ΠΑΝΕΠΙΣΤΗΜΙΟ ΠΕΙΡΑΙΩΣ

UNIVERSITY OF PIRAEUS

Energy and Environmental Policy Laboratory

Overview of the energy sector and the energy policy of Poland

---

Kamila-Anna Giantas

Working Paper 14

February 2019

The contents of this paper are the author's sole responsibility. They do not necessarily represent the views of the Energy and Environmental Policy Laboratory of the University of Piraeus, of any of the Laboratory's members, and/or of the author's other affiliations.

ISBN

xxxx

ABSTRACT

Poland is the 6th largest consumer among the countries-members of the European Union. The polish energy sector creates nearly 8% of GDP.[1] Taking into consideration the importance of the energy sector in Poland's economy, this research offers a detailed review of the energy sector and the energy system of Poland. The polish energy sector is dominated by coal, making the country's energy mix rather unbalanced, despite the increasing share of other energy sources. This fact, combined with high dependency on certain sources and certain suppliers, creates concerns regarding the energy security of the country. Thus, the study puts special focus on the energy security of the country, which serves as stimulus to discuss projects and possibilities of diversification of routes, sources and suppliers.

[1] (Bieliszczuk, Kowalewski, & Stolarz, 2016)

TABLE OF CONTENTS

INTRODUCTION 6
COUNTRY OVERVIEW 8
1. ENERGY SYSTEM OVERVIEW 11
2. ENERGY SECTORS 20
COAL 20
OIL 29
NATURAL GAS 34
RENEWABLE SOURCES 38
NUCLEAR POWER 41
ELECTRICITY 44
3. KEY POLICIES 51
4. ENERGY SECURITY 64
5. CONCLUSION 76
BIBLIOGRAPHY 81

ACRONYMS AND ABBREVIATIONS

BEMIP	Baltic Energy Market Interconnection Plan
CARG	Compound Annual Rate Growth
CEF	Connecting Europe Facility
EPP2030	Energy Policy of Poland until 2030
ETS	Emission Trading System
EU	European Union
GDP	Gross Domestic Product
GHG	Green House Gasses
GIPL	Gas Interconnection between Poland and Lithuania
IEA	International Energy Agency
LNG	Liquefied Natural Gas
LPG	Liquefied Petroleum Gas
MRA	Material Reserves Agency
NATO	National Atlantic Treaty Organization
NCBJ	National Centre for Nuclear Research
NESO	National Emergency Strategy Organization
NPP	Nuclear Power Plant
OECD	Organization for Economic Co-operation and Development
PiS	Prawo i Sprawiedliwość
PNPP	Polish Nuclear Power Program
RES Act	Renewable Energy Sources Act
SPA 2020	Strategiczny plan adaptacji dla sektorów i obszarów wrażliwych na zmiany klimatu do roku 2020 z perspektywą do roku 2030
SSO	Storage System Operator
TFC	Total Final Consumption
TPES	Total Primary Energy Supply
TSO	Transmission System Operator

INTRODUCTION

The energy sector is inevitably connected to a country's economy. The smooth functioning of an economy, social development and prosperity require efficient energy systems and infrastructure. Last years more and more focus has been directed to the concepts of energy security, diversification of sources, routes, and the environmental impact of energy. Many countries, including Poland, have taken efforts in order to secure energy supply and seal a prosperous future. Poland has to deal with several challenges, including high dependence on oil and natural gas imports, increasing electricity demand, insufficient share of renewable sources in energy basket combined with high reliance on coal.

The purpose of this research is to broaden the understanding of multiple aspects of the energy sector and energy system of Poland. Reviewing the polish energy sector will give us a great insight of the energy sources that are of central importance for Poland, aspects of its energy security and some weaknesses of the country's energy sector. Additionally a descriptive presentation of polish policies (national and European) and existing institutional framework and responsibilities of the institutions individually supplement the research. Great attention is directed towards the issues of energy security and energy dependency.

Therefore, the above parameters of the energy sector of Poland are the subject of examination in five parts of this research. In the first part, the study will introduce the basic characteristics of the energy profile of Poland. The questions that will be answered are: What is the long-term trend in total supply and consumption of energy in Poland? What is the dependency ratio from imports generally and from each source individually? As it will be presented, Poland faces great problem because of its high dependency ratio from energy imports. As the demand for energy is increasing, the domestic production cannot meet the demand needs and Poland is forced to import energy, decreasing its energy security.

The presentation of the most important institutions in the energy sector of Poland follows. The most notable institution responsible for the execution of polish energy policy is the Ministry of Energy, created in 2015.

The second part is an in depth analysis of each of the energy sectors. Some key-concepts (supply, demand, structure and institutions) will direct this analysis.

In the third place, the dimensions of key policies in the energy sector will be explained. Poland, as a member state of the European Union, does not only implement national policies, but also is responsible for reaching goals stated in EU policies. The scope of the policies is broad, since it includes among other environment and renewable energy, transport, energy security, energy efficiency.

The concept of energy security is illustrated in the fourth part of this research. The elements that are introduced in this section refer to how Poland ensures its security of supply, and secondly what are the threats for energy security of Poland.

Last but not least, the last part will conclude with some outcomes of the research.

COUNTRY OVERVIEW

Poland is one of the countries of Central Europe, in the Baltic Sea. It borders with Germany, Ukraine, Kaliningrad Oblast, the Czech Republic, Slovak Republic, Lithuania and Belarus. The country is the 9th largest in Europe with its territory counting 312.679 km^2 and population of 38 million. (Figure 1.1)

Figure 1.1: Poland in Europe[2]

Poland is divided into 16 voivodeships and further to powiats and gminas. Warsaw is the capital of the country and Zloty (PLN) is the currency.

The Republic of Poland is a democratic state, with its governmental system to be based on the principle of separation and balance between legislative, executive and judicial powers.

[2] (Central Intelligence Agency, n.d.)

The President is the head of the state, while the government is represented by the Council of Ministers with the Prime Minister as its leader. Polish Parliament is bicamneral with a Senat (100 members) and Sejm (460 members).

The most recent presidential and parliamentary elections were held in 2015, with the right-wing party of Law and Justice to win the majority of the votes. Prime Monister of Poland is Mateusz Morawiecki, succeeding since December 2017 Beata Szydło. Next parliamentary elections are planned for in 2019. In presidential elections, PiS candidate, Andrzej Duda prevailed.

Poland participates in many international organizations such as the European Union, the North Atlantic Treaty Organization (NATO), Organization for Economic Co-operation and Development, World Trade Organization.

From economic perspective Poland follows economic liberalization since the 1990s. Today Poland is a steady growing country. Since the 90's the polish economy has doubled its size and has made impressive effort to catch up with other OECD countries.[3] Additionally Poland was one of the fastest growing economies in Europe not only in pre-crisis but also in post-crisis period in Europe. The Figure 1.3 confirms that Poland is one of the countries in Europe that during the period 2008-2013 showed positive Compound Annual Growth Rate of GDP per capita. The annual growth rate of GDP of Poland has one of the best scores in the European Union as depicted in Figure 1.2. Among 28 countries-members of the European Union, polish real GDP growth rate is the 7th highest. The GDP is rising (4,8% in 2017) while unemployment is the 5th lowest in the EU.[4]

[3] (International Energy Agency, 2017)

[4] (Szymański, 2018)

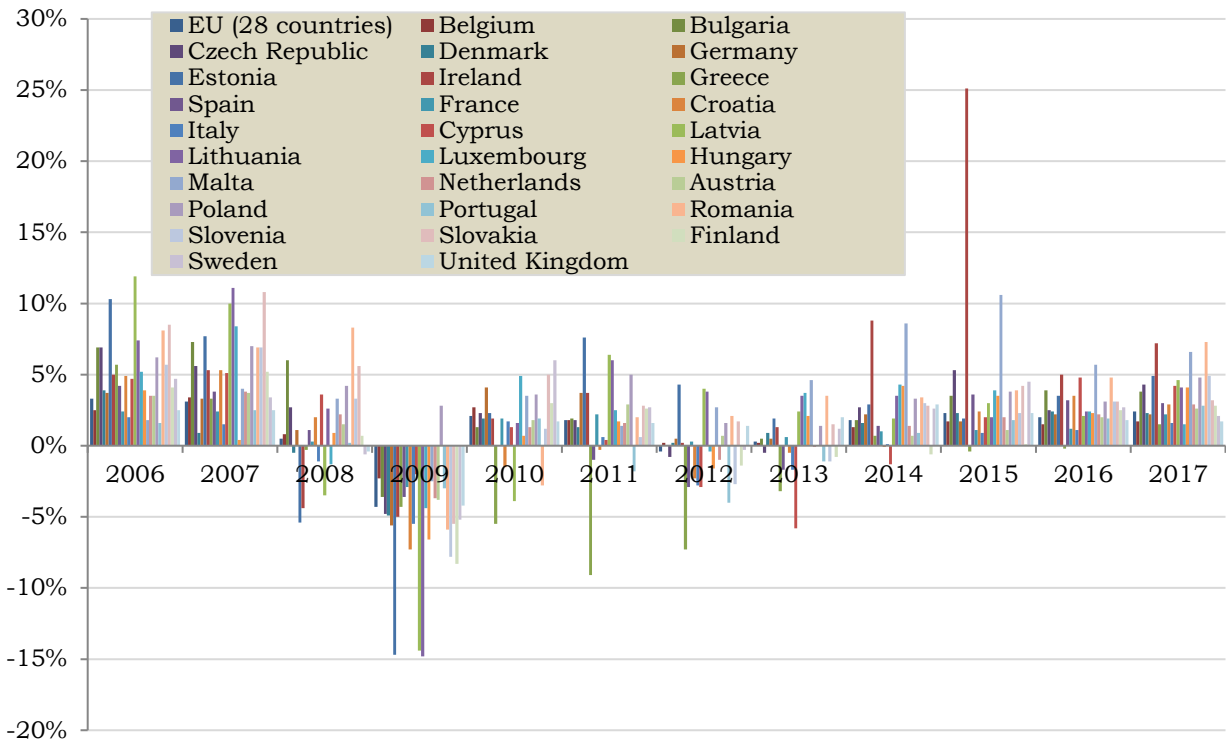

Figure1.2: Real GDP Growth Rate [5]

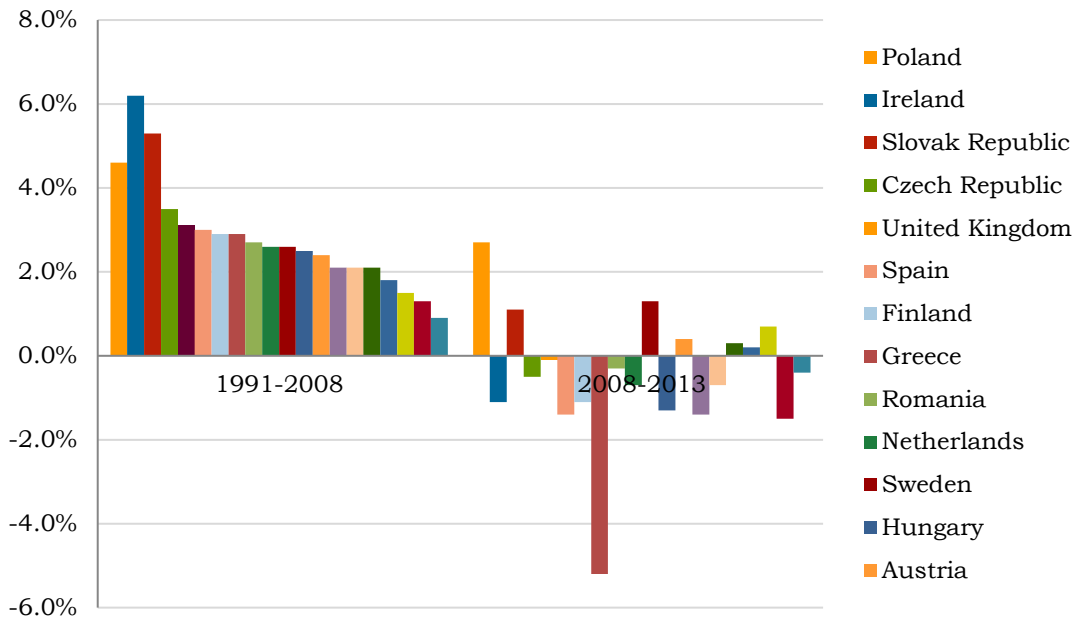

Figure 1.3: GDP per capita CAGR (%) Real Local Currency Unit [6]

[5] (Eurostat, n.d.)

[6] (Bodgan, Boniecki, Labaye, Marciniak, & Nowacki, 2015)

1. ENERGY SYSTEM OVERVIEW

The first section provides insight of the main components of the energy sector of Poland. Poland's energy sector is mainly based on fossil fuels. Hard coal and lignite have the largest share in total energy supply of the country, and the largest share in electricity generation. Thus, coal is strongly connected to the energy security of Poland, making the country highly dependent on domestic production of the source. Thanks to the existing production Poland is a net exporter in coal sector. The gradual decrease in coal production raises questions about security of supply of the country. In addition, Poland's dependence on oil imports, is around 95%, creates similar concerns. That is why Poland has been taking steps in order to further diverse its energy mix, by increasing the share of natural gas, renewable sources, and introducing nuclear power. Despite the efforts to encourage alternative sources production, the transition towards less coal-driven economy is slow.

1.1 ENERGY SYSTEM

When analyzing the polish energy sector some key concepts, that shape and affect the actions of polish governments, must be examined. These concepts are: *Total Primary Energy Supply, Total Final Consumption, Energy Sectors, Energy Security, National and European Policies.* The first two notions will be examined in the next paragraphs of this unit, while the rest are subjects of separate units.

Total Primary Energy Supply (TPES) includes mainly the indigenous production of energy resources of a country, imported and exported energy, and secondary additions of international marine and aviation bunkers and stock changes.[7]

Regarding Total Primary Energy Supply in Poland, it has dropped from over 100 Mtoe in 1990 to around 88 Mtoe in the beginning of the next decade. Since the 2000s TPES has been steadily rising, reaching over 99 Mtoe in 2016.[8] (Figure 1.1)

[7] (International Energy Agency, n.d.)
[8] (International Energy Agency, n.d.)

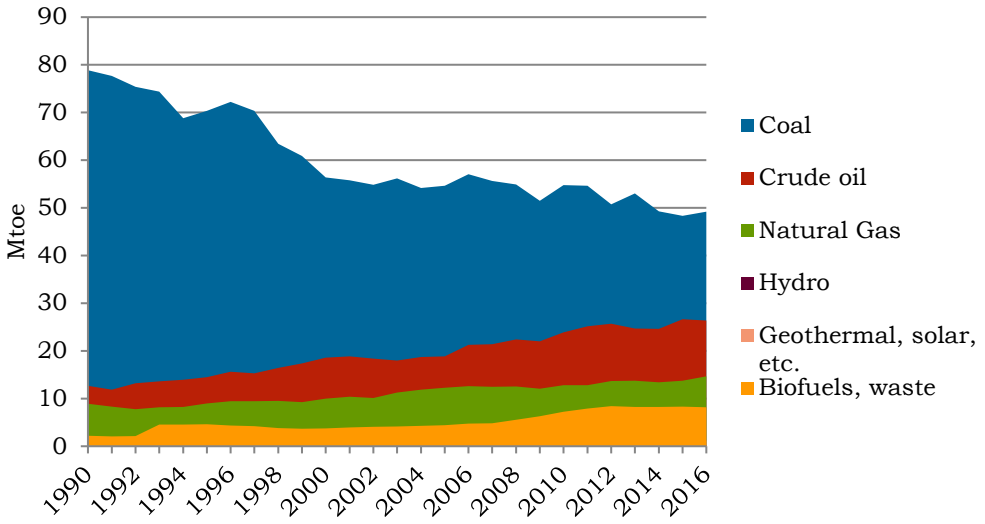

Figure1.1: Total supply by energy source[9]

In 2016 the largest share in energy supply came from indigenous production, accounting 67% of TPES. This result is not satisfying, considering that in 1990 the domestic production covered the sum of internal domestic demand. On Figure 1.2 the evolution of domestic production of energy resources is depicted.

Today the largest share in energy supply mix has coal (almost 50%). Unlike other OECD countries, Poland has not substituted coal production with energy sources other than coal or lignite in a sufficient way. According to International Energy Agency, when comparing all IEA countrie, Poland has the largest share of coal in the country's energy mix (not included oil shale in Estonia).[10]

Specifically, coal production in 2016 (52.308 ktoe) is by 52.52% lower than in 1990 (98.969 ktoe). This has happened mainly due to the lower level of existing coal reserves in polish mines and the fact that polish mines are not profitable and the government invents large sums to keep the industry alive. This fact is of growing importance since coal is the key energy source for energy security for the country. For now, domestic production meets the majority of the total demand for coal. In 2016 the total consumption of coal in the scale of the country was 74.176 ktoe, while the demand was 52.308 ktoe.

On the other hand, as domestic coal production decreases, the shift in use of other than coal energy sources can be observed. To be more precise, in a spam of the last 25 years natural gas, crude oil, hydro

[9] (International Energy Agency, n.d.)
[10] (International Energy Agency, 2017)

energy, biofuels and waste, and geothermal , solar and other energy sources have an increased their share in Poland's energy production. For example the production of geothermal or solar energy started in 2000. Still the shift is rather slow and the alternative to coal sources cannot compensate the deficit in energy production.

The supply of natural gas has noted since the 1990 has noted an increase of 61%. Larger total supply of natural gas is a result of the increase of imports of this source. In particular the imports doubled during the period 1990-2016.

It should be also mentioned that renewable sources (biofuels, waste hydro, geothermal, solar) have an ever-growing share. The share of the above sources in 2016 (over 9,577%) is four times larger than twenty five years ago (2,281%). Biofuels and waste constitute the largest renewable source, reaching over 80% of renewables in energy supply and representing at least 8% in TPES.

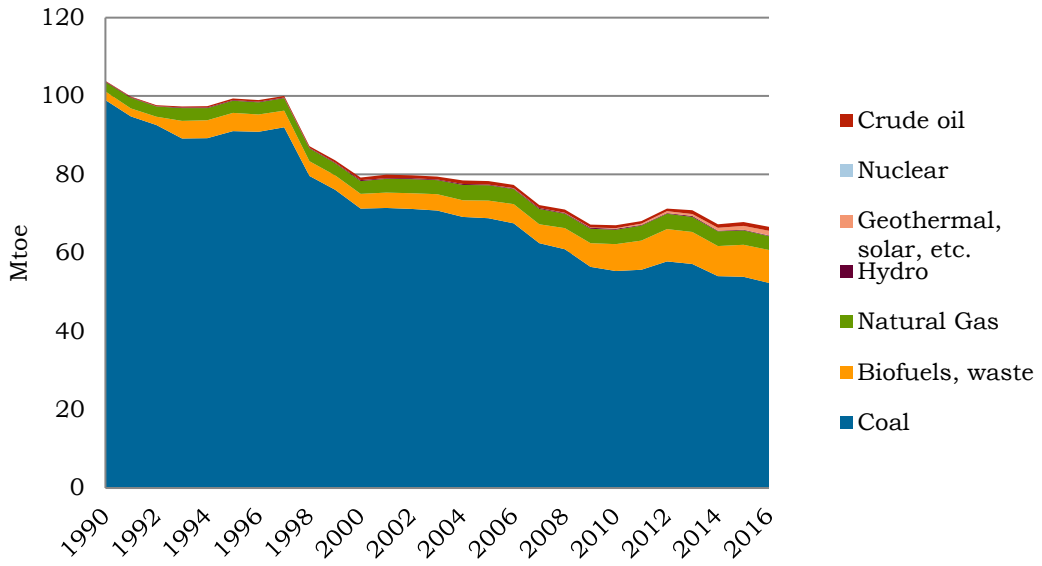

Figure 1.2: Production by energy source[11]

Since the 1990s the overall production of energy has declined, as mentioned above. At the same time the country's Total Primary Energy Supply has remained generally steady throughout the last 25 years. The vacuum between energy production and a steady TPES is covered by imports. This means that the self-sufficiency of the country in energy terms is declining.

[11] (International Energy Agency, n.d.)

The dependency rate shows the extent to which an economy relies upon imports in order to meet its energy needs. It is measured by the share of net imports (imports - exports) in gross inland energy consumption (meaning the sum of energy produced and net imports). Till 1995 Poland was a net energy importer. The exported energy amounted 23.834 ktoe, while imports reached 23.625 ktoe. Gradually, as the production downfall, the country faced a greater need for imports. Today imports stand at 51,913 ktoe and exports at 20,973 ktoe.

In the EU in 2016, the dependency rate was equal to 54 %, which means that more than half of the EU's energy needs were met by net imports. In Poland this rate in 2016 was over 31%, a percentage that has tripled compared to the levels of 1990, when it was below 1%.

The highest rate of dependency can be observed in oil with values from 94% to over 100%, showing overall stability. According to data retrieved from the International Energy Agency, in 2016 dependency from oil imports reached over 95% with the majority of the imports to concern crude oil.

Dependency from imports of natural gas is lower (almost 80%) but still made up over one fifth of total imports. The dependency rate didn't show many fluctuations through the years. In the future Poland's dependency on imported, mainly from Russia, natural gas is expected to increase since the country implements a gradual shift from coal-based economy.

Dependency on imports of biofuels and waste is almost negligible, but since 2006 it is rising. Last but not least, Poland, despite the large domestic production, imports a small amount of coal for reasons that are presented in the Unit: *ENERGY SECURITY*.

Poland's dependency from the most important energy sources and generally from energy imports since 1990 are depicted on the graphs that follow. (Figure 1.3 and 1.4) The increasing import dependency follows since the 90s an upward trend and there is no indication that this situation will change significantly in the near future, since no turning point (e.g. introducing domestic production) can be observed in imports, for example, of natural gas or oil from external supplies. High rates of dependency from imports are threatening for the energy security of the country.

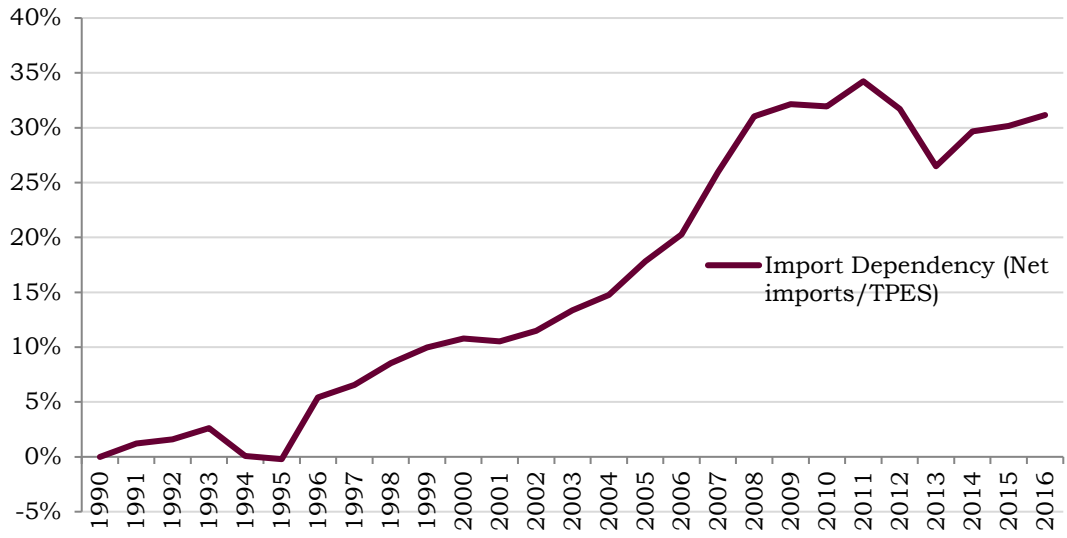

Figure 1.3: Import dependency (Net imports/TPES)

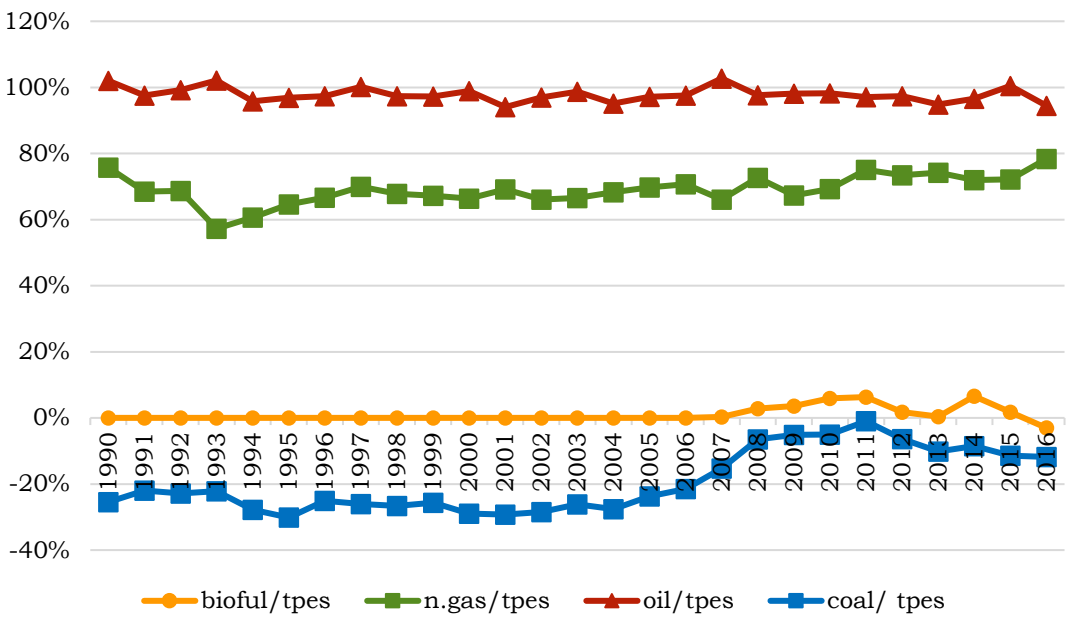

Figure 1.4: Dependency from energy sources (Net imports of source/TPES of source)[12]

[12] Calculation for overall dependency and for each source dependency is based on: https://www.iea.org/statistics/?country=POLAND&year=2016&category=Key%20indicators&indicator=TPESbySource&mode=chart&categoryBrowse=false&dataTable=BALANCES&showDataTable=true for each year.

The second concept that needs to be examined is *Total Final Consumption.* TFC is the sum of energy consumed by end users (households, industry, and agriculture). The unit excludes the energy that is used by the sector itself (delivery, transformation).[13]

Since the early 1990s, with the collapse of the Soviet Union, the energy sector of the country underwent some weighty changes. On one hand some assets were privatized, on the other hand the state gained large stakes and control over the most important companies in the industry, such as Katowicki Holding S.A. and Kompania Węglowa.[14] After 1989 a drop in the consumed energy can be observed. This decline, especially of coal (Figure 1.6), remained until the early 2000s (Figure 1.5) and was caused mainly due to the shrinking activity of heavy industries.[15]

Total Final Consumption showed fluctuations until 1995. During 1996- 2002 final energy consumption decreased, reaching its lowest point in 2002 (57.274 ktoe). Since then an overall tendency (with some exceptions in years 2009, 2011-2014) for increase can be observed. The highest point since 1990 was reached in 2016.

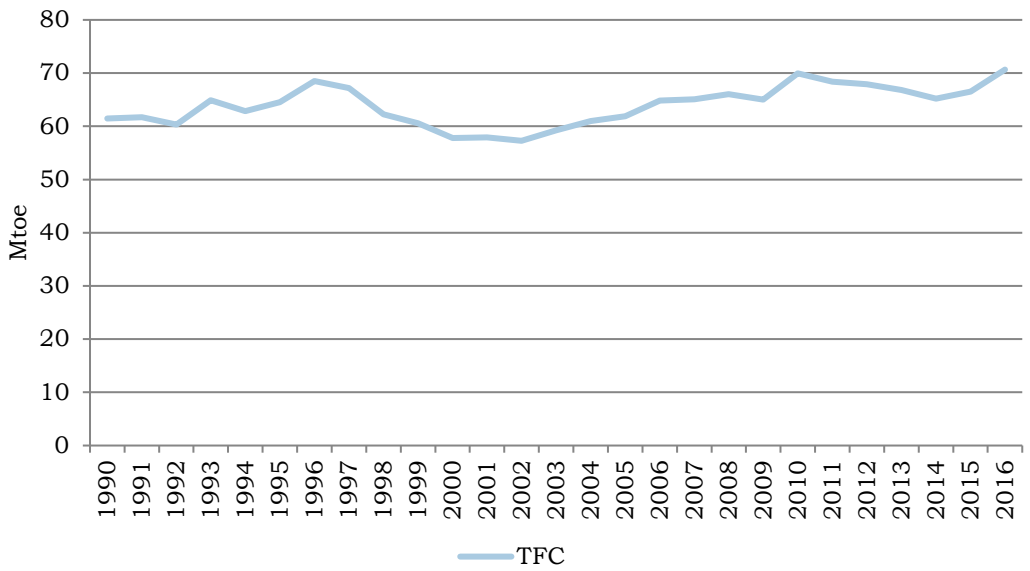

Figure 1.5: Total Final Consumption[16]

[13] (Eurostat, n.d.)
[14] (OECD, 2016)
[15] (Piszczatowska, 2018)
[16] (International Energy Agency, n.d.)

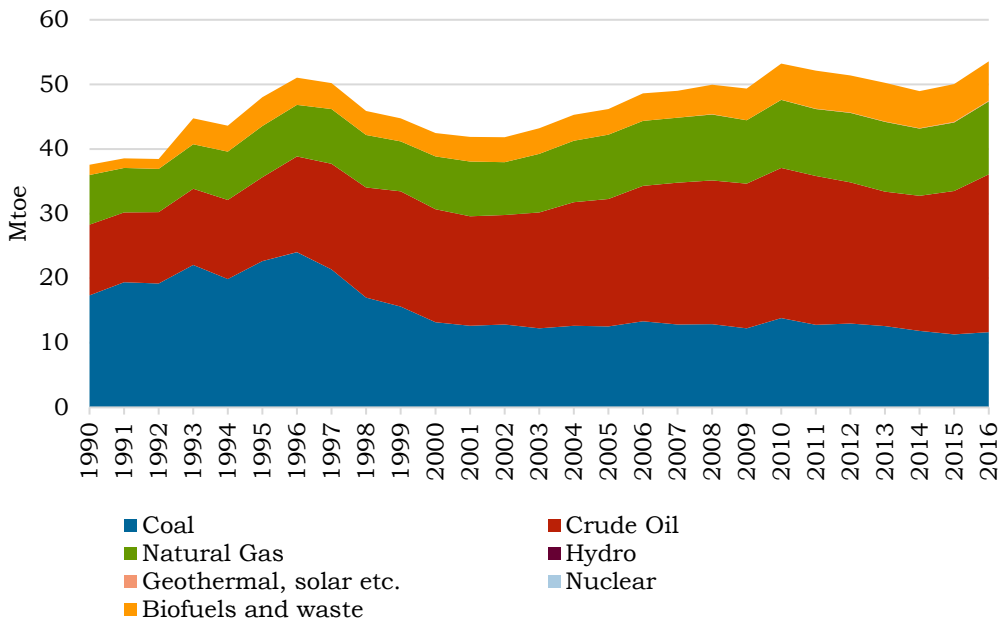

Figure 1.6: Total Final Consumption by energy source[17]

In Poland the sectors requiring the most energy are transport, residential and industry. The largest source of energy is crude oil for transport, natural gas for industry and coal for residential. Poland has one of the largest district-heating markets in Europe, providing one-fifth of TFC in the residential sector. [18] (Figure 1.7)

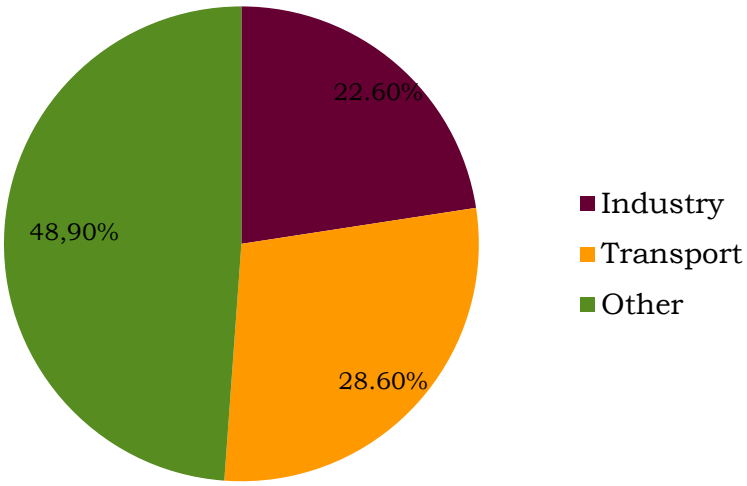

Figure 1.7: Share of Total Final Consumption by sector[19]

[17] (International Energy Agency, n.d.)
[18] (International Energy Agency, 2017)
[19] (International Energy Agency, n.d.)

One of the foundations of each country's economy is its energy security. Security of energy supplies, according to European Commission, means uninterrupted availability of energy sources at an affordable price. [20] In other words, the preservation or the improvement of current level of economic growth needs great amount of energy. Economic growth and prosperity, transportation and functioning of cities depend on secure energy supplies. Poland's energy sector is based mainly on coal. The indigenous production of this source provides the majority of supply of energy in Poland. Thus, the introduction of other than coal energy sources is conducted in order to enhance energy security of the country, but the transition is executed in a very slow pace. At the same time import dependency is over 30%. The polish governments have demonstrated efforts on institutional level to co-ordinate bodies and shape its polish energy policy that will secure the country's energy security. The most prominent example is the creation of Ministry of Energy, as it will be examined in the part that follows.

1.2. INSTITUTIONS

In this part of the study, the attention is directed towards the institutional framework of polish energy system. The institutional framework of Poland's energy policy includes first and foremost its Ministry of Energy. The Ministry of Energy was created in 2015. The Ministry is in charge of the implementation of the legal framework and the key elements of polish energy policy. To be more specific, the Ministry of Energy is co-responsible with other ministries for executing the overall energy policy, and for participating in EU bodies and shaping the energy policy of the European Union. The goals that the ministry has set are developing renewable and nuclear energy for socio-economic needs, improving energy infrastructure and initiating and coordinating international cooperation in the field of energy. The Ministry of Energy disposes and manages the property of the Treasury of state.[21] In this field the Ministry of Treasury can restructure public energy companies. The Ministry of Finance is also involved in energy policy, mainly by providing funds for energy companies owned by the polish state and by regulating end-use energy prices.

[20] (European Comission, 2014)
[21] (Ministerstwo Energii, 2018)

Another institution with relevant competence is the Ministry of Development. The overall policy, the improvement of energy sufficiency and securing energy security, increasing the use of renewable sources and reducing the impact of energy on the environment and co-shaping the energy policy and environmental regulations are among the responsibilities of the above ministry. Climate policy and environmental policy of Poland are shaped mainly by the Ministry of the Environment. There is also the National Atomic Energy Agency that engages when issues of atomic energy arise. The Energy Regulation Office is the key authority that is responsible for coordinating and monitoring the energy sector and energy prices. It also issues licenses for production, storage and transmission of fuels, natural gas and electricity. The antitrust policy and the policy for customer protection are shaped by the Office of Competition and Consumer Protection.[22]

In the next part, each of the energy sources will be examined separately with more detail and interpretation. Additionally more institutional framework will be presented in each energy source.

[22] (European Committee of the Regions, n.d.)

2. ENERGY SECTORS

In the second chapter we will explore in depth and separately the each of the energy sectors that form the polish energy industry, starting with the main energy source, coal, concluding with electricity.

COAL

Referring to the energy mix, coal dominates[23] the power sector of Poland making the country the 10th largest coal consumer in the world.[24] As a result coal is closely connected to the country's energy security.

Supply

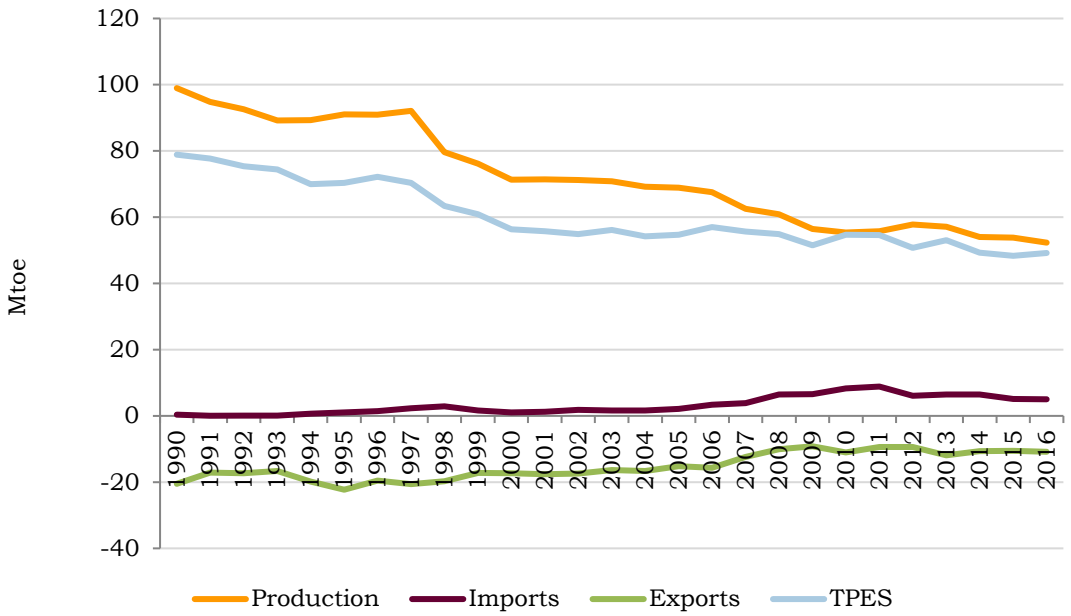

Figure 2.1: Balance of coal[25]

The existence of coal reserves was a critical condition for developing mining sector and domestic production. Coal constitutes 79% of energy production and 51% of total primary energy supply (TPES)[26] and is used mainly for heat and power generation, but also in residential and industry sectors. Most of the coal is produced domestically and the country is sufficient in both hard coal and lignite. At the same time the production has been gradually declining since 1970s[27], mines have been closing and the population engaged in

[23] (World Energy Council, n.d.)
[24] (Herold, Siemons, & Wojtal, 2017)
[25] (International Energy Agency, n.d.)
[26] (International Energy Agency, 2017)
[27] (Państwowy Instytut Geologiczny- Państwowy Instytut Badawczy, n.d.)

the mining sector is continuing to decrease. In 1990, 70 mines were active[28], while today the number dropped to around 30. Another assumption that arises is that the highest potential in exploiting hard coal is located in Lublin Coal Basin (where the "Bogdanka" mine operates and reserves amount to 20%) and in Upper Silesian Coal Basin (Górnośląski Zagłęb Węglowy) where the most hard coal is exploited and where around 80% of polish hard coal reserves are located[29] (Figure 2.2). On the Lower Silesian Coal Basin the exploiting operations ended in 2000[30], despite the existence of reserves.

Existing hard coal reserves, according to Polish Mining Institute are 51,9 gigatonnes (Gt).[31]

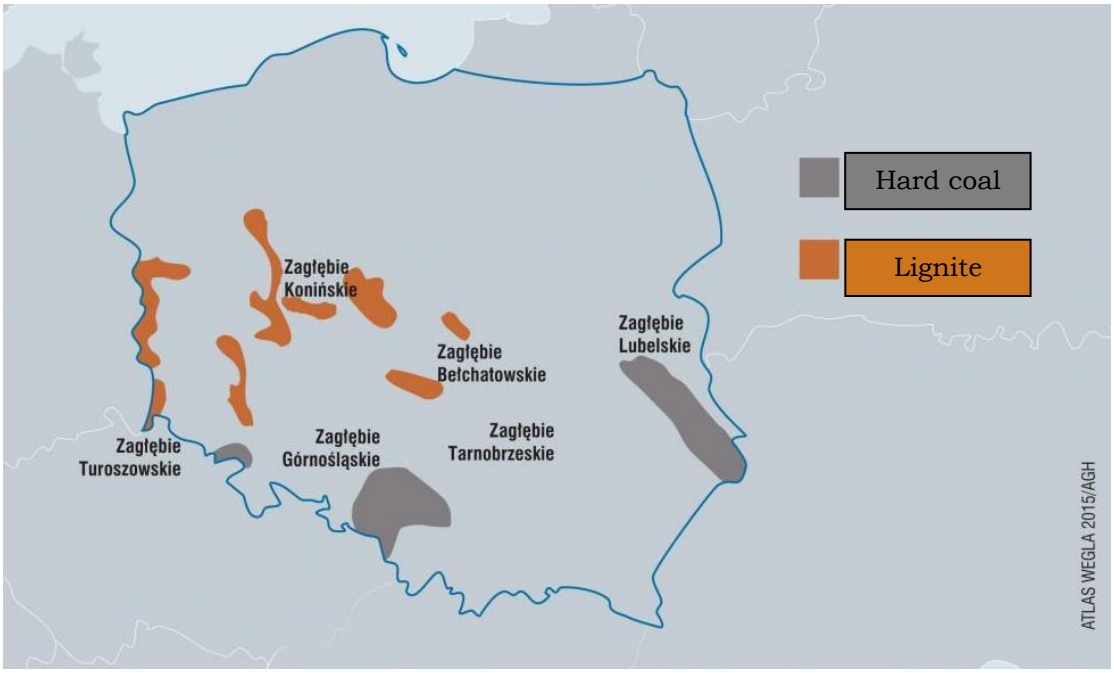

Figure 2.2: Map presenting deposits of hard coal and lignite[32]

Over the course of history Poland was known for being net exporter of the source. Still the country holds the status of net exporter. Poland is the larger exporter among all OECD countries of Europe[33]. The total exported coal for 2016 over 10Mtoe. The main countries-destinations for polish coal exports are Germany, the Czech Republic, Austria and even Turkey, Ukraine and Morocco. As for imports, Poland imported in 2016 over 5 Mtoe coal. The imported coal comes mostly from Russia

[28] (Państwowy Instytut Geologiczny- Państwowy Instytut Badawczy, n.d.)
[29] (World Energy Council, n.d.)
[30] (Państwowy Instytut Geologiczny- Państwowy Instytut Badawczy, n.d.)
[31] (International Energy Agency, 2017)
[32] (Heinrich Böll Stiftung, 2016)
[33] (World Energy Council, n.d.)

(60%) and Australia (19%).[34] The combination of domestic production and imports is explained on reasons of quality, seasonality and geography (proximity with Russia).[35]

Demand

Overall Poland is the 2nd largest coal consumer in Europe, only behind Germany. Coal demand has decreased since the 1990s in all sectors.

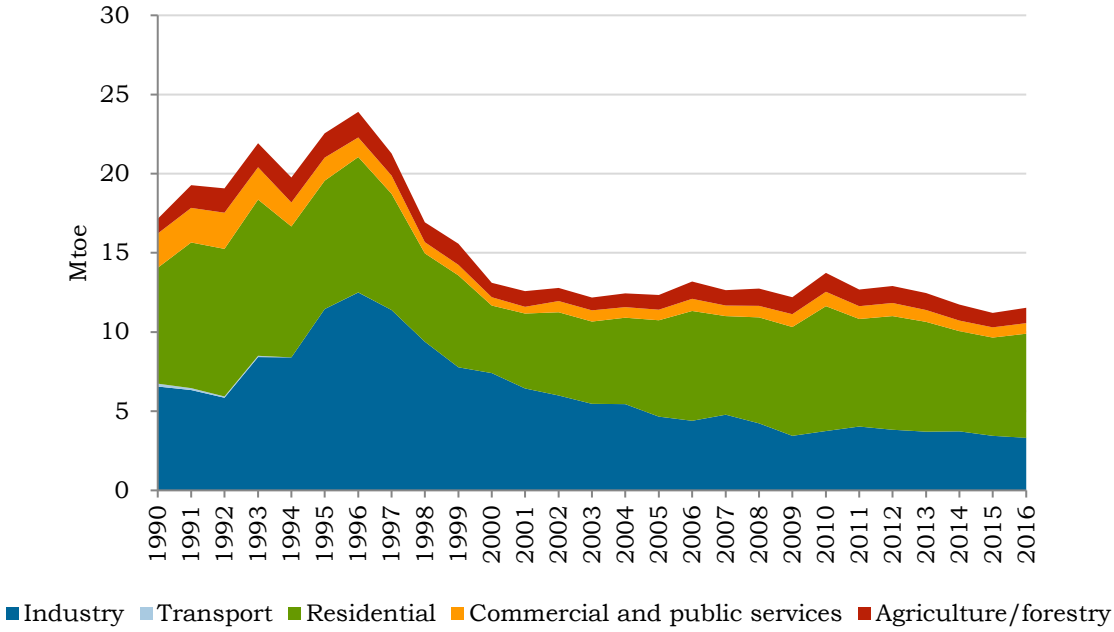

Figure 2.3: Demand of coal by sector (ktoe)[36]

Referring specifically to the year 2016, the share coal demand among the above sectors creates the pie chart in Figure 2.4, with the residential sector to fill the first place (6.586 ktoe), followed by the industry (3.315 ktoe).

[34] (International Energy Agency, 2017)
[35] (International Energy Agency, 2017)
[36] (International Energy Agency, n.d.)

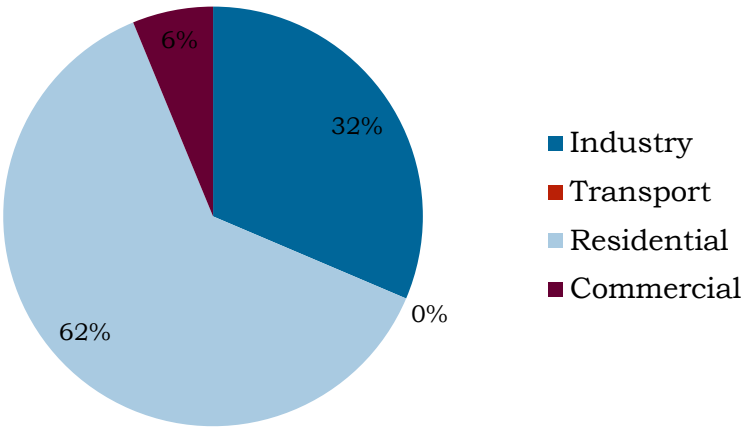

Figure 2.4: Share of coal by sector in 2016[37]

As for electricity, the main source for electricity production is coal, with almost 2/3 of hard coal is headed for electricity generation.[38]

In 2016 the production of lignite reached 60.246 kt, the lowest since 2010. Still Poland has the 2nd largest lignite production among EU countries, being behind only Germany with 171.547 kt produced lignite in 2017. In additional to that, the country's lignite exploitation is executed in five mines, and five power stations powered by lignite located nearby (Kopalnia Adamów, Kopalnia Konin, Kopalnia Turów, Kopalnia Sieniawa).[39]

The mine that exploited the largest amount of lignite is Bełchatów Mine, where the extracted resource accounted in 2017 70% percent of Poland's total production, and 40% of total exploited lignite since 1945. Konin Mine produced 14% of total lignite; Turów Mine reached 11% and Adamów Mine 5%. Sieniawa Mine exploited around 100.000 Mg, a marginal amount regarding the scores of the previous mines.[40] Since the last year the country made investments and modifications in order to modernize the sector and reach higher standards in exploitation systems. As the PGE GiEK Group informed, the Minister of the Environment extended the mining license for Bełchatów fields until December 31, 2026. The continuation of exploiting lignite in Bełchatów is of vital importance for the country. That happens because the fuel from extracted lignite provides power for Power

[37] (International Energy Agency, n.d.)
[38] (International Energy Agency, 2017)
[39] (Rosicki & Gielnik, n.d.)
[40] (Kasztelewicz, 2018)

Station Bełchatów, the most important station for Poland's energy security. Additionally the mine provided the cheapest fuel and as a result the cheapest energy for the country.[41] In next years-decades, the closure of the above mines will be conducted gradually: Adamów in 2029, Bełchatów in 2050, Konin in 2037 and Turów in 2035.[42] Areas with perspectives of exploitation are the Legnica reserves, the largest reserves in Europe, discovered in the 50s. To understand the scale of the reserves, a simple comparison is useful. Bełchatów's resources, the largest power plant are around 2 billion tons, while the reserves in Legnica are estimated for around 35 billion tons (from which 15 billion tons suitable for exploitation). The depth is around 200m, similarly as in Bełchatów. The extraction of those resources is economically and technically feasible.[43] Other potential areas include the deposits in Gubin (reserves of Gubin, Gubin-Zasieki-Brody, Lubsko) , where the coal is of high quality, has low sulfur content and medium ash. Moreover a positive element is the fact that the area is not built-up.[44] The Gubin coal deposits are estimated for 1.561 million Mg, while Gubin-Zasieki-Brody deposit amounts around 4.215 million Mg, making the area one of the most profitable deposits in Poland.[45]

Deposits of polish interest are also in Złoczew in Bełchatów Basin (around 450 million Mg)[46], Radomierzyce in Turoszów Basin (180 million Mg)[47], Tomisławice, Piaski, Ościsłowo, Dęby Szlacheckie, Mąkoszyn-Grochowiska, Rogóźno in Konin-Turek Basin. (όλο αυτό είναι από την πηγη του πίνακα) The size of the deposits in these areas is depicted on the Table 2.5.

[41] (Rosicki & Gielnik, n.d.)
[42] (Kasiński, n.d.)
[43] (Nowaczyk & Zasuń, 2008)
[44] (Kasztelewicz, 2008)
[45] (Kasztelewicz, 2018)
[46] (PGE, n.d.)
[47] (Kasztelewicz, 2010)

Table 2.5: Deposits of coal[48]

DEPOSITS WITH PERSPECTIVES	**Geological resources (million tons)**
Tomisławice	55
Piaski	114
Ościsłowo	50
Dęby Szlacheckie-Izbica Kukawska	113
Mąkoszyn-Grochowiska	50
Rogóźno	623

Institutions[49]

Institutions	**Responsibilities**
Ministry of Energy	Policy maker in the coal sector and for supervision of state-owned companies, coal related R&D, new coal technologies, mining concessions and regulations of air quality and climate change.
Ministry of Development	Promotion and development of mining technologies.
The Ministry of State Treasury	Performing ownership supervision and managing of state-owned coal companies' portfolio, controlling the use of state-owned assets, providing aid to the industry.
Plenipotentiary for the Reconstructing of Polish Mining Sector	Preparation and implementation of reforms in coal sector.

Structure

The coal sector is characterized by the strong presence of the polish state, with only three small private producers in Silesia. Coal producing companies include Kompania Węglowa, Katowicki Holding Węglowy, LW Bogdanka, Jastrzębska Spółka Węglowa, Tauron Wydobycie, Polska Grupa Górnicza and Węglokoks Kraj, PGE GiEK S.A., Fundusz Inwestycji Polskich Przedsiębiorstw. (The latter is main

[48] (Kasztelewicz, 2018) & (Kasztelewicz, 2010)
[49] (International Energy Agency, 2017)

investor in some companies, such as in Polska Grupa Górnicza.[50]) The sector includes also the Mine Restructuring Company Spółka Restrukturyzacji Kopalń S.A.

Company [51]	**Share of polish Ministry of State Treasury**	**Mines**
Katowicki Holding Węglowy (KHW)	100% of shares A merger of KHW and Spółka Restrukturyzacji Kopalń S.A is planned.[52]	4 mines (Murcki-Staszic, Myslowice-Wesola, Wieczorek, and Wujek) were transferred to Polska Grupa Górnicza in 2017.
TAURON Group	30% of shares	TAURON Wydobycie, Brzeszcze.
Enea Group	51.5% of shares	Holds 66% of shares in LW Bogdanka.
Weglokoks Kraj	100% of shares	Bobrek-Piekary
PG Silesia	Private-owned (Czech Group EPH)	Silesia
Siltech	100% of shares is private-owned	KWK Pstrowski[53]
Eko-Plus	100% of shares is private-owned	Bytom
Kompania Węglowa	The company was split among Spółka Restrukturyzacji Kopalń S.A, Holding KW and Nieruchomości S.A.[54] The remaining property belongs to	All of the 11 mines were transferred to Polska Grupa Górnicza.[56]

[50] (Ministerstwo Energii, 2018)
[51] (International Energy Agency, 2017)
[52] (Katowicki Holding Węglowy S.A., 2018)
[53] (Barecki, n.d.)
[54] (Rzeczpospolita, 2017)
[56] (Rzeczpospolita, 2017)

	State of Treasury.[55]	
Polska Grupa Górnicza	0,00002 % of shares [57]	8 mines (ROW,Ruda, Piast-Ziemowit, Bolesław Śmiały, Sośnica, Mysłowice-Wesoła, Murcki-Staszic, Wujek)[58]
Jastrzębska Spółka Węglowa S.A	41,39% (2018, August 22)[59]	4 hard coal mines (Borynia-Zofiówka-Jastrzębie, Budryk, Knurów-Szczygłowice, Pniówek)[60]
Lubelski Węgiel Bogdanka S.A.	The polish state sold in 2010 its shares (46,7%). Since 2015 parent company is Enea, which bought 66% of LWB's shares.[61]	Bogdanka[62]
Spółka Restrukturyzacji Kopalń S.A.	100% of shares	Makoszowy mine[63]
PGE Górnictwo i Energetyka Konwencjonalna Spółka Akcyjna (PGE GiEK S.A)	Belongs to Polska Grupa Energetyczna.	The company is leader in exploiting lignite. It owns 2 mines (Bełchatów and Turów) and several power stations.[64]

[55] (Ministerstwo Energii, 2018)
[57] (Ministerstwo Energii, 2018)
[58] (Polska Grupa Górnicza S.A., n.d.)
[59] (Jastrzębska Spółka Węglowa S.A., 2018)
[60] (Jastrzębska Spółka Węglowa S.A., n.d.)
[61] (Ministerstwo Energii, 2018)
[62] (Lubelski Węgiel „Bogdanka" S.A., n.d.)
[63] (Ministerstwo Energii, 2018)
[64] (PGE, n.d.)

The last years the sector, due to economic problems was subjected to measures such as liquidations and acquisitions of assets. For example Kompania Węglowa sold whole or partially over 20 mines.[65]

[65] (Ministerstwo Energii, 2018)

OIL

The second largest source of energy for the country is oil, which constitutes ¼ (26,5%) of Poland's TPES.[66] It also constitutes the largest share in Total Final Consumption, representing 37% of TFC.

Supply

Poland's TPES of crude oil in 2016 (26.365 ktoe) was lower than last year (26.642 ktoe) but still the 2nd highest since 1990. Historically the Total Primary Energy Supply of crude oil is depicted on Figure 2.6. As we can observe, the total supply of the resource doubled since the 1990s and continues to follow an upward trend.

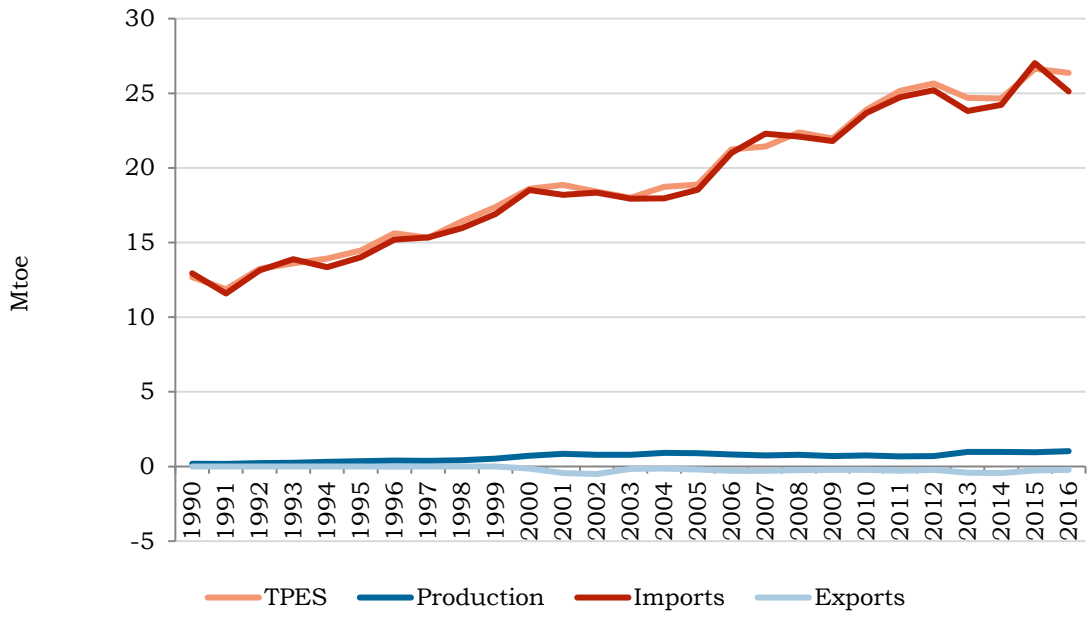

Figure 2.6: Balance of crude oil[67]

The majority of oil supply comes from imports, since the production is too low to cover the country's need for crude oil. Specifically in 2016, Poland produced 1.027 ktoe of crude oil, and imported 25.133 ktoe. That means that around 95% of oil supply is delivered from imports, making the country very dependent on imports and reducing its energy security. Since 2000 the country initiated exporting activity, as the domestically produced oil almost doubled. As for production, the produced crude oil today represents around 4% of TPES, a share that

[66] (International Energy Agency, 2017)
[67] (International Energy Agency, n.d.)

increased gradually from 1,2% since 1990. The production of crude oil is located in 86 oilfields with 22.82 million tons of resources.[68]

These fields are located in four main areas: in the Carpathian Mountains, in the Carpathian Foreland, within the Polish Lowlands and in the Polish Economic Zone in the Baltic Sea.

The most vital fields from economic perspective are in Polish Lowlands, where the exploited oil accounted around 65% of the total production of the resource last year. Here is located the largest oil field in Poland, Barnówko-Mostno-Buszewo (which except from being oil field, it is also a gas field). Discovered in 1993, the estimated deposits in this field account 12,6 million tons of crude oil.[69] Other large field includes Lubiatów, Grotów, where oil deposits were discovered in 2002 and 2003 respectively.[70] Geological and extractable deposits of crude oil are shown on Table 2.7.

Table 2.7: Geological and extractable crude oil deposits[71]

Deposits	**Geological deposits (million tons)**	**Extractable deposits (million tons)**
Grotów	12,2	1,9
Lubiatów	27,8	5,4

On the second place stood the Baltic Sea fields (28% of production in 2017).[72] The extraction of the B3 oil field in the Baltic Sea is valid until 2026.[73]

Lastly the produced oil in Carpathian Foreland and Mountains, the most exhausted deposits, represented 4% and 3% percent of domestic oil production respectively.[74]

Coming back to import activity, the main importer of crude oil for Poland is Russian Federation. At least since 1963- when Druzhba pipeline in Poland was created- to date Russia has preserved Poland's dependency on its coal, and no indication that this relation will change exist at the moment. That happens because of two facts: the low price of Russian oil and the existing infrastructure. Despite that

[68] (Polish Geological Institute - National Research Institute, n.d.)
[69] (PGNiG, n.d.)
[70] (PGNiG, n.d.)
[71] (PGNiG, n.d.)
[72] (Polish Geological Institute - National Research Institute, n.d.)
[73] (LOTOS, 2016)
[74] (Polish Geological Institute - National Research Institute, n.d.)

fact, the terminal in Gdańsk provides opportunities for greater diversification of energy suppliers. Other importers include Saudi Arabia, Iraq, Kazakhstan, Norway, Iran, and the United States. For more detailed information about polish imports*: OIL SECURITY*. Specifically about LPG, Poland is highly dependent on imports of that product. The domestic production in 2016 reached 601 ktoe, while the imported LPG was 2.196 ktoe, meaning that 87% of total LPG supply came from imports. Poland imports LPG from Russian Federation, Kazakhstan and Belarus, the Czech Republic and Lithuania.[75]

With the above countries Poland has made long-term and by spot contracts, with the first one to represent almost 70% of total refinery oil imports. The biggest players in the sector are PKN Orlen S.A. and Grupa LOTOS S.A. that control four major refineries in Płock, Gdańsk.

Last but not least , Poland preserves stocks of oil with capacity of 88,8 million cubic metres, which are mainly operated by IKS SOLINO S.A. and PERN S.A. (and its subsidiary OLPP Sp. z o.o.)

Demand

According to data extracted from the International Energy Agency, the largest consumer of crude oil is the transport sector accounting over 70% of total oil consumption. In transport sector, the demand for road transport constitutes 95% of total oil demand in the sector.

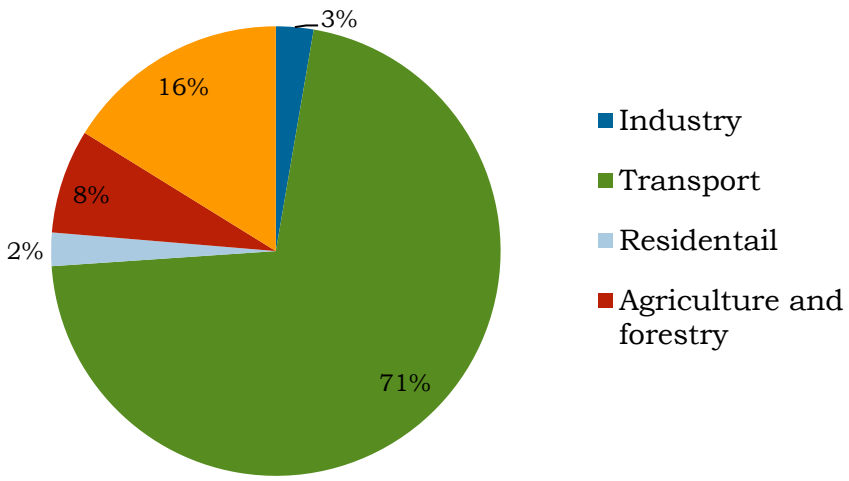

Figure 2.8: Oil demand by sector[76]

The consumption of crude oil is in rise, since 2014. In 2017, the demand for crude oil amounted 27.6 million tons per year, which

[75] (Polska Organizacja Gazu Płynnego, 2018)
[76] (International Energy Agency, 2018)

represents an increase of 6,1% compared to 2016 (2nd largest increase among the country members of the European Union, after Czech Republic).[77]

On Figure 2.9 the share in product use among oil products is depicted, with gas/diesel accounting the most, since it is used in transport sector. Demand for diesel has been increasing since 2014 (Figure 2.10.)

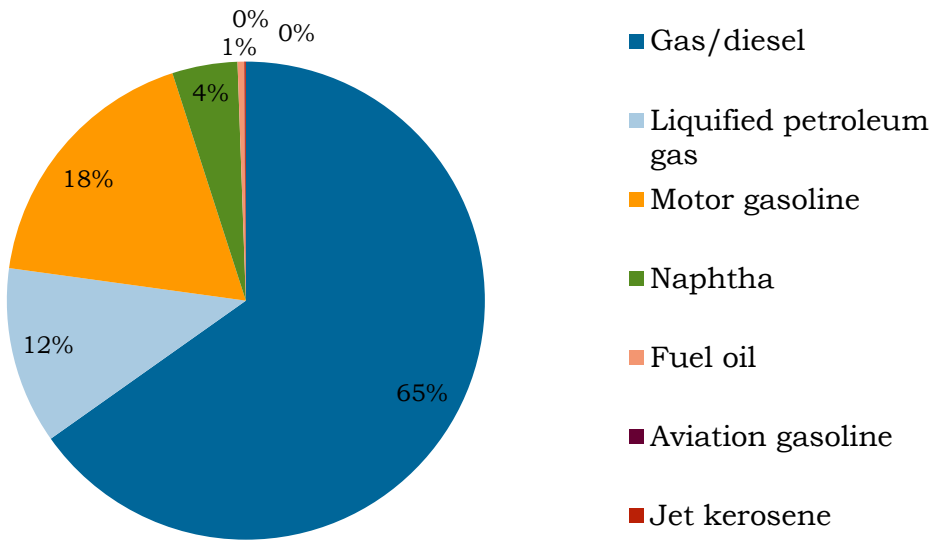

Figure 2.9: Share of oil products in product use[78]

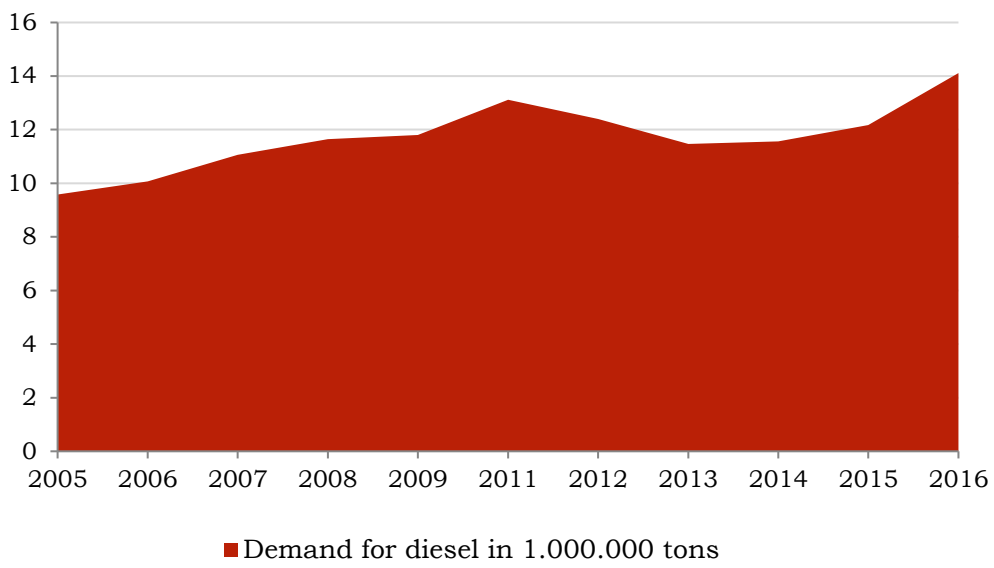

Figure 2.10: Demand for diesel in 1.000.000 tons[79]

[77] (Fuels Europe, 2018)
[78] (International Energy Agency, n.d.)

As for 2016, the demand for diesel increased for 86 % since 2015. This trend is a result of increasing economic growth and more frequent use of diesel engines in car fleets. Petroleum products and LPG are used in passenger cars.[80]

It is also interesting that Poland has the largest share of LPG in product use among all OECD countries, which is explained by the existing low taxes resulting in low price of the source.[81]

Structure[82]

Company	**Characteristics**
Polish Oil and Gas Company S.A. (PGNiG)	Polish state-controlled oil and natural gas company.
Exploration and Mining of Petroleum and Gas Deposits Petrobaltic S.A. (LOTOS Petrobaltic S.A.)	Company belonging to Grupa LOTOS S.A., active in crude oil production, refining and marketing of oil products. It is the only company that exploits crude oil and gas in Baltic Sea. The company is the owner of Gdańsk Refinery.
PKN ORLEN S.A. is a major	Oil refiner and gasoline retailer. The company owns refineries in Poland (Płock, Jedlicze and Trzebinia), the Czech Republic (Litvinov and Kralupy) and Lithuania (Mažeikiai).
Naftoport	Activity in oil shipment and delivery in the Port of Gdańsk.

[79] (Eurostat, n.d.)
[80] (International Energy Agency, 2017)
[81] (International Energy Agency, 2017)
[82] (International Energy Agency, 2017)

NATURAL GAS

Supply

An important share in energy supply has natural gas accounting over 14.633 ktoe in 2016, which represents 14,7% of TPES. Since the 90s the total supply of natural gas in Poland has been increasing, a trend that will be observed in the years that follow.

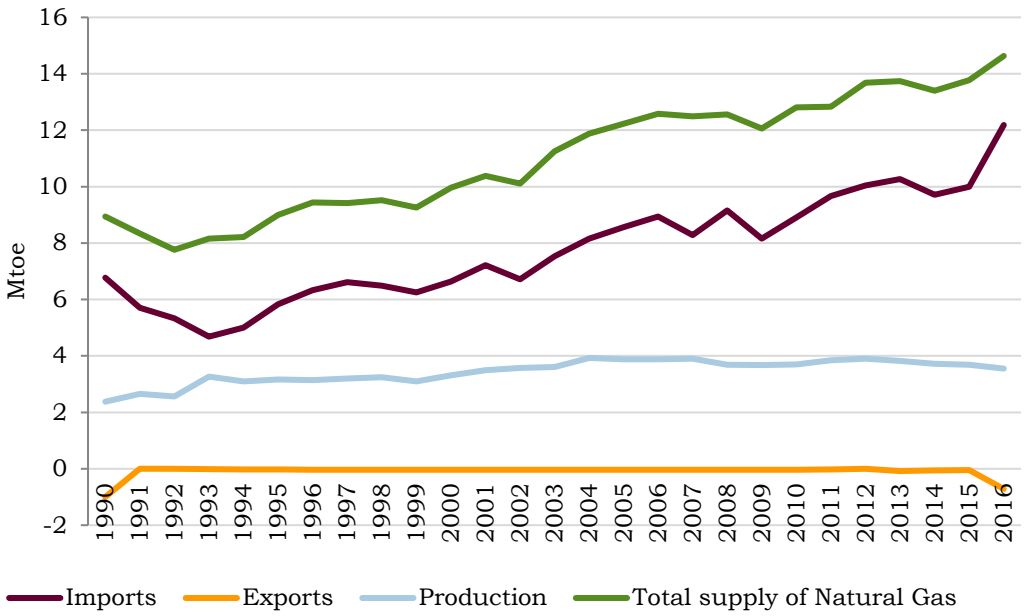

Figure 2.11: Balance of natural gas[83]

Similarly to the previous sources of energy, Poland's supply of natural gas derives from domestic production and from imports.

With regards to domestic production, the domestically produced natural gas in 2016 (3.553 ktoe) gave 3,5% percent of totals supply in natural gas, which covered around 30% of total demand for natural gas in Poland. The majority of the natural gas produced in Poland is consumed internally, as the export level is modest.

Totally around 295 deposits (of which 207 are under "development") exist with capacity of 116,96 billion cubic meters.[84]

Deposits of natural gas exist in Niż Polski, where 67% of today's extracted areas are located. Deposits in Cychry i Sulęcin contain over 90% of nitrogen that makes them inappropriate for fuel.[85] Quality

[83] (International Energy Agency, n.d.)
[84] (Państwowy Instytut Geologiczny – Państwowy Instytut Badawczy, 2018)
[85] (Państwowy Instytut Geologiczny – Państwowy Instytut Badawczy, 2018)

parameters of natural gas indicate that the maximum limit of nitrogen in NG is calculated by Wobbe Index.[86] For example the limit of nitrogen in Natural Gas transmitted by Yamal Pipeline is 2% mol.[87] Extraction of gas in conducted in Cychry, with the gas to be used for correcting of the composition of natural gas transmitted in national pipelines.[88]

Other locations include Przedgórze Karpat and Western Pomerania. In the Carpathian Mountains gas, characterized by high level of methane and few percent of nitrogen was discovered.[89] Other deposits (deposits B4 and B6, and B3 and B8 compound with crude oil) are in the polish Economic Zone in the Baltic Sea.[90] New deposits are still discovered, showing the geological potential of the country.

Additionally underground natural gas storage facilities exist in numerous locations in salt caverns or natural reservoirs (Table 2.12) with total capacity of 6,65 million cubic metres.[91] These USF are operated by Operator Systemu Maganyzowania (OSM).[92]

Table 2.12: Underground reserves of natural gas[93]

Storage facility	**Existing reserves (million m^3)**
Bonikowo	328,63
Brzeźnica II	45,59
Daszewo	27,72
Husów	372,88
Strachocina	121,50
Swarzów	28,80
Wierzchowice	5.728,12

In these facilities, under high pressure strategic reserves can be stored for future use, increasing the energy security of the country.

Poland is net importer of natural gas, with imports in 2016 to account over 12.000 ktoe. Russia is main importer, with imports also coming

[86] (Rozporządzenie ministerialne nr xx/yy/2018, 2018)
[87] (Gaz System, n.d.)
[88] (Państwowy Instytut Geologiczny – Państwowy Instytut Badawczy, 2018)
[89] (Państwowy Instytut Geologiczny – Państwowy Instytut Badawczy, 2018)
[90] (Państwowy Instytut Geologiczny – Państwowy Instytut Badawczy, 2009)
[91] (Państwowy Instytut Geologiczny – Państwowy Instytut Badawczy, 2018)
[92] (International Energy Agency, 2017)
[93] (Państwowy Instytut Geologiczny – Państwowy Instytut Badawczy, 2018)

from Norway, Germany. For more information: *NATURAL GAS SECURITY.*

Demand

In reference to Total Final Consumption natural gas constitutes 16% of TFC, staying behind oil products and coal. The largest natural gas consumer is the industry sector, with over 30% of total demand in 2016. Since 2007 the demand in industry has generally showed stability, accounting over 3.000 ktoe/year. Stability trend is also observed in the residential and commercial sectors, exceeding 3.000 and 2.000 ktoe annually respectively.

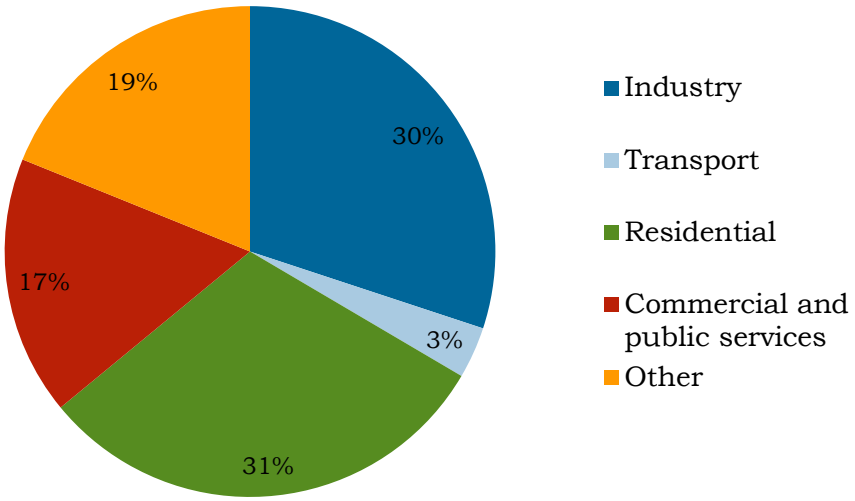

Figure 2.13: Share of natural gas by sector[94]

Institutions[95]

Institution	**Responsibility**
Ministry for Energy	Development and implementation of natural gas policy, operation of natural gas market, development of natural gas infrastructure, international cooperation, ensuring the energy security of Poland.
Energy Regulatory Office (ERO)	Regulator of the activities of participants in the natural gas market.

[94] (International Energy Agency, 2018)
[95] (International Energy Agency, 2017)

Structure[96]

Company	**Characteristics**
Polskie LNG	Subsidiary to Gaz-System, owner of LNG terminal in Świnoujście.
OGP Gaz-System S.A. (Gaz-System)	100% owned by the State Treasury, is the owner and operator of the natural gas transmission system in Poland.
PGNiG	Owner nine underground gas storage (UGS) facilities. Activity in exploiting natural gas reserves.[97]
Operator Systemu Magazynowania (OSM)	Company created by PGNiG in order to provide volumes and capacities of storage facilities in a way that meets the market participants' demand for gas storage services.[98]
Polska Spółka Gazownictwa (PSG)	Part of PGNiG Capital Group. The company is the national Distribution System Operator of natural gas with 97% control over polish natural gas distribution network.[99] PSG operates through 17 branches (including in Gdańsk, Poznań, Warszawa, Wrocław, Tarnów and Zabrze).[100]

[96] (International Energy Agency, 2017)
[97] (PGNiG, n.d.)
[98] (Gaz Storage Poland, n.d.)
[99] (Polska Spółka Gazownictwa, n.d.)
[100] (Polska Spółka Gazownictwa, n.d.)

RENEWABLE SOURCES

Poland has made some significant effort in order to increase the share of renewable sources in energy supply.

Total supply of renewable is 9.511 ktoe, which means that almost 10% of Poland's TPES comes from energy produced domestically from renewable sources.

Regarding hydro energy, the supply, which comes solely from domestic production, is low and has not increased much since the 90s.

On the other hand the available amount of biofuels and waste has increased. In fact the amount of biofuels and waste has increased almost 4 times during the period 1990-2016.

Finally, the production of geothermal, solar energy started in 2000, and since then each year more energy is being produced comparing to previous years.

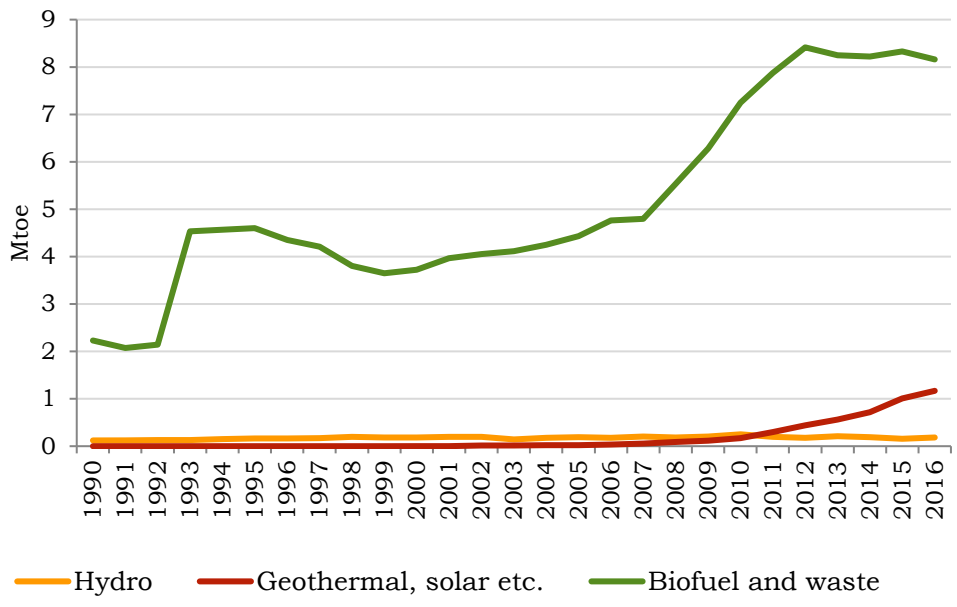

Figure 2.14: Total supply by renewable source[101]

[101] (International Energy Agency, n.d.)

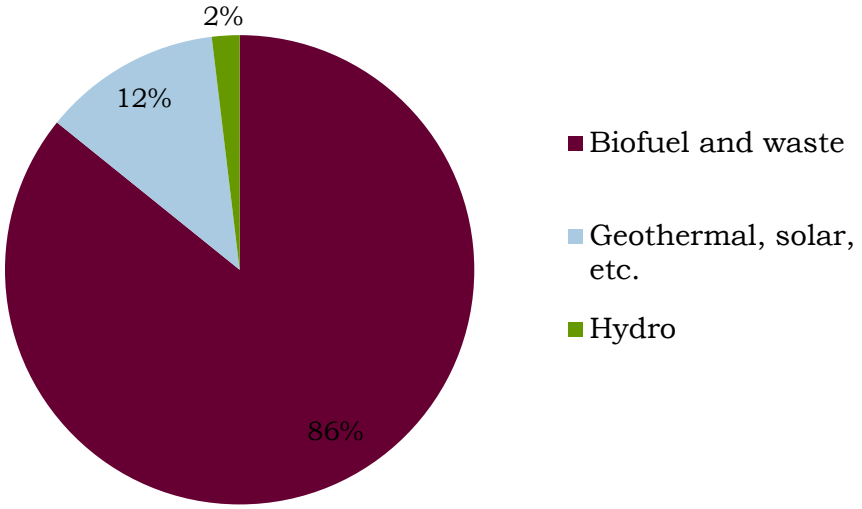

Figure 2.15: Share of renewable sources in energy supply (Supply of source/TPES)[102]

The largest share in total supply of renewable has biofuel and waste. Its production not only fully covers domestic demand, but also is exported. In 2016 Poland was a net exporter of the source. The most common form is solid biofuels, used in heat and power plants and in residential and industrial sector. Waste is mainly used as fuel in industry sector, and biogases for heat and power plants.

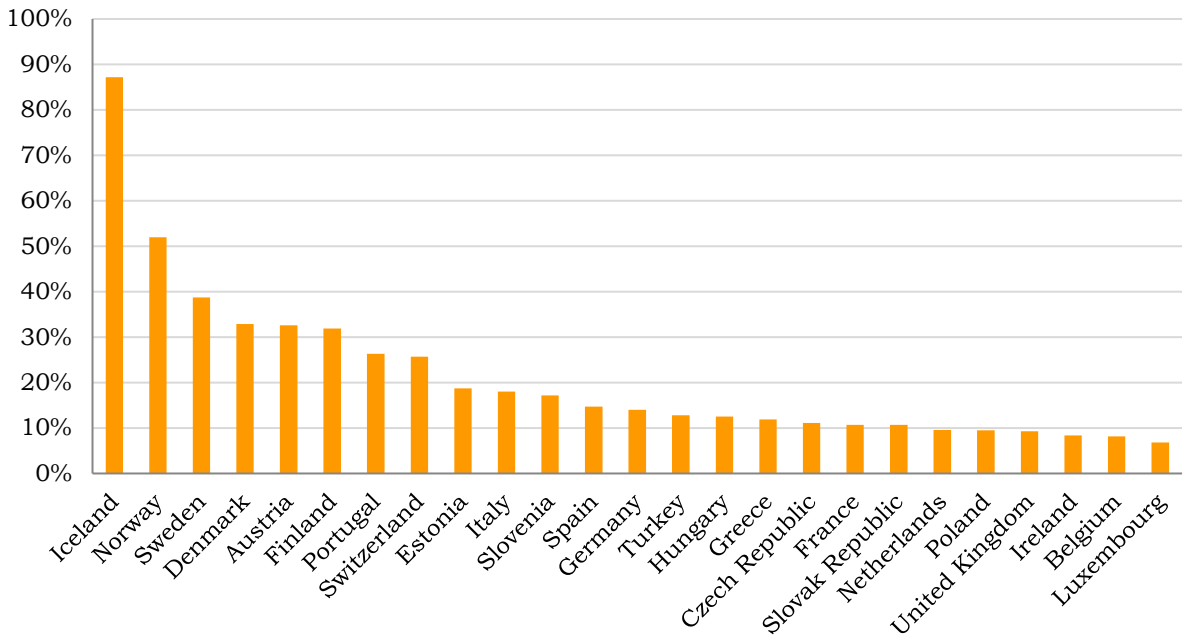

Figure 2.16: Comparison of the share of renewable sources in TPES in 2016[103]

[102] (International Energy Agency, n.d.)

Comparing Poland to the group of OECD Europe countries, Poland is 21st among 25 countries, standing in front of United Kingdom, Ireland, Belgium and Luxembourg. The share of renewable has definitely increased since 1990, when it was just 1,8% of TPES, but still the transition towards more renewable based supply is slow.

[103] Collected from 2016 Balances of OECD Europe countries

NUCLEAR POWER

Nuclear power has no share in Poland's TPES as there is no nuclear power plant in the country. But the discussion over introducing nuclear power for energy security and environmental reasons has been circulating over the last years.

Nuclear energy is presented as a tool for diversification of the energy mix and increasing the energy security of the country. Poland has a growing need for electricity that will be provided at an affordable price and with stability of supply. In this case nuclear energy can be used in electricity production, ensuring the required amount of electricity in the future and limiting the dependence of the country from external suppliers. Additionally nuclear energy is seen as a realistic option in the county's effort to comply with the goals of EU's climate policy. It can replace other sources of energy, especially those with high carbon intensity, decreasing the level of greenhouse gases.

With the EPP 2030, plans for establishing nuclear capacity were deployed. The Polish Nuclear Power Program (PNPP) outlines in even more specific way that developing nuclear power in the country not only is feasible from economic and technological perspective, but also it constitutes a low-cost option for reducing GHG emissions securing at the same time stability of supply and price.[104] The policy framework is in total compliance with national and European policies and laws that apply to the energy sector and the environment such as Europe 2020, EPP 2030, Industrial Emissions Directive etc.

Additional legal framework is provided by the Polish Atomic Law. The law that was passed in 2011 establishes more principles for nuclear energy development in accordance with European and international law, involving nuclear safety nuclear and material safeguards.[105]

Establishing nuclear capacity needs proper infrastructure and technology and investment conditions. Moreover two more conditions should be pointed out: the consent of the public and the high culture of nuclear security in all stages (location, design construction, operation, closure of nuclear power plants).[106] The proposed plan is to construct two nuclear power plants (NPPs) with electrical capacity of 3 gigawatts each, starting in 2022. The program includes a four step plan that would finish 2030 for the first plant and 2035 for the second

[104] (Ministerstwo Gospodarki, 2014)
[105] (Kancelaria Sejmu, 2011)
[106] (Ministerstwo Gospodarki, 2009)

plant.[107] The domestically produced electricity in NPPs could constitute around 16-20% of total generated electricity.[108] Additional efforts include the creation of the National Centre for Nuclear Research (NCBJ) with the responsibility of implementing PNPP, appointing Government Plenipotentiary for Polish Nuclear Power with Social Advisory Team and an Interdepartmental Task Force for Polish Nuclear Power, reconstruction of National Atomic Energy Agency, establishing a Team for completing a National Plan for the management of radioactive waste and spent nuclear fuel.[109]

Possible locations for constructing nuclear power plants are presented on the Figure 2.17

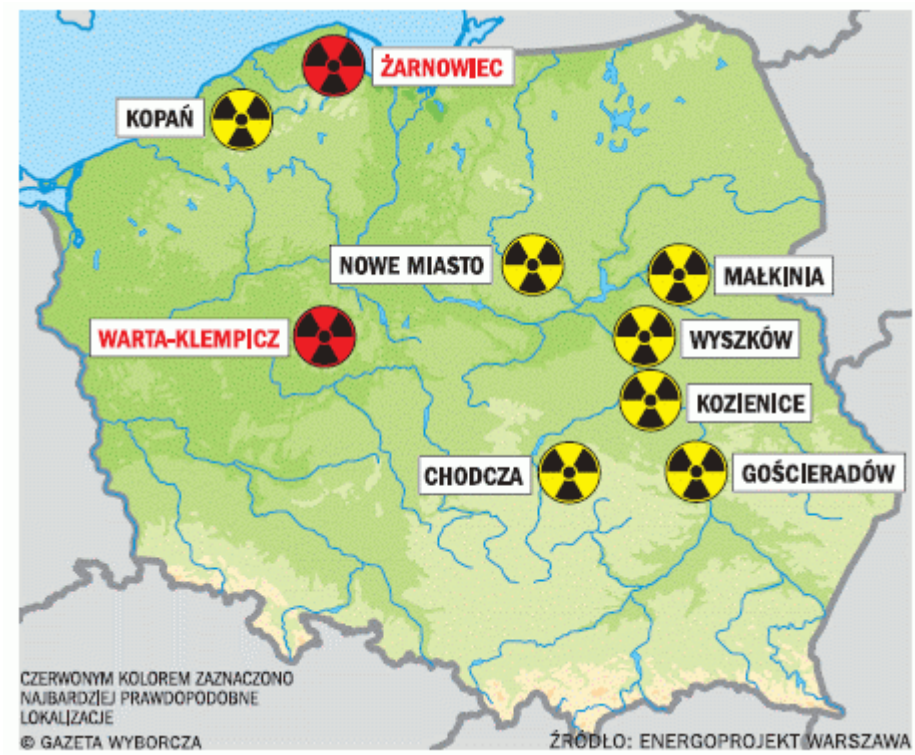

Figure 2.17: Potential locations of nuclear power plants in Poland[110]

The two sites marked with red color the most possible sited for constructing nuclear power plant.

It is expected that with the new strategy that is being developed (Strategy 2050) will follow this direction.

---

[107] (International Energy Agency, 2017)
[108] (International Energy Agency, 2017)
[109] (Ministerstwo Gospodarki, 2014)
[110] (Energoprojekt Warszawa, n.d.)

Institutions[111]

Institution	**Responsibility**
Ministry of Energy	Implementing PNPP, coordinating of state actions in the sector and cooperating with polish and other governments.
National Atomic Energy Agency	Government regulatory body responsible for regulating and controlling nuclear safety and radiological protection in facilities.
Radioactive Waste Disposal Enterprise	State-owned public benefit company responsible for managing radioactive waste. The National Radioactive Repository exists in Rozan near Warsaw.
PGE Energia Jądrowa S.A.	A limited liability company responsible for direct preparation and implementation of the construction of the first nuclear power plant in Poland, which means that the company has to conduct research for appropriate location and environmental tests, obtaining permits, safe construction and operation.[112]

[111] (International Energy Agency, 2017)
[112] (PGE, n.d.)

ELECTRICITY

Supply

In Poland electricity is produced mainly from coal, since around 80% of electricity production comes only from this source. Thus Poland is the country among all IEA countries with the highest share of coal in electricity generation, and 2nd (only after Australia) in electricity production from fossil fuels.

The production of electricity from coal has remained generally stable since 1990. (Figure 2.18) In second place is the electricity produced from wind, accounting 7% of total generated electricity (Figure 2.19). Electricity produced from wind grew steadily from the middle 90s, reaching over 12.000 GWh in 2016.

Biofuels and gas shares have also increased, from 0,04% in 1990 to 5% for biofuels, and from 0,09% to 5% in 2016. Solar and waste produce a very small amount of electricity. Lastly electricity from hydro energy has been decreasing since 2002, with some exceptions (years 2004, 2005, 2009, 2010, 2013, 2016). (Figure 2.18 and 2.19)

Generally Poland has increased the share of renewable sources in electricity production; still the share is one of the lowest among IEA countries.[113] In 2016 the share of renewable sources reached 14,2% comparing to the share of 2,6% in 1990.

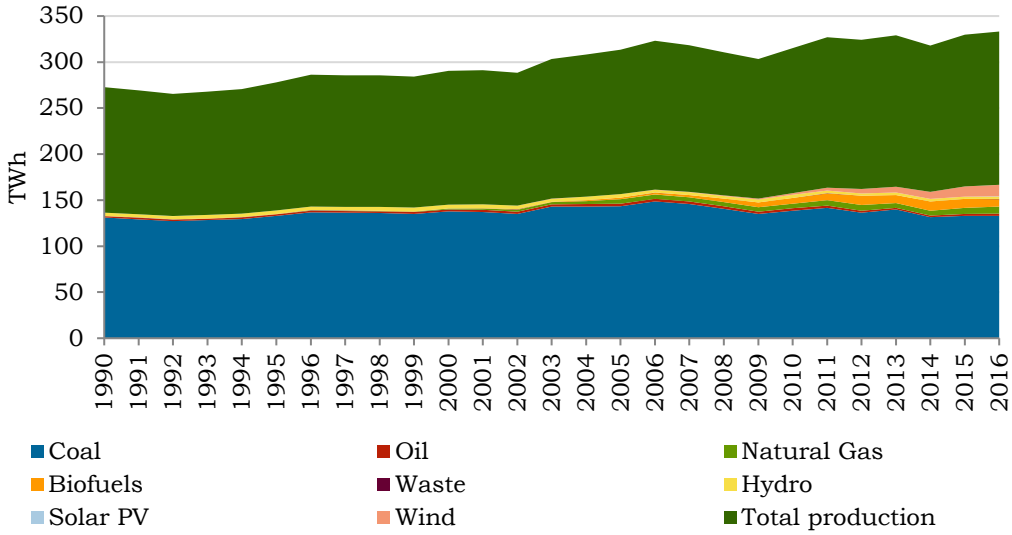

Figure 2.18: Balance for electricity production[114]

[113] (International Energy Agency, 2017)
[114] (International Energy Agency, 2018)

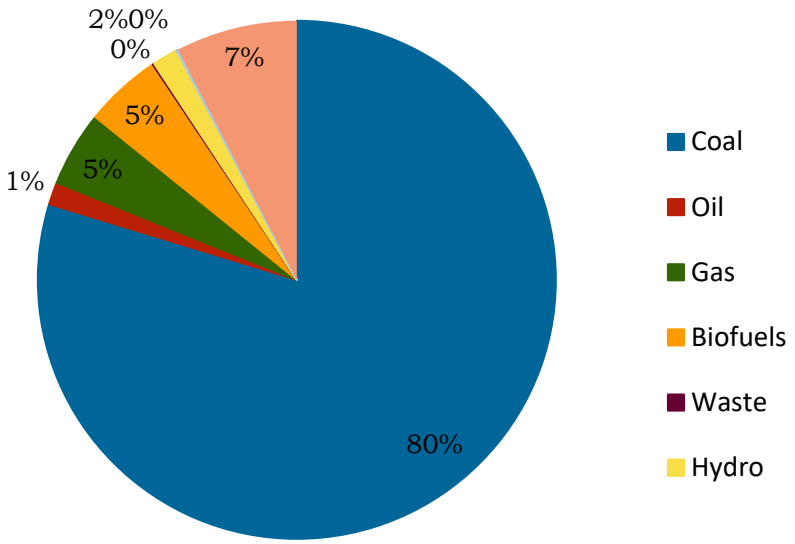

Figure 3.19: Share of electricity generation by fuel[115]

In addition Poland in 2016 was a net importer of electricity, with imports to reach 1.205 ktoe and exports 1.033 ktoe. There are generally fluctuations regarding the status of net importer or exporter, since in 2015 Poland was a net exporter, in 2014 was a net importer and again in 2013 a net exporter. Import countries are Germany and Sweden, while polish exports head to Czech Republic and Slovak Republic.[116]

Referring to electricity imports and exports, Poland has to deal with loop flows. Electricity is transmitted on the basis of the least resistance from source to sink. Nevertheless it is possible that existing grids are not able to support the flows of electricity to the fullest extent. In other words scheduled flows substantially deviate from physical flows. To deal with this problem part of produced energy and/or surplus must be transmitted to a neighboring bidding zone or control area (areas that are not part of the transaction). These are the loop flows (unscheduled flows), which are external effects for the host country.[117]

In case of Poland, in reality the imports from Germany represent loop flows. High production of variable renewable electricity in Germany (mainly from wind power) causes problems to polish energy grid and the polish Transmission System Operator (TSO).[118] The surplus electricity is transmitted through Poland and the Czech Republic and Slovak Republic towards the final destination-country: Austria. Polish

[115] (International Energy Agency, 2018)
[116] (International Energy Agency, 2017)
[117] (THEMA Consulting Group, 2013)
[118] (International Energy Agency, 2017)

imports from Germany and polish exports to the Czech Republic and Slovak Republic are loops flows, not commercial loops. Polish TSO undertakes the costs related to security of supply and system services, and costs due to reduced capacity of market trade (for example re-dispatching).[119]

Demand

Electricity consumption follows an upward trend since 2010 (Figure 2.20). The sector with the largest (and still increasing) share of total consumption of electricity is the industry sector, accounting almost 40% of total electricity consumption. Second stands the commercial sector showing an increase of 40% from 1990 to 2016. Transport and agriculture consume small amounts of electricity. Both of the sectors show a decreasing tendency in electricity demand. The decrease amounts 19% and 60% from 1990 to 2016.

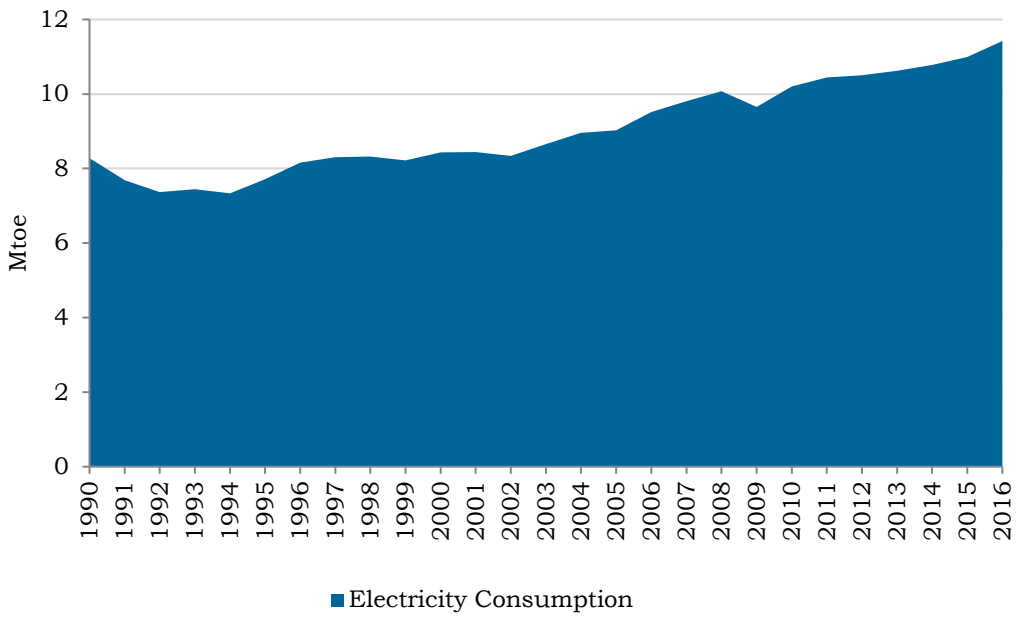

Figure 2.20: Electricity consumption[120]

[119] (THEMA Consulting Group, 2013)

[120] (International Energy Agency, n.d.)

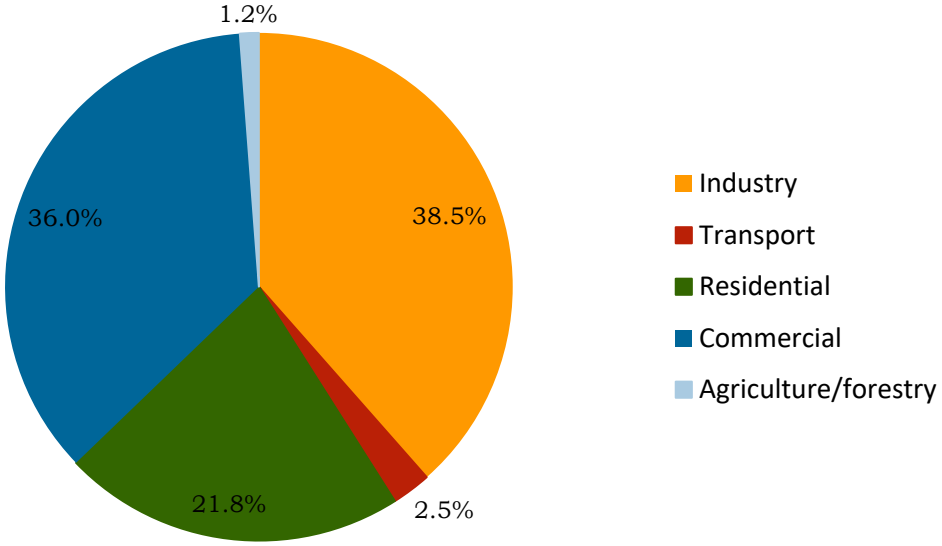

Figure 2.21: Share of electricity consumption by sector[121]

Institutions[122]

Institution	**Responsibility**
Ministry of Energy	Development and implementation of polish electricity policy, operating of electricity market, development of electricity infrastructure, cooperation on international level.
Government Commissioner for Strategic Energy Infrastructure	Supervising of Transmission System Operators in electricity and gas sectors.
Energy Regulatory Office (ERO)	Regulating the activity of participants in electricity and natural gas markets
The Office of Competition and Customer Protection	Providing opinions, shaping antitrust policy and consumer protection policy

The market structure is dominated by state-owned companies in accordance with the Act on Energy from 1997. The consumers have the right to choose the producer of electricity, but the distributing

[121] (International Energy Agency, n.d.)
[122] (International Energy Agency, 2017)

company is determined by geography. On Map 2.22 the geographical distribution of the generators is depicted.

Map 2.22: Geographical distribution of energy generating companies[123]

The key players are:

Key players[124]	**Characteristics**
PGE Polska Grupa Energetyczna S.A.	Electricity generation (including nuclear, transmission, distribution and retail Markets). Owner of over 40 infrastructure spots (3 lignite mines, 40 heat and power stations, 8 distribution network operator, 7 retail selling businesses). 57,39% of the company is owned by the State Treasury and the rest is traded on Warsaw Stock Exchange.
TAURON Polska Energia S.A.	Activities in coal mining, generation, distribution and sale of electricity and heat. Owner of 3 wind farms and 35 hydroelectric power plants. 30,06% of the

[123] (Polska Agencja Informacji i Inwestycji Zagranicznych, n.d.)
[124] (Polska Agencja Informacji i Inwestycji Zagranicznych, n.d.) and (International Energy Agency, 2017)

	company is owned by the State Treasury. The company controls around 30,06% of polish resources in hard coal.
Enea S.A.	Electricity production, distribution and retailing. The company operates the coal power station in Kozienice. The State Treasury owns 51,5% of the company.
ENERGA S.A.	Generation, distribution and sale of electricity and heat. Operator of 47 hydroelectric power plants and the coal power plant in Ostrołęka. The company's 51,52% is owned by the State Treasury.
ZE PAK	Production and sale electricity and production and distribution of heat. The second largest producer of electricity from lignite. The company owns 3 coal power plants.[125]

As for 2017, the highest share in electricity generation holds PGE Polska Grupa Energetyczna S.A. (43,5% increased by 7,7% in comparison to the previous year). TAUTRON Polska Energia S.A. has 10,8% of the production, a share that increased by 0,6% since 2016.

The three largest generators are PGE Polska Grupa Energetyczna S.A., TAURON Polska Energia S.A. and ENEA S.A. They hold 2/3 of total installed capacity and produce around 70% of total domestic electricity production. The share of the most important companies is depicted on Figure 3.23, with PGE Polska Grupa Energetyczna S.A. as the frontrunner.

[125] (Zespół Elektrowni Pątnów - Adamów - Konin SA, n.d.)

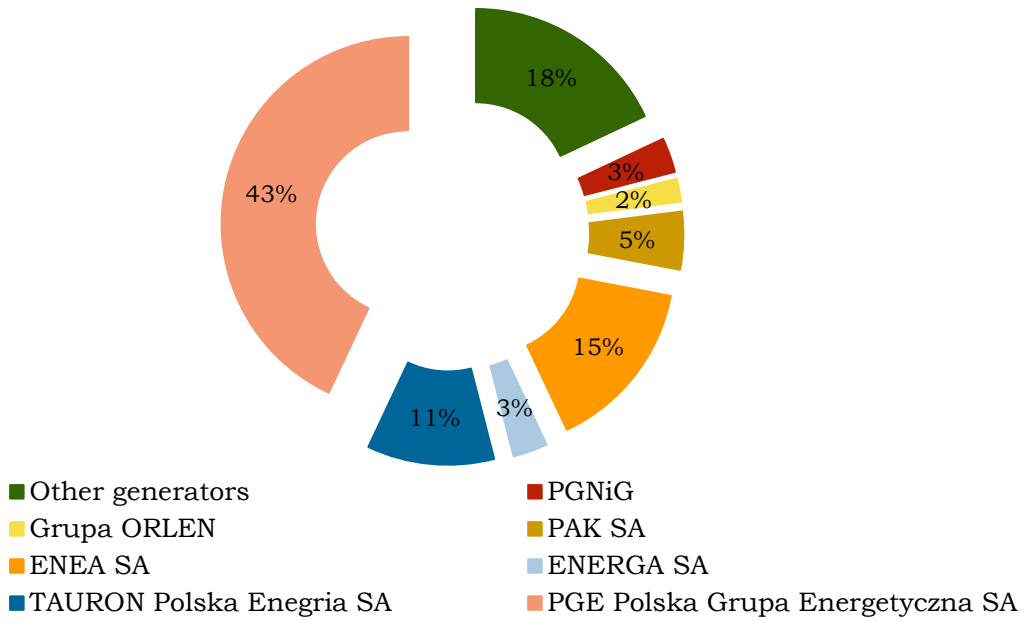

Figure 2.23: Share in volume of electricity fed into the national grid in 2017[126]

To sum up, Poland energy sector is dominated by coal (both hard coal and lignite), which represents almost 80% of TPES and over half of TFC of the country. The existing resources ensure the continuous importance of this source in a highly developed coal mining sector. Additionally 80% of domestically produced electricity comes from coal. Second in total energy supply comes oil. The demand for oil is mostly met through imports, mainly from the Russian Federation. Natural gas, which is the third largest energy source, is produced partly domestically and to a greater extent is imported from Russian Federation. High dependency on Russian oil and natural gas increases concerns over existing threats to the energy security of the country.

Poland has achieved visible progress in introducing renewable energy sources, since their share in TPES has increased since 1990 from 1,8% to 10%. Biofuels and waste have the largest share in TPES and TFC. Last but not least, Poland considers and has make steps towards developing nuclear energy for energy security.

The energy sector analysis is supplemented by the review of the policies that Poland implements in various sectors and aspects of the energy policy. These policies are divided to policies that are shaped and implemented on national level and European Union's policies that concern Poland too.

[126] (Energy Regulatory Office, 2018)

3. KEY POLICIES

The energy policy of Poland can be explained when referred to a number of strategies that the country has adopted and implements in different areas connected to the energy sector. These policies are shaped and implemented within national and European framework.

NATIONAL POLICIES

I. Energy Policy of Poland until 2030

First and foremost in 2009 the Energy Policy of Poland until 2030, known also as EPP 2030, was issued by the Ministry of Economy as a response to the increasing challenges that the country faces in terms of climate change, import dependency, degrading infrastructure. At the same time on a global level the prices of energy show fluctuations, the demand for energy is rapidly increasing and the energy sector is facing new threats (cyber threats, damages to the energy systems)[127]. The strategy aims to give solutions to the above challenges. The priorities of the EPP 2030 are:

a. improving energy efficiency,
b. enhance security of energy supply,
c. diversification of the structure of electricity generation by introducing nuclear energy,
d. increased use of renewable sources, especially the energy produced from biofuels,
e. development of competitive fuel and energy markets and
f. reduction of environmental impact of energy.[128]

The goals of the EPP 2030 are highly correlated and they aim to a find a balance between sustainable development and energy security. When increasing the share of renewable or other alternative sources in the energy mix of the country, the energy security can be improved since the imports of energy are reduced and the structure of electricity production is effectively diversified, and more environmentally friendly energy is produced.

[127] (Ministerstwo Gospodarki, 2009)
[128] (Ministerstwo Gospodarki, 2009)

Referring to the energy efficiency, Poland aims to achieve zero-energy economic growth which means that while the economy growths, no extra demand for primary energy is needed. Additionally the energy intensity of polish economy needs to be reduced to achieve the level of EU-15.

Security of fuels and energy supplies means ensuring stability in energy supplies at affordable prices. The main objectives in this area are effective management of coal deposits located within the territory of the country, the diversification of supplies of raw materials and fuels.

Poland's energy security requires the examination of the possibility to introduce nuclear energy. Nuclear energy does not produce CO_2 emissions and could be a solution to the growing need for energy. But the introduction of nuclear energy requires broad social consultation and consent. Moreover the need for appropriate technology and safety at all stages of nuclear energy generation is of great concern.

One of the key elements of the EPP 2030 is increasing the participation of renewable energy sources in energy production of Poland which translates into a higher degree of independence from imported energy supplies and increased diversification of energy sources. Also development of renewable sources meets with the goal to reduce CO_2 emissions and generally reduce the environmental impact of energy production. The goals that Poland has set is to increase the use of renewable to at least 15% in the final energy use in 2020, to achieve by 2020 a 10% share of biofuels in the transport fuel market, to protect forests against overexploitation for biomass and balanced used of agricultural areas for production of renewable sources.

The objectives in developing competitive fuel and energy markets are to ensure undisturbed operation of markets and counteracting against too severe price increase.

Last but not least, the mitigation of the environmental impact of the power industry is at the heart of EPP 2030. Poland aims at reducing CO_2 emissions by 2020, maintaining at the same time a high level of energy security and economic development, reducing the emissions of SO_2 and NO and dust according to EU regulations, reusing waste in the economy, and encouraging low-emission technologies.

The coordination of the implementation of the above measures and sets of goals is executed by the Minister of Economy with the support

of an interministerial team. It is also required that the energy policy objectives will be applied by central and local government bodies, as well as by energy companies.[129]

Regarding renewable sources, Poland has been using since 2005 mandatory quotas for utilities and a certificate system in order to encourage production and use of renewable sources. Electricity generators and suppliers need to fulfill annual quota of renewable electricity. At the end of each year the Energy Regulatory Office awarded "green certificates" to the producers of green energy. These certificates testify the source of electricity generation from a renewable source.[130] In 2016 this system was replaced by an auction system for installation between 3kW and 10Kw.[131] This system has been helpful in developing wind capacity and co-firing biomass with coal, but did not encourage investments in new types of technology. As a result, biomass generates the majority of electricity resulting in an unbalanced renewable energy mix. In 2010 brown certificates were introduced (certificates of origin from biogas) that testify production and introduction of agricultural biogas to the gas distribution network.[132]

Other certificates are: purple certificates for co-generation, yellow certificates for entities that generate electricity in high efficient co-generation fired by gaseous fuels or with total electrical capacity below 1MW. Lastly, there is a possibility for obtaining more than one certificate for co-generation electricity from the same unit. According to Energy Law has legally sanctioned the possibility of obtaining support certificates twice.[133]

In addition to that the "Amendment" of polish RES Act, published in 2018, should also be mentioned. It generally introduces changes to Renewable Energy Sources Act, to the Act of Act of 20 May 2016 on investments in wind power ("Distance Act") and the Construction Law Act of 7 May July 1994 ("Construction Law"). [134]

Key changes to the RES Act include alteration of some definitions (such as biomass, small RES installation, micro installation, etc.),

---

[129] (Ministry of Economy, 2009) and (The London School of Economics, 2009)
[130] (Energy Regulatory Office, n.d.)
[131] (International Energy Agency, 2017)
[132] (Energy Regulatory Office, n.d.)
[133] (Energy Regulatory Office, n.d.)
[134] (USTAWA z dnia 7 czerwca 2018 r. o zmianie ustawy o odnawialnych źródłach energii oraz niektórych innych ustaw, 2018)

modifications in calculation of state aid for auction support (replacement of existing model by a "adjusted price" system), reform of the shape of auction baskets (creation of five categories). Additionally the auction system is reformed by simplifying the list of required documents for participation in the auction, increasing deposits that generators need to pay, more provisions on the age (maximum 36 months and for solar and onshore wind installations 18 and 24 months respectively) of equipment used for construction or modernization of RES installations, introducing the options of

a. transferring the rights and obligation from winning the auction to a purchaser of the RES installation (the consent of the President of the Energy Regulatory Office) and
b. selling by the generator that won the auction exclusively on the exchange.[135]

Lastly, a new support mechanism for smaller installations using biogas or hydro energy is implemented. Two mechanisms are introduced. The first mechanism gives generators the option to sell the unused electricity at fixed purchase price, which is the 90% of the reference price and it will be indexed annually based on consumer goods and services prices of the previous year. The second one ensures the right for generators of electricity in RES installations with capacity between 500 kW and 1MW to sell unused electricity to an entity other than the obligated seller.[136]

Besides RES Act, the "Amendment" refers to the Distance Act and Construction Law. The changes include dealing with definition issues, such as wind power plant and building structure, an obligation of returning of property where wind farm is located to the owner. There are also new regulations that imply that power plants that do not meet distance criterion can only be the subject of renovating activities and proper management only if the latter do not need capacity increase or have a larger impact on the environment. Finally, the law for granting building permits continues to be valid under the condition that the occupancy permit is granted within three years.

Another measure is loans with low interest for encouraging installation of renewable granted by National Fund for Environmental Protection and Water Management.

---

[135] (USTAWA z dnia 7 czerwca 2018 r. o zmianie ustawy o odnawialnych źródłach energii oraz niektórych innych ustaw, 2018)
[136] (Centrum Informacji o Rynku Energii., 2018)

II. Strategy for Energy Security and Environment

Another important strategy that covers two extremely important areas: energy and environment is Strategy for Energy Security and Environment introduced in 2014. The strategy includes key reforms and necessary actions that should be taken until 2020.[137] In a way its target is to build a bridge between energy security and protection of the environment and integrate environment policy and energy policy that is depicted in Figure 3.1. The specific objectives are: sustainable management of natural resources, safe and competitive energy supply and improvement of the quality of the environment.[138]

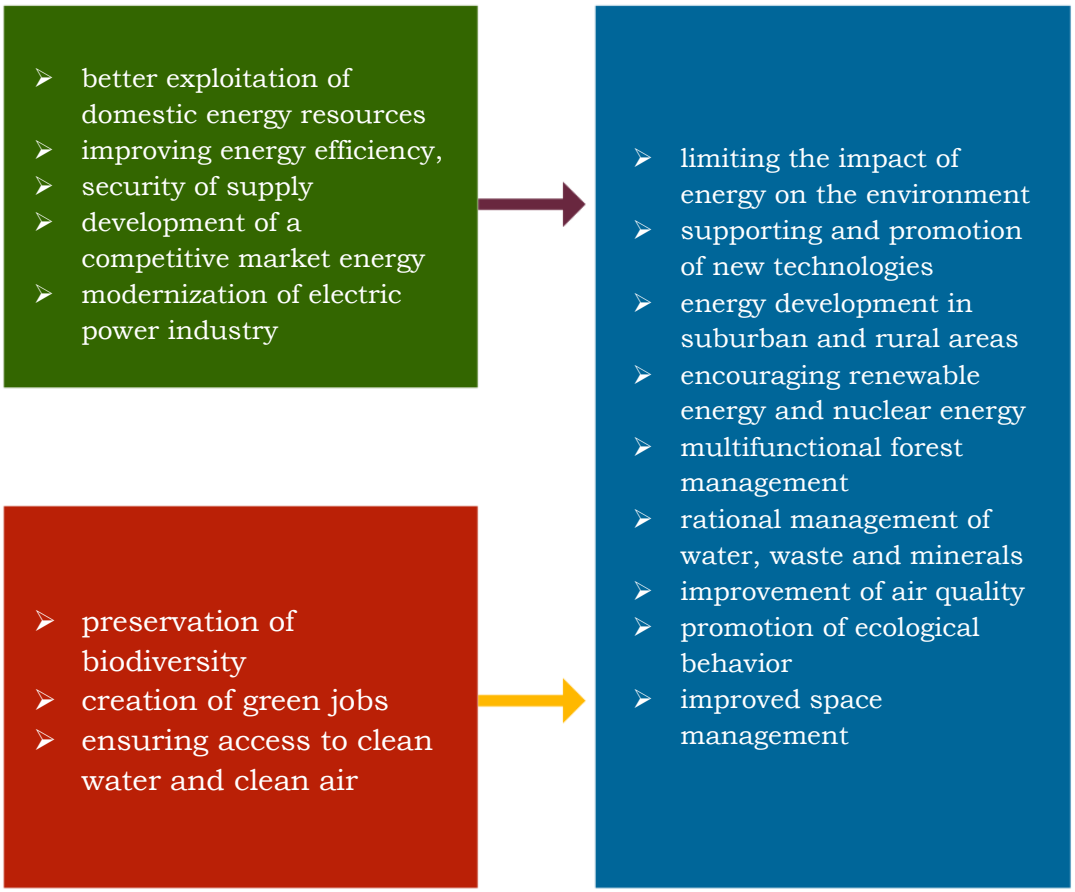

Figure 3.1: Objectives of the Strategy for Energy Security and Environment[139]

III. Polish National Strategy for Adaptation to Climate Change

[137] (Ministerstwo Gospodarki & Ministerstwo Środowiska, 2014)
[138] (Ministerstwo Energii, 2018)
[139] (Ministerstwo Gospodarki & Ministerstwo Środowiska, 2014)

Climate change and its effects on social and economic development of Poland in the future makes it necessary for the country to take measures in order to adapt to changes such as the increase of temperature, increased frequency and intensity of extreme phenomena, rising water level. As result in 2013 the Ministry of the Environment drafted a document entitled "Strategic Adaptation Plan for sectors and areas sensitive to climate change (water management, agriculture, forestry, biodiversity and legally protected areas, mountain areas, coastal zone, urban areas etc.) by 2020 with perspective up to 2030" (Strategiczny Plan Adaptacji dla sektorów i obszarów wrażliwych na zmiany klimatu do roku 2020 z perspektywą do roku 2030) also known as SPA2020. The main goal of the new policy is to secure sustainable development and reduce economy's vulnerability to conditions that caused by climate change. In other words with SPA2020 the polish government wants to reduce the costs resulting from the abandonment of adaptation measures.[140] The cost attributed to climate change in the years 2001-2011, according to relevant ministries and institutions and expert opinions, amounted 54 billion PLN. In case of failing to adapt to the effects of climate change, it is estimated that the total cost can rise even to 86 billion PLN by 2020, and 119 billion PLN during the period 2021-2030.[141] The primary cause of this cost is floods. The suggested measures are in complete agreement with other strategies or frameworks (e.g. Strategy for the Development of the country, White paper: Adapting to climate change: Towards a European framework for action composed by the European Commission in 2009).

IV. National Transport Development Strategy

Modern infrastructure and efficient transport system favor the social, economic and spatial cohesion, since they connect highly developed city centers with barely accessible areas of the country.[142] To support the development of transport system, National Transport Development Strategy by 2020 with perspective up to 2030 was published in 2013. It is Poland's first comprehensive strategy for transport sector.[143] The strategy applies to all sectors (rail, road, air, sea, inland waterway transport) and its priorities are improvement of transport accessibility

[140] (Klimada, n.d.)
[141] (Ministry of the Environment, 2013)
[142] (Uchwałę w sprawie „Strategii Rozwoju Transportu do 2020 r. (z perspektywą do 2030 r.), przedłożoną przez ministra transportu, budownictwa i gospodarki morskiej, n.d.)
[143] (International Energy Agency, 2017)

and transport management, safety and efficiency of transport system, limiting the negative impact on the environment, encouragement of innovative solutions and investments.[144]

EUROPEAN POLICIES

Poland's integration into the European Union is also a significant factor that shapes the country's energy policy. The energy policy of Poland is determined on a high level by the energy policy of the European Union. Energy strategy of the EU consists of three fundamental pillars: overall competitiveness, security of energy supply and environmental protection.[145] The most prominent example of the influence that the European Union and its energy policy have on Poland is the EU regulations and directives for liberalizing gas and electricity market. Poland took major steps towards adopting relevant EU regulation. The process of liberalization of polish market was accelerated because of the fact that Poland was supposed to join the European Union in 2004. As a result the country had to transpose EU directives into national law. The most prominent example is the Third Energy Package.

The first directive 2003/54/EC, adopted in 2003 establishes the principles of the common electricity market and covers the most important areas of the sector (generation, transmission, distribution and supply of electricity) and generally common rules for the organization and operation of the energy sector including market access and criteria-procedures for submitting and granting permits.[146] Some years later, the second directive was adopted repealing the previous directive. The 2009/72/EC Directive introduces common rules for the generation, transmission, distribution and supply of electricity, and lays down service obligations, consumer rights and competition requirements.[147] Another example is the Directive 2009/73/EC that repeals former Directive 2003/55/EC, which concerns the internal market in gas sector.[148]

Poland's obligations regarding industrial emissions, according to European Parliament and Council of the European Union's directive

---

[144] (Ministerstwo Transportu, Budownictwa I Gospodarki Morskiej, 2013)
[145] (European Commission, 1995)
[146] (Miciuła, 2014)
[147] (Directive 2009/72/EC , 2009)
[148] (European Commission, 2011)

2010/75/EU (replaces 2008/1/EC), the so called Industrial Emissions Directive, are preventing, reducing and eliminating when possible emissions of sulphur dioxide, nitrogen oxides and dust in combustion plants.[149] The general objective is to reduce-eliminate coal-fired power. The new limits are depicted on Figure 3.2.

Table 3.2: Limits of industrial emissions[150]

	SO_2	**NO_x**
From 2016	200 mg/Nm3	200 mg/Nm3
From 2019 (planned)	10-130 mg/Nm3	50-180 mg/Nm3

Furthermore Poland's energy policy is defined by European Union's 2020 Energy Strategy. In 2007 the heads of the states of the country members of the European Union decided to take further steps in order to reduce CO_2 emissions, to increase the use of renewable sources in energy production and enhance energy efficiency. The 2020 package is a set of binding targets, enacted in legislation in 2009 with three directives: Energy Efficiency Directive, Renewable Energy Directive and Emissions Trading System (ETS).[151]

The key targets of 2020 Energy Strategy are:

- 20% cut in greenhouse gas emissions (from 1990 levels)
- 20% of EU energy from renewable sources
- 20% improvement in energy efficiency

Emissions Trading System (ETS) is the cornerstone of EU'S effort to reduce manmade greenhouse gas emissions from large-scale facilities in power, industry and aviation sectors. The target is to lower down by 21% by 2020 the emissions in these sectors in comparison with the emissions level in 2005.[152] Installations that are included in the system must comply with limitations on overall emissions. At the same time a "cap and trade" approach is the second pillar of the ETS. To be more specific, companies are allowed to buy and sell emission allowances.[153] In this way they are granted the time and the flexibility they need in order to make the appropriate adjustments in the most

[149] (Official Journal of the European Union, 2010)
[150] (Nuclear Energy Department - Ministry of Economy, n.d.)
[151] (European Commission, n.d.)
[152] (European Commission, n.d.)
[153] (European Union, 2016)

cost-effective way. Overall the system is designed to cover around 45% of EU'S GHG emissions.[154]

In addition to the ETS, countries members of the EU are obliged to set National emission reduction targets on an annual basis until 2020 (compared to 2005) in sectors that ETS does not cover (housing, agriculture, waste and transport) under the "Effort-sharing decision.[155] The targets differ among countries according to national wealth. In case of Poland, the country undertook the binding commitment to limit GHG emissions to 14% in comparison to 2005 levels.[156]

Renewable Energy Directive establishes the framework for encouraging production of energy from renewable sources in the EU. The requirement is 20% of EU'S energy needs to be covered from renewable energy. Each country has to increase the share of renewable sources in energy production and ensure that at least 10% of their transport fuels come from renewable sources.[157] For Poland national renewable energy target is 15% as presented in the National Renewable Energy Action Plan.[158] On November 2016 the Commission published a revised Renewable Energy Directive setting the target of at least 27% of renewable in EU'S final energy consumption by 2030.[159]

Finally the *Energy Efficiency Directive* established in 2012 brings to life a set of measures for achieving EU'S 20% energy efficiency target until 2020. The measures include higher efficiency at all stages of energy chain (from production to final consumption).[160] This means that EU members collectively have agreed to maintain primary energy consumption of no more than 1483 million tons of oil equivalent and final energy consumption lower than 1086 Mtoe in 2020.[161] On November 2016 a revised Energy Efficiency Directive was proposed. The new document included a new energy efficiency target (increase by 30% energy efficiency until 2030).[162] Individually, as well as with the Renewable Energy Directive, every country determines national energy efficiency goals based on primary or final energy consumption,

---

[154] (European Commission, n.d.)
[155] (European Commission, n.d.)
[156] (International Energy Agency, 2017)
[157] (European Commission, n.d.)
[158] (International Energy Agency, 2017)
[159] (European Commission, 2017)
[160] (European Comission, n.d.)
[161] (Eurostat, 2016)
[162] (European Parliament Think Tank, 2018)

primary or final energy savings, or energy intensity. For Poland the target for primary energy consumption and final energy consumption is 96,4 million tones of oil equivalent and 71,6 Mtoe in 2020 respectively.[163]

Another Directive that applies to Poland is Directive 2009/31/EC of the European Parliament and of the Council on the geological storage of carbon dioxide. By virtue of this directive, a regulatory framework for geological storage and associated capture and transport activities is established.[164]

I. 2030 Energy Strategy

A new framework for climate and energy for the period 2020-2030 was agreed in 2014 with the aim of achieving 2050 GHG emission target (a cut of 80-95%).

Three fundamental targets are:

- At least 40% cuts in greenhouse gas emissions (from 1990 levels)
- At least 27% share for renewable energy
- At least 27% improvement in energy efficiency[165]

The total cut of emissions by at least 40% is served in the first place by EU Emission Trading System (ETS). Sectors that are included in the system would have to reach a cut of emissions by 43%, while the no-ETS sectors would have to cut emissions by 30% (compared to the level of 2005) with national binding targets for all member states.

Regarding renewable sources, their share in energy consumption is agreed to at least 27% percent by 2030. A new energy savings target was also set, to 27% by 2030 with prospects of revising.[166]

II. Energy Strategy 2050 and Power Perspective 2030.

The European Union with the Energy Roadmap 2050 ("A roadmap for moving to a competitive low carbon economy in 2050") sets the goal of reducing GHG emissions by 80-95% by 2050 compared to 1990 levels.

[163] (European Comission, n.d.)
[164] (Global CCS Institute, n.d.)
[165] (European Commission, n.d.)
[166] (European Commission, n.d.)

The strategy expresses the will to achieve decarbonisation in near future ensuring security of energy supply and competitiveness, as the 2020 Energy Strategy is insufficient in achieving EU'S decarbonisation objective by 2050.[167] There are seven main scenarios for 2050 that combine the most pillars of EU'S energy policy: energy efficiency, renewable energy, nuclear energy, and carbon capture and storage.

Concerning the targets of Energy Strategy 2050, in 2011 the European Commission indicated the year 2030 as the reference year of whether the steps that will enable a decarbonised EU in 2050 are implemented.[168] As carbon dioxide reduction range was established between 54% - 68% by 2030 compared to 1990 levels. This strategy is known as Power Perspective 2030.

Poland's, as well as all the other members of the European Union, must take action in terms of -among others- cutting emissions, increase investments, promote a diverse portfolio of low-carbon generation technologies[169] in order to comply with the goals set in the above strategies-policies.

III. European Energy Security Strategy

As a part of the European Energy Security Strategy, EU members conducted in 2014 stress test in order to examine the stability and abundance of energy supply in case of complete halt or disruption of Russian gas imports. During the period 2014-2015 member states adopted a series of short-term measures to ensure that consumers will have access to energy. Additionally long-term actions in five areas have been proposed:

a. increasing energy efficiency and reaching the proposed 2030 energy and climate goals,
b. increasing energy production in the EU and diversifying supplier countries and routes,
c. completing the internal energy market and building missing infrastructure links,
d. one external energy policy and

[167] (European Union, 2012)
[168] (Roadmap 2050, n.d.)
[169] (Power Perspective 2030: on the road to a decarbonised power sector, n.d.)

e. strengthening emergency and solidarity mechanisms and protecting critical infrastructure.[170]

This strategy is an integral part of EU'S 2030 Strategy. Generally Poland was very pleased with the outcome of Commission's actions since the pillars of the European Energy Security Strategy correspond to a large extent with the priorities of polish energy policy.

However the government of Republic of Poland is opposed to addressing the policy as integral part of 2030 climate and energy policy framework. In contrary it believes that the EU is based on three equivalent, interlinked pillars: energy security, competitiveness and sustainable development, where the energy security plays the key role in EU's energy policy.[171]

IV. Clean Energy for All Europeans

On November 2016 the European Commission published a new set of measures facilitating the clean energy transition and the creation of Energy Union by giving energy efficiency priority, achieving global leadership in renewable energy and protecting consumers. The package includes 8 legislative proposals:

a. Energy Performance in Buildings,

b. Renewable Energy,

c. Energy Efficiency,

d. Governance,

e. Electricity Market Design:
- the Electricity Regulation
- Electricity Directive
- and Risk-Preparedness Regulation and

f. Rules for the regulator ACER

From the above proposals the first four and Risk Preparedness Regulation have reached political agreement. Additionally the first four have been adopted by the European Parliament, and only the proposal for Energy Performance in Buildings has been adopted by the Council

[170] (Polskie Stowarzystwo Energetyki Wiatrowej, 2014)
[171] (Dobroczyńska & Juchniewicz, 2009)

and included Directive 2018/844/EU(19/06/2018).[172] This directive amends previous directives (Directive 2010/31/EU on the energy performance of buildings and Energy Efficiency Directive 2012/27/EU).[173] Changes that are introduced with this directive are mainly the need for increased pace of renovation of buildings and using of intelligent technologies.[174]

To conclude Poland has developed programs, strategies and policies in order to meet the goals of creating a more secure, green and efficient energy sector in the next decades. The concept of energy security in each of the sectors will be reviewed in the chapter. This includes national policies for energy shortages, plans for diversification of routes and suppliers of energy sources and relevant implications.

[172] (European Commission, n.d.)
[173] (Official Journal of the European Union, 2018)
[174] (Bogdan, 2017)

4. ENERGY SECURITY

In this part we will focus on energy security regarding the different energy sources that the country uses in order to cover its needs for energy.

First of all, what is energy security? According to IEA energy security is the "uninterrupted availability of energy sources at an affordable price".[175]

OIL SECURITY

Concerning oil security, the global market is characterized by vulnerabilities such as natural disasters, technical accidents, geo-political uncertainties and tensions. For Poland coal is of vital importance since it covers ⅕ of needs for energy.

There are two options for every country to deal with sudden oil supply shortages: 1) increase oil supply 2) reducing demand.[176]

Regarding the first policy every country needs to hold emergency oil stocks as a part of its emergency response policy. As for 2014 Poland met its stockholding obligations towards IEA and the European Union (14 days of governmental stocks and 76 days for fuel producers and importers).[177] According to the European Commission EU member states must maintain emergency stocks of crude oil and/or petroleum products "equal to at least 90 days of net imports or 61 day of consumption".[178] IEA Member countries can meet their obligations in three different ways: industry stocks, government stocks and agency stocks or a combination.[179] Poland in the beginning maintained a combination of industry and governmental stocks, which means that part of the obligations covers the government with state owned stocks, and the rest are held by industry (companies, importers, refiners, wholesalers etc.).[180] Since 2014 the government stocks became agency stocks, with the Agencja Rezerw Materialowych (Material Reserves Agency- MRA) being responsible for creating the required stocks. Additionally the MRA monitors the stockholding obligation of the industry and performs controls on the storing locations (each year

[175] (International Energy Agency, n.d.)
[176] (International Energy Agency, 2017)
[177] (International Energy Agency, 2017)
[178] (European Commission, n.d.)
[179] (International Energy Agency, n.d.)
[180] (International Energy Agency, n.d.)

30% of stocks). Thus the agency can impose relevant fines for non-compliance. Moreover the financing of these stocks is undertaken on a monthly basis by the companies in the industry that also responsible for storing them.[181]

Since January 2013 till August 2018 Poland has maintain stocks securing supply for over 90 days, meeting the requirements of the EU and the International Energy Agency.[182] Moreover since 2014 progressing decrease of the participation of industry in fulfilling the overall obligations can be observed. This is happening due to the will of the polish agency to increase systematically the role of its stocks, as this trend can be observed in the Figure 4.1.

Table 4.1: Compulsory stocks that industry is obligated to maintain[183]

Days and average daily production of oil and fuels (except LPG)	**Start-up-period**
76	Until 31/12/2014
68	Since 01/01/2015
63	Since 31/03/2016
60	Since 01/10/2016
57	Since 31/03/2017
53	Since 31/12/2017

In other words, agency stocks must cover energy needs for 37 days today. The release of emergency stocks and its parameters (price, type, volumes etc.) is decided by the Minister of Energy. Usually the agency stocks are released by sale, but loans are not excluded. Priority in purchasing have the companies that regularly pay stockholding fee, but the Minister of Energy can skip the rule. Compulsory stocks are released by reducing of obligation. Additionally the Minister of Energy can impose on companies an obligation to hold some of the stocks for eligible customers. The price is based generally on market price.[184]

In case of global disruption of supply, Poland can decide on participating in an IEA collaborative action in order to take adequate measures.[185]

[181] (International Energy Agency, 2017)
[182] (Eurostat, 2018)
[183] (Agencja Rezerw Materiałowych, 2015)
[184] (International Energy Agency, 2017)
[185] (International Energy Agency, 2017)

Key institution is the so called NESO, National Emergency Strategy Organization with responsibilities of:

a. preparing actions on national and international level,
b. consultations with oil industry and key players (Agencja Rezerw Materialowych, local authorities and Agencja Rynku Energii),
c. developing and implementing emergency response measures,
d. contacting with IEA and the European Commission.[186]

Secondly, in order to reduce energy demand, demand restraint can be applied but only in case of a long-lasting severe crisis in the energy sector. These measures include light-handed (e.g. public information campaigns, voluntary actions), medium-and-heavy-handed measures (fuel rationing, maximum fuel that filling stations can sell, driving restrictions, maximum fuel purchased by customer in one transaction, maximum speed rules etc.).[187] The decision is made by the ordinance of Ministers.

Energy security is strongly connected to imports of crude oil. Poland's main importer is Russia, which makes the country highly dependent. On Figure 4.2 the imports of crude oil are depicted. It is obvious that imports of crude oil from Russia are mainly stable, but in 2017 the imports were the lowest in a decade. At the same time the share of Russian crude oil in overall energy imports is decreasing. In 2007 imported oil from Russia represented 95,5% of all energy imports and a decade later the share is above 80%. Since 2015 Poland focuses on diversifying the energy importers to decrease its dependency on Russia adding or increasing imports from Saudi Arabia, Iraq, Azerbaijan, Iran and Nigeria. This step is linked to the plan of the country to increase its oil security.

Table 4.2: Polish imports of crude oil by country of origin[188]

Country	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Algeria			424			103					
Saudi Arabia						59			407	1.525	1.789
Azerbaij-an		212								84	
Denmark				85							85
Iraq						120		256	1.807	1.470	1.102

[186] (International Energy Agency, 2017)
[187] (International Energy Agency, n.d.) and (International Energy Agency, 2017)
[188] (Minister Energii, 2018)

Iran					123					287	257
Canada											90
Kazakhstan	73	25						567	499	184	882
Columbia				97							
Lithuania							62	63	49	48	32
Nigeria										89	
Norway	502	1.138	276	1.226	1.337	828	757	518	340	177	386
Russia	19.966	19.241	18.931	21.113	21.853	24518	22.270	22.140	23.388	20.707	19.682
South Africa			131								
USA											251
Great Britain	341	163	323	166	477		246	158			80
Other	3	8	13	1	2	5	11	11	2	2	12
Overall	**20.885**	**20.787**	**20.098**	**22.688**	**23.792**	**24.633**	**23.346**	**23.713**	**26.492**	**24.573**	**24.648**

Another step is to diversify the energy routes. The gas imported from Russia arrives via the Druzhba Pipeline that connects the base in Adamowo with the base in Miszewko Strzałkowskie (a village in the administrative district of Płock). Additionally oil is supplied to Poland by sea, via the Naftoport oil terminal in Gdańk, where the seaport is adapted to transshipments of oil and petroleum products.[189] The total potential capacity of Nafroport is 44 million tonnes of crude oil and liquid fuels per year.[190]

Two minor oil terminals exist in Port of Gdynia (with capacity of 3,5 Mt/year) and Szczecin (1,5 Mt/year).[191] With the Pomeranian pipeline russian crude oil from Druzhba Pipeline is transmitted from Płock to the oil terminal in Gdańk. This oil is destined for the city's refinery and the exporting activity of Grupa LOTOS S.A.[192] The pipeline supports transmission of oil in both directions (from Płock to Gdańk- capacity 22Mt/year- and Gdańk to Płock with 30 Mt/year capacity). The latter connection gives opportunities for import of oil via sea.[193] The above routes are illustrated in Figure 4.3

[189] (Filina-Dawidowicz & Kozłowska, 2012)
[190] (Naftoport, n.d.)
[191] (International Energy Agency, 2017)
[192] (International Energy Agency, 2017)
[193] (International Energy Agency, 2017)

Figure 4.3: Routes of transshipments of oil[194]

The key diversification project is the creation of a connection between the existing pipeline Odessa-Brody and the polish cities Płock and Gdańsk in order to link Poland and Ukraine by skipping Russia.[195] The under discussion option provides benefits such since it ensures diversification of routes for Poland (and the European Union) while at the same time it offers a stable route of transport of crude oil from Caspian and Black Sea increasing the energy security of the country, the EU and the region. Another interesting aspect of this project is the cooperation of the European Union, Ukraine and even other countries in the Caspian region, encouraging solidarity and long-lasting partnership.[196] In this sense the implementation of the project is an alternative to the Russian oil. Countries such as Azerbaijan and Kazakhstan are open to this kind of cooperation. Moreover, once the pipeline is constructed, exporting activity from Gdańsk can be developed. For the above reasons the European Union has included

194 (Weglowodory.pl, 2010)
195 (Kostiugova, 2008)
196 (Lubbe & Deptuła, 2013)

the projects in the Projects of Common Interests.[197] Although the Odessa-Płock pipeline is considered very beneficial, the implementation of this project has been delayed.

Natural Gas Security

From the historical point of view, natural gas markets have always been divided into regional markets, connected via pipelines. Last years have shown changes in the markets: the introduction of Liquefied Natural Gas (LNG). The latest trend is the shift from regional integration towards a globalised and interdependent natural gas market.[198]

This situation creates new challenges for the energy security of countries. Natural gas becomes a more and more important source of energy in the polish energy mix. Natural gas is the third energy source of the country.

Poland's gas security policy focuses on the diversification of the energy sources by increasing the share of natural gas in energy production, developing gas infrastructure, increasing storage capacity.

In Poland due to the existence of coal reserves, the production of natural gas is low. In 2016 the domestic production of natural gas was the lowest in 15 years. Despite that trend, in the next decades, as the need for energy is rising, it is expected that natural gas will play a more important role in covering energy needs of Poland.

The Minister of Energy with the support of the Polish gas National Emergency Strategy Organization (NESO) is responsible for security of supply of natural gas. The Oil and Gas Department is the secretary of NESO.

When approaching gas security, the mechanism of compulsory reserves needs to be examined. Every company that undertakes activities in import and trade of natural gas on an international level is obligated to hold compulsory stocks in or outside Poland. Poland fulfills requirements for 30 days of gas stocks. Additionally it complies with the obligation of delivering the entire inventory to the transmission system within 40 days. The Minister of Energy is responsible for managing those stocks. Gaz-system –the transmission

[197] (Ministerstwo Energii, n.d)
[198] (International Energy Agency, n.d.)

system operator (TSO) for natural gas- with Gas Storage Poland Sp. Z o.o.- natural gas storage system operator (SSO)- conduct the withdrawal of compulsory stocks when needed with maximum withdrawal rate: 43 million cubic meters per day.[199]

There is also the possibility of increasing supply on the basis of existing contracts, e.g. increasing the flow from reversed Yamal Pipeline. Lastly, there is no official policy or legal authority for fuel switching although over 300 facilities have confirmed this ability.[200]

Regarding imports of natural gas to Poland, the country's dependence on imports of this particular source is over 78%. The most important importers of gas for Poland are presented in Figure 4.4.

Table 4.4: Polish imports of natural gas by country[201]

Country of origin	**2009**	**2010**	**2011**	**2012**
Russian Federation and Central Asia	8.397,4	9.028,4	9.335,5	9.017,3
Germany	1.072,8	9.028,4	1.031,9	1.426,9
Czech Republic	0,3	0,3	0,22	555,7
Norway	-	-	-	-
Ukraine	4,8	5,9	-	-

Poland depends mostly on Russian gas. According to PGNiG in 2015 around 90% of gas imports came from Gazprom, while in 2017 the percentage to 70%[202], which means that the need for gas in Poland is less and less covered by Russian gas. Additionally the instabilities in imports from Russia are a result of Russia's policy "take or pay" (the imported amount must be higher that the quantities imposed by Gazprom and lower that the maximum annual amount established in a long-term import contract that expires in 2022.[203]

[199] (International Energy Agency, 2017)
[200] (International Energy Agency, 2017)
[201] (Kołbuk & Kołbuk, 2014)
[202] (Ministry of Foreign Affairs, 2018)
[203] (PGNiG, 2018)

Figure 4.5: Routes of natural gas imports to Poland[204]

The main route is Yamal pipeline, thought which russian is transmitted to the West. The pipeline goes though polish territories under the Yamal contract for sale and purchase of gas between Gazprom Export and PGNiG (25.09.1996).[205] Today the polish section of the pipeline is owned by TGPS EuRoPol GAS S.A., where shareholders are Gazprom Eksport (48%), PGNiG (48%) and Gas Trading S.A. (4%). Since 2014, Poland gained the permission to use the Yamal pipeline in reverse flow to import natural gas from Germany.

Poland explores possibilities for limiting dependency on Russian gas. The country's first step towards that objective was the refusal of extension of the long-term deal with Gazprom after its expiration date in 2022.[206]

A great alternative to the Russian gas is Liquefied Natural Gas. The terminal in Świnoujście (operating since 2015) is a great way of increasing the energy security of the country, since it provides the opportunity to import the source from any place on the world. In 2018 the dynamic of the increase of imports of LNG was ten times higher than the dynamic of imports of Russian gas.[207]

---

[204] (Górnosląski Serwis Gospodarczy, 2006)
[205] (PGNiG, 2007)
[206] (Barteczko, 2018)
[207] (PGNiG, 2018)

The first deliveries came from Qatar in December, 2015. The tanker All Sadd originating from LNG terminal in Ras Laffan, belongs to the company Qatargas, a subsidiary of Qatar Petroleum. The 20-year delivery agreement was signed in 2009, and in 2017 the parties agreed to double the delivery of LNG since 2018.[208]

Introducing LNG in Poland does not limit the country's dependency generally on gas imports, but on Russian gas, improving the polish position in negotiations with Russia.

In addition to that, in June 2018 the polish state-run company PGNiG signed agreement on long-term basis with U.S. companies Port Arthur LNG and Venture Global LNG for Liquefied Gas (LNG) deliveries, and the possibility of further trade of LNG. The agreements refer to 2 million tones/year of American LNG from each of the firms for the next two decades. The so called "free-on-board" basis is at the heart of the agreements. This means that the purchaser of LNG undertakes the responsibility of its transportation from the loading port.[209]

Previously, in November 2017 Poland signed a mid-term deal with another company in the sector, Centrica LNG Co Ltd for nine LNG shipments during 2018-2022.[210] The most important aspect of the new cooperation is the issue of price. According to PGNiG, LNG delivered from U.S. will be at least 20% cheaper that the Russian natural gas.[211]

The contract with Qatar is based on the principle "take or pay", which means that PGNiG has to pay for the source even if eventually it wouldn't collect it.[212]

Another important aspect of polish gas security policy is the creation and improvement of infrastructure and connections with neighboring countries. Poland's interests should focus on promoting regional cooperation with countries such as Norway and countries of Eastern and Central Europe in order to reduce the risk of gas shortages in case of energy crisis and encourage the diversification of energy routes and suppliers.

One of the most important projects in gas market is the Gas Interconnection between Poland and Lithuania (GIPL). The project is

[208] (Kublik, 2017)
[209] (Barteczko, 2018)
[210] (Barteczko, 2018)
[211] (Kublik, 2018)
[212] (Kublik, 2017)

part of the Baltic Energy Market Interconnection Plan and aims at creating a new cross-border gas pipeline that will link natural gas transmission systems of Poland and Lithuania. The parties of the project are GAZ-SYSTEM and Amber Grid AB (the Lithuanian TSO). The project is co-financed by the European Union as part of the Connecting Europe Facility (CEF) and was granted the status of Project of Common Interest. The planned route of the pipeline includes 12 countries and in Poland is it located in 3 provinces (Mazowieckie, Podlaskie, Warmińsko-Mazurskie).[213] The project is beneficial for both countries and the European Union. From the perspective of the EU the Polish-Lithuanian pipeline can contribute in the integration of the European gas system and liberalizing the gas market. Additionally it excludes the possibility of creation of "energy islands" in this part of Europe. As for the two countries the project has the potential to increase energy security by diversifying energy routes.

Another project of polish interests that involve Baltic Energy Market Interconnections Plan (BEMIP) for gas is the development of Baltic Pipeline Project, a new gas supply corridor in Europe that will enable 1) the transmission of gas from Norway and Denmark to polish markets and other neighboring countries, and 2) the supply of polish gas to Denmark and Sweden. The project has been undertaken by Energinet (Danish gas and electricity TSO) and Gaz-system (polish gas TSO).[214]

Another two important investments include the extension of entry points to the Yamal pipeline in Lwówek and Włocławek, and the extension of the LNG terminal in Świnoujście in order to increase its capacity from 5 to 7,5 billion cubic meters of natural gas per annum.[215]

Another proposed interconnection is the development of North South Corridor that would link Central-Easter Europe and South –Eastern Europe. Specifically the North-South Gas Corridor will link the LNG terminal in Świnoujście in Poland with the Baltic Pipe, thought central Poland, the Czech Republic, Slovakia, and Hungary ending in LNG terminal in Croatia. Obviously the project includes many bi-directional inter-system gas connections and domestic gas pipelines that already exist or are planned or constructed. These include the

[213] (Gaz-System, n.d.)
[214] (Baltic Pipe Project, n.d.)
[215] (Gaz-System, 2017)

Poland-Czech Republic interconnection and Poland-Slovakia interconnection.[216]

These projects provide certain benefits for Poland and for the region in general since it encourages the integration of regional and the European gas markets, promotes energy security by creating access to new sources of supply (Norway, LNG), unifying market principles and coordination of regional infrastructure projects.[217] The above pipeline projects are illustrated on Figures 4.6, 4.7 and 4.8

Figure 4.6: Gas Interconnection between Poland and Lithuania [218]

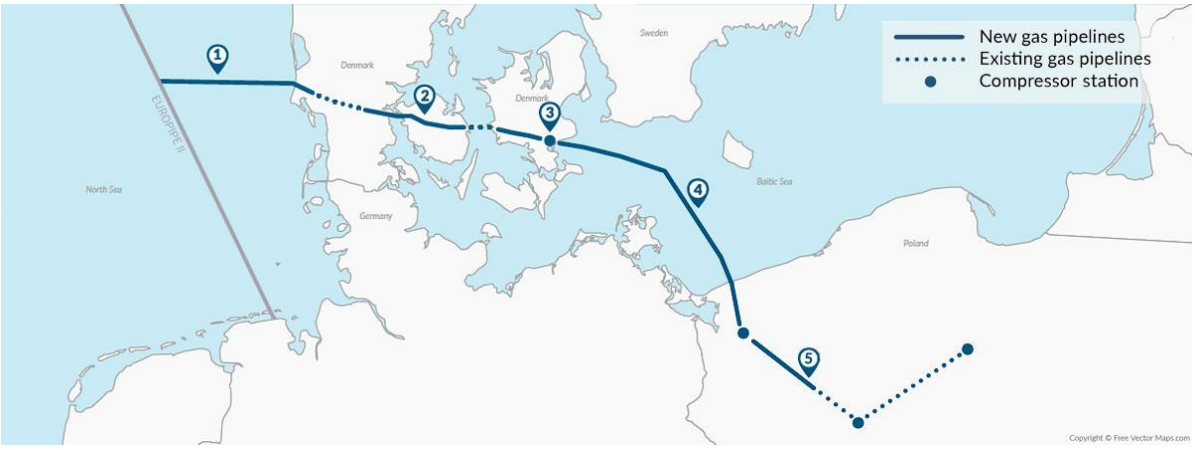

Figure 4.7: Baltic Pipeline Project [219]

---

[216] (Gaz-System, n.d.)
[217] (Strzymiński, 2018)
[218] (Fandrich & Iden, 2015)

Figure 4.8: North-South Gas Corridor [220]

Undoubtedly in Poland coal plays the key role in the energy security of the country. The high dependency on Russian gas and oil creates worries over the security of energy supply. Thus, as stated in the last part, Poland has developed several projects that will help to diverse energy suppliers and routes, increase energy security and shift towards a more balanced energy mix in the future.

[219] (Baltic Pipeline Project, n.d.)
[220] (Posaner, 2015)

5. CONCLUSION

To conclude, Poland's energy mix is not balanced. Almost half of Poland's energy mix consists only from coal. Because of the availability of deposits and a highly developed coal sector, coal will continue to play a strategic role in polish economy. Additionally huge "costs" of abundance of this source are another argument in favor of continuation of domestic production. The coal sector employs a large part of the population, which is high skilled. So, distancing from coal production will have a negative impact on a part of polish society. Thus it is a politically sensitive decision. Lastly, coal production provides Poland energy security and independency. On the other hand, it creates difficulties in adapting to climate change and decreasing GHG emissions that would lead to a more green economy.

In addition, Poland's dependency on imports of natural gas (78%) and oil (94%), especially from Russian Federation, creates threats to the energy security of Poland. The issue of energy security is high on the political agenda in the country and that is why relevant actions and projects have been proposed. LNG from Qatar and U.S., Gas Interconnection between Poland and Lithuania (GIPL), extension of Odessa-Brody pipeline, Baltic Pipeline Project are on the list of such projects.

Nevertheless, the implementation of the above proposals is not enough in guaranteeing the energy security of the country. Thus, the introduction of renewable sources is considered crucial. The total share of renewable sources in energy supply has increased to 10% in 2016, compared to 1990, when the share was around 1%. Still the transition is slow, comparing Poland to other EU countries. Total Primary Energy Supply for the best 7 members includes at least 30% of renewable sources in energy mix, and for the first two the share is more that 50%. Following this direction Poland develops and implements policies, regulatory and economic measures for encouraging production of renewable sources (amendment of RES Act, different certificates, loans of low interests for encouraging production and investment in renewable sources). A major step is expected to be taken in the New Strategy for 2050, by including additional actions for the promotion of renewable sources.

Last but not least, the discussion of increasing energy security includes the goal of creating nuclear power plants in Poland. The introduction of nuclear energy constitutes a solution for energy dependency and increasing electricity demand. The plan is ambitious

but Poland has the technological, technical, economic and infrastructural foundation to implement this goal.

Energy security is and will be the burning issue in Poland for the next decades. In order to increase its energy security Poland needs to conduct changes in its energy sector with the support of policy framework and institutional structure. In this context, crucial role for this transition will certainly play the formulation of the Polish Energy Strategy for 2050. This policy is expected to draw additional measures, though which the energy security of the country will be based more on renewable sources and diversified imports of energy sources.

Poland: Balances for 2016[221]

	Coal*	Crude oil	Oil products	Natural gas	Nuclear	Hydro	Geothermal, solar, etc.	Biofuels and waste	Electricity	Heat	Total**
	ktoe	*ktoe*	*ktoe*	*ktoe*	*ktoe*	*ktoe*	*ktoe*	*ktoe*	*ktoe*	*ktoe*	*ktoe*
Production	52 308	1 027	0	3 553	0	184	1 168	8 416	0	12	66 666
Imports	5 039	25 133	7 518	12 185	0	0	0	833	1 205	0	51 913
Exports	-10 837	-227	-7 078	-716	0	0	0	-1 081	-1 033	0	-20 973
International marine bunkers***	0	0	-182	0	0	0	0	0	0	0	-182
International aviation bunkers****	0	0	-683	0	0	0	0	0	0	0	-683
Stock changes	2 677	432	-148	-389	0	0	0	-8	0	0	2 565
TPES	49 187	26 365	-573	14 633	0	184	1 168	8 159	172	12	99 307
Transfers	0	210	-168	0	0	0	0	0	0	0	42
Statistical differences	364	15	8	53	0	0	0	0	0	0	441
Electricity plants	-425	0	-1	0	0	-184	-1 093	-456	1 640	-13	-531
CHP plants	-32 112	0	-431	-1 482	0	0	0	-1 533	12 646	4 515	-18 397
Heat plants	-2 686	0	-21	-204	0	0	0	-68	0	2 467	-511

221 (International Energy Agency, 2018)

	Coal*	Crude oil	Oil products	Natural gas	Nuclear	Hydro	Geothermal, solar, etc.	Biofuels and waste	Electricity	Heat	Total**
	ktoe	*ktoe*	*ktoe*	*ktoe*	*ktoe*	*ktoe*	*ktoe*	*ktoe*	*ktoe*	*ktoe*	*ktoe*
Gas works	0	0	0	0	0	0	0	0	0	0	0
Oil refineries	0	-27 896	27 419	0	0	0	0	0	0	0	-477
Coal transformation	-1 501	0	0	0	0	0	0	0	0	0	-1 501
Liquefication plants	0	0	0	0	0	0	0	0	0	0	0
Other transformation	-128	1 306	-710	-599	0	0	0	0	0	0	-130
Energy industry own use	-1 078	0	-1 089	-1 042	0	0	0	-1	-2 220	-648	-6 078
Losses	0	0	0	-27	0	0	0	0	-816	-664	-1 507
Total final consumption	11 622	0	24 434	11 334	0	0	74	6 102	11 422	5 669	70 657
Industry	3 315	0	648	3 411	0	0	0	2 185	4 403	685	14 648
Transport	0	0	17 416	383	0	0	0	458	283	0	18 539
Other	8 219	0	2 839	5 432	0	0	74	3 459	6 736	4 984	31 744
Residential	6 586	0	588	3 467	0	0	63	2 662	2 486	3 893	19 744
Commercial and public services	657	0	421	1 934	0	0	11	277	4 110	1 070	8 479
Agriculture / forestry	976	0	1 830	31	0	0	0	521	140	21	3 521
Fishing	0	0	0	0	0	0	0	0	0	0	0

	Coal*	**Crude oil**	**Oil products**	**Natural gas**	**Nuclear**	**Hydro**	**Geothermal, solar, etc.**	**Biofuels and waste**	**Electricity**	**Heat**	**Total****
	ktoe	*ktoe*	*ktoe*	*ktoe*	*ktoe*	*ktoe*	*ktoe*	*ktoe*	*ktoe*	*ktoe*	*ktoe*
Non-specified	0	0	0	0	0	0	0	0	0	0	0
Non-energy use	87	0	3 531	2 108	0	0	0	0	0	0	5 727
-of which chemical/petrochemical	*0*	*0*	*1 999*	*2 108*	*0*	*0*	*0*	*0*	*0*	*0*	*4 107*

** The column of coal also includes peat and oil shale where relevant.*
*** Totals may not add up due to rounding.*
**** International marine bunkers are included in transport for world totals.*
***** International aviation bunkers are included in transport for world totals.*

BIBLIOGRAPHY

[1] Bieliszczuk, B., Kowalewski, K., Stolarz, A. (2016, June). *Jaka energia będzie napędzać polską gospodarkę?*, p. 4, Instytut Jagielloński. Retrieved from: http://jagiellonski.pl/files/other/1536000634.pdf

[2] Central Intelligence Agency. (n.d.). *The World Factbook: Poland*. Retrieved from: https://www.cia.gov/library/publications/the-world-factbook/geos/pl.html

[3] International Energy Agency. (2017, January 25). *Energy Policies of IEA Countries : Poland 2016 Review*, p. 18. Retrieved from: https://webstore.iea.org/energy-policies-of-iea-countries-poland-2016-review

[4] Szymański, D. (2018, June 1). Polska wśród państw z najniższym bezrobociem w Europie. Królują Czesi, *Business Insider Polska*. Retrieved from: https://businessinsider.com.pl/twoje-pieniadze/praca/bezrobocie-w-europie-kwiecien-2018-r-dane-eurostatu/0t7z9pt

[5] Eurostat. (n.d.). *Real GDP growth rate – volume*. Retrieved from: https://ec.europa.eu/eurostat/tgm/table.do?tab=table&init=1&language=en&pcode=tec00115&plugin=1

[6] Bogdan, W., Boniecki, D., Labaye, E., Marciniak, T., Nowacki, M. (2015, January). *Poland 2025: Europe's new growth engine*, p. 1. Retrieved from: https://www.mckinsey.com/~/media/mckinsey/business%20functions/economic%20studies%20temp/our%20insights/how%20poland%20can%20become%20a%20european%20growth%20engine/poland%202025_full_report.ashx

[7] International Energy Agency. (n.d.). *Balances definitions*. Retrieved from: https://www.iea.org/statistics/resources/balancedefinitions/

[8] International Energy Agency. (n.d.). *Poland: Balances for 1990-2016*. Retrieved from: https://www.iea.org/statistics/?country=POLAND&year=2016&category=Key%20indicators&indicator=TPESbySource&mode=chart&categoryBrowse=false&dataTable=BALANCES&showDataTable=true

[9] International Energy Agency. (n.d.). *Poland: Balances for 1990-2016*. Retrieved from: https://www.iea.org/statistics/?country=POLAND&year=2016&category=Key%20indicators&indicator=TPESbySource&mode=chart&categoryBrowse=false&dataTable=BALANCES&showDataTable=true

[10] International Energy Agency. (2017, January 25). *Energy Policies of IEA Countries : Poland 2016 Review*, p. 19. Retrieved from: https://webstore.iea.org/energy-policies-of-iea-countries-poland-2016-review

[11] International Energy Agency. (n.d.). *Poland: Balances for 1990-2016*. Retrieved from: https://www.iea.org/statistics/?country=POLAND&year=2016&category=Key%20indicators&indicator=TPESbySource&mode=chart&categoryBrowse=false&dataTable=BALANCES&showDataTable=true

[12] International Energy Agency. (n.d.). *Poland: Balances for 1990-2016*. Retrieved from: https://www.iea.org/statistics/?country=POLAND&year=2016&category=Key%20indicators&indicator=TPESbySource&mode=chart&categoryBrowse=false&dataTable=BALANCES&showDataTable=true

[13] Eurostat. (n.d.). *Glossary: Final energy consumption*. Retrieved from: https://ec.europa.eu/eurostat/statistics-explained/index.php/Glossary:Final_energy_consumption

[14] OECD. (2016, September). *Fossil Fuel Support Country Note: Poland*,p.1. Retrieved from: https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=3&ved=2ahUKEwjSwu_3jN7fAhWFyqQKHVutBGYQFjACegQIBxAC&url=http%3A%2F%2Fstats.oecd.org%2Fwbos%2Ffileview2.aspx%3FIDFile%3D0f62c68f-0ed0-484d-8414-3089183d6c35&usg=AOvVaw3IH3ZI8Av5gC5BGik-qXvn

[15] Piszczatowska, J. (2018, February 5). *Wydobycie węgla w Polsce spadło do poziomu z 1950 roku.* Retrieved from: https://wysokienapiecie.pl/7870-wydobycie-wegla-w-polsce-spadlo-poziomu-z-1950-roku/

[16] International Energy Agency. (n.d.). *Poland: Balances for 1990-2016*. Retrieved from: https://www.iea.org/statistics/?country=POLAND&year=2016&category=Key%20indicators&indicator=TPESbySource&mode=chart&categoryBrowse=false&dataTable=BALANCES&showDataTable=true

[17] International Energy Agency. (n.d.). *Poland: Balances for 1990-2016*. Retrieved from: https://www.iea.org/statistics/?country=POLAND&year=2016&category=Key%20indicators&indicator=TPESbySource&mode=chart&categoryBrowse=false&dataTable=BALANCES&showDataTable=true

[18] International Energy Agency. (2017, January 25). *Energy Policies of IEA Countries : Poland 2016 Review*, p. 19. Retrieved from: https://webstore.iea.org/energy-policies-of-iea-countries-poland-2016-review

[19] International Energy Agency. (n.d.). *Share of Total Final Consumption (TFC) by sector*. Retrieved from: https://www.iea.org/statistics/?country=POLAND&year=1990&category=Key%20indicators&indicator=TFCShareBySector&mode=chart&categoryBrowse=false&dataTable=BALANCES&showDataTable=true

[20] European Commission. (2014, July 2). *In-depth study of European Energy Security*, p.4. Retrieved from: https://ec.europa.eu/energy/sites/ener/files/documents/20140528_energy_security_study.pdf

[21] Ministerstwo Energii. (2018, November 22). *O Ministerstwie*. Retrieved from: https://www.gov.pl/web/energia/o-ministerstwie

[22] European Committee of the Regions. (n.d.). *Poland-Energy*. Retrieved from: https://portal.cor.europa.eu/divisionpowers/Pages/Poland-Energy.aspx

[23] World Energy Council. (n.d.). *Coal in Poland*. Retrieved from: https://www.worldenergy.org/data/resources/country/poland/coal/

[24] Herold, A., Siemons, A., Wojtal, L. (2017). *Climate and energy policies in Poland,* p.1. Retrieved from: http://www.europarl.europa.eu/RegData/etudes/BRIE/2017/607335/IPOL_BRI(2017)607335_EN.pdf

[25] International Energy Agency. (n.d.). *Poland: Balances for 1990-2016*. Retrieved from: https://www.iea.org/statistics/?country=POLAND&year=2016&category=Key%20indicators&indicator=TPESbySource&mode=chart&categoryBrowse=false&dataTable=BALANCES&showDataTable=true

[26] International Energy Agency. (2017, January 25). *Energy Policies of IEA Countries : Poland 2016 Review*, p. 18. Retrieved from:

https://webstore.iea.org/energy-policies-of-iea-countries-poland-2016-review

[27] Państwowy Instytut Geologiczny-Państwowy Instytut Badawczy. (n.d.). *Wydobycie węgla kamiennego w Polsce*. Retrieved from: https://www.pgi.gov.pl/psg-1/psg-2/informacja-i-szkolenia/wiadomosci-surowcowe/10418-wydobycie-wegla-kamiennego-w-polsce.html

[28] Państwowy Instytut Geologiczny-Państwowy Instytut Badawczy. (n.d.). *Wydobycie węgla kamiennego w Polsce*. Retrieved from: https://www.pgi.gov.pl/psg-1/psg-2/informacja-i-szkolenia/wiadomosci-surowcowe/10418-wydobycie-wegla-kamiennego-w-polsce.html

[29] World Energy Council. (n.d.). *Coal in Poland*. Retrieved from: https://www.worldenergy.org/data/resources/country/poland/coal/

[30] Państwowy Instytut Geologiczny-Państwowy Instytut Badawczy. (n.d.). *Wydobycie węgla kamiennego w Polsce*. Retrieved from: https://www.pgi.gov.pl/psg-1/psg-2/informacja-i-szkolenia/wiadomosci-surowcowe/10418-wydobycie-wegla-kamiennego-w-polsce.html

[31] International Energy Agency. (2017, January 25). *Energy Policies of IEA Countries : Poland 2016 Review*, p. 125. Retrieved from: https://webstore.iea.org/energy-policies-of-iea-countries-poland-2016-review

[32] Heinrich Böll Stiftung. (2016, June 20). *Polska. Nie tak łatwo określić zasoby*, p.1. Retrieved from: https://pl.boell.org/pl/2016/06/20/polska-nie-tak-latwo-okreslic-zasoby

[33] World Energy Council. (n.d.). *Coal in Poland*. Retrieved from: https://www.worldenergy.org/data/resources/country/poland/coal/

[34] International Energy Agency. (2017, January 25). *Energy Policies of IEA Countries : Poland 2016 Review*, p. 122. Retrieved from: https://webstore.iea.org/energy-policies-of-iea-countries-poland-2016-review

[35] International Energy Agency. (2017, January 25). *Energy Policies of IEA Countries : Poland 2016 Review*, p. 127. Retrieved from: https://webstore.iea.org/energy-policies-of-iea-countries-poland-2016-review

[36] International Energy Agency. (n.d.). *Poland: Balances for 1990-2016*. Retrieved from: https://www.iea.org/statistics/?country=POLAND&year=2016&category=Key%20indicators&indicator=TPESbySource&mode=chart&categoryBrowse=false&dataTable=BALANCES&showDataTable=true

[37] International Energy Agency. (n.d.). *Poland: Balances for 1990-2016*. Retrieved from: https://www.iea.org/statistics/?country=POLAND&year=2016&category=Key%20indicators&indicator=TPESbySource&mode=chart&categoryBrowse=false&dataTable=BALANCES&showDataTable=true

[38] International Energy Agency. (2017, January 25). *Energy Policies of IEA Countries : Poland 2016 Review*, p. 124. Retrieved from: https://webstore.iea.org/energy-policies-of-iea-countries-poland-2016-review

[39] Rosicki, R. & Gielnik, A. (n.d.). *Bezpieczeństwo energetyczne I ekologiczne na przykładzie węgla brunatnego w Polsce*. Retrieved from: https://repozytorium.amu.edu.pl/bitstream/10593/14655/1/Bezpieczce%C5%84stwo%20energetyczne%20i%20ekologiczne%20na%20przyk%C5%82adzie%20w%C4%99gla%20brunatnego%20w%20Polsce.pdf

[40] Kasztelewicz, Z. (2018, April 23). *Raport o stanie branży węgla brunatnego w Polsce i w Niemczech wraz z diagnozą działań dla rozwoju tej branży w I połowie XXI wieku*, p. 10. Retrieved from: https://www.cire.pl/pliki/2/2018/raport_o_stanie_branzy_wegla_brunatnego_w_polsce_i_w_niemczech.pdf

[41] Rosicki, R. & Gielnik, A. (n.d.). *Bezpieczeństwo energetyczne I ekologiczne na przykładzie węgla brunatnego w Polsce*. Retrieved from: https://repozytorium.amu.edu.pl/bitstream/10593/14655/1/Bezpieczce%C5%84stwo%20energetyczne%20i%20ekologiczne%20na%20przyk%C5%82adzie%20w%C4%99gla%20brunatnego%20w%20Polsce.pdf

[42] Kasiński, J. R. (n.d.). *Zasoby węgla brunatnego w Polsce - stan rozpoznania i podstawowe problem*, p. 7. Retrieved from: https://www.pgi.gov.pl/images/stories/artykuly/wegiel_brunatny/tekst_kasin_2.pdf

[43] Nowaczyk, M. & Zasuń, R. (2008, January 9). Mamy największe złoża węgla brunatnego na świecie. *Wyborcza.pl*. Retrieved from: http://wyborcza.pl/1,75248,4820533.html

[44] Kasztelewicz, Z. (2008, June) .*Uwarunkowania wydobycia węgla brunatnego i produkcji energii elektrycznej w Polsce i Europie*, p. 63.

Retrieved from:
https://www.pgi.gov.pl/images/stories/artykuly/wegiel_brunatny/tekstkasztel_mini.pdf

[45] Kasztelewicz, Z. (2018, April 23). *Raport o stanie branży węgla brunatnego w Polsce i w Niemczech wraz z diagnozą działań dla rozwoju tej branży w I połowie XXI wieku*, p. 10. Retrieved from: https://www.cire.pl/pliki/2/2018/raport_o_stanie_branzy_wegla_brunatnego_w_polsce_i_w_niemczech.pdf

[46] PGE. (n.d.). *Parametry złoża*, Retrieved from: https://kwbbelchatow.pgegiek.pl/Zloze-Zloczew/Parametry-zloza

[47] Kasztelewicz, Z. (2010, December). *Górnictwo węgla brunatnego w Polsce*, p.5. Retrieved from: https://www.cire.pl/pliki/2/gorn_wegl_brun_polska.pdf

[48] Kasztelewicz, Z. (2010, December). *Górnictwo węgla brunatnego w Polsce,* p.5. Retrieved from: https://www.cire.pl/pliki/2b/gorn_wegl_brun_polska.pdf

[49] International Energy Agency. (2017, January 25). *Energy Policies of IEA Countries : Poland 2016 Review*, p. 127-131. Retrieved from: https://webstore.iea.org/energy-policies-of-iea-countries-poland-2016-review

[50] Ministerstwo Energii. (2018, January 23). *PROGRAM dla sektora górnictwa węgla kamiennego w Polsce*, p. 34. Retrieved from: https://www.teraz-srodowisko.pl/media/pdf/aktualnosci/4177-program-dla-sektora-gornictwa-kamiennego.pdf

[51] International Energy Agency. (2017, January 25). *Energy Policies of IEA Countries : Poland 2016 Review*, p. 127-131. Retrieved from: https://webstore.iea.org/energy-policies-of-iea-countries-poland-2016-review

[52] Katowicki Holding Węglowy S.A. (2018, October 4). *Ogłoszenie Planu Połączenia*. Retrieved from: http://www.khw.pl/aktualnosci/aktualnosci2/OGLOSZENIE-PLANU-POLACZENIA/idn:924.html

[53] Barecki, Z. (n.d.). *Zakończenie eksploatacji węgla przez skonsolidowaną Kopalnię „Pstrowski" w Zabrzu*, p. 11. Retrieved from: http://www.sbc.org.pl/Content/113516/Szyb_Maciej_KSIAZKA50_300DPI.pdf

[54] Rzeczpospolita. (2017, July 18). *Kompania Węglowa przestała istnieć - jej następcą prawnym jest SRK.* Retrieved from: https://www.rp.pl/Wegiel/170719008-Kompania-Weglowa-przestala-istniec---jej-nastepca-prawnym-jest-SRK.html

[55] Ministerstwo Energii. (2018, January 23). *PROGRAM dla sektora górnictwa węgla kamiennego w Polsce*, p. 34. Retrieved from: https://www.teraz-srodowisko.pl/media/pdf/aktualnosci/4177-program-dla-sektora-gornictwa-kamiennego.pdf

[56] Rzeczpospolita. (2017, July 18). *Kompania Węglowa przestała istnieć - jej następcą prawnym jest SRK.* Retrieved from: https://www.rp.pl/Wegiel/170719008-Kompania-Weglowa-przestala-istniec---jej-nastepca-prawnym-jest-SRK.html

[57] Ministerstwo Energii. (2018, January 23). *PROGRAM dla sektora górnictwa węgla kamiennego w Polsce*, p. 34. Retrieved from: https://www.teraz-srodowisko.pl/media/pdf/aktualnosci/4177-program-dla-sektora-gornictwa-kamiennego.pdf

[58] Polska Grupa Górnicza S.A. (n.d.). *Kontakt.* Retrieved from: https://www.pgg.pl/kontakt/dane-teleadresowe

[59] Jastrzębska Spółka Węglowa S.A. (2018, November 21). *Skonsolidowany Raport*, p. 13. Retrieved from: https://www.jsw.pl/relacje-inwestorskie/raporty-gieldowe/raporty-okresowe/raporty-okresowe-2018/ and https://www.jsw.pl/relacje-inwestorskie/raporty-gieldowe/raporty-okresowe/raporty-okresowe-2018/index.php?eID=tx_securedownloads&u=0&g=0&t=1547063467&hash=40caa274e01fd5a50e9d25c75fa7fc3b0d9436eb&file=/fileadmin/user_files_ri/raporty-okresowe/pl/2018/3q/1_SKONSOLIDOWANY_RAPORT_KWARTALNY_3Q_2018.pdf

[60] Jastrzębska Spółka Węglowa S.A. (n.d.). *About JSW.* Retrieved from: https://www.jsw.pl/en/about-us/about-jsw/

[61] Ministerstwo Energii. (2018, January 23). *PROGRAM dla sektora górnictwa węgla kamiennego w Polsce*, p. 33. Retrieved from: https://www.teraz-srodowisko.pl/media/pdf/aktualnosci/4177-program-dla-sektora-gornictwa-kamiennego.pdf

[62] Lubelski Węgiel „Bogdanka" S.A. (n.d.). *Położenie Kopalni "Bogdanka"*. Retrieved from: https://www.lw.com.pl/pl,2,s168,polozenie_kopalni.html

[63] Ministerstwo Energii. (2018, January 23). *PROGRAM dla sektora górnictwa węgla kamiennego w Polsce*, p.25-26. Retrieved from: https://www.teraz-srodowisko.pl/media/pdf/aktualnosci/4177-program-dla-sektora-gornictwa-kamiennego.pdf

[64] PGE. (n.d.). *Kim jesteśmy*. Retrieved from: https://pgegiek.pl/O-firmie/Kim-jestesmy

[65] Ministerstwo Energii. (2018, January 23). *PROGRAM dla sektora górnictwa węgla kamiennego w Polsce*, p. 29. Retrieved from: https://www.gov.pl/documents/33372/436746/Program_dla_sektora_g%C3%B3rnictwa_w%C4%99gla_kamiennego_w_Polsce.pdf/4cd0f128-45a8-0f98-c4e0-c763d0f1754d

[66] International Energy Agency. (2017, January 25). *Energy Policies of IEA Countries : Poland 2016 Review*, p.157. Retrieved from: https://webstore.iea.org/energy-policies-of-iea-countries-poland-2016-review

[67] International Energy Agency. (n.d.). *Poland: Balances for 1990-2016*. Retrieved from: https://www.iea.org/statistics/?country=POLAND&year=2016&category=Key%20indicators&indicator=TPESbySource&mode=chart&categoryBrowse=false&dataTable=BALANCES&showDataTable=true

[68] Polish Geological Institute- National Research Institute. (n.d.). *Crude oil*. Retrieved from: http://geoportal.pgi.gov.pl/surowce/energetyczne/ropa_naftowa

[69] PGNiG. (n.d.). *KRNiGZ Dębno*, p. 4. Retrieved from: http://pgnig.pl/documents/29748/961630/KRNiGZ+D%C4%99bno/30612bc8-a047-4953-9e44-6c247a23cfb9

[70] PGNiG. (n.d.). *KRNiGZ Lubiatów*, p. 2. Retrieved from: http://pgnig.pl/documents/29748/961630/lubiat%C3%B3w_folder.pdf/cb25e1df-8d53-4d00-9645-313cfc4eed48

[71] PGNiG. (n.d.). *KRNiGZ Lubiatów*, p.2. Retrieved from: http://pgnig.pl/documents/29748/961630/lubiat%C3%B3w_folder.pdf/cb25e1df-8d53-4d00-9645-313cfc4eed48

[72] Polish Geological Institute- National Research Institute. (n.d.). *Crude oil*. Retrieved from: http://geoportal.pgi.gov.pl/surowce/energetyczne/ropa_naftowa

[73] LOTOS. (2016, January 5). *Pierwsza ropa z bałtyckiego złoża B8 już w rafinerii*. Retrieved from:

http://www.lotos.pl/322/p,174,n,4394/grupa_kapitalowa/centrum_prasowe/aktualnosci/pierwsza_ropa_z_baltyckiego_zloza_b8_juz_w_rafinerii

[74] Polish Geological Institute- National Research Institute. (n.d.). *Crude oil*. Retrieved from: http://geoportal.pgi.gov.pl/surowce/energetyczne/ropa_naftowa

[75] Polska Organizacja Gazu Płynnego. (2018*). Annual Report*, p. 65. Retrieved from: http://pogp.pl/wp-content/uploads/2018/04/POGP_2018-RAPORT_internet.pdf

[76] International Energy Agency. (2018). Share of oil products final consumption by sector: Poland 2016. *IEA World Energy Balances 2018*, Retrieved from: https://www.iea.org/statistics/?country=POLAND&year=2016&category=Key%20indicators&indicator=ShareOilProductsConsBySector&mode=chart&categoryBrowse=false&dataTable=BALANCES&showDataTable=true

[77] Fuels Europe. (2018). *Statistical Report 2018*, p. 12. Retrieved from: https://www.fuelseurope.eu/wp-content/uploads/FuelsEurope-Statistical-Report-2018.pdf

[78] International Energy Agency. (n.d.). *Production of crude oil and other products Poland 1990 – 2016.* Retrieved from: https://www.iea.org/statistics/?country=POLAND&year=2016&category=Key%20indicators&indicator=OilProd&mode=chart&categoryBrowse=false&dataTable=OIL&showDataTable=true

[79] Eurostat. (n.d.). *Final energy consumption by product*. Retrieved from: https://ec.europa.eu/eurostat/web/products-datasets/-/ten00095

[80] International Energy Agency. (2017, January 25). *Energy Policies of IEA Countries : Poland 2016 Review*, p. 160. Retrieved from: https://webstore.iea.org/energy-policies-of-iea-countries-poland-2016-review

[81] International Energy Agency. (2017, January 25). *Energy Policies of IEA Countries : Poland 2016 Review*, p. 161. Retrieved from: https://webstore.iea.org/energy-policies-of-iea-countries-poland-2016-review

[82] International Energy Agency. (2017, January 25). *Energy Policies of IEA Countries : Poland 2016 Review*, p. 165-166. Retrieved from:

https://webstore.iea.org/energy-policies-of-iea-countries-poland-2016-review

[83] International Energy Agency. (n.d.). *Poland: Balances for 1990-2016*. Retrieved from: https://www.iea.org/statistics/?country=POLAND&year=2016&category=Key%20indicators&indicator=TPESbySource&mode=chart&categoryBrowse=false&dataTable=BALANCES&showDataTable=true

[84] Państwowy Instytut Geologiczny – Państwowy Instytut Badawczy. (2018). *Bilans zasobów Złóż Kopalin w Polsce*, p. 15. Retrieved from: http://geoportal.pgi.gov.pl/css/surowce/images/2017/pdf/bilans_2017.pdf

[85] Państwowy Instytut Geologiczny – Państwowy Instytut Badawczy. (2018). *Bilans zasobów Złóż Kopalin w Polsce*, p. 10. Retrieved from: http://geoportal.pgi.gov.pl/css/surowce/images/2017/pdf/bilans_2017.pdf

[86] *Rozporządzenie ministerialne nr xx/yy/2018.* (2018), p. 6. Retrieved from: https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&ved=2ahUKEwihzYu56-DfAhU-A2MBHVkoD7YQFjAAegQIABAC&url=http%3A%2F%2Fec.europa.eu%2Fgrowth%2Ftools-databases%2Ftris%2Fen%2Findex.cfm%2Fsearch%2F%3Ftrisaction%3Dsearch.detail%26year%3D2018%26num%3D58%26dLang%3DPL&usg=AOvVaw1BUeQDul172srnb2CtafaK

[87] Gaz System. (n.d.). *Parametry charakteryzujące jakość przesyłanego gazu*. Retrieved from: http://www.gaz-system.pl/strefa-klienta/sgt-gazociag-jamalski/parametry-charakteryzujace-jakosc-przesylanego-gazu/

[88] Państwowy Instytut Geologiczny – Państwowy Instytut Badawczy. (2018). *Bilans zasobów Złóż Kopalin w Polsce*, p. 10. Retrieved from: http://geoportal.pgi.gov.pl/css/surowce/images/2017/pdf/bilans_2017.pdf

[89] Państwowy Instytut Geologiczny – Państwowy Instytut Badawczy. (2018). *Bilans zasobów Złóż Kopalin w Polsce*, p. 11. Retrieved from: http://geoportal.pgi.gov.pl/css/surowce/images/2017/pdf/bilans_2017.pdf

[90] Państwowy Instytut Geologiczny – Państwowy Instytut Badawczy. (2009). *Gaz ziemny*, p. 1. Retrieved from:

http://geoportal.pgi.gov.pl/css/surowce/images/2008/pdf/08_04_gaz_ziemny.pdf

[91] Państwowy Instytut Geologiczny – Państwowy Instytut Badawczy. (2018). *Bilans zasobów Złóż Kopalin w Polsce*, p. 13. Retrieved from: http://geoportal.pgi.gov.pl/css/surowce/images/2017/pdf/bilans_2017.pdf

[92] International Energy Agency. (2017, January 25). *Energy Policies of IEA Countries : Poland 2016 Review*, p. 145. Retrieved from: https://webstore.iea.org/energy-policies-of-iea-countries-poland-2016-review

[93] Państwowy Instytut Geologiczny – Państwowy Instytut Badawczy. (2018). *Bilans zasobów Złóż Kopalin w Polsce*, p. 13. Retrieved from: http://geoportal.pgi.gov.pl/css/surowce/images/2017/pdf/bilans_2017.pdf

[94] International Energy Agency. (2018). Share of natural gas final consumption by sector Poland 2016*, IEA Gas Information 2018.* Retrieved from: https://www.iea.org/statistics/?country=POLAND&year=2016&category=Key%20indicators&indicator=ShareNatGasCons&mode=chart&categoryBrowse=false&dataTable=GAS&showDataTable=true

[95] International Energy Agency. (2017, January 25). *Energy Policies of IEA Countries : Poland 2016 Review*, p. 142. Retrieved from: https://webstore.iea.org/energy-policies-of-iea-countries-poland-2016-review

[96] International Energy Agency. (2017, January 25). *Energy Policies of IEA Countries : Poland 2016 Review*, p. 143. Retrieved from: https://webstore.iea.org/energy-policies-of-iea-countries-poland-2016-review

[97] PGNiG. (n.d.). *Poszukiwanie i Wydobycie.* Retrieved from: http://pgnig.pl/segmenty-dzialalnosci

[98] Gaz Storage Poland. (n.d.). *The Scope of Activity*. Retrieved from: https://ipi.gasstoragepoland.pl/en/menu-en/about-gsp/#the-scope-of-activity

[99] Polska Spółka Gazownictwa. (n.d.). *Informacje o Spółce*. Retrieved from: https://www.psgaz.pl/informacje-o-spolce

[100] Polska Spółka Gazownictwa. (n.d.). *Oddziały Zakłady Gazownicze*. Retrieved from: https://www.psgaz.pl/oddzialy-zaklady-gazownicze

[101] International Energy Agency. (n.d.). *Poland: Balances for 1990-2016*. Retrieved from: https://www.iea.org/statistics/?country=POLAND&year=2016&category=Key%20indicators&indicator=TPESbySource&mode=chart&categoryBrowse=false&dataTable=BALANCES&showDataTable=true

[102] International Energy Agency. (n.d.). *Poland: Balances for 1990-2016*. Retrieved from: https://www.iea.org/statistics/?country=POLAND&year=2016&category=Key%20indicators&indicator=TPESbySource&mode=chart&categoryBrowse=false&dataTable=BALANCES&showDataTable=true

[103] International Energy Agency. (n.d.). *Poland: Balances for 1990-2016*. Retrieved from: https://www.iea.org/statistics/?country=POLAND&year=2016&category=Key%20indicators&indicator=TPESbySource&mode=chart&categoryBrowse=false&dataTable=BALANCES&showDataTable=true

[104] Ministerstwo Gospodarki. (2014, January). *Polish Nuclear Programme*, p. 5. Retrieved from: http://www.paa.gov.pl/sites/default/files/PPEJ%20eng.2014.pdf

[105] Kancelaria Sejmu. (2011). *USTAWA z dnia 13 maja 2011 r. o zmianie ustawy – Prawo atomowe oraz niektórych innych ustaw*. Retrieved from: http://prawo.sejm.gov.pl/isap.nsf/download.xsp/WDU20111320766/T/D20110766L.pdf

[106] Ministerstwo Gospodarki. (2009, November 10). *Polityka energetyczna Polski do 2030 roku*, p. 17. Retrieved from: https://www.gov.pl/documents/33372/436746/DE_Polityka_energetyczna_ost_2030.pdf/78b689ec-62ec-af88-b0d7-decf95abdb70

[107] International Energy Agency. (2017, January 25). *Energy Policies of IEA Countries : Poland 2016 Review*, p. 116. Retrieved from: https://webstore.iea.org/energy-policies-of-iea-countries-poland-2016-review

[108] International Energy Agency. (2017, January 25). *Energy Policies of IEA Countries : Poland 2016 Review*, p. 113. Retrieved from: https://webstore.iea.org/energy-policies-of-iea-countries-poland-2016-review

[109] Ministerstwo Gospodarki. (2014, January). *Polish Nuclear Power Programme*, p. 6-9. Retrieved from: http://www.paa.gov.pl/sites/default/files/PPEJ%20eng.2014.pdf

[110] Energoprojekt Warszawa. (n.d). Potencjalne lokalizacje elektrowni jądrowych, *Gazeta Wyborcza.* Retrieved from: https://www.inwestycje.radom.pl/forum/printview.php?t=726&start=0

[111] International Energy Agency. (2017, January 25). *Energy Policies of IEA Countries : Poland 2016 Review*, p. 117-118. Retrieved from: https://webstore.iea.org/energy-policies-of-iea-countries-poland-2016-review

[112] PGE. (n.d.) *About the Company*. Retrieved from: https://pgeej1.pl/en/O-Spolce

[113] International Energy Agency. (2017, January 25). *Energy Policies of IEA Countries : Poland 2016 Review*, p. 96. Retrieved from: https://webstore.iea.org/energy-policies-of-iea-countries-poland-2016-review

[114] International Energy Agency. (2018). Electricity generation by fuel: Poland 1990 – 2016*, IEA Electricity Information 2018*. Retrieved from: https://www.iea.org/statistics/?country=POLAND&year=2011&category=Key%20indicators&indicator=ElecGenByFuel&mode=chart&categoryBrowse=false&dataTable=ELECTRICITYANDHEAT&showDataTable=true

[115] International Energy Agency. (2018). *Share of electricity generation by fuel: Poland 2016*. Retrieved from: https://www.iea.org/statistics/?country=POLAND&year=2016&category=Key%20indicators&indicator=undefined&mode=chart&categoryBrowse=false&dataTable=ELECTRICITYANDHEAT&showDataTable=true

[116] International Energy Agency. (2017, January 25). *Energy Policies of IEA Countries : Poland 2016 Review*, p. 75. Retrieved from: https://webstore.iea.org/energy-policies-of-iea-countries-poland-2016-review

[117] THEMA Consulting Group. (2013, October*). Loop flows- final advice*, p. 1. Retrieved from: https://ec.europa.eu/energy/sites/ener/files/documents/201310_loop-flows_study.pdf

[118] International Energy Agency. (2017, January 25). *Energy Policies of IEA Countries : Poland 2016 Review*, p. 75. Retrieved from: https://webstore.iea.org/energy-policies-of-iea-countries-poland-2016-review

[119] THEMA Consulting Group. (2013, October*). Loop flows- final advice*, p. 1. Retrieved from: https://ec.europa.eu/energy/sites/ener/files/documents/201310_loop-flows_study.pdf

[120] International Energy Agency. (n.d.). *Poland: Balances for 1990-2016*. Retrieved from: https://www.iea.org/statistics/?country=POLAND&year=2016&category=Key%20indicators&indicator=TPESbySource&mode=chart&categoryBrowse=false&dataTable=BALANCES&showDataTable=true

[121] International Energy Agency. (n.d.). *Poland: Balances for 1990-2016*. Retrieved from: https://www.iea.org/statistics/?country=POLAND&year=2016&category=Key%20indicators&indicator=TPESbySource&mode=chart&categoryBrowse=false&dataTable=BALANCES&showDataTable=true

[122] International Energy Agency. (2017, January 25). *Energy Policies of IEA Countries : Poland 2016 Review*, p. 77-78. Retrieved from: https://webstore.iea.org/energy-policies-of-iea-countries-poland-2016-review

[123] Polska Agencja Informacji I Inwestycji Zagranicznych. (n.d.). *Sektor energetyczny w Polsce,* p. 5. Retrieved from: https://www.paih.gov.pl/files/?id_plik=19609

[124] International Energy Agency. (2017, January 25). *Energy Policies of IEA Countries : Poland 2016 Review*, p. 77-78. Retrieved from: https://webstore.iea.org/energy-policies-of-iea-countries-poland-2016-review

And

Polska Agencja Informacji I Inwestycji Zagranicznych. (n.d.). Sektor energetyczny w Polsce, p. 3. Retrieved from: https://www.paih.gov.pl/files/?id_plik=19609

[125] Zespół Elektrowni Pątnów - Adamów - Konin SA(n.d.). *Company Overview*. Retrieved from: http://zepak.pl/en/about-us/company-overview.html

[126] Energy Regulatory Office. (2018, July). *National Report of the President of the Energy Regulatory Office*, p. 28. Retrieved from: https://www.ure.gov.pl/download/2/452/NationalReport2018.pdf

[127] Ministerstwo Gospodarki. (2009, September 3). *Polityka energetyczna Polski do 2030 roku*, p. 4-5. Retrieved from:

https://www.gov.pl/documents/33372/436746/DE_Polityka_energetyczna_ost_2030.pdf/78b689ec-62ec-af88-b0d7-decf95abdb70

[128] Ministerstwo Gospodarki. (2009, September 3). *Polityka energetyczna Polski do 2030 roku*, p. 4-5. Retrieved from: https://www.gov.pl/documents/33372/436746/DE_Polityka_energetyczna_ost_2030.pdf/78b689ec-62ec-af88-b0d7-decf95abdb70

[129] Ministry of Economy. (2009, November 10). *Energy Policy of Poland until 2030*, p. 25. Retrieved from: https://climateobserver.org/wp-content/uploads/2014/09/Poland_EPP-2030-2009.pdf

And

The London School of Economics. (2009). *Energy Policy of Poland until 2030 (EPP2030)*. Retrieved from: http://www.lse.ac.uk/GranthamInstitute/law/energy-policy-of-poland-until-2030-epp-2030/

[130] Energy Regulatory Office. (n.d.). *Polish support schemes for renewable and cogeneration sources*, p. 1-7. Retrieved from: http://www.ure.gov.pl/download/2/241/Polish_support_schemes_for_renewable_and_cogeneration_so.pdf

[131] International Energy Agency. (2017, January 25). *Energy Policies of IEA Countries : Poland 2016 Review*, p. 102. Retrieved from: https://webstore.iea.org/energy-policies-of-iea-countries-poland-2016-review

[132] Energy Regulatory Office. (n.d.). *Polish support schemes for renewable and cogeneration sources*, p. 1-7. Retrieved from: http://www.ure.gov.pl/download/2/241/Polish_support_schemes_for_renewable_and_cogeneration_so.pdf

[133] Energy Regulatory Office. (n.d.). *Polish support schemes for renewable and cogeneration sources*, p. 1-7. Retrieved from: http://www.ure.gov.pl/download/2/241/Polish_support_schemes_for_renewable_and_cogeneration_so.pdf

[134] *USTAWA z dnia 7 czerwca 2018 r. o zmianie ustawy o odnawialnych źródłach energii oraz niektórych innych ustaw.* (2018, June 29). Retrieved from: http://prawo.sejm.gov.pl/isap.nsf/download.xsp/WDU20180001276/O/D20181276.pdf

[135] *USTAWA z dnia 7 czerwca 2018 r. o zmianie ustawy o odnawialnych źródłach energii oraz niektórych innych ustaw.* (2018, June 29). Retrieved from: http://prawo.sejm.gov.pl/isap.nsf/download.xsp/WDU20180001276/O/D20181276.pdf

[136] Centrum Informacji o Rynku Energii. (2018, March 6). *Rząd przyjął projekt nowelizacji ustawy o odnawialnych źródłach energii.* Retrieved from: https://www.cire.pl/item,159622,1,0,0,0,0,0,rzad-przyjal-projekt-nowelizacji-ustawy-o-odnawialnych-zrodlach-energii.html

[137] Ministerstwo Gospodarki & Ministerstwo Środowiska. (2014, April). *Strategia Bezpieczeństwo Energetyczne i Środowisko.* Retrieved from: http://kigeit.org.pl/FTP/PRCIP/Literatura/008_3_Strategia_Bezpieczenstwo_Energetyczne_i_Srodowisko_2020.pdf

[138] Ministerstwo Energii. (2018, July 31). *Strategia bezpieczeństwa energetycznego.* Retrieved from: https://www.gov.pl/web/energia/strategia-bezpieczenstwa-energetycznego

[139] Ministerstwo Gospodarki & Ministerstwo Środowiska. (2014, April). *Strategia Bezpieczeństwo Energetyczne i Środowisko*, p. 4. Retrieved from: http://kigeit.org.pl/FTP/PRCIP/Literatura/008_3_Strategia_Bezpieczenstwo_Energetyczne_i_Srodowisko_2020.pdf

[140] Klimada. (n.d.). *SPA 2020 Przyjęty przez Radę Ministrów.* Retrieved from: http://klimada.mos.gov.pl/blog/2013/10/29/spa-2020-przyjety-przez-rade-ministrow/

[141] Ministry of the Environment. (2013, October). *Polish National Strategy for Adaptation to Climate Change (NAS 2020) with the perspective by 2030*, p. 7. Retrieved from: https://klimada.mos.gov.pl/wp-content/uploads/2014/12/ENG_SPA2020_final.pdf

[142] *Uchwałę w sprawie „Strategii Rozwoju Transportu do 2020 r. (z perspektywą do 2030 r.), przedłożoną przez ministra transportu, budownictwa i gospodarki morskiej.* (n.d.). Retrieved from: https://www.premier.gov.pl/wydarzenia/decyzje-rzadu/uchwale-w-sprawie-strategii-rozwoju-transportu-do-2020-r-z-perspektywa-do.html

[143] International Energy Agency. (2017, January 25). *Energy Policies of IEA Countries : Poland 2016 Review*, p. 102. Retrieved from: https://webstore.iea.org/energy-policies-of-iea-countries-poland-2016-review

[144] Ministerstwo Transportu, Budownictwa I Gospodarki Morskiej. (2013, January 22). *Strategia Rozwoju Transportu do 2020 roku (z perspektywą do 2030 roku)*, p. 7-8. Retrieved from: https://www.gov.pl/documents/905843/1047987/Strategia_Rozwoju_Transportu_do_2020_roku.pdf/ead3114a-aac7-3cdd-c71d-7f88267ce596

[145] European Commission. (1995, January 10). *Press Release*. Retrieved from: http://europa.eu/rapid/press-release_IP-95-1418_en.htm

[146] Miciuła, I. (2014, January 3). Liberalizacja rynku energetycznego w Polsce i zobowiązania wobec UE, p. 310, *Journal of Management and Finance*, 12, 3, Retrieved from: http://zif.wzr.pl/pim/2014_3_1_19.pdf

[147] *Directive 2009/72/EC. (2009).* Retrieved from: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=LEGISSUM%3Aen0016

[148] European Commission. (2011, March 2). *Questions and Answers on the third legislative package for an internal EU gas and electricity market*. Retrieved from: http://europa.eu/rapid/press-release_MEMO-11-125_en.htm?locale=en

[149] DIRECTIVE 2010/75/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 24 November 2010 on industrial emissions (integrated pollution prevention and control). (2010, December 17), *Official Journal of the European Union. Retrieved* from: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32010L0075

[150] Nuclear Energy Department - Ministry of Economy. (n.d.). *Nuclear power in Poland Environmental and economical background,* p. 6. Retrieved from: https://tu-dresden.de/ing/maschinenwesen/iet/wket/ressourcen/dateien/lehre/lections/46.ket_kern/03_Kuzniarski.pdf?lang=de

[151] European Commission. (n.d.). *2020 climate & energy package*. Retrieved from: https://ec.europa.eu/clima/policies/strategies/2020_en

[152] European Commission. (n.d.). *2020 climate & energy package*. Retrieved from: https://ec.europa.eu/clima/policies/strategies/2020_en

[153] European Union. (2016). *The EU Emissions Trading System (EU ETS*), p. 2. Retrieved from: https://ec.europa.eu/clima/sites/clima/files/factsheet_ets_en.pdf

[154] European Commission. (n.d.). *2020 climate & energy package*. Retrieved from: https://ec.europa.eu/clima/policies/strategies/2020_en

[155] European Commission. (n.d.). *2020 climate & energy package*. Retrieved from: https://ec.europa.eu/clima/policies/strategies/2020_en

[156] International Energy Agency. (2017, January 25). *Energy Policies of IEA Countries : Poland 2016 Review*, p. 23. Retrieved from: https://webstore.iea.org/energy-policies-of-iea-countries-poland-2016-review

[157] European Commission. (n.d.). *Renewable energy directive*. Retrieved from: https://ec.europa.eu/energy/en/topics/renewable-energy/renewable-energy-directive

[158] International Energy Agency. (2017, January 25). *Energy Policies of IEA Countries : Poland 2016 Review*, p. 96. Retrieved from: https://webstore.iea.org/energy-policies-of-iea-countries-poland-2016-review

[159] European Commission (2017, February 23). *Proposal for a DIRECTIVE OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL on the promotion of the use of energy from renewable sources*. Retrieved from: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52016PC0767R%2801%29

[160] European Comission. (n.d.). *Energy Efficiency Directive*. Retrieved from: https://ec.europa.eu/energy/en/topics/energy-efficiency/energy-efficiency-directive

[161] Eurostat. (2016, February 5). *Energy consumption in 2016*, p. 1. Retrieved from: https://ec.europa.eu/eurostat/documents/2995521/8643581/8-05022018-BP-EN.pdf/1338cf55-5c91-4179-a6ca-808675e40bbd

[162] European Parliament Think Tank. (2018, October 24). *Revised Energy Efficiency Directive*. Retrieved from:

http://www.europarl.europa.eu/thinktank/en/document.html?reference=EPRS_BRI(2017)595923

[163] European Comission. (n.d.). *Energy Efficiency Directive*. Retrieved from: https://ec.europa.eu/energy/en/topics/energy-efficiency/energy-efficiency-directive

[164] Global CCS Institute. (n.d.). *Offshore provisions of EU Directive 2009/31/EC*. Retrieved from: https://hub.globalccsinstitute.com/publications/offshore-co2-storage-legal-resources/offshore-provisions-eu-directive-200931ec

[165] European Commission. (n.d.). *2030 climate & energy framework*. Retrieved from: https://ec.europa.eu/clima/policies/strategies/2030_en

[166] European Commission. (n.d.). *2030 climate & energy framework*. Retrieved from: https://ec.europa.eu/clima/policies/strategies/2030_en

[167] European Union. (2012*). Energy roadmap 2050*, p.3. Retrieved from: https://ec.europa.eu/energy/sites/ener/files/documents/2012_energy_roadmap_2050_en_0.pdf

[168] Roadmap 2050. (n.d.). *POWER PERSPECTIVE 2030*. Retrieved from: http://www.roadmap2050.eu/project/power-perspective-2030

[169] *Power Perspective 2030: on the road to a decarbonised power sector*. (n.d.), p. 2. Retrieved from: http://www.roadmap2050.eu/attachments/files/PowerPerspectives2030_ExecutiveSummary.pdf

[170] Polskie Stowarzystwo Energetyki Wiatrowej. (2014, June 9). *Europejska Strategia Bezpieczeństwa Energetycznego*. Retrieved from: http://psew.pl/europejska-strategia-bezpieczenstwa-energetycznego/

[171] Dobroczyńska, A. & Juchniewicz, L. (2009). *Bezpieczeństwo energetyczne Polski – kategoria autonomiczna czy komplementarna? Konsekwencje dla polityki publicznej,* p. 7. Retrieved from: http://cejsh.icm.edu.pl/cejsh/element/bwmeta1.element.desklight-9d78878f-6a1f-49c6-8f2e-1572f7ba2649/c/zp07-1.pdf

[172] European Commission. (n.d.). *Clean energy for all Europeans*. Retrieved from: https://ec.europa.eu/energy/en/topics/energy-strategy-and-energy-union/clean-energy-all-europeans

[173] DIRECTIVE (EU) 2018/844 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 30 May 2018 amending Directive 2010/31/EU on the energy performance of buildings and Directive 2012/27/EU on energy efficiency. (2018, June 19), *Official Journal of the European Union*. Retrieved from: https://eur-lex.europa.eu/legal-content/EN/TXT/?toc=OJ%3AL%3A2018%3A156%3ATOC&uri=uriserv%3AOJ.L_.2018.156.01.0075.01.ENG

[174] Bogdan, A. (2017, July). *Czy czeka nas rewolucja w warunkach technicznych?,* p. 23. Retrieved from: http://www.pzits.pl/www/wp-content/uploads/2017/07/22-27-ww-Bogdan-chik07.pdf

[175] International Energy Agency. (n.d.). *What is energy security?.* Retrieved from: https://www.iea.org/topics/energysecurity/whatisenergysecurity/

[176] International Energy Agency. (2017, January 25). *Energy Policies of IEA Countries : Poland 2016 Review*, p. 170-172. Retrieved from: https://webstore.iea.org/energy-policies-of-iea-countries-poland-2016-review

[177] International Energy Agency. (2017, January 25). *Energy Policies of IEA Countries : Poland 2016 Review*, p. 170-172. Retrieved from: https://webstore.iea.org/energy-policies-of-iea-countries-poland-2016-review

[178] European Commission. (n.d.) *EU oil stocks*. Retrieved from: https://ec.europa.eu/energy/en/topics/imports-and-secure-supplies/eu-oil-stocks

[179] International Energy Agency. (n.d.). *Oil Security: Frequently Asked Questions*. Retrieved from: https://www.iea.org/topics/energysecurity/respondingtomajorsupplydisruptions/

[180] International Energy Agency. (n.d.). *Oil Security: Frequently Asked Questions.* Retrieved from: https://www.iea.org/topics/energysecurity/respondingtomajorsupplydisruptions/

[181] International Energy Agency. (2017, January 25). *Energy Policies of IEA Countries : Poland 2016 Review*, p. 170-172. Retrieved from: https://webstore.iea.org/energy-policies-of-iea-countries-poland-2016-review

[182] Eurostat. (2018, December 13). Oil stocks-stock level-montly data. Retrieved from: http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=nrg_141m&lang=en

[183] Agencja Rezerw Materiałowych. (2015, August 27). *Zapasy interwencyjne*. Retrieved from: https://www.arm.gov.pl/index.php?doc=615

[184] International Energy Agency. (2017, January 25). *Energy Policies of IEA Countries : Poland 2016 Review*, p. 170-172. Retrieved from: https://webstore.iea.org/energy-policies-of-iea-countries-poland-2016-review

[185] International Energy Agency. (2017, January 25). *Energy Policies of IEA Countries : Poland 2016 Review*, p. 170-172. Retrieved from: https://webstore.iea.org/energy-policies-of-iea-countries-poland-2016-review

[186] International Energy Agency. (2017, January 25). *Energy Policies of IEA Countries : Poland 2016 Review*, p. 170-172. Retrieved from: https://webstore.iea.org/energy-policies-of-iea-countries-poland-2016-review

[187] International Energy Agency. (2017, January 25). *Energy Policies of IEA Countries : Poland 2016 Review*, p. 170-172. Retrieved from: https://webstore.iea.org/energy-policies-of-iea-countries-poland-2016-review

And

International Energy Agency. (n.d.). *Oil Security*. Retrieved from: https://www.iea.org/topics/energysecurity/oilsecurity/

[188] Minister Energii. (2018, Maj 8), *[Response to Mr. Sylwester Chruszcz].* Retrieved from: http://orka2.sejm.gov.pl/INT8.nsf/klucz/658C47F3/%24FILE/i21381-o1.pdf

[189] Filina-Dawidowicz, L. & Kozłowska, A. (2012, June). *Dywersyfikacja dostaw ropy naftowej do Polski transportem morskim i przesyłowym,* p. 756-757. Retrieved from: https://www.czasopismologistyka.pl/artykuly-naukowe/send/253-artykuly-na-plycie-cd-3/3227-artykul

[190] Naftoport. (n.d.). *About the company*. Retrieved from: http://www.naftoport.pl/en/index92ae.html?option=com_content&view=article&id=94&Itemid=97

[191] International Energy Agency. (2017, January 25). *Energy Policies of IEA Countries : Poland 2016 Review*, p. 164. Retrieved from: https://webstore.iea.org/energy-policies-of-iea-countries-poland-2016-review

[192] International Energy Agency. (2017, January 25). *Energy Policies of IEA Countries : Poland 2016 Review*, p. 164. Retrieved from: https://webstore.iea.org/energy-policies-of-iea-countries-poland-2016-review

[193] International Energy Agency. (2017, January 25). *Energy Policies of IEA Countries : Poland 2016 Review*, p. 164. Retrieved from: https://webstore.iea.org/energy-policies-of-iea-countries-poland-2016-review

[194] Weglowodory.pl (2010, December 22). *Ropa naftowa w Polsce [map]*. Retrieved from: http://weglowodory.pl/ropa-naftowa-w-polsce/

[195] Kostiugova, V. (2008, April). *The prospects of Belarus joining in the exploitation of Odessa-Brody Pipeline, Belarusian Institute for Strategic Studies*. Retrieved from: http://www.belinstitute.eu/images/stories/documents/odessabrodyen.pdf

[196] Lubbe, R. & Deptuła, K. (2013, March). *Rurociąg (Odessa)–Brody–Płock–(Gdańsk)*, p. 1. Retrieved from: http://poland.ilf.com/fileadmin/user_upload/bueros/subsite_poland/pdf/2013.09__Rurociag_Brody-Plock.pdf

[197] Ministerstwo Energii. (n.d.). *Projekty wspólnego zainteresowania Unii Europejskiej*. Retrieved from: https://www.gov.pl/web/energia/projekty-wspolnego-zainteresowania-unii-europejskiej

[198] International Energy Agency. (n.d.). *Natural Gas Security*. Retrieved from: https://www.iea.org/topics/energysecurity/naturalgassecurity/

[199] International Energy Agency. (2017, January 25). *Energy Policies of IEA Countries : Poland 2016 Review*, p. 28. Retrieved from: https://webstore.iea.org/energy-policies-of-iea-countries-poland-2016-review

[200] International Energy Agency. (2017, January 25). *Energy Policies of IEA Countries : Poland 2016 Review*, p. 150-151. Retrieved from: https://webstore.iea.org/energy-policies-of-iea-countries-poland-2016-review

[201] Kołbuk, W. & Kołbuk, A. (2014). Gazprom na polskim rynku paliw w latach 1989-2014. *Roczniki Ekonomii I Zarządzania*, 6, 42, p. 133. Retrieved from:https://www.kul.pl/files/433/roczniki_2015_nr_2/06-_Kolbuk_Corr.pdf

[202] Ministry of Foreign Affairs. (2018, March 1). *Polska mniej zależna od Gazpromu. Import surowca spada*. Retrieved from: https://tvn24bis.pl/surowce,78/import-gazu-z-gazpromu-do-polski-spada,818925.html

[203] PGNiG. (2018, August 3). *Konsumpcja gazu w Polsce rośnie. Spada udział importu gazu z Rosji, rośnie udział importu LNG*. Retrieved from: http://pgnig.pl/aktualnosci/-/news-list/id/konsumpcja-gazu-w-polsce-rosnie-spada-udzial-importu-gazu-z-rosji-rosnie-udzial-importu-lng/newsGroupId/10184

[204] Górnośląski Serwis Gospodarczy. (2006, April 24). *Dostępność gazu ziemnego na terenie Województwa Śląskiego [map]*. Retrieved from: https://slideplayer.pl/slide/835870/

[205] PGNiG (2007*). Raport roczny PGNiG. Definicje i objaśnienia*. Retrieved from: http://pgnig.pl/documents/10184/248609/Raport_Roczny_PGNiG_PL_2007_16_Definicje_i_objasnienia.pdf/0e1ad5d1-f8de-4853-bdcb-cccd809b4d8b

[206] Barteczko, A. (2018, June 27). Poland's PGNiG signs agreements for long-term LNG supplies from U.S. *Reuters*. Retrieved from: https://www.reuters.com/article/us-pgnig-lng-usa/polands-pgnig-signs-agreements-for-long-term-lng-supplies-from-u-s-idUSKBN1JN0LW

[207] PGNiG. (2018, August 3). *Konsumpcja gazu w Polsce rośnie. Spada udział importu gazu z Rosji, rośnie udział importu LNG*. Retrieved from: http://pgnig.pl/aktualnosci/-/news-list/id/konsumpcja-gazu-w-polsce-rosnie-spada-udzial-importu-gazu-z-rosji-rosnie-udzial-importu-lng/newsGroupId/10184

[208] Kublik, A. (2017, July 4). Katar zamierza ostro zwiększyć eksport skroplonego gazu. *Wyborcza.pl*. Retrieved from:

http://wyborcza.pl/7,155287,22051287,katar-planuje-gwaltownie-zwiekszyc-eksport-skroplonego-gazu.html?disableRedirects=true

[209] Barteczko, A. (2018, June 27). Poland's PGNiG signs agreements for long-term LNG supplies from U.S. *Reuters*. Retrieved from: https://www.reuters.com/article/us-pgnig-lng-usa/polands-pgnig-signs-agreements-for-long-term-lng-supplies-from-u-s-idUSKBN1JN0LW

[210] Barteczko, A. (2018, November 8). Poland's PGNiG signs long-term LNG deal with Cheniere. *Reuters*. Retrieved from: https://www.reuters.com/article/usa-energy-pgnig/polands-pgnig-signs-long-term-lng-deal-with-cheniere-idUSL8N1XJ2GW

[211] Kublik, A. (2018, October 17). PGNiG kupi gaz z USA taniej niż z Rosji. Przełomowy kontrakt polskiej firmy. *Wyborcza.pl*. Retrieved from: http://wyborcza.pl/7,155287,24053703,pgnig-kupuje-gaz-z-usa-taniej-niz-z-rosji-przelomowy-kontrakt.html

[212] Kublik, A. (2017, March 14). PGNiG podwoi import skroplonego gazu z Kataru. Nowy kontrakt czekał na gazoport. *Wyborcza.pl*. Retrieved from: http://wyborcza.pl/7,155287,21494246,pgnig-podwoi-import-skroplonego-gazu-z-kataru-nowy-kontrakt.html

[213] Gas- System. (n.d.). *Poland-Lithuania Gas Pipeline*. Retrieved from: http://en.gaz-system.pl/our-investments/integration-with-european-gas-tramsmission-system/poland-lithuania/

[214] Baltic Pipeline Project (n.d.). *Crossing borders for secure, affordable and sustainable energy.* Retrieved from: https://www.baltic-pipe.eu/

[215] Gaz-System. (2017, April 21). *Gaz-System will expand the LNG terminal in Świnoujście.* Retrieved from: http://en.gaz-system.pl/press-centre/news/information-for-the-media/artykul/202479/

[216] Gaz-System. (n.d.). *North-South Gas Corridor*. Retrieved from: http://en.gaz-system.pl/our-investments/integration-with-european-gas-tramsmission-system/north-south-gas-corridor/

[217] Strzymiński, A. (2018, May 16). *The North-South Corridor*, p. 7. Retrieved from: http://www.jaspersnetwork.org/download/attachments/24150652/5.%20Gas%20pipeline%20project%20CBA%20-%20Poland.pdf?version=1&modificationDate=1526662935000&api=v2

[218] Fandrich, D. & Iden, M. (2015, August 26). Submission Bid Deadline for the Gas Interconnection Poland - Lithuania Pipeline Project Extended . *Pipeline Technology Journal*. Retrieved from: https://www.pipeline-journal.net/news/submission-bid-deadline-gas-interconnection-poland-lithuania-pipeline-project-extended

[219] Baltic Pipeline Project. (n.d.). *The project.* Retrieved from: https://www.baltic-pipe.eu/the-project/

[220] Posaner, J. (2015, April 20). *Croatia's LNG terminal is 'for the region' – Plinacro*. Retrieved from: http://interfaxenergy.com/gasdaily/article/15878/croatias-lng-terminal-is-for-the-region-plinacro

[221] International Energy Agency. (2018). Poland: Balances for 2016, *IEA World Energy Balances 2018*. Retrieved from: https://www.iea.org/statistics/?country=POLAND&year=2016&category=Key%20indicators&indicator=TPESbySource&mode=table&dataTable=BALANCES