

## MANAGEMENT OF ELECTRICITY PRODUCTION FROM DIFFERENT ENERGY SOURCES IN EU-28

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### Abstract

The topic elaborated in this paper is rather specific, important and relevant due to the fact it targets different energy sources, and in this context, the research is mainly based on carefully selected and processed data on electricity production and shares of different sources in this production, including renewable energy sources (RES) in the final energy consumption, which have a significant role and direct impact in approaching, reaching and achieving the determined targets for each country in the European Union and as well in the Republic of North Macedonia by 2020.

This paper is of particular importance as it presents a realistic image of the different sources and their shares in the production of electricity. This enables one to make comparisons and see the differences and impacts of this type of production in various countries as opposed to the share of energy from renewable energy sources in the final energy consumption, where the ultimate challenge lies in fulfilling the European targets for each country separately. In the same context, the growing production of electricity from renewable sources has a large influence on the reduction of gas emissions, thus meeting the strictest European environmental standards for protection and preservation of the environment.

**Keywords:** electricity production, final energy consumption, renewable energy sources, European targets

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### 1. Introduction

Electricity is, of course, the noblest form and main type of energy which humanity learned to create, control and use. The production of electricity is an economic activity that has a promising future. Hence, the issue that has been elaborated is very up to date, due to the fact that it covers the production of electricity from different sources and their shares in this production in general, and particularly the share of RES in the consumption of final energy, as well as their interconnection and management within the European Union and the Republic of North Macedonia.

In the context of this, the analysis in this paper is summarized in four parts and eventually the paper finishes with conclusions.

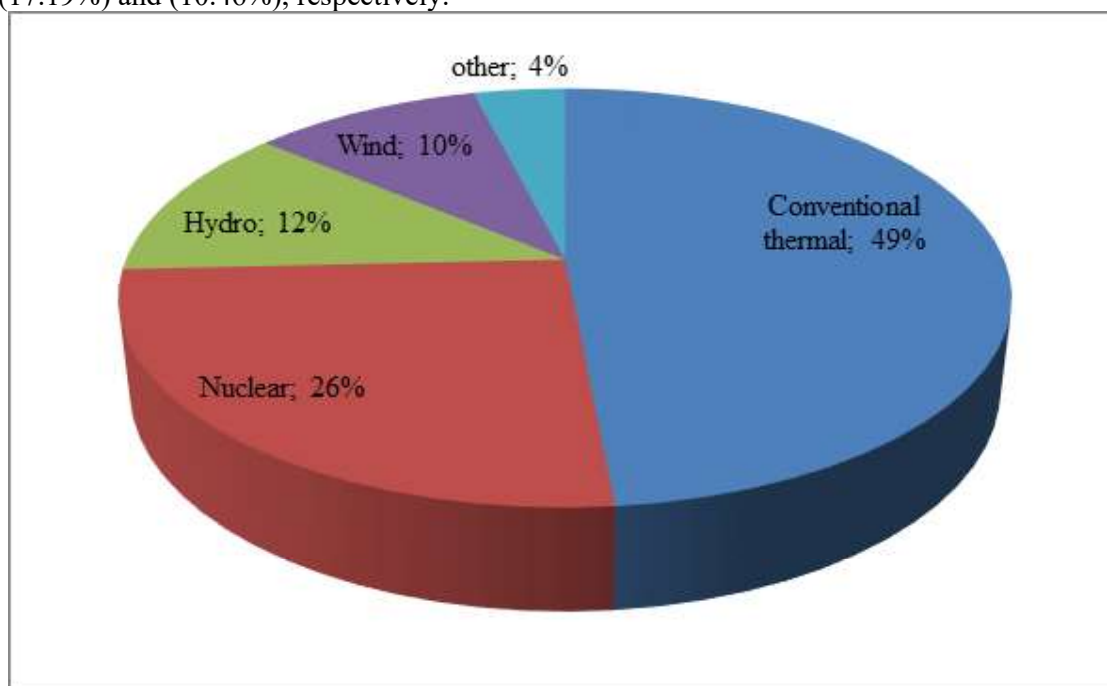
### 2. Shares of different energy sources in the electricity production in EU-28

The share of electricity from conventional thermal energy sources in the production of electricity in EU-28 in 2018 was 48.6% that is 25.8% nuclear power, 12 % hydropower, 9.7% wind power and 4% other (Figure 1).

Regarding the electricity production in various countries, we will consider the EU-28 countries, the Republic of North Macedonia and six other counties. Based on the data for 2016, given in Table 1, the order of the countries with large electricity production in EU-28

for 2016 is as follows: Germany (614.2 GWh), France (532.9 GWh), Great Britain (324.1 GWh), then Italy, Spain, Turkey, Sweden, Poland, Ukraine, Norway, Holland, Belgium, Czech Republic, and finally Malta with (0.8 GWh). The total net electricity production in 2016, at the level of EU-28, amounts to 3099.8 GWh, while the total production of electricity in the countries from Table 1 amounts to 3581.5 GWh.

The largest net electricity production was reached by the following EU-28 countries: Germany, France, and Great Britain. These countries also had a higher level of net electricity production in 2016 in the total net electricity production in EU-28, i.e. a share of (19.81%), (17.19%) and (10.46%), respectively.



**Figure 1.** EU-28 electricity production by source, 2016 (in %)

**Source:** <https://ec.europa.eu/eurostat/statistics>

[explained/index.php/Electricity\\_generation\\_statistics\\_%E2%80%93\\_first\\_results#Production\\_of\\_electricity](https://ec.europa.eu/eurostat/statistics-explained/index.php/Electricity_generation_statistics_%E2%80%93_first_results#Production_of_electricity)

Electricity from conventional thermal energy sources is produced in all countries, however the highest share between the EU-28 member states was observed in Estonia (94%), Cyprus (92%), Poland (90%), Holland (87%), Malta (85%), Ireland (76%), Greece (70%), Italy (68%) and the lowest was observed in Sweden (9%). Outside of the EU-28, Turkey had a share of 66%.

Electricity from nuclear sources is produced in 14 countries and the highest share between the EU-28 member states was observed in France (73%), Slovakia (57%), Belgium and Hungary (51% each), Sweden (40%), Bulgaria (37%), Slovenia (35%), Finland (34%), Czech Republic (30%), Portugal (28%) whereas in Holland it was 3%.

Electricity from hydropower sources is produced in almost all countries and the highest share between the EU-28 member states was observed in Luxemburg (69%), Austria (63%), Croatia (56%), Latvia (41%), Sweden (40%), Romania (32%), Slovenia (30%), Portugal (28%) and at the end is Great Britain with 1%, while outside of the EU-28 countries there is Norway with a share of 96%.

Electricity from wind power sources is produced in almost all countries and the highest share between the EU-28 member states was observed in Denmark (44%), Lithuania (28%),

Ireland and Portugal (21% each), Spain (18%), Germany and Great Britain (12% each), Greece and Sweden (11% each), Romania (10%) and finally Czech Republic with 1%.

Electricity from other energy sources is produced in almost all countries and the highest share between the EU-28 member states was observed in Malta (15%), Italy (10%), Greece and Lithuania (8% each), Germany (7%), Spain and Luxemburg (5% each), Belgium, Bulgaria and Romania (4%) and finally Croatia and Finland with 1% each.

**Table 1.** Shares of different sources in the production of electricity and the share of RES in the consumption of final energy in EU-28

	Net EP 2016	Share in EU- 28 2016	Share of CTHP in EP 2016	Share of NP in EP 2016	Share of HP in EP 2016	Share of WP in EP 2016	Share of OP in EP 2016	Share of RES in GCFE 2016	2020 Target	S2005
Countries	1000 GWh	%	%	%	%	%	%	%	%	%
EU-28	3099.8		48	26	12	10	4	17.0	20	
EA-18	2222.5	71.69	46	28	12	9	5			
Belgium	82.2	2.65	36	51	2	7	4	8.7	13	2.2
Bulgaria	41.2	1.32	46	37	10	3	4	18.8	16	9.4
Czech R.	76.4	2.46	63	30	3	1	3	14.9	13	6.1
Denmark	29.0	0.93	53	/	/	44	3	32.2	30	17.0
Germany	614.2	19.81	64	13	4	12	7	14.8	18	5.8
Estonia	10.4	0.33	94	/	/	6	/	28.8	25	18.0
Ireland	29.6	0.95	76	/	3	21	/	9.5	16	3.1
Greece	50.2	1.61	70	/	11	11	8	15.2	18	6.9
Spain	264.4	8.52	41	21	15	18	5	17.3	20	8.7
France	532.9	17.19	10	73	11	4	2	16.0	23	10.3
Croatia	12.3	0.39	35	/	56	8	1	28.2	20	12.6
Italy	279.7	9.02	68	/	15	7	10	17.4	17	5.2
Cyprus	4.7	0.15	92	/	/	5	3	9.3	13	2.9
Latvia	5.9	0.19	57	/	41	2	/	37.2	40	32.6
Lithuania	4.1	0.13	39	/	25	28	8	25.6	23	15.0
Luxemb.	2.2	0.07	21	/	69	5	5	5.4	11	0.9
Hungary	29.5	0.95	45	51	1	2	1	14.2	13	4.3
Malta	0.8	0.02	85	/	/	/	15	6.0	10	0.0
Holland	111.0	3.58	87	3	/	8	2	6.0	14	2.4
Austria	64.7	2.08	28	/	63	7	2	33.5	34	23.3
Poland	152.0	4.90	90	/	2	8	/	11.3	15	7.2
Portugal	58.8	1.89	49	/	28	21	2	28.5	31	20.5
Romania	60.3	1.94	36	18	32	10	4	25.0	24	17.8
Slovenia	15.5	0.50	33	35	30	/	2	21.3	25	16.0
Slovakia	25.0	0.81	23	57	18	/	2	12.0	14	6.7
Finland	66.2	2.13	38	34	23	4	1	38.7	38	28.5
Sweden	152.5	4.92	9	40	40	11	/	53.8	49	39.8
United K.	324.1	10.46	63	21	1	12	3	9.3	15	1.3
Iceland	18.2	/	/	/	/	/	/	72.6	67.5	58.2
Norway	149.6	/	2	/	96	2	/	69.4	64	55.0
Monteneg.	3.0	/	/	/	/	/	/	41.5	33	/
FYROM	5.6	/	63.3	/	33.7	1.9	1.1	18.2	28	13.8
Albania	7.1	/	/	/	/	/	/	37.1	38	/
Serbia	36.6	/	/	/	/	/	/	20.9	27	/
Turkey	261.9	/	66	/	25	6	3	/	/	/

Source: [https://ec.europa.eu/eurostat/statistics-explained/index.php/Electricity\\_generation\\_statistics\\_%E2%80%93\\_31\\_results#Production\\_of\\_electricity](https://ec.europa.eu/eurostat/statistics-explained/index.php/Electricity_generation_statistics_%E2%80%93_31_results#Production_of_electricity) and [http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=nrg\\_ind\\_335a&lang=en](http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=nrg_ind_335a&lang=en)

### 3. RES share in the consumption of final energy in EU-28

The targets which apply for the member-states of the EU are calculated based on the share of RES in the total consumption of final energy in the observed country in 2005, plus 5.5% for each member state, plus a certain percentage proportionally to the gross domestic product per capita [9].

The share of energy from renewable sources in the gross consumption of final energy in EU-28 amounts to 17% in 2016 (Table 1). This is evidence of sustainable growth towards the Europe 2020 target of 20%. The same higher level in 2016 amongst the member states was observed in Sweden and Finland (38.7% each), Latvia (37.2%), Austria (33.5%), Denmark (32.2%), Estonia (28.8%), Portugal (28.5%) and at the end Luxemburg, where a lower level of 5.4% was observed, while outside of the EU-28 countries Island had a share of 72.6%.

To achieve a quantified share of energy from renewable energy sources in the gross consumption of final energy in the EU-28 countries until 2020 compared to 2016, it is necessary to increase the share for additional 3%. To achieve the same target, 6 countries need to increase the share for less than 3%, compared to 2016, including Austria 0.5%, Slovakia 2%, Portugal 2.5%, etc. The following 11 countries need to increase the share for more than 3%: Holland 8%, France 7%, Ireland 6.5%, United Kingdom 5.7%, Luxembourg 5.6%, etc. The quantified target by 2020 was achieved by 11 countries in 2016. Amongst them the quantified target of 49.0%, 38.0%, 30.0%, 25.0% and 20.0% until 2020 was achieved by Sweden with 53.8%, Finland with 38.7%, Estonia with 28.8% and Croatia with 28.2% respectively in 2016.

Taking into consideration the impact of the electricity production from different sources in meeting the quantified targets of the EU-28 member states, which total number is 11 countries that have met the target since 2016, the situation is as follows:

From a total of 13 countries, four have met the target, although over 50% of their production is based on conventional thermal sources.

From a total of 4 countries, one has met the target, although over 50% of its production is based on nuclear sources.

From a total of 5 countries, where over 50% of the production is based on RES, three have met the target.

Three other countries have met the target, although their production based on conventional thermal and nuclear sources surpasses 50%.

Norway, a country outside of EU-28 meets the target, since its production is mainly based on RES – approximately 100%.

In the end, Island and Montenegro, also countries outside of EU-28 met the target, however, there are no available data for these countries regarding the resources for electricity production.

### 4. Share of different energy sources in the production of electricity in the Republic of North Macedonia

Concerning the Republic of North Macedonia, the electricity production from conventional thermal sources in 2016 amounted to 3563 GWh, that is, 63.3% compared to the total domestic production of electricity, which amounted to 5630 GWh.

The production of electricity from hydropower sources amounted to 1897 GWh, i.e. 33.7%.

The production of electricity from wind power amounted to 109 GWh, i.e. 1.9%.

The production of electricity from solar power amounted to 24 GWh, while from biogas it amounted to 36 GWh, or in total 60 GWh i.e. 1.1%.

## 5. RES share in the consumption of final energy in the Republic of North Macedonia

In regards to the production of electricity by power plants using different RES, this production has an upward trend, and year after year it increases drastically. This is the result of the continuous increase in the number of power plants, as well as the installed capacity. This installed capacity reached 132.4 MW in 2018 (Table 2).

The Register of power plants for electricity generation from RES as of 20.06.2018, is given in Table 2.

**Table 2.** Register of power plants for electricity generation from RES

Power plant type	Solar FV	Small HPP	Wind power plants	Biogas	Total
Number of power plants	102	79	1	3	185
Total installed power (MW)	16.71	71.88	36.8	6.999	132.4
Planned annual production (MWh)	21.411	258.595	100.000	58.593	438.599

Source: [http://www.ea.gov.mk/index.php?option=com\\_content&view=article&id=679&Itemid=124&lang=mk](http://www.ea.gov.mk/index.php?option=com_content&view=article&id=679&Itemid=124&lang=mk)

It is important to mention that the share of electricity from RES of over 35% in 2016 indicates that the increased electricity production from RES has a direct impact on the increase of energy from renewable energy sources and achieving a share of 18.2% in the consumption of final energy.

The percentage share of RES in the total consumption of final energy in Macedonia, according to the actual average values, shall increase from 13.8% in 2005 to 21% in 2020. In accordance with the adopted methodology for calculation of the target percentage share of RES in the total consumption of final energy in 2020 by the EU member-states, the target share for Macedonia shall be 21% [10]. Therefore, the conclusion is that Macedonia needs to increase the share for an additional 2.8% compared to 2016. Thus, it will meet one of the targets of the Internal Market of the EU, which should be achieved until 2020.

In fact, in 2020, the percentage share of RES will amount to 21.0% (6699 GWh) compared to the final energy consumption (31850 GWh), whereas the share of electricity from RES (2889 GWh) compared to the final energy consumption (31850 GWh) will amount to 9.07%. The percentage share of RES in 2020 would amount to 24.7% of the electricity production [10].

On the other hand, despite the Strategy's forecast of 21.0% share of energy from RES in 2020 in the total energy consumption in the Republic of North Macedonia, the Ministerial Council of the Energy Community set a 2020 target of 28% [4] (Table 1 and Diagram 1). The same diagram shows that the highest percentage share of 19.6% in North Macedonia was achieved in 2014.

Afterward, upon the request of the Government of RNM and by a Decision of the Ministerial Council of the Energy Community from 29 November 2018, the target of 28% was substituted with a target of 23% [1].

In order to achieve this target, and at the same time to develop RES in the period until 2020, the Government of the Republic of North Macedonia, through the Law on Energy [7] allows for the public, private or public-private partnership investments in RES. In this context, the electricity generation company ESM JSC will build a photovoltaic power plant in the mine of MPC Oslomej, with an installed capacity of 10 MW. This project will cost 7 million EUR [6], and it will be stimulated and supported by the EBRD securing a loan of 6 million EUR. In the future, there are plans to further build a second power plant with an installed capacity of 20 MW.

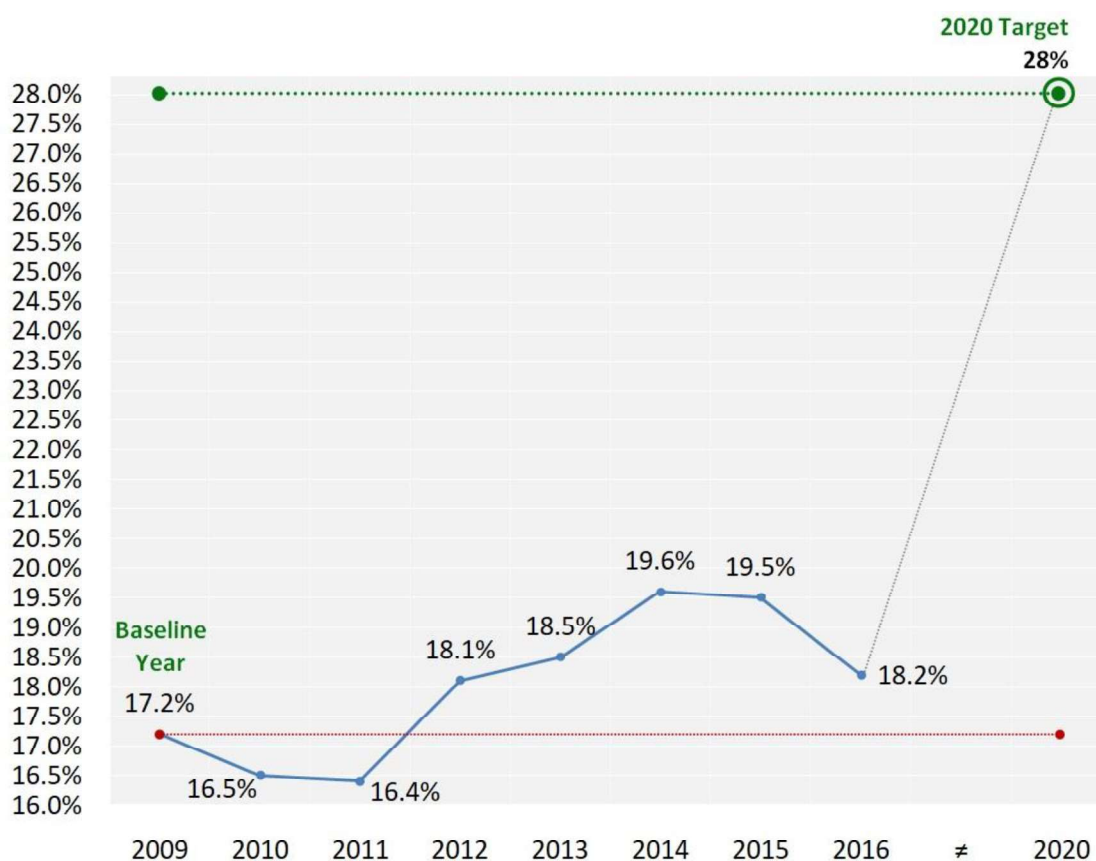


Figure 2. Shares of Energy from Renewables Sources

Source: Energy Community Secretariat, Annual Implementation Report, Vienna, (1 September 2018), p.109

## Conclusions

The detailed and practical processing of selected data and their analysis related to the electricity production and the share of RES in the gross consumption of final energy, along with the levels in the European Union and the Republic of North Macedonia, the following conclusion can be made:

Electricity production is still mainly based on conventional thermal sources, approx. 50%, and nuclear sources, 26%. RES contributes to 1/4 of the production.

The quantified European target of RES share in the gross consumption of final energy in 2016, was achieved by countries which mainly have the highest production of electricity from renewable energy sources.

To meet the quantified European target of RES share in the gross consumption of final energy, many member states of EU-28 should reduce, that is, substitute the electricity production from conventional, thermal and nuclear sources with RES.

Utilization of all possible sources for investments in the development of RES, to improve the results in the electricity production sector specifically and the development of the electric power system as a whole, and at the same time reducing the dependence of the country from import of electricity and reducing the trade deficit. All of this would directly contribute to the development of the domestic economy and the macroeconomic stability of the country in general.

Increasing the RES share in the electricity production, thus in the consumption of final energy, the Republic of North Macedonia will make a contribution to the global commitment for reduction of the greenhouse gasses and as a candidate country for accession to the EU, it will be part of these efforts and targets of the EU, although as a country it has no quantified commitments.

The Republic of North Macedonia should continue in the direction of meeting the obligations deriving from the Treaty Establishing the Energy Community, and referring to RES, competition, environment as well as energy efficiency.

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