Energy Indicators in the Context of Globalization

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Abstract. Globalization leads to new challenges. There is a trend of growth of the population. At the same time, production processes are subject to changes. If the new technologies are based on environmental protection, then we can also be considered that the greenhouse gas emissions will be reduced. As energy requirements are rising, it is important to efficient use of natural resources. This, especially, as energy sources differ from one country to another. In this context, dependence on energy imports becomes important. From this point of view, for the countries of the European Union, the article analyzes the evolution of energy efficiency. In recent years, it trying to replace fossil fuels with renewable fuels. Analyzing the share of energy from renewable sources in total electricity allows us to observe the degree of decarbonisation of the European Union economy. The use of energy from renewable sources allows the development of green technologies and contributes to the protection of the environment. Producing of the energy in a region and transporting it to another region creates bridges and contributes to globalization. Thus, in the process of globalization, the role of energy is increasingly important. The article presents a European analysis of gross and net electricity production.

1 Introduction

One of the current challenges is to use as high share of clean and sustainable energy [1]. However, fossil fuels are used in a high percentage [2]. It is estimated that, in 2060, the share of renewable energy will be around 75% of total world electricity production [3]. Bear in mind that often the functioning of the electricity production from renewable sources is influenced by weather conditions [4].

Even if we are talking about renewable energy from traditional biomass and hydropower resources or if we are talking about modern renewable energy based on geothermal, wind and solar energy, energy services lead to more flexible production and autonomy of consumption. In addition, the benefits for both individuals and their communities are related to job security and income [5].

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In the last decade of the 20th century and the first decade of the 21st century, although fossil fuel prices were lower than those for renewable energy, energy consumption based on renewable energy increased [6]. Thus, energy services have made it possible to reduce carbon dioxide emissions, as well as to customize energy technologies. In many countries, revenue increases have been observed based on the replacement of fossil fuels with renewable energy. At the same time, this was accompanied by a reduction in carbon dioxide emissions [5].

The implementation of new energy models leads to the emergence of regional electricity markets. One such example is the Iberian Electricity Market (Mibel). Through a common electricity market, both consumers in Spain and Portugal have access to electricity under equivalent conditions [7]. Another example can be given by generating electricity in the Drina Basin. In this case, cross-border collaboration on hydro-electric power has increased, interconnections between countries have increased and energy efficiency measures have been implemented [8].

World population growth, industrialization and economic growth, lead to structural and lifestyle changes in the urban and rural populations [9]. Thus, in addition to increasing energy consumption, consumer areas also change [10].

2 Methods

Through this article, an analysis was made of the comparative situation of gross and net electricity production for the year 2008, respectively for the year 2017, in the member countries of the European Union. It also presents the structure of the share of energy resources in the gross electricity production corresponding to 2017. The energy efficiency indicator is analyzed by monitoring the progress in 2017 compared to 2008 for primary energy consumption, respectively for final energy consumption. In the second part, the evolution of the share of renewable energy in gross final energy consumption for renewable energy sources in transport, electricity, heating and cooling is presented.

3 Results and Discussion

The Europe 2020 Strategy has set energy efficiency targets [11]. Thus, by 2020, the EU wants to reduce energy consumption by about 20%. The demand for energy is quite high [12]. Thus, decreasing consumption as well as renewable sources can form the basis of the energy transition [13]. Regarding energy use, energy transitions will have an impact both on the local environment and on the economy [14] as well as on human development [15].

From the comparative situation presented in Table 1, it is noted that in 2017 gross electricity production was raised in: Germany (596.959 GWh), France (541.579,394 GWh), Italy (276.048,398 GWh), Spain (239.698 GWh). Countries where gross electricity production was low in 2017 are: Malta (1.479,476 GWh), Luxembourg (1.956,871 GWh), Lithuania (3.361,1 GWh), Cyprus (4.896,404 GWh), Latvia (7.336,933 GWh). Compared to 2008, in 2017, the highest increases were recorded in Latvia (+ 41,12%), Portugal (+ 27,71%), Estonia (+ 22,12%), Sweden (+10,08 %). At the same time, compared to 2008, the most significant decreases in gross electricity production in 2017 are recorded in Lithuania (-75,03%), Luxembourg (-41,09%), Malta (-36,01 %), Hungary (-20,25%). The situation is similar for net electricity production.

Table 1. Gross and net electricity production - comparative situation, 2008-2017 (GWh)

Countries	Gross electricity production		Net electricity production	
	2008	2017	2008	2017
European Union	3.130.104,693	2.998.424,809	2.973.045,785	2.852.579,730
Austria	57.926,114	63.109,672	54.680,353	59.893,933
Belgium	82.053,000	75.166,100	78.683,000	71.830,400
Bulgaria	44.166,000	44.925,176	39.957,000	40.765,454
Croatia	12.426,000	11.563,700	11.933,000	11.123,900
Cyprus	4.997,637	4.896,404	4.729,637	4.670,319
Czechia	73.959,000	77.938,740	68.399,000	71.731,224
Denmark	34.319,000	28.198,715	32.555,000	26.813,091
Estonia	10.468,000	12.783,685	9.397,000	11.133,000
Finland	65.308,000	57.690,000	62.871,000	55.688,000
France	554.117,900	541.579,394	529.818,831	518.248,851
Germany	591.008,000	596.959,000	555.428,000	566.281,000
Greece	62.438,000	53.332,980	58.118,000	48.911,464
Hungary	39.643,000	31.616,000	37.026,000	29.503,000
Ireland	28.360,025	28.670,582	27.095,993	27.950,280
Italy	300.365,000	276.048,398	289.204,127	266.124,512
Latvia	5.199,000	7.336,933	4.833,000	6.839,190
Lithuania	13.462,000	3.361,100	12.381,000	3.214,500
Luxembourg	3.367,896	1.956,871	3.327,771	1.926,542
Malta	2.312,000	1.479,476	2.185,000	1.430,156
Netherlands	85.495,073	92.218,951	82.276,073	89.217,930
Poland	148.564,000	158.553,598	135.157,000	143.854,239
Portugal	39.932,048	50.995,738	38.542,000	49.232,995
Romania	62.060,000	57.282,522	57.593,000	52.637,838
Slovakia	26.210,000	24.646,000	24.014,000	23.079,000
Slovenia	15.860,000	15.594,811	14.845,000	14.693,119
Spain	275.858,000	239.698,000	265.563,000	230.065,000
Sweden	143.566,000	158.035,000	140.150,000	154.529,000
United Kingdom	346.664,000	282.787,263	332.283,000	271.191,793

Depending on the type of fuel used, the gross electricity production structure for the European Union in 2017 is shown in Figure 1 (%). It is noted that the most used resources are: combustible fuels (46,233%), nuclear fuels and other fuels n.e.c. (27,672%), wind (11,686%), hydro (10,846%). Combustible fuels are most used in: Germany (348.810 GWh), Italy (189.673,731 GWh), United Kingdom (161.416,285 GWh), Poland (140.614,172 GWh). Hydro is predominantly used in: Sweden (65.156 GWh), France (54.553,994 GWh), Austria (41.773,288 GWh), Italy (37.535,978 GWh).

Economic development involves increasing consumption, including the consumption of resources needed to produce electricity. This has led to the depletion of fossil fuel resources. So, they raise the requirements for clean energies that use renewable sources. Geothermal energy is an example of a renewable source used more and more often lately. Their advantage is given by their continued availability. Thus, carbon dioxide emissions can be reduced [16, 17]. Countries where geothermal energy is most used are: Italy (6.201,159 GWh), Portugal (216,659 GWh), Germany (163 GWh), France (124,539 GWh).

The use of wind and solar energy and the growth of renewable energy sources with low carbon emissions allow the mitigation of the effects of climate change [18]. Wind is used to

generate electricity in: Germany (105.693 GWh), Spain (49.115 GWh), United Kingdom (41.005,751 GWh), France (23.032,706 GWh).

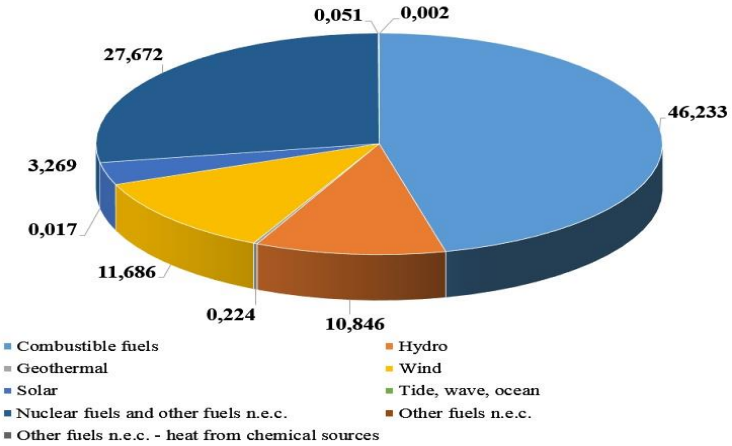

Fig. 1. Share of energy resources in gross electricity production, 2017 (%)

With regard to solar photovoltaic panels, their cost has decreased in recent years. Under these circumstances, the interest of local communities in energy generation and consumption has also increased. Solar power production is achieved in: Germany (39.401 GWh), Italy (24.377,711 GWh), Spain (14.364 GWh), and with tide, wave, ocean in France (521,706 GWh). Nuclear fuels and other fuels n.e.c. are used to produce electricity in: France (398.359,129 GWh), Germany (76.324 GWh), United Kingdom (70.336,426 GWh), Sweden (65.696 GWh), Spain (58.039 GWh). Using other fuels n.e.c. (not elsewhere classified) is carried out in: Germany (585 GWh), Italy (517,910 GWh), France (254,693 GWh), and in Sweden (51 GWh) other fuels n.e.c. - heat from chemical sources are used.

Combating the effects of global warming can also be achieved by using renewable energies. Such a renewable technology is biogas. It can be used both for the production of electricity and for the removal of carbon dioxide [19].

Technology improvement allowed global renewable energy costs to be lower than for fossil fuels [20]. Energy efficiency measures have led to a reduction in the pressure on primary energy supplies. Also, the production of hydropower plants could be improved by better cooperation in the operation of hydropower plants [8]. Thus, for the energy efficiency indicator, the monitoring of the progress achieved in 2017 compared to 2008 for primary energy consumption and final energy consumption respectively is shown in the table below, in million tonnes of oil equivalent (Mtoe).

From the data presented at the level of the European Union, the descending trend is observed. Thus, the most significant decreases for primary energy consumption were recorded in: United Kingdom (-34,98%), Italy (-27,17%), Germany (-18,79%), France (-15,87 %), Spain (-8,81%), Greece (-7,19%). For final energy consumption, significant decreases were in: Italy (-19,09%), United Kingdom (-14,94%), Spain (-10,50%), France (-6,92%), Greece -4,62%).

One of the sectors using fossil fuels is the transport sector. A strong impact on the reduction of carbon dioxide emissions may be in electric vehicles and hybrid systems (Razmjooa & Sumpera, 2019). Analyzing the comparative situation presented in Table 3, it is noted that in 2017 compared to 2004, renewable energy sources in transport increased significantly for: Ireland (7,394%), France (7,666%), Portugal (7,51%), Finland (17,815%), Sweden (25,825%). In 2017, the highest values were recorded in Sweden (32,112%), Finland (18,825%), Austria (9,74%), France (9,141%), Portugal (7,934%).

Table 2. Comparative situation primary-final energy consumption (Mtoe)

Countries	Primary energy consumption		Final energy consumption	
	2008	2017	2008	2017
European Union	1.696,86	1.561,59	1.180,27	1.122,77
Austria	32,09	32,55	27,32	28,42
Belgium	51,13	49,12	37,00	36,05
Bulgaria	19,02	18,33	9,98	9,89
Croatia	9,20	8,33	7,40	6,92
Cyprus	2,85	2,52	1,97	1,85
Czechia	42,51	40,36	26,09	25,49
Denmark	19,90	17,74	15,53	14,62
Estonia	5,36	5,64	3,10	2,87
Finland	34,57	31,93	25,70	25,29
France	255,39	239,52	155,87	148,95
Germany	317,10	298,31	218,05	218,71
Greece	30,31	23,12	21,37	16,75
Hungary	25,16	24,48	17,44	18,51
Ireland	15,63	14,41	13,36	11,76
Italy	176,12	148,95	134,28	115,19
Latvia	4,58	4,47	4,15	4,01
Lithuania	8,26	6,16	5,13	5,35
Luxembourg	4,61	4,30	4,38	4,18
Malta	0,96	0,81	0,50	0,63
Netherlands	69,89	64,54	53,92	50,34
Poland	93,09	99,11	62,40	70,92
Portugal	23,59	22,79	18,40	16,56
Romania	37,32	32,37	24,68	23,21
Slovakia	16,98	16,15	11,45	11,13
Slovenia	7,49	6,64	5,27	4,86
Spain	134,44	125,63	94,83	84,33
Sweden	47,52	46,48	32,39	32,64
United Kingdom	211,80	176,82	148,29	133,35

Renewable energy sources in electricity increased significantly for: Denmark (36,602%), Germany (25,033%), Ireland (24,059%), Italy (18,018%), Portugal (26,778%), United Kingdom (24,58%). In 2017, the highest values were recorded in: Austria (72,173%), Sweden (65,885%), Denmark (60,356%), Latvia (54,357%), Portugal (54,168%). Major increases for renewable energy sources in heating and cooling were registered in: Denmark (25,906%), Estonia (18,423%), Malta (18,798%), Sweden (22,437%).

Table 3. Comparative situation of share of renewable energy in gross final energy consumption by sector (%)

Countries	Renewable energy sources in transport		Renewable energy sources in electricity		Renewable energy sources in heating and cooling	
	2004	2017	2004	2017	2004	2017
European Union	1,390	7,386	14,299	30,747	10,405	19,484
Austria	4,533	9,740	61,625	72,173	20,165	32,050
Belgium	0,526	6,576	1,688	17,237	2,846	8,032
Bulgaria	0,876	7,244	9,095	19,117	14,056	29,901
Croatia	0,993	1,181	35,026	46,415	29,439	36,546
Cyprus	0	2,571	0,011	8,905	9,264	24,491
Czechia	1,570	6,580	3,693	13,654	9,930	19,654
Denmark	0,445	6,847	23,754	60,356	20,642	46,548
Estonia	0,181	0,405	0,470	17,027	33,222	51,645
Finland	1,010	18,825	26,711	35,221	39,504	54,849
France	1,475	9,141	13,782	19,907	12,524	21,349
Germany	2,212	7,034	9,372	34,405	7,147	13,423
Greece	0,078	1,804	7,842	24,473	12,774	26,569
Hungary	0,917	6,806	2,220	7,485	6,450	19,642
Ireland	0,040	7,434	6,031	30,09	2,873	6,863
Italy	1,213	6,484	16,086	34,104	5,713	20,083
Latvia	2,139	2,544	45,958	54,357	42,488	54,584
Lithuania	0,410	3,689	3,587	18,254	30,446	46,499
Luxembourg	0,126	6,435	2,765	8,054	1,829	8,112
Malta	0	6,797	0	6,585	1,035	19,833
Netherlands	0,464	5,912	4,447	13,804	2,210	5,928
Poland	1,441	4,203	2,209	13,089	10,207	14,485
Portugal	0,424	7,934	27,390	54,168	32,504	34,391
Romania	1,600	6,558	24,968	41,634	17,337	26,581
Slovakia	1,459	7,026	15,403	21,343	5,062	9,837
Slovenia	0,850	2,738	29,271	32,427	18,361	33,245
Spain	1,034	5,917	18,981	36,339	9,497	17,523
Sweden	6,287	32,112	51,181	65,885	46,63	69,067
United Kingdom	0,346	5,05	3,531	28,111	0,728	7,454

4 Conclusion

Solutions for managing and storing energy produced by solar photovoltaic panels can reduce dependence on a particular network.

The analysis shows a downward trend in gross and net electricity production. It has also been found that the most used resources are: combustible fuels, nuclear fuels and other fuels n.e.c., wind and hydro. At the same time, the evolution of the share of renewable energy in gross final energy consumption shows a growth trend due to the attention given to renewable energy sources.

The transition to sustainable energy requires tackling those low-carbon energy sources. Measures against environmental damage are therefore needed. In this way, renewable energies can diminish the negative impact of climate change [21].

Worldwide, the rural-urban distribution of the population shows a higher share of the urban area [22]. Thus, the energy supply of local communities becomes an increasingly

important issue. Another important aspect is the degree to which a community has access to energy systems and at what cost. Limited access and high energy costs affect the education and health of members of a community [20].

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