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IDENTIFICATION AND QUANTIFICATION OF THE FISCAL EFFECTS OF ELECTRICITY GENERATION IN POLAND

Abstract
The economic costs of electricity generation in Poland differ significantly from its accounting costs. Overt and covert forms of public support and taxation obscure the picture of the relationship between the public sector and the energy industry, and give rise to speculations whether one generation technology is privileged over another, i.e. used more often than other technologies with lower economic costs. The analysis presented in this article shows that there are significant differences in terms of impact of individual electricity generation technologies on public finances in Poland.

Key words:
electricity, cost-benefit analysis, public finances, energy economics, energy subsidies

Introduction

The scope and impact of government interventions on energy markets have been the topic of both public debate and scientific studies for years, e.g. by the European Commission [1], Organisation for Economic Cooperation and Development [2], International Monetary Fund [3]. To date, however, different energy generation technologies have not been compared explicitly from the point of view of their influence on the performance of public finances. The issue is particularly challenging in Poland, where one of the main targets of the planned National Energy Policy by 2050 [4] is to "rationalise the costs of primary energy", with limited reflection on the existing differences between the actual economic and accounting costs. These differences may be caused by external costs, but also by the overt and covert forms of public support and taxation for different energy generation technologies. This paper aims at addressing this question by identifying and quantifying the net streams between the public finances and different energy generation technologies in Poland.

We define positive fiscal effects as financial and non-financial benefits achieved by the public sector, whereas the negative fiscal effects as the financial and non-financial costs incurred by the public sector. The primary source of positive fiscal effects are taxes [5]. Their general typology can be considered by the subject of taxation, as well as by their intended use and the relation of the subject of taxation to the source of taxation. Apart from traditional forms, such as income taxes, electricity companies in the EU pay also special taxes, for instance: tax on installed electric power, payable in France for local and regional authorities. In certain countries, there are exotic forms of taxation, for example in Hungary – a charge for the reduction of energy cost for former and current employees of power industry, or a charge for the restructuring of the coal industry. On the other hand, the negative fiscal effects (transfers of values from the public sector to the private sector – energy industry) may concern: direct capital transfers, tax revenue foregone, other government revenue foregone, transfer of risk to the public sector, or induced transfers [6].

As far as the implications of the fiscal effects are concerned, they may be twofold. Energy subsidies may have distortionary impact on the energy market, leading to changes in overall energy consumption [7], carbon emissions [8], income redistribution [9]. On the contrary, several sources of fiscal receipts directly related with energy generation can also have a strong positive stimulus for effective implementation of public environmental policies or local development initiatives (e.g. property taxes) [10].

The article focuses on estimating the positive and negative fiscal effects of electricity generation in Poland, in relation with the following energy carriers: hard coal, lignite, natural gas, biomass, biogas, wind energy, solar energy. We use several types of data sources, such as statistics and reports published by EU and Polish public authorities at different levels of governance, as well as a number of case studies describing several types energy generation installations and the taxes related with their costs and revenues. This data analysis approach

aims to develop a conceptual framework for providing clear comparison between different energy generation technologies in terms of their influence on the public finances in Poland. The fiscal effects analysed are expressed in monetary units per MWh of electricity, generated using different technologies (hard coal, lignite, natural gas, biomass, biogas, wind energy, solar energy), which allows for direct reasoning and drawing conclusions that may be useful for energy mix planning by decision makers of public energy policy.

Positive fiscal effects

The positive fiscal effects connected with electricity generation in Poland, understood as public sector receipts, include:

- value added tax (VAT),
- income tax,
- land tax,
- property tax,
- environmental fees, including fees for CO_2 emissions,
- excise duty [6].

VAT tax

We estimate the budgetary receipts from VAT, associated with an added value obtained from various energy technologies, based on the 2012 *Balance sheet financial results of business entities* [11]. The basic rate of tax was adopted in line with the Polish standard VAT tax rate (23%). Due to the lack of available sources on the added value obtained at the generation of one MWh of electricity with the use of various technologies, in order to estimate the value added tax, we assume that the tax value can be calculated upon the base of the sum of the electricity price (per one MWh) and the price of green certificates (per one MWh, if applicable – the green certificates are granted by relevant public authority for production of electrical energy from renewable energy sources and high-performance co-generation using natural gas) [11].

Table 1. Estimated value of VAT according to energy carriers [PLN/MWh]

Description	hard coal	lignite	natural gas	biomass	biogas	wind energy	solar energy
Electricity price on competitive market (price on Polish Power Exchange) [PLN/ MWh]	201.36	201.36	201.36	201.36	201.36	201.36	201.36
Price of property rights or green certificates[1] [PLN/MWh]	0.00	0.00	123.43	253.31	389.38	253.31	253.31
Total price [PLN/MWh]	201.36	201.36	324.79	454.67	590.74	454.67	454.67
VAT [PLN/MWh]	46.31	46.31	74.70	104.57	135.87	104.57	104.57

Source: Author's calculations based on [6]

The obtained results of calculations indicate that the amount of VAT is very highly dependent on the level of prices for the green certificates. The accounting added value, from which VAT is charged, is therefore considerably greater in the case of non-conventional technologies.

[1] Green certificates are tradable commodities proving that certain electricity is generated using renewable energy sources. One certificate represents generation of one MWh of electricity and it is granted to the energy producer by the relevant public authority (Energy Regulatory Office).

Income tax

The energy industry pays 2.8 billion PLN annually to the state budget by way of income tax and corporate income tax (CIT) [12]. To estimate the share of receipts from CIT, we estimate the profitability of electricity generation from various technologies, which is shown in table 2[2].

Table 2. Estimated value of CIT according to energy carriers [PLN/MWh]

Description	hard coal	lignite	natural gas	biomass	biogas	wind energy	solar energy
CAPEX [EUR/MWh] [1]	39	39	51	96	30	70	85
OPEX [EUR/MWh] [1]	7	7	6	26	10	11	22
Total costs [EUR/MWh]	46	46	57	122	40	81	107
Electricity price [EUR/MWh] [1]	108	108	108	108	108	108	108
Price of property rights [EUR/MWh] [13]	0	0	30	62	95	62	62
Total selling price [EUR/MWh]	108	108	138	170	203	170	170
Profitability [EUR/MWh]	62	62	81	48	163	89	63
Profitability [PLN/MWh][3]	254	254	332	196	668	364	257
CIT prior to correction [PLN/MWh]	48	48	63	37	127	69	49
Amount of energy generated annually in Poland [GWh] [14]	87,326	52,529	5,821	7,459	142	3,205	0
Estimated CIT prior to correction (19%) [mln PLN]	4,213.8	2,534.7	367.6	277.7	18.0	221.6	0.0
Estimated CIT after correction [mln PLN][4]	1545.7	929.8	134.8	101.8	6.6	81.3	0.0
Estimated CIT after correction [PLN/MWh]	**17.70**	**17.70**	**23.20**	**13.70**	**46.60**	**25.40**	**0.00**

Source: Author's calculations based on [1], [12], [13], [14]

The resulting estimates regarding the income tax indicate that the state budget can expect the largest unit receipts from CIT [in PLN/MWh] from the producers of electricity from biogas and wind (46.6 PLN/MWh and 25.4 PLN/MWh respectively). Due to the very low generation of electricity from solar energy in the National Power System, it was impossible to estimate the value of income tax paid by photovoltaic power plants.

Property tax

Property tax rates are determined by means of resolution of local councils. The law on local taxes and charges regulates only the maximum rates – e.g. 22.82 PLN per 1 m^2 of functional area and 2% of the value of buildings [15]. To assess fiscal receipts from the property tax on various types of power plants, Tables 3, 4 and 5 propose the calculation of the estimate based on three case studies: a lignite-fired power plant in Bełchatów, a biogas power plant in the province of Świętokrzyskie and a wind power plant in the province of Łódź.

[2] There is no data on the profitability of individual energy technologies at the state level. The data accepted from the EU level were corrected, matching the profitability structure at the EU level to Polish conditions.

[3] Adopted exchange rate: 4.1 PLN/EUR. Exchange rate applied to all energy generation technologies analysed.

[4] The adopted correction assumes that the profitability structure of the generation technology in Poland corresponds to the profitability structure in the EU, but the total profitability is proportionately smaller. The total amount of CIT was calculated on the basis of [12].

Table 3. Estimation of the amount of the property tax for a conventional electricity generation system (hard coal, lignite, natural gas)

Item	Value
Tax value [PLN/capita] [16]	33,100
Number of inhabitants [17]	5,165
Total value of the property tax [PLN]	170,961,500
Total electricity generation in power plant in Bełchatów [MWh] [18]	28,000,000
Value of the property tax [PLN/MWh]	6.11

Source: Author's calculations based on [16-18]

Table 4. Estimation of the amount of the property tax for biomass and biogas installations

Item	Value
Amount of the property tax [PLN/MW] [19]	100,000
Estimated operation time annually [h]	8,400
Value of the property tax [PLN/MWh]	11.90

Source: Author's calculations based on [19]

Table 5. Estimation of the amount of the property tax for the wind power industry

Item	Value
Value of the property tax [PLN] [20]	2,386,000
Estimated generation of electricity [MWh] [20]	151,200
Property tax value [PLN/MWh]	15.78

Source: Author's calculations based on [20]

Table 6 presents the summary of estimated property tax values, broken down into generation technology. As expected, the largest single receipts from the property tax relate to the wind power industry (15.78 PLN/MWh). The property area in the case of wind power plants includes not only the land occupied by the turbine tower, but also the area swept by the rotor of the turbine, tower surface and access roads. The lowest property taxes (zero) apply to the solar power plants, which are not considered real properties [21].

Table 6. Estimated value of the property tax according to energy carriers [PLN/MWh]

Item	hard coal	lignite	natural gas	biomass	biogas	wind energy	solar energy
Estimated value of property tax [PLN/MWh]	6.11	6.11	6.11	11.91	11.91	15.78	0.00

Source: Author's Author's calculations

Environmental fees and compensatory payments

Annual receipts of the National Fund for Environmental Protection and Water Management (NFOŚiGW) and 16 Regional Funds for Environmental Protection and Water Management (WFOŚiGWs) from fees and penalties for damaging the environment, as well as the remaining fees paid by the companies amount to approx. 1.84 billion PLN. As we show in Table 7, the largest amount comes from compensatory payments and penalties, resulting directly from the Energy Law.

Table 7. Annual receipt of NFOŚiGW related to charges incurred by energy companies and other [PLN thousand]

Description	Amount [PLN thousand]
Fees and penalties for using the environment	384,229
Usage fees and license fees	192,913
Product fees	3,630
Registration fees for the issue of integrated permits	1,195
Fees referred to in art. 142 of the Water Law Act	12,018
Fees for granting of emission allowances	217
Fees for substances depleting the ozone layer	376
Compensatory payments and fees resulting from the Energy Law Act	470,447
Penalties resulting from the Waste Act	2,801
TOTAL	**1,067,826**

Source: own study based on [22]

On the other hand, as shown in Table 8, the largest receipts from fees for the use of the environment and penalties at the provincial level are recorded by WFOŚiGWs in Łódź and in Katowice – 142 million and 125 million PLN respectively. In 2015, more than 33% of the total generation capacity of the Polish energy sector was installed in these provinces [23]. Receipts to WFOŚiGWs in these provinces constitute similar share (35%) of the total receipts of all WFOŚiGWs in Poland.

Table 8. Annual receipts of WFOŚiGWs from fees for the use of the environment and penalties [PLN thousand]

Province	Amount [PLN thousand]
Dolnośląskie	57,459
Kujawsko-pomorskie	40,561
Lubelskie	25,595
Lubuskie	13,549
Łódzkie	142,431
Małopolskie	44,176
Mazowieckie	90,215
Opolskie	22,984
Podkarpackie	20,021
Podlaskie	9,574
Pomorskie	36,591
Śląskie	125,781
Świętokrzyskie	25,116
Warmińsko-mazurskie	15,137
Wielkopolskie	62,012
Zachodniopomorskie	41,234
TOTAL	772,436

Source: own study based on [22]

Table 9 shows the estimate of the environmental charges connected with the electricity generation from hard coal in Poland. Per MWh, the greatest costs incurred by energy companies refer to charges for sulfur from combustion gas desulfurization (more than 4 PLN/MWh).

Table 9. Environmental fees related to the generation of electricity from coal

Specification	**Coal of average parameters in international trade classifications (class 25/12/08)**	**Coal of average parameters in the Polish professional power engineering classification (class 25/22/08)**	**Coal of average parameters in the Polish professional power engineering classification (class 18/25/12)**
Fees for storage of waste and for dust [PLN/tonne]	4.6	8.4	9.5
Fees for sulfur from flue gas desulfurization [PLN/tonne]	8.8	8.9	13.5
Fees for emission of NO_x, CO and CO_2 [PLN/tonne]	2.6	2.3	1.9
Sum of charges [PLN/tonne]	16.0	19.54	24.89
Fees for storage of waste and for dust [PLN/MWh]	1.8	3.8	5.3
Fees for sulfur from flue gas desulfurization [PLN/MWh]	3.5	4.1	7.5
Fees for emission of NO_x, CO and CO_2 – emission permits [PLN/MWh]	1.0	1.0	1.1
Sum of charges [PLN/MWh]	6.4	8.9	13.8

Source: own calculations based on [24]

To estimate the environmental charges from the remaining energy technologies considered, we assume that the fees are proportional to the equivalent emission factor characterizing the utilized energy carrier. The results of calculations are presented in Table 10.

Table 10. Estimation of environmental charges related to the generation of energy from various energy technologies

Specification	**hard coal**	**lignite**	**natural gas**	**biomass**
Equivalent emission factor [t CO_2-eq /MWh] [25]	0.385	0.375	0.237	0.002
Environmental fees [PLN/MWh]	8.9 [24]	8.67	5.48	0.05

Source: The author's own study based on [25]

The conducted calculations show that the largest unit environmental fees relate to hard coal power plant (8.9 PLN/MWh). It is worth noting that the amount of these fees is several times less than the amount of VAT and CIT tax. The largest part of environmental fees relates to fees for sulfur from flue gases desulfurization. Estimated environmental fees are the smallest in the case of wind and solar power plants (0 PLN/MWh), which are characterized by relatively low impact on the environment.

Excise duty

Pursuant to art. 9 of the Act of December 6, 2008 on excise duty [26] the following are subject to excise duty:
1) intra-community acquisition of solar energy by the final purchaser;
2) the sales of electricity to the final purchaser within the country, including by the entity without the license for generation, transmission, distribution or trade of electricity within the meaning of the Act of April 10, 1997 - the Energy Law, who generated this energy;
3) electricity consumption by the entity holding the license referred to in item 2;
4) electricity consumption by the entity without the license referred to in item 2, who generated this energy;
5) import of electricity by the final purchaser;
6) electricity consumption by the final purchaser, if the excise duty was not paid in the due amount and it is impossible to identify the entity, who executed the sale of electricity to the final purchaser. Pursuant to

appendix no. 1 to the aforementioned Act, on the other hand, the excise duty must also be settled from hard coal, brown coal and natural gas.

Table 11. The estimated value of the excise duty according to energy carriers

Description	**hard coal**	**lignite**	**natural gas**	**biomass**	**biogas**	**wind energy**	**solar energy**
Rate of excise duty according to energy carrier [PLN/GJ in fuel] [27]	1.3	1.3	1.3	0.0	0.0	0.0	0.0
Rate of excise duty from energy carrier [PLN/GJ in fuel]	4608.0	4608.0	4608.0	0.0	0.0	0.0	0.0
Energy conversion efficiency [%] [28]	32.3	39.6	26.8	31.9	29.9	–	–
Rate of excise duty from energy carrier [PLN/MWh electricity]	14.3	11.6	17.2	0.0	0.0	–	–
Rate of excise duty from electricity [PLN/MWh] [27]	20.0	20.0	20.0	20.0	20.0	20.0	20.0
The rate of excise duty in total [PLN/MWh]	34.3	31.6	37.2	20.0	20.0	20.0	20.0

Source: own study based on [27] and [28]

The calculations performed show that single budgetary receipts from excise duty are the greatest in the case of power plants fired by natural gas (37.2 PLN/MWh), which derives from the highest rates of excise duty from energy carrier, as well as the lowest conversion efficiency of primary energy to final energy, from among the considered technologies.

Negative fiscal effects

In 2012 the hard coal mining sector received subsidies worth 5,591 million PLN [29], including:

- PLN 861 million – from the state budget and support programs for the hard coal sector;
- PLN 8 million – from the Infrastructure and Environment Operational Program, the Innovative Economy Operational Program and the LIFE+ program;
- PLN 300 million – form the Silesia Province Regional Operational Program
- PLN 4,421 million – for miners' pensions (data for 2012).

Therefore, the subsides per unit of electricity generated from hard coal amount to 64 PLN/MWh. Calculations by CASE-Doradcy show that the value of subsidies for the coal mining in the years of 2010-2012 was 60% greater than the value of support for the renewable energy sector. According to the OECD, on the other hand, the Polish coal sector receives PLN 2,535 million per year from the public support (data as of 2011) [2], including:

- support for manufacturers – compensations for stranded costs (PLN 2,128 million),
- support for consumers – coal benefits in the hard coal mining sector (PLN 162 million),
- support for services – assistance for closing the mines (PLN 214 million), recultivation of the areas transformed as a result of mining activities (PLN 9 million), pre-retirement benefits for dismissed miners (PLN 22 million).

Therefore, the public support per unit of electricity generated from hard coal according to the OECD amounts to 29 PLN/MWh. Yet another results are provided by the International Monetary Fund [3], according to which the public support for the coal sector is annually approx. EUR 6.82 billion and EUR 0.7 billion for the gas sector, which is, respectively, approx..: 327 PLN/MWh and 56 PLN/MWh[5]. The cited analyses are not comparable, though. Elaborations of the IMF include external costs, whereas analyses of the OECD and CASE-Doradcy do

[5] Adopted rate: 4,1 PLN/EUR.

not. The estimates similar to analyses of the OECD can be found in the report by ECOFYS, commissioned by the European Commission [1], the results of which are presented in Table 12. Due to the fact that the ECOFYS' data have been verified by the European Commission and they fall within the confidence limit, specified by elaborations of CASE-Doradcy and of the OECD, the calculation from this particular source are considered for further deliberations.

Table 12. Structure of subsidies to energy technologies according to energy carriers in Poland 2012

Specification of fiscal effects	**hard coal**	**lignite**	**natural gas**	**biomass**	**biogas**	**wind energy**	**solar energy**
Subsidies [EUR million]	730	4.5	30	50	0[6]	20	30
Subsidies [PLN/MWh][7]	34.2	0.4	21.1	27.5	0.0	25.6	0.0

Source: own study based on [1]

Table 13 presents the comparison of the main fiscal effects related to electricity generation in Poland according to energy carrier. The biggest net positive financial receipts per MWh are recorded by the public sector by generating electricity from biogas, whereas the lowest gains come from generating electricity from hard coal. However, our analysis does not cover external effects, which represent a significant economic cost, especially for certain technologies like hard coal and lignite.

Table 13. Comparison of the main fiscal effects related to electricity generation in Poland according to energy carriers

Specification of estimated fiscal effects [PLN/MWh]		**hard coal**	**lignite**	**natural gas**	**biomass**	**biogas**	**wind energy**	**solar energy**
FISCAL RECEIPTS	VAT	46.31	46.31	74.70	104.57	135.87	104.57	104.57
	CIT	17.70	17.70	23.20	13.70	46.60	25.40	0.00
	Property tax	6.11	6.11	6.11	11.91	11.91	15.78	0.00
	Environmental fees	8.9	8.67	5.48	0.05	0.00	0.00	0.00
	IN TOTAL	**79.02**	**78.79**	**109.49**	**130.23**	**194.38**	**145.75**	**104.57**
FISCAL EXPENDITURES	Subsidies	34.2	0.4	21.1	27.5	0.0	25.6	0.0
	IN TOTAL	**34.2**	**0.4**	**21.1**	**27.5**	**0.0**	**25.6**	**0.0**
NET RESULT		**44.82**	**78.39**	**88.39**	**102.73**	**194.38**	**120.15**	**104.57**

Source: Author's

Conclusions

The estimated fiscal receipts from the state budget and non-budgetary funds obtained from energy companies exceed the amount of granted subsidies, regardless of the type of electricity generation technology. The largest component of individual fiscal effects [PLN/MWh] for all the considered technologies is VAT. There is significant difference as to the scale of impact of particular technologies on public finances.

[6] There are no complex data sources that could verify the ECOFYS estimates regarding the subsidies for the biogas plant, but the null value presented in the report raises doubts.

[7] Adopted rate: 4,1 PLN/EUR.

According to the presented results, the biggest net fiscal receipts concern electrical energy generated from biogas, biomass, sun and wind. The main underlying reason for this is the green certification scheme, which promotes the generation of energy from renewables in Poland. As the price of certificates is the basis for VAT calculations, they strongly contribute to the increase of tax revenues. The second most important source of fiscal receipts in all cases analysed is CIT. However, the results in this field are also very much dependent on the price of green certificates. Even though environmental fees resulting from generation of one MWh of electricity based on hard coal and lignite constitute a significant fiscal burden for this technology, they are still estimated to be much smaller than real property taxes paid by owners of wind turbine as well as biomass and biogas installations.

As far as the fiscal expenditures are concerned, the subsidies granted to different power plants seem to be the highest in the case of installations based on hard coal. Public support offered to biomass and wind energy power plants is also significant, but much lower, as also pointed in [30]. In all cases, the subsidies offered are smaller than the fiscal receipts per one MWh of energy generated. Therefore, we have showed that – at least in comparison to the fossil fuel-based installations – renewable energy plants are not privileged in terms of subsidies received, contrary to some popular beliefs in Poland [31].

Even though the presented analyses compile several disparate figures and data sources on various taxes and subsidies to be assessed on a PLN/MWh basis, future research should extend and cross-validate them with other sources of information. Furthermore, the determination of deadweight loss from the point of view of social costs, resulting from the non-optimal fuel structure in the Polish energy sector, is not possible without the quantification of external effects. It should be further investigated whether current levels of environmental fees allow for full internalization of those effects, safeguarding Poland's socioeconomic interests and sustainable development in the long run.

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