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Professional paper

PRODUCTION OF ELECTRICITY AND RES IN THE EU-28 AND RNM

Imer Zenku

Faculty of Applied Sciences, University of Tetova, RNM
**Corresponding authore-mail: imer.zenku@unite.edu.mk*

Abstract

The topic elaborated in this paper is rather specific, important and relevant, due to the fact that 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, including and renewable energy sources (RES) in this production. Then continues with the participation of RESin gross electricity and final energy consumption, as well as the activities of the Government for the construction of photovoltaic power plants, which have a significant role and direct impact in approaching, reaching and achieving the determined targets for each individual 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 RES in gross electricity and final energy consumption. In the same context, the growing production and replacement of conventional and nuclear power generation with electricity from RES 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, electricity consumption, final energy consumption, renewable energy sources, European targets.

1 Introduction

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 gross electricity and final energy consumption, as well as their interconnection within the European Union and the Republic of North Macedonia. In this context, the analysis in this paper is summarized in four parts and lastly the paper ends with conclusions.

2 Share of different energy sources in the production of electricity in the EU-28

The share of electricity from conventional thermal energy sources in the production of electricity in EU-28 in 2017 was 48.3% that is 25.6% nuclear power, 10.3 % hydropower, 11.7% wind power, 4.0% solar power and 0.2% geothermal & other (Figure 1).

Regarding the electricity production in various countries, we will consider the EU-28 countries, Republic of North Macedonia and six other counties. Based on the data for 2017, given in Table 1, the order of the countries with large electricity production in EU-28 for 2017 is as follows: Germany (619.1 GWh), France (538.0 GWh), Great Britain (323.4 GWh), than Italy, Spain, Sweden, Poland, Norway, Holland, Belgium, Czech Republic, and finally Malta with (1.6 GWh). The total net electricity production in 2017, at the level of EU-28, amounts to 3138.0 GWh, while the total production of electricity in the countries from Table 1 amounts to 3635.9 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 2017 in the total net electricity production in EU-28, i.e. a share of (19.72%), (17.14%) and (10.30%), respectively.

Electricity from conventional thermal energy sources is produced in all counties, however the highest share between the EU-28 member states was observed in Estonia (92.9%), Cyprus (92.2%), Malta (91.7%), Poland (88.5%), Holland (85.7%), Greece (73.5%), Ireland (71.6%), Italy (70.0%) and the lowest was observed in France (11.9%). Outside of the EU-28, Turkey had a share of 69.5%.

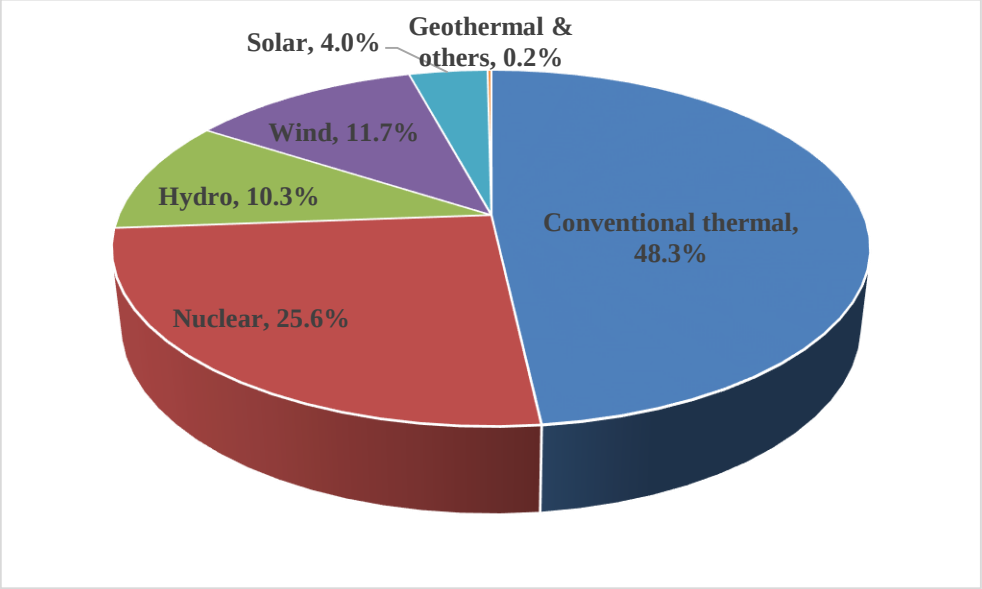

Figure 1. EU-28 electricity production by source, 2017 (in %) (Source:https://ec.europa.eu/eurostat/statistics explained/index.php/Electricity_generation_statistics_%E2%80%93_first_results#Production_of_electricity)

Electricity from nuclear sources is produced in 14 countries and the highest share between the EU-28 member states was observed in France (71.5%), Slovakia (56.4%), Belgium (49.9), Hungary (49.6%), Croatia (47.1%), Slovenia (39.1%), Bulgaria (36.1%), Finland (33.2%), Czech Republic (33.1%), whereas in Holland it was 2.9%.

Electricity from hydro power sources is produced in almost all countries and the highest share between the EU-28 member states was observed in Luxemburg (65.7%), Latvia (59.3%), Austria (57.8%), Lithuania (29.2%), Slovenia (26.8%), Romania (25.0%), Finland (22.5%) and at the end is Holland with 0.1%, while outside of the EU-28 countries there is Norway with a share of 95.8%.

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 (50.2%), Lithuania (34.0%), Ireland (25.3%), Portugal (21%), Germany (18.4%), Spain (18.2%), Great Britain (15.6%), Romania (12.7%), Luxembourg (10.9%), Greece (10.8%), and finally Croatia with 0.6%.

Electricity from solar energy sources is produced in almost all countries and the highest share between the EU-28 member states was observed in Italy (8.7%), Malta (8.3%), Greece (7.8%), Germany (6.9%), Spain (5.3%), Luxemburg (4.7%), Belgium and Great Britain (3.6%), Bulgaria and Cyprus (3.4%), Romania (3.2%) and finally Hungary with 1.1%.

Electricity from geothermal and other energy, the highest share between the EU-28 member states was observed in Lithuania (6.0%) and in Holland (1.9%), while outside of the EU-28 countries there is Turkey with a share of 3.6%.

Table 1. Shares of different sources in the production of electricity *(Source: https://ec.europa.eu/eurostat/statistics-explained/index.php/Electricity_generation_statistics_%E2%80%93_first_results#Production_of_electricity and http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=nrg_ind_335a&lang=en)*

	Net EP 2017	Share in EU-28 2017	Share of CTHP in EP 2017	Share of NP in EP 2017	Share of HP in EP 2017	Share of WP in EP 2017	Share of SP in EP 2017	Share of G&OP in EP 2017
Countries	1000 GWh	%	%	%	%	%	%	%
EU-28	3138.0		48.3	25.6	10.3	11.7	4.0	0.2
EA-19	2246.7	71.60	46.6	27.0	10.0	11.5	4.6	0.3
Belgium	82.9	2.64	37.0	49.9	1.7	7.7	3.6	0.1
Bulgaria	41.4	1.32	49.5	36.1	7.4	3.6	3.4	0.0
Czech R.	79.9	2.54	59.8	33.1	3.7	0.7	2.7	0.0
Denmark	29.6	0.94	47.1	/	0.0	50.2	2.7	0.0
Germany	619.1	19.72	58.1	12.5	3.9	18.4	6.9	0.2
Estonia	11.2	0.35	92.9	/	0.3	6.8	/	0.0
Ireland	30.1	0.95	71.6	/	3.1	25.3	/	0.0
Greece	50.6	1.61	73.5	/	7.9	10.8	7.8	0.0
Spain	264.9	8.44	47.5	21.2	7.8	18.2	5.3	0.0
France	538.0	17.14	11.9	71.5	10.2	4.6	1.7	0.1
Croatia	11.5	0.36	42.1	47.1	10.2	0.6	/	0.0
Italy	285.3	9.09	70.0	0.0	13.2	6.1	8.7	2.0
Cyprus	4.8	0.15	92.2	/	0.0	4.4	3.4	0.0
Latvia	3.0	0.09	38.7	/	59.3	2.0	/	0.0
Lithuania	4.0	0.12	29.2	0.0	29.2	34.0	1.6	6.0
Luxemb.	2.2	0.07	18.7	/	65.7	10.9	4.7	0.0
Hungary	30.6	0.97	46.2	49.6	0.7	2.4	1.1	0.0
Malta	1.6	0.05	91.7	/	/	/	8.3	0.0
Holland	113.5	3.61	85.7	2.9	0.1	9.4	/	1.9
Austria	67.7	2.15	31.9	/	57.8	8.5	1.7	0.1
Poland	154.9	4.93	88.5	/	2.0	9.4	/	0.1
Portugal	57.7	1.83	64.1	/	12.9	21.0	1.7	0.3
Romania	59.3	1.88	40.8	18.3	25.0	12.7	3.2	0.0
Slovenia	15.4	0.49	32.2	39.1	26.8	/	1.9	0.0
Slovakia	25.7	0.81	22.0	56.4	18.9	/	2.4	0.3
Finland	65.0	2.07	36.5	33.2	22.5	7.4	/	0.4
Sweden	160.5	5.11	/	/	/	/	/	/
United K.	323.4	10.30	59.2	20.1	1.5	15.6	3.6	0.0
Iceland	18.8	/	/	/	/	/	/	/
Norway	148.6	/	2.3	/	95.8	1.9		0.0
Monteneg.	2.3	/	/	/	/	/	/	/
N. Maced.	5.6	/	76.9	/	19.8	2.0	0.4	0.9
Albania	4.5	/	/	/	/	/	/	/
Serbia	34.3	/	/	/	/	/	/	/
Turkey	284.2	/	69.5	0.0	20.6	6.3	/	3.6

3 RES share in the gross electricity and final energy consumption in the EU-28

The participation of renewable energy in gross electricity consumption in the EU-28 grows year by year and that from 28.8% in 2015 to 30.7% in 2017 (Table 2). Also, higher level in 2017 among the member states, i.e. participation of over 50% was in following 5 countries: (72.2%) Austria, Sweden (65.9%), Denmark (60.4%), Latvia (54.4%), and Portugal (54.2%), while outside the EU-28 member states Albania participated with (90.7%) and Montenegro with (50.1%). This also has an effect on the fulfillment of the quantified share of renewable energy in gross final energy consumption in the EU-28 by 2020, whose countries have met or are close to achieving this objective.

Table 2. Share of RES in gross electricity and final energy consumption in the EU-28 (*Source:https://ec.europa.eu/eurostat/statisticsexplained/index.php/Renewable_energy_statistics#of_electricity_generated_come_from_renewable_sources*)

	Share of RES in GEC 2015	Share of RES in GEC 2016	Share of RES in GEC 2017	Share of RES in GFEC 2015	Share of RES in GFEC 2016	Share of RES in GFEC 2017	2020 Target	S_{2005}
Countries	%	%	%	%	%	%	%	%
EU-28	28.8	29.6	30.7	16.7	17.0	17.5	20.0	/
Belgium	15.5	15.8	17.2	7.9	8.6	9.1	13.0	2.2
Bulgaria	19.1	19.2	19.1	18.2	18.8	18.7	16.0	9.4
Czech R.	14.1	13.6	13.7	15.0	14.9	14.8	13.0	6.1
Denmark	51.4	53.9	60.4	31.4	32.6	35.8	30.0	17.0
Germany	30.8	32.2	34.4	14.9	14.9	15.5	18.0	5.8
Estonia	14.9	15.2	17.0	28.4	28.6	29.2	25.0	18.0
Ireland	25.5	26.8	30.1	9.1	9.3	10.7	16.0	3.1
Greece	22.1	22.7	24.5	15.4	15.1	16.3	18.0	6.9
Spain	37.0	36.6	36.3	16.2	17.4	17.5	20.0	8.7
France	18.8	19.2	19.9	15.2	15.9	16.3	23.0	10.3
Croatia	45.4	46.6	46.4	29.0	28.3	27.3	20.0	12.6
Italy	33.5	34.0	34.1	17.5	17.4	18.3	17.0	5.2
Cyprus	8.4	8.6	8.9	9.4	9.3	9.9	13.0	2.9
Latvia	52.2	51.3	54.4	37.5	37.1	39.0	40.0	32.6
Lithuania	15.5	16.9	18.3	25.8	25.6	25.8	23.0	15.0
Luxemb.	6.2	6.7	8.1	5.0	5.4	6.4	11.0	0.9
Hungary	7.3	7.3	7.5	14.4	14.3	13.3	13.0	4.3
Malta	4.3	5.7	6.6	5.1	6.2	7.2	10.0	0.0
Holland	11.0	12.5	13.8	5.7	5.9	6.6	14.0	2.4
Austria	70.6	73.3	72.2	32.8	33.0	32.6	34.0	23.3
Poland	13.4	13.4	13.1	11.7	11.3	10.9	15.0	7.2
Portugal	52.6	54.0	54.2	28.0	28.4	28.1	31.0	20.5
Romania	43.2	42.7	41.6	24.8	25.0	24.5	24.0	17.8
Slovenia	32.7	32.1	32.4	21.9	21.3	21.5	25.0	16.0
Slovakia	22.7	22.5	21.3	12.9	12.0	11.5	14.0	6.7
Finland	32.5	32.9	35.2	29.3	39.0	41.0	38.0	28.5
Sweden	65.8	64.9	65.9	53.6	53.8	54.5	49.0	39.8
United K.	22.3	24.6	28.1	8.4	9.2	10.2	15.0	1.3
Monteneg.	49.6	51.0	50.1	43.1	41.5	40.0	33.0	
N. Maced.	21.7	24.1	24.8	19.5	18.0	19.7	28.0	
Albania	79.2	86.0	90.7	34.4	37.1	34.6	38.0	
Serbia	28.9	29.2	28.7	21.9	21.0	20.6	27.0	
Turkey	33.2	34.8	35.1	13.6	13.7	13.2		
Kosovo	1.8	3.7	3.2	18.5	24.4	22.9	25	

The share of energy from renewable sources in the gross consumption of final energy in EU-28 is growing from year to year by 16.7% in 2015, reaching 2017 of 17.5% (Table 2). This is evidence of sustainable growth towards the Europe 2020 target of 20%. The same higher level in 2017 amongst the member states was observed in Sweden (54.5%), and Finland (41.0%), Latvia (39.0%), Denmark (35.8%), Austria (32.6%), Estonia (29.2%), Portugal (28.1%) and at the end Luxemburg, where a lower level of 6.4% was observed, while outside of the EU-28 countries Montenegro had a share of 40.0%.

In order 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 2017, it is necessary to increase the share for additional 2.5%. For the purposes of achieving the same target, 3 countries need to increase the share for less than 2.5%, compared to 2017, including Latvia 1.0%, Austria 1.4% and Greece 1.7%. The

following countries need a further increase of over 2.5% increase: Germany, Spain and Slovakia.The following 11 countries need to increase the share for more than 2.5%: Holland 7.4%, France 6.7%, Ireland 5.3%, United Kingdom 4.8%, Luxembourg 4.6% etc. The quantified target by 2020 was achieved by 11 countries in 2017. Amongst them the quantified target of 49.0%, 38.0%, 30.0%, 25.0% and 20.0% until 2020 was achieved by Sweden with 54.5%, Finland with 41.0%, Denmark with 35.8%, Estonia with 29.2% and Croatia with 27.3% respectively in 2017.

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 2017, the situation is as follows:

- From a total of 13 countries, where over 50% of the production is based on conventional thermal sources, however three have met the target.
- From a total of 2 countries, where over 50% of the production is based on nuclear sources, none have met the target.
- From a total of 5 countries, where over 50% of the production is based on RES, two have met the target.
- From a total of 8 other countries, whose joint production, based on conventional thermal and nuclear sources surpasses 50%, five have met the target.
- Sweden is also meeting its target, but there is no data on resources for electricity production.
- Montenegro as a country outside the EU-28 is meeting its target, but there is no data on resources for electricity production.

4 Share of different energy sources in the production of electricity in the RNM

Concerning the Republic of North Macedonia, the electricity production from conventional thermal sources in 2017 amounted to 4304 GWh, that is, 76.9% compared to the total domestic production of electricity, which amounted to 5600 GWh.

The production of electricity from hydro power sources amounted to 1110 GWh, i.e. 19.8%.

The production of electricity from wind power amounted to 110 GWh, i.e. 2.0%.

The production of electricity from solar power amounted to 24 GWh, i.e. 0.4%, while from biogas it amounted to 52 GWh, i.e. 0.9%, or in total 76 GWh i.e. 1.3% (Energy balance of the Republic of North Macedonia for 2019, 2018, 23)

5 RES share in the gross electricity and final energy consumption in the RNM

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 132.88 MW in 2019 (Energy Agency of the RNM, 2019). The Register of power plants for electricity generation from RES as of 20.03.2019 is given in Table 3.

Table 3. Register of power plants for electricity generation from RES (Source:http://www.ea.gov.mk/index.php?option=com_content&view=article&id=679&Itemid=124&lang=mk)

Power plant type	Solar FV	Small HPP	Wind power plants	Biogas	Total
Number of power plants	102	80	1	3	186
Total installed power (MW)	16.71	72.36	36.8	6.999	132.88
Planned annual production (MWh)	21.411	259.969	100.000	58.593	439.973

It is important to mention that the share of electricity from RES of over 23% in 2017 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 19.7% in the consumption of final energy.

The participation from renewable energy sources in the gross electricity consumption in the Republic of North Macedonia is growing year by year and is 21.7% in 2015, reaching 24.8% in 2017 (Table 2). This also has an effect on the fulfillment of the quantified participation of renewable energy in the gross final energy consumption in the Republic of North Macedonia by 2020, which rises throughout the country from year to year.

The participation of energy from renewable energy sources in the gross final energy consumption in the Republic of North Macedonia has been increasing year by year and by 19.5% in 2015, reaching a value of 19.7% in 2017 (Table 2). This is an evidence of a sustained progress towards the Europe 2020, with a target achievement of 20%.

Unlike the Strategy's forecast of 21.0% (MASA, 2010, 11) 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% (Energy Community Secretariat, 2018, 109) (Table 2).

Afterwards, 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% (Decision of the Ministerial Council of the Energy Community, 2018, 1). Hence, North Macedonia has a need to increase its share by 3.3% compared to 2017.

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 (Law on Energy, 2018) allows for public, private or public-private partnership investments in RES. In this context, the electricity generation company ESM JSC will build a photovoltaic power plant, located on the reinstated land covering a surface area of 15 ha in the mine of MPC Oslomej, with an installed capacity of 10 MW. This project will cost 7 million EUR (JSC ELEM, 2018, 32), and it will be stimulated and supporter by the EBRD securing a loan of 6 million EUR. The project is currently in the process of starting the construction by Girishim Electric - Turkey, with whom a Construction Contract has been signed on 28 November 2019, which was selected as the most favorable bidder, following the published international public call by ESM JSC in cooperation with EBRD on 26 March 2019, which was opened until 10 May 2019 (ELEM, 2018).

For the purpose of achieving the renewable energy targets in 2020, on 5 February 2019 the Government of North Macedonia made a Decision for the total installed capacity of photovoltaic power plants, for which premium should be awarded on produced and sold electricity, to be 200 MW (Government of the Republic of North Macedonia, 2019, 49). These premiums for the producers of electricity from photovoltaic power plants would be paid by the state, reducing it for the price charged to the supplier. Therefore, the market price depends on the electricity exchange while the amount of the premium would be determined by a negative auction.

Furthermore, in order to implement the governmental Decision, on 7 February 2019 the Minister of Economy made a decision to initiate a tender procedure with an auction, for the purpose of determining the total installed capacity of photovoltaic power plants for which based on this tender procedure a premium

of 35 MW is awarded for plants that should be constructed in the municipalities of: Sveti Nikole with a planned surface area od approx. 49 ha for installed capacity of 25 MW and Makedonski Brod with a planned surface area od approx. 21,3 ha for installed capacity of 10 MW.

Therefore, on 10 June 2019 the Ministry of Economy announced a public call with a deadline for submission of offers until 21.08.2019(Ministry of Economy, 2019, 1-6).

For the construction of the 11 photovoltaic plants, 10 in Sveti Nikole and one in Makedonski Brod, the Government of the Republic of North Macedonia on 29 January 2020 signed contracts with 9 private companies.

On 31.07.2019, the Ministry of Economy also announced a public announcement with a deadline for submission of offers until 02.10.2019, for awarding premiums for electricity produced from photovoltaic power plants built on private land with total installed capacity of 27 MW (Ministry of Economy, 2019a, 3-9).

The procedure for signing the Contracts for the construction of these photovoltaic power plants is ongoing and 43 bids have been submitted for the construction of 108 public facilities in over 40 municipalities.

The criteria for selection of the best offer in both cases for construction of photovoltaic power plants for construction on public and private land will be the lowest offered fixed premium.

Otherwise, an ongoing procedure is the public calling for pre-qualification of AD ESM for expansion of the Bogdanci II Phase wind park with new 3-4 windmills and 13.2-15 MW wind capacity. The public calling was announced on January 29, 2020, in two LOTs with a deadline for companies interested in building the project by March 2, 2020 (JSC ESM, 2020a).

To achieve the goal of total installed capacity of photovoltaic power plants of 200 MW, AD ESM-Skopje on February 11, 2020 issued a public calling for a construction through public-private partnership, of 100 MW photovoltaic power plant in the wasted area of the coal mine of REK Oslomej, ie two 50 MW photovoltaic power plants, with a deadline for offer submission until May 08, 2020. The criteria for selecting the best offer will be a private partner, who will pay ESM a higher percentage of the energy sold per year according to the HUPX regional stock exchange (JSC ESM, 2020, 1-4).

Undoubtedly, with the cessation of TPP Oslomej operation and the replacement of the production electricity from conventional thermal sources with renewable energy sources through photovoltaic plants, will significantly increase the production of electricity from these sources, and thus the participation of renewable energy sources in final energy consumption.

To increase electricity production from renewable energy sources and thereby gradually replace production from conventional thermal sources, the Government on February 19, 2020 issued a public calling to participate in the pre-qualification for allocating the concession of constructing the Chebren hydroelectric power plant through public-private partnership, with a deadline for offer submissions until April 03, 2020 (Republic of North Macedonia, 2020, 1-3).

6 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 contribute to ¼ of the production.

- The quantified European target of RES share in the gross consumption of final energy in 2017 was achieved by countries which mainly have the highest production of electricity from renewable energy sources.
- In order 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.
- The Republic of North Macedonia, as a candidate country for EU membership, is making efforts to build renewable energy facilities for the production of electricity from RES, thereby replacing the production of conventional thermal sources and at the same time reducing greenhouse gas emissions.
- Utilization of all possible sources for investments in the development of RES, with the intention of improving 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.
- With the increased share of RES in electricity generation and thus in final energy consumption, the Republic of North Macedonia is included in the EU efforts and objectives to meet the quantified obligation of 23% share of renewable energy in gross electricity consumption. The final energy by 2020.
- 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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