



Structure of Primary Energy Mix, Electricity Production and Emissions from Power Sector in Ethiopia, Pakistan, Poland, Spain and Turkey

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Abstract

In this article, a review of energy mix, electricity production and emissions from power sector of Ethiopia, Pakistan, Poland, Spain and Turkey is investigated. The choice of countries is varied to let see how it looks in different parts of the world. The time interval chosen to show some changes that follow. Primary energy consumption of the countries is given in percentage of resources used. Electricity production of the countries are analyzed in 2006 and 2011 respectively. Furthermore, emissions of CO₂, NO_x, SO_x and PM are compared with respect to population and area and GDP. As a result, the analysis of the highest and lowest emitting countries are presented in the article.

Keywords: energy, electricity, emission

Streszczenie

Struktura pierwotnych źródeł miks energetycznego, produkcji energii elektrycznej i emisji z sektora energetycznego w Etiopii, Pakistanie, Polsce, Hiszpanii i Turcji.

W artykule przedstawiono przegląd źródeł miks energetycznego, produkcji energii elektrycznej i emisji z sektora energetycznego w Etiopii, Pakistanie, Polsce, Hiszpanii i Turcji. Wybór krajów jest zróżnicowany aby przybliżyć jak wygląda to w różnych częściach świata. Przedział czasu dobrano tak, aby pokazać pewne zmiany, które następują. Zużycie energii pierwotnej krajów podane jest w procentach zasobów używanych. Produkcja energii elektrycznej z wymienionych krajów jest analizowana odpowiednio dla danych z roku 2006 i 2011. Ponadto, emisje CO₂, NO_x, SO_x i PM są porównywane pod względem ludności, powierzchni i produktu krajowego brutto - PKB. W rezultacie, przedstawiono analizę najbardziej i najmniej uciążliwych pod względem emisji krajów porównywanych.

Słowa kluczowe: energia, elektryczność, emisje

1. Introduction

Over the last century, the energy demand of the world has been increasing at a fast rate. As a result, all countries have been using more resources to meet the growing energy demand. Thus, the energy production has become the major source of environmental pollution. Because of the restricted regulations of emissions, all countries are trying to develop new ways of power generation.

In this study, five different countries are investigated according to their energy consumption, electricity production and emissions from power sector. 2006 and 2011 are selected due to the availability of the data for the comparison of all of the countries. The aim of the article is to give a perspective about how the trends of primary energy consumption, electricity production and emissions have changed within five years.

Present day situation of the countries is briefly described to help the reader to give a clear understanding of the article.

Ethiopia is located in the Horn of Africa, with a territory of 1,104,300 km² [1]. The population is around 91.3 million [2]. In Ethiopia, biomass fuels (fire wood, agricultural residue and animal waste) and hydropower are considered the main energy sources in the country. Biomass fuels are the principal energy sources which are used mainly for cooking purposes in households. Biomass energy covers over 90% of the total energy consumption as it is available and affordable to the majority of the people [1].

Pakistan is the 7th most populated country in the world with current estimated population of almost 190 million and area of 796,096 km² [3]. More than half of Pakistan's primary energy consumption is dependent upon fossil fuels. Pakistan has huge capacity for solar energy because of the plentiful sunshine for whole year. Recently in May 2014, Pakistan's first large-scale solar power project, the Quaid-e-Azam Solar Park project, has been inaugurated. The project is expected to start generating 100 MW of power by the end of the year 2014, and 1000 MW after its completion by the end of year 2016 [4].

Poland is located in the center of Europe, with a territory of 312,685 km² and population of over 38.5 million [5]. Energy sector in Poland is well developed and based mostly on fossil fuels. As a major European coal exporter, Poland extracts 80 millions Mg of coal annually and in 2011 Poland was the 10th hard coal producer in the world [6].

Spain is located in southwest of Europe, with a territory of 505,963 km² and population around 47.1 million [7, 8]. The energy is produced in fossil fuel power plants, from renewable sources, nuclear power plants and hydroelectric power plants. It should be mentioned that Spain is a model in developing wind energy. Its generating capacity is the third-highest in the world and will continue to grow fast [9].

Turkey has a land of 783,562 km² and population around 76 million [10, 11]. Its geographical position holds a big importance because of the fact that it has land both in Europe and Asia. Hence, the investigation of the energy sector in Turkey concerns a lot of countries. Turkey is mostly dependent on fossil fuels in energy consumption. Although hydropower and other renewables such as wind energy are used, non-renewables in energy production and consumption are dominant. However, the trend has been going towards renewables for several years. Besides, in Turkey 71.49 % of energy used is imported because of high demand for oil and natural gas [12].

2. Primary Energy Mix

2.1. Primary Energy Mix in Ethiopia

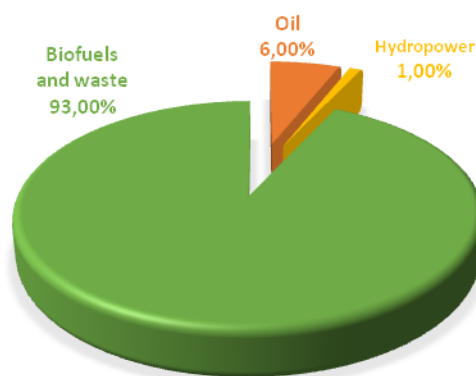


Fig. 2.1. Primary Energy Consumption in Ethiopia in 2011 [13]

It is shown in Fig. 2.1 that the primary energy consumption of Ethiopia is highly dominated by biofuels and waste, which accounts 93 % of the primary energy consumption. Due to insufficient production of electricity, unavailability of natural gas and oil, biomass fuels are the principal energy sources which are used mainly in households in both urban and rural areas. Meanwhile, hydropower and oil contribute only 6% and 1% of the primary energy consumption of the country, respectively. According to International Energy Agency data, primary energy consumption of Ethiopia was 34.064 megatons of oil equivalent (Mtoe) in 2011 [13].

2.2. Primary Energy Mix in Pakistan

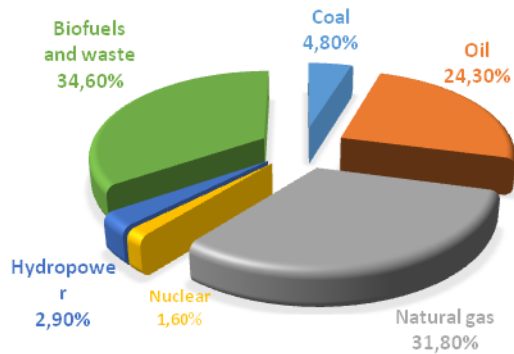


Fig. 2.2. Primary Energy Consumption in Pakistan in 2011 [14]

Primary energy consumption in Pakistan is shown in Fig. 2.2 in year 2011. According to the data from International Energy Agency, biofuels & waste has highest consumption followed by natural gas and oil. On the other hand, nuclear energy has the lowest share in primary energy consumption. Also, some share of primary energy consumption comes from hydropower and coal [14]. The primary energy consumption was 84.85 Mtoe in 2011 [14]. The energy sector is in a state of huge crisis because of the shortfall of electricity between 6000 and 8000 MW and over the past few years it has negatively impacted the social and economic development of the country [15].

2.3. Primary Energy Mix in Poland

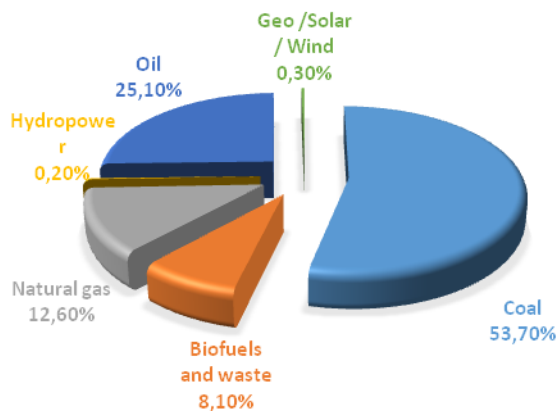


Fig. 2.3. Primary Energy Consumption in Poland in 2011 [16]

It is shown in Fig. 2.3 that fossil fuels such as coal, oil and natural gas have 91.4% share in primary energy consumption. Rest of the share is divided among biofuels and waste, hydropower, geothermal, solar and wind energy. Biofuels and waste hold 8.1% of primary energy consumption whereas the others have only small fraction of total consumption. Primary energy consumption was 101 Mtoe in 2011 [16].

2.4. Primary Energy Mix in Spain

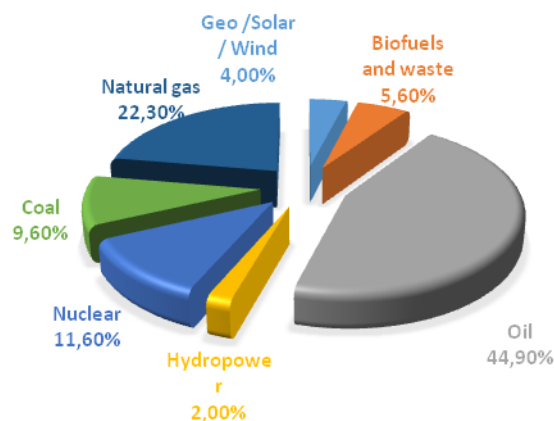


Fig. 2.4. Primary Energy Consumption in Spain in 2011 [17]

Primary energy consumption for Spain in 2011 is shown in Fig. 2.4 according to the data provided by Spanish government. It can be seen that oil is the main source used, with 44.9% of the total energy consumption, followed by natural gas with 22.3% and hydropower with only 2%. The primary energy consumption was 129.34 Mtoe in 2011 [17].

2.5. Primary Energy Mix in Turkey

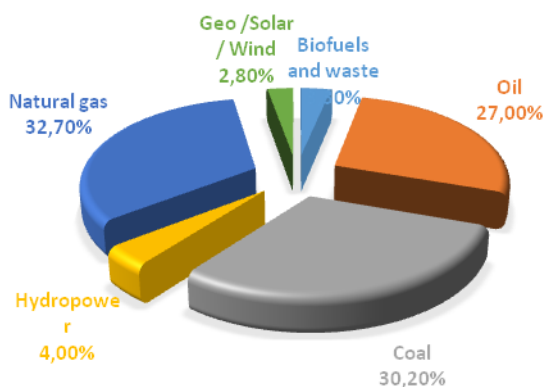


Fig. 2.5. Primary Energy Consumption in Turkey in 2011 [18]

It is represented in Fig. 2.5 that non-renewables which are coal, natural gas and oil have the share of almost 90 % in primary energy consumption. The rest is shared among hydropower, biofuels and waste, geothermal, solar and wind energy. In these types of energy sources, hydropower has the highest value as 4 % and renewables have the lowest value as 2.8 %. The primary energy consumption was 112 Mtoe in 2011 [18].

3. Electricity Production

3.1. Electricity Production in Ethiopia

As it shown in Table 3.1, hydroelectric is the main source of electricity production in Ethiopia in both 2006 and 2011. The electricity production from hydroelectric sources was 99.69% and 98.99% in 2006 and 2011 respectively. Meanwhile, electricity production from oil increased from 0.31% in 2006 to 0.64% in 2011. There is no electricity production from coal, natural gas and nuclear until 2011. However, in 2011 the country started to produce electricity from renewable sources other than hydroelectric sources, which accounts 0.37% of the share of electricity production. The total electricity production was 3269 GWh/year in 2006 and it increased to 5161 GWh/year in 2011.

Table 3.1. Electricity Production by Sources in Ethiopia in 2006 and 2011 [2].

Electricity production from different sources (% total)	2006	2011
Electricity production from coal sources (% total)	0	0
Electricity production from hydroelectric sources (% total)	99.69	98.99
Electricity production from natural gas sources (% total)	0	0
Electricity production from nuclear sources (% total)	0	0
Electricity production from oil sources (% of total)	0.31	0.64
Electricity production from renewable sources, excluding hydroelectric (% total)	0	0.37
Electricity production (GWh/year)	3269	5161

3.2. Electricity Production in Pakistan

Electricity production by source in 2006 and 2011 is shown in Table 3.1. It can be seen that natural gas, hydropower and oil are continuously dominant sources of electricity production for the given years. Lowest electricity production comes from coal for both years regardless of having huge reserves of coal in all provinces of Pakistan. The electricity production from natural gas is decreased considerably to 29 % from 36 %. On the other hand, the electricity production from oil increases gradually year by year from 28 % to 35 %. There is no electricity production from renewables except hydropower plants for the given years. Finally, it can be concluded that the total electricity production is decreased from 9835 GWh/year in 2006 to 9525 GWh/year in 2011.

Table 3.2. Electricity Production by Sources in Pakistan in 2006 and 2011 [19]

Electricity production from different sources (% total)	2006	2011
Electricity production from coal sources (% total)	0.14	0.10
Electricity production from hydroelectric sources (% total)	32.50	29.94
Electricity production from natural gas sources (% total)	36.40	29.03
Electricity production from nuclear sources (% total)	2.33	5.53
Electricity production from oil sources (% of total)	28.63	35.40
Electricity production from renewable sources, excluding hydroelectric (% total)	0	0
Electricity production (GWh/year)	9835	9525

3.3. Electricity Production in Poland

As it is shown in Table.3.3 coal is the major source of electricity production in Poland. In 2006, the share of electricity produced from coal is more than 90% of the total. Other sources such as natural gas, oil and renewables are not being used in electricity production. In Poland, electricity is not produced in nuclear power plants. In 2011, the share of electricity produced from coal is decreased to 86.71% whereas the share of renewable sources in electricity production is increased to 6.63%.

Table 3.3. Electricity Production by Sources in Poland in 2006 and 2011 [20]

Electricity production from different sources (% total)	2006	2011
Electricity production from coal sources (% total)	92.52	86.71
Electricity production from hydroelectric sources (% total)	1.27	1.43
Electricity production from natural gas sources (% total)	2.86	3.57
Electricity production from nuclear sources (% total)	0	0
Electricity production from oil sources (% of total)	1.81	1.50
Electricity production from renewable sources, excluding hydroelectric (% total)	1.41	6.63
Electricity production (GWh/year)	161000	163000

3.4. Electricity Production in Spain

In Spain, 30.64% of electricity production comes from natural gas in 2006, according to the data provide by the World Bank. With reference to oil, hydroelectric and renewables, it can be seen in Table 3.4 that the production is similar for all, around 8% of the total. In 2011, it can be seen that natural gas is still the main source of

electricity production due to a number of combined cycle power plants which are installed in Spain, more than 50 plants in 2010 [21]. Oil is keeping its share of electricity production; however, there is a decrease in the electricity production by using coal from 23 % in 2006 to 15.54 % in 2011. At the same time, electricity production from renewables has increased from 8.86% in 2006 to 19.25 % in 2011. Nowadays, Spain is one of the main countries in the world in photovoltaic energy as well as wind energy production [9].

Table 3.4. Electricity Production by Sources in Spain 2006 and 2011 [8]

Electricity production from different sources (% total)	2006	2011
Electricity production from coal sources (% total)	23.00	15.54
Electricity production from hydroelectric sources (% total)	8.78	10.59
Electricity production from natural gas sources (% total)	30.64	29.24
Electricity production from nuclear sources (% total)	20.34	19.97
Electricity production from oil sources (% of total)	8.06	5.11
Electricity production from renewable sources, excluding hydroelectric (% total)	8.86	19.25
Electricity production (GWh/year)	295582	289045

3.5. Electricity Production in Turkey

In Table 3.5, electricity production by source is shown in 2006 and 2011 respectively. In 2006, electricity production from natural gas sources has 45.77 % share and it remains almost the same in 2011. The share of coal sources increased slightly within five years as 2.43 % whereas hydroelectric share is decreased as 2.28 %. Moreover, it is shown that electricity production from oil has a very small portion in 2006 and it becomes almost zero in 2011. On the other hand, electricity production from renewables increases from 0.16 % to 2.51 %. At the end of April in 2012, total installed capacity of power generation in Turkey was stated as 53.943 MW [22].

Table 3.5. Electricity Production by Sources in Turkey in 2006 and 2011 [12].

Electricity production from different sources (% total)	2006	2011
Electricity production from coal sources (% total)	26.46	28.87
Electricity production from hydroelectric sources (% total)	25.1	22.82
Electricity production from natural gas sources (% total)	45.77	45.36
Electricity production from nuclear sources (% total)	0	0
Electricity production from oil sources (% of total)	2.46	0.39
Electricity production from renewable sources, excluding hydroelectric (% total)	0.16	2.51
Electricity production (GWh/year)	176299	229393

4. Emissions

4.1. Emissions in Ethiopia

As it shown in Table 4.1, emissions of CO₂ in Ethiopia are 10000 and 40000 Mg in 2006 and 2011 respectively. The emission of CO₂ in 2011 is higher than that of 2006. This increment of CO₂ emission might be caused by the rise of electricity production in the country. The data is not available for NO_x, SO_x and particulate matter (PM) emissions in Ethiopia. Since Ethiopia produces almost all electricity from hydropower, the amount of NO_x, SO_x and particulate matter (PM) emissions are insignificant.

Table 4.1. Emission from power sector in Ethiopia in 2006 and 2011 [2]

Emission from power sector	2006				2011			
	CO ₂	NO _x	SO _x	PM	CO ₂	NO _x	SO _x	PM
Total Emission in National Scale [Mg]	10000	N/A	N/A	N/A	40000	N/A	N/A	N/A
Emission with respect to population [Mg/cap.]	1.27E-4	N/A	N/A	N/A	4.474E-4	N/A	N/A	N/A
Emission related to GDP[Mg/1USD GDP]	6.59E-07	N/A	N/A	N/A	1.26E-06	N/A	N/A	N/A
Emission related to area [Mg/km ²]	9.06E-3	N/A	N/A	N/A	3.62E-2	N/A	N/A	N/A

4.2. Emissions in Pakistan

The emissions of CO₂ are shown in Table 4.2. The data is available for NO_x, SO_x and particulate matter (PM) emissions for some cities but not for whole country. CO₂ emission is decreased from 42.27 million Mg to 40.20 million Mg in 2011.

Table 4.2. Emission from power sector in Pakistan in 2006 and 2011 [19]

Emission from power sector	2006				2011			
	CO ₂	NO _x	SO _x	PM	CO ₂	NO _x	SO _x	PM
Total Emission in National Scale [Mg]	42270000	N/A	N/A	N/A	40200000	N/A	N/A	N/A
Emission with respect to population [Mg/cap.]	0.262	N/A	N/A	N/A	0.228	N/A	N/A	N/A
Emission related to GDP[Mg/1USD GDP]	3.08E-04	N/A	N/A	N/A	1.88E-04	N/A	N/A	N/A
Emission related to area [Mg/km ²]	53.09	N/A	N/A	N/A	50.49	N/A	N/A	N/A

4.3. Emissions in Poland

According to Table 4.3, the emission of CO₂ is the highest as 320 million Mg in 2006. However, due to modernization in energy sector, more strict legislations and bigger share of renewables in power generation, emissions of CO₂, NO_x, SO_x and PM are decreased in 2011.

Table 4.3. Emission from power sector in Poland in 2006 and 2011 [20, 23]

Emission from power sector	2006				2011			
	CO ₂	NO _x	SO _x	PM	CO ₂	NO _x	SO _x	PM
Total Emission in National Scale [Mg]	17491E+4	303350	858840	48290	16567E+4	275650	479660	33020
Emission with respect to population [Mg/cap.]	4.539	7.9E-3	2.23E-2	1.25E-3	4.299	7.2E-3	1.24E-2	9E-4
Emission related to GDP[Mg/1USD GDP]	5.12E-04	8.88E-7	2.51E-6	1.41E-7	3.21E-4	5.35E-7	9.30E-7	6.40E-8
Emission related to area [Mg/km ²]	559.392	0.970	2.747	0.154	529.841	0.882	1.534	0.106

4.4. Emissions in Spain

According to World Bank and Eurostat data, it can be seen that all emissions, which are shown in Table 4.4, are decreased due to the improvements made in the power generation sector as well as the increment of renewable energy utilization, which has contributed in the reduction of pollutants. Furthermore, the economic crisis has contributed in the emissions reduction due to the reduction of electricity production. For example, CO₂ emission and SO_x emission are decreased by 21% and 79 % from 2006 to 2011 respectively.

Table 4.4. Emission from power sector in Spain in 2006 and 2011 [8, 23]

Emission from power sector	2006				2011			
	CO ₂	NO _x	SO _x	PM	CO ₂	NO _x	SO _x	PM
Total Emission in National Scale [Mg]	12814E+4	336850	948010	24681	10111E+4	224600	196540	9730
Emission with respect to population [Mg/cap.]	2.904	7.6E-3	2.15E-2	6E-4	2.163	4.8E-3	4.2E-3	2.08E-4
Emission related to GDP[Mg/1USD GDP]	1.04E-4	2.72E-7	7.67E-7	2E-8	6.95E-5	1.54E-7	1.35E-7	6.69E-9
Emission related to area [Mg/km ²]	253.259	0.665	1.873	4.88E-2	199.8367	0.443	0.388	1.92E-2

4.5. Emissions in Turkey

The total emissions of CO₂, NO_x, SO_x and particulate matter are shown in Table 4.5. It is clear that CO₂ emission is the highest among all pollutants followed by SO_x, NO_x, and PM. In five years, emissions of all of the hazardous components are increased in some extent. When the emissions per capita are investigated, it can be said that CO₂ and PM emissions are increased by 36.4 % and 37.5 % respectively. Besides, SO_x and NO_x emissions are increased by 19.9 % and 29.2 % respectively.

Table 4.5. Emission from power sector in Turkey in 2006 and 2011 [12, 23]

Emission from power sector	2006				2011			
	CO ₂	NO _x	SO _x	Pm	CO ₂	NO _x	SO _x	PM
Total Emission in National Scale [Mg]	8885E+4	275110	1232490	18650	12123E+4	355380	1478320	25650
Emission with respect to population [Mg/cap.]	1.174	3.64E-3	1.63E-2	2.50E-4	1.603	4.70E-3	1.96E-2	3.40E-4
Emission related to GDP[Mg/1USD GDP]	1.67E-04	5.18E-7	2.32E-6	3.51E-8	1.56E-4	4.59E-7	1.91E-6	3.31E-8
Emission related to area [Mg/km ²]	113.392	0.351	1.573	2.38E-2	154.716	0.453	1.886	3.27E-2

5. Comparison of the Countries

5.1. Primary Energy Mix

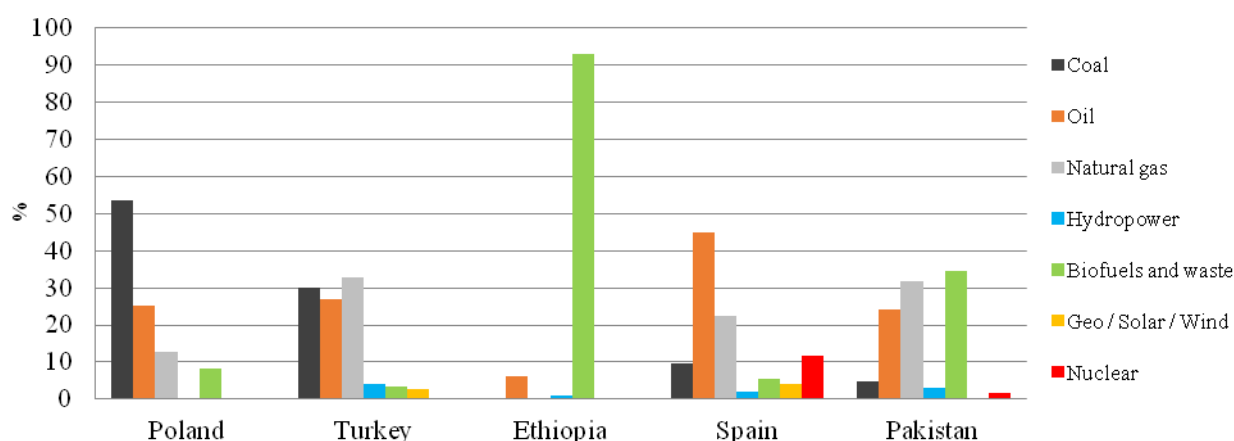


Fig. 5.1. Distribution of Primary Energy of the Countries in 2011 [9, 13, 14, 16, 18]

Energy consumption comparison in different countries given in percentage is shown in Fig. 5.1. According to the data, coal is widely used primary energy source in Poland (53.7%). It is also used as one third of total energy

consumption in Turkey but it is not common in the other countries. However, oil takes more than one fourth of total energy consumption in Poland and Turkey. It has a share of around 25% in Pakistan, almost 45% in Spain and only 6 % in Ethiopia. Natural gas is widely used in Pakistan (31.8%), Turkey (32.7%) and Spain (22.3%), but in Poland it is only 12.6%. Natural gas is not used in Ethiopia. The share of primary energy from hydropower is less than 5% in all of the countries. Biofuels and waste is widely used source of primary energy in Pakistan and Ethiopia. Geothermal, solar or wind are only used in Turkey and Spain. Nuclear power is only used in Spain (11.6%) and Pakistan (1.3%).

5.2. Electricity Production by Sources

5.2.1. Electricity Production in 2006

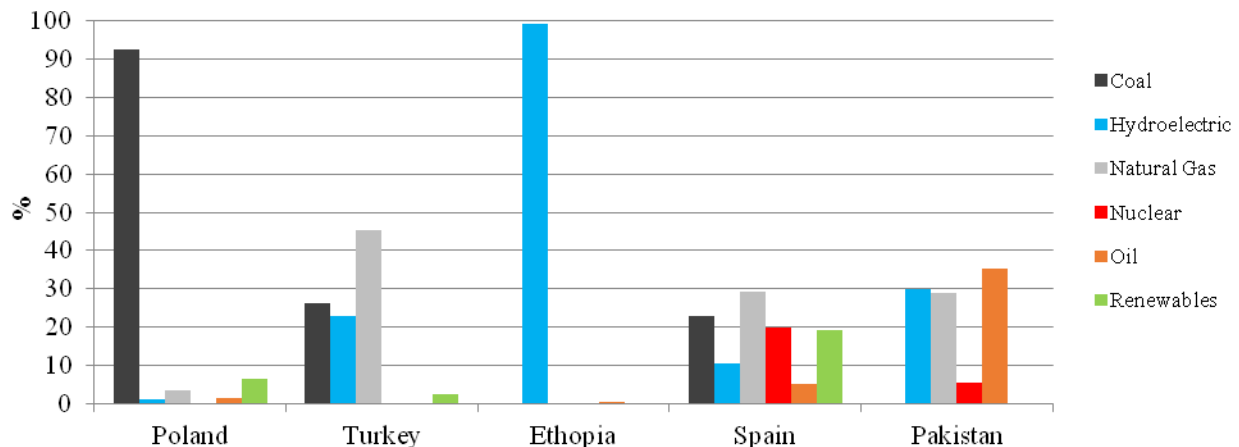


Fig. 5.2.1. Electricity Production by Sources in 2006 [2, 8, 12, 19, 20]

The electricity production of the countries in 2006 is illustrated in Fig. 5.2.1. More than 90 % of electricity is produced from coal in Poland and from hydropower in Ethiopia. Mostly coal, hydropower and natural gas is used to produce electricity in Turkey. Almost all of the electricity is produced from hydro power plants in Ethiopia. It can be seen that natural gas along with coal and nuclear are the dominant sources of electricity production in Spain. Hydropower, natural gas and oil are main sources of electricity production and also there is a small share of nuclear power in Pakistan.

5.2.1. Electricity Production in 2011

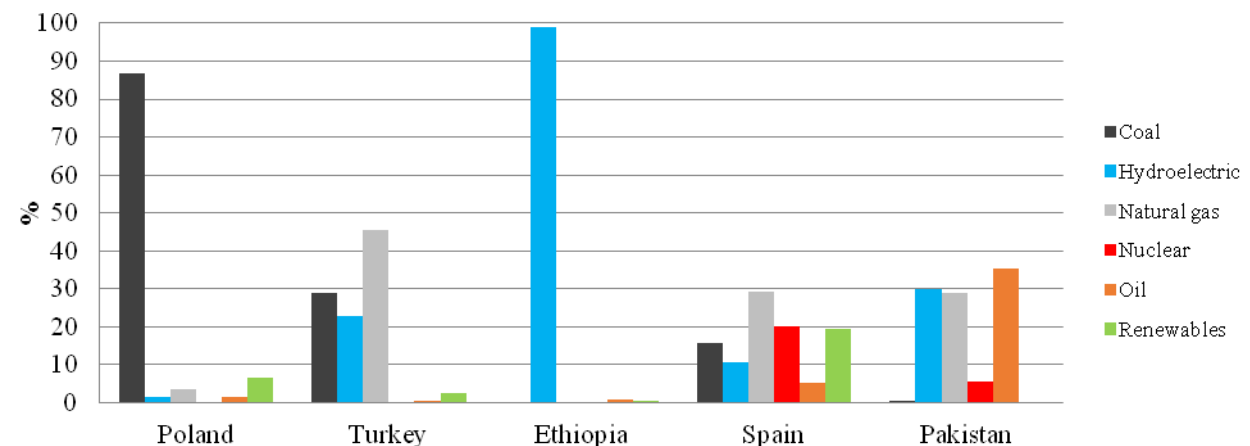


Fig. 5.2.2. Electricity Production by Sources in 2011 [2, 8, 12, 19, 20]

Electricity production in 2011 is depicted in Fig. 5.2.2. The proportion of electricity production from coal and hydropower remains almost the same in Poland and Ethiopia respectively. The trend in Turkey is also the same however, there is a small increment of the use of renewables and decrease of the use of oil. In Ethiopia, it can be seen that oil is started to be used in very small amount. In Spain the share of all the sources is decreased, however renewables share has reached around 20%. In Pakistan, the shares of nuclear power and oil are increased whereas the share of natural gas and hydropower are decreased.

5.3. Emissions

In this section, emissions of CO₂, NO_x, SO_x and PM are compared for all of the countries in 2006 and 2011. It is important to mention that NO_x, SO_x and PM emissions data is not available for Ethiopia and Pakistan.

5.3.1. Emissions of CO₂

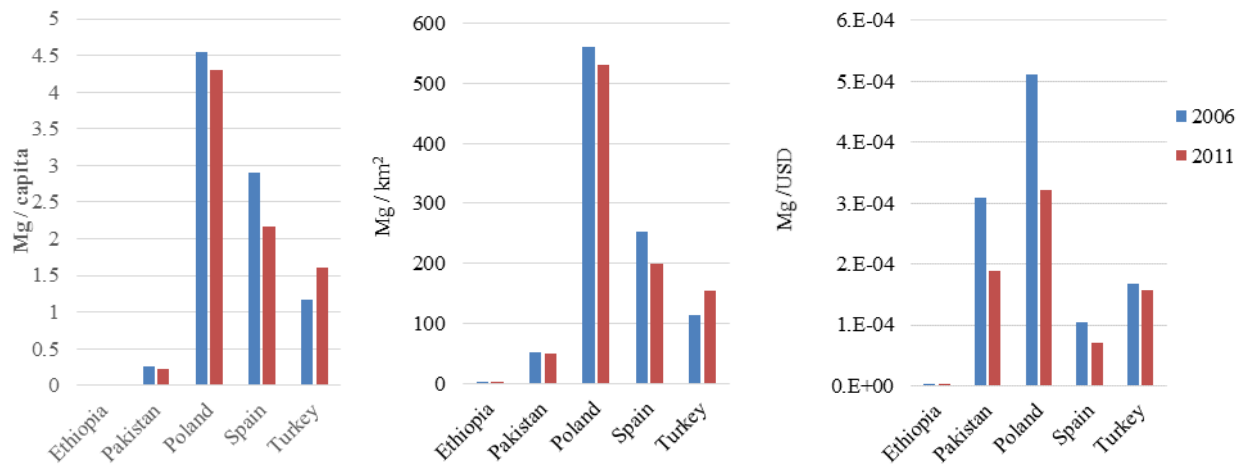


Fig. 5.3.1. Emissions of CO₂ per capita, per area and per USD [2, 8, 12, 19, 20]

Emissions of CO₂ in 2006 and 2011 per capita, per area and per GDP are shown in Fig.5.3.1 for different countries. According to the data, Poland is the major emitter of CO₂ in both years followed by Spain and Turkey. On the other hand Ethiopia has almost negligible emissions. The trend is decreasing for all countries except Turkey. In terms of GDP, Poland has the highest emission of CO₂ in 2006 however it has decreased significantly in 2011.

5.3.2. Emissions of NO_x

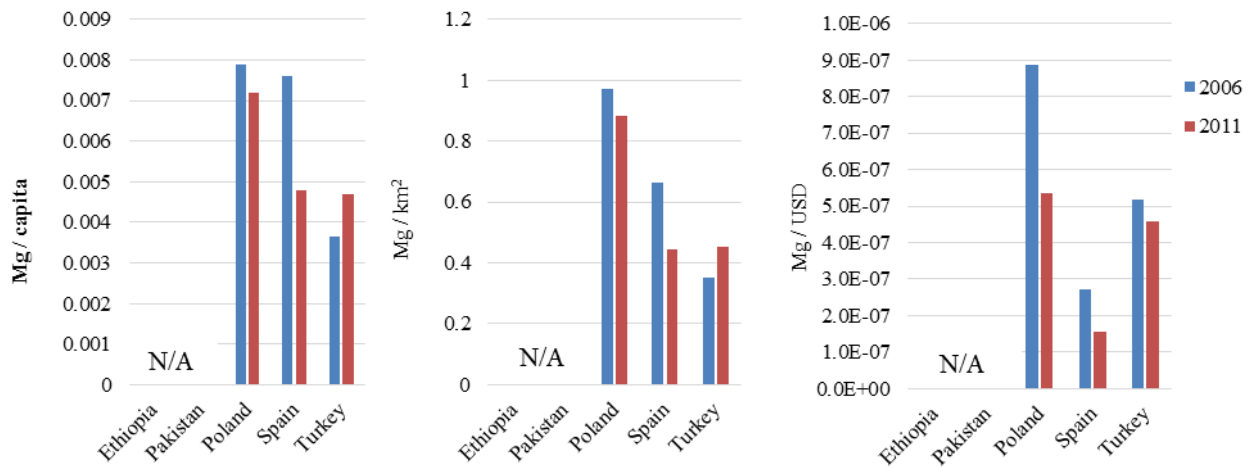


Fig.5.3.2. Emissions of NO_x per capita, per area and per USD [23]

The trend for NO_x emission per capita is decreasing for all countries as in case of CO₂, but for Turkey it is increasing. There is highest NO_x emission reduction per capita of around 36 % in Spain within five years. Furthermore, the behavior of NO_x emission per area is the similar. With reference to GDP the emissions of NO_x has decreased considerably in 2011 in Poland and Spain.

5.3.3. Emissions of SO_x

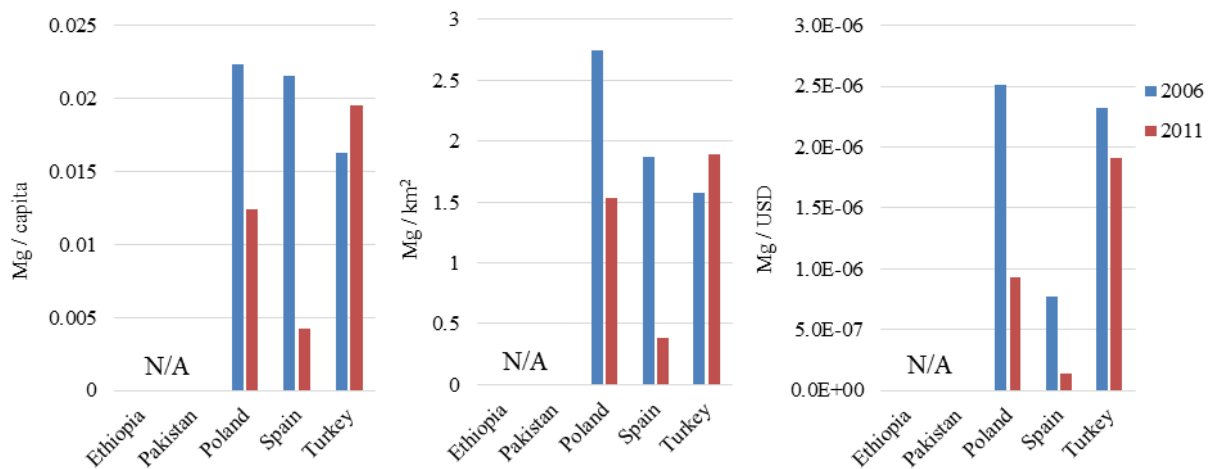


Fig. 5.3.3. Emissions of SO_x per capita, per area and per USD [23]

It is represented in Figure 5.3.3 that Poland and Spain are the highest emitters of SO_x per capita in 2006. Emission of SO_x per capita is highly decreased in Spain in five years. However, the tendency is growing for Turkey. Moreover, emission of SO_x per area is the lowest in Spain but it is the highest in Turkey in 2011. With reference to GDP, Poland and Spain has decreased the emissions of SO_x significantly in 2011.

5.3.4. Emissions of PM

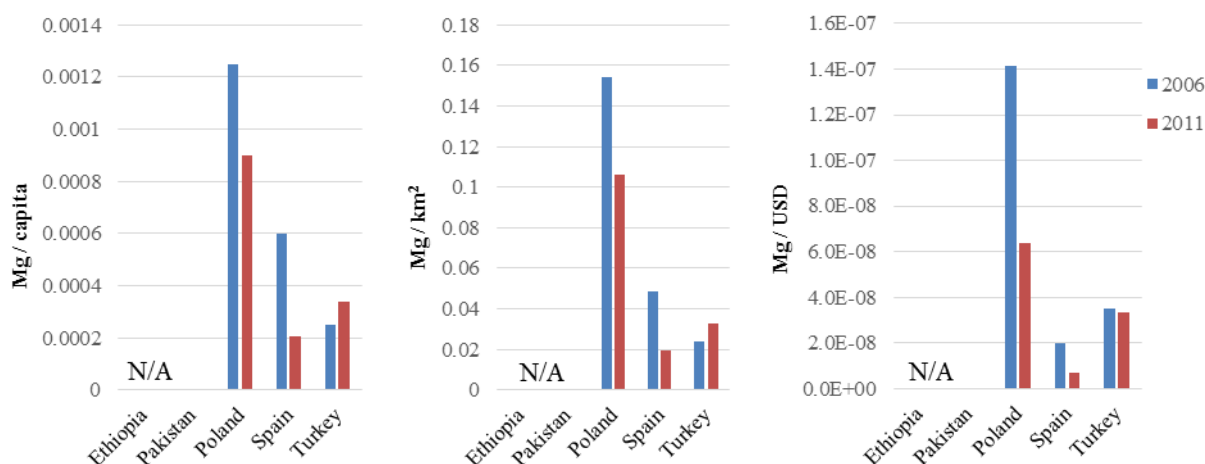


Fig. 5.3.4. Emissions of PM per capita, per area and per USD [23]

It is illustrated in Fig. 5.3.4 that Poland is the highest emitter of PM per capita, per area and per GDP in 2006 and 2011. The emission of PM per capita in Spain is reduced around 65 %. On the contrary, it is increased by 37 % in Turkey. It can be seen that emissions of PM in terms of GDP has decreased considerably in Poland and Spain.

6. Conclusions

In this article energy consumption, electricity production and emission of CO₂, NO_x, SO_x and PM are investigated. Primary energy consumption in all of the countries is highly dependent on fossil fuels with the exception for Ethiopia where the most common energy source is biofuels and waste. For instance, in Poland, the main source of energy consumption is coal. The energy use of the countries in 2011 shows that Spain is the highest energy consumer as 129.34 Mtoe whereas Ethiopia is the lowest energy consumer as 34.06 Mtoe. Turkey, Poland and Pakistan has primary energy consumption of 112 Mtoe, 101 Mtoe and 84.85 Mtoe respectively.

Electricity production of the countries in 2006 and 2011 is examined. Total amount of electricity production is almost doubled in Ethiopia. In spite of the fact that more than 75 % of the people have no access to electricity. In addition, there is a shortfall of electricity between 5000 MW to 7000MW in Pakistan and nearly 21 % of the population has no access to electricity in 2011. There is a significant increase of electricity production in Turkey within analyzed years. On the other hand, other countries do not have the same trend. For instance, electricity consumption is even decreased in Pakistan and Spain. There is a small increase in Poland. The distribution of the energy sources for electricity production is different in each country due to many factors such as availability of natural resources, technology, politics and economy. For instance, electricity production is 99 % in Ethiopia from hydropower. The same behavior is also observed for coal in Poland. Almost 87 % of the electricity production is supplied from coal. Electricity is produced mainly from natural gas, coal and hydropower in Turkey and the major sources of electricity production are natural gas, oil and hydropower. However, Spain meets approximately 40 % of the demand from nuclear power and renewables unlike other countries.

Furthermore, emissions of CO₂, NO_x, SO_x and PM from power sector in 2006 and 2011 are examined. The evaluation is made on the basis of emissions per capita, per area and per GDP. In case of CO₂ emission, Ethiopia has the lowest emission due to the dominance of hydropower. The main reason of lower emission in Ethiopia is that there is nearly no usage of fossil fuels. Turkey has relatively low CO₂ emission as compared to Poland and Spain. However, Spain decreased the emission by 21 % since there is a significant increase in the use of renewables in analyzed period. Although Poland decreased its coal usage to some extent, the emission is not affected much. Pakistan is the second least emitter of CO₂ because of many factors such as low installed capacity, very less usage of coal in power generation and one third of electricity generation comes from hydropower. In Pakistan, the value is around 1 Mg/capita and it stays almost the same. Both Spain and Poland

have decreased the emissions to some extent. Especially, Spain has significant reduction of emissions in five years. On the contrary, Turkey has increased the emissions. The reason for the increment, might be the dramatic increment in the capacity of power generation.

After the analysis, it can be concluded that Ethiopia is the least emitting country because it produces almost all of the electricity from hydropower. On the contrary, Poland is the highest emitter of CO₂, NO_x and PM per capita, per area and per GDP. The main reason is that more than 85 % of electricity is produced from coal fired power plants. However, it can be seen that the emissions are decreased due to strict regulations and new technologies having been installed in power plants. Finally, Spain would be regarded as a model in distribution of resources for electricity production and tendency of reduction of the emissions.

In the article, it has been discussed that there are many ways of power generation from coal, natural gas, water, nuclear etc. It is not easy to decide which way of power generation is better. There are many constraints such as availability of natural resources, technology and economy which impact the ways of power generation in different countries. For instance, the capital cost of nuclear power plants are substantially higher than coal power plants. On the contrary, the emissions are higher in coal power plants. Moreover, the preferred way of power generation is the use of fossil fuels for those countries which are rich in these resources. Nevertheless, the countries which are using fossil fuels have to focus on the development of technology to decrease the environmental impacts. As a final point, taking into consideration the emissions, renewables are the best choice of power generation from environmental point of view.

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