Energy Transitions in Western Europe

Subjects: Social Issues

Contributor: Federica Cucchiella

Shifting from fossil to renewable energy sources is a major global challenge, and in this context, the European Union has promoted sustainable and environmentally friendly growth as early as the Maastricht Treaty of 1992. To date, European institutions have promulgated a series of environmental regulations and directives aimed at promoting and imposing adoption by member states of internal regulations. This entry focused on Western Europe, and it explores, for each state under analysis, energy policies adopted, the results achieved and recommendations for the future growth of renewable energy. The results show that in countries where energy policy is not fragmented, the yield in renewable energies has been higher, and also in the states where more and various forms of subsidies are foreseen, growth seems to be greater.

Keywords: renewable energy ; Western Europe ; climate policy ; sustainability ; policy implication

1. Introduction

From a sustainability perspective, renewable energy plays a fundamental role [1]. To date, in fact, great use is made of non-renewable energies, whose overall quantity is limited; moreover, the greater the amount of non-renewable energy extracted and used today, the lesser the amount available for future generations [2]. It therefore appears essential that industrialized states rush to invest in the development of eco-sustainable technologies, exploiting renewable resources, such as the sun, wind and water and their interaction [3][4][5]. The “sustainable” energy thus produced can be used for activities related to the production of electricity, as well as cooling and heating [6][7]. In this regard, there is talk of sustainable energy produced from natural sources (solar, wind, biomass [8], hydro, wave and tidal energy [9][10][11]) that do not harm the environment and are always available, as they are not destined to run out [12][13][14].

To verify and analyze the current energy situation in the European Union, this entry is focused on Western European countries according to the UN geographic scheme: Austria, Belgium, France, Germany, Luxembourg and Holland.

In particular, the objectives of this entry are to analyze the following:

- The progress made by the states under analysis in the field of renewable energy;
- The energy policies adopted and the results that have been reported following the regulatory innovations, in order to identify the potentials and limits for the development of renewable energies;
- Recommendations for the future growth of renewable energy in these regions.

The results may be of interest to academics, economists, entrepreneurs and especially the political leadership involved in the development of long-term energy scenarios internationally, nationally and regionally.

2. Leading Features of Renewable Energy Policies in Western European Countries

As required by Directive 2009/28/EC, each member state has developed its own path to achieve the objective set for it by the European Union by 2020. These paths were published in the form of national action plans for renewable energy during the years 2010 and 2011.

Support and funding for RES investment policies are typically based on a combination of different types of policies and grants and cover all three main energy sectors analyzed above: RES-E; RES-T; RES-H&C.

This paper will analyze the main incentive schemes for renewable energy sources of the EU member states under analysis, namely: feed-in tariffs (FIT), feed-in prizes (FIP) and green certificates (GC) granted through tender contracts (TND) or other administrative procedures (**Figure 1**).

	Type of Support	Support Source	Photov.	On-shore Wind	Off-shore Wind	Bio-Energy	Hydro-power	Duration of Support (y)
Austria	FIP	Td. Pr.*	※	※	※			-
	FIT	Ad. Pr.**					※	
	FIP	Ad. Pr.				※		
Belgium	GC	Ad. Pr.	※	※		※	※	10 to 20
	FIP	Ad. Pr.	※	※	※	※	※	
France	FIT	Td. Pr.	※					10 to 20
	FIP	Td. Pr.	※	※	※	※	※	
	FIT	Ad. Pr.	※			※	※	
	FIP	Ad. Pr.		※		※	※	
Germany	FIP	Td. Pr.	※	※	※	※		20
	FIT	Ad. Pr.	※	※		※	※	
	FIP	Ad. Pr.	※	※		※	※	
Luxembourg	FIP	Td. Pr.	※					15
	FIT	Ad. Pr.	※	※		※	※	
	FIP	Ad. Pr.		※		※	※	

Figure 1. Energy policies 2018. * Td. Pr., tendering procedures; ** Ad. Pr., administrative procedures.

This paper will also evaluate the success of a specific incentive policy. In this regard, it is important to highlight that the success of a given support tool can be assessed in multiple ways: in this document, the assessment is carried out considering the level of effectiveness, that is, the ability to achieve the set objectives, for example, the increase in the share of electricity generated from renewable sources in the total supply within a certain period of time.

2.1. Austria

Guidelines for funding REs are published separately for each Land; however, they differ neither in the eligibility criteria for the incentives, nor in the respective amounts.

In 2009 (BGBL, II no. 251/2009), the federal government and the individual Länder reached an agreement on the measures to be adopted in the construction sector aimed at reducing greenhouse gas emissions (art.15 bis B- VG). Moreover, most of the subsidies envisaged are directed mainly to the construction sector, for example, in the field of solar heat, heat pumps and biomass heating systems [15].

To support the development of renewable energy, several policies have been adopted in Austria; thus, using the year 2005 as a starting point, in **Figure 2**, the percentage growth in the consumption of energy from renewable sources in this country is depicted. There is an increasing monotonous trend from 2011 to 2018, with an average value of 1.75% and a minimum growth rate of 1.1% in 2013–2014. The last red column of the figure indicates the percentage to be reached in 2020 according to Dir. 2009/28/CE, which, for Austria, is 34%, meaning that the actual gap is 3.7%.

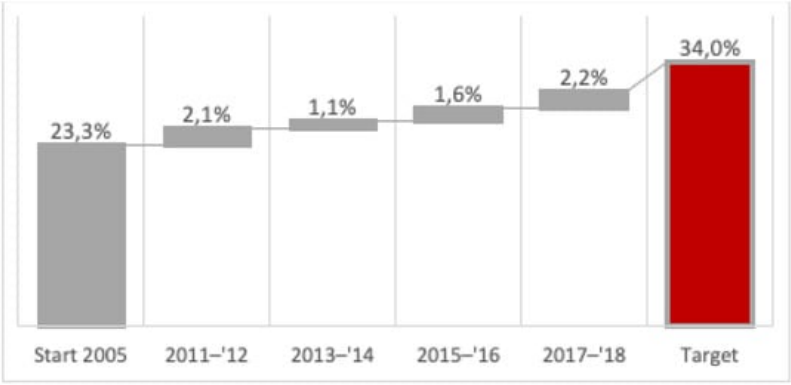

Figure 2. Austria—energy consumption trend. Source: https://ec.europa.eu/eurostat/web/energy/data/shares, accessed on 28 June 2021.

2.2. Belgium

In Belgium, the energy policy responsibilities are divided between the Federal Authorities and the three regions of Flanders, Walloon and Brussels, subject to the control of the Commission for the regulation of electricity and gas (CREG) [16].

It should be noted that in 2017, Belgium spent 2.58% of its GDP on scientific and technological research. Therefore, the boundaries of competences between the regions and the federal state seem sufficiently outlined, but the energy policies of the individual regions are not uniform on the whole: Brussels has opted for a complex system of energy subsidies and investment incentives for companies; Flanders' energy policy, on the other hand, is based on a quota system; and, finally,

Wallonia has laid down obligations for new residential buildings which must be built according to a series of principles of eco-sustainability.

To support the development of renewable energy, several policies have been adopted in Belgium; thus, using the year 2005 as a starting point, in **Figure 3**, the percentage growth in the consumption of energy from renewable sources in this country is depicted. There is an increasing monotonous trend from 2011 to 2018, with an average value of 1.75% and a minimum growth rate of 1.0% in 2013–2014. The last red column of the figure indicates the percentage to be reached in 2020 according to Dir. 2009/28/CE, which, for Belgium, is 13%, meaning that the actual gap is 3.8%.

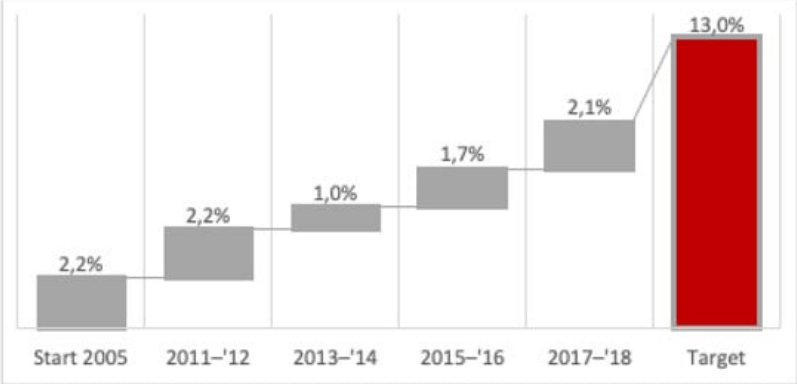

Figure 3. Belgium—energy consumption trend. Source: https://ec.europa.eu/eurostat/web/energy/data/shares, accessed on 28 June 2021.

2.3. France

The structure of the total primary energy supply (TPES) is still characterized by a high percentage of nuclear energy, where in 2014, it was still 44%, compared to 40% in 2004 [17], and in 2018, Eurostat still identified France as Europe's main producer of nuclear energy (**Figure 4**).

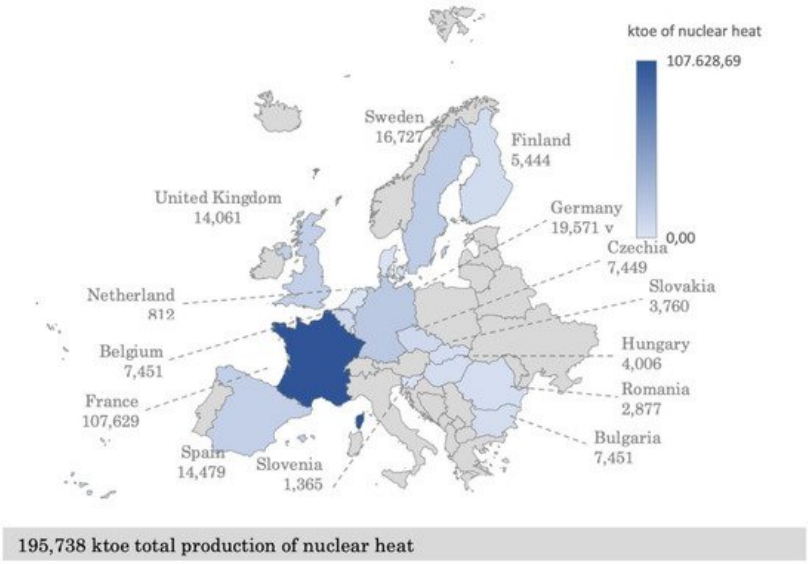

Figure 4. Nuclear energy in the EU—data for 2018. Source: Eurostat.

In France, nuclear energy is considered a source of clean energy with a low environmental impact [18] and has allowed France great energy independence. However, a number of reasons [17] led the French government to plan the decommissioning of nuclear power plants: in spring 2020, for example, the first of the two reactors at the Fessenheim nuclear power plant was shut down, and the ultimate goal is to shut down 14 nuclear reactors. According to the "programmation pluriannuelle de l'énergie" (PPE), the "weight" of nuclear power will have to drop to 50% of the electrical mix in 2035.

The PPE represents a decisive step for France because it sets the objectives for energy and climate for the next ten years and thus directs the country towards "coal neutrality" in 2050.

The target should be achieved through, for example, increasing the consumption of thermal energy from renewable sources by 40–60% compared to 2016 levels, from 218–247 to 155 TWh, and, at the same time, reducing emissions by 30% of greenhouse gases due to the combustion of fossil sources compared to the values recorded in 2016 (from 227 Mt of CO_2 to 322 Mt).

In **Figure 5**, the percentage growth in the consumption of energy from renewable sources in this country is depicted. There is an increasing monotonous trend from 2011 to 2018, with an average value of 2.08% and a minimum growth rate of 1.3% in 2013–2014. The last red column of the figure indicates the percentage to be reached in 2020 according to Dir. 2009/28/CE, which, for France, is 23%, meaning that the actual gap is 4.4%.

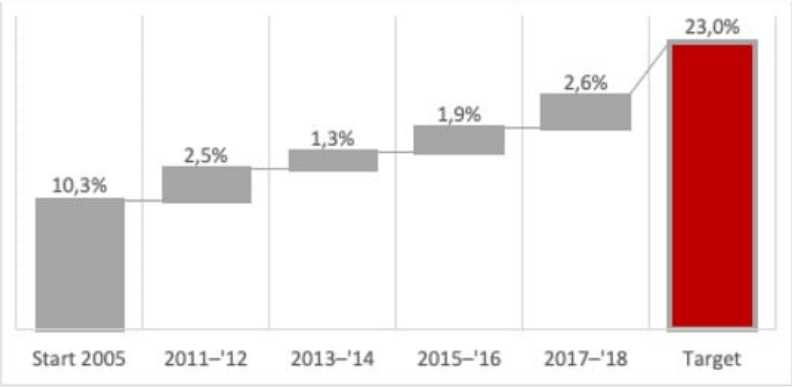

Figure 5. France—energy consumption trend. Source: https://ec.europa.eu/eurostat/web/energy/data/shares, accessed on 28 June 2021.

2.4. Germany

The German policy for a great increase in its dependence on renewable sources is known as the 2010 Energiewende (literally “energy revolution”) [19]. It is based on the Energiekonzept policy (concept of energy), as well as on the law on renewable energy sources (Erneuerbare Energien Gesetz) of 2000.

The purpose of the Energiewende is to minimize, until elimination, the use of energy from nuclear power, replacing it with the use of eco-sustainable energy sources; in this way, the nation should achieve decarbonization by 2022 and considerably reduce its CO_2 emissions.

To achieve these objectives, the government has provided for a series of FIT and FIP incentives that practically cover all energy sectors. However, the plan to envisage the allocation of considerable sources would seem to be well viewed by the German population and academics [20][21].

In addition to the Energiewende energy plan, there is the Germany Renewable Energy Act, a very complex regulation that has been subject to numerous modifications, the last of which is from 2017. The aim, in line with what was also asserted by the previous authors, would seem to abound the form of FIT incentive, in favor of public auctions organized and monitored by the Federal Network Agency—Bundesnetzagentur [22].

To support the development of renewable energy, several policies have been adopted in Germany; thus, using the year 2005 as a starting point, in **Figure 6**, the percentage growth in the consumption of energy from renewable sources in this country is depicted. There is an increasing monotonous trend from 2011 to 2018, with an average value of 1.98% and a minimum growth rate of 1.3% in 2013–2014. The last red column of the figure indicates the percentage to be reached in 2020 according to Dir. 2009/28/CE, which, for Germany, is 18.0%, meaning that the actual gap is 4.3%.

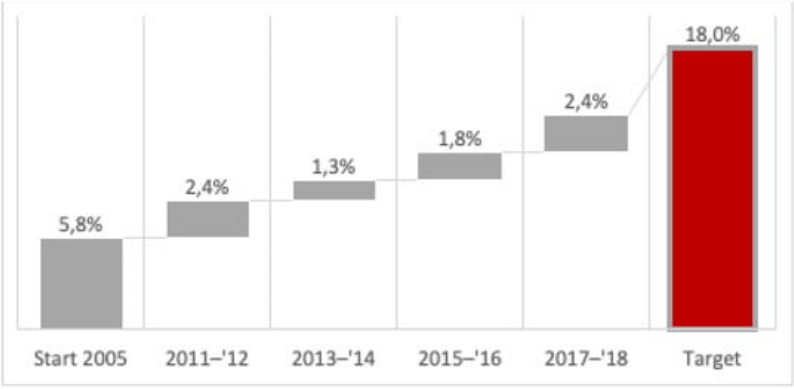

Figure 6. Germany—energy consumption trend. Source: https://ec.europa.eu/eurostat/web/energy/data/shares, accessed on 28 June 2021.

2.5. Luxembourg

According to IEA, the strong economic and demographic growth of Luxembourg is unique among the member countries of the IEA which highlights how, in the grand duchy, "energy demand and GHG emissions show signs of decoupling from GDP and the country doubled the share of renewables in the last decade".

The renewable energy legislation has recently been changed: from the first law in 1999 that had established the first fund for environmental protection, in 2017, the Loi du 15 décembre 2017 entered into force which establishes a new support system for environmental protection and efficient use of energy.

To support the development of renewable energy, several policies have been adopted in Luxemburg; thus, using the year 2005 as a starting point, in **Figure 7**, the percentage growth in the consumption of energy from renewable sources in this country is depicted. There is an increasing monotonous trend from 2011 to 2018, with an average value of 1.65% and a minimum growth rate of 1.0% in 2013–2014. The last red column of the figure indicates the percentage to be reached in 2020 according to Dir. 2009/28/CE, which, for Luxemburg, is 11.0%, meaning that the actual gap is 3.5%.

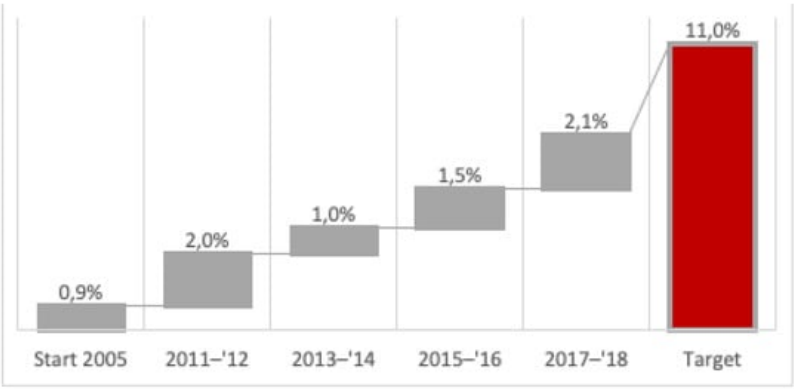

Figure 7. Luxemburg—energy consumption trend. Source: https://ec.europa.eu/eurostat/web/energy/data/shares, accessed on 28 June 2021.

2.6. Netherlands

According to Eurostat data, Dutch energy is the least sustainable of the whole European Union. In 2018, 7.4% of the energy used came from renewable sources. That is 6.6% less than the 14% that the Netherlands is expected to reach in 2020.

Dutch data have improved slightly compared to previous years, but development is slow. Between 2015 and 2018, the share of renewable energy in the Netherlands grew by 1.7%.

Based on these data, the Dutch Environmental Assessment Agency has calculated that the Netherlands will not reach their target by 2020, although there seems to be an acceleration compared to previous years.

Meanwhile, as regards wind energy, the climate agreement sets a target of 6000 MW of wind energy by 2020, which is estimated to be achieved through wind farms.

At the end of 2018, there was 3382 MW of onshore wind energy usable in the Netherlands, and this would represent over 56% of the national target; therefore, the Netherlands should add 2618 MW. As an average wind turbine delivers around 3.5 MW, the Netherlands needs around 750 new wind turbines on the ground to achieve the target by 2020.

To support the development of renewable energy, several policies have been adopted in the Netherlands; thus, using the year 2005 as a starting point, in **Figure 8**, the percentage growth in the consumption of energy from renewable sources in this country is depicted. There is an increasing monotonous trend from 2011 to 2018, with an average value of 1.88% and a minimum growth rate of 1.2% in 2013–2014. The last red column of the figure indicates the percentage to be reached in 2020 according to Dir. 2009/28/CE, which, for the Netherlands, is 14.0%, meaning that the actual gap is 4.1%.

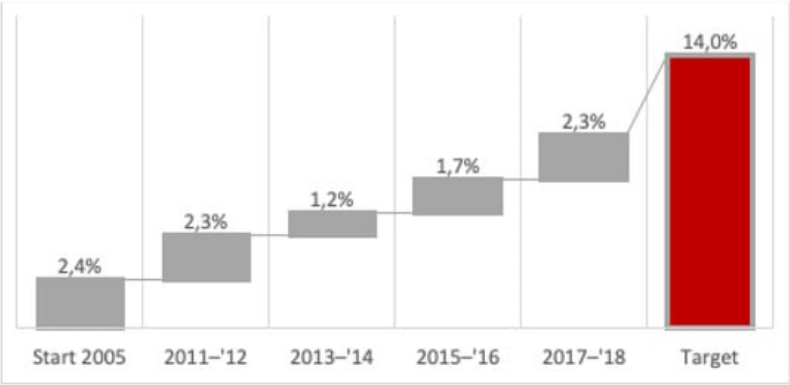

Figure 8. The Netherlands—energy consumption trend. Source: https://ec.europa.eu/eurostat/web/energy/data/shares accessed on 28 June 2021.

3. Conclusions and Policy Implications

From the data published by Eurostat, it emerges that Austria is the state with the highest RES production; however, it is not the state that has obtained the greatest growth, indeed, over the years, as energy production has shown a fluctuating trend, even if the level starting points were higher. This could depend on the fragmented nature of energy policy, since a similar trend characterized by low constancy is also found in Germany, where energy competence is also divided between central power and Länder. In the context of energy policy, therefore, the principle of subsidiarity, as the basic principle of the European Union, does not seem to fully unfold its effects. The subsidiarity principle is defined in Article 5 of the Treaty on European Union. It aims to ensure that decisions are taken as close as possible to the citizen, verifying that the action to be taken at the community level is justified with respect to the possibilities offered by the action at the national, regional or local level. However, in countries where energy policy is not fragmented, the yield in RES has been higher; for example, this happened in Luxembourg, where RES production growth has increased significantly in recent years. Therefore, surely to obtain a higher yield, it is necessary that the energy policy adopted is unified throughout the territory.

It should also be noted that in the states where more and various forms of subsidies are foreseen, growth seems to be greater. For example, in France, although the population density is higher than in Luxembourg, the production growth of RES H&C has been higher. Therefore, more clean energy is produced for a higher population density. It is believed that the main difference is due precisely to the greater number and greater variability of incentives. This is also evident compared to Belgium, which, by combining green certificates with FIT and FIP subsidy systems, could achieve greater results in terms of energy efficiency. Belgium has a position of merit, however, for the amount of incentives provided for research; it would be necessary for each state to invest in research, particularly Germany, where it could be possible to make more use of the resources of the territory, especially solar energy. Renewables in some situations have reached record levels compared to other states, but much remains to be carried out to decarbonize the country, above all avoiding job losses: investing in research could help remedy the problem and increase the use of resources from neglected energies, such as solar energy. On the other hand, the German RES-T results are excellent. In this regard, there seems to be no great variability, since almost all the sample states make use of a quota system as with Germany; indeed, Germany has been the subject of criticism from both the IEA and the RES LEGAL database, yet the results obtained are commendable [23]. This is believed to be due to the loan system by KfW. Such a loan system should be used in all states, as it appears to lead to good results. Additionally, in Holland, which seems to hold the primacy for the whole of Europe in terms of RES-T, the forms of subsidy for the purchase of electric cars not only for citizens but also for public transport lead to an increase in the use of renewable resources and a decrease in CO_2 emissions.

Belgium also appears to be currently engaged in a progressive elimination of nuclear power, but the policy on this matter is not unanimous, and most scientific reports recommend extending the nuclear license in order to reduce the current pressure on supply uncertainty [24].

Having said this, it was previously reported that the member states of the European Union have published new national energy–climate plans. The European Commission has finished analyzing them, and ad hoc assessments have been carried out for each European nation (also collected and summarized by the IEA) which should be integrated into the definitive national energy plan for 2050. As of today, according to Brussels, the documents still make insufficient contributions to achieve the energy efficiency targets for 2050.

Moreover, if energy plans are not carefully designed, they can distort the functioning of the energy market and entail higher costs for European families and businesses [25].

In addition, support schemes should be flexible and respond to falling production costs. As technologies become obsolete, the patterns should gradually be removed. For example, feed-in rates should be replaced by premium feeds and other support tools that incentivize manufacturers to respond to market developments, and it has been seen that not all states have provided or are replacing incentive tools now obsolete for the needs of their national market. At the same time, the economic and financial crisis has blocked investment in new construction generation capacity. Low demand, combined with increased deployment of wind and solar energy, has also pushed down wholesale electricity prices in some member states such as Germany, Belgium or Spain, putting pressure on public service yields.

References

1. Mikova, N.; Eichhammer, W.; Pfluger, B. Low-carbon energy scenarios 2050 in north-west European countries: Towards a more harmonised approach to achieve the EU targets. Energy Policy 2019, 130, 448–460.
2. Turner, R.K.; Pearce, D.W.; Bateman, I. Environmental Economics: An Elementary Introduction; Johns Hopkins University Press: Baltimore, MD, USA, 1993.
3. Pérez-Díaz, J.I.; Jiménez, J. Contribution of a pumped-storage hydropower plant to reduce the scheduling costs of an isolated power system with high wind power penetration. Energy 2016, 109, 92–104.
4. Jurasz, J.; Dąbek, P.B.; Kaźmierczak, B.; Kies, A.; Wdowikowski, M. Large scale complementary solar and wind energy sources coupled with pumped-storage hydroelectricity for Lower Silesia (Poland). Energy 2018, 161, 183–192.
5. Schmidt, J.; Cancella, R.; Pereira, A.O., Jr. The role of wind power and solar PV in reducing risks in the Brazilian hydro-thermal power system. Energy 2016, 115, 1748–1757.
6. Park, E. Potentiality of renewable resources: Economic feasibility perspectives in South Korea. Renew. Sustain. Energy Rev. 2017, 79, 61–70.
7. Cucchiella, F.; D'Adamo, I.; Gastaldi, M. Modeling optimal investments with portfolio analysis in electricity markets. Energy Educ. Sci. Technol. Part A Energy Sci. Res. 2012, 30, 673–692.
8. Hashemizadeh, A.; Ju, Y.; Bamakan, S.M.H.; Le, H.P. Renewable energy investment risk assessment in belt and road initiative countries under uncertainty conditions. Energy 2021, 214, 118923.
9. Ramos, V.; Giannini, G.; Calheiros-Cabral, T.; Rosa-Santos, P.; Taveira-Pinto, F. Legal framework of marine renewable energy: A review for the Atlantic region of Europe. Renew. Sustain. Energy Rev. 2021, 137, 110608.
10. Wang, Z.; Carriveau, R.; Ting, D.; Xiong, W.; Wang, Z. A review of marine renewable energy storage. Int. J. Energy Res. 2018, 43, 6108–6150.
11. Chang, Y.-C.; Wang, N. Legal system for the development of marine renewable energy in China. Renew. Sustain. Energy Rev. 2017, 75, 192–196.
12. Adams, S.; Klobodu, E.K.M.; Apio, A. Renewable and non-renewable energy, regime type and economic growth. Renew. Energy 2018, 125, 755–767.
13. Gisler, T.; Capezzali, M.; Guittet, M.; Burkhard, R.; Favrat, D. Evaluation and recommendation of a subsidy instrument for new large hydropower plants, use case of Switzerland. Sustain. Energy Technol. Assess. 2018, 26, 6–16.
14. Di Dio, V.; Favuzza, S.; La Cascia, D.; Massaro, F.; Zizzo, G. Critical assessment of support for the evolution of photovoltaics and feed-in tariff(s) in Italy. Sustain. Energy Technol. Assess. 2015, 9, 95–104.
15. Kranzl, L.; Hummel, M.; Müller, A.; Steinbach, J. Renewable heating: Perspectives and the impact of policy instruments. Energy Policy 2013, 59, 44–58.

16. GREG, Commission for Electricity and Gas Regulation. Available online: (accessed on 28 June 2021).
17. Andriosopoulos, K.; Silvestre, S. French energy policy: A gradual transition. Energy Policy 2017, 106, 376–381.
18. Poinssot, C.; Bourg, S.; Ouvrier, N.; Combernoux, N.; Rostaing, C.; Vargas-Gonzalez, M.; Bruno, J. Assessment of the environmental footprint of nuclear energy systems. Comparison between closed and open fuel cycles. Energy 2014, 69, 199–211.
19. Energy in Transition—Powering Tomorrow. Available online: (accessed on 28 June 2021).
20. Wüstenhagen, R.; Bilharz, M. Green energy market development in Germany: Effective public policy and emerging customer demand. Energy Policy 2006, 34, 1681–1696.
21. Bechberger, M.; Reiche, D. Renewable energy policy in Germany: Pioneering and exemplary regulations. Energy Sustain. Dev. 2004, 8, 47–57.
22. Condemi, A.; Cucchiella, F.; Schettini, D. Circular Economy and E-Waste: An Opportunity from RFID TAGs. Appl. Sci. 2019, 9, 3422.
23. IEA. Energy Policy Review; International Energy Agency: Paris, France, 2020.
24. Cachorro, J.D.F.; Willeghems, G.; Buysse, J. Strategic investment decisions under the nuclear power debate in Belgium. Resour. Energy Econ. 2019, 57, 156–184.
25. Technical Guidance for Deriving Environmental Quality Standards. Common Implementation Strategy for the Water Framework Directive (2000/60/EC); Guidance Document No. 27; European Communities: Brussels, Belgium, 2011; Available online: (accessed on 12 March 2013).