

EU RENEWABLE ENERGY POLICY FOR SMART CITIES

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Abstract: *The European Union energy policy has been more and more focused on how to become more friendly with the environment and looked for efficient measures to assure the protection of the environment and for sustain the development of the cities through participatory governance: human capital, communication infrastructure (including informational communication systems), economic growth and high quality of life. Because the energy sector has the biggest share of total Greenhouse gas emissions (GHGs), the attention was directed to this sector. Although the EU member states claim that they support the transition from fossil fuels to renewable energy, it is important to see concrete actions into achieving this goal. Our study is structured in two parts: the first one, that includes an analysis of main energy indicators like energy production, energy consumption and share of renewable energy sources (RES) in gross final consumption, based on data available on Eurostat for 2019 and a second part that includes an analysis of the future perspectives and the goals of the EU Member States according to their National Energy and Climate Plans (NECP). The results show that the energy policy is a major factor that has great impact on the development of the smart cities, creating the added value for society.*

Keywords: *smart cities, EU energy policy, innovation, strategy*

Introduction

Smart city is a very dynamic concept that implies the development of the communities using creativity and innovation as a main tool. Using the innovative technologies and artificial intelligence and being oriented for increasing the quality of life of the citizens, the smart city is one of the key concepts for the European policies (European Commission, 2015). The urban development trend is present in European Union and the challenges are to respond to the clean energy policy during the urbanisation process. In this process, the cities are important energy consumers, and the EU energy policy follows to limit the negative effects of the gases emissions through innovative solutions.

Smart city is related to the digital technologies for facilitating the development of the communities and for sustaining the growth of the economies (Bakici et al., 2013). The new energy policies are meant to improve the smart city given the other dimensions of the EU policy and strategies.

Our study is meant to present an analysis of the current situation and future perspectives on the energy sector among the EU member states. The energy policy of the European Union is described by Solorio and Jorgens (Solorio & Jorgens, 2017:4) as a 'set

of policy instruments developed at the European level to promote RES between the member states', to achieve the EU's 2030 goals on Greenhouse gas emissions (GHGs). The study is divided into two parts: a first one which includes the analysis of energy production and consumption among the EU member states and the share of renewable energy in gross final consumption in 2019 and their 2030 target and a second part which includes a series of public policy decisions adopted by the EU members to reach the 2030 target.

The subject of decarbonisation was put in the spotlight by the European Union in recent years, as observed by Simionescu, Strielkowski and Tvaronavičienė (Simionescu et al., 2020). One of the main reasons why EU chose to give such attention to the subject of reducing the pollution was exposed by Pablo del Río (Del Río, 2011) and is represented by the fact that more than one third of the total GHGs emissions were produced by power generation. Another important fact was illustrated and confirmed by Ranjula Bali Swain and Amin Karimu (Swain and Karimu, 2020) is that there is a link between the renewable energy, especially used when producing electricity, and carbon dioxide emissions reduction.

According to data available on Eurostat (European Commission, 2021), the GHGs emissions generated by the energy sector represented, in 2019, 76.66% of total GHGs emissions excluding LULUCF. This data represents the motivation for the EU member states to seek for and implement efficient decisions in the energy sector to reduce the air pollution. Thus, the European Union has to find and implement new and less pollutive ways to produce energy and, specially, to generate electricity, but also to reduce the allarming amounts if GHGs emissions generated in the atmosphere. Furthermore, the EU member states need to strive to assure the succes of these measures, meaning that they must set realistic goals and formulate energy policy decisions in accordance with these goals.

Methodology

The question that the present research seeks to answer is “are the EU and its member states able to fulfil their energy and climate objectives set for 2030 and 2050?”. The specific objectives of the current study are:

O1: To analyse the data on energy production, energy consumption and share of renewable sources in gross inland consumption registered among the EU member states in 2019.

O2: To analyse the EU member states' National Energy and Climate Plan, the main objectives set for 2030 and the deficiencies of their energy sectors.

O3: To make proposals to improve the energy sectors of member states to ensure that the EU's 2030 and 2050 targets are met.

For the present study there have been used both quantitative information represented by primary energy production, gross inland consumption and share of renewable energy sources in gross inland consumption from Eurostat database, and qualitative information represented by energy policy decisions implemented by the EU member states, to reveal the EU states' perspective on the energy sectors and its future.

ANALYSIS AND RESULTS

The main data used to reveal the intensity of the energetic activity of the EU member states were the energy production and the energy consumption. In 2019 the energy production among the EU member states is exposed into table 1, in descending order.

Table 1. Primary energy production on EU member states in 2019

No.	EU member state	energy production (thousand tonnes of oil equivalent)
1	France	133 920.169
2	Germany	105 426.218
3	Poland	59 345.211
4	Sweden	37 019.097
5	Italy	36 909.779
6	Spain	34 981.684
7	Netherlands	33 116.152
8	Czech Republic	26 597.965
9	Romania	24 529.894
10	Finland	19 268.926
11	Belgium	15 946.835
12	Denmark	12 509.911
13	Austria	12 359.595
14	Bulgaria	11 692.964
15	Hungary	10 785.730
16	Slovakia	6 939.977
17	Portugal	6 561.130
18	Greece	6 367.193
19	Estonia	4 909.228
20	Ireland	4 134.830
21	Croatia	3 900.369
22	Slovenia	3 378.696
23	Latvia	2 826.912
24	Lithuania	2 039.440
25	Luxemburg	232.365
26	Cyprus	208.337
27	Malta	38.004

Source: European Commission, Eurostat. Retrieved from <https://ec.europa.eu/eurostat/databrowser/bookmark/f7dab7c0-f2d5-414d-af86-17a36fc437b5?lang=en>

From the data exposed in the table above, it turns out that among the EU member state that has the biggest energy production is France, one of the founding states of the European Union. At the end of the table there are member states with little surface and population, which means the energy requirement is lower than in the other states of the Union.

On the other side, the energy consumption among the EU states registered in 2019 can be observed in the following table 2.

Table 2. Gross inland energy consumption on EU member states in 2019

No.	EU member state	Gross inland energy consumption (thousand tonnes of oil equivalent)
1	Germany	305 605.530
2	France	251 417.892
3	Italy	155 432.667
4	Spain	126 969.978
5	Poland	103 968.829
6	Netherlands	75 932.100
7	Belgium	56 777.208
8	Sweden	49 703.985
9	Czech Republic	42 995.792
10	Austria	34 698.218
11	Finland	34 234.932
12	Romania	33 107.423
13	Hungary	26 708.150
14	Portugal	23 914.607
15	Greece	23 551.592
16	Bulgaria	18 847.668
17	Denmark	17 313.653
18	Slovakia	17 023.933
19	Ireland	14 955.497
20	Croatia	8 790.716
21	Lithuania	7 800.523
22	Slovenia	6 721.680
23	Estonia	4 824.124
24	Latvia	4 649.810
25	Luxemburg	4 539.717
26	Cyprus	2 630.367
27	Malta	903.139

Source: *European Commission, Eurostat. Retrieved from <https://ec.europa.eu/eurostat/databrowser/bookmark/766dbc70-6525-41da-b22a-3619e558379f?lang=en>*

The biggest energy consumer is Germany, also one of the founding states of the European Union. At the end of the table there can be found the same three states that registered the lowest energy production. Nowadays the analysis of the energy sector of a state only through the production and the consumption of energy can be hallow. The energy sector's impact on the environment has become so big that EU member states started to pay more attention on different indicators, like the share of renewable sources (RES) in gross inland consumption. This indicator reveals the quantity of energy consumed by a state which has been produced with renewable, eco-friendly sources. Among the EU

member states, the share of RES in gross inland consumption reached values according with data from table 3.

Table 3. Share of renewable energy in gross final energy consumption on EU member states in 2019 and 2020 target

No.	Eu member state	share of renewable energy in gross final energy consumption in 2019 (%)	2020 target (%)
1	Sweden	56.931	49
2	Finland	43.081	38
3	Latvia	40.975	40
4	Denmark	37.204	30
5	Austria	33.626	34
6	Estonia	31.889	25
7	Portugal	30.619	31
8	Croatia	28.466	20
9	Lithuania	25.461	23
10	Romania	24.290	24
11	Slovenia	21.974	25
12	Bulgaria	21.564	16
13	Greece	19.667	18
14	Spain	18.356	20
15	Italy	18.181	17
16	Germany	17.354	18
17	France	17.216	23
18	Slovakia	16.894	14
19	Czechia	16.244	13
20	Cyprus	13.800	13
21	Hungary	12.614	13
22	Poland	12.164	15
23	Ireland	11.984	16
24	Belgium	9.924	13
25	Netherlands	8.768	14
26	Malta	8.488	10
27	Luxembourg	7.047	11
	EU 27 Average	19.729	20

Source: *European Commission, Eurostat. Retrieved from <https://ec.europa.eu/eurostat/databrowser/bookmark/766dbc70-6525-41da-b22a-3619e558379f?lang=en>*

France, the biggest energy producer of EU and Germany, the biggest energy consumer have, according to these two indicators, intense activity in the energy sector, but the problem is the way they produce these big amounts of energy they need. According to the data in Table 3, in 2019 Germany was the 16th member state and France is the 17th EU

member regarding the share of RES in gross inland consumption and nor France nor Germany managed to achieve the 2020 goal. Even if these two states have similar share of RES, the 2020 goal is different: Germany's goal is to achieve 18% but France's goal is bigger and reaches 23% share of RES. As observed above, there are common elements about these two states' energy policy, but there are also differences that make every state's energy policy unique. This situation is encountered into the entire European Union, and this is the reason why it is harder for the EU to achieve its energy and climate objectives.

All the EU member states elaborated in 2019 and 2020 a National Energy and Climate Plan (NECP) which include objectives and targets, but also policies and measures meant to develop a less pollutive and more efficient energy sector. The framework is common for all the member states, meaning that national objectives and targets and also the policies and measures are explained through five dimensions:

- Dimension decarbonization
- Dimension energy efficiency
- Dimension energy security
- Dimension internal energy market
- Dimension research, innovation, and competitiveness.

For this study, there will be used information referring the first two dimensions of the NECPs of the member states.

The first dimension, the one called decarbonization, is the dimension which states that all the EU members must find and implement efficient measures and policies to reduce the greenhouse gases (GHGs) emissions. GHGs emissions is usually measured as part of the level of their gas emissions registered in 1990 and few of the EU states have settled the reduction of the emissions as follows: France (Gouvernement de la Republique francaise, 2020: 6) set a reduction of 40%, Germany (German Government, 2020: 11) set a reduction of 55%, Sweden (The Minsitry of Infrastructure, 2020: 5) has set its emission goal for 2045, but it is more ambitious than France's or Germany's goals, because it wants its emissions to represent 15% of the 1990 level.

States from the middle of the production ranking like Romania, Finland, Belgium, Denmark have also set objectives for the future: Romania (Ministry of Environment, 2020, 11) set a reduction of 40% by 2030, compared to the level from 1990. Finland (Ministry of Economic Affairs and Employment, 2019: 16) set a reduction of 39% compared to 2005. Belgium (Federal Government of Belgium, 2019: 13) set a goal to reduce the emission by 35% by 2030 compared with the 2005 levels of the emissions. Denmark (Danish Ministry of Climate, Energy and Utilities, 2019: 6), the last of the four member states from the middle of the production ranking, wants to reduce its GHGs emissions by 70% by 2030, compared to the 1990 level.

At the bottom of the production ranking can be found member states like Luxembourg, Cyprus and Malta. Luxembourg's goal for 2030 (Le Gouvernement de Luxembourg, n.d.: 9) is to reduce its GHGs emissions with 55% compared to the 2005 level. Cyprus (Ministry of Energy, Commerce, and Industry, 2020: 16) and Malta (The Energy and Water Agency, 2019: 14) don't have a specific goal set for 2030 and they follow the collective EU's target of 40% GHGs emissions reduction by the year 2030 compared to the levels registered in 1990. The data above reveals the fact that not all the member states have specific objectives to reduce pollution, and they choose to put only enough effort to support the EU's collective objective for 2030.

The EU states with more intense activity in the energy sector have set ambitious goals for 2030, meaning that these states assumed that they will radically change the GHGs emissions situation. All the EU member states mentioned above in the NECPs analysis on objectives for pollution reduction, except for Luxembourg, Cyprus, and Malta, have set very ambitious objectives. The biggest goal is Sweden's, which stated that it will reach an 85% reduction of GHGs emissions compared to 1990. Romania has the lowest percentage of reduction between these seven states, but it is not the same situation as could be observed in Cyprus and Malta. The 40% reduction is a specific objective mentioned in Romania's NECP and it is not just a statement that claims support for EU's collective target. Even if these percentages seem ambitious and they seem to ease the achievement of the EU's 40% reduction, it is important to see if these member states' percentages are realistic. For this, it is necessary to correlate the data from the analysis that was made above with the share of RES in gross inland consumption among the EU states.

According to Eurostat (European Commission, 2018), the energy producing industries registered in 2018 the largest share of GHGs emissions, more specifically 28% of the total GHGs emission came from this sector. The energy producing sector is followed by fuel combustion by users with 25.5% and the transport sector with 24.6%. The fact that the energy producing sector has a relevant impact on air pollution has determined the EU member states pay special attention not only to the levels of GHGs emission, but also to the source of these emissions. As it could have been observed above, the EU member states have set goals to reach in 2030, 2045 or even in 2050 regarding the GHGs emissions. These states also set goals for the future regarding the share of RES in consumption. The analysis of the current situation of the share of RES correlated with the future perspectives will support the current study in understanding if the EU states have set realistic goals or those objectives will never be achieved.

Further, the study will continue with the analysis of the same 10 EU member states as above, trying to extract different types of behavior in the energy sector.

The first EU member states mentioned before were France and Germany, the biggest energy producer and the biggest energy consumer respectively. The fact that they need big energy supplies can be an obstacle on their way to produce cleaner energy, because the transition from fossil fuels to RES involves more effort and financial resources. In France's case, the data from Table 3 shows that France registered a 17.22% share of RES in 2019 and set a goal to reach 23% share of RES by 2020. By 2030, France's goal is to reach 33% share of RES (Gouvernement de la Republique francaise, 2020: 8) in gross final energy consumption. Germany, the second biggest energy producer, had 17.35% share of RES in 2019 and an 18% goal for 2020. Its goal for 2030 (German Government, 2020: 11) is to achieve 30% share of RES in gross final energy consumption. Sweden has a unique situation among the EU member states and can be considered a positive model regarding the transition to renewable sources. With 56.93% share of RES in gross final energy consumption in 2019, Sweden is the biggest EU renewable energy consumer. Its 2020 target is 49% share of RES, a goal obviously achieved from 2019. Surprisingly, in its NECP is mentioned that it "has no national targets for the share of renewable energy in 2030" (The Ministry of Infrastructure, 2020: 19) but according to the same document, The Swedish Energy Agency realised a scenario where the target for 2030 is set to 65% share of RES in gross energy consumption. Among the EU member states from the middle of the production ranking, the situation is as follows:

- Romania registered, according to Table 3, 24.3% share of RES in final consumption, making it the 10th EU state in the ranking of share of RES. It has already overcome its 2020 target of 24% share. According to Romania's (Ministry of Environment, 2020: 11) the target for 2030 is to reach 32% renewable energy consumption.
- Finland implemented successful decisions in the energy sector and it is the second EU member state in the share of RES ranking, with 43.09%. Its 2020 goal to reach 38% share of RES was obviously overcome in 2019. In its NECP, Finland set its 2030 goal to "at least 51%" (Ministry of Economic Affairs and Employment, 2019: 17) share of RES in final consumption.
- Belgium registered only 9.92% share of RES in final consumption, being the 24th EU member state the share of RES ranking. Its 2020 goal is set to 13%, and seems impossible to be accomplished in just one year. According to its NECP, the 2030 goal is to reach 23.5% share of RES (Federal Government of Belgium, 2019: 57).
- Denmark, the last of the four states in the middle of the production ranking, registered 37.2% share of RES in 2019, which means that its goal for 2020 is exceeded with more than 7 percents. For 2030, Denmark set a goal to reach 55% share of RES (Danish Ministry of Climate, Energy and Utilities, 2019: 8).

The EU member states with low energy production have also set goals for the future regarding the renewable energy sources. Therefore, the current situation of the share of RES and the perspectives for 2030 are these:

- Luxembourg is currently the last EU member state in the share of RES ranking, with 7.04% share of RES in 2019 and a 2020 target of 11%. In its NECP (Le Gouvernement de Luxembourg: 9), Luxembourg stated that the 2030 target is to reach 25% share of RES in gross final energy consumption.
- Cyprus is the 20th member state in the share of RES ranking with 16.2% share registered in 2019 and it already exceeded its 2020 target, which was set to 13% share.
- Malta is above Luxembourg in the share of RES ranking with 8.5% registered in 2019 and 10% share target for 2020. Its 2030 target is to reach 11.5% share of RES in gross final energy consumption (The Energy and Water Agency, 2019: 17, a target which is close to the 2020 one).

From the analysis of the share of RES in gross final consumption indicator, there are a few conclusions to be drawn:

- All the EU member states set ambitious targets for 2030, representing an average 10% growth in share of RES in 10 years. Malta is the EU member state which set the lowest 2030 target, with only 1.5% higher than the 2020's one. Sweden is the EU's biggest green energy consumer with more than half of its consumption being produced by renewable sources and can represent a role model for the other EU members in implementing the transition from fossil fuels to RES. Even if France and Germany have low shares of RES compared to Sweden, as the biggest green energy consumer or even Romania or Denmark, as smaller energy producers, they predicted big growths of share of RES for 2030.

- It is not enough for the EU member states to set a goal represented by a growth of the share of RES in gross consumption indicator. They need to sustain the achievement of these goals by implementing efficient measures. Some of the most common measures found in the EU states' NECPs are:

- A carbon dioxide tax whose role is to discourage the companies to produce CO₂ emission in states like Germany (German Government, 2019: 62), Sweden (The Ministry of Infrastructure, 2020: 42) and Finland (Ministry of Economic Affairs and Employment, 2019: 88);
- Measures and schemes to support renewable energy consumption, including tax incentives in states like Sweden (The Ministry of Infrastructure, 2020: 60), Finland (Ministry of Economic Affairs and Employment, 2019: 95), Romania (Ministry of Environment, 2020: 93) and Luxembourg (Le Gouvernement de Luxembourg: 82)
- Conversion of a coal based electricity production facility to a facility based on natural gas and photovoltaic energy in Romania (Ministry of Environment, 2020: 81);
- Replacing fossil fuels with renewable energy in the transport sector in Finland (Ministry of Economic Affairs and Employment, 2019: 86) and Cyprus (Ministry of Energy, Commerce, and Industry, 2020: 105).

Conclusions

Our study proposed an analysis of the energy policy of the European Union. More precisely, this study wants to reveal the main EU member states' decisions that sustain the 2030 target achievement regarding the reducing of the carbon dioxide reduction. The main question of the present study is that if the EU member states can completely achieve their 2030 goal regarding the GHGs emissions reduction.

For realizing this study and for giving an appropriate answer to its question, there were set three specific objectives that follows to reveal the current state of the energy policy in the EU Member States and the impact for smart cities development. A first objective which includes the analysis on main energy indicators like production and consumption, and the analysis of the share of RES in gross final energy consumption among the EU member states in 2019. The second objective proposes an analysis of the 2030 EU member states' targets and some of the measures implemented or planned for implementing to support the achievement of these targets. The third specific objective which includes deficiencies and suggestions to fix and improve the EU states' energy policy.

Regarding the first specific objective of the present study, the analysis of the data available on the Eurostat database of the European Commission reveal the current position of the EU Member States in producing energy, consuming, and sharing the RES in final energy consumption. The results show that France is the biggest energy producer and Germany is the biggest energy consumer among the EU states. The data show that the biggest share of RES among the EU member states was registered in Sweden, having a value of over 56 percent. Another fact discovered by analysing the data is that at the end of the production and consumption rankings are the same three EU member states: Luxembourg, Cyprus, and Malta. Malta and Luxembourg are also the member states with the lowest share of RES. The biggest producer and the biggest consumer, France and Germany are below the middle of the share of RES ranking with only 17.35% share and 17.21% share, respectively. This ranking will be used further to outline the main measures adopted by the EU member states to reduce the carbon dioxide emissions.

Regarding the second specific objective, there was proposed an analysis of some of the EU member states' National Energetic and Climate Plans, which include the EU states'

objectives and targets for 2030 and specific measures to achieve them. One of the measures adopted by the EU member states, an efficient measure according to Swain and Karimu noted (Swain & Karimu, 2020) was the electrification, because electricity can be produced easier from renewable sources. As observed above, this type of measures were proposed for the transport sector in different countries like Finland and Cyprus and in Romania, as a process of transformation of a coal-based facility to one based on photovoltaic source. Thus, we consider that, from this point of view, the EU member states implement the right decisions to achieve their 2030 goals. Other measures proposed were a carbon taxation based on the ‘polluter pays’ principle and fiscal incentives for the final consumers who join the transition.

Regarding the third objective of the present study, there are some deficiencies that need to be analysed and revised. The fast development of the electricity production from renewable sources was not harmonized with the development of the grid (Solorio & Jorgens, 2017: 298), which reduces the possibility of the member states to consume to the fullest that produced energy. An incompatible grid cannot sustain the use of renewable energy, so, even if there are capacities that produce the energy, it would be impossible to contribute to the country’s share of RES in final consumption and its growth. Even if some of the EU member states managed to accomplish and even exceed their 2020 target, according to the analysed data, some of them have set high targets for 2020 and were not able to get close to that target in 2019. One good example in this regard is France, which registered 17.2% share of RES in 2019 and set a target to reach 23%. The slow process of growing the share of RES in final consumption can lead to a failure in reaching the 2030 not just in the member states, but even at the EU level, as a whole.

Regarding the first deficiency exposed above, we suggest that the EU member states should formulate appropriate strategies after making detailed studies on every aspect of the energy sector. Investments can be partially redirected from building new facilities of production to the development and modernisation of the grid, otherwise the produced energy will never reach the final consumers.

For the second deficiency found in the present study, we consider important that the EU main institutions to get more involved into the states’ way on making the transition from fossil fuels to renewable ones. As observed by Solorio and Jorgens, the promotion of using renewable energy has become politicized (Solorio & Jorgens, 2017: 4) and it would be a mistake by the EU to ignore this aspect. It is very important that the EU drives all its resources, either financial or cognitive, to truly sustain the achievement of these goals for real, not just into political speeches and to respond to a sustainable development of the communities creating smart cities for smart people.

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