Understanding the spatial unevenness of regional renewable energy deployment: insights for policy design

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Abstract

Background

This paper suggests that renewable energy (RE) deployment processes and their spatial unevenness can be explained by analysing the socio-material dimensions of RE. It explains how particular regional RE paths come to be favoured or hampered, and identifies factors that have contributed to these different outcomes. The paper shows the merit of investigating regional agency in energy research.

Methods

Using a novel analytical framework, the research performs a comparative case study analysis of selected regions in Italy and the UK, drawing on data obtained via documentary analysis and extensive in-depth interviews.

Results

The factors that explain regional variation in RE deployment are highlighted, providing evidence of how the distinctive features of RE deployment in five different regions arose and could be identified. The paper shows that understanding the socio-material dimensions of RE offers opportunities to understand the spatial unevenness of RE deployment at the regional levels and how to address it. While some regions have managed to successfully align their strategies and governance in order to maximise their RE potential, others have been less effective. The key features that influence the pace and direction of RE deployment at the regional level are i) the ways in which targets and resource availability are seen as drivers for RE deployment, ii) the degree of political autonomy in planning and the capacity to facilitate consenting processes at sub-regional levels, iii) the political will for RE expansion, elite consensus and the presence of relevant industry actors, and iv) the participation and involvement of regional government, even in the absence of formal regulatory powers, in shaping essential energy infrastructure investment.

Conclusion

While institutional capacity, planning and governance, the variety of actors and interests, compelling visions and credible expectations are all necessary prerequisites for coherent policy outcomes, the effects and degree of success can vary. This variance is influenced by the peculiarities and specificities of the regional contexts in which RE projects emerge. By identifying which aspects tend to constrain or enable RE deployment at the regional level, the paper helps to reveal the policy challenges that emerge and how they might be addressed.

1.0 Introduction
Countries worldwide continue to set ambitious targets, policies and strategies to develop renewable energy (hereafter, RE) (IRENA, 2019), not least because of the growing urgency of accelerating progress towards net-zero greenhouse gas emissions (IPCC, 2019). Yet critical questions remain as to how to speed up RE deployment, especially at the regional level, the focus of this paper, where projects either are or are not developed. Regions (defined here as territories smaller than their state and possessing significant supra-local governance capacity and cohesiveness) have been chosen as the spatial unit of analysis because regional governments in many parts of the world ‘hold a wide range of the competences to implement policy actions for both adaptation and mitigations’ relating to climate change (Galarraga et al., 2011: 164) and can play a key role in the global energy transition, often setting ambitious targets, including commitments to a 100% RE agenda. This paper draws from research that has sought to unpack and explain how particular regional RE paths come to be favoured or hampered, and to identify factors that have contributed to these different outcomes. We argue that our findings yield policy-relevant insights at both national and regional levels that can usefully inform RE policy thinking and decision making.

Even where financial incentives for deployment have been applied consistently across the same country, there have been differences in the regional distribution of RE deployment. This spatial unevenness can stem both from differences in RE resource endowments and from socio-economic factors. Recent research has shown three ways in which existing regional differences, including uneven economic development, social interactions and land use patterns, can create positive and/or negative externalities that attract or deter investment in renewables and influence their deployment.

Firstly, some elements of economic development, such as higher sectoral growth rates, job creation, product and process innovation, can generate positive externalities and attract clustering activities around renewable resource exploitation and low carbon technology deployment (Balta-Ozkan et al., 2015). Secondly, energy systems are also shaped by complex interactions between social and political factors; in particular, a rich body of research has been devoted to understand how actors and social networks shape and influence transition processes (Farla et al., 2012). Thirdly, the spatially extensive nature of many RE technologies has long been recognised as creating challenges in reconciling them with other land uses and values (Bridge, 2018; Wolsink, 2017; Walker, 1995). These contributions suggest that we need deeper insights into the wider social and geographical contexts of how and where renewable technologies are or might be deployed, and into the factors and policy strategies that promote or hinder their deployment.

Drawing on an analytical approach developed to explore regional differences, this paper explores the spatial unevenness and variation of RE deployment in five case-study regions in Italy and the UK. While both Italy and the UK have been subject to similar pressures from European and international regulatory frameworks and have introduced targets for RE and financial and legislative incentives for its expansion, there are significant differences between them and between their regions. In both countries, a process of devolution of power (and different degrees of delegation of responsibility to the regional and local authority level) has enabled diverse approaches to emerge in support of RE. These countries show
differences in their institutional make up, being often seen as an example of a liberal market economy (UK) and as a variation of a coordinated market economy (Italy) (Hall and Soskice, 2001). These differences have affected energy policy preferences and influenced RE policies, shaping the adoption of RE technologies (Dahlmann et al., 2017; Ćetković and Buzogány, 2016).

The specific aims of this paper are: i) to identify relevant distinguishing features of the case study regions and explain how and why some regions have managed more successfully than others to align their strategies and governance in order to maximise their RE potential; and ii) to highlight the policy-relevant insights that the research has identified. In what follows, Sect. 2 sets the research within the emerging literature that discusses the role of materiality in energy geography to better understand its place in explaining the dynamics of energy transitions. While Sect. 3 discusses the research design and data collection methods, Sect. 4 presents the empirical evidence, examining regional differences that have emerged in Italy and the UK. Section 5 summarises what characterises the spatial unevenness of regional RE deployment and illustrates the paper's policy relevance. It shows why it matters to understand how and why regional governance, policy-making and infrastructure arrangements vary and how they can shape future energy pathways. Section 6 concludes, highlighting avenues for future research and the contribution made to the energy geography literature.

2.0 Examining Regional Differences In Re Implementation: The Materiality Of Renewable Energy Sources

This paper suggests that RE deployment processes and their spatial unevenness can be better understood by analysing the socio-material dimensions of RE (following De Laurentis and Pearson (2018)), as these socio-material forms can structure the many ways in which local and regional actors engage with energy systems, flows and infrastructures in order to meet particular goals. Research has highlighted the central role of institutional variations as foundations for geographical differences in the adoption of RE (Hansen and Coenen, 2015; Truffer et al., 2015). This paper contends that these contributions can be enhanced by stressing the influence that socio-material forms of energy exert on energy infrastructure and its governance (De Laurentis and Pearson, 2018; Bridge et al., 2018; Kuzemko et al., 2016), focusing on RE deployment at the regional level.

By framing renewable energies as natural resources we emphasise them as simultaneously physical entities and social categories (Bridge, 2009). Harnessing the natural resource from the sun, the wind, a river or the sea is, of course, a core feature of any RE project. How the extent and potential of such natural resources are estimated and valued influences the investments and expected returns from projects aiming to recast them into exploitable, acceptable sources of energy production. Resource assessment procedures are often presented as ‘objective’. However, many such assessments are strongly influenced by assumptions about average values and trends that may themselves be conditioned by the assessments’ purposes and the actors’ interests and agency. Sometimes apparently unlikely materials, entities and sites are recast with the potential for RE generation (e.g. as sites for wind turbines, roof space for solar PV, fields for biomass, etc.) challenging the existing resource use (Armstrong and Bulkeley,
Understanding these aspects of RE helps to unpack how specific RE resources become realised in some areas and regions and not in others and yields useful insights into the spatial unevenness and variation of regional RE deployment.

This approach builds upon the analysis of materiality originally developed for the extractive industries, including fossil fuels (Bakker and Bridge, 2006; Kaup, 2008; Kaup, 2014; Bridge and Bradshaw, 2017) and discussed in relation to RE in De Laurentis and Pearson (2018). The deployment of RE, the process of turning renewable ‘natural resources’ into viable forms of energy through stages of energy conversion, storage, transmission and distribution has material aspects like those involved in fossil fuel deployment. Recent research suggests that more work on materiality is needed in energy geography to better understand ‘the coupled biophysical and political processes shaping and shaped by energy systems and how these processes vary within and across energy systems’ (Baka and Vaishnava, 2020: 9). It also reinforces the significance of materiality for illuminating the ‘political stakes of energy infrastructure and explaining the dynamics of energy transitions’ (Jones, 2018: 378).

De Laurentis and Pearson (2018) identified three ‘socio-material dimensions’ of RE, positing that these both directly influence RE deployment potential and help understand how, through political-economic and cultural processes, apparently ‘physical’ RE resources come to be socially constructed as exploitable energy resources (cf. Calvert, 2015). These socio-material dimensions are:

1. **RE sources as potentially deployable sources of energy, their appraisal and their interactions with current land-based resource use**: The processes involved in the physical, technical and socio-economic appraisal of the resources, including their extent and potential (or the ‘quality’); and how these processes interact with the resources’ contextual conditions (e.g. land areas required and their location, land use preferences, land use ownership, land use protection and land cover);

2. **Discourses, narratives and visions for renewable energy deployment**: The nature and content of the visions and narratives actors use to promote their interests and influence RE deployment, partly by framing or reframing debates on priorities around the deployment of new energy sources and their potential contribution towards the region's objectives and status;

3. **Built infrastructure requirements for RE delivery and the power to shape infrastructure networks**: The ways in which renewable deployment outcomes are influenced by the physical characteristics of renewable resources and the requirement for a robust infrastructure for RE delivery. This includes how the pre-existing built infrastructure may enable or limit RE potential, as well as the new infrastructure requirements, including the transportation or distribution network developments required to harness the renewable resource into a marketable form of energy, and the power to shape them.

Acknowledging RE resources in dialectical terms as combinations of physical and discursive practices highlights that what is in practice deemed to constitute a renewable resource is not only contained within a particular physical territory but is also socially and politically constructed by networks of actors at different scales. Table 1 summarises how the material dimensions of RE might influence the institutional,
economic and governance dimensions at the regional level, identifying the factors that could potentially explain regional differentiation in RE deployment.
Table 1
How the socio-material dimensions of RE might influence regional institutions, governance and firms’ decision making

| Socio-material Dimensions of RE | How the socio-material dimensions of RE might influence regional institutions, governance and firms decision making |
|--------------------------------|----------------------------------------------------------------------------------------------------------|
| RE sources as potentially deployable sources of energy, their appraisal and their interactions with current land-based resource use | • The regional level often has responsibilities over regional economic development and planning and for the construction and operalisation of mapping methodologies e.g. spatial planning  

  • The processes of resource assessment stimulate deliberation between regional stakeholders about weighing of different environmental values against RE targets  

  • Negotiation between the delivery of EU/ national and regional targets vs. land use policy traditions and values:  
    - Limit to expansion and pressures for and regional responses to RE deployment  

  • Strategies that draw upon siting criteria to create new representations of development opportunities:  
    - incentivise local communities to make more sites available  

    - Developers dash to exploit most commercially attractive locations  

    - Attraction of inward investments  

  • Regional renewable companies might hold research or land-use permits and have the know-how to negotiate/ understand local planning issues |
| Socio-material Dimensions of RE | How the socio-material dimensions of RE might influence regional institutions, governance and firms decision making |
|--------------------------------|---------------------------------------------------------------------------------------------------------------|
| **Discourses, narratives and visions for renewable energy deployment** | • Which characteristics of the resource become incorporated into mapping and which get excluded and the extent to which (these spatial representations) are accepted or resisted by different actors  
• Locations as sources of inward investment (‘open for business’)/ simplification of legal and regulatory frameworks to support ambitious deployment policies  
• Coherent narratives provide legitimisation of a particular process of regional development and RE and are used as a conduit and a way of communicating the articulation of particular RE development paths  
• Regional actors and governance systems channel finance and support of RE technology/ promotion of R&D solutions and deployment  
• Creation of discourses that offer opportunities to produce ideas about nation/region building and/ or regional and national identity and citizenship associated with RE development |
| **Physical characteristics and built infrastructure requirements for RE deployment** | • Researchers and technology developers choose sites for testing and experimental activities according to the availability of natural resources. This is particularly relevant to emerging technologies  
• Potential sites are promoted for demonstration projects and experimental platforms  
• Existing local economic and technological structures, knowledges and competences are mobilized through the purposive actions of agents resulting in the local emergence of new paths  
• Regional governments provide funding for local infrastructure development (e.g. production, distribution and storage) |

These socio-material dimensions are used here to address three research questions: Why are there regional differences in RE deployment in a given national context? How do particular RE paths come to be favoured or hampered in different regions? And what policy-related factors help promote RE deployment in particular regions? Before turning to identify the spatial unevenness of RE deployment in the selected regions, the next section explains the methodological and research approach used for data collection and analysis.
3.0 Research Design

The research uses comparative case study analysis of selected regions (Apulia, Tuscany and Sardinia in Italy and Wales and Scotland in the UK). As suggested, both Italy and the UK have been subjected to broadly similar pressures from European and international regulatory frameworks and have introduced targets for RE as well as financial and legislative incentives for its expansion. However, while the Italian central government shares responsibility for energy policies with regional governments, in the UK energy policy is a reserved function, much of which is not devolved. Yet, elements of devolution and local government reform have allowed the emergence of a degree of regional and local governance of RE in the UK, with significant institutional differences across Wales, Scotland and the rest of the UK (De Laurentis, 2013; Cowell et al., 2015). These and other similarities and differences within and between the two countries and their regions were judged to make them appropriate subjects for comparative analysis.

Case study research design (Yin, 2014) is helpful to tease out some different contextual conditions: 'since social, cultural and institutional forces vary considerably across territories, the geographical context of these factors should provide critical input' (Farole et al., 2011: 59). Hence examining the influence of institutions is highly contextual (Wirth et al., 2013). Additionally, it was judged important to analyse case studies both within and between two countries as comparative methodologies (e.g. cross-regional and transnational fieldwork) can aid in identifying the influence of context and enhance the validity and transferability of research findings (Peck, 2003).

Data were obtained via documentary analysis and 35 extensive in-depth interviews across the two countries (De Laurentis, 2018), between April 2014 and December 2015. The documentary analysis included an extensive critical review of the academic literature, press reports and national and regional policy documents associated with the greening of energy systems. The interviews involved stakeholder participants from both Italy and the UK, chosen from different institutions and organisations involved in RE systems. These included policy makers, regional and national government representatives, organisations that supported innovation and RE development (e.g. development agencies), firms, and private and research organisations. The interviews offered the opportunity to collect more detailed information about recent RE deployment and policy frameworks at national and regional levels and explore the role of regional actors in promoting RE deployment. The interviews explored actors’ activities that are often not documented and probed their perceptions and narratives around RE deployment. The data generated from the research, both in the form of interview transcripts and secondary documents, were organised under thematic summaries, and combined under analytical categorisations, including:

- Regional responses to pressures, targets and existing constraints on RE deployment;
- Renewable deployment and opportunities sought for renewable resource exploitation;
- Policy perceptions of RE support and geographical scale of relevance;
- Barriers to current and future deployment of RE.
The next section discusses in more detail the differences in regional implementation of RE electricity projects that were identified through analysing the three socio-material dimensions listed above in the five case-study regions.

4.0 Identifying Spatial Unevenness In Renewable Energy Deployment In Five Selected Regions

Both Italy and the UK, under EU targets and international regulatory frameworks, were challenged to achieve a significant increase in the deployment of RE and have put in place support incentives to promote deployment. These commitments reflected the characteristics of each country’s energy system (e.g. privatisation in the UK and Italy’s fossil fuel import dependency) and different resource endowments (with a focus on solar and onshore wind in Italy and onshore and offshore wind in the UK).

Due to the absence for some time of a national energy strategy and a clear roadmap for RE, RE deployment in Italy occurred mainly through market forces which were aimed at exploiting resources favoured by support mechanisms that ensured high returns for large scale investments. In the UK, the overall design of RE support schemes has reflected the UK government’s commitment to reducing greenhouse gas emissions while minimising government intervention in markets and seeing competition as a key element to drive costs down. The two countries share, to varying degrees, responsibility for energy policies with regional governments and have displayed great variations in the number, type and distributions of RE installations, which are particularly evident by region. Figures 1 to 3 summarise these differences.

4.1 Iteration between spatial resource assessment and land-use

As suggested, the first socio-material dimension used to identify differences across regions relates to the processes involved in the physical, technical and socio-economic appraisal of the resources and how these processes interact with the resources’ contextual conditions. This occurs via the iteration between spatial resource assessment, land use and land protection and negotiation among conflicting land use interests. Consequently, the devices used to frame such negotiations become highly important. We refer here to target setting and spatial planning.

The former entails the identification of potential capacity via the evaluation of renewable natural resource endowments and availability for their exploitation; the latter reflects the capacity and willingness (or the lack of) of a number of actors both to identify the challenges that renewables present for land use management and to make land available for RE development. The differences that have emerged across the regions investigated are detailed next.

4.1.1 Targets
Targets at different scales have been set for increased levels of electricity production from renewable sources. They have also often become instruments for evaluating future planning (and consenting) of RE deployment, not only at the national but also at other spatial levels. In both Italy and the UK, there have been differences in the way in which national targets have been delegated to the regional level. Italy adopted a principle of ‘burden sharing’ that ‘distributed’ the national target for RE between Italian regions following a detailed methodology (MISE, 2010). However, the multi-year delays that occurred in the development of such a methodology left the regions to decide on their own targets, indeed whether to set targets at all. Regional targets reflected a fragmented and uncoordinated approach to identify regional RE potential, underestimating technological and legislative developments. Regional targets (before and after the burden-sharing) were exceeded in both Apulia and Sardinia by the intermediate period of 2016 while Tuscany was set to achieve its burden-sharing targets only by 2020.

In Scotland and Wales, on the contrary, target settings have become a key feature, and a policy output of devolution, providing an important act of differentiation from Westminster (Cowell et al., 2015). The process of target setting was not influenced by Westminster. Rather they were derived directly from regional growth agendas that reflected mainly ‘domestic’ processes: such as political agenda setting, assessment of the resources available and projects in the pipeline (Cowell et al., 2015). While Scotland managed to meet a succession of its own targets set above the UK norm, acting as a ‘positive feedback loop’ (WWF, 2014: 26), Welsh ambitions for RE expansion have been described as ‘a wish list, rather than a concrete action plan for delivery’ (De Laurentis, 2012: 1992).

4.1.2 Spatial planning

Forms of spatial planning are often considered valuable policy mechanism to help accelerate the growth of RE deployment and manage the potential disruption to existing land uses and the diverse values attached to them. The processes of weighing resource potential and different environmental values against RE targets are often articulated through deliberation between national, regional and local stakeholders. While planning institutions, at national and regional levels, are often required to mobilise a dominant strategic line around the delivery of specific objectives and guidance, it is the regional government (and the local authority or the municipality) that often engages with local stakeholders and can design and regulate locally tailored implementation strategies in accordance with local and regional specificities and priorities. Spatial planning therefore reflects the capacities and willingness of governments to render land available for RE development and manage social response (Cowell et al., 2015). In both Italy and the UK, it is the regional (and local) levels that are tasked with weighing resource potential and different environmental values against RE targets.

In Italy, the national government was set to provide, following the Legislative Decree 387/2003, a set of guidelines for the siting of RE plants, under the principle that RE installations were considered of ‘public utility, urgent and could not be deferred’. However, such guidelines were issued in 2010, seven years later than planned, contributing to a great variety of spatial planning approaches for RE at the regional level. This variety resulted in some regions becoming more amenable to large-scale development, while others attempted to restrict the sizes of RE projects.
Tuscany adopted a coordinated approach between the regional and the provincial levels, that identified resource potential but also the environmental implications of RE deployment. Although Apulia lacked coordination among the different spatial levels, it created a fast track approval and simplified licensing system that helped streamline the authorisation process for RE planning, project approval and installation. This provided ‘a positive image’ of the region, leading to increased interest from RE developers and investors attracted by lucrative national incentives and favourable natural resource conditions. An attempt to regulate and limit RE deployment via a Regional Landscape and Territorial Plan was adjudged unconstitutional and abolished by the Italian Supreme Court as it contravened the principle of the Legislative Decree 387/03 (cf. Perrotti, 2015). The Sardinian regional government sought to regulate energy-environmental planning for wind installations via the instrument of moratoriums. These moratoriums became the subject of long-term contestation and had the effect of delaying RE projects, ultimately discouraging investors.

Land use planning and energy consenting have been critical for both Scotland and Wales in shaping RE deployment, offering much scope for autonomous policy development and influencing outcomes. In Wales, planning responsibility for energy is divided between the Welsh and UK governments depending on project size and onshore/offshore location. The Technical Advice Note 8: Planning for RE (TAN 8) represents the sphere in which the regional government has done most to steer energy development (especially on-shore wind) within its territory, acting as a Welsh ‘national zoning framework’ (Cowell et al., 2017: 175). TAN 8 offered a supportive policy context for wind power development and was considered, by the wind energy sector, as a ‘stabilising condition for investment’ (Cowell et al., 2017). Nevertheless, wind deployment has been slower and patchier than in Scotland (see Ellis et al., 2013). To some extent, the spatial concentration of large-scale windfarm applications, within the seven TAN 8 zones, coupled with the requirement for major new grid connections, triggered protests and subsequent refusal of planning consent despite the supportive spatial policy. This cast a shadow over the suitability of the zoning approach to yield the desired implementation targets for renewables.

Planning is often seen as another ingredient in Scotland’s success in delivering RE (Cowell et al., 2013). The Scottish Government played a key role in steering RE consent, by encouraging local planning authorities to adopt a favourable stance towards RE development and using its power of ‘strategic plan approval’ to overturn local authority zone definitions if these were considered too spatially restrictive. The Scottish National Heritage, responsible for the conservation of landscape and nature in Scotland, has also provided a generally supportive and facilitative stance (Toke, 2014).

These examples show some of the differences that occurred in organising the relationship between RE energy resources and the challenges that RE deployment has presented for the management of land use. The regions considered have shown an increased governance capacity over energy and have made use of targets and spatial panning to promote RE deployment. Regional governments have sought to organise the relationship between energy resource and land-use values and interests, reflecting the differing capacities and willingness of a number of regional actors to render land available for RE development, constructing opportunities for, and barriers against, RE development.
4.2 Visions for renewable energy development

As discussed, different actors can organise and mobilise particular resources, with the aid of, and in relation to, natural resource endowments, creating a particular vision(s) and development path, prioritising interests and mobilising resources for RE generation. In many cases, regions, although they may lack control over economic framework conditions (e.g. subsidies and feed-in tariffs), can mobilise coherent shared visions for the exploitation of their indigenous renewable resources (Essletzbichler, 2012; Späth and Rohracher, 2010; Dawley et al., 2015). Visions can often mobilise actors and resources, influencing which RE-related discourses gain hegemonic status and which are marginalised (Lupp et al., 2014) and how the dominance of other energy sources can dilute or reinforce the power of emerging discourses in favour of RE (Szarka, 2007). Opposing and supporting discourses can also be framed differently at local and national levels via competing conceptualisations of the rural ‘resource’ (Lennon and Scott, 2015).

There are differences in the way in which the regions under investigation promoted RE deployment, exploiting regional renewable resources for the benefit of their territory, identifying priorities that differ from those at national levels, and prioritising specific RE sources over other energy sources (renewables and non-renewables). RE development in Apulia was seen as an opportunity to alter patterns of economic growth. Breaking the trajectory of fossil fuel path dependence has become a major goal of its regional energy policy, combined with the desire to support RE development rather than the re-introduction of nuclear capacity. Strong signals in this direction were sent by the region’s commitment to support the growing number of firms and research capabilities in the RE cluster. Most significant was the way in which the Apulian government streamlined and accelerated the bureaucratic procedures of license concessions, promoting public sector deployment and financial support for the creation of energy parks.

The measures adopted for the diffusion of RE in Tuscany were primarily aimed at overcoming the lack of technology transfer processes from university to industry, as these processes were much less present than elsewhere in Northern Europe and the US (Di Minin et al., 2006). The regional energy plan promoted a new model and vision for Tuscany, the ‘Modello Toscana Green’, based on an industrial strategy for RE that would stimulate networking and technology transfer activities between local research institutes and the small and medium firm base. Moreover, in Tuscany, the presence of a higher capacity of RE resources already deployed, such as geothermal and hydro, has influenced the choices made concerning RE deployment, with RE targets having been reached by these sources alone.

The peculiarities of Sardinia’s energy system, devoid of natural gas resources or supply, with 94% energy dependence on mainland Italy, have had an important effect on RE deployment narratives. Two major infrastructure projects have de facto dominated RE and energy priorities in the region: the construction of a large submarine power cable to connect Sardinia with Tuscany to overcome a condition of energy isolation (Corsale and Sistu, 2016); and the opportunity offered by the construction of a gas pipeline connecting Algeria to the Italian mainland passing through Sardinia (the GALSI National Project). The latter was originally conceived as a win-win solution for region and nation, guaranteeing the natural gas...
supply to the region and helping the national government to deliver a more secure energy system. While the project has currently come to a halt, energy development in Sardinia has been supported and RE developments constrained by an investment argument that could provide the main solution to the national energy security problem.

Scotland and Wales have each produced energy strategies that stress their own regional visions and aspirations for RE development. Successive Scottish Governments have positioned RE expansion as central to Scotland’s national economic future, with a sustained emphasis on green jobs, economic growth and international competitive advantage, developing an ambitious strategy for the development and deployment of indigenous natural resources. Post-1998 Scottish independence debates offer an example of how the Scottish National Party, and its leadership, has regarded energy development- and RE- as part of the imagery of an independent Scotland (Dawley et al., 2015; Toke et al., 2013). The vision(s) for RE deployment became part of a much stronger drive towards Scottish independence (e.g. to gain further control over energy policy). Significantly, this political vision of harnessing the comparative advantage of Scotland’s natural resource potential benefitted from cross- party support that also opposed nuclear new-build. A critical mass of actors (e.g. major energy businesses, RE energy trade association and regional development agencies) have also mobilised financial and other resources for project delivery, helping the Scottish Government to use its available powers assertively to facilitate the implementation of projects.

Welsh governments have sought to ‘act’ on energy as an integral part of their wider economic and environmental agendas and to ‘maximise the potential for RE in Wales’, based on harnessing the region’s natural resources, to attract significant new investment. Nonetheless, there has been a lack of clarity and focus in the economic development thinking of RE policy. Between 2007 and 2011, RE policy was closely tied to climate change policy and since then ministerial responsibility for the energy portfolio has not been clear. Ministerial drive also lacked in the face of some public dissent towards windfarm and associated infrastructure developments. These factors, to some extent, increased developers’ scepticism around the capacity and willingness of the Welsh Government leaders to demonstrate leadership on driving the RE agenda forward, perpetuating the view that there has been a tentativeness regarding the ‘visions’ for RE deployment in Wales. Wales also lacked the industry presence and support that was evident in Scotland and elite consensus has been more difficult to maintain (Cowell et al., 2017).

Summarising, this section has explored how some regions have sought to capitalise on the opportunities offered by RE deployment to promote clustering activities and to foster economic development and innovation within their territory; some have seen RE deployment as an opportunity to promote networking and knowledge transfer across many actors involved, while others have mobilised RE deployment as an opportunity to foster regional identity and independence. Different deployment rates and RE paths have been pursued in order to fulfil specific visions and trajectories, showing how specific RE sources can get selected over other energy sources (renewables and non-renewables) and priorities.
4.3 Infrastructure requirements and legitimacy to shape infrastructure networks

The upgrading of transmission and distribution networks is critical for the successful integration of renewable power (Tenggren et al., 2016). With the expansion of RE capacity, electricity network structures and their management have increasingly become a strategic concern (Sataøen et al., 2015). While the national level plays an important role, most challenges surrounding energy infrastructure provision and governance simultaneously involve various spatial levels (Goldthau, 2014). Managing grid capacity and infrastructure upgrades becomes a site-specific issue that questions the role of the region in steering infrastructure requirements; this includes planning processes and approvals (Balta-Ozkan et al., 2015; Sataøen et al., 2015).

The rapid increase in RE penetration that occurred in Italy between 2010 and 2012, has required changes both at transmission and distribution levels, ranging from dispatch operations (to increase system efficiency) to the introduction of mechanisms to enhance performance and measurement of frequency regulation and the construction of new lines (IEA, 2016). However, congestion problems have become more evident in Southern Italy. The overwhelming number of RE initiatives in Apulia resulted in negative effects on the national electricity system, increasing the pressure, at the regional level, to overcome the impact of the plants and their connection to the wider energy network. Apulia’s regional network capacity relies especially on old 150 kV lines, which do not allow the dispatch of all the power produced. Moreover, small municipalities show high electricity reverse flow among the regional primary substations. Pending connection requests in Apulia by 2014 represented almost 50% of the entire national figure, 3–4 times larger than those of other southern regions and significantly above the national average (BURP, 2014). While Tuscany has been affected to some extent by infrastructural issues, against the two interventions necessary in the north and in the centre of Italy, Apulia required 12, three of which were for new interregional interconnections, while the remaining nine related to the development of 380 kV high-voltage collection stations.

Sardinia has a relatively confined electricity grid with limited interconnection to the Italian mainland, a limited thermoelectric park and a reduced energy demand due to the economic downturn of recent years (Tema, 2017). The network infrastructure also presents some distinctive bottlenecks and weaknesses, including a weakly ‘meshed’ transmission and distribution line (the meshing of the 380 kV network is non-existent) which causes line overloads and voltage problems (Purvins et al., 2011). Such peculiarities have reduced the opportunities for connection and export of energy, making the energy infrastructure subject to a more severe control from the transmission operator and more liable to limiting dispatch orders (RSE, 2011). These physical constraints represented a limiting factor for RE deployment (Regione Sardegna, 2012; Benini et al., 2011).

Although both Apulia and Sardinia have experienced higher levels of congestion due to the physical constraints of their respective local transmission and distribution networks, they have also managed to establish relations with network operators to: i) facilitate and speed up the consenting processes; and ii)
collaborate with network providers on the programming of electricity network infrastructure enhancement (via infrastructure governance round tables and Memoranda of Understanding). Infrastructure limitations have also offered areas in Apulia and Sardinia to become key sites for the experimentation of innovative technologies and electrical infrastructure (e.g. electricity storage).

The speed and extent of electricity network upgrading in the UK has been unsatisfactory and the national grid infrastructure was considered a main ‘external failures’ that delayed RE targets achievement (Wood and Dow, 2011). Network developments and enhancements tended to follow a response-mode approach to new electricity generation. Moreover, a regulatory approach based on an ‘invest then connect’ principle, in vigour until 2009, led to an extensive queue of prospective new projects waiting for the completion of any necessary reinforcements to support their connection (IEA, 2012). While regulatory changes have partially mitigated this problem, the increase in RE generation capacity has caused many parts of the grid to become ‘closed to new connections’, with congestion problems unevenly distributed across the UK.

Power from RE generation in the north of Scotland has increasingly flowed towards the south (Scotland and GB), adding to a network system that was already operating at its maximum capacity (ENSG, 2012). The Scottish Government’s Electricity Generation Policy Statement (SG, 2013) highlighted how Scotland expected to have an ‘excess generation capacity that can be exported through existing and planned export links’ (2013: 35). Hence, wider linkages have been needed for grid upgrades and reinforcements to enable electricity distribution from the north of Scotland energy sources to English demand centres. Improved interconnectors between Scotland to England, and the North and Irish Seas and intra-regional connections between the main islands of the Western Isles, Orkney and Shetland are planned to resolve such bottle necks.

Wales provides an ‘object lesson’ of the importance of grid capacity to promote RE generation (Cowell et al., 2013: 38). Both onshore and offshore wind generation connections in Wales, together with the potential connection of a new nuclear power station, have raised regional connection issues, in North and mid-Wales (ENSG, 2012). The TAN 8 planning area in mid-Wales did not contain capacity for large-scale wind developments (Ove ARUP, 2010) due to infrastructural constraints both at transmission and distribution levels. Plans for major new 400 kV grid lines were met with protests that ultimately halted further project developments in the area. The need for a flexible and affordable grid infrastructure is considered ‘a fundamental enabler to connect the new generation that Wales needs for a prosperous low-carbon future’.

Since UK electricity privatisation in 1990, key electricity decisions have been taken by arms-length regulators that operate on a UK-basis, and regulatory arrangements make it difficult to drive forward major system reinforcements. This creates challenges and delays and, at the regional level, can also frustrate policies for RE delivery. Hence, the Scottish Government has signalled consistently the importance of infrastructure renewal. The first National Planning Framework in 2004 for Scotland already contained a section on energy infrastructure and subsequent versions followed suit (Ritchie et al., 2013). The Scottish Government also showed support for the most significant piece of grid reinforcement (the
transmission line from Beauly to Denny). Beyond the immediate and practical management of the decision-making process, the Government provided a clear signal and commitment to the project going ahead, which sustained industry efforts towards RE generation during a heavily contested consenting process (Cowell et al., 2013). The Scottish Government has also played a key active role in the negotiations around grid issues at a strategic level, engaging with the UK Government, Scottish Power Transmission and Scottish Hydro Electric Transmission plans, the National Grid, and OFGEM on future network development and on the regulatory frameworks that deliver this. These relationships allowed for the fast-tracking of Scottish Power Transmission and Scottish Hydro Electric Transmission plans, including investment of £7 billion in Scotland’s high voltage transmission network by 2021.

Steering the electricity network, at the regional level, is clearly often problematic. In Italy and the UK there have been underlying differences and similarities in the opportunities, actions, and constraints in infrastructure development, at national level, and in the way in which existing infrastructure and plans for the transmission and distribution network development have been governed. Nevertheless, we have stressed how the regions under consideration have variously participated in, and supported, decision-making processes for infrastructure renewal, and we have identified the types of constraints the available infrastructure and its upgrading have posed in these regions.

5.0 Discussing The Spatial Unevenness In Renewable Energy Deployment: Some Key Features And Policy Insights

The section above discussed the spatial unevenness and variation of RE deployment in Italy and the UK. We argued that RE deployment processes and their spatial unevenness can be better understood by analysing the many ways in which local and regional actors engage with RE and how they can be captured via the three socio-material dimensions highlighted. Instrumental to the understanding of spatial unevenness in RE deployment is the fact that some instruments (e.g. targets, planning guidance and subsidies) can have multiple, sometimes interacting effects. As we have shown, this multiplicity is influenced by the specific regional contexts in which RE projects emerge (e.g. land availability and the cultural and historical characteristics of each region).

Although national incentives for renewables have been applied consistently across the regions in the two countries, regional RE deployments have differed significantly. The evidence shows that regional governments have sought to organise the relationship between energy resources, land-use values and interests by variously constructing opportunities for, and in some cases barriers against, RE development.

Several distinguishing features have emerged, showing how some regions (e.g. Apulia in Italy and Scotland in the UK) have managed to successfully align their strategies and governance in order to maximise their RE potential. These factors are summarised in Table 2. We argue that the RE capacity deployment successes achieved by Apulia and Scotland can be explained in terms of the alignment of the following features:

- The ways in which targets and resource availability acted as drivers for RE deployment;
• The degree of political autonomy in planning, the capacity to facilitate consenting processes at sub-regional levels, and the reservoir of land;

• The political will for RE expansion, elite consensus and the presence of relevant industry actors, together with in some cases a compelling narrative against nuclear energy;

• The participation and involvement in infrastructure renewal by the regions, despite the lack of formal regulatory powers and political legitimacy to shape energy infrastructure.
**Table 2**
Key features that influenced RE deployment in the regions investigated*

| Features derived from the socio-material dimensions of RE | Apulia | Tuscany | Sardinia | Scotland | Wales |
|----------------------------------------------------------|--------|---------|----------|----------|-------|
| Targets and resource availability:                       |        |         |          |          |       |
| Targets and resource availability as drivers for RE    | XXX    | X       | X        | XXX      | XX    |
| Planning and land use:                                   |        |         |          |          |       |
| Distribution of power in planning                       | XX     | XX      | XX       | XXX      | X     |
| Facilitation of consenting processes                    | XXX    | X       | X        | X        | X     |
| Land ownership and availability (e.g. ‘land reservoir’) | XXX    | X       | X        | XXX      | X     |
| Visions:                                                 |        |         |          |          |       |
| Political will for RE expansion                         | XXX    | X       | X        | XXX      | XX    |
| Elite consensus and presence of actors                  | XXX    | XX      | X        | XXX      | X     |
| RE vis-à-vis alternative sources                        | XXX    | XX      | X        | XXX      | X     |
| Infrastructure:                                         |        |         |          |          |       |

*The number of Xs represents the extent to which each feature was present and influenced RE deployment in each region, as derived from the case study research. For instance, one X denotes that although the feature is present, it has shown little impact on the deployment of RE, whereas three Xs (XXX) shows that this feature has played a leading role in influencing RE deployment in the region. Two Xs (XX) indicates that while the feature is significant, it is not a key driver of RE deployment.
The research shows that these features have influenced regional RE uptake, but can combine in different ways, depending on the peculiarities and specificities of the context in which RE projects emerge. This can have wider implications for policy. A ‘one-size fits all’ solution that disregards local and regional specificities might have a detrimental effect; it is likely to cause frictions at local and regional levels, including problematic public acceptance of projects, and act as a barrier to development. Moreover, infrastructures that deliver energy from source to user may or may not benefit regional communities along the way. Regional policy makers are wise if they ensure that renewable electricity delivery systems deliver local benefits and design them in ways that spread the costs and benefits in as fair a manner as possible (cf. Jones, 2018). While regions have shown differences in their incentives, capacities and capabilities to increase RE deployment, a number of scholars show that their ability to act is shaped by nation-states. This this has strong implications for the practice and outcome of territorial governance (De Laurentis, 2020; Bridge et al., 2018).

The case studies investigated also suggest that several issues have influenced regional agency, including: i) regulatory power over infrastructure and market supports manifested at the national level; and ii) the role and influence of the lower levels of governance in providing administrative functions (their role, for instance, in planning and consenting). Nevertheless, as the example(s) illustrate, regional political commitment has often been able to overcome lack of formal power and facilitate RE deployment via coordination and the establishment of relationships with network operators (e.g. in Apulia, Sardinia and Scotland) and local authorities/ provinces (e.g. in Tuscany to limit large scale RE deployment). Therefore, it seems likely that a strong engagement in formal and informal networks at different spatial levels can
be very beneficial for RE deployment processes. Such engagements can be effective not only in enabling extensive exchanges of expertise (Lutz et al., 2017) but also in influencing outcomes (e.g. facilitating consenting processes, enhancing infrastructure, and allowing regions to become sites of experimentation with innovative technologies).

RE deployment can also be affected by different governance contexts and by different social interests. The roles of different types of actors and how they organise interests and priorities for RE deployment are important. The roles they play and the coalitions they assemble to promote renewable deployment, and the different interests involved in the framing of RE strategies all matter (cf. Farla et al., 2012). For instance, Scotland’s success builds on a strong actor-network coalition involving a range of organisations. Engaging with a wider group of actors and interests can facilitate access to finance and resources for project delivery and, by the process of ‘joining forces’, helps to build a supportive environment for RE promotion. Hence, factors such as the degree of heterogeneity of the actor-sets, the level of coordination between them, and the interests/objectives that connect them can exert significant influence. The devices used for consultation, experimentation and consensus building become highly important.

The research discussed here has also shown the importance of visions mobilised around RE deployment at the regional level. While visions can be framed differently depending on local/regional specificities, their policy relevance can be expressed in two ways. Firstly, policy decision-makers are often faced with a choice around competing regional imaginaries. A process of negotiation around priorities is required to enrol the assistance of different actors. This process involves a sort of multi-dimensional contest over the relative potency and authority of different vision(s) and their significance for driving RE deployment. An important question to ask is whether a champion narrative can be identified to convey and translate local/ regional relevance and whether the political will is there to pursue it, in face of dissent. Secondly, the vision(s) promoted needs to be nurtured by credible expectations, building from past development (and success) and the actual level of performance if it is to become a convincing path forward. The research has shown that as well as the lack of clarity or the ‘tentativeness’ of regional visions, regulatory and policy uncertainty and delay, at national and regional levels, can act as institutional and administrative barriers. These are important policy issues that need considering for the effective deployment of RE.

6.0 Conclusion

Through comparative case study analysis, the paper has highlighted the factors that can help explain regional variation in RE deployment. We have provided new evidence of how the distinctive features of RE deployment in five different regions in two countries, Italy and the UK, arose and could be identified. The paper shows that understanding the socio-material dimensions of RE offers opportunities to unpack how specific RE resources become realised in some areas and regions and not in others. The analysis yields useful insights into the spatial unevenness of RE deployment at the regional levels and how to address it.
The paper highlights that some instruments (e.g. targets, planning guidance and subsidies) can have multiple effects. These effects are influenced by the specific regional contexts in which RE projects emerge (e.g. land availability and the cultural and historical characteristics of each region). We stressed that institutional capacity, planning and governance, how varied actors organise interests and priorities for RE deployment, compelling visions and credible expectations are all necessary prerequisites for coherent policy outcomes. Their effects, and how they combine in practice, will be influenced and contoured by specific regional contexts: each with their own particular environments, resource endowments, infrastructure, demographic, socio-economic and governance structures. We contend that the three socio-material dimensions of RE investigated are useful in understanding RE deployment processes and their spatial unevenness, contributing to research that highlights the role of institutional variations and governance as foundations for geographical differences in the adoption of RE.

The paper shows the increasing importance of attending to the socio-material dimensions of energy systems and, using RE deployment as an example, it stresses how intertwined physical and political processes can shape energy systems and how these processes can vary at the regional level. It shows that by being specific about which aspects tend to constrain or enable RE deployment at the regional level, we can identify the governance challenges that emerge and how they might be addressed. The paper shows the merit of investigating the role of regional agency in energy research and points towards the relevance of further understanding what regions can and cannot do to influence energy infrastructure and the tensions that might arise in a highly centralised energy policy landscape.

**Abbreviations**

RE- Renewable energy

**Declarations**

1. **Ethical Approval and Consent to participate**

The research conducted during this study was approved by the Ethics committee of the Welsh School of Architecture of Cardiff University, reference n. EC 1504.231. All research participants signed consent to participate.

2. **Consent for publication**

N/A

3. **Availability of supporting data**

As described in the section on methods, the data used for the study was collected from many different sources. Documents consulted are publicly available and were referred to in text. The data collected during the interviews are confidential.
4. Competing interests

The authors declare that they have no competing interests.

5. Funding

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6. Authors’ contributions

CDL and PJGP have made substantial contributions to the design of the paper. CDL conceived the analytical framework, and was responsible for the acquisition, analysis and interpretation of data. Both authors have drafted the work or substantively revised it. They both approved the submitted version (and any substantially modified version that involves the authors’ contribution to the study). They both agreed to be personally accountable for their own contributions.

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References

Armstrong A and Bulkeley H. (2014) Micro-hydro politics: Producing and contesting community energy in the North of England. Geoforum 56: 66-76.

Baka J and Vaishnava S. (2020) The evolving borderland of energy geographies. Geography Compass, n/a

Bakker K and Bridge G. (2006) Material worlds? Resource Geographies and the 'matter of nature'. Progress in Human Geography 30: 5-27.

Balta-Ozkan N, Watson T and Mocca E. (2015) Spatially uneven development and low carbon transitions: Insights from urban and regional planning. Energy Policy 85: 500-510.

Benini M, Cirio D, Gatti A, et al. (2011) Espansione della fonte eolica e sicurezza del sistema elettrico: il caso della Sardegna al 2020.

Bridge G. (2009) Material Worlds: Natural Resources, Resource Geography and the Material Economy. Geography Compass 3: 1217-1244.
Bridge G. (2018) The map is not the territory: A sympathetic critique of energy research’s spatial turn. Energy Research & Social Science 36: 11-20.

Bridge G and Bradshaw M. (2017) Making a Global Gas Market: Territoriality and Production Networks in Liquefied Natural Gas. Economic Geography 93: 215-240.

Bridge G, Özkaynak B and Turhan E. (2018) Energy infrastructure and the fate of the nation: Introduction to special issue. Energy Research & Social Science 41: 1-11.

BURP. (2014) Bollettino Ufficiale Regione Puglia n. 51 del 15/04/2014 ‘Analisi di Scenario della produzione di energia e fonti energetiche rinnovabili sul territorio regionale. Criticita’ di sistema e iniziative conseguenti. Bari: Regione Puglia.

Calvert K. (2015) From ‘energy geography’ to ‘energy geographies’. Progress in Human Geography 40: 105-125.

Četković S and Buzogány A. (2016) Varieties of capitalism and clean energy transitions in the European Union: When renewable energy hits different economic logics. Climate Policy 16: 642-657.

Corsale A and Sistu G. (2016) Surrounded by Water: Landscapes, Seascapes and Cityscapes of Sardinia: Cambridge Scholars Publishing.

Cowell R, Ellis G, Sherry-Brennan F, et al. (2013) Promoting Renewable Energy in the UK What Difference has Devolution Made? Cardiff, Cardiff University.

Cowell R, Ellis G, Sherry-Brennan F, et al. (2015) Rescaling the Governance of Renewable Energy: Lessons from the UK Devolution Experience. Journal of Environmental Policy & Planning: 1-23.

Cowell R, Ellis G, Sherry-Brennan F, et al. (2017) Energy transitions, sub-national government and regime flexibility: How has devolution in the United Kingdom affected renewable energy development? Energy Research & Social Science 23: 169-181.

Dahlmann F, Kolk A and Lindeque J. (2017) Emerging energy geographies: Scaling and spatial divergence in EUropean electricity generation capacity. European Urban and Regional Studies 24: 381-404.

Dawley S, MacKinnon D, Cumbers A, et al. (2015) Policy activism and regional path creation: the promotion of offshore wind in North East England and Scotland. Cambridge Journal of Regions, Economy and Society 8: 257-272.

De Laurentis C. (2012) Renewable Energy Innovation and Governance in Wales: A Regional Innovation System Approach. European Planning Studies 20: 1975-1996.

De Laurentis C. (2013) Innovation and Policy for Bioenergy in the UK: A Co-Evolutionary Perspective. Regional Studies.
De Laurentis C. (2018) The material dimensions of renewable energy deployment: understanding spatially uneven processes at the regional level in Italy and the UK. Welsh School of Architecture Cardiff Cardiff University.

De Laurentis C. (2020) Mediating the form and direction of regional sustainable development: the role of the State in renewable energy deployment in selected regions. European Urban and Regional Studies, na

De Laurentis C and Pearson PJG. (2018) Understanding the material dimensions of the uneven deployment of renewable energy in two Italian regions. Energy Research & Social Science 36: 106-119.

Di Minin A, Lazzeroni M and Piccaluga A. (2006) Economic growth in knowledge intensive emerging areas: the high-tech cluster in Pisa. In: Cooke P and Piccaluga A (eds) Regional Development in the Knowledge Economy. Oxford (UK): Routledge.

Ellis G, Cowell R, Sherry-Brennan F, et al. (2013) Planning, energy and devolution in the UK. Town Planning Review 84: 397-409.

ENSG. (2012) Our Electricity Transmission Network: A Vision for 2020 A Summary of an Updated Report to the Electricity Networks Strategy Group. London: Electricity Networks Strategy Group.

Essletzbichler J. (2012) Renewable Energy Technology and Path Creation: A Multi-scalar Approach to Energy Transition in the UK. European Planning Studies 20: 791-816.

Farla J, Markard J, Raven R, et al. (2012) Sustainability transitions in the making: A closer look at actors, strategies and resources. Technological Forecasting and Social Change 79: 991-998.

Farole T, Rodriguez-Pose A and Storper M. (2011) Human geography and the institutions that underlie economic growth. Progress in Human Geography 35: 58-80.

Galarraga I, Gonzalez-Eguino M and Markandya A. (2011) The Role of Regional Governments in Climate Change Policy. Environmental Policy and Governance 21: 164-182.

Goldthau A. (2014) Rethinking the governance of energy infrastructure: Scale, decentralization and polycentrism. Energy Research & Social Science 1: 134-140.

Hansen T and Coenen L. (2015) The geography of sustainability transitions: Review, synthesis and reflections on an emergent research field. Environmental Innovation and Societal Transitions 17: 92-109.

IEA. (2012) Energy Policies of IEA Countries - The United Kingdom 2012 Review. Paris: International Energy Agency.

IEA. (2016) Energy Policies of IEA Countries - Italy 2016 Review. In: IEA (ed). Paris: International Energy Agency.
IPCC. (2019) Global warming of 1.5°C: Summary for Policymakers (revised version). Switzerland: Intergovernmental Panel on Climate Change.

Jones C, F. (2018) The Materiality of Energy. Canadian Journal of History 53: 378-394.

Kaup BZ. (2008) Negotiating through nature: The resistant materiality and materiality of resistance in Bolivia's natural gas sector. Geoforum 39: 1734-1742.

Kaup BZ. (2014) Divergent paths of counter-neoliberalization: materiality and the labor process in Bolivia's natural resource sectors. Environment and Planning A 46: 1836-1851.

Kuzemko C, Lockwood M, Mitchell C, et al. (2016) Governing for sustainable energy system change: Politics, contexts and contingency. Energy Research and Social Science 12: 96-105.

Lennon M and Scott M. (2015) Opportunity or Threat: Dissecting Tensions in a Post-Carbon Rural Transition. Sociologia Ruralis: n/a-n/a.

Lupp G, Steinhäußer R, Starick A, et al. (2014) Forcing Germany's renewable energy targets by increased energy crop production: A challenge for regulation to secure sustainable land use practices. Land Use Policy 36: 296-306.

Lutz LM, Fischer L-B, Newig J, et al. (2017) Driving factors for the regional implementation of renewable energy - A multiple case study on the German energy transition. Energy Policy 105: 136-147.

MISE. (2010) Piano di azione nazionale per le energie rinnovabili (direttiva 2009/28/CE) In: Economico MdS (ed). Rome: Ministero dello Sviluppo Economico, 1-210.

Ove ARUP. (2010) Research: Strategic Search Area (SSA) Reassessment and Validation. Cardiff: Ove Arup and Partners.

Peck J. (2003) Fuzzy Old World: A Response to Markusen. Regional Studies 37: 729-740.

Perrotti D. (2015) Of other (energy) spaces. Protected areas and everyday landscapes of energy in the southern-Italian region of Alta Murgia. In: Frolova M, Prados MJ and Nadaï A (eds) Renewable Energies and European Landscapes: Lessons from Southern European Cases, Dordrecht: Springer, 193-215.

Purvins A, Wilkening H, Fulli G, et al. (2011) A European supergrid for renewable energy: local impacts and far-reaching challenges. Journal of Cleaner Production 19: 1909-1916.

Regione Sardegna. (2012) Piano energetico ambientale regionale al 2020, Rapporto preliminare di scoping Cagliari: Regione Autonoma della Sardegna, 1-26.

Ritchie H, Hardy M, Lloyd MG, et al. (2013) Big Pylons: Mixed signals for transmission. Spatial planning for energy distribution. Energy Policy 63: 311-320.
RSE. (2011) Energia eolica e sviluppo locale Territori, green economy e processi partecipativi. Rome: Ricerca Sistema Energetico - RSE SpA, 1-173.

Sataøen HL, Brekke OA, Batel S, et al. (2015) Towards a sustainable grid development regime? A comparison of British, Norwegian, and Swedish grid development. Energy Research & Social Science 9: 178-187.

SG. (2013) Electricity Generation Policy Statement Edinburgh: Scottish Government.

Späth P and Rohracher H. (2010) ‘Energy regions’: The transformative power of regional discourses on socio-technical futures. Research Policy 39: 449-458.

Szarka J. (2007) Why is there no wind rush in France? European Environment 17: 321-333.

Tenggren S, Wangel J, Nilsson M, et al. (2016) Transmission transitions: Barriers, drivers, and institutional governance implications of Nordic transmission grid development. Energy Research & Social Science 19: 148-157.

Terna. (2017) Piano di sviluppo della Rete Elettrica Nazionale 2017. Roma: Terna S.p.A. - Rete Elettrica Nazionale.

Toke D. (2014) Renewable Energy and Scotland- ebbs and flows in cooperation with Westminster. Symposium on 'Sub-national government and paths to sustainable energy. Cardiff University.

Toke D, Sherry-Brennan F, Cowell R, et al. (2013) Scotland, Renewable Energy and the Independence Debate: Will Head or Heart Rule the Roost? The Political Quarterly 84: 61-70.

Truffer B, Murphy JT and Raven R. (2015) The geography of sustainability transitions contours of an emerging theme. Environmental Innovation and Societal Transitions.

Walker G. (1995) Energy, land use and renewables. A changing agenda. Land Use Policy 12: 3-6.

Wirth S, Markard J, Truffer B, et al. (2013) Informal institutions matter: Professional culture and the development of biogas technology. Environmental Innovation and Societal Transitions 8: 20-41.

Wolsink M. (2017) Co-production in distributed generation: renewable energy and creating space for fitting infrastructure within landscapes. Landscape Research: 1-20.

Wood G and Dow S. (2011) What lessons have been learned in reforming the Renewables Obligation? An analysis of internal and external failures in UK renewable energy policy. Energy Policy 39: 2228-2244.

WWF. (2014) Scotland: a renewable power house. Dunkeld: WWF Scotland.

Yin R, K. (2014) Case Study Research Design and Methods 5th Edition, Thousand Oaks: Sage Publications
**Figures**

Renewable Electricity installed capacity (MW) Italy and the UK (2003-2018)

Sources: GSE, 2018 & BEIS (2018); BEIS (2015). Italian data for 2018 are estimated.

**Figure 1**

Renewable Electricity capacity (MW) in Italy and the UK
Figure 2

Regional distribution of renewable electricity (n. of sites and MW) in Italy (2014)

Source: GSE (2016)
Figure 3

Regional distribution of renewable energy (n. of sites and MW) in the UK (2014)

Source: BEIS (2014)