 emission allowances' market on the Polish electricity market should be considered as strong in terms of price correlation. In the next few years, this impact will be increasingly shaped the level of market prices due to the declining number of free allowances for CO2 emissions (see section 1).

As saw in the 2nd section, markets do not include external effects or their costs. It is therefore important to identify the external effects of different energy systems and then to monetize the related external costs. It is then possible to compare the external costs with the internal costs of energy, and to compare competing energy systems, such as conventional electricity generation technologies and wind energy. As markets do not intrinsically internalize external costs, internalization has to be achieved by adequate policy measures, such as taxes or adjusted electricity rates. Before such measures can be taken, policy-makers need to be informed about the existence and the extent of external costs of different energy systems.

Section 3: the wind farms as a potential of growth in Poland in a 2020 perspective

This section focuses on the wind power for several reasons. First of all, Poland has an interesting potential in wind (see map in annex 1), mainly on the Baltic coast and inside the country. Secondly, other technologies are not developed on the market (geothermal or solar with few perspectives due to geographical and technical reasons), are very controversial (nuclear and its consequences after Chernobyl and Fukushima) or are already quite developed as biomass. Finally, wind power presents a learning curve[47] which allows to think that the technical potential is real, which will impact positively (decrease) the price of turbines (capital costs) and installation . It will let this technology be more competitive.
Based on the forecasts made by the Institute for Renewable Energy on the request of the Polish Wind Energy Association in 2009, it's possible that wind farms with a total capacity of about 13 GW will be installed in Poland till 2020. 1.5 GW should come from offshore wind farms and 115 GW from onshore wind farms.(Graph 9)

Graph 9 *: the potential growth of wind power in Poland 2011-2020*



Potential growth of onshore wind farms

Potential growth of offhore wind farms

** Dane historyczne.*

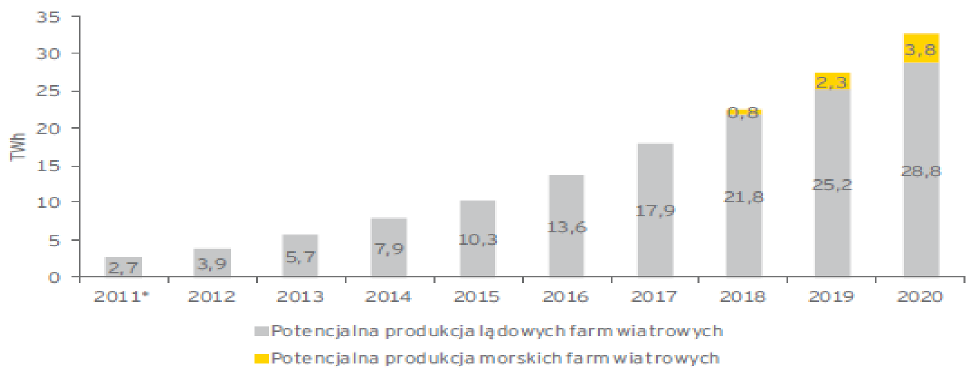
Źródło: Opracowanie własne na podstawie: Wizja rozwoju energetyki wiatrowej w Polsce do 2020 roku, IEO, 2009

Source: Wpływ energetyki wiatrowej na wzrost gospodarczy w Polsce, Ernst&Youg, March 2012

47 Juginger M., Faaij A, *A global experience curve of wind energy*, Copernicus Institute, Utrecht University, Netherlands. Typically, the costs of technology come down with increased experience, increased penetration of technology.

Assuming that offshore wind farms in 2020 reach capacity utilization rate of 30%, and offshore wind farms will have a ratio of at least 35%, the production of electricity coming from farms wind could reach 32.6 TWh in 2020. This is significantly more than the entire production of renewable electricity in Poland today (12.5 TWh). Detailed information regarding the assumed production of wind farms in Poland to 2020 are shown in the graph 10.

Graph 10 *: projected annual electricity production from wind farms in Poland 2011-2020*



* Dane historyczne.
Źródło: Opracowanie własne

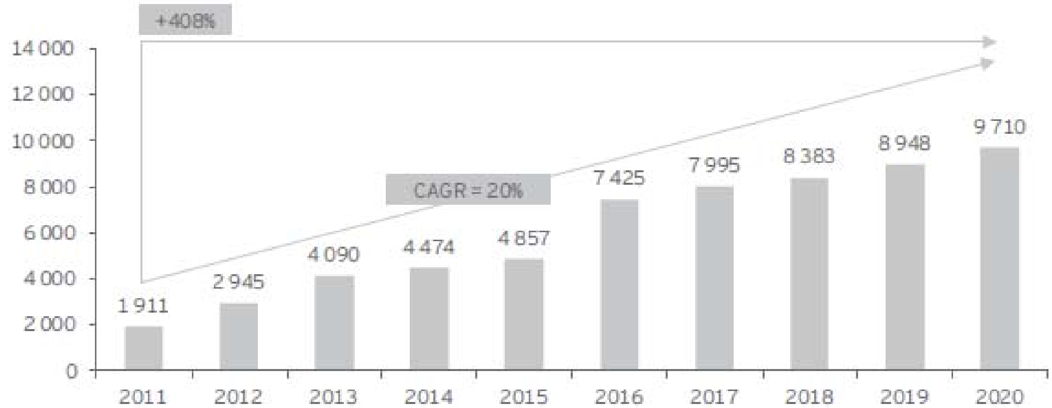
Source: Wpływ energetyki wiatrowej na wzrost gospodarczy w Polsce, Ernst&Youg, March 2012

At present time, more than 860 turbines are installed in Poland with a total capacity of 1616 MW at the end of 2011. Turbines operate in 118 installations of wind farms, which means that a wind farm operates an average of 7 wind turbines. However, more than half has a capacity equal to or less than 5MW. The biggest turbines operating in Poland are 3 megawatt Vestas turbines, operating in three locations: Karcinie (near Kołobrzeg on the Baltic coast), Pągowie (near Namysłow in Opole voivodeship) and Gołdap / Wronki (close to the border with Kalinigrad in Warmian-Masurian voivodeship).
As we will see in this section, the impact of investments in wind farms on the national economy are positive at different levels.

3.1 / The impact of wind energy on the labor market

Currently, the wind energy sector in Poland does not belong to the industries with significant impact on the labor market. Although there are no accurate data on actual jobs created by this area. However, depending on the method used, the number of direct jobs is estimated to be around 1 700 – 2 000 (1.1-1.3% of people employed in the energy sector). Added, there are no companies in Poland involved in the production of turbines or wind towers as in countries which are leader in this field (mainly Spain, Germany, Denmark). This mean that the vast majority of jobs (over 80%) which may arise due to the development of wind energy is not reflected in its full-time jobs actually created in Poland. The graph 11 shows the potential of job creation based on the methodology of the European Wind Energy Association (EWEA).

Graph 11 *: Estimated number of jobs in the wind energy sector 2011-2020*

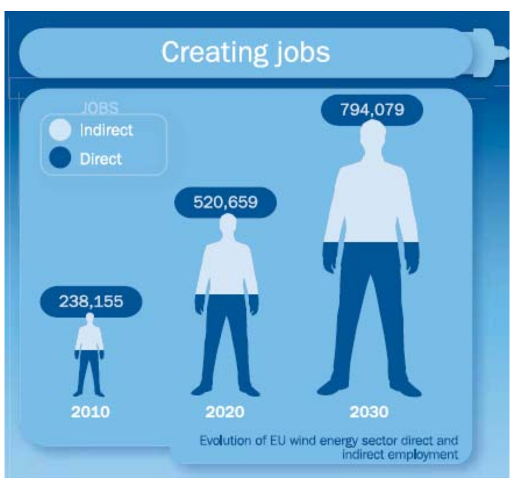


Source: Wpływ energetyki wiatrowej na wzrost gospodarczy w Polsce, Ernst&Youg, March 2012

The EWEA methodology is based on the following assumptions:

- full recognition of other direct jobs associated with the wind industry (1.3Full Time Equivalent (FTE)/ MW annual capacity growth)
- creation of jobs in the maintenance and services of wind farms (0.33FTE/ MW cumulative power) and full recognition of other direct jobs associated to the maintenance and services of wind farms (0.07FTE/MW cumulative power)
- the creation of 50% of potential jobs in the installation of wind turbines (0.6 FTE / MW annual capacity growth),
- creation of about 13% of the direct jobs at the production of wind farms (1FTE/MW annual capacity growth)

The number of created jobs in the wind energy sector is estimated in 2011 to 1 911 jobs and will increase to approximately 9 710 full jobs in 2020, which represents an increase of 408%. At a European level, the EWEA forecasts a creation of jobs of 282 504 persons in the wind energy sector to reach 520 659 jobs in 2020 as the figure shows below.

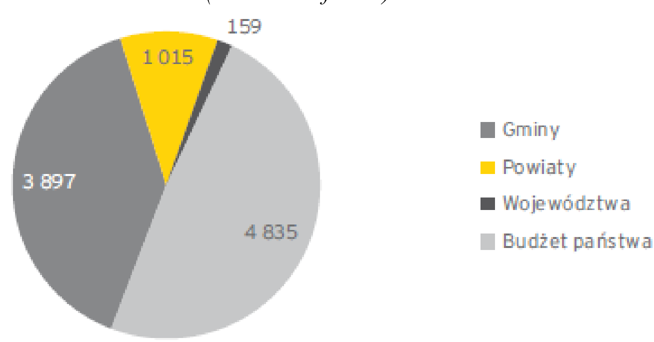


Source: The Green Growth - The impact of wind energy on jobs and the economy, EWEA, April 2012.

3.2 /The growth of income tax from persons working in the energy wind sector

The presence of companies operating the wind energy sector has also a direct positive impact on the public sector, thanks to income taxes that enter both to the state budget and to the local authorities one. Assuming that the average wage of jobs created in the wind energy sector does not differ significantly from the average wage of the energy sector (according the Central Statistical Office in 2011 this one was 5 635 PLN per month) and the number of full-time jobs generated by the wind energy sector in 2011 was 1 911, the income tax paid in the whole year reached a total of about 10 million PLN. The greatest beneficiaries are the state (4 835 KPLN) but also the local authorities (3 897 KPLN) as the graph 12 shows.

***Graph 12**: share of income tax paid by workers of the wind energy sector according beneficiaries in 2011 (thousand of PLN)*

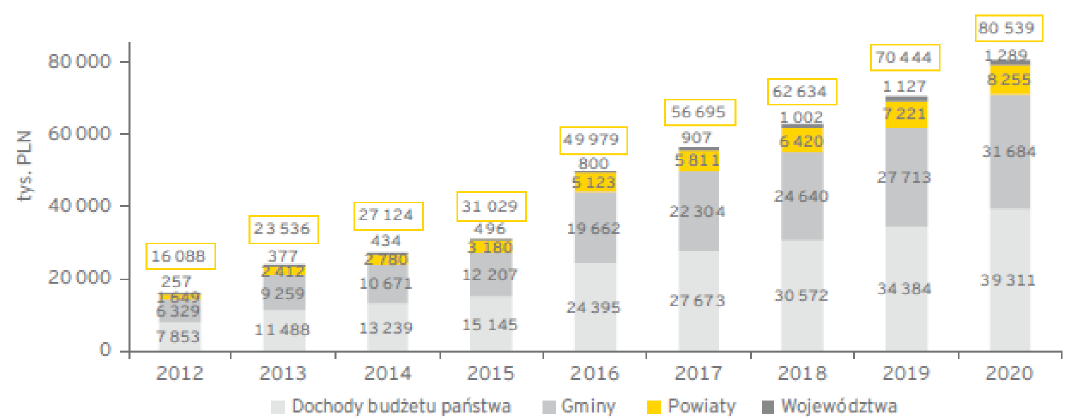


Źródło: Opracowanie własne na podstawie Ustawy o dochodach jednostek samorządu terytorialnego z 13 XI 2003 r.

Source: Wpływ energetyki wiatrowej na wzrost gospodarczy w Polsce, Ernst&Youg, March 2012

If we consider the same in a perspective 2020, we obtain results as in graph 13 and there's no doubt that the development of energy sector can be an argument to finance the Polish growth.

***Graph 13**: projection of income tax paid by workers of the wind energy sector according beneficiaries in 2012-2020 (thousand of PLN)*

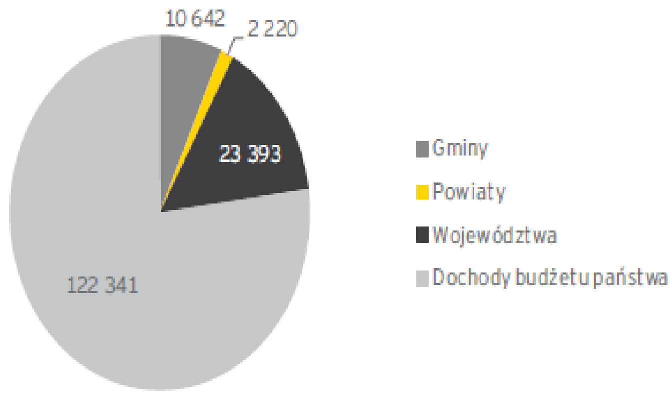


Source: Wpływ energetyki wiatrowej na wzrost gospodarczy w Polsce, Ernst&Young, March 2012

3.3 / The tax revenue on the companies involved in the wind energy sector

Another benefit from the wind energy sector is the tax revenue derived from the producers of electricity based on wind technology. According the analysis of Ernst & Young, the average value of tax revenue (CIT) per MW installed coming from the wind energy sector was estimated at 98.2 thousand PLN. In this terms, in 2011, the public sector received 158.6 million PLN from tax revenue charged on the sale of electricity produced by wind farms. Most of the benefits have been due to the state budget and the region (respectively 122.3 and 23.4 million PLN) while municipalities and counties received a total of 12.9 million PLN.(graph 14)

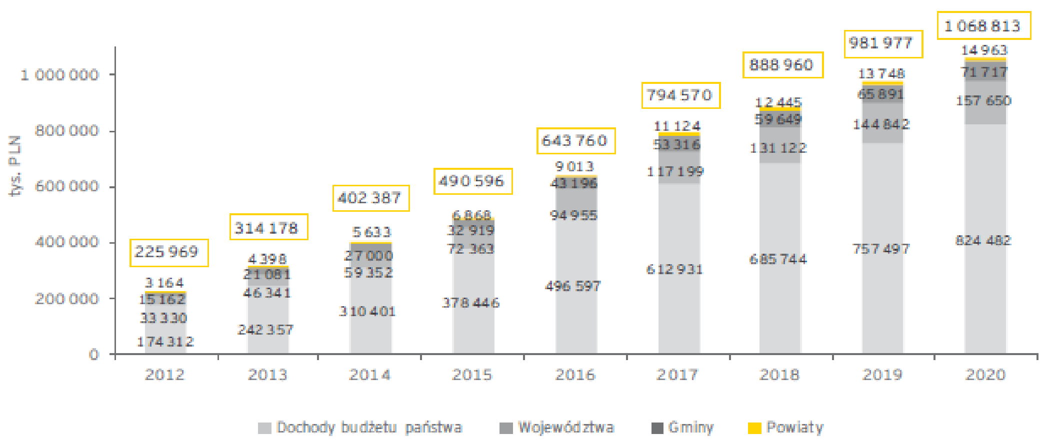
Graph 14: *share of tax revenue paid by companies of the wind energy sector according beneficiaries in 2011(thousand of PLN)*



Source: Wpływ energetyki wiatrowej na wzrost gospodarczy w Polsce, Ernst&Young, March 2012

If values are projected, the total amount of the tax revenue paid by companies will reach 1 billion PLN in 2020. The main beneficiaries will stay the state budget and the regions. (graph 15)

Graph 15: *projection of tax revenue paid by companies of the wind energy sector according beneficiaries in 2012-2020 (thousand of PLN)*



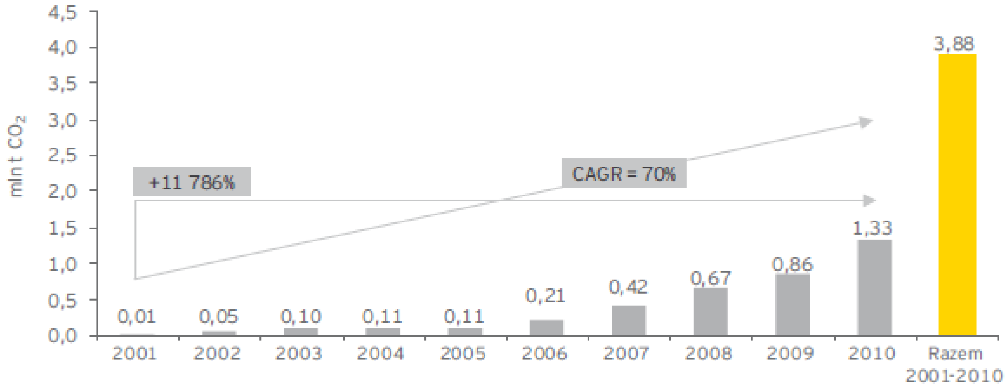
Source: Wpływ energetyki wiatrowej na wzrost gospodarczy w Polsce, Ernst&Youg, March 2012

3.4 / The reduction of CO2 emissions

The development of wind power, whose first feature is the absence of GHG emissions, represents an important potential to reduce CO2 emissions associated with electricity production.

The current production of electricity based on coal leads to emissions of more than 130 million tons of CO2 per year. Therefore, a potential way of reducing CO2 emissions is the development of wind energy, which can contribute both to achieve specific environmental objectives and measurable economic benefits by not buying CO2 emissions allowances. Theoretically assuming that all the electricity generated by wind farms (2001-2011) would be produced by conventional power plants, the amount of CO2, that is not emitted as a result of wind energy's development, can be estimated. Then, wind power contributed in Poland to decrease CO2 emissions of 3.9 million tons. (graph 16)

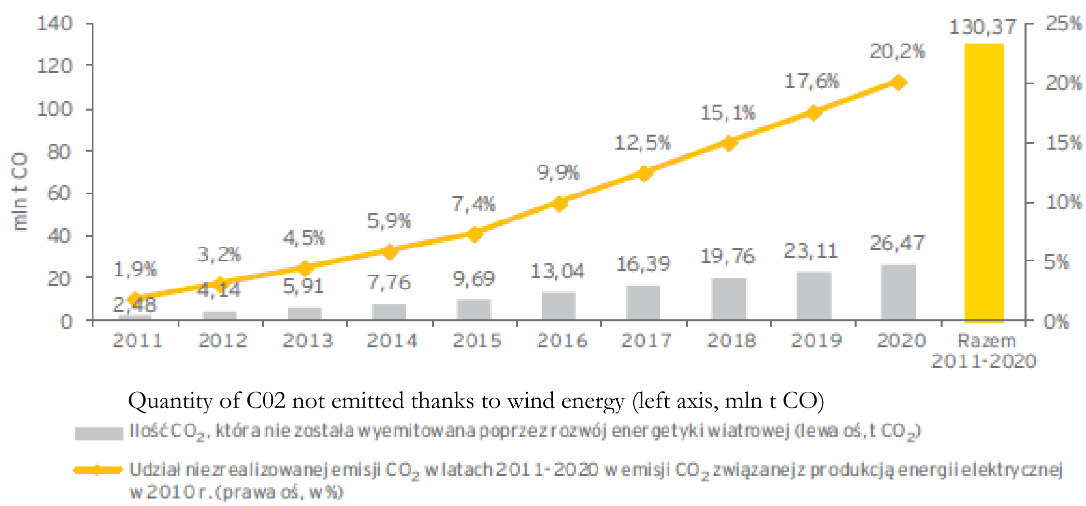
***Graph 16**: amount of CO2 not emitted per year thanks to wind energy (2001-2010)*



Source : Wpływ energetyki wiatrowej na wzrost gospodarczy w Polsce, Ernst&Youg, March 2012

Taking into consideration the potential of wind energy by 2020, it seems possible to significantly reduce CO2 emissions caused by electricity production. The total amount of unrealized CO2 emissions thanks to wind farms for the period 2011-2010 could reach about 130 billion tons of CO2, which is the equivalent to the annual CO2 emitted by electricity producers in 2010. This also means that the CO2 emissions from electricity production could be as much as 20% lower than in 2010, under assumption that the current level of electricity production will be stable till 2020.(graph 17)

***Graph 17**: amount of CO2 not emitted per year thanks to wind energy (2011-2020)*



Share of unrealised CO2 emissions for the period 2011-2020 in the CO2 emissions based on the electricity production in 2010

Source: Wpływ energetyki wiatrowej na wzrost gospodarczy w Polsce, Ernst&Youg, March 2012

3.5 / The impact of renewable sources of energy and wind energy on the final consumer

The cost to support wind farms is 21% of the global cost to all renewable sources of energy. It's equal to the share of electricity based on wind energy into the total of electricity based on renewable energies. Several specialists conclude that the taxation of the selling price of 1 MWh produced by wind farms should cost only 6

PLN/MWh (1.5 €/MWh) and will impact of +1.3% the consumer's final energy bill. It should be noted that the alternative production of 1MWh based on carbon source (assuming full payment for CO2 emission allowances) will be significantly more expensive. Assuming full payment of CO2 emission allowances for new installations, a key difference will be linked to CO2 emissions between electricity production based on renewable and conventional sources (eg coal). The result is that additional cost due to full payment of CO2 emissions could be higher of 21 PLN/ MWh (5.25 €/MWh). It's almost 3.5 times higher than the supporting costs for wind turbines. It's important also to emphasize that electricity produced by renewable energy sources in Poland is exempt of excise duty. It increases also its competitiveness compared to conventional energy sources.

Conclusion

If we take into account the geological predisposition wind of Poland, the fact that according to the European Institute of Environment, Polish power plants generate 3 billion Euro of loss per year and cost between 11 and 18 billion euro to the Polish economy, that the wind industry could provide employment for more than 66 000 people (among them 10 000 direct jobs in 2020), significant taxes to the state budget, municipalities and regions, it is reasonable to think that wind power will play a role by 2020 and will boost the Polish economy. It will mainly depend on the capacity of the Polish policy to break down administrative, legal and tax barriers. The experience of other Member States more advanced in the wind technology (eg. Germany, Denmark or Spain) can benefit to the Polish economy and can avoid making the same mistakes two times. The learning experience curve as well as the scale effect will be for sure a help to decrease the CAPEX and will allow to implement this technology at a more competitive cost.

Poland is faced with the demands of competitiveness in a highly globalized world. It must also deal with the social and environmental consequences of its strong carbon based economy particularly harmful in human and economic terms. It's difficult to believe that this country will continue to produce electricity based on coal which will condemn the competitiveness of its businesses and the growth of its GDP in the next decade. Poland can not continue a policy of the ostrich, wasting precious time pursuing an energy policy profitable at a short horizon but irrational in a medium-long-term. Poland knows that delaying decisions to decarbonize its economy will increase the cost of measures that it will inevitably be obliged to take, if the Polish government wants to respect the EU climate and energy pack till 2020.

The policies which have to be implemented by a coordinated way between the Member States will have positive effects only in the medium-long term. The paradox is that the first results are expected in the short term and nobody wants really to pay for this energetic transition. By focusing on the competitiveness of the firms in the very short term, mainly due to the financial crisis in EU, Poland as well as other European countries, undermines the competitiveness of those same firms in a medium term. Keynes said that at long term, we will be dead, considering that current or future problems will be solved by future human beings. Yes, we will be dead at long term, but in a short term, we have to take all necessary decisions and to do our best to limit the price of our electricity bill, which is very current. Our responsibility is to leave our common house, at least, in the same state as that in which we received it. "*Our immediate and crucial task is to link the public capital with the private one and particularly with the capital of humanity to serve one mission: to facilitate the world's transition to the third industrial revolution and the post carbon era. A such transformation will require simultaneously a great jump towards the biosphere consciousness".*[48] (Rifkin, 2011)

[48] Rifkin .J, *The third Industrial Revolution*, 2011. (*La troisième révolution industrielle. Comment le pouvoir lateral va transformer l'énergie, l'économie et le monde*), LLL, Paris, 2012, p.380.

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**ANNEX 1 : WIND ENERGY ZONE IN POLAND - PERIOD OBSERVED 1971-2000
POLISH NATIONAL CENTRE OF METEOROLOGII**