DIVERSE ENERGY TRANSITION PATTERNS IN CENTRAL AND SOUTHERN EUROPE: A COMPARATIVE STUDY OF INSTITUTIONAL LANDSCAPES IN THE CZECH REPUBLIC, HUNGARY, ITALY, AND SPAIN

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Abstract: Growing awareness of anthropogenic climate change, deep cuts in CO_2 emissions, and the exhaustion of easy-to-extract fossil fuels have led to a growing interest in developing renewable energy sources as a part of the (desired) transition to a low-carbon society. The target of the European Union for 2020 is to cover 20% of final energy consumption by renewable energy sources, and for 2030 it should reach at least 32%. While there are ambitious goals to boost the energy transition, it is becoming increasingly evident that the processes run differently in different countries, some of which still prefer path-dependent options and resist major changes. This comparative study applies a historical institutionalist approach to examine the institutional factors influencing the development of renewable energies in the Czech Republic, Hungary, Italy and Spain, countries with different geographies, political and socio-cultural traditions, belonging respectively to Central and Southern Europe, whose comparison has so far been largely neglected in the literature. The general objective of this paper is to investigate and exemplify how diverse energy traditions, institutional frameworks, policies, and practices shape the processes and outcomes of the renewable energy transition.

Introduction

In response to climate change, limited fossil fuels, national energy security, and rising global energy demand, renewable energies (RE) have been rapidly developing throughout Europe. Since 1990 most European countries have adopted policy frameworks and measures in order to stimulate a transition to more sustainable energy systems (Klessmann et al. 2011). The target of the EU for 2020 is to cover 20% of final energy consumption by RE, and for 2030 it should reach at least 32% (EU 2030 Energy Strategy, http1). The overall EU target of 20% of final energy consumption from renewable sources by 2020 was allocated to the different member states according to their current mix and potential for contribution. In Southern Europe, the targets vary from 17% in Italy and over 20% in Spain and France to 31% in Portugal. Among the Central European countries, the Czech Republic and Hungary (both 13%) have one of the highest proportions supposed to be reached in the region (Chodkowska-Miszczuk et al. 2017, RES21 2019).

While these targets are subject to constant evolution, as has happened in the 2030 EU framework (EU, 2014), they have already led member states to define, adopt and implement more or less ambitious renewable energy policy measures. The policy support heavily influenced the pace of development of renewable energy, that have undergone dramatic changes and adjustments, which have resulted in some unintended environmental and socioeconomic consequences (Ajanovic 2011, Luňáčková et al. 2017, Martinát et al. 2016), such as new land-use conflicts and disconnections between policymakers and stakeholders (e.g., Calvert and Mabee 2015, Warren 2014).

Social-technical transitions involve far-reaching changes along different dimensions, such as technological, material, economic, organizational, institutional, political and sociocultural (Markard et al. 2012). In addition to the technological dimension, the energy transition includes changes in user practices and institutional (e.g. regulatory and cultural) structures (idem). While there are ambitious objectives to boost RE transition, it is more and more evident that it is going differently in different European countries, as the nature of restructuring trends in the energy sector is contingent upon regional and national circumstances (Bouzarovski and Tirado Herrero 2016). Thus, the desired end state of the energy transition is understood differently in the EU countries. In Southern European countries (SEC), where energy transition is framed within the decarbonization of the economy, the countries like Spain and Italy have been ahead in the energy transition process, although their development trajectories were interrupted due to the scaling back of financial support mechanisms (Wang and Zhan 2019). In the former socialist Central and Eastern European countries (CEEC), which have been lagging or even resisting until recently the expansion of new developments, energy transition has been considered primarily as a liberalization and privatization of the energy sector with key changes occurring in the structure of ownership and the role of competition (Bouzarovski 2009).

Thus, it is of utmost importance to understand what is the role of energy policies and landscape planning systems in the EU states with different heritages of energy systems and political and cultural planning contexts which have been shaping the energy transitions in each case (Suškevičs et al. 2019, Frolova et al. 2019). This understanding can provide valuable hints for effective policymaking and avoid the risk of one-size-fits-all energy policies that time to time resonates in political discussions. Based on a comparative analysis of institutional landscapes in four European countries (the Czech Republic, Hungary, Italy, and Spain), the objective of this paper is to investigate and exemplify how diverse energy traditions, institutional frameworks, policies, and practices shape the processes and outcomes of the ongoing low-carbon energy transition.

Material and methods

Numerous studies have examined the diffusion dynamics and factors affecting differences in renewable energy deployment outcomes across European countries (Buen 2006, Toke et al. 2008, Pettersson et al. 2010, Davies and Diaz-Rainey 2011, Chen et al. 2014, Frolova et al. 2015, Chodkowska-Miszczuk et al. 2017, Lauf et al. 2018, etc.). Simply said, these factors may be divided into two groups, including 'hard' and 'soft' factors. The hard factors include geographical determinants important for a local scale, as for example geographical potential, urban forms, concentrated or dispersed settlement structure, etc. These factors are more static, i.e. change very slowly or do not significantly change throughout time. By contrast, the soft factors, related to political-institutional, economic, social and cultural characteristics of each country, are crucial for a wider scale (regional and national), and generally are much more dynamic (changing in time) than 'hard' factors.

A widely-cited study by Toke et al. (2008) introduced a conceptual framework for a comparative analysis involving four main types of institutional variables, which have an impact on wind energy deployment outcomes, including planning practices and systems, landscape protection norms and organizations, the financial support mechanisms, and ownership patterns of projects. This conceptual framework has been further developed and specified by Ferguson-Martin and Hill (2011). Apart from the system of planning and approvals, renewable incentive systems, market structure and patterns of ownership, and stakeholder support and opposition, they pointed out also the role of path dependency and structural and technological factors, such as the historical use of particular energy technologies and the grid infrastructure (Ferguson-Martin and Hill (2011).

Being inspired by the works of Toke et al. (2008) and Ferguson-Martin and Hill (2011) and their calls for further testing of their conceptual frameworks through additional case studies, this comparative study applies a historical institutionalist approach to examine the factors influencing the development of renewable energies in the Czech Republic, Hungary, Italy, and Spain. Our main hypothesis is that there are two patterns in the renewable energy development configuration in these countries, namely Southern and Central-Eastern European patterns, with substantial differences between them.

Our selection is conceptually based on an attempt to compare factors affecting the development of renewable energies in countries with different geographical location (in Central and in Southern Europe), and diverse political and socio-cultural traditions, whose comparison has so far been largely neglected in the literature (Suškevičs et al. 2019). Our research consisted of two main parts. Firstly, we have reviewed existing literature, policy documents, industry reports, and other stakeholder publications to identify differences and similarities between studied countries. Secondly, selected statistical data obtained from the International Energy Agency and national statistical reports for the period from 1990 till 2017 were harmonized and interpreted, being summarized into tables and explanatory graphics presentations. We start with the comparison of basic indicators related to the energy production in each country, after which the main factors identified in the conceptual framework by Ferguson-Martin and Hill (2011) were compared and contrasted in our analysis. Finally, lessons to be learned from different patterns of the energy transition in each region are defined and discussed. Several policy recommendations on how the future development of renewable energy sectors could be directed in a more sustainable way were also outlined.

Results and discussion

Energy dependence and the share of resources in electricity generation

On the overall EU-28 level, net imports of electricity in 2016 represented 1% of overall electricity consumption by end-users (http1). However, there is a substantial difference if we focus our attention on this data for the Czech Republic, Spain, Italy, and Hungary. While Hungary had the biggest share of imports in their electricity consumption with 34%, the Czech Republic was the biggest exporter with 20% of electricity produced. In 2016, the biggest net importers of electricity among them were Italy (43,181 GWh) and Spain (21,845 GWh), while, on the other hand, the Czech Republic, with its 24,791 GWh was the biggest net exporter of electricity among four studied countries (Table 1). As for energy imports, for Italy, Spain, and Hungary, we have found high energy dependency ratios with imports of about 76%, 71% and 58% of energy respectively. Only the Czech Republic imports less than 32% of energy (Table 1).

Table 1. Electricity consumption and trade, and energy imports in the Czech Republic, Hungary, Italy and Spain (Source: Eurostat, 2016; IEA Statistics © OECD/IEA, 2014)

Country	Final consumption of electricity (GWh)	Electricity imports (GWh)	Electricity exports (GWh)	Net imports of electricity (GWh)	Share of imports (%) on electricity consumption	Energy imports net of energy use (%)
Czech Republic	56,050	13,817	24,791	-10,974	-20	31.62
Hungary	37,118	17,951	5,240	12,711	34	57.67
Italy	286,027	43,181	6,154	37,027	13	76.42
Spain	232,515	21,845	14,178	7,667	3	71.43

The view on the national energy mixes (Figure 1), respectively on the availability of domestic resources that contribute to electricity production in particular countries, can help us explaining different energy transition patterns and the levels of renewable energy development (Figure 2). In Italy, the development of renewable energies has been driven by the absence of nuclear power plants and efforts to reduce the dependence on imported coal. Although Spain has its own nuclear power plants (which generated nearly one-third of the total electricity in 2018), it is still, together with Italy, among the top coal importing countries in the world (Ricketts et al. 2017). This has also been an important driver that pushed both countries to exploit domestically located renewable energy sources such as wind and sun. On the other hand, the Czech Republic and Hungary are typical by relying on their nuclear power plants and coal reserves from a long-term perspective, which in fact caused that the pressure on developing renewable energy has not been so strong.

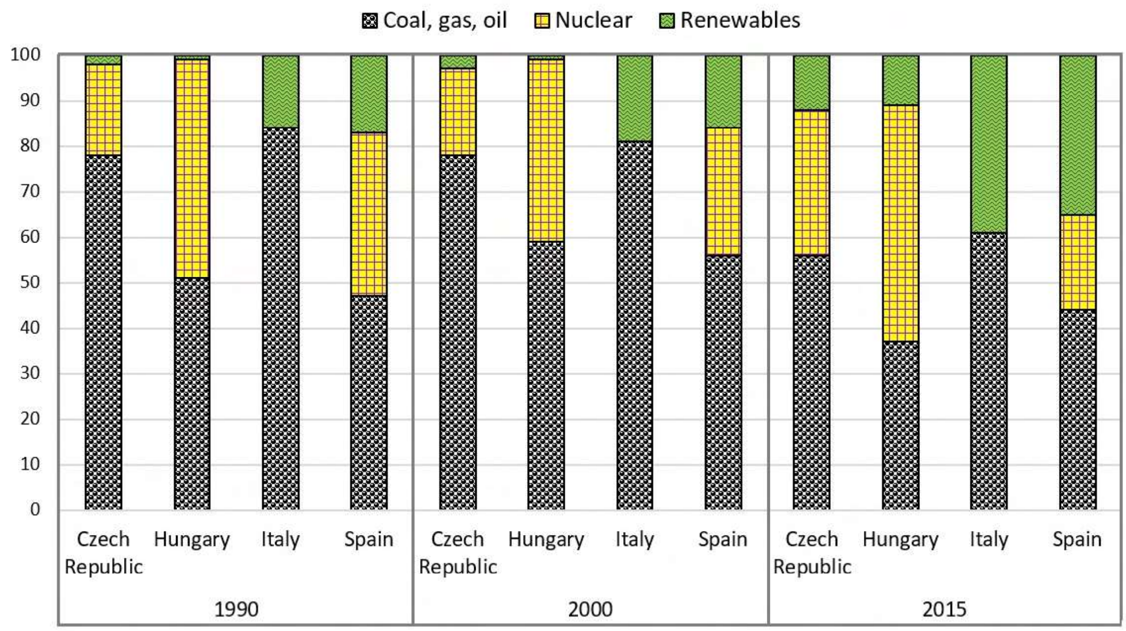

Figure 1. Share of energy resources (%) on total electricity generation (1990, 2000, 2015) (Authors´ elaboration, Source of data: IEA 2018)

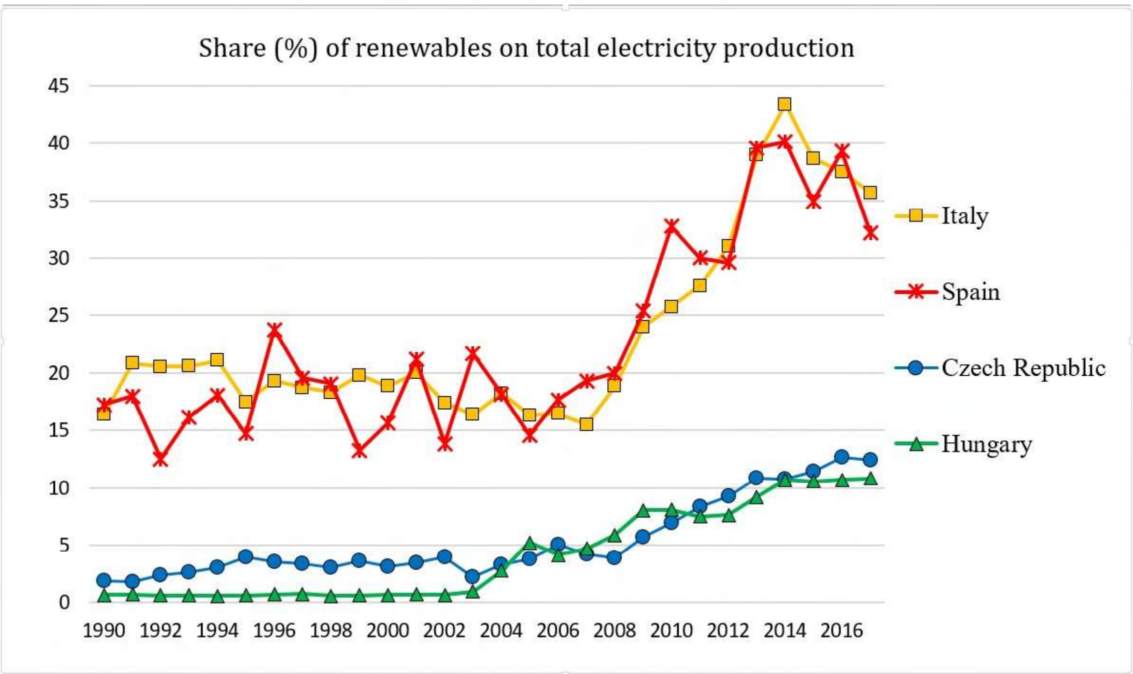

Figure 2. Share of renewables in total electricity production (1990–2017) (authors´ elaboration, source of data: IEA (2018))

In all studied countries, we are able to identify certain characteristics related to the structure of renewable energy sources contributing to electricity generation that variously reflect historical settings and development of their energy policies, national specifics, and contextual differences. Let us start our analyses with the focus on the structure of renewable energy in each of countries (Figure 3).

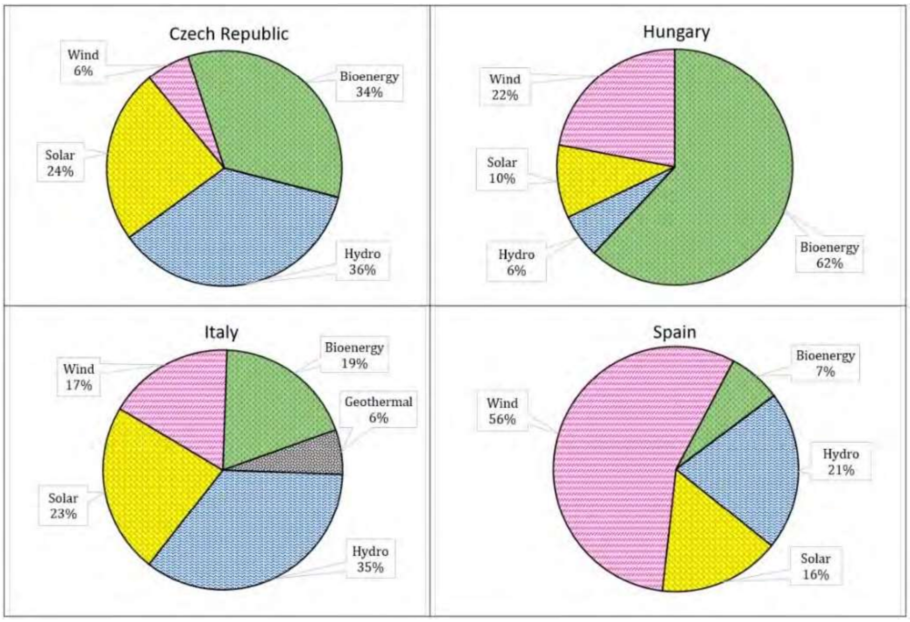

Figure 3. Share of sources in renewable electricity generation (2017)
(Authors' elaboration, Source of data: IRENA (2019))
Note: The category of bioenergy includes energy from renewable waste, solid biofuels, liquid biofuels, and biogas.

First, we must mention a significant difference in the total amount of electricity production from renewable energy sources. The total annual production (in 2017) was 103,910 GWh in Italy, 88,384 GWh in Spain, while only 9,621 GWh in the Czech Republic, and 3,468 GWh in Hungary (IRENA, 2019). The Czech Republic is characterized by the biggest shares of electricity generation from bioenergy, particularly from agricultural AD plants, hydropower plants and solar PVs and, on the other hand, by the smallest share of electricity generated from wind energy. This is quite a paradoxical finding if we consider the high realizable potential of wind energy in the country. The electricity generated from renewable energy in Hungary is primarily based on bioenergy (particularly from renewable waste and solid biofuels) and partly from wind power. In this case, the share of hydropower is very small. As is visible in Figure 3, Italy is the only from studied countries that effectively exploit geothermal energy, but in total, the dominant source of renewable electricity in Italy is hydropower followed by solar PVs, bioenergy and wind energy. In Spain, wind farms and hydropower plants are two dominant producers of renewable electricity. Spain has the lowest share of electricity production from bioenergy in the four studied countries.

Concerning the territorial distribution of RE within studied countries, it is interesting to compare the installed capacities of solar photovoltaic energy (Figure 4), wind energy (Figure 5) and bioenergy (Figure 6). The information on installed capacities presented in maps for the NUTS3 regions' level corresponds to the province/county level in individual countries (*kraje* in the Czech Republic, *megye* in Hungary, *province* in Italy and *provincia* in Spain). The most recent data that we worked with were influenced by the availability of information for NUTS3 regions level in individual countries. For Italy and Spain, we worked with data from 2018, while for the Czech Republic and Hungary it was 2017. To enable the comparability of data on wind energy, only onshore installed capacities were included in analyses. Concerning bioenergy, it is appropriate to note that Spanish data contains power plants that use as main fuel biomass from energy crops, agricultural livestock or gardening activities, forestry exploitation and other forestry operations in forest stands and green spaces. On the other hand, bioenergy data for the Czech Republic includes installed capacities of biogas plants based on agricultural materials, which affects the comparability of this data. NUTS3 regions with the highest installed power capacities of solar, wind and bioenergy are summarized in Table 2.

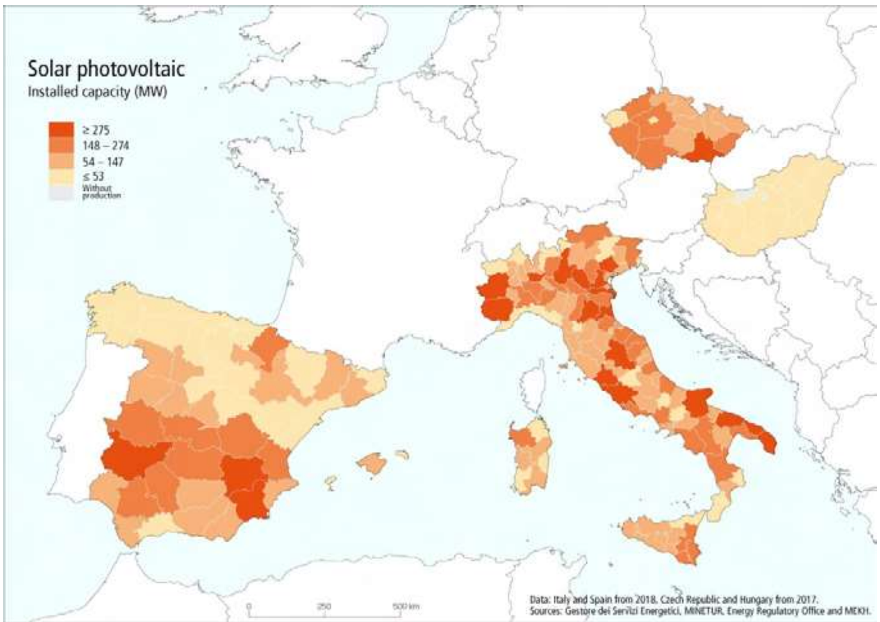

Figure 4. Photovoltaic installed capacity (MW) in the Czech Republic (2017), Hungary (2017), Italy (2018) and Spain (2018) at NUTS3 level. (Authors' elaboration, source of data: Energy Regulatory Office, MEKH, GSE, and MINETUR).

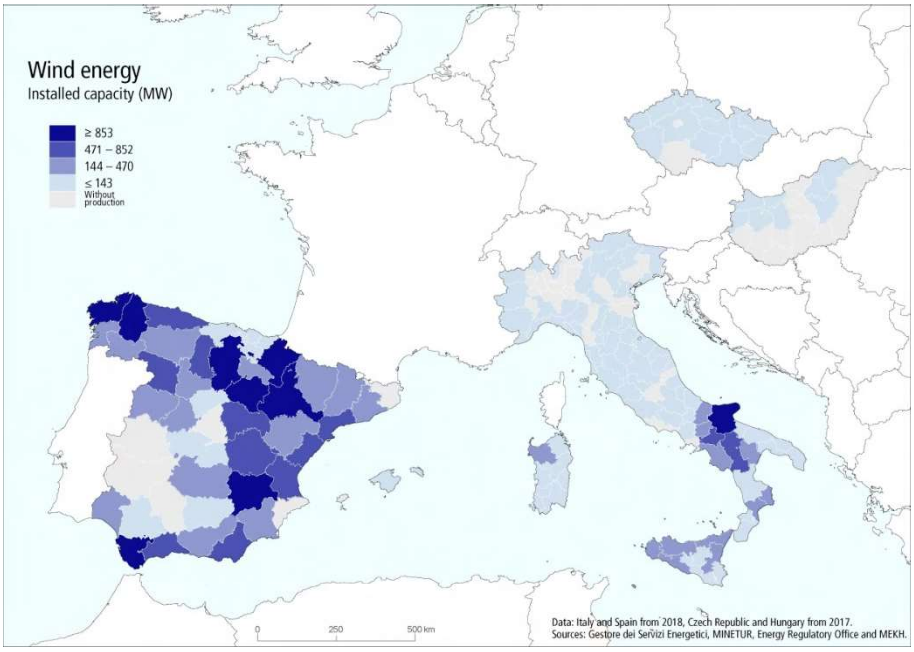

Figure 5. Wind energy installed capacity (MW) in the Czech Republic (2017), Hungary (2017), Italy (2018) and Spain (2018) at NUTS3 level. (Authors´ elaboration, Source of data: Energy Regulatory Office, MEKH, GSE, and MINETUR).

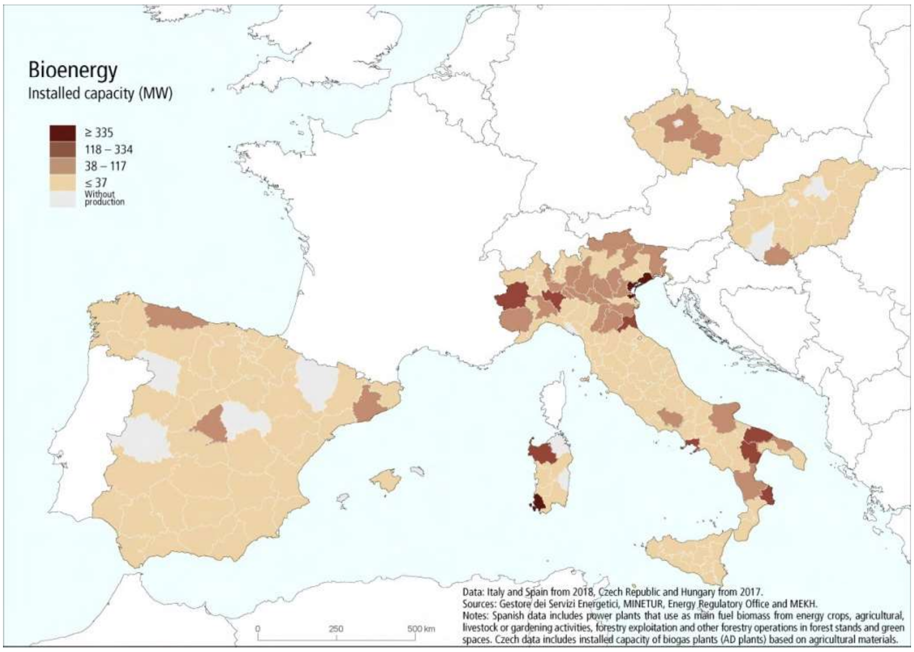

Figure 6. Bioenergy installed capacity (MW) in the Czech Republic (2017), Hungary (2017), Italy (2018) and Spain (2018) at NUTS3 level. (Authors' elaboration, source of data: Energy Regulatory Office, MEKH, GSE, and MINETUR).

Table 2. Ranking with the 10 NUTS3 with the highest installed power capacity according to renewable sources in the Czech Republic (2017), Hungary (2017), Italy (2018) and Spain (2018). (Authors' elaboration, Source of data: Energy Regulatory Office, MEKH, GSE, and MINETUR)

No.	Wind energy		Solar photovoltaic		Bioenergy	
	NUTS3	MW	NUTS3	MW	NUTS3	MW
1	Albacete (ES)	2057.7	Lecce (IT)	531.8	Venezia (IT)	725.0
2	Foggia (IT)	1997.6	Cuneo (IT)	475.7	Carbonia-Iglesias (IT)	587.0
3	Burgos (ES)	1864.6	Jihamoravský (CZ)	446.2	Sassari (IT)	334.1
4	Zaragoza (ES)	1414.6	Murcia (ES)	436.0	Ravenna (IT)	258.8
5	Lugo (ES)	1401.5	Brindisi (IT)	425.1	Torino (IT)	238.3

6	Cádiz (ES)	1318.2	Bari (IT)	410.2	Bari (IT)	224.5
7	Navarra (ES)	1253.2	Brescia (IT)	375.8	Napoli (IT)	218.5
8	La Coruña (ES)	1174.4	Rome (IT)	355.2	Crotone (IT)	191.8
9	Soria (ES)	1164.6	Foggia (IT)	351.2	Matera (IT)	163.1
10	Potenza (IT)	852.0	Torino (IT)	351.2	Pavia (IT)	151.5

Energy traditions and energy policies: common points and divergences

There is no doubt that renewable energy development in the studied countries is affected by certain similarities as it is generally shaped by the common EU energy policy. However, divergences are also obvious. These divergences are linked to national energy tradition in each country, which is influenced by a complicated and complex past and present developments and contexts of particular energy sectors (Table 3).

While Italy and Spain entered the EU before the beginning of the development of European energy policies (1997), in 1957 and 1986 respectively, the Czech Republic and Hungary became the full members of the EU much later, in 2004. Therefore, both the latter mentioned countries started the implementation of European RE policies later, in 2005. In spite of the EU energy policy, that is common for all four countries, the public and political support for renewable energies is closely interconnected to specific configurations of the energy sector in particular countries. The differences in the institutional landscapes of these countries allow us to distinguish two patterns of the configuration of renewable energy development, namely Southern and Central-Eastern European patterns, with substantial differences among each other.

Both Italy and Spain developed their renewable energy policies in a context of very limited conventional energy sources, external energy dependence, diversity of resources in energy mix and availability of a wide range of renewable energy sources (e.g. Mahalingam and Reiner 2016, Pareja-Alcaraz 2017) (Table 3).

Table 3. General contexts of the development of renewable energy policies in the Czech Republic, Hungary, Italy and Spain (Source: authors' elaboration)

Country	**Conven-tional energy sources**	**Support for nuclear power**	**External energy depen-dence**	**Diversity of resources in the energy mix**	**Energy markets**	**Energy intensity of national economies**	**Availabi-lity of RE resources**
Czech Republic	Coal and Nuclear power	High	Lower	Domi-nance of coal	Centra-lized	Higher Ratio	Wind, biomass, solar PV
Hungary	Nuclear power	High	Moderate	Domi-nance of nuclear power	Centra-lized	Higher Ratio	Solar, wind, biogas
Italy	Little oil reserves	Low	High	High diversity of energy resources	Decentra-lizing	Lower Ratio	Wide range of RE
Spain	Nuclear power	Low	High	High diversity of energy resources	Decentra - lizing	Lower Ratio	Wide range of RE

On the contrary, energy sectors of the Czech Republic and Hungary are typical by a dominance of only one energy source in the structure of national energy production (it is hard coal in the Czech Republic and nuclear energy in Hungary) and a narrower range of renewable energy sources available (e.g. Ürge-Vorsatz et al. 2006, Buzar 2007, Frantál and Kunc 2010, Lofstedt 2008, Martinovský and Mareš 2012, Chodkowska-Miszczuk et al. 2017, 2019). Another substantial difference between the two mentioned modes of renewable energy development is the energy intensity of national economies (the ratio between energy supply and gross domestic product measured at purchasing power parity (http2)). From the 1990s to 2015, Italy and Spain have been having a relatively low ratio of such intensity (0.85 and 0.92 kWh/$ respectively), which means that less energy is used to produce one unit of economic output. On the contrary, the Czech Republic and Hungary have been developing from a very high energy intensity of their economies in the 1990s (2.81 and 1.9 kWh/$ in 1990 respectively) to moderate energy intensity in 2015 (1.53 and 1.20 kWh/$) which is in line with the transition of these economies from their focus on heavy industry during the Socialist era. In addition, these two modes differ by a degree of centralization of their energy markets: while in Italy and Spain energy markets are gradually decentralizing, in the Czech Republic they are rather centralized which enormously affects ongoing energy transition. Traditionally state-controlled energy industry (based on the coal and nuclear power plants) is still persisting and thus, energy issues are primarily solved on the national level. Finally, RE in Southern European countries have been developing in the context of low public support for nuclear power (even in Spain where a substantial share of electricity production is from nuclear power) (Eurobarometer, 2008), while in the Czech Republic and Hungary there is a high support for nuclear energy among the general public (Eurobarometer 2008, Frantál 2015).

Among other important characteristics of energy sectors in the Czech Republic and Hungary several authors (Frantál 2015, Chodkowska-Miszczuk et al. 2017, Frantál and Prousek 2016, Suškevics et al. 2019) cite following factors:

- Persisting energy dependency on Russia,
- Agriculture shaped under the socialist regime (during this period, after confiscation and nationalization of small private farms, large-scale and state-owned farms were created) which persisted until the early 1990s (Chodkowska-Miszczuk et al. 2017),
- The backwardness and inconsistency of the planning and decision-making process in which regional authorities interpret the national energetic strategy differently and apply willfully the correlative legislation norms,
- Low level of trust in state institutions that affects attitudes of population towards RE subvention schemes and their misuse,
- Limited linkages between the transition of energy policies and environmental consequences.

Market structure and patterns of ownership

In wind and solar PV energy the Spanish market, which peaked in 2007-2009, was dominated by large-scale systems (del Rio and Mir-Artigues 2012, Frolova et al. 2014). The dominance of large-scale industrial plants in Spain is related to the top-down planning without the involvement of local actors into the RE planning process (Dewald and Truffer 2011, Hammarlund et al. 2016, Kriechbaum et al. 2018).

In addition, the dominance of the large-scale segment in the Spanish solar PV market from 2004 to 2008 (so-called solar orchards/"huertas solares") could be explained by an ownership structure that allowed investors to divide large installations into small participations. By applying such a measure that they could obtain the high feed-in tariff level for small installations and thus to reduce costs for large installations and consequently to reach higher profitability than originally expected by the regulators (Kriechbaum et al. 2018). Therefore, the financialization of the solar PV market caused PV investments to become a financial product rather than a renewable investment (Prieto and Hall 2013). This situation has changed, primarily due to different restrictive measures which will be discussed in the following sections. However, due to price cuts, including lower production costs by 80% over the last 10 years, better frameworks for self-consumption of solar power both on state and regional levels, and the cancellation of fees and charges, the large volume of investments in the development of photovoltaic projects occurred and has once again positioned Spain as a benchmark worldwide in solar PV projects development. Solar PV installations increased by 94% in 2018 compared to the prior year, of which around 90% (235.7MW) of last year's deployment was in the rooftop self-consumption segment, with the other 26 MW in ground-mount projects, according to the data registered by Spanish solar association, UNEF (http3 https://unef.es/).

As for ownership patterns, in Spain, leading electricity companies (Ibedrola, Acciona, Gamesa Eólica, etc.) are the main owners of wind farms. Solar PV owners are numerous Spanish and foreign companies: Endesa, Acciona Solar, Soltec Energías Renovables, Green Power Technologies, Enel Green Power, etc.). However, there are very few community or farmer-owned wind and solar PV installations. Finally, for bioenergies there exist a wide variety of ownership patterns, from micro-SME or family-owned companies to large companies operating in different energy subsectors or even in other economic sectors. Companies involved in the development of electricity and biofuel projects use to be larger and often collaborate with different biomass suppliers (industries, cooperatives or farmers) (Agencia Andaluza de la Energía, 2018).

As for Italy, the energy market, in general, continues to be strongly influenced by the legacy of the nationalization period. In 2015, the former national monopolist, ENEL, still dominated the Italian electricity production with a share of 25.7%, followed by ENI (8.6%), and EDISON (6.4%). The first 6 operators produce nearly 50% of the Italian power generation (AEEGSI 2016). These are also leading companies in the different energy sectors on a global scale. Otherwise, as regards renewable energy, the Italian market structure is quite uneven.

Italian PV ownership pattern, for example, is considerably less concentrated than other European countries. Considering only industrial and large-scale capacity, in 2014 the first 10 operators represented just 10.3% of the total, against 68% in the UK, 28% in France and 18% in Spain (Cruccu et al. 2014). With regard to wind energy, installed capacity is mostly concentrated in the southern regions. Even if the total number of plants is quite high (5,579), around 90% of wind power generation is produced by farms over 10 MW of installed capacity. Contrary to PV, the wind sector is dominated by large players, led by ERG (more than 11% of the market share in 2017). As regards bioenergies, installed capacity is concentrated mainly in northern regions. The ownership structure is highly dependent on different sub-sectors, with larger companies mostly involved in biofuel and bioliquids production. As for biofuels, it is worth noting that only 27.5% of biofuels released for consumption in 2017 were produced in Italy, as the rest was imported from abroad (and mainly from Spain). Regarding biogas, a large number of small plants are owned by farmers. The average installed capacity of new biogas stations decreased significantly in the last years, as incentives were limited to small plants up to 300 kW in order to limit the use of food crops (like maize, sorghum, and wheat), typical of larger plants until 2012. Finally, it is to be mentioned that in Italy various grassroots initiatives in the field of community energy exist across different sectors, although they are still quite limited if compared to other European countries (Candelise and Ruggeri 2017).

REs implementation meets many obstacles in Hungary and the Czech Republic. Investors have to tackle with prices of technologies that are imported mainly from Western Europe, fluctuations of energy prices, etc. (Chodkowska-Miszczuk et al. 2017).

The energy sector in the Czech Republic is heavily influenced by the central position of the state-owned (from 70%) the ČEZ company in the energy market as it generates almost three-quarters of the total electricity generation in the country. The influence of the ČEZ company on the formulation of Czech energy policy is enormous as they own major facilities for energy generation in the Czech Republic (two nuclear power plants, ten coal mines, etc.). Investments of the company are spread beyond the Czech Republic in Bulgaria, Germany, Hungary, Poland, Romania, Slovakia, and Turkey. Four other major owners of facilities for energy generation could be found but their share market does not exceed a tenth of the total energy production. The concentration of energy generation in the Czech Republic is enormous. The ownership of renewable energies is various. Plenty of investments into renewable energies originate in Austria (wind energy) or Germany (biogas energy). On the other hand, the majority of agricultural biogas stations are owned by farmers that usually operate their farms on large acreages (in comparison to other EU countries). Community ownership of facilities for generating renewable energies is rather rare but successful examples might be found. The boom of solar installations that occurred in the Czech Republic as a result of generous subsidies scheme at the end of the first decade of the 2000s caused a situation when phenomena of unknown ownership of solar installation occurred. Consequently, together with plenty of scandals and controversies, the reputation of renewable energy among the public was significantly affected.

The structure of the Hungarian electricity market was basically formed around 1995, when the majority of the production capacities, the providers for public use and distribution networks were detached from the former owners and then they were privatized one by one, in a way that the single units were mostly bought by foreign investors (RWE, AES, EdF, Electrabel, etc.). The Hungarian Electricity Works (MVM) Group is the only, nationally owned actor in the electricity sector with 6 plants. It is operating as a Recognized Corporate Group since 2007. MVM is a successful, vertically integrated, nationally-owned energy group with a portfolio that covers the total domestic energy system.

The biggest energy producer in Hungary is the Paks Nuclear Power Plant (also belongs to the MVM Group). Besides, there are coal, gas and biomass plants in the system and in smaller proportions of hydro and wind plants. At the time of writing, there are 19 big plants and more than 270 smaller (<50 MW) plants operating in Hungary. The total gross built capacity of the big plants was 6996 MW while the smaller ones were 1621 MW on the 31st of December, 2017.

MVM Ltd. is buying produced and imported electricity. The process is controlled by MAVIR (Hungarian Electricity Energy Industry Transmission System Coordination) Ltd, organizes the distribution of electricity that is finally distributed to local users by local electricity providers. The renewable and waste-based electricity energy falls into a specific selling category that MAVIR Ltd. is obliged to buy at an obligatory price (called KÁT).

While the production of the plants decreased by 22%, the consumption and import increased by 3 % since 2008. The production decreased due to the aging of the plants and the lack of new investments after the policy landscape changed with the central regulation of the prices, with the distraction from the sector and the decrease of the computability (stability) of the regulatory environment the sector became non-attractive for investors. A slight improvement can be seen from 2015 due to mainly the PV plant constructions.

Almost half of the total electricity production of Hungary was produced in the Paks Nuclear Power Plant in 2018. However, its production was decreasing, similarly to the coal, gas, oil-fueled, or wind and biogas plants. All national renewable energy production is decreasing since 2015. In RE production the biomass is dominating, but the quantity of production based on biomass is decreasing since 2015, it decreased by 10% in 2018. Its proportion in RE is still above 70% (it was almost 80% in 2014). Among the primary renewable sources, there was a decrease of the produced quantity in case of communal waste, biogas, geothermal and hydro based production in 2018, while the production of biofuels and solar energy is increasing since 2014 but it was getting only bigger than wind energy (where the last production capacity building was in 2010, and its proportion is just over 2% in the total RE production) in 2017.

Until the end of 2018, there was 726 MW PV capacity connected to the grid. In 2018 there were approximately 400 MW new capacity built, the former capacity more than doubled in one year. There was approximately 80–100 MW (as part of the 400 MW) new capacity originating from the household size (<50 kW) small plants. Half of the capacity (35 000 plants) belongs to households with an average of 5.6 kW capacity, 50 % belongs to other (non-natural) owners, with an average of 18.7 kW capacity.

There was a considerable increase in the case of the <0.5 MW built-in capacity, non-household size plant category, where the biggest investments were in PV plants. It was the decreasing investment costs and the support in the FIT system that boosted this size category.

Renewable incentive systems

Regulatory policies played an essential role in RE deployment. Spain, the Czech Republic, Hungary, and Italy have introduced various support mechanisms for RE production technologies (Table 4), adapting their policies to different national circumstances. The most effective of them was the development of the feed-in system. The feed-in systems for renewable energies – most often first for wind power and solar PV – have been introduced in the Southern European countries about ten years earlier than in Central and Eastern European countries studied: first in Italy (1992) and Spain (1994–1997), then in the Czech Republic (2002) and Hungary (2004). This price-based instrument uses two different options: the feed-in tariff (FIT), consisting of the fixed price paid to RE producers per unit of electricity, and more market-oriented feed-in premium (FIP), consisting of payment on top of the electricity market price (premium). The premium has been used in Spain, the Czech Republic, and Italy, as the main support system or in combination with other incentive systems (Schallenberg-Rodríguez 2017). FIT support was always used at least during the first stage of development of renewable energy markets, although at the further stages the most part of the studied countries reduced and even suppressed their FIT/FIP rates as in the case of Spain (REN21 2019).

Table 4. Institutional contexts of the development of renewable energy policies in the Czech Republic, Hungary, Italy, and Spain during 2000-2018 (adapted from Toke et al. 2008, Iglesias et al. 2011)

	Spain	Italy	Czech Republic	Hungary
Competences and administrative levels of REs planning	**State**: national energy strategy, legislates on RE, authorizes plants >50 MW **Regions**: regional legislation and energy planning, authorizes plants ≤50MW, regional registry of plants **Local-level**: Municipal land-use plans, granting of building permits	**State**: national energy strategy, legislates on RE **Regions:** “Unique authorization” for plants >250 kW “Simplified authorization “ for plants from 20 and 250 kW **Local-level**: Communication to the municipality for small domestic installation	**State**: national energy strategy, legislates on RE **Regions**: regional energy strategies, EIA and SEA processes **Local-level**: Municipal land-use plans, granting of building permits	**State**: national energy strategy, legislation **Regions**: NUTS 3 regions develop plans but have to follow the national plan. Small modifications of the national plan are permitted **Local-level**: Municipal land-use plans, otherwise it is the same as NUTS 3 level
Financial support system (Source REN21, 2019)	FIT/FIP, Tendering, Net metering/billing, Biofuel blend obligation/ mandate, Renewable heat obligation, Fiscal incentives, and public financing	FIT/FIP, Tendering, Net metering/billing, Biofuel blend obligation/ mandate, Fiscal incentives and public financing, Green certificates	FIT/FIP, Biofuel blend obligation or mandate, Tradable REC, Fiscal incentives and public financing, Green bonuses	FIT/FIP, Tendering, Biofuel blend obligation or mandate, Fiscal incentives and public financing

Stability of financial support	Varying/unstable, with retroactive measures	Varying	Varying/unstable, with retroactive measures	Stable
Characteri-stics of administra-tive procedure	Differ considerably from region to region with mismatches between different administrative levels, complexity, and tardiness	Differ from region to region with mismatches between different administrative levels, complexity	Hierarchical with mismatches between different administrative levels Complexity and tardiness	Hierarchical. Regions can decide which part of the national administration procedure can be followed less strictly
Grassroots initiatives (historical roots)	Rare Dispersed and localized, grassroots initiatives against large-scale RE power plants	National anti-nuclear movement Dispersed and localized grassroots initiatives against new power plants. Environmentalist associations criticize RE policy	Regional anti-coal and anti-nuclear movements Localized initiatives against new wind power plants and hydropower projects	Strong national opposition against a large hydropower plant (Bős-Nagymaros) in 1988 Dispersed and localized grassroots initiatives against some RE plants
Level of land-use and landscape planning systems	Regional, supra-municipal	Regional, municipal No specific spatial planning needed for RE plants	Regional, sub-regional (municipalities with extended power), local (municipal)	National, regional and local

For example, most of the PV infrastructures have been installed under a feed-in scheme in all the four countries (Figure 4), where the feed-in system implementation has led to the strong stimulation of formally insignificant PV markets. The “booms” of PV development in Spain in 2008, in the Czech Republic in 2010 and in Italy in 2011 were caused by a lack of adaptation of the tariff level (Figure 7) to the rapid price decrease of solar PV technology cost (Schallenberg-Rodríguez 2017). Only in Hungary, FIT/FIP support has been maintaining relatively stable, although in spite of growing FIT/FIP rates in Hungarian Forints due to their devaluation this increase cannot be appreciated in Euros, on Figure 4.

Among regulatory policies, that provide access to grid networks and remuneration for surplus electricity that is fed into the grid, net metering and billing is a primary mechanism used at the residential and commercial levels (REN21, 2019). These policies often help to spur the development of small-scale rooftop solar PV systems, as it happened in Spain in 2018, due to the revision of its net metering policy for solar PV in order to simplify registration procedures and to remove the charge on self-consumption. As for other regulatory policies that incentivize RE development, biofuel blend obligation or mandate is applied in all the four countries and tendering - in the most part of our study area, - except the Czech Republic.

Another mechanism for support RE are fiscal incentives and public financing – tax incentives and biofuel blend obligation or mandate (applied in all the four countries), grants and rebates or tax credits (used in Czech Republic, Italy and Spain), reduction in sales, energy, CO_2 or other taxes (used in Czech Republic, Italy, and Hungary) (REN21 2019). However, they played only a secondary role in renewable energy development and deployment.

Spain is an interesting case of discontinued development of feed-in schemes. Together with Germany, it was the first European country that supported the diffusion of solar PV systems on a larger scale by implementing effective FIT and FIP from the late 1990s (del Rio and Mir-Artigues 2012, Schallenberg-Rodríguez and Haas 2012, López Prol 2018, Kriechbaum et al. 2018). However, the Spanish feed-in systems were not shaped for self-generation solar PV systems and gave priority, from the beginning to the ground-mounted grid-connected plants

(Talavera et al. 2016). In response to the REs growth (mainly the exponential growth in wind energy installations) Royal Decree 436/2004 allowed RE generators to sell their products into the electricity market and guaranteed feed-in tariffs for wind energy technology. Due to the essential growth of REs, especially wind, new integration was needed in order to improve the stability of the premium options, and a cap and floor system were introduced (Schallenberg-Rodríguez and Haas 2012). In order to control the incomes of RE producers that were under premium option, Royal Decree 661/2007 adjusted the premium on an hourly basis, depending on the hourly wholesale electricity prices and the cap and floor values (idem.). These Decrees have also promoted the growth of solar PV sector by extending the feed-in tariff system to medium and large scale plants and guaranteed the future continuity of these subsidies, leading to growth of the rate of installations of PV systems (Azofra et al. 2016, Kriechbaum et al. 2018) and to so-called "Spanish PV power boom (2004–2008)" (de la Hoz et al. 2013). This exponential growth led to a corresponding large increase in public spending to pay for the production premiums, just at a time of beginning of economic crisis and growing concerns about so-called "tariff deficit", i.e. the difference between the high cost of the energy system and the relatively low income it generated (de la Hoz et al. 2013, Mérida-Rodríguez et al. 2015).

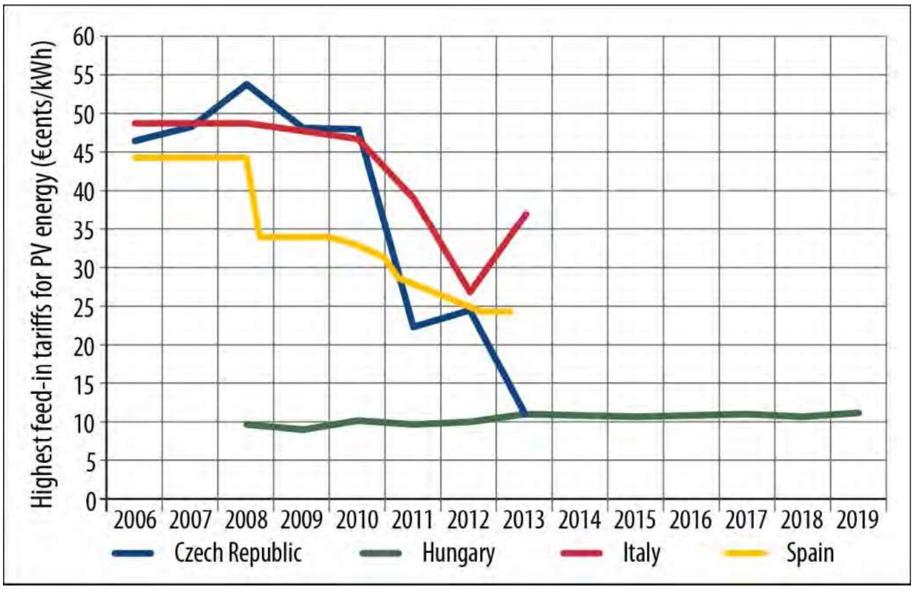

Figure 7. Evolution of the highest FIT for PV energy in the Czech Republic, Hungary, Italy, and Spain between 2006 and 2019 (Source: authors' elaboration).

After this first phase of development, in order to control the further diffusion of PV, the government reduced the premiums and established a procedure of pre-assignation of tariffs for photovoltaic installations, which distinguished between ground-mounted installations (photovoltaic plants) and those installed on roofs (BIVPs); the latter which until then had been in a very small minority would now be prioritized and would receive higher premiums. In order to limit further expansion, annual quotas were established for each type of production, and these were more restrictive for ground-mounted installations (de la Hoz et al. 2013, Mérida-Rodríguez et al. 2015). For other RE technologies in 2009 and 2010 Royal Decrees 6/2009, 1565/2010 and 1614/2010 reduced the tariffs and introduced an annual cap of maximum installed capacity and made additional retroactive cutbacks (i.e., cutbacks of already granted remunerations).

During the third phase, in 2012, characterized by stagnation of REs deployment, Royal Decree 1/2012 removes all incentives for REs. Additionally, cost-containment mechanisms were implemented for solar PV between 2010 and 2013, undermining the profitability of already existing installations and increasing the investment risk for future potential projects by increasing legal uncertainty (Talavera et al. 2016, López Prol 2018). The Law 24/2013 and Royal Decree 900/2015 abolished the feed-in tariff, replacing it with a per kWh charge, and increased charges to grid-connected consumers with accumulation (battery storage) (Hernández-Jiménez et al. 2018).

Italy had discontinued the development of RE support mechanisms, too. These mechanisms suffered the overlapping of different approaches and measures through time. Like in Spain, incentives to PV and to other RE need to be distinguished. At first, photovoltaic was supported by a feed-in tariff (named "Contoenergia"). From 2005 to 2013, five editions of the Contoenergia were launched, each characterized by different criteria and tariffs. Being too much repaying and non-restrictive, the first editions favored the investment into large plants on agricultural land, raising concern from the point of view of soil consumption. As a consequence, at a later time, higher tariffs were set in support of building-integrated photovoltaics and in 2012 ground PV stopped to be subsidized. The average new PV capacity reached its peak in 2011 (54.7 kW), then decreased until 8.8 kW in 2018. From 2013, once the budget for the fifth Contoenergia was depleted and direct subsidy to new plants had ended, photovoltaic could anyway still indirectly benefit from tax relief in the framework of building renovation (50% until 2018, decreased to 36% in 2019). The possibility of selling exceeded self-produced energy was also maintained. After the boom terminated (Schallenberg-Rodríguez 2017) the PV sector continued to slightly expand (+6.2% in 2018 compared to 2017) (GSE 2018). At the end of 2018, the average capacity of PV installations in Italy is reported to be 24.5 kW and 90% of total installations are lower than 20 kW. With regards to other RE – included wind, hydroelectric, geothermal, biomass, biogas, landfill gas, and bioliquids – a double support mechanism based on Green Certificates and feed-in tariffs was into operation from 2002 and 2011, then converted from 2012 into a unique feed-in tariff (named "Tariffa onnicomprensiva") differentiated for plant size and technology type. For plants exceeding 5 MW of capacity, incentives are defined on the base of public auctions. Finally, other incentive schemes – like "Certificatibianchi", "Contotermico" and tax reliefs on energy efficiency interventions – support investments in the reduction of energy consumption as well as in the generation of thermal energy from domestic RE plants.

Among various forms of support for energy production from REs in the Czech Republic and Hungary, the price system prevails, including the support by feed-in tariffs and bonuses (Chodkowska-Miszczuk et al. 2017). In the Czech Republic, historically, the governmental support for the generation of renewable energy has been based on the Act no. 180/2005, on support for the usage of renewable energies from 2005. In 2012, the act has been replaced by Act no. 165/2012, on supported sources of energy that came into force from 2013. This was in response to the Directive 2009/28/EC and consequently the National Action Plan for Renewable Sources of Energy in the Czech Republic. One of its fundamental targets is a share of energy from renewable sources to amount to 13.5% of gross energy consumption in the Czech Republic by 2020. Due to generous support for renewable energy generation, we have experienced tremendous development of renewable energy in the Czech Republic. As a result of the dramatic decrease in prices for PV technology in 2008–2009 that has not been reflected in the supporting scheme, plenty of new PV plants occurred in 2009–2010. Before the supporting scheme was adopted in 2010, the Czech Republic became with 2067.2 MW of solar installed capacities one of the solar energy leaders in Europe (despite not so favorable solar irradiation in comparison to the South-European countries). As a result of chaotic support in the second half of the 2000s, electricity generated from PV plants commissioned before the end of 2010 is purchased by the state for twenty years for highly generous guaranteed prices (with an annual minimal increment of 2%). Almost two-thirds of total solar installed capacities were commissioned during the critical year of 2010 before the support was ended. Such a situation when plenty of speculative capital (sometimes with the hidden origin and unknown owners) appeared in the solar energy sector in a short time caused plenty of scandals and damaged reputation of renewable energy among the population for a long time. Another way how renewable energy is supported in the Czech Republic is the utilization of green bonuses as a state contribution to generated renewable energy. As a reply to the state to a dramatic increase in PV plant, the solar tax has been introduced in 2010 (26% of the guaranteed purchase price of electricity and 28% of green bonuses. The necessity for paying the tax has been later reduced just for PV plants commissioned in 2010 and the tax was reduced to 10% (11% in case of green bonuses).

For other sources of renewable energy, the guaranteed purchase prices stay at an original higher level. Controversies are also linked to the support of the development of biogas energy. Due to strong support from both national and the EU levels, in addition to the above-mentioned guaranteed purchase prices of electricity it was possible to get half of the investment in biogas plant funded by subsidies. This measure has caused the boom of the biogas sector until the end of 2013 when all subsidies for new installations were stopped. Consequently, more than 550 biogas stations appeared (with an installed capacity of 366 MW) that are processing agricultural waste for energy only partially and are rather focusing on the processing of purpose-grown crops (like maize). Development of wind energy (currently 320 MW) is concentrated in the sub-mountain parts of the country in western Bohemia (the Krušné Hory Mts.) and in north Moravia and west Silesia (the Jeseníky Mts.). Further development in other parts of the country is rather symbolic due to local protests and rejection by regional administrations. Despite suitable nature conditions other biomass energy (besides the biogas plants using usually agricultural products) has not been significantly utilized yet.

In Hungary, the FIT/FIP support has been stable: between 2008/2009 and 2019 they with an increase of approximately 11-13% between 2008 and 2019 (in HUF) in all kinds of renewables. After France, Italy, and Belgium, Hungary (together with Spain) are the leader of solar PV installations in Europe with its 0.4 GW installed in 2018 (REN21, 2019). In 2018 Hungary had a record year (410 MW added for a total of around 700 MW), driven by a FIT and net metering (REN21 2019). In accordance with the Hungarian National Energy Plan, there are numerous programs for energy saving (including insulation of houses, change of windows and doors, change of heating system, etc.) and support of investments in RE for households and for bigger PV plants equally. There was a 60% support for households to place PV on the roof. This support does not exist anymore, although a long-term loan with 0% interest is offered. It has always been criticized that this small size PV has very little effect on the overall share of energy consumption and production, but a continuous increase is visible and after a certain time can reach a threshold that we can calculate with. There are certain civil movements to collect/calculate these grid inputs in a group to call attention to its importance. For bigger PV investments there are billions of HUF (1EUR=320HUF at the time of the call) for certain calls, and sometimes in these cases, 1–3 applicants are expected and funded. These biggest PV plants siting could be considered as good examples of RE projects planning, as all of them are sited on former landfills, open mining areas, etc.

Biomass plays an important role in the production of REs in Hungary. The sustainability of bioenergy development is questionable, as in many cases natural or semi-natural forests are cut to feed some of these plants and new tree plantations are created from alien (and even invasive) species that draws many criticisms from environmental, landscape protection and nature conservation perspectives (Möckel 2017a,b).

There is a hold on wind projects investments, however, wind power is not favored by the Hungarian government. No one can install any new windmill at the time of writing.

Systems of planning and approvals

The administrative procedure is considered as one of the main access barriers to RE development (de la Hoz et al. 2013).

The siting of RE schemes in Spain and Italy is decided at a regional level. For example, Spain's autonomous regions have full powers to legislate on industry, town-planning and the environment, with the result that the authorizations and permits required to set up RE installations have been regulated independently by each region (IDEA, 2010:64). Planning procedures for PV installations practiced by regional authorities is very complex, and specific regulations and handling in practice may differ considerably from region to region (PV Policy Group, European Best Practice Report 2006). The location of facilities for the generation of renewable energy is not permitted in natural protected areas.

Since 2001, the energy sector in Italy is subjected to concurrent legislative competence between national, regional, and sectoral authorities. This causes a fragile administrative background, characterized by frequent institutional conflicts between the central State and regional governments and by uneven procedures of authorization between different and sometimes contiguous territories. As a consequence, such a condition has always been considered as an important brake to renewables' development. In response to this scenario, with the aim of reducing spatial and institutional heterogeneity, a unique authorization procedure has been centrally defined by a government decree in 2010 (DM 10/09/2010). According to the decree, the authorization process depends on the power capacity and on other characteristics of the power plants, such as cogeneration and building integration. In the case of small domestic installations, a new plant between 20 and 250 kW - depending on the type of energy source can be authorized through a simple communication to the Municipality, though a "simplified authorization procedure" (*procedura abilitativa semplificata*). Larger power plants are authorized through a "unique authorization" (*autorizzazione unica*) released by all the competent authorities at once. Public participation in decision making is not required.

As for the Czech Republic, since the introduction of Czech legislation for support of renewable energies in 2005, strong decision-making power is given to regional authorities (NUTS3 level). Consequently, the distribution of facilities for the generation of renewable energies strongly regionally differs. This is clearly visible in the case of wind, biogas, but also solar energy. The permission for the operation of renewable energy projects is usually issued by local authorities, however, this is conditioned by the size of a particular project. From a certain size (various for different types of renewable energy), the decision is to move to the regional administration when also the approval of the environmental impact assessment for larger particular projects is authorized. Various local stakeholders are usually having their voices in the process of permission. Within the permission, necessary preconditions for future operations are usually stated and need to be kept (like the specification of the structure of biomass to be fed in biogas stations, particularly technology requirements). The location of facilities for the generation of renewable energy is not permitted in areas with designated landscape protection.

In Hungary, the authorization of the energy plants is a complex process, the number of permissions and thus the number of authorities are as follows: 3–6 chief/main authorities, 5–20 authorities depending on the size and type of the plant. There is another legal possibility, if an investment is announced by the government as of national (or outstanding) importance, the authorization process is much faster and easier. In the process of authorization, the authority of a given region (County Government Authority, NUTS3) is making the decision according to the national regulation, based on the local circumstances. National authorities must be involved if needed (e.g. in case of plants above 5 MW, as it is considered "element of national and regional importance" thus the State Chief Architect must agree), or local governments (e.g. the notary public of the municipality government). Municipalities (LAU2) can announce their requirements in case of a given authorization process (as mentioned above) or in general, based on the Municipality Land Use Plan (certain land-use types, activities, by the controlling/prohibition/allowance of facilities/machinery.

An interesting example of the difference in administrative and grid procedures between the four countries is a survey on onshore wind project development hold in 2010 (EWEA 2010). It demonstrated that Spain has the longest lead time for the administrative procedure (76 months), more than 20 months above the EU-27 average, while the three countries are below the average, although the Czech Republic has a longer procedure (39 months), comparatively to Hungary and Italy (about 32 months). The same difference could be observed for the time necessary for grid access procedure: while Spain needs 33.5 months (above the EU-27 average of 26 months), the Czech Republic, Hungary, and Italy need only about 25, 18 and 19 months respectively (Survey on administrative and grid procedures for wind projects development in 2010, EWEA 2010, Wind Barriers survey).

Land-use planning and landscape protection

In Spain land-use planning and related policies are shaped on a regional level; several autonomous regions incorporated landscape as an important issue in land use regulation through their landscape laws and municipal norms. Contrarily, land-use planning in Italy is defined at the municipality level, within a general frame provided by Regional spatial planning and Regional landscape planning. Regional landscape plans are co-planned by the Regions and the Ministry of Cultural Heritage. In some regions, spatial planning and landscape planning coincide. The renewable energy transition is rarely taken into account by spatial planning procedures, while it recently began to be considered by Regional Landscape planning and Landscape protection policies.

Although there are many national and regional tools which directly or indirectly concern landscape conservation and the term “landscape” is used in many of the recent laws approved after signing the ELC, energy planning systems, which are often based on engineering and economic considerations, are difficult to match with landscape management on a local level.

In spite of the new laws, landscape impacts have only a secondary role in the decision-making process concerning wind farms (Hammarlund Kramer et al., 2016). As recent research has demonstrated, local authorities in Spain do not have the capacity to introduce landscape impacts of RE projects as a substantial factor in the decision-making process, since they have limited power in this process (de la Hoz et al., 2013). For example, there are only three requirements for giving wind farm license by these authorities: wind turbines should be situated out of any protected natural area, they should be close to electric evacuation line and in case of wind power they should correspond to a territory officially defined as “wind resource area”. The process of planning and authorization in Spain does not give enough power to landowners and the general public in the environmental impact assessment process. Information about projects and procedures lack transparency and clarity. The landscape is considered in EIA of RE projects, and there are some specific guidance for RE planning in some municipalities, affected by large-scale RE projects (Hammarlund Kramer et al. 2016).

In Italy, according to the 2004 National Law on Cultural Heritage, the landscape is planned by Regional authorities in cooperation with the Ministry of Cultural Heritage. The situation is nowadays extremely fragmented since some Regions have delivered and approved a landscape plan, while many others are still in the process and others have not started yet. Except for some cases, in regional landscape plans, REs are rarely and/or only generically mentioned. At the National level, however, some guidelines have been adopted to better integrate new plants in the landscape. The Ministry of Cultural Heritage published some guidelines in 2006 (landscape integration of wind power plants) and in 2013 (landscape integration of new energy plants). Besides, in 2010 the Ministry of Economic Development, in accordance with the Ministry of Cultural Heritage, the Ministry of Environment, and the Regional Authorities, delivered national guidelines for the authorization of renewable energy plants, containing a specific part dedicated to the landscape integration of the new plants (D.M. 10/09/2010, part IV). Guidelines also give criteria for the identification of "unsuitable areas", where renewable energy plants have a low probability to be authorized. Unsuitable areas are defined in accordance with the general principles of environmental protection, landscape, and cultural heritage preservation. Each Regional authority was expected to adopt the national guidelines and to integrate them with additional areas, considering the potential impact of each renewable energy source (biomass, photovoltaic, wind, hydroelectric and biogas). Nowadays, however, not all the regional governments have adopted the guidelines and the national framework still results as spatially heterogeneous.

A potential landscape impact is definitely the bone of contention and a major limiting factor for further development of renewables in the Czech Republic. The protection of landscape character was enshrined in §12 of the Act No.114/1992 Coll., *On the Conservation of Nature and Landscape,* as amended. Since then, a number of methodologies and expert approaches have been developed for the assessment of landscape quality and landscape character being based either on biogeographical or architectural approaches. In 2009, the Ministry of the Environment issued a *"Methodological guide to the assessment of the location of wind and photovoltaic power plants in terms of the protection of nature and landscape"*, which has set out a procedure for the preparation of preventive studies identifying the interests of nature and landscape protection at the regional scale and determines (in the form of negative delimitation) the inappropriateness or potential suitability of the power plants´ construction in a particular territory. The document gives basic information about the value and significance of the landscape in terms of nature and landscape protection. The individual regions vary in the rate of rigidity, however, and most of them commissioned their own methodological studies as a base for regional territorial planning documentation.

In 2011, an ambitious project called *Regional Sustainable Energy Policy based on the Interactive Map of Sources* (ReStEP) supported by the European Commission and the Ministry of the Environment and lead by the Czech University of Life Sciences was launched to introduce a new comprehensive method for urban management and regional planning in the field of proposing and assessing renewable energy projects. The result is an interactive web-based map in form of GIS layers, which is to define the potential and contexts of all renewable energy sources in the selected territory taking into account the landscape character, technical capabilities of the transmission grid, but also the existing needs of municipalities and regions. The wider use of this tool in the planning and decision-making practice remains a question so far, however.

In Hungary, the main guidance for land use planning is the National Land Use Plan. The new national plan is operative from the 15th of March, 2019. The next level is the county level (NUTS3) and the final level is the municipality level. Municipalities have 2 years to check their land use planning tools and to change them if necessary. The new plan makes it easier to build a house. Furthermore, whenever the government decides that construction is of high importance, basically the majority of the regulations can be neglected. However, it emphasizes that environmental and natural conditions must be maintained.

The fourth version of the Landscape Protection Handbook was published on-line in 2014 (http4) but it only deals with wind power investments. As the handbook is not a legal decree, it only lists suggestions, such as wind pylons should not be built 800-1000 meters from any protected land (local, national and international (e.g. Ramsar and Natura 2000 sites, etc. also included). The handbook connects landscape protection regulations with any possible legally binding documents but it seems like solar parks and biomass/biogas plants are not included in the suggestions at all. There are suggestions for energy plants above 20 MW but the majority of the plants are just below or equal to 20 MW.

Stakeholder support and opposition

According to Eurobarometer (European Commission, 2013), while in all the four countries, RE sources is the most mentioned priority for energy option, Spain, Italy, and Hungary (81%, 77%, and 74%, respectively) have the highest percentage of respondents who consider RE as the best energy option, while in the Czech Republic this percentage is the lowest in EU (52%).

In Spain, REs installations have a positive image (Frolova and Pérez Pérez 2011; Mérida-Rodríguez et al. 2015), although their development has not been free of conflicts. These conflicts are dispersed and grassroots initiatives against large-scale RE power plants have local character (Hammarlund Kramer et al. 2016). The absence of strong and organized opposition to REs infrastructures with strong visual impact (as large-scale wind and solar farms) in Spain is related to limited role of public opinion in decision-making process and the absence of powerful landscape protection organizations rooted in socio-cultural traditions explain the fact that landscape concerns, in a social and cultural sense, have appeared late in Spain's discourses on renewable power landscapes (Frolova and Pérez Pérez 2011).

Despite REs in Italy have always been strongly supported by the Government, new energy plants are often contested by grassroots initiatives (see Figure 8). According to official data, of the 300 controversies every year, more than 57% is referred to the energy sector, and 75% of them are against REs (Nimby Forum 2018). This data could be underestimated, since Ferrario and Reho surveyed more than 20 controversies in 2013, only against biogas, in a single region (Ferrario and Reho 2015).

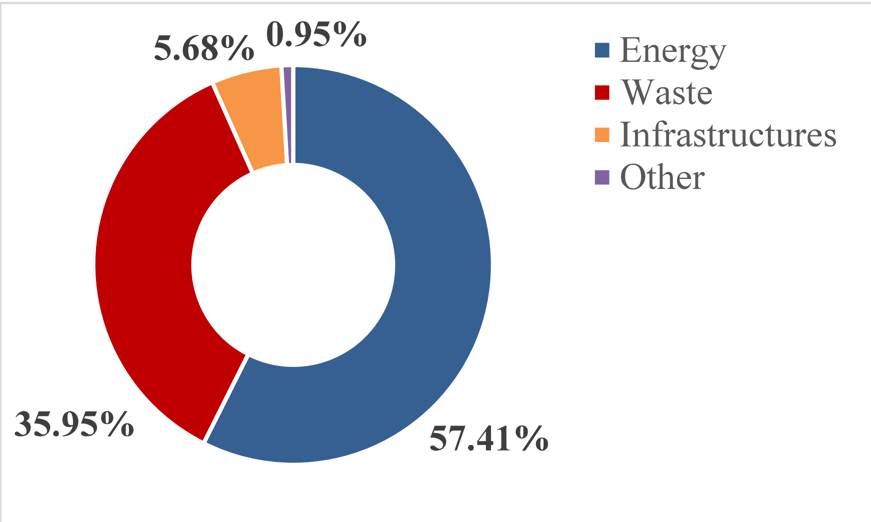

Figure 8. Energy has the largest share of grassroots initiatives against new plants in Italy in 2017 (Nimbyforum 2018)

Major environmentalist associations, while supporting energy transition as an important sustainability goal, alert against the landscape and environmental impact of Res (Legambiente 2011). In some cases, the high level of controversy pushed the producer's associations to react positively. For example, the biogas producers developed a protocol (Biogasfattobene/Biogasdoneright), aiming at minimizing the negative aspects of the production process (CIB 2011).

In the Czech Republic, renewable energy developments are primarily supported for economic benefits, not for environmental reasons or as an alternative to coal or nuclear power

(Frantál 2015, Frantál and Prousek 2016, Van der Horst 2018). The image of and political attitudes to renewables have been adversely affected by the unrestrained boom of solar business between 2008-2011 (Williams 2010) and by few ´bad-practice´ examples of wind farms and biogas plants, which are often presented in the media as common standards. It often happens that proposed wind farms are being accepted by local communities (for economic reasons) but the projects are rejected at the regional level. The primary argument of the opponents is the negative impact on the local landscape character.

There was a decisive bad example of the creation of a huge hydropower plant in Hungary (http5). The plan was already discussed in the 1950s; finally, there was an agreement between Hungary and Czechoslovakia, but people started to demonstrate against some of the decisions at the end of the socialist era of Hungary. Tens of thousands of people were demonstrating against the hydropower plant, so finally the Hungarian part was never finished. This was such a huge event that there was never again such a big opposition about a huge energy plant. The new National Land Use Plan makes it possible again to start construction (not only REs) without any public hearing. Its effect is not known yet. There was some opposition against wind parks but no more plants can be installed since 2010. In the case of other RE plants, there was not any considerable opposition. The people support PV on roof that is visible from the number of small plants installed all over the country.

Conclusions and implications

This study provides an overview of different patterns of energy transition in the four countries. These patterns have some common features and divergences. Some common features between the Czech Republic and Hungary (CEEC), and Italy and Spain (SEC) can be explained by the contexts in which their energy transitions are framed, and similarities between energy traditions and energy policies. There is a clear difference between a centralized model of CEEC, based on the dominance of only one energy source, and a rather decentralized and diversified model of SEC. The high support of nuclear power and lack of trust in CEEC creates an additional barrier for RE development.

While the similarities between the general contexts within CEEC and SEC are clear there are different patterns of institutional contexts in the four countries. Market structure and patterns of ownership follows the general context patterns, with the less centralized market in Italy and Spain, which have a wide variety of ownership patterns, especially in bioenergies, followed by solar PV, and much more centralized market in the Czech Republic and Hungary, influenced by the important role of state-owned companies.

The main support system used in Spain, the Czech Republic and Italy, was the premium, normally in combination with other incentive systems. However, FIT/FIP support was used mostly during the first stage of development of renewable energy markets, while at the further stages the most part of the studied countries reduced and even suppressed this support. The exception is Hungary, where FIT/FIP support has been maintaining relatively stable.

As for systems of planning and approvals, some of the differences between relatively small Hungary and the Czech Republic, and relatively big Italy and Spain can be explained by their size. Due to these differences in size between two groups of countries, national and regional regulations have totally different effects in the first two and the last two countries. For example, in Hungary and Czech Republic national regulations are more determinative than in Italy and Spain, as the NUTS 2 and 3 levels are much smaller in the first two countries. In Italy and Spain where some regions can have the size of entire Hungary or the Czech Republic, regional planning has a much bigger effect on RE planning.

Land-use and landscape planning are held on regional and sub-regional levels, with the exception of Hungary, where the national level is important. Landscape impacts considerations are stronger in the normative of the Czech Republic and Italy, where it became a major limiting factor. Finally, while in Spain RE facilities have a positive image and are widely supported by the population, in Italy and the Czech Republic they are contested by grassroots initiatives. During the last years, probably also due to the high rate of landscape conflicts, some guidelines for better control of RE impact on the landscape have been adopted in all the countries examined. Their application is an interesting topic to be analyzed in the future, to see if a greater landscape sensibility can better shape the process and outcomes of the energy transition.

Our study offers useful lessons to be learned from different patterns of energy transition in the analyzed countries:

1. The historical and political heritage greatly influences national RE policy, it takes time to change these roots and this time has not passed yet which means that in these individual cases more non-national (e.g. EU) measures are needed to increase the willingness and will of RE investments.
2. The national specialties, such as the size of a country and its geographical conditions are strong modifiers of RE use and its policy. This should be taken into account in future RE planning and policy issues.
3. Nuclear power still plays an important role in energy production in the Czech Republic, Hungary, and Spain. The policy based on the use of more nuclear than renewable energy does not necessarily reflect people's feelings.
4. European RE policy should be more adapted to national and regional singularities to be more efficient. On the other hand, specifics that are common in Central or Southern Europe are also visible and worth consideration.
5. It is necessary to diversify the economic support mechanisms with respect to specific typologies, location, natural and social conditions and technologies to consider landscape aspects of RE plants.
6. It is essential to apply sustainability measures into supporting schemes, based on changes in technology prices.

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