

Poland's energy policy: a contribution

by

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Biographical note

Mário Silva is a Master's Degree student at the Economics Faculty of Porto (FEP) where he studies Environmental Economics and Management. As an integrant part of this degree, this research focused on energy policies of Poland emphasis and allows the continuation of the work provided by it. Mário Silva studied Geography for its Bachelor Degree also at the University of Porto which allowed him to continue researching and learning topics such as sustainability and spatial organization. On a side note, Mário Silva has published articles connected to Eastern European post-Soviet football.

Abstract

This research intends to analyze of Poland's energy policy and its change of paradigm in the EU integration framework.

Energetically, it was an integration that made sense and was fruitful for both sides, since Poland was able to adapt to new rules as an EU member and, as a consequence, external capital flows entered the country providing the much needed investment to rebuild the economy. This economic/energetic links are interlaced (as the research will explore) on every market and on every branch of them; renewable energy sources became a priority, despite the country heavy reliance on fossil fuels. Actually, EU membership forced Poland to a deep reshaping of its energy sector.

Poland not only grew economically and retransformed its energy but was also able to exercise its influence diplomatically by trying to rush an energy policy at a European level. This policy of an integrated European energy market is perhaps its biggest goal and will be probably its main achievement as a European Union partner. The paths for this country is clear, to assume itself as leader inside European diplomacy.

Keywords: Poland; Energy; Policy; RES; European Union.

Resumo

Esta investigação pretende analisar a política energética da Polónia e a mudança de paradigma da mesma na intergração europeia.

Energeticamente, foi uma integração que fez todo o sentido e que obteve resultados positivos em ambos os lados; desde então, a Polónia foi capaz de se adaptar às novas regras Europeias e como consequência disso, capitais externos fluíram para o país fornecendo o até então muito necessitado investimento para reconstruir a economia. Esta ligação economia/energia está interligada (como a pesquisa vai detalhar) em todos os mercados e em todos os sectores destes; as energias renováveis desde então, tornaram-se uma prioridade apesar da ainda larga dependência nos combustíveis fósseis. A integração na EU forçou a Polónia a uma transformação do seu sector energético.

A Polónia não só cresceu economicamente e transformação a sua energia mas foi também capaz de exercer a sua influência diplomaticamente ao tentar apressar uma política energética ao nível europeu. Esta política de integração do mercado energético Europeu é talvez o maior objectivo da Polónia e seria talvez a sua maior conquista como membro da União Europeia. Os caminhos para este país estão assim traçados, o de se assumir como líder dentro da diplomacia europeia.

Palavras-chave: Polónia; Energia; Política; Energias renováveis; União Europeia.

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Chapter 1 – Introduction

This dissertation, “Poland’s energy policy: a contribution” is a reflection of Poland’s energy market reforms since the democratic transition period of the early 1990’s but, also focus on the post European Union membership period.

This research was developed as part of the Master Degree in Environmental Economics and Management for the Economics Faculty of Porto (FEP) in order to achieve the respective degree.

Following my interest on Polish culture, history and more, the opportunity for approaching a topic from Poland for a research seemed a great opportunity not only to expand my source of knowledge about the country but also to give some perspective of a thematic that isn’t a widely researched topic in my home country of Portugal.

On this globalized world, economic relations are primordial to understand each nation; on this perspective, energy economics are even more important to understand the role of strategies, opportunities and adaptability that each nation faces now and will face on the future.

The international context also held a big influence in choosing this topic; the unfortunate conflict in East Ukraine poses new questions that have to be answered and Poland is on the center of it when it comes to decisions since the country is and needs to assume its role as bridge between the West and the East by reshaping itself as a regional power.

This new need of a balance of power affects Poland energy policy and since the 1990’s it has been evolving in order to “catch” some western countries. This evolution can be assumed by the will of the Polish to join the European Union and therefore the need to comply with its rules.

The European process has been the great power behind Poland’s restructuration post-1990; on it, the relations between the country and others suffered greatly but, and more importantly the society was completely overhauled by changes. With new ideas arriving from the west, Poland managed to regenerate it and for those that followed this process

closely there's a role of investigative opportunities that can be seized and transported to other countries as a manual of good practices.

The topic of Poland's energy has always been intriguing for me; the fact that is thematic that can be extremely diverse and approached from multiple angles makes it an even more interesting topic. In spite of my interest in this topic, credit is due to other authors that before me started investigational work on it; home authors like Radzka, B. (2006) investigated the process of conglomeration and market liberalization in Poland while "foreign" authors like McGowan *et al.* (2004) focused the thematic at macro level by investigating regional influences of decision making policies.

To elaborate this dissertation and understand these changes, a division of work was needed:

- Electricity market is the 1st to be analyzed on this research; the transformation that it suffered on its 3 main sectors (generation, transmission, distribution) since the fall of communism until nowadays will be reviewed to identify its strengths, weaknesses and transformations. This won't be focusing on a typical general assessment since the objective will be tendentially to expose the errors and to give a more detailed insight on how the market works including its companies.
- Investigating the gas market follows the same pattern as the electricity market; the transformation post communism and evolution after the European Union including the role of the sector companies in it, however this market introduce us the geopolitics role of gas as an energy source. The introduction of this trending topic allows us to expand and have a better understanding of the importance of gas for some countries but also the motives for Poland's agenda inside the European Union.
- It is impossible to address the energy topic of any country without relating to the new technologies being implemented worldwide. These new environmental policies are a top concern across the European Union and Poland is no exception from it. Following its own strategies as well European Directives, we will analyze the level of implementation of some of the most important alternatives energies for the future.

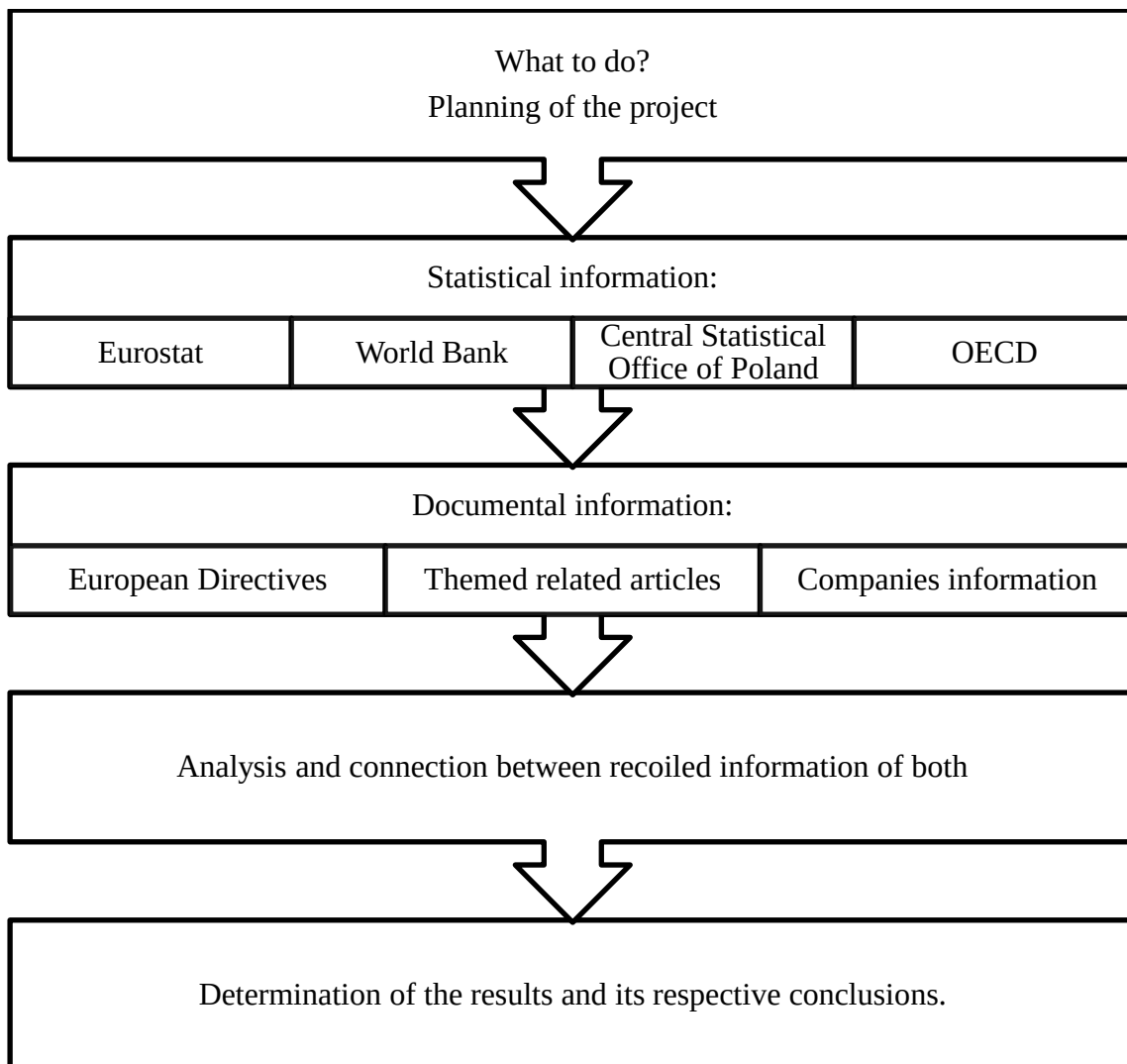
Overall, this research will be a review and a critical analysis of Poland's energy decisions; our main final goal will be an interesting study that the readers will find satisfying and at the same time elucidative of the different constraints that a country and its energy market suffer over the years.

According to the above, this dissertation is organized in the following way: chapter 2 presents the methodology of this work; in chapter 3 Poland's energy economics and policy is assumed as a case study and thus analyzed as such; chapter 4 treats Poland's situation and policy concerning green energy technologies. Chapter 5 presents our main conclusions.

Chapter 2 – Methodology

Basically, this dissertation follows a case study methodology. To deliver such research results it was necessary to investigate on secondary information databases like the Eurostat, World Bank amongst others. After, the recoiled information was processed onto Excel data and correlated with the information obtained from articles, Directives and company information available to obtain the final results of this research.

Table 1: Methodological process



Source: Own elaboration.

As a diagram above shows, the dissertation took 5 different steps to reach its conclusion and the 1st step of it was as the plan for the dissertation. This step consisted on choosing the topic, on which angle I wanted to explore it and how I pretended to do it:

- Topic: Poland energy;
- Angle: critical analysis of its energy policy since 1990 approaching both pre and pro-European Union membership;
- How: through statistical data that can be comparable to other countries, documentation both from official sources (Directives, government), research articles and information released by the companies on the researched sector;

After the above objectives were completed, it was imperative to obtain the statistics for the purposed thematic we would approach; for this, we decided to use 4 main databases:

1. Eurostat;
2. World Bank statistics;
3. OECD data;
4. Central Statistical Office of Poland;

After this statistical information was treated and transformed into graphics or tables, the dissertation secured the necessary documentation to interconnect to the previous step. We delineated 3 main sources to obtain these information's: 1st European directives that would give us a sense of the law and rules that Poland had to comply including specific targets; 2nd, the research respected and was influenced by articles related to this thematic from several authors; 3rd, this dissertation approach a more practical side of the investigation by analyzing the market and its structure by retrieving information from the companies operating in it.

Having done what we can consider has the pre-research, this dissertation assimilated and compressed all the information retrieved from there into the final text. On this text we were able to give an analysis on both macro as well as micro level. On the macro level we were able to identify the progress that Poland made as whole on the energy sector by adopting the European common rules, the transformation of the country since post-communist years (1990's); on a smaller scale (micro), we were capable of doing an analysis on both electricity and gas market sector that comprehended the companies

operating there. The RES market wasn't forgotten and with the information retrieved we were capable of demonstrate Poland's evolution on this market segment.

This dissertation concludes with a critical analysis of Poland's energy sector; after the previous chapter's analysis, we dedicate the conclusion to understand the options that the country followed until now and verify if those were valid strategies. These conclusions show us not only the pursued policy by the country but also give us the information of a spill-over effect when it comes to diplomatic solutions.

Chapter 3 – Poland as a case study

3.1. – Overview of the Polish economy

After more than 40 years of planned economy, Poland changed on the end of the 1980's. However, and due to the deeply embedded previous system, the transition to the free-market economy was characterized by profound structural issues mainly because of the huge discrepancy between the both. Under the socialist system, the polish economy was (as it was normal on the eastern bloc countries) developed centered on the industry output; Poland however had also a large percentage of the population employed on the primary sector, mainly on agriculture and mining related jobs (World Bank statistics of 2015).

Both sectors are largely correlated with each other and Poland, having one of the largest deposits of coal in Europe made their industrial economy dependent on this resource. Despite the before presented, the tertiary sector is the one that has biggest share of population employed during the transition of Poland to the democratic system. The gap between sectors increased during the years and in 2004, date of the European Union membership, the tertiary sector already had more than 50% of active population employed, with this increase being at the expense of the other 2 sectors; this trend continued with the tertiary sector approaching the 60%, the secondary 30% and the primary diminishing to roughly 10% of the population.

This development of the Polish economy was sustained by a new matrix of politics implmented by the governments. The need for reformation at the time was dire, much due to the poor state of the economy that was largely inefficient and uncompetitive; the dissolution of the eastern bloc and more importantly the COMECON¹ putted Poland in a delicate position. Inflation, reached historic values during the democratic transition with values topping at 550% in 1990 and only passed below the 10% mark in 1999, however, only after 2002 this value stabilized below 5% reaching last year of 2014 as low as 0.1% (World Bank statistics from 2015).

¹ Council for Mutual Economic Assistance was an organization that coordinated the development of economies on the Soviet sphere of influence.

With the progress of the reforms, unemployment rates also galloped to values never seen before, if we consider that in January of 1990 the % of unemployment was 0.3 of the active population and on the same period in 1991 it rose up to 6.6%, peaking in 1994 at 16.7% to decrease and steeply increasing again after 2000, reaching an historic high of 20.6% both in 2003 and 2004. (Central Statistical Office of Poland data of 2015).

To understand the transition period of Poland, we need to go back in time to the 1970's, where a series of measures implemented by the then leader Edward Gierek of the Polish People's Republic led to a failure on the long run. In an attempt to improve the country living conditions, Gierek government oversaw the influx of loans from western countries/investors; this attempt of economic Keynesianism economics proved to be fruitless as the Oil crisis of 1973-74 swept the world into global recession, leaving Poland that was starting to "unprotect" its economy at the mercy of the lenders but also to an influx of western goods that caused a trade deficit due to the massive imports, which ultimately led to a spiral of debt growth. (Nuti, 1982)

This situation was key for the economic Polish economic transition on the late 1980's; as the economy took a hit, the country entered recession with the GDP dropping as much as 7% in 1991 (**Figure 1**); also the ratio of debt per GDP peaked in 1992 and 1993 values around to 80% (OECD stats from 2015), which meant that major structural reforms were needed to appease international institutions such as the IMF. Known as the "*Balcerowicz*² plan", these reforms were able to bring Poland from the old centralized to the free-market economy but also had the power to significantly reduce the weight of debt on the country as Poland would end up receiving a 50% "haircut" of its debt³.

The energy sector was also included on this plan. The then government proposed 4 key measures to reform the energy sector and, although none of them were a direct indictment to sectorial privatizations, it was clear that the objective was to create a

² Leszek Balcerowicz is a former Prime and Finance minister of Poland. Was also president of the Polish national bank.

³As reported by: <http://www.nytimes.com/1991/03/15/business/west-plans-50-write-off-of-polish-debt.html> last accessed on July 29, 2015

competitive free-market. The set of measures were an intent to liberalize the sector and on a letter sent to the World Bank the 4 measures were as follow: (World Bank, 1998)

- adjust the planned controlled prices;
- restructure the sector by unbundling the “behemoths”;
- transformation to shareholders companies;
- creation of regulations and a regulatory energy agency.

Further on this dissertation, this measures will be detailed on the discussion of both electricity and gas sector policies.

3.2. – The post EU- membership

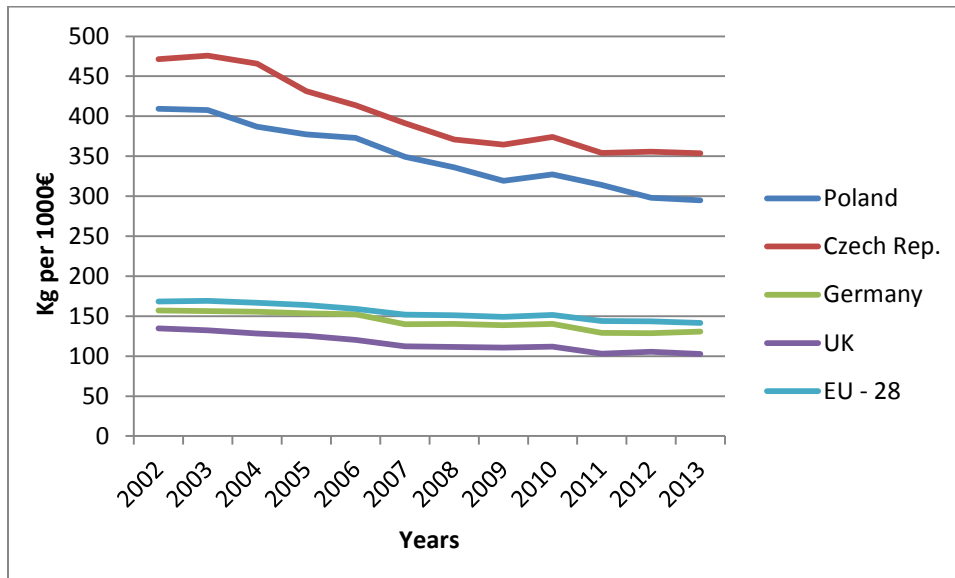
Always a key issue in Poland politics after the society democratization was the European Union membership. The increasing trade with European Union members and the influx of investment capitals from these (mainly from Germany) facilitated the process of European integration and also provided Poland a boost to a closer relation with other European Union members.

This membership provided Poland with more economic stability but without neglecting the traditional economic sectors. As an example of this, Poland inflation stabilized on the year post-2002 to numbers below 5% much due requirements imposed by EU laws in order to achieve full membership status (World Bank stats from 2015); the GDP growth returned to figures above 5% after decelerating on the years pre membership (2001 and 2002 had the lowest figures of growth since 1992 until 2014 (**Figure 1**)); despite this externalities, the high unemployment rate remained an issue to be solved. After some fluctuations over the years, this rate peaked in both 2003 and 2004 (the exact year of Poland’s entrance) decreasing then until 2009 (the lowest % since 1991) which, cannot be dissociated to the large wave of emigration (in particular to the British isles); this rate increased again over the next years stabilizing on 13% per year on average. (Central Statistical Office of Poland data of 2015)

3.2.1. – Post-EU energy sector

The membership effects of Poland in the European community were also felt on the energy sector. For starters, with the previous indicators improving (emphasis on the GDP growth) but also with some transformations on the type of labor (Population per activity sector) it soon had an effect on the country energy intensity (**Figure 2**). The fact that less people were working on the primary sector meant that less energy was consumed on those types of activities; as an example, the fewer people working on the mining sector (which is an energy-intensive industry), could have helped with this decay of energy intensity.

Figure 2: Energy intensity of the economy (ratio between gross consumption and GDP)



Source: [Eurostat, 2015]

The tremendous GDP growth that Poland had from these past 20 years also helps to explain the decrease of energy intensity of the economy. With an economy growing at sometimes 7% (like in 2007), one would think that the energy consumption would go up, however there are certain considerations we have to take before. The first consideration is an economic structural change that was already highlighted on the paragraph before; the second consideration is the adoption of energy efficiency

measures promoted by the government and with EU approval (this factor we will aboard it further on this dissertation); thirdly, we can argue about new habits of consumption from the general population such as replacing old electronics for new and more energy efficient ones.

Despite the reduction of roughly 24% of energy intensity in the economy from 2004 to 2013, Poland is still far from countries like Germany or the United Kingdom as both already boast low energy consumptions. However, Poland can be compared and be presented as a better example than the Czech Republic. Both countries gained membership to the European Union at the same time (2004) and both belonged to the former Eastern bloc but, the Baltic country presents a consumption of energy 20% smaller in 2013 than its peer from the south. In general, both countries perform poorly even if we compare with the data of the European Union of 28 countries.

Poland energy dependence began to set a trend on the years after the democratic transition, but it was only after 2004 that this tendency started to be dictated more intensively. In 2004 Poland dependence on energetic resources from abroad was 14.5%, in 2008 this value had doubled to 30.3% (**Figure 3**). Objectively and when compared to the rest of the analyzed group, Poland has the best results in terms of auto-sufficiency; starting in 2005, the country managed to get the lowest value on energy dependence of the group, surpassing the United Kingdom despite doubling the value during the identified date, as we have saw before. Several explanations can be pursuit to explain this evolution and, amongst them the most important we can argue about are the fossil fuels influence on a country economics and the development of new energy sources like the RES⁴.

The first explanation can and should be divided into three parts with each one representing the three types of fossil fuels that are mainly used in a country: coal, oil and gas.

The dependency of gas was kept stable at around 70% despite some peaks and lows during that period; Poland is above average if we consider the numbers on EU – 28 and can't be compared to the United Kingdom in 2004 due to the advantageous

⁴ Renewable Energy Sources

circumstances that the British Isles have with the North Sea platforms providing both oil and gas, however the gap diminished significantly over the years (according to Eurostat estimative). The gas market will be explored in more detail further on this dissertation.

Oil dependency in Poland has been steady over the years; ever since the communist regime, Poland has been dependent on this energetic resource, with some years the percentage of imports being calculated as more than 100%. Post-2004, the country kept its values within the EU-28 average and the only analyze due to note is the value of United Kingdom that as we have seen on the gas issue before it can also be applied to the oil (Eurostat estimative).

The coal sector is perhaps the key sector of Poland energy and where the biggest share of questions should arise.

As European's Union biggest coal producer, according to the Eurostat with around 1/3 of the total input, Poland takes a massive advantage of this resource and that is reflected later on the energy dependence of it. Unlike the others resources (gas and oil), coal always had an excess of production in comparison to the domestic consume; this is reflected by the negative values on the dependence of it. Poland on this topic is only comparable with the Czech Republic, as they both have the same level of independency from abroad when it comes to coal; it is undeniable that geography is their "best friend", as the both countries share a border and that border is located on the Silesia⁵ region, which means that the European Union largest coal basin is shared by both countries. Despite this geographically similarity, both countries behave differently on post-2004 membership; while the Czech Republic manages to keep its independency values above the 10% mark, Poland dwindles between the 10% and virtually no independency at all (example of 2011 with just 1.1% of excess). Despite this abnormality, the explanations for this situation are standard when we look at a European level.

To start with, Poland had to make significant structural changes on its economy to gain the right for the European Union membership. Of these structural changes, the energy sector was one of the most affected, as the country saw new legislations being passed at

⁵ Region that comprehends Poland, Czech Republic and Germany and home to several main cities like Ostrava (CZ), Wroclaw and Katowice (POL). Industrial heart of Poland and the most densely populated area of the country.

a transcontinental level that would link up with the domestic already in use. An example of this is the Directive 2002/358/EC that obliges all the countries inside the European Union to comply with the measure of the Kyoto Protocol as described:

“The European Community and its Member States shall take the necessary measures to comply with the emissions levels set out in Annex II, as determined in accordance with Article 3 of this Decision.” (Council Decision 2002/358)

The decision on this directive would eventually mean a cut on GHG⁶ which subsequently lead to a slower pace on the production of coal units to decrease pollutions rates.

As a direct consequence of this act, the consumption of RES nearly doubled in % from 2004 to 2013 (**Figure 4**) making Poland a 2 digit country when it comes to this. Being far from the EU-28 average, Poland can be comparable to Germany, having both virtually the same % of RES consumptions.

Other external factor that contributes to the decline of coal consumption are its prices; according to data from BP⁷, coal prices reached historical peaks since 2004 even reaching above 100 \$US per tonne on the European market in 2008 and 2011. This situation can have influenced the demand for coal as higher prices would provide a cause for the decrease of it.

Alternatives to coal were found not only on RES (as we saw before) but also on other fossil fuels resources. Gas and oil consumption increased over the years with only a small exception being made to oil that had been in decline since 2012; gas on other hand, has been on a steady yet slow pace of increasing which validates its position as a future alternative to coal (Eurostat statistics).

⁶ GHG: Greenhouse Gas

⁷ British Petroleum

3.2.2. – European regulations on the energy sector

Convergence of the energy sector and environmental sustainability was always a key problematic between Poland and the European Union, therefore in 1997 the Polish government approved the *Energy Law* that would build bridges between both and allow a greater similarity between systems.

As a direct influence of this act, 5 European directives were enforced in as a base scenario for the countries new energy strategy; these were related to the transmission grids on both the electricity (90/547/EEC) and gas market (91/296/EEC), the functioning of the markets (96/92/EC⁸, 98/30/EC⁹) and the last was concerning the incorporation of the production of RES on the market (2001/77/EC¹⁰).

The evolution of economic, social and technological paradigms across Europe allowed not only the update of European rules but also the chance to implement others. Amongst these, the main focus was directed towards enforcing the Kyoto protocol in all European members (as we have seen on chapter before) with the Directive 2002/358/EC and the directive promoting a strategy on energy efficiency (2012/27/EU).

This measures, implemented through the years were/are part of broader European program; perhaps the most famous of all is the *2020 Energy Strategy*, that aims for a reduction at an European level as a whole of 20% of GHG, 20% increase of RES consumed and a 20% increase in energy efficiency and Poland, like the rest of the European members is obliged to make a contributive effort to achieve the proposed targets.

3.2.3. – Energy efficiency modifications in Poland

It is imperative to have a more detailed approach to the energy efficiency plan for Poland as this is a key topic for the country's future and also a priority to the rest of the European member states.

⁸ The directive has been updated since its first release; the first update was the 2003/54/EC and the latest updated was verified in 2009 with the 2009/72/EC directive.

⁹ Also updated firstly to the 2003/55/EC and recently to the 2009/73/EC.

¹⁰ Last updated on the 2009/28/EC directive.

As we saw on the last subchapter, the European Union promoted a Directive to deal with this topic. The Directive 2012/27/EU gives the basis scenario in which all member-states have to find common ground as noted on the 1st article of this act:

“This Directive establishes a common framework of measures for the promotion of energy efficiency (...) to ensure the achievement of the Union’s 2020 20% headline target...” (European Parliament & Council Directive 2012/27)

In this common ground, each Member State is allowed to take one of two roads; the 1st choice implicates a scheme of obligations in which the companies under the country/European laws are obligated to implement a series of measures (freely) that reduces the energy consumption to the agreed levels¹¹. The 2nd choice is in case of companies covered by the later that reject the measure can replace it by contributing in form of taxation, bilateral agreements with the government for a new set of regulations or implementing cutting edge technology to reduce the amount of wasted energy¹².

Despite these 2 roads that each Member State has to adopt, there was/is still space for traditional measures. As depict on the directive, the introduction or increase the energy audits (article 8) will address concerns for possible forgeries; Article 10 on the other hand represents the bond between final consumers and the suppliers as a “billing information” is adopted on it which allows consumers to have their historical data and help them to make the best choice in their favor.

To evaluate the energetic efficiency, we have put a spin-off table of **Table 2** (Electricity availability) which shows the electricity lost between production and the available in the end for consumption (**Table 3**). The results of these calculations are expectable if we consider that both Poland and the Czech Republic are still experiencing a transition of their energetic model; while the Baltic country as greatly improved (32.1% of loss in 2004 to 24.6% in 2013) the Czechs had a much less pronounced improvement (36% to 34%). The surprise of this table is Germany that has worsened its result, passing from a loss of 15.5% in 2004 to 18% in 2013; this can be explained with the aging infrastructures and the lack of renovation, unlike in Poland where the great influx of structural EU funds allowed improving facilities.

¹¹ Directive 2012/27/EU, Article 7, Paragraph 1.

¹² Directive 2012/27/EU, Article 7, Paragraph 9.

3.3. – Electricity market

Polish electricity market can be divided into two parts; the 1st part related to the afterwards of the transition period and the 2nd to the most recent European Union integration (which we will approach with more detail further).

Due to Poland's type of government and the fact that the energy sector was considered a key asset of the country future, it only received a minor restructure while the vertically integrated type of market remained, albeit with some changes on its composition (as previously explained).

In 1990 and after the separation of the mining sector with the electricity sector, P.S.E.¹³ was founded. The ongoing market restructure allowed a certain degree of independence to the companies in it; the vertical unbundling of this sector allowed for the energy sector to have a certain degree of independence, although the companies that resulted from that market change were still SOE¹⁴. Despite the lack of privatization the idea to promote efficiency and encourage market competition was still present.

“...33 national distribution companies, 32 power stations and a heat-and-power plant and several dozen local heat-and-power plants were established (...) PSE S.A.'s emergence from the structure of five vertically integrated enterprises was positive. But on the other hand it enabled PSE S.A. to obtain a monopolistic position.” (Radzka, B., 2006)

With the progress towards a broader European integration, it is important to address once more the 1997 Energy Law and the Directive 96/92/EC as they both represented the 1st step towards a process of market liberalization.

As noted before, the directive was the biggest influence to this draft because it allowed Poland to implement key decisions ahead of the European Union membership. Amongst these decisions, we can highlight some articles that we do believe are essential (European Parliament & Council Directive 96/92):

¹³ *Polskie Sieci Elektroenergetyczne S.A.*, the Polish Power Grid Company.

¹⁴ State-owned enterprise

- Article 7 & 8: the transmission sector is essential to the energy supply security and, as such shall be maintained with a very good maintenance even if its users aren't connect to the company who owns it (no discrimination);
- Article 14 & 15: vertically integrated companies must be independent from each branch by ensuring a accountability separation between them and keeping the influx of information between them as less as possible (only important information shall be transmitted) thus promoting a level playing field;
- Article 16 to 20: each EU member shall promote a free-market within the parameters established.

These markets regulations are essential to promote what Poland believes that is the one of the foundations of the European project, the unique and integrated energy market that can both secure the wellbeing of the Europeans and the energy security across Europe.

3.3.1. – Electricity market post – EU

Statistically, since 2004 the electricity sector has suffered some changes; the electricity produced increased nearly 7% (6.7%), from 154 GWh to 164 in 2013 (**Table 2**), however it is due to notice that the biggest improvement in this sector is the efficiency which, brings more available electricity to consumption (**Table 3**). Despite this improvement Poland isn't auto-sufficient on the electricity production and imports energy mainly from the Czech Republic (**Figure 5**). These electricity imports were in total 14 521 GWh in 2004 and decreased to 12 124 in 2013, always originated from the same 4 countries: the already mentioned Czech Republic, Germany (lowest value), Sweden and Slovakia; the geographically localization of the exporters to Poland is worth to explain, both Czech Republic and Slovakia border the Silesia region (the most industrialized and in need of energy) which can explain the reason for this high level of import from these 2 countries.

Renewable energy had a stimulus during this decade of Poland on the EU as this source of energy passed from a residual value of 2.1% in electricity consumption to nearly 11% in 2013 (**Table 2**). Although in % Poland is still very far from what the EU – 28 averages (25%), this is a clear improvement and step forward in Poland's energy policy.

Related to all of these changes are the electricity prices for both household consumers and industrial (**Figure 6**). In 2004, the bill for domestic users was on the 10 cent of € per KWh and peaked in 2011 and 2013 to 15 cents; this tariff increase is not random and much like with the rest of Europe can be attributed to development of the RES that need subsidization to be competitive (especially in Poland where coal is an abundant and cheap resource) and, to new energetic efficiency practices that incentives a lower use of energy at the expense of rising tariffs. Industrial tariffs also rose during this period, however and due to the type of agreements that companies are capable to make with energy providers, the tariffs between 2003 and 2014 are on average 7 cents of € per KWh, having its peak in 2010 with 10 cents and the lowest value in 2004 with 4 cents.

The European membership in 2004 brought new challenges to the sector; the pursuit of a more integrated market and a new series of measures, pushed Poland to a new sector restructure. For a better understanding of this restructure, we will separate the electricity market in 3 sectors: generation, transmission and distribution.

Once more, European directives played a big part on Poland's restructure; the directive 2003/54/EC takes even further steps towards an energy integrated and competitive market as it goes further on the unbundling issue (article 10 & 15). This new regulation also goes further than its predecessor (Directive 96/92/EC) when it comes to separate accounts from each branch (article 19) and obligates each member state to implement a TPA system¹⁵ (article 20) where no discrimination is accepted between users; new regulatory bodies are also an obligation and should not have ties to the industry (article 23).

Considering these regulatory changes, the polish government took action and decided to implement transformations on the electricity sector. As we saw before, during the transition the system received a revamp to allow a competitive market on the generation and distribution sectors leaving the total bulk of the transmission sector to PSE.

¹⁵ Third-party access.

3.3.1.1. – Generation

After the 1st restructuration of the energy sector (in the early 90's), the generation market became fragmented in more than 30 companies where, the biggest part were under state supervision that at the time created a certain artificial competition to bring capital and promote more efficiency. It was only after the 1997 Energy Law and the European directives that a more serious push towards a more privatized and open to competition happened.

Despite some degree of privatization on the production sector with EDF¹⁶ buying a major CHP¹⁷ plant in Krakow and several minors across the country (McGowan, Radošević & Von Tunzelmann, 2004), the major plan for this branch were dependent on the documents legitimized by the government, where is stated that once the restructuration is done, mergers would be put into place between generation and distribution enterprises (World Bank, 1998). From this major organization, 5 major public generation companies were formed: PGE SA¹⁸, Tauron SA¹⁹, Energa SA, Enea SA and ZE PAK SA²⁰.

According to the ERO²¹ National Report (2014), PGE was the largest feeder of electricity onto to grid with a share of 39.3% in 2013 (decreased from 40.5% in 2012); being a company vertically integrated with the exception to the transmission system, PGE takes a big advantage of this factor as they possess 2 of the biggest power plants in Poland (Belchatów and Turów) with relative ease access to the also controlled mines of coal/lignite, necessary to power these 2 stations. Being a society constituted by majority of roughly 58% by the State Treasury, it is clear that it was intentional by the Polish state to sell % of shares in order to attract capital to invest modernizing the equipment's. (GKPGE.pl, 2015)

Tauron, unlike PGE has a very different shareholder constituency, with the State Treasury being only entitled to 30.06% of the shares; however it is due to notice that

¹⁶ Électricité de France

¹⁷ Combined Heat and Power (Cogeneration plants)

¹⁸ Polska Grupa Energetyczna SA

¹⁹ Tauron Polska Energia SA

²⁰ Zespół Elektrowni Pątnów – Adamów – Konin SA

²¹ Energy Regulatory Office

one of the largest partners is also a State controlled company (KGHM Polska Miedz S.A.) that technically upgrades the public sphere of the company to roughly 40%. Also a vertically integrated company, Tauron has on hard coal and lignite the main sources of material to generate power (87% of it) and it is also the 2nd biggest feeder of electricity to the grid according to the ERO National Report (2014) with 13.6% of the total electrical power in Poland in 2013.(Tauron.pl, 2015)

Enea is the 3rd company with public status on our list; according to the data recoil, the State Treasury has in its possession 51.5% of the company. Although not possessing mineral resources like PGE and Tauron, Enea can still be considered a vertical integrated company due to its generation and upwards market activity (distribution and retail). Having the largest plant on the outskirts of Warsaw, Enea relies on fossil fuels for roughly 92% of its electricity production despite possessing several RES (Wind and Hydro) plants (Enea.pl, 2015). It is according to the ERO National Report (2014) the 4th largest producer of electricity power in Poland (8.1%).

Energa is the last of the “big 4”²² to be analyzed. This company, as opposite to the other 3 has a better approach on the sustainability front since 41% of their installed capacity is from RES; however it is the smallest of the 4 in electricity to generated to the grid with 3.2% in 2013 (ERO National Report, 2014). Maintaining the tradition of energy companies in Poland, Energa has the State Treasury as its biggest shareholder with a majority of 51.52%. (Energa.pl, 2015)

Having been recently privatized at 100% (in 2012), ZE PAK S.A. (*Zespol Elektrowni Patnow-Adamow-Konin*) is the only polish company that is able to be on the top of the electrical producers with a 7.3% share in 2013 (ERO National Report 2014). This enterprise is composed by 4 large power plants (as the company names itself names it and Patnow has 2 located there), with a total capacity of 1 200MW and completely

²² Big 4: Name attributed to PGE, Tauron, Enea and Energa; as the symbol of the consolidation process, mergers these 4 companies have activity in all energy sectors with the backing of the State therefore the name.

powered by lignite²³, which makes them an ecological concern despite best attempts to reduce pollution.

The last generator to be analyzed is EDF. Having 9.7% of market share EDF is the biggest foreign company to operate on the production of electricity in Poland (ERO National Report, 2014); much of this operation is contributed by the power plant located in Rybnik that alone is able to output 1 775 MW of electricity. After being privatized successfully in 2001²⁴, this coal based power plant has been on the center of the EDF Polska strategy.

Table 4: Market power (proxy) and corporate structure.

Name	Market share	State % shareholder
PGE SA	39.3%	58.39%
Tauron SA	13.6%	30.06%
Enea SA	8.1%	51.5%
Energa	3.2%	51.52%
ZE PAK SA	7.3%	0
EDF Polska	9.7%	0

Source(s): [ERO National Report 2014; GKPGE.pl; Tauron.pl; Enea.pl; Energa.pl]

3.3.1.2 - Transmission

The electricity transmission sector is the opposite of both the generator and distribution solely because there is only one player in it, PSE. Being separated from its origin company PGE-PSE in 2007 in direct consequence of the Directive 2003/54/EC that obliged the unbundling of the energy market (transmission and distribution), PSE was named as a vital component of the polish energy security by the State Treasury:

²³ According with data provided by: <http://zepak.com.pl/pl/o-nas/struktura-paliw/ze-pak-sa.html>, last visited on September 12, 2015;

²⁴ As informed by: http://energetyka.wnp.pl/zakonczenie-prywatyzacji-elektrowni-rybnik,124599_1_0_0.html, last accessed on September 12, 2015;

“In line with the regulations under the Energy Law Act, the State Treasury shall hold the entire package of shares. Pursuant to the regulation of the Council of Ministers, the company was included on the list of companies of key importance to public order or public security, and to the economic well-being of the State.” (State Treasury, 2008)

As so, PSE remains fully under State control, more objectively under the Treasury administration control with the strategic goal of expanding the network, increase the safety and reliability of it and implementing the single buyer model (World Bank, 1998); if the objective was to bring competition (as legitimized by the directive) into the market, this single buyer model created an impediment to it that even the European Commission started to investigate.

In 2005, the Commission launched an investigation to these PPA's²⁵ arguing that the lack of competition was distorting the market and as such, cancelation of these agreements would be required. The Commission noted that during the transition period of the 90's, Poland enforced this type of program to encourage innovation and protect the investments made, however and according to European rules, the liberalization of the market is a must and shall have to be enforced. The problem with enforcing this are the duration of these contracts, which range from 2005 to 2027 making it necessary to compensate those prejudiced by it. The compensation to end these contracts follows the basis of the date of when Poland entered the European Union (2004) which means that all aid is deductible on the compensation package of the generators that benefited from it²⁶. In spite of these attempts, the level of contract cancelations wasn't the expected and in 2007 only 1.5% of electricity was bought on the liberalized market (Nowak, B., 2009).

Currently, the statute of PSE has been discussed at a European level; recently, in 2014 the Commission published an opinion required by ERO²¹ where it was asked to verify if PSE was complying with the European unbundling rules. This verification process had 2 significant analyses; the 1st was concerning the ownership of the transmission system

²⁵ Long-term power purchase agreements

²⁶ The European Commission started to evaluate this situation 1st in 2001: http://europa.eu/rapid/press-release_IP-01-1077_en.htm?locale=en, 2nd in 2005: http://europa.eu/rapid/press-release_IP-05-1455_en.htm?locale=en, until the decision was made in 2007: http://europa.eu/rapid/press-release_IP-07-1408_en.htm; all data was last visited on September 12, 2015;

and the 2nd was concerning the State/political influence on the company. On the 1st analysis, the Commission puts certain doubts on ownership of some equipment's, mainly on the low-voltage lines (220Kv) that aren't owned by PSE but are administrated by it and on the independency of the operator towards the electricity producers (if all are entitled to the same conditions on the access to the market). The 2nd analysis by the commission is concerning the independency of PSE relative to the State, namely to the other energy SOE's¹⁴ (PGE, Tauron, Enea and Energa); according to ERO there's enough separation between both cause, while PSE is indeed part of the State Treasury it's the Economy Ministry that *de facto* runs and dictates the company policy therefore creating the needed independency between sectors. As a conclusion to this process, the Commission upholds any further detailing of these highlighted cases arguing that it's up to the ERO to enforce European laws on the national sector by it represented. (European Commission, 2014)

3.3.1.3 - Distribution

Like the generation sector, the electricity distribution sector is a consequence of the restructure followed by the polish State that eventually led to the consolidation processes; PGE, Tauron, Enea and Energa are the main players involved into this sector and despite the fact that there aren't any geographic/entry barriers, this sector is run in a relative false competition market. The system is divided in 4 regions where each company has the upper hand (**Figure 7**): the north is operated by Energa, the north-west by Enea, the east by PGE and the south by Tauron; the only exception to this rule is RWE that has the distribution of the city of Warsaw and until 2011 Vattenfall had a distribution center on the Silesia region (Tauron region).

"The agreement with Tauron includes the distribution, network services and sales operations of GZE (...) GZE is a Polish Distribution System Operator providing approximately 10 per cent of the electricity consumed in Poland (...) serving 1.1 million customers..." (Vattenfall, 2011).

The control of the distribution channels by producers raises concerns to how truly independent is this sector from the rest; if we take a look back we know that these 4

represented distributors have State treasury stakes and that the transmission company belongs also to the State treasury (although its being controlled by the Economy ministry). This conflict of interests arises to such an extent that even national law (article 9d of the Energy Act) is broken by this and consequently European laws as well (Nowak, B., 2007).

Another issue on this market segment is the existence of regulated prices that “kills” possible competition; this regulatory implemented measure to protect the poor users is in fact harming them for the simple that with regulated prices the distribution companies fail to provide the innovation to the networks that may come from possible increase in income. Another reason for this harm is the highly concentrated market that fails to bring competition and therefore is not providing the best possible service to the consumer (Energy Charter Secretariat, 2011).

3.4. – Gas

Poland’s gas market is characterized by the high levels of dependency from abroad; nearly 75% of its needs are imported and the tendency is for this dependency to continue its growth. This tendency is explained not by a decrease in production (which in fact increased although by a residual value) but by increases on the consumption. As written previously, gas could be a natural replacement to coal as the primary energy provider to the economy, however if we take a look at the Eurostat stats we will note that the coal consumption remained solid at around 50 thousand tones and gas only increased roughly 3 thousand tones since 2002 to 2013. Being a dependent country on gas, Poland is on average with the rest of the EU and below Germany on the %; the only country analyzed that wasn’t dependent on imports was the UK during a short that now seems very unlikely to return considering the shortage on the North Sea explorations (data according to Eurostat).

Having only sole actor on the gas market, Poland committed to make reforms on it during the transition period, much like it did for the electricity sector. The planned reforms committed to the World Bank involved transforming PGNIG into a stock company and to separate the diverse branches of it creating more independency between

companies and, to prepare for the future of market liberalization (World Bank, 1998). Following this, Poland adopted the European common rules, the Directives that promoted a more profound restructure on gas market and in PGNiG.

Having energy security as the key point on gas energy policy, the polish State started to implement the directives needed to comply with the European common rules; at that time, PGNiG had the total vertical control of the market which included the imports of this resource mostly from Russia. Being a strategic company to the country due to its multiple influences on the gas market, the polish State Treasury holds roughly 72% of its shares (PGNiG.pl, 2015) with the rest being disperse amongst several members of the company/employers.

The production of this fossil fuel is key part on PGNiG strategy; being the sole producer (directly or through subsidiaries) in Poland, PGNiG is capable of getting a sizeable income from this and, with proven reserves that account to more than 85B m³ in 2013 this income will still be able to continue (PGNiG.pl, 2015). It comes with no surprise after these facts that despite the best efforts from the polish government to promote market liberalization, its gains are residual; according to Energy Act of 1997, the market should be forcibly liberalized to allow competition in every segment, however in 2007 only 1.8% of all gas bought was from companies with no relations to PGNiG thus creating a severe unbalanced market (MRPA, 2009).

Long term contracts for gas imports also hinder the development of the market not only because it creates a barrier upstream but also because it can be financially prejudicial. An example of this is the contract negotiated between the polish government (by the hand of PGNiG) and Qatargas in 2009. Back then, with the price of gas indexed to high oil prices, the government celebrated a contract between 340 and 380 US dollars per Mcm²⁷; if we compared this value to values practiced on the import from Russian gas (400 to 500 US dollars) they are objectively low, however as speculated by the Polish press this value can rise and even surpass the values of the Russian contracts by the time it will finish in 2029²⁸. This type of business creates therefore 2 types of problems; 1st,

²⁷ Mcm: Million cubic metre

²⁸ Has reported by: <http://www.naturalgaseurope.com/poland-to-renegotiate-lng-contract-with-qatar>, last visited on September 11, 2015;

we have the risk of swaps that can either go both ways and 2nd, we have the infrastructural problem of it on which PGNIG controls storage and prioritizes their imports/production storages.

The 1st problem is the exact same problem that the polish government/PGNIG faced; with the gas prices decreasing from 2009 (date of the contract) to 2012 (date of the renegotiation) the polish enterprise was left with a bad deal in hands.

The 2nd problem is more complex, since European market rules are not technically being broken but the conflict of interests exists; PGNIG is the owner of all the storage units in Poland through its subsidiary company OSM²⁹ that was created to comply with European rules of unbundling. This however creates a conflict of interests since OSM may prioritize the storage of PGNIG gas imports/production over other gas companies. This issue has been emphasized by the European Commission that warned Poland in 2010 through a press release:

“The obligation to store gas on the Polish territory discriminates EU companies importing gas to Poland and forces them to seek for ways to transport gas to these storage facilities. Since transmission capacities to and in Poland are not available and since the Yamal pipeline is not accessible for importers, the so called "territoriality clause" forecloses the market for EU gas suppliers endangering in turn security of supply of Poland.” (European Commission, 2010)

Natural gas transmission is at Gaz-System SA responsibility which is a subsidiary of PGNIG created from the obligation of unbundling the market; like on other branches of the market, this independency between companies is only on paper because the conflict of interests still exists. The best example of this happened in 2006 when Gaz-System SA demanded from Emfesz³⁰ a deposit of gas in gas storages in order to be able to provide the gas contracted by Emfesz to the final consumer (Icis.com, 2015); the fact that Gaz-System SA and not PGNIG, who is the *de facto* owner of the reserves created obstacles to the realization of this deal shows, or at least raises suspicion of the true independency between them.

²⁹ Operator Systemu Magazynowania Sp. Z o.o.

³⁰ Hungarian gas supplier;

Being the transmission operator, Gaz-System SA is at the helm of the polish section of the Yamal pipeline in spite it being a joint project from PGNIG and Gazprom named as EuRoPol Gaz³¹. This operation as seen earlier on the European Commission press release is violating internal market rules by not allowing a correct and loyal competition between market actors. The “territoriality clauses” as they are called, are an impediment of foreign companies to have access to the market as they prevent them from using facilities without certain compensations (in this case a % of storage); this creates the market discrimination that lead to the already before studied case between PGNIG/Gaz-System SA vs. Emfesz.

Like on the rest of the gas sector, the distribution market still has its share of problems when facing competition. According to the polish regulator ERO, in 2014 the share of sales of PSG Sp. z o.o.³² was 89.24% and despite a decrease from 94.42% from the previous year it is still an extremely high percentage³³. Once more, PGNIG controls this branch of the market through the previous mentioned company as it is its only shareholder, using the same kind of influence as previously.

Changes of this market are taken care with severe caution; this “tweezers” policy is ambiguous at times since it implies Poland to play a nearly double game, 1st with Russia and 2nd with the European Union.

Table 5: Gas sector structure.

Name	Branch	PGNIG subsidiary
PGNIG GK	Exploration/Production	-----
Gaz-System SA	Transmission	Yes
OSM Sp. z. o.o.	Storage	Yes
PSG Sp. z. o.o.	Distribution	Yes

Source: [PGNiG.pl]

³¹ According to: <http://www.gazprom.com/about/production/projects/pipelines/yamal-evropa/> and last visited on September 11, 2015;

³² Polska Spółka Gazownictwa

³³ Based on information provided by: <http://www.ure.gov.pl/pl/rynki-energii/paliwa-gazowe/charakterystyka-rynku/6161,2014.html>, last accessed on September 10, 2015;

3.4.1. - Poland and the geopolitics of gas: final considerations

There is no more ambiguous economic relation for Poland than its relation with Russia. Due to the historical common history, both countries always had a troubled relation and, if during the Middle Ages or after the relation was decided by military means, nowadays the economy is the new “battlefield” with its focus mainly on the gas market and economics. This “front” can be one of the reasons to why Poland is advancing slowly on the reformation of the gas market; the need for a strong company in it that can and is able to compete with the Russia giant gas company Gazprom.

As we saw before, Poland embarked on a wave of diversification of the gas suppliers and, the deal with the Qatari gas company was one of the examples of it. In fact, if we take a look into Gazprom exports to Poland we can see a decline of gas transitioned (**Table 6**); in 2012 the imports from Gazprom peaked at 13.1 Bcm³⁴ while in 2014 the imports were already at 9.1 Bcm. This tendency is not only felt in Poland but also across Europe; perhaps, on this, the Czech Republic holds the best example since it managed to pass from importing 9 Bcm in 2010 to 0.8 Bcm in 2014, almost stopping importing Russian gas.

Gas pricing has also been an issue for Poland; this makes even more case to have a strong national company on the gas sector like PGNIG; as it is shown, Poland pays a price of over 475 \$US per thousand of cubic meter it imports (in 2013); alongside it are other countries like the Czech Republic, Ukraine, Lithuania and, while the other 2 Baltic countries (Estonia and Latvia) pay a smaller fee it isn't much different from the latters (**Figure 8**). The curious fact jumping right to everyone conclusions is that all of these countries were part or belonged to the sphere of influence of the late Soviet Union; this can be seen as an attempt of blackmailing by Russia to these countries if, we consider that most them have no other means to import gas but from Russia and therefore are total or highly dependent on Russian gas.

Poland sees gas and energy security as a matter of national identity; PGNIG therefore is key for this strategy since it is (with the support of the State and the European Union) the only polish company of this sector that can make a stand against these types of

³⁴ Billion cubic metres

intromissions. This was proven in 2012 when PGNIG successfully negotiated with Gazprom a reduction of between 10 to 15% from the 550 \$US paid in 2011³⁵; more recently, PGNIG and Gazprom embarked once again on conversations to further reduce the price of imported gas with no visible results up to this date³⁶.

³⁵ Has confirmed by: <http://www.naturalgaseurope.com/russia-and-poland-agrees-on-gas-price-reduction>, last accessed on September 11, 2015;

³⁶ Based on reports from: <http://www.bloomberg.com/news/articles/2014-11-05/poland-starts-talks-with-russian-gazprom-to-cut-gas-price> and last visited on September 10, 2015;

Chapter 4 - Towards a greener energy policy

Given Poland late European Union entry (2004), but still in line with countries from the former Eastern bloc (Czech Republic, Slovakia etc.), renewable energies sources were vastly underused as Poland never felt the necessity to adapt, invest and adopt these kind of alternatives due to the cheap access to coal. The first attempt to improve this situation was presented by the Energy Act of 1997; on it, the definition of RES in Poland would appear:

“renewable energy source – a source which uses wind power, solar power, geothermal energy, sea wave, sea current and tidal energy, or energy obtained from the fall of rivers and biomass energy, energy from landfill biogas as well as biogas produced in the process of sewage disposal and treatment or decomposition of plant and animal remains;” (The Office of Sejm, 1997)

This comprehensive definition is important to understand what is possible to consider or not RES; the best example of this is if nuclear energy should or not be considered as a RES source, since a small amount of uranium can produce a tremendous energetic power.

To put into practice this plan of a more sustainable energy policy, it was essential for the Energy Act to provide certain type of terms that could help a quicker implementation of green energies. Reviewing the Act, we found some measures that are indeed helpful for a more competent implementation; on these measures we found 1 that we can considered as informative and other 3 that are exclusive to improve competitive chances.

The informative measure refers to the implementation of a certificate of origin; this measure, allows people and the State to be informed of the amount produced and, can have various uses like for example on taxation issues. This measure is present on the 1st paragraph of the 9e article.

More important for the daily issues of the company are perhaps the competitive measures proposed by this Act that we will present.

The 1st set of measures obliges companies that are connected to this sector to give full priority on the purchase of electricity from RES (article 9a.1) and provide full priority plus acceptance on the grid to all electricity from these sources (article 9a.4).

Secondly, it is provided to all RES producers' tax exemptions if their producing capacity is below 5 MW by sparing them of paying for license fees (on article 34(4));

“The energy enterprises which generate electricity using renewable energy sources of capacity not higher than 5 MW shall be exempt from the fees referred to in (1) in the scope of the energy generated by them in those sources.” (The office of Sejm, 1997)

Thirdly, it is worth noticing a possible ambiguous measure for this program; the subsidization of RES through taxation of other energy sources (oil etc.) that may (or not) reflect on the final consumer price to pay (article 45(3));

“The tariffs for gaseous fuels, electricity and heat may reflect the costs of co-funding of the development of renewable energy sources by the energy enterprises.” (The Office of Sejm, 1997)

Despite Poland being on the vanguard at the time on RES with the 1997 Energy Act, it was only in 2001 that the European Union promoted a more serious approach to this issue with the 2001/77/EC Directive; this Directive (which was later updated with the 2009/28/EC Directive) can be consider as the 1st European response to the previous signed Kyoto Protocol. The implementation of support schemes to the producers/investors on RES (article 4) or the purchase prioritization of RES powered electricity by transmission/distribution companies (article 7) are just some of the obligatory points that the EU inscribes on this Directive in order to promote and facilitate the expansion of RES.

To facilitate the implementation of the previous policies and its updates on the 2009/28/EC Directive, Poland adopted the National Renewable Energy Action Plan (NREAP) for a better strategy and policies integration. Targets and measures are both established considering the specific features of Poland, as we will discuss further.

This plan is incorporated on a broader strategy; the Energy Policy of Poland until 2030 allows people to have a more in depth strategy of Poland energy policy for the next

decade(s); energy security, energy efficiency, environmental issues and the energy mix (where RES are included) are some of the topics that this wide reform program will study the implementation of.

4.1. – RES current development

Renewable energy in Poland has been in constant rise since 2004; having agreed to a target of 15% in gross energy consumption from renewable energy sources by 2020, Poland (if we look at the recent numbers) seems capable of achieving it. As seen on **Figure 4**, since 2004 the percentage of energy originated from renewable sources almost doubled, increasing from 6.9% in 2004 to 11% in 2013; it is expected that this number have rose since we are already in 2015.

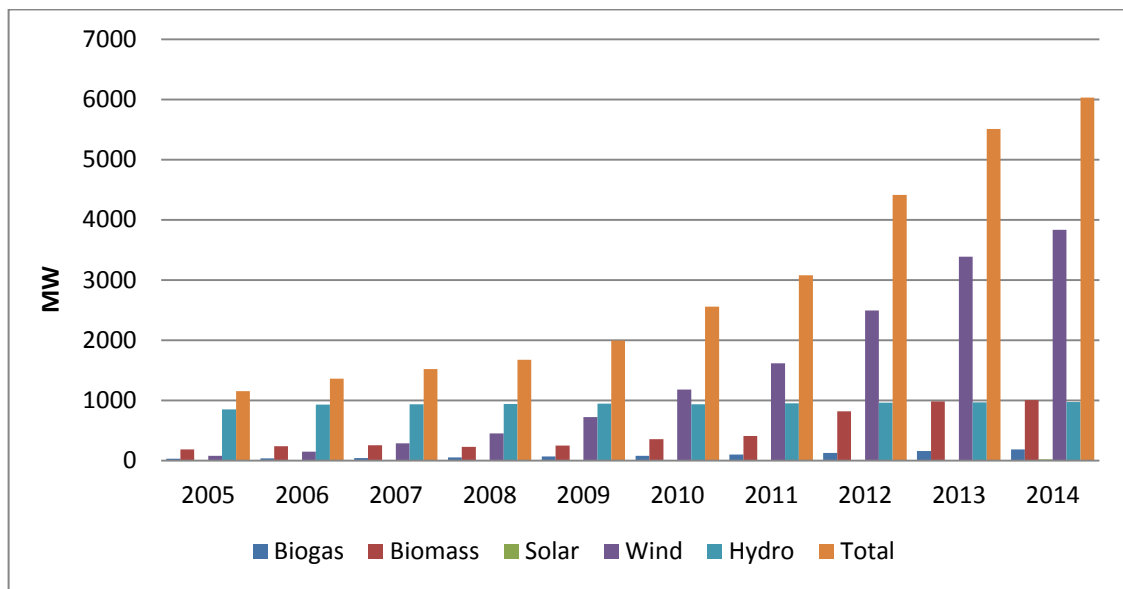
A consequence of this rise in renewable solutions can be found on the other type of energies specially the coal sector. Numbers show a steady decline of production which is accompanied by a not very pronounced decline in consumption; if we compare it to pre-EU years this is quite meaningful given the fact that Poland is one of world's biggest coal producers.

From 2006 to 2010, Poland experienced a decrease (according to Eurostat data) on the production of coal from 67 105.9 TOE to 55 076.9 TOE; this, comprises a break in production around 17.9% in 4 years which nearly turned the country from exporter to importer; consumption also decreased around 5 000 TOE from 2006 to 2009, rising in 2010 by 3 000 TOE. Comparing this data to the ones on **Figure 4** it is clear to access that renewable energies benefited from this fall, experiencing a rise in demand of 3% after a slow start.

As seen on previously, for this increase on RES, investments had to be made in infrastructures; according to the polish government stats (**Figure 9**), the installed capacity of RES increased nearly 6 times on the period from 2005 to 2014. This period, after the European Union membership saw changes on the type of energy with more usage. In 2005, which can be consider as the baseline year, Hydro type of energy was prominent and had the biggest share amongst RES; this situation where Hydro

“dominated” continued until the year 2010, when Wind energy “overthrown” Hydro as the type of energy with more installed capacity. Until the year 2014, this increment in Wind energy continued, being this by a long difference the type of energy with more installed capacity.

Figure 9: Poland installed capacity of RES (MW)



Source: [ERO (retrieved from: <http://www.ure.gov.pl/pl/rynki-energii/energia-elektryczna/odnawialne-zrodla-ener/potencjal-krajowy-oze/5753,Moc-zainstalowana-MW.html> and last accessed on September 10, 2015)]

It's also clear that we have to highlight the growing figures from Biomass installed capacity; this type of energy was in 2005 the second with more capacity but, it was quickly surpassed by Wind on the following years. Having stabilized until 2010, it received a new impulse and was capable to surpass Hydro capacity in 2013 as the number two of RES with most installed capacity in Poland.

4.2. – Wind energy

Wind energy is, according to the polish government data, the type of energy that will increase more from 2006 to 2030 (**Table 7**).

Starting with a residual 22 ktoe of electricity generated in 2006, the objective will be to increase this production up to 1 530 ktoe in 2030; if the figures turn out correctly then wind energy will increase its share on the renewable energy market from approximately 6% in 2006 to 45% in 2030. Given this vast increase it becomes imperative to understand the reasons to why the polish government has such high expectations.

The polish government assumes that the installed capacity of Wind energy will continue to increment (**Figure 9**) over the years; in order for these projections to materialize, the government added financial aid packages to the already enlisted Energy Act measures that will allow Wind energy producers to reduce costs of production.

On the measures implemented by the Energy Act is the minus 5MW producers exemption fee; on it, we came to the conclusion that of the total of 188 installations of Wind energy, 74 are below the required 5MW of production to have the tax exemption; this, is a relative high number of nearly 40% of exemptions that means micro/small generation in Poland is very popular amongst investors (**Table 8**).

An interesting measure on the NREAP strategy document is the exchange of experience/know-how with other companies or organizations; in this particular case, the cooperation was between the polish State by the hand of the Environment ministry and the Danish Energy Agency and focused on the improvement of Wind powered energy. The campaign, named as *Polish-Danish Energy Branding* allows and facilitates Polish companies and individuals to learn from some of the best in the business.

Location of Wind farms takes a comprehensive and exhaustive research, since, it is necessary to identify the best spots in order to maximize the investment. Due to this, sometimes the best spots available are placed in more sensible areas which, makes it necessary to obtain certain certifications and proper studies to comply with the territorial spatial organization:

“The draft National Spatial Development Concept 2030 prepared by the Ministry of Regional Development, assumes appointing zones for the purposes of the development of wind energy, which are going to be determined at the level of voivodship spatial development plans and are to be reflected in documents drawn up on the local planning level.” – (Minister of Economy, 2010)

There's a correspondence between the locals where Wind farms are implemented and the regions where the wind is stronger and more capable of having a more profitable production (**Figure: 10**). The Baltic coast has the highest value of wind per m/s (the darker the green is the highest is the wind speed) is the place with more potential for Wind energy; after it, the center of Poland (corridor between Warsaw-Poznan to the German border) is another "safe" place to invest. As it is clear from the huge concentration of Wind farms, investors followed the wind map to program their investments.

Wind strategy in Poland won't be concentrated only in land. The government prepared a series of measures/strategies to facilitate offshore Wind power production on the Baltic Sea; for it, it was published on the NREAP a 4 point program:

1. Identification of legal barriers that are preventing investments in offshore wind farms;
2. Preparation of regulations/laws that can contribute to facilitate investment;
3. Develop and make key important decisions for the future of offshore energy (grid systems);
4. Create synergies between different government bodies to find and allocate specific places to the development of offshore energy.

4.3. – Biomass

Biomass has an enormous potential in Poland; not only is the country one of the largest in Europe by area it also contains a vast % of it used by either forest or agriculture purposes (**Table 9**).

Foreseeing this potential, the Polish government is expectant and has projected that similarly to Wind, Biomass will be another key energy source for the future of the country. In 2006, Biomass was the 2nd type of energy most required (amongst RES) for the consumption of electricity and, in 2010 Biomass topped the energy charts as the most demanded surpassing Hydro energy; this growing tendency is assumed by the Polish government and, it is simulated that in 2030 the demand of Biomass power will be 994.9 ktoe (an increase of roughly 100% since 2015).

Energy competitiveness is always a key issue surrounding RES types; for Biomass to be competitive, the Polish government introduced a series of measures to improve this key aspect.

For starters, and considering the vast rural population that it still possesses, Poland developed a document entitled *Overall perspective on rural development*³⁷ that, clarifies strategies on Biomass development. This document provides a new strategy of new dynamics to rural areas by implementing new ways of subsistence and as the *National Renewable Energy Action Plan* states:

“(...) assumes that socio-economic function of rural areas cannot be reduced only to production of agricultural raw materials (...) but, to a growing extent, involves supply of other goods and fulfillment of functions that are significant from the point of view of society and ensuring sustainable social and economic development (...)” (Minister of Economy, 2010)

This new dynamic towards the rural development demonstrates that in the future (short-medium term), agricultural food production will cohabit with the production of RES either from Wind, Solar or as in form of Biomass provided by farms indicated for production.

Biomass production can be a topic very vague when we address it since, there are a lot of resources that can be used in it. In Poland, the government emphasizes 3 sectors that can contribute more regularly and consistently:

- Forests: given the vast area that of forests of roughly 30% (**Table 9**) it is only normal that this would be a key sector on Biomass production; several initiatives concerning efficiency on the forestry sector and forest cleaning allow this type of energy to develop even further. The projections of 2015 and 2020 (**Table 10**) are relative identical for energy produced based on forest resources.
- Agriculture: much like forestry, agriculture in Poland is characterized by a vast territory of production (**Table 11**); the NREAP argues that the primary objective for agriculture is undoubtedly to guarantee food supply but, products whose are not needed (therefore considered an excess) are subject to Biofuel transformation. In 2009, the production of Biofuels was destined to be 3.2% of

³⁷ Document in Polish: *Zarys kierunków rozwoju obszarów wiejskich*

the total of agricultural land according to the Ministry of Agriculture and Rural development.

- Waste: of all 3 sectors, Biomass production from Waste residues has the biggest diversity of sources, however not all residues are acceptable to produce energy. To support this claim, we can argue that in terms of energy production, Waste is the 3rd source behind Forestry and Agriculture; despite this, Waste production energy is estimate to take a leap from 2015 to 2020 according to the NREAP but will still continue to be the 3rd source of Waste energy (**Table 10**). Diversity of sources is a big advantage of this type of energetic source; in total, the NREAP identifies 11 types from within the Waste sector that can be used for energy development. Of these 11 types I would highlight municipal waste, waste related to the industry sector and agricultural/livestock animal waste. Each of these is a representation of 3 traditional sectors (the urban/city life, industries and agriculture) in Poland and that is the reason for this selection.

4.4. – Biogas

Energy produced from biogas is an alternative to the co-firing of residues that we have seen previously on the biomass subchapter; derived from the same type sources, biogas represents a valuable alternative not only for RES but also as a substitute or complementary for natural gas energy.

This fact helps to empower biogas production since both (natural gas and biogas) can use transmission, storage and distribution installations, which in end is a tremendous boost on the competitiveness of this energetic resource. The 2009/28/EC also helps fomenting this type of energy by leveling the gas market:

“(...) Member States shall ensure that the charging of transmission and distribution tariffs does not discriminate against gas from renewable energy sources.”(European Parliament & Council Directive 2009/28)

Despite this, Poland had in 2014 only 33 plants producing Biogas which is a rather small number of it if we consider the potential of these energetic resource (Muradin, M., 2014).

4.5. – Hydro energy

Despite being the RES with more demand in 2006, hydroelectric power in Poland has ever since stagnated; on **Table 7** this situation is noticeable and, while hydro power demand stagnated, the rest of RES grew at a pace of around 100% from 2006 to 2010 and doubled its value to 2015. Meanwhile, Hydro power only grew around 20% from 2006 to 2010 and, approximately 14% from 2010 to 2015. Looking again for the table, it is clear that the polish government doesn't perceive Hydro energy as one of the top priorities for its future considering the low amount of growth that it's estimated for it from 2015 to 2030.

The environment is a key element when considering Hydro power plants. The impact that these projects have on the surrounding habitats can be sometimes destructive and that's perhaps one of the main reasons to why these types of installations in Poland are small sized plants; in fact, the polish government agrees that only small hydro plant will have an increase (which can explain the relative stagnation of these RES energetic sector).

The fact that small hydro plants are on the rise unlike large ones can be explained by the measures promoted by the government. Much like we saw earlier in Wind farms, Hydro plants below 5MW have special benefits that reward them with a boost in competitiveness. Apart from this boost, entry barriers play a big part in this sector; on it, small hydro has a big advantage over larger plants by the fact that since it has a small construction it will cause less damage than a large construction, how Paska, J. *et al.* declares:

“Even though the existing potential for hydropower in Poland is not yet completely exploited, because of political decision, further expansion is only possible to a limited extent. Operating a hydropower station is always associated with a serious intrusion into ecological systems. Energy policy indicates development of hydropower only in small-scale power stations.” (Paska, J. *et al.*, 2007)

Not only environment impacts are an entry barrier for hydro plants in Poland, the terrain is also a handicap to develop these infrastructures. With the country inserted on the European plain (that extends from Netherlands to Russia), Poland is plan country with

very few elevations, valleys or other sort of terrain that hydro plants can benefit from; on the south of country where the Carpathian Mountains influence the terrain roughness, it is a prime terrain to develop this RES. As seen on **Figure 11**, the big chunk of hydro plants are indeed located on the south of country where the more rugged terrain is felt; there's however some exceptions that we can locate on the map. Environmental risk is indeed a big factor when it comes to develop Hydro powered energy in Poland and this is perhaps one of the biggest challenge this sector faces that eventually leads to a more careful approach by investors and therefore a preference for small plants.

4.6. – Nuclear energy

The dilemma of Nuclear energy affects not only Poland but also the contemporary world in general; with the resolution 4/2009 approved by the Council of Ministers, Poland is undertaking efforts to retransform its energy mix in order to include nuclear energy. These efforts by the polish government are so intense that later that year of 2009, on the approval of the Poland Energy Policy until 2030, an entire chapter of it is dedicated to this energy by promoting measures and defining a strategy since mining to future locations of the plant and possible radioactive waste treatment.

Nuclear energy not only counts with the high level of approval by government but it also boost a tremendous popular support by its people; according to poll realized in 2014, 64% were in favor of the nuclear option which, is an improvement from past years when the “Yes” scored 50% (2009). (World-nuclear-news.org, 2014)

Despite this popular support, public consultation is still required not only at an internal level but also externally; on the external consultation, bordering countries were invited to give their opinion on the matter. Amongst them there was Germany, Slovakia and Austria that despite not having a physical border with Poland is still close enough for these types of projects to have an impact:

“Acting under the Environmental Impact Assessment (EIA) Act, the draft PNPP has been subjected to the Strategic Environmental Impact Assessment process” (Minister of Economy, 2014)

Internal consultations were also held mostly at an environmental level but also to possible investors; on it, the *Voivodeship/Voivode* play a key part on defining the specifics of the project since, they are responsible for the conduction of the consultations amongst their constituents and, also responsible to realize impact studies on the location the project is to be instituted.

“The Voivode is competent for the following (...) requesting GDEP³⁸ to reconcile the environmental conditions, together with a renewed impact report; conducting public consultation for renewed environmental impact assessment (...)” (Minister of Economy, 2014)

Being this a massive project, PGE took control of it; however in order to reduce costs, an agreement was forged between other important companies of the energy sector and mining:

“Partnerships may get formed (...). This enables to reduce the cost of acquisition of debt financing, which in the case of NPP³⁹ is the key factor (...). PGE Polska Grupa Energetyczna S.A., the investor of the first Polish NPP, has entered into talks with Tauron Polska Energia S.A., Enea S.A. and KGHM Polska Miedz S.A. (...)” (Minister of Economy, 2014)

The key to understand this is that all of these companies cited above are heavily linked to the State Treasury, on which it controls it or has a very generous shareholding percentage.

There is no denying the importance that nuclear power can have in Poland; the document Energy Policy of Poland until 2030 puts this energy source with over 10% share on the final energy production by that same year; this increment will also have to lead to changes on the transmissions systems which means that PSE as the sole system provider will have to invest to comply to the new needs that nuclear powered electricity brings to the market.

Nuclear energy can be a two way street; on the PNPP, the Fukushima accident of 2011 is highlighted as serious accident but, and I quote:

³⁸ General Directorate for Environmental Protection (Poland)

³⁹ Nuclear Power Plant

“(...) bears no immediate or direct consequence with respect to Poland whatsoever. In particular, there is no need to amend or modify the strategic governmental documents.”
(Minister of Economy, 2014)

This self-assurance by the Polish government is corroborated by its security strategy and also on its geological conditions, since it is very unlikely for Poland to suffer a major earthquake like Japan did; on the security matter, Poland follows 2 strategies: the 1st strategy encompasses the infrastructures of the plant that have to be state of the art, modern facilities; the 2nd strategy follows safety procedures connected mostly to the workers at the nuclear plant, where formations and information play a big part of it.

The build up to gain access to this energy source represents a tremendous effort by the Polish authorities that can't be dismissed. When it comes fruitful it will have the potential to boost immensely the energy mix of the country as well as providing an increase of electricity production that can eventually spill-over to a cheaper access of it. This project seems to be well underway to become Poland's symbolism of the future.

5. - Conclusions

Following the trend of the European Union, Poland is slowly advancing to the much required reforms on its key energetic sectors, both electricity and gas. On the electricity the reforms have been implemented according to EU parameters however, if we withdraw the generation branch of the equation there's a false sensation of competition on the other 2 branches transmission and distribution; while on the 1st its nearly inevitable the lack of competition, on the 2nd the measures engaged by Poland's energetic policy of consolidation dictates a *status quo* on the branch and a policy of non-aggression pact between the 4 majors.

“The creation of the energy giants might have been a good idea in theory, assuming that they would compete with each other on the domestic market (...)” (Nowak, B., 2009)

The gas sector isn't much different from the electricity; although the unbundling is completed, the influence of PGNIG is still felt vertically on the sector. This situation disrupts the market and puts Poland on a delicate situation that requires a balanced approach both to the European Union and on the other hand to Russia. A game of geopolitics is what is at stake on the gas sector so, despite Poland “*mistakes*” it is almost impossible to recriminate the country for wanting to keep a strong hand and influence on the market.

Renewable energy sources still continue to be the “Achilles' heel” of Poland energetic policy; being a country heavily dependent on fossil fuels with emphasis on coal, Poland only obliges to the RES initiative mostly due to imposition of the European Union and its environmental goals. Despite it, there is a significant improvement from the post-2004 to today and the expectation is for it to keep growing alongside other measures and investments (example of nuclear). Overall, the objective of diversifying the country energy sources is being accomplished.

Europe's current situation allows Poland to push forward one of its more substantial agendas inside the European community; the current and unfortunate situation of Ukraine provides Poland with a policy window to advocate for a more integrated

European energy market that will be able to cope with Russia and its attempts to “blackmail” and handicap the gas market. One of the idea enthusiasts is Donald Tusk, former Polish prime-minister and currently at the helm of the European Commission that on April of 2014 wrote to Financial Times an article entitled “A united Europe can end Russia’s energy stranglehold” on which he advocated:

“Regardless of how the stand-off over Ukraine develops, one lesson is clear: excessive dependence on Russian energy makes Europe weak (...) I therefore propose an energy union. It will return the European project to its roots.” (Financial Times, 2014)

Being at the forefront of this project, Poland will have to assume on the coming years its place as a regional leader in Europe, not only because it will be one of the countries that will benefit the most from it but also because historically it can be the place of converge between the West and the East, the big and the small countries that will be together for a single cause.

Following this dissertation, our future work will be done in Poland where the author has already signed a job contract and hope to upgrade his local knowledge on energy and sustainability policy.

6. - References

Council Decision (CE) 2002/358, (2002) concerning the approval by the European Community of the Kyoto Protocol and its Climate Change frameworks resolutions;

Enea.pl, (2015): “Enea Group information”:

- On <http://ir.enea.pl/en/ir/investor-relations/shares-and-shareholders/shareholders-structure>, last accessed on September 10, 2015;
- On http://ir.enea.pl/en/ir/investor-relations/enea-capital-group/business_profile, last accessed on September 10, 2015;

Energa.pl, (2015): “Energa group information”:

- On http://grupa.energa.pl/segment_wytwarzanie.xml, visited last on September 10, 2015;
- On <http://ir.energa.pl/pl/ir/serwis-relacji-inwestorskich/Akcjonariat/akcjonariat>, visited last on September 10, 2015;

Energy Charter Secretariat, (2011): “Poland in depth review of the investment climate and market structure in the energy sector”;

ERO, (2014): “National Report 2014”

European Commission, (2010): “Commission requests Poland to stop violation of EU rules on internal gas market”, last accessed on September 11, 2015 and available here: http://europa.eu/rapid/press-release_IP-10-945_en.htm;

European Commission, (2014): “Commission Opinion of XXX pursuant to Article 3(1) of Regulation (EC) No 714/2009 and Article 10 of Directive 2009/72/EC – Poland – *Polskie Sieci Elektroenergetyczne* S.A., last accessed on September 11, 2015 and available here:

<https://ec.europa.eu/energy/sites/ener/files/documents/2014%20093%20pl%20en.pdf>;

European Parliament & Council Directive (EC) 96/92, (1996) concerning the adoption of common rules for the electricity internal market;

European Parliament & Council Directive (EC) 2009/28, (2009) concerning the promotion of RES within the European Union and amending/repeal former Directives;

European Parliament & Council Directive (EU) 2012/27, (2012) concerning energy efficiency measures in the European Union and repealing/amending former Directives;

Financial Times (2014), “A United Europe Can End Russia’s Energy Stranglehold”, FT.com, last accessed on September 10, 2015 and available at: <http://www.ft.com/intl/cms/s/0/91508464-c661-11e3-ba0e-00144feabdc0.html#axzz3lPbNq92H>;

GKPGE.pl, (2015): “PGE Group information”:

- On <http://www.pgegiek.pl/index.php/elektrownie/elektrownia-belchatow/>, last visited on September 10, 2015;
- On <http://www.pgegiek.pl/index.php/elektrownie/elektrownia-turow/>, accessed last on September 10, 2015;
- On <http://www.pgegiek.pl/index.php/kopalnie/kopalnia-wegla-brunatnego-belchatow/>, last accessed on September 10, 2015;
- On <http://www.pgegiek.pl/index.php/kopalnie/kopalnia-wegla-brunatnego-turow/>, visited last on September 10, 2015;
- On <http://www.gkpge.pl/en/shares/shareholders>, last visited on September 10, 2015;

Icis.com, (2015): “Poland’s first liberalized market delayed by Gaz System”, last accessed on September 11, 2015 and available here: <http://www.icis.com/resources/news/2006/04/25/9286982/poland-s-first-liberalised-market-deal-delayed-by-gaz-system/>;

McGowan, F., Radosevic, S., & Von Tunzelmann, G. (2004): “The emerging industrial structure of the wider Europe”, London, Routledge;

Minister of Economy (2010): “National Renewable Energy Action Plan”, Warsaw;

Minister of Economy (2014): “Polish Nuclear Power Programme”, Warsaw;

Muradin, M. and Foltynowicz, Z. (2014): “Potential for producing biogas from agricultural waste in rural plants in Poland”, *Sustainability* 2014;

Nowak, B. (2007): “Adaptation of the polish gas and electricity sector to the requirements of the EU internal market directives – how far to the competitive electricity and gas market? Legal and business perspective”, *Yearbook of Polish European Studies*;

Nowak, B. (2009): “Challenges of Liberalization. The case of Polish Electricity and Gas Sector”, *MPRA Paper* No. 23804;

Nuti, D.M., (1982): “The Polish Crisis: Economic Factors and Constraints”;

Paska, J. and Surma, T. (2014): “Electricity generation from renewable energy sources in Poland”, *Renewable Energy* 71;

PGNiG.pl, (2015): “PGNiG information data”:

- On, <http://en.PGNiG.pl/investor-relations/stock-informations/shareholder-structure>, last visited on September 12, 2015;
- On, <http://en.PGNiG.pl/segments-of-activity/exploration-and-production/reserves>, last visited on September 12, 2015;

Radzka, B., (2006): “Liberalisation, privatization and regulation in the Polish electricity sector”, available at: http://www.pique.at/reports/pubs/PIQUE_CountryReports_Electricity_Poland_November2006.pdf;

State Treasury, (2008), “Privatisation Programme for the years 2008-2011”, Warsaw, last accessed at September 10, 2015 and available at: <http://msp.gov.pl/download.php?s=3&id=2006>;

Tauron.pl, (2015): “Tauron Group information”:

- On <http://en.tauron.pl/tauron/investor-relations/Pages/shareholder-structure.aspx>, last accessed on September 10, 2015;
- On <http://en.tauron.pl/tauron/about-tauron/Pages/generation-portfolio.aspx>, last accessed on September 10, 2015;

The Office of Sejm, (1997): “The Energy Law”, Warsaw;

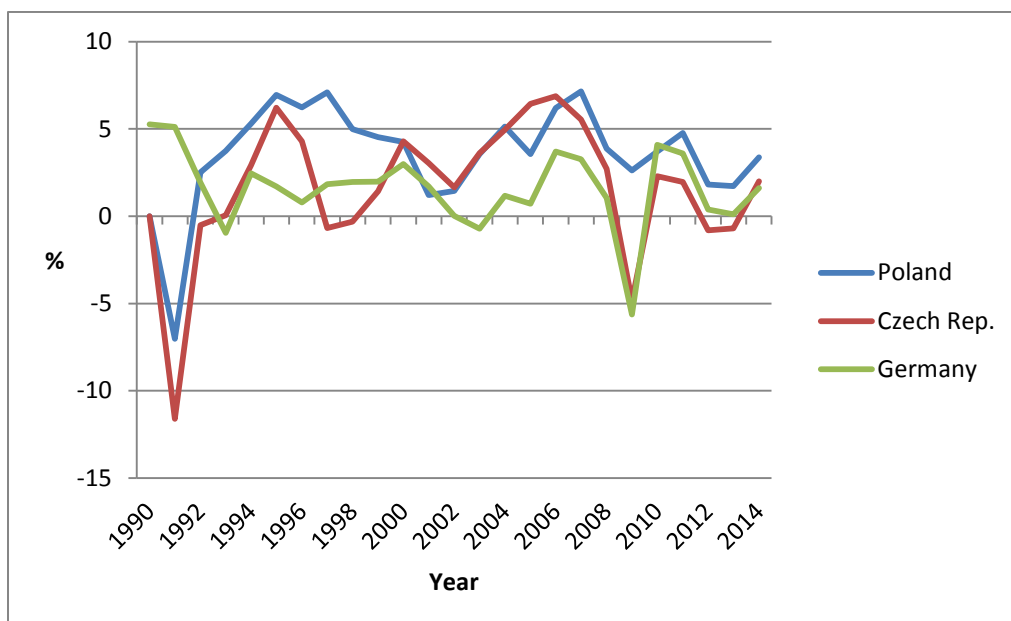
Vattenfall, (2011): “Vattenfall sells its Polish business”, Press Release, last accessed on September 10, 2015 and available here: http://corporate.vattenfall.com/globalassets/corporate/news_and_media/doc/press_release_poland_18558525.pdf;

World Bank, (1998): “Poland: energy sector restructuring program - establishing the Energy Regulatory Authority”. Energy Sector Management Assistance Programme (ESMAP); no. ESM 208 / 98. Washington, DC: World Bank.

World-nuclear-news.org, (2014): “Polish Public Supports Nuclear Plan”, last accessed at September 10, 2015 and available at: <http://www.world-nuclear-news.org/NP-Polish-public-supports-nuclear-plan-2608147.html>;

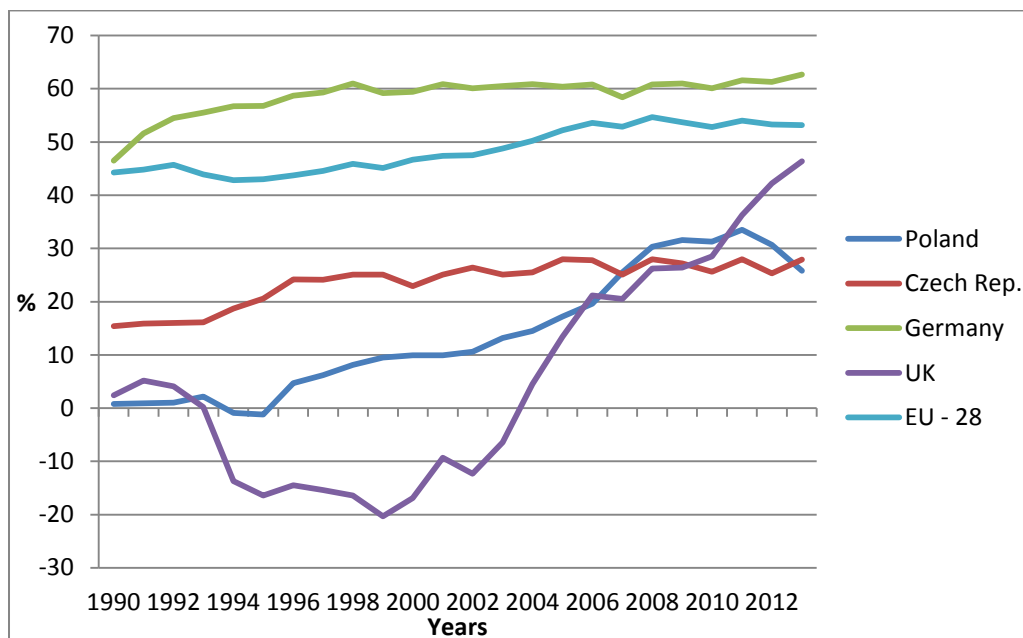
7. – Annex

Figure 1: GDP growth (%) since 1990



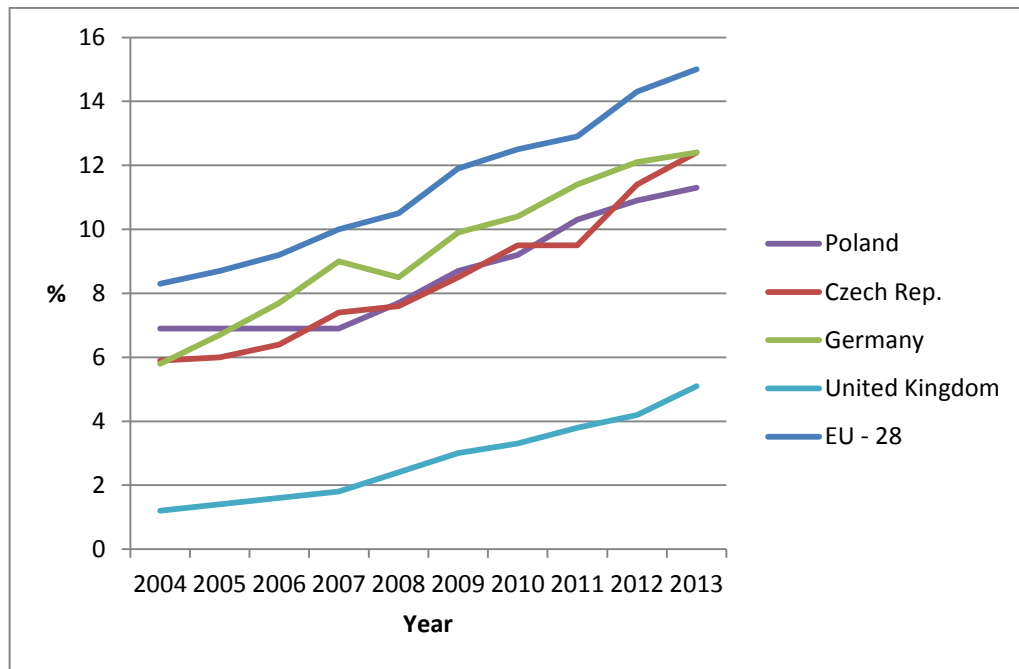
Source: [World Bank (World Development Indicators), 2015]

Figure 3: Energy dependence of all energetic sources (total %)



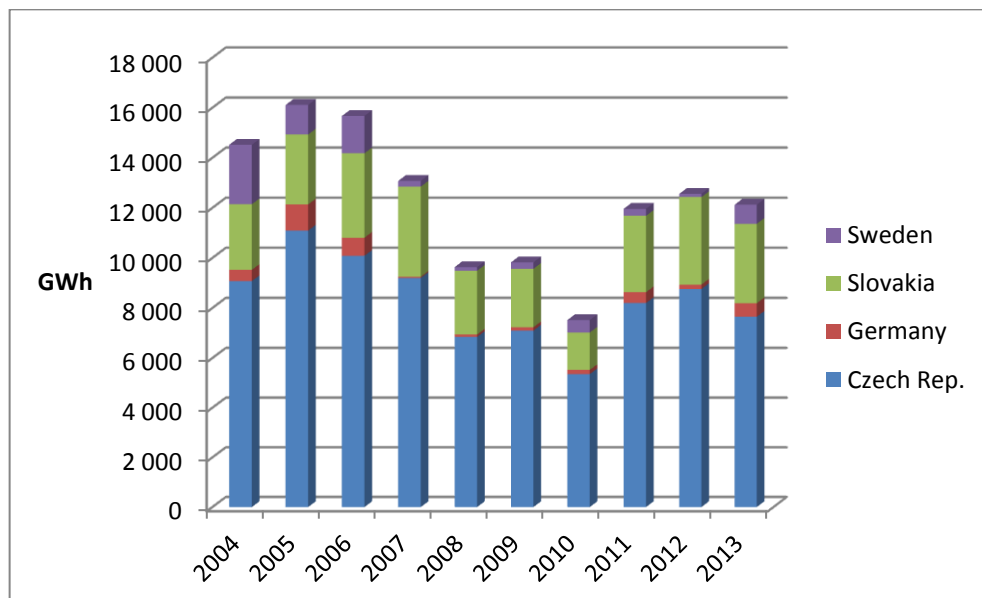
Source: [Eurostat, 2015]

Figure 4: Share of RES on gross energy consumption (%)



Source: [Eurostat, 2015]

Figure 5: Poland annual electricity imports (GWh)



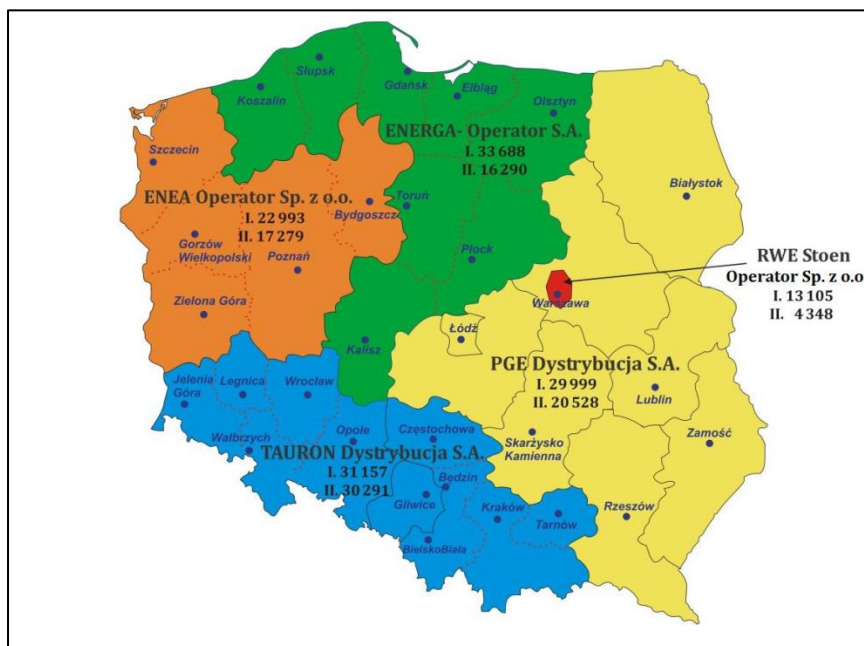
Source: [Eurostat, 2015]

Figure 6: Poland electricity prices per type of user



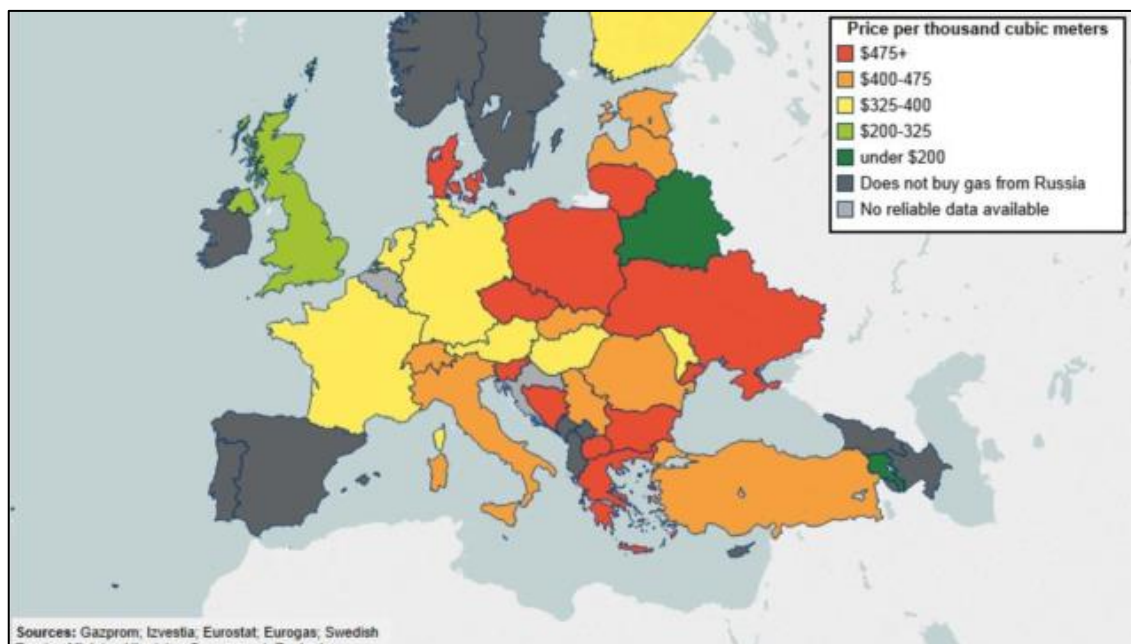
Source: [Eurostat, 2015]

Figure 7: Poland electricity DSO's activity areas



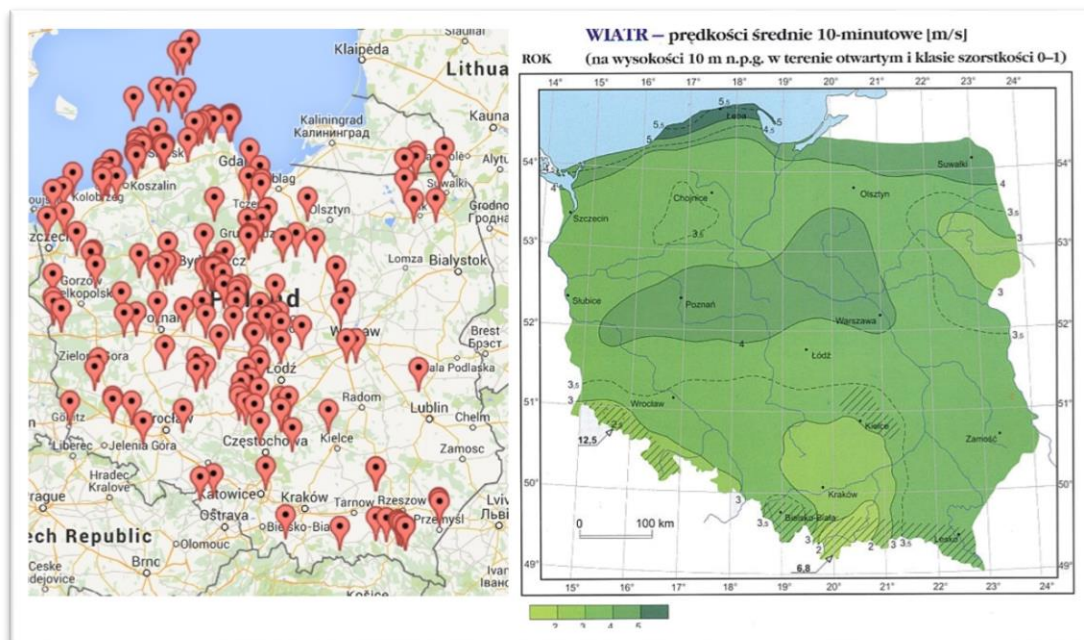
Source: [ERO (Energy Regulatory Office), National Activity Report 2014]

Figure 8: Price of Russian gas paid by European countries in 2013 (US\$)



Source: [Several sources (retrieved from: <http://www.rferl.org/content/russian-gas-how-much-gazprom/25442003.html> and last accessed on September 10, 2015)]

Figure 10: Poland wind farm locations and best spots for their implementation



Source: [Several sources (retrieved from: http://www.thewindpower.net/country_maps_en_27_poland.php and

<http://www.mae.com.pl/odnawialne-zrodla-energii-energia-wiatru.html>, both last accessed on September 10, 2015)]

Figure 11: Poland Hydroelectric plants locations



Source: [Retrieved online from: <http://gramwzielone.pl/mapa-instalacji-oze/elektrownia-wodna> and last accessed on September 10, 2015]

Table 2: Electricity availability

Country/Years		2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Poland	Total Produced (GWh)	154 159	156 936	161 742	159 348	155 305	151 720	157 657	163 548	162 139	164 557
	Total Available (GWh)	104 667	105 416	111 076	114 530	117 632	112 717	119 063	121 975	122 674	124 059
	RES %	2,1	2,7	3	3,5	4,4	5,8	6,6	8,2	10,7	10,7
Cz	Total Produced (GWh)	84 333	82 578	84 361	88 198	83 518	82 250	85 910	87 561	87 573	87 065
	Total Available (GWh)	53 832	55 291	57 016	57 234	58 033	54 906	57 204	56 751	56 654	56 691
	RES %	3,6	3,7	4	4,6	5,2	6,4	7,5	10,6	11,6	12,8
Ger	Total Produced (GWh)	617 469	622 579	639 492	640 578	640 406	595 617	632 983	613 068	629 812	633 158
	Total Available (GWh)	521 268	522 264	527 970	529 356	527 574	497 259	532 424	525 546	525 833	518 089
	RES %	9,4	10,5	11,8	13,6	15,1	17,4	18,1	20,9	23,6	25,6
UK	Total Produced (GWh)	393 936	398 355	397 282	396 830	388 892	376 718	381 707	367 251	363 406	359 150
	Total Available (GWh)	339 316	348 874	345 413	341 942	341 954	321 870	328 960	318 002	317 954	317 451
	RES %	3,5	4,1	4,5	4,8	5,5	6,7	7,4	8,8	10,8	13,9
EU	Total Produced (GWh)	3 303 358	3 325 137	3 370 363	3 383 249	3 386 623	3 221 430	3 364 421	3 296 044	3 296 551	3 261 537
	Total Available (GWh)	2 747 926	2 785 751	2 835 914	2 853 118	2 865 839	2 713 405	2 843 273	2 786 077	2 796 100	2 769 885
	RES %	14,3	14,8	15,3	16,1	17	19	19,6	21,7	23,5	25,4

Source: [Eurostat, 2015]

Table 3: Electricity losses since production to the final consumer (calculated based on Table 2)

Country	Loss % (2004)	Loss % (2013)
Poland	32,10	24,61
Cz	36,17	34,89
Germany	15,58	18,17
UK	13,87	11,61
EU - 28	16,81	15,07

Source: Own elaboration

Table 6: Gazprom exports of Natural Gas to Poland, Czech Republic and Germany

Gazprom gas sales (Bcm)					
Year	2010	2011	2012	2013	2014
Poland	11.8	10.3	13.1	12.9	9.1
Czech Rep.	9	8.2	8.3	7.9	0.8
Germany	35.3	34.1	34	41	40.3

Source: *[Factbook "Gazprom in figures 2010-2014]*

Table 7: Demand of RES from gross energy consumption (ktoe)

	2006	2010	2015	2020	2025	2030
Wind	22.0	174.0	631.9	1 178.4	1 470.0	1 530.0
Biomass	159.2	298.5	503.2	892.3	953	994.9
Hydro	175.6	211	240.3	271.4	276.7	276.7
Biogas	13.8	31.4	140.7	344.5	555.6	592.6
Total	370.6	715.0	1 516.1	2 686.6	3 256.3	3 396.3

Source: [National Renewable Energy Plan, 2010]

Table 8: Number of wind farms in Poland by capacity

Capacity ≤ 5MW	Capacity >5MW
74	114

Source: [Retrieved online from:
http://www.thewindpower.net/country_windfarms_en_27_poland.php and last accessed
on September 10, 2015]

Table 9: Percentage of land in Poland covered with forest

Years	2000-2004	2005-2009	2010-2014
%	30.7	30.8	30.8

Source: [World Bank (World Development Indicators), 2015]

Table 10: Biomass energy sources in Poland

Year	2015	2020
Forestry	2002	2081
Agriculture	1763	2929
Waste	1151	1758

Source: [National Renewable Energy Plan, 2010]

Table 11: Percentage of area of Poland that can be used to agriculture

Years	2000-2004	2005-2009	2010-2014
%	48	48.6	47.4

Source: *[World Bank (World Development Indicators), 2015]*