Managing environmental and energy transitions for regions and cities

Challenges and policies to support rural environmental and energy transitions

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Background information

This paper was prepared as a background document for an OECD/EC high-level expert workshop on "Managing environmental and energy transition in rural areas" held on 9 September 2019 at the OECD Headquarters in Paris, France. It sets a basis for reflection and discussion. The background paper should not be reported as representing the official views of the European Commission, the OECD or one of its member countries. The opinions expressed and arguments employed are those of the author(s).

Managing environmental and energy transitions for regions and cities

The workshop is part of a five-part workshop series in the context of an OECD/EC project on "Managing environmental and energy transitions for regions and cities". The five workshops cover "Managing the transition to a climate-neutral economy, "Managing environmental and energy transitions in cities", "Managing the transition to a circular economy", "Managing environmental and energy transitions in rural areas", and "Financing, scale-up and deployment". The outcome of the workshops supports the work of the OECD Regional Development Policy Committee and its mandate to promote the design and implementation of policies that are adapted to the relevant territorial scales or geographies, and that focus on the main factors that sustain the competitive advantages of regions and cities. The seminars also support the Directorate-General for Regional and Urban Policy (DG REGIO) of the European Commission in work of integrating sustainability transitions in the next generation of European Union Cohesion Policy programmes 2021-2027, as well as to support broader discussion with stakeholders on managing long-term environmental and energy goals in EU regions and cities. The financial contributions and support from DG REGIO are gratefully acknowledged.

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1 Introduction: the significance of rural areas in environmental and energy transitions

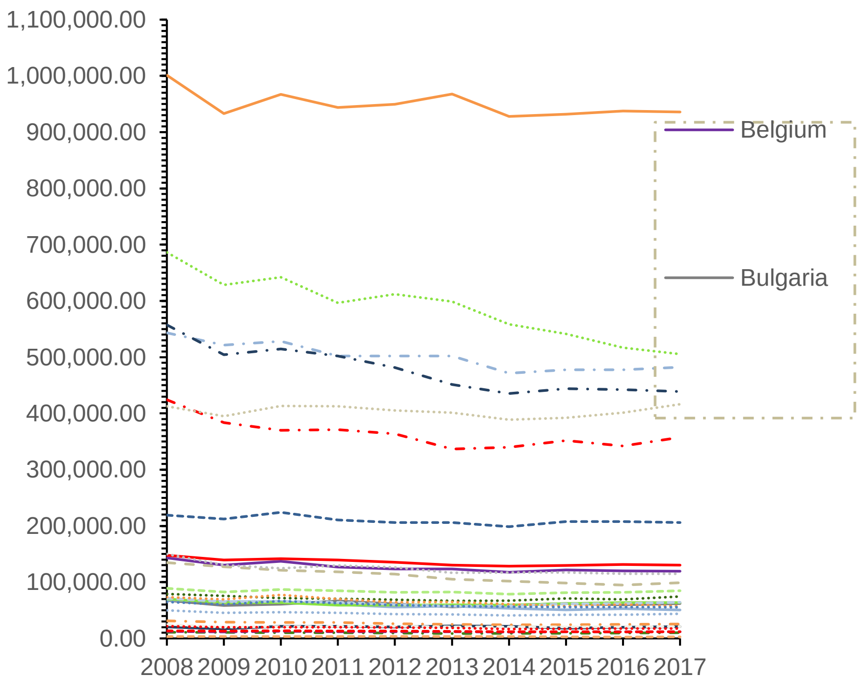
Rural areas have long been valued economically and culturally for their resource value in relation to food and fibre production, although it has also been increasingly recognised that they serve a multiple range of functions and services. Concepts such as a 'multi-functional countryside' and 'ecosystem services' have risen to some prominence within many OECD countries and international policy-making organisation such as the European Union, the United Nations and the Word Trade Organisation (e.g. OECD, 2001; 2010; Potter and Burney, 2002; Moon, 2015; Bouwma et al., 2018). The latter concept in particular has also been linked to widespread perceptions that the environmental resources of the countryside (or as it is sometimes characterised, it's natural capital), have been increasingly threatened by practices of over-extraction and resource destruction. This is not only linked to agriculture but also to a range of other uses, including industry, building construction and recreation and tourism, and also by wider scale changes linked to the anthropogenic impacts on environmental processes, particularly climate change.

The relationships between resource destruction and climate change are, however, complex. On the one hand, there are clear synergistic relations between them. For example, resource extraction and destruction associated with deforestation has been identified as a major contributor to global climate change, both through the release of greenhouse gases, principally carbon dioxide (CO_2), and the reduction of carbon sequestration capacity. It is also clear that global climate change is leading to environmental resource loss, including the loss and degradation of land through sea-level rise, seawater incursion, thawing permafrost and heightened aridity (Intergovernmental Panel on Climate Change, 2018). On the other hand, it is also important to recognise that many instances of resource extraction and destruction have limited connections to climate change, and indeed some actions orientated at climate change mitigation, such as movement towards some forms of renewable energy production, may themselves be the source of environmental degradation and destruction. Particular concerns, for instance, have been expressed about the environmental impacts of extensive biofuel production (e.g. Delucchi 2010; Berger et al. 2015; Intergovernmental Panel on Climate Change, 2018).

Rural areas have also been major sites of energy production, distribution and indeed consumption, although their role within energy regimes has been less widely recognised than their position with respect to food and fibre production, and indeed as spaces providing a range of ecosystem and environmental services to people. This relative neglect is rather surprising given the historical role rural areas have played in energy production: Jones (2003: 287), for example, highlights how farm animals such as horses have "for centuries" constituted a major source of power, in what might, after Wrigley (1990; 2006), be described as an 'organic economy'. Within this form of economy, animals and humans formed the principal source of mechanical energy, supplemented in some locations by wind and water as sources of power. The mechanical energy of animals and people was fuelled by biological sources of energy, with rural areas playing a key role in the production of this energy in terms of food and foodstuffs for people and animals. However, the onset of industrialisation was accompanied by, and indeed required, a movement towards a 'mineral based energy economy' in which human and animal sourced power was supplemented by energy obtained from minerals, particularly hydrocarbons such as charcoal and coal, and, somewhat later, by oil and natural gas. Many of these hydrocarbons, as well as the resources used in other elements of the 'mineral based energy economy', such as nuclear power and 'unconventional hydrocarbons' like shale gas, were and continue to be extracted from rural locations, often creating considerable localised environmental and social transformations. Even forms of energy production that are not reliant on the use of mineral based fuels may employ a range of minerals in their infrastructural technologies that are also often extracted from rural areas, including fluorspar, nickel, silver, copper, magnesium, neodymium and indium (see Kleijn et al. 2011; Kim et al., 2015). However, it has been increasingly recognised that the mineral-based economy has been a major source of greenhouse gases such as carbon dioxide and environmental changes associated with climate change derived from their concentration in the Earth's atmosphere.

Rural areas have not only been important sites of production within the organic and mineral energy economies, but also appear likely to play a key role in transitioning to a low- or post-carbon economy. All members of the OECD signed the Paris Agreement within the *United Nations Framework Convention on Climate Change*, which included commitments to reduce CO_2 emissions, increase renewable energy production and energy efficiency, although Turkey has, yet, not ratified it, and the government of the USA has announced its intention to withdraw from it. In relation to the EU, a policy framework for climate and energy established targets of lowering domestic greenhouse gases emissions by at least 40 percent by 2030 compared to 1990 levels (European Commission, 2014), which exist alongside longer-term goals to transition to a competitive yet climate-neutral and low-carbon economy (European Commission, 2011; 2018). It is, however, evident that the rate of progress is uneven, with countries such as the UK, Italy, Romania, Greece, Finland, Denmark and Malta showing declines in greenhouse gas emissions of over 20 percent over the last decade, whilst Poland and Estonia have seen emissions increase, and in many countries, emissions have declined by much smaller amounts and in very uneven ways (see Figure 1). Given this uneven and fluctuating pattern, it is unsurprising that concerns are repeatedly raised about the overall rate of progress, particularly given that it is widely acknowledged that many of the advances achieved have occurred in areas where transitioning is least challenging, and hence it is likely that further transition activities will increasingly tackle areas where change will be harder to implement, and thereby the rate of greenhouse gas reduction is likely to be lower.

Figure 1. Greenhouse Gas emissions EU 28 Countries



Source: Eurostat (2019) Greenhouse gas emissions by source sector (source: EAA) (file env_air_gge). (https://ec.europa.eu/eurostat/web/environment/air-emissions-inventories/database).

Whilst rural areas are important sites of energy production, they are also spaces of energy distribution and locations of energy consumption, as well as major areas for food and fibre production and for the performance of a range of ecosystem and environmental services. This means that rural areas are locked in, in numerous ways, to existing practices and dynamics of rural land use, many of which exhibit high carbon dependencies. Attention, for instance, has been drawn to the extensive use of hydrocarbons in productivity and globally distributed agriculture, and how counter urban population movement and associated housing construction, along with the rise of 'out-of-town' retailing and business parks, have encouraged heighten levels of carbon fuelled travel (e.g. see Bannister 1992; Pfeiffer 2006; Weis 2010; Dujardin 2016). This means that transitioning to a low-carbon economy is likely to pose significant challenges to a range of existing rural land uses and land users, and also create complex dynamics of change that will impact on other major areas of social and policy concern, including food and water security, housing provision, and rural employment and livelihoods. Post-carbon and environmental transition pathways may themselves come to be in conflict with each other, with renewable energy technologies and resources coming to be located in areas where environmental protection is also desired.

Table 1. Domestic electricity consumption in England and Wales

Electricity consumption data for 2017, population data for 2011, in rural and urban areas

Rural-urban character	Domestic electricity consumption (Million kWh)	Domestic energy consumption (% of total)	Population (,000)	Population (%)
Rural village & dispersed in sparse setting	201	1.1	552	1.0
Rural village & dispersed	2,212	11.6	4,657	8.3
Rural town & fringe in sparse setting	72	0.4	296	0.5
Rural town & fringe	1,887	9.9	4,844	8.6
Total rural	4,372	23.0	10,350	18.5
Urban city & town in sparse setting	44	0.2	146	0.3
Urban city & town	7,782	40.9	24,890	44.4
Urban minor conurbation	585	3.1	1,906	3.4
Urban major conurbation	6,245	32.8	18,784	33.5
Total urban	14,656	44.2	45,726	81.5
Total England and Wales	19,028		56,076	

Source: Derived from Office for National Statistics (2013) 2011 Census Analysis - Comparing Rural and Urban Areas of England and Wales (London: OPCS); National Statistics (2019) Middle Layer Super Output Area (MSOA) Domestic Electricity 2017 (https://www.gov.uk/government/statistics/lower-and-middle-super-output-areas-electricity-consumption).

A long-standing focus of rural planning has been on the reconciliation of alternative land uses and dynamics, particularly through mechanisms of development control, but also encompassing rural development policies. Within many OECD use has been made of spatial planning practices such as zonation's as to where particular forms of energy development might be viewed as inappropriate or, conversely, where there appears to reasons to accommodate their construction (e.g. see Cowell 2007, 2010; Bunzel et al 2019). There has also been increasing use of more collaborative forms of planning focused on seeking to make use of partnerships, coalitions and incentives to indirectly steer development outcomes (Cowell 2007; Pitt and Congreve 2017). Both forms of planning have often been promoted as a counterweight to predominant sectoral based policy making. This can be clearly seen in the EU, where policy making with regard to rural areas has long been very clearly focused on providing agricultural support. There has been a gradual, although far from linear, movement to incorporate some environmental considerations into agricultural policy making, as well as the development of a separate, and much less well-resourced, policy 'pillar' related to rural development that provided support to elements of the non-agricultural rural. These elements have included energy, with many rural development practitioners viewing energy infrastructural developments as a means to stimulate rural economic growth, both directly through the economic and financial benefits generated by the energy development, or indirectly through the provision of power supplies to an area.

The EU has come to recognise such arguments, with "facilitating the supply and use of renewable energy sources" being included as one of the focus areas of the *European Agricultural Fund for Rural Development* for the 2014-2010 period. However, it is only one of 18 focus areas, and although there are no detailed break-downs of funding within the focus areas, within at least six EU countries there has apparently been no funding of projects within this area (European Court of Auditors, 2018), and it appears likely that rural development projects related to renewable energy are less prominent than those in other focal areas across many other countries. A recent report on renewable energy and rural development found that most member states did not employ any form of prioritisation of renewable energy when making decisions concerning rural development projects, notwithstanding the presence of national commitments to expand renewable energy production (ibid). The report argued that the European Commission needed to ensure that project funding decision-making amongst member states employed selection procedures that meant support was given "only to viable renewable energy projects with a clear benefit for sustainable rural development"(ibid.:12). Having said this, it is clear that some national and regional governments have made clear links between post-carbon energy developments and concerns such as local economic development, community development, social cohesion and well-being. The Scottish Government, for instance, has for over a decade explicitly sought to foster community based renewable energy and energy saving initiatives, although the overall impacts of these have been a source of debate (e.g. Creamer 2015; Macdonald et al 2015; van Veelan 2017). It is clear that the impacts and responses to policy initiatives are highly differentiated, which supports the need for place sensitive approaches, although it is also clear that these need to be integrated into more translocal initiatives and support, including pricing mechanisms such as carbon pricing and feed-in tariffs.

Alongside these changing foci of rural policy-making have been changes in modes of government. It has been argued, for instance, that rural policy-making within OECD countries has moved gradually, and unevenly, from sector-focused, standardised and quite centralised policy-making through to more multi-sectorial, diverse and territorially focused and integrative policy-making. As illustrated in Table 2, these changes have been summarised as a movement away from an 'Old paradigm' of rural policy-making that emerged in the three decades following the Second World War, through a 'New Rural Paradigm' that prevailed in the decades spanning the millennium, and into an emergent 'Rural Policy 3.0' (see OECD, 2017; Tomaney et al., 2019), or alternatively as a movement from exogenous rural development policies to endogenous ones and then to neo-endogenous forms (Ray, 2006; Shucksmith, 2010).Whilst promoted as a means for developing greater connections between rural development and the fostering of renewable energy (OECD, 2012), there exist clear challenges and tensions surrounding its enactment and hence concerns that notions associated with Rural Policy 3.0 are "more aspirational than operational" (McMcDonagh, 2013: 713). Challenges include the extent to which its desired integration of policy dimensions, levels of government and partnerships can be achieved; the extent to which it can deliver the speed and scale of change required to address international targets related to greenhouse gas emissions and use of fossil fuels; and the degree to which it acts to accentuate existing inequities in rural areas.

This working paper seeks to detail the significance of energy within rural areas in OECD countries and the role that these areas are already playing in delivering on climate change mitigation through transitioning to a post-carbon energy regime. It will examine the significance of rural areas to renewable energy production and the challenges associated with further expansion of this activity. Attention will also be paid to rural areas as spaces of energy consumption and the role energy has played in constructing contemporary rural life. It is argued that the significance of energy to the performance of everyday lives in the countryside creates a series of major challenges to transitioning to a post-carbon society that have received much less attention than the development of renewable energy but are of equal significance in achieving carbon neutral countrysides. The working paper will end by considering some of the key challenges of transitioning to a post-carbon society as well as policy options for achieving change. However, before commencing these tasks it will briefly discuss the formation of energy and environmental policies and their relationships with rural development policies, plus consider the environmental demands that are placed on rural areas and how these create both localised and dispersed impacts.

Table 2. Changes in Rural Development Policy Making

Rural Development Strategies	Objectives	Key actors & stakeholders	Policy focus	Policy Approach	Rural Development Concepts
Old rural paradigm	Equalisation	Agricultural organisations and national government	Primary sector focused	Uniformly applied top down policy	Exogenous Rural Development
New rural paradigm	Competitiveness	All levels of government plus key stakeholders	Multiple sectors based on their competitiveness	Bottom-up policy, local strategies	Endogenous Rural Development
Rural policy 3.0	Deliver improvement in multiple dimensions of economic, social, environmental well-being	Multi-sectoral & multi-level	Low-density economies differentiated by type of rural area	Integrated approach with multiple policy dimensions	Neo-Endogenous Rural Development

Source: derived from OECD (2016) OECD (2018) RURAL 3.0: A Framework for Rural Development. Paris: OECD Publishing;Tomaney J et al. (2019) 'Regional planning and rural development: evidence from the OECD. In: Scott M et al (eds.) The Routledge Companion to Rural Planning. London: Routledge, 173.

2 Evolutions in environment, energy and rural development policy frameworks

The changing modes of rural development policies outlined in Table 2 can be seen in part to have emerged in association with changes in the character of rural land use associated with what has been described as a transition to a multi-functional or post-productivist countryside. The value of these two terms has been the subject to some debate (e.g. Evans et al., 2002; Wilson and Rigg, 2003; McCarthy, 2005; Mather et al., 2006), but both point to the way a growing series of demands are being placed on rural areas. Whilst rural areas have long been viewed and valued as spaces of agricultural production and, with some reservations, as places of primary resource extraction, these demands are in many areas supplemented, and indeed frequently, surpassed by a series of other land use demands, including housing, recreation, tourism and, as highlighted in the introduction, by energy production. Running alongside these were also a series of cultural values attached to the countryside, related in part to it as a productive resource space, but also viewing it as a space for less exploitative relationships (Phillips and Mighall, 2000). Whilst such relationships have arguably always been of significance to people, notions of multi-functionality and post-productivism that emerged from the 1990s suggested that they were becoming of increasing significance, not least because a series of problems were emerging in association with the productivist relationships being forged within advanced capitalist societies, including over-production, falling farm-gate prices and environmental pollution. Such problems increasingly became the focus of rural policy-making within OECD counties, with governments and international organisations such as the EU developing policies to try to address issues of over-production, pollution and environmental degradation, as clearly illustrated by the series of modifications to the EU Common Agricultural Policy (CAP). Whilst primary attention was given throughout these modifications to agricultural support, they gradually incorporated greater recognition of non-agricultural rural activities and the need to address environmental problems. Accompanying this was growing recognition that these problems might extend beyond quite direct but localised impacts, to involve consideration of indirect transnational and, eventually, global impacts. Climate change represents one acute manifestation of a wider 'up-scaling' of environmental concerns, and policies, that has been identified by a series of commentators (e.g. Cater 2001).

As discussed in the introduction, rural development policy has been impacted by rising recognition of environmental concerns, with concepts such as sustainable development emerging as key concerns in the New Rural Development paradigm. Such notions highlighted the need to consider issues beyond economic productivity and encouraged recognition that activities beyond agriculture were part of contemporary life in many rural areas. The concept of a multi-functional countryside provided a way to articulate the simultaneous presence of a range of activities, whilst concepts such as natural capital and ecosystem services enabled incorporation of environmental concerns into policy discussions (Maes et al., 2012; Sitas et al., 2014; Scott et al., 2018). Ecosystem services in particular connected to growing concerns about global climate change, highlighting how rural spaces were not only spaces of human resource extraction, land use and enjoyment - or to use the language of ecosystem services, places for the performance of 'provisioning' and 'cultural' ecosystem services (Millenium Ecosystem Assessment, 2005) - but were also important locations for so-called 'supporting' and 'regulating' ecosystem services. The former relates to the provision of resources that quite directly enable life for plants and animals, including people, whilst the latter referred to interactions that help constitute and circulate the key resources. The functioning of supporting ecosystem services was the focus of many of the localised environmental concerns and policies that surrounded productivist agriculture in the early decades of EU environmental policy-making, whilst regulating services were increasing recognised within the subsequent up-scaling.

Central within this regulation focused up-scaling was climate change, it being increasingly recognised that local actions impacted on wider processes, including the carbon-cycle, inducing changes that could have large scale and potentially irreversible impacts. Application of concepts such as regulating ecosystem services has served to highlight the contributions that rural areas make to environmental circulatory systems, such as the carbon system. As outlined, in the introduction rural areas may be important sites of carbon extraction and emission, but they are also areas of carbon storage and sequestration.

As also highlighted in the introduction, energy extraction and use has been an important source of greenhouse gases and hence global climate change. Within many OECD countries, policies with respect to energy have been developed and pursued in relative isolation from both environmental and rural policy-making. There have, however, been clear attempts to develop more integration between these areas. In the EU, for example, the European Commission's (1997) '*Energy for the Future: Renewable Sources of Energy*' connected energy development into concerns over climate change, arguing for a doubling of renewable energy's contribution to fulfilling gross energy demand by 2010, while specific targets for renewable energy's contribution to electricity production were set by the '*Renewable Electricity Directive*' (Directive 2001/77/EC) in 2001, and in 2009 the EU adopted a '*Climate and Energy Package*' that established not only a 20 percent target for the use of renewable energy sources but also a 20 percent reduction target for greenhouse gas emissions (Council of the European Union 2008), both of which were doubled in the European Commission's (2014) *Policy Framework for Climate and Energy in the Period from 2020 to 2030*. However, as Strambo et al. (2015) highlight, within the EU, and indeed more widely, energy policy makers are often simultaneously managing several major policy agendas in addition to those related to climate change mitigation, with concerns such as energy security and marketisation being given higher priority at particular points in time (see also Stevenson and Richardson, 2003). Sutherland et al. (2015: 1551) indeed argue that EU renewable energy policy-making exhibits an inherent multifunctionality, "as governments seek to meet multiple objectives" in addition to any particular original purpose, with different national governments often pursuing quite different objectives in connection with the same policies. In addition to multiple and changing priorities, there are potential divergences in modes of governance, with energy policies in many countries often seen as concerns for central government, whilst rural development and environmental policy-making often promotes more local involvement. The European Court of Auditors (2018: 24) has recently argued that the EU's renewable energy policy framework "could better exploit the opportunities of renewable energy development in rural areas whilst mitigating the risks related to it", and argues that current policy arrangements mean that opportunities of rural renewable energy development "have not been sufficiently exploited".

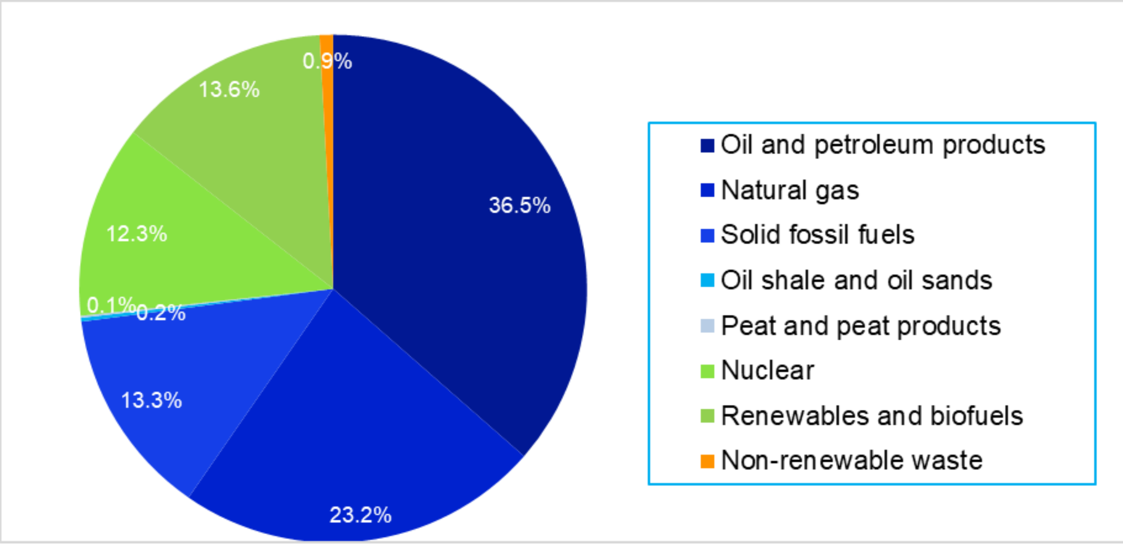
3 Energised ruralities

Rural areas in changing energy regimes

As outlined in the introduction, rural areas have long been important locations for energy production, distribution and consumption, and have played these roles across organic, mineral/hydrocarbon and emergent post-carbon energy regimes. Whilst emphasis is often placed on fossil fuels as a source of both energy and greenhouse gas emissions, it is important to recognise that people in many rural areas of the world are still heavily reliant on organic sources of energy, including human and animal labour power and the burning of biomass. Nejat et al. (2015: 846), for example, argues that 'traditional biomass', principally firewood and charcoal, provides the major source of energy for 40 percent of the global population, even though it only accounts for 11.5 percent of the world's primary energy supply. Conversely, whilst official figures suggest that by 2017 all OECD residents have access to electric energy supplies, in officially designated low income countries the figure lies at just under 28 percent (World Bank, 2018). However, OECD countries exhibit different energy mixes, as illustrated by Figure 2 which shows the energy balance of countries in the European Union. It shows clearly the significance of fossil fuels as a source of energy within these countries (contributing over 72 percent of gross available energy), alongside significant energy inputs from nuclear and renewable power sources. Within the renewable sector, biomass is the largest contributor when this is taken to encompass wood and other solid biofuels, biogas, liquid biofuels and biodegradable wastes, accounting for over 63 percent of renewable energy production within the EU (European Court of Auditors, 2018).

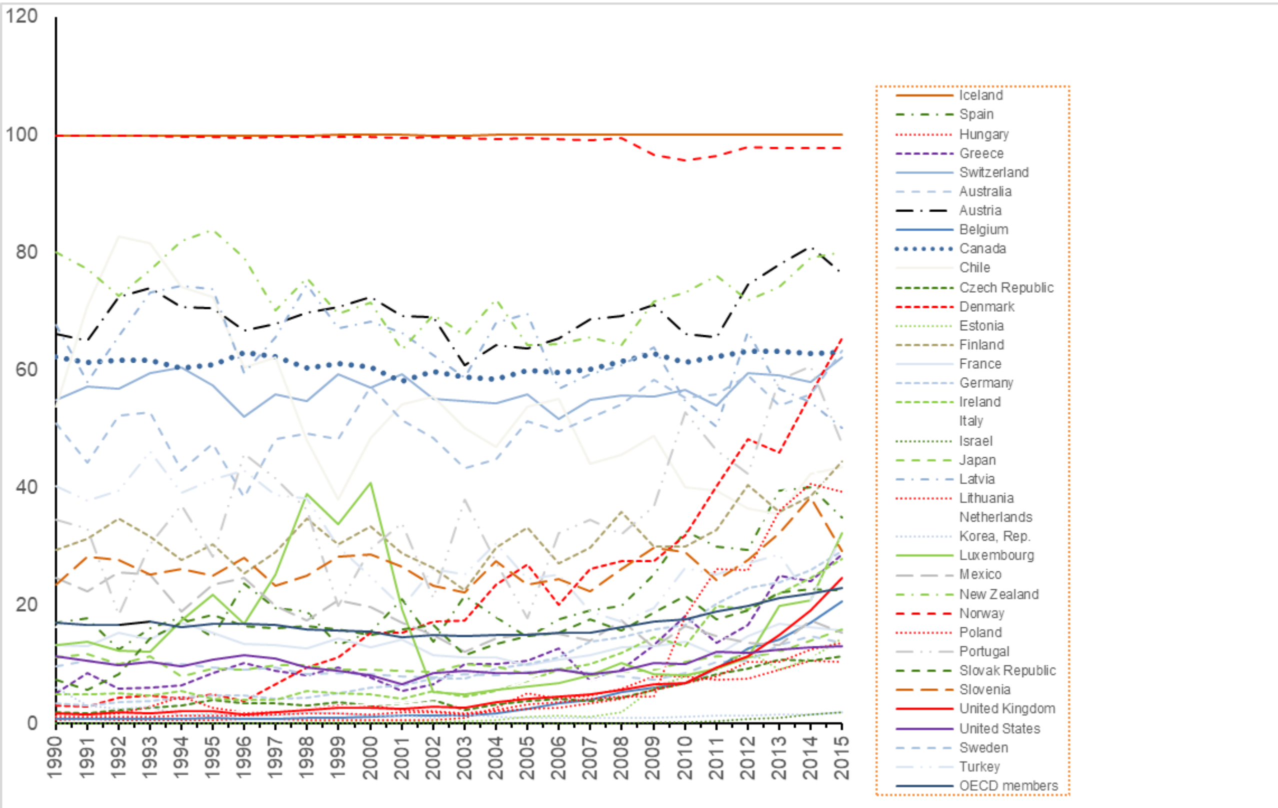
As illustrated in Figure 3, there has been an overall growth in the contribution of renewable energy production within many OECD countries, although the pattern is extremely variable, with some countries such as Luxembourg seeing significant declines in the proportion of the power they consume being produced through renewable energy, particularly in the early 2000s, whilst countries such as Denmark, Lithuania and the UK have seen significant increases. The figures for Luxembourg reflect a rapid rise in total energy consumption, in part reflection of rapid population growth, rather than an actual decline in renewable energy production, and in the last decade there have been clear efforts to increase renewable energy production and reduce energy consumption levels, although Luxembourg is also making use of the 'statistical transfer' provision of the EU's *Renewable Energy Directive* (2009/28/EC) whereby part of its contribution to meeting its targets for increasing renewable energy production as set by the EU under its climate and energy policy framework can be met from the renewable energy production of Lithuania (European Commission 2017).

Figure 2. EU (28) Energy Mix, Gross Available Energy 2017



Source: Eurostat (2019) Simplified energy balances 2017 (file nrg_bal_s). (http://ec.europa.eu/eurostat/web/energy/data/database

Figure 3. Renewable electricity output as % of total electricity output, OECD countries 1990-2015



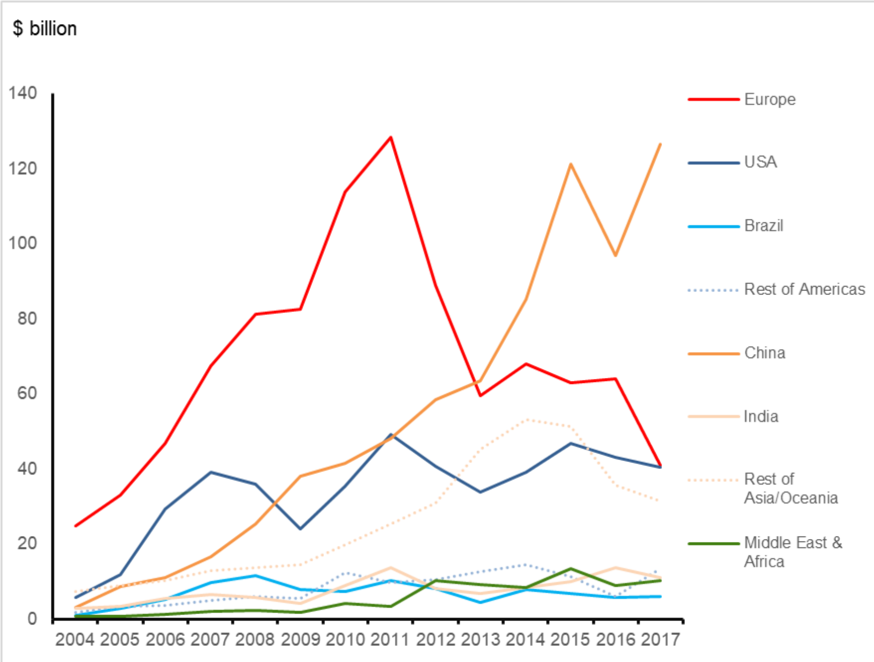
Source: Derived from OECD/IEA (2018) Renewable electricity output (% of total electricity output). <https://data.worldbank.org/share/widget?indicators=EG.ELC.RNEW.ZS>.

It is also evident from Figure 3 that there are some countries, which had invested strongly in renewable energy production by the 1990s and continue to produce most of their electricity from such sources: Scandinavian countries, along with the central European countries of Austria and Switzerland, and New Zealand and Iceland, stand out as long having strong renewable energy production. The latter two countries have sources of geothermal energy, and it is clear that the applicability of particular renewable energy technologies plays a significant role within these early and strong adopters of renewable energy. Having said this, it is also clear that strong policy leadership, and continuity, has been significant in these early and extensive adopters of renewable energy, with the movement to renewable energy often starting long before contemporary concerns over climate change (Kelly, 2011). In contrast, in countries such as France, Germany and the UK, there have long been a series of competing policy agendas, including energy security and market liberalization (Strambo et al., 2015), alongside some considerable governmental and industry scepticism as to the value of renewable energy, as well as active resistance to change (see Jacobsson and Lauber, 2006; Stenzel and Frenzel, 2008; Geels et al., 2016). It is also evident that countries such as Israel and South Korea are still heavily dependent on non-renewable based electricity generation.

Hohmeyer and Bohm (2015) have suggested that from around 2010 there has been something of a paradigm shift in national governmental energy policy-making within many European countries and in the policy-strategies being advanced by international organisations such as the European Union, such that a largely renewable energy system is envisioned as a realizable option. Figure 3 clearly indicates that about this time there was a considerable increase in renewable energy production in countries such as Denmark, Lithuania and the UK that now are producing much of their electricity in this way. Concerns have, however, been expressed about whether this increase will be sustained into the future given clear evidence of declining levels of European investment in renewable energy production (Figure 4), although it has also been argued that significant reductions in the costs of renewable energy technologies is resulting in a lowering of investment required for installing increased renewable energy capacity (European Environment Agency 2017). It is also evident that the strategies to develop renewable energy have varied. In the UK there has been a considerable focus on the construction of large-scale renewable energy infrastructure, including large-scale onshore and offshore wind farms, biomass conversion of coal power stations and landfill gas extraction, alongside heavy involvement of existing energy utilities companies (Stenzel and Frenzel, 2008; Geels et al., 2016). Utility companies have also been key players in the development of renewable energy in Spain (Stenzel and Frenzel, 2008), but in Denmark and Germany there has been much greater involvement of independent companies, farmers, co-operatives and individuals (see Hvelplund et al., 2017; Stenzel and Frenzel, 2008; Geels et al., 2016, and Figure 5).

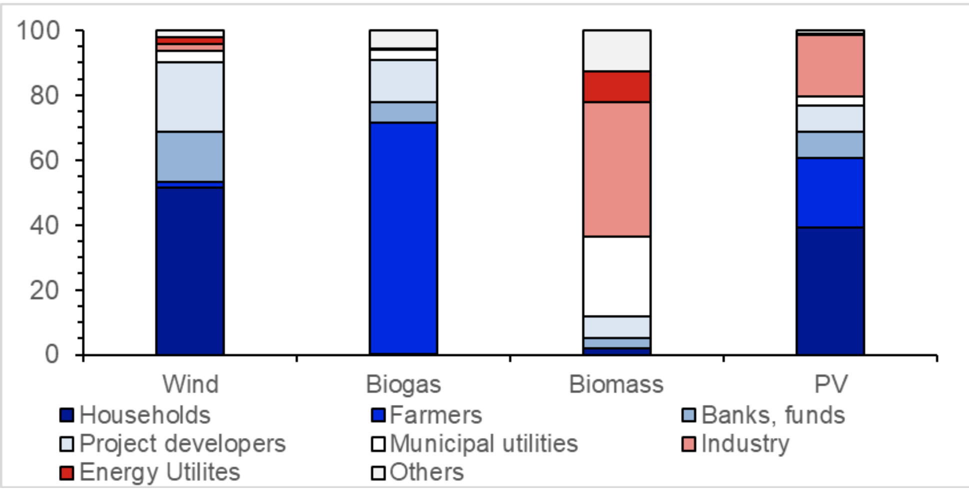
As well as national differences in strategies of renewable energy development, it is clear that there are internal differentiations in involvement in the renewable energy development, both regionally and with respect to rural and urban differences. Table 3, for example, indicates how hydro-electric power generation in the UK is predominately located in Scotland, which also hosted 42 percent of the wind generation units and over 60 percent of the wind power generation capacity that had been installed between 1990 and 2017 in the UK. Conversely, power generation from use of biomass, anaerobic digestion and waste and from solar sources was much stronger in England, which accounted for over 82 percent and 87 percent of the installed units and 89 and 88 percent of installed capacity respectively within this period.

Figure 4. Investment in Renewable Energy, 2004-2017



Source: derived from Frankfurt School of Finance and Management, United National Environment Programme Centre, Bloomberg New Energy Finance (2018) Global Trends in Renewable Energy Investment 2018 (Frankfurt: Frankfurt School of Finance and Management)

Figure 5. Ownership structure (%) of installed capacity of different renewable electricity technologies, Germany 2010



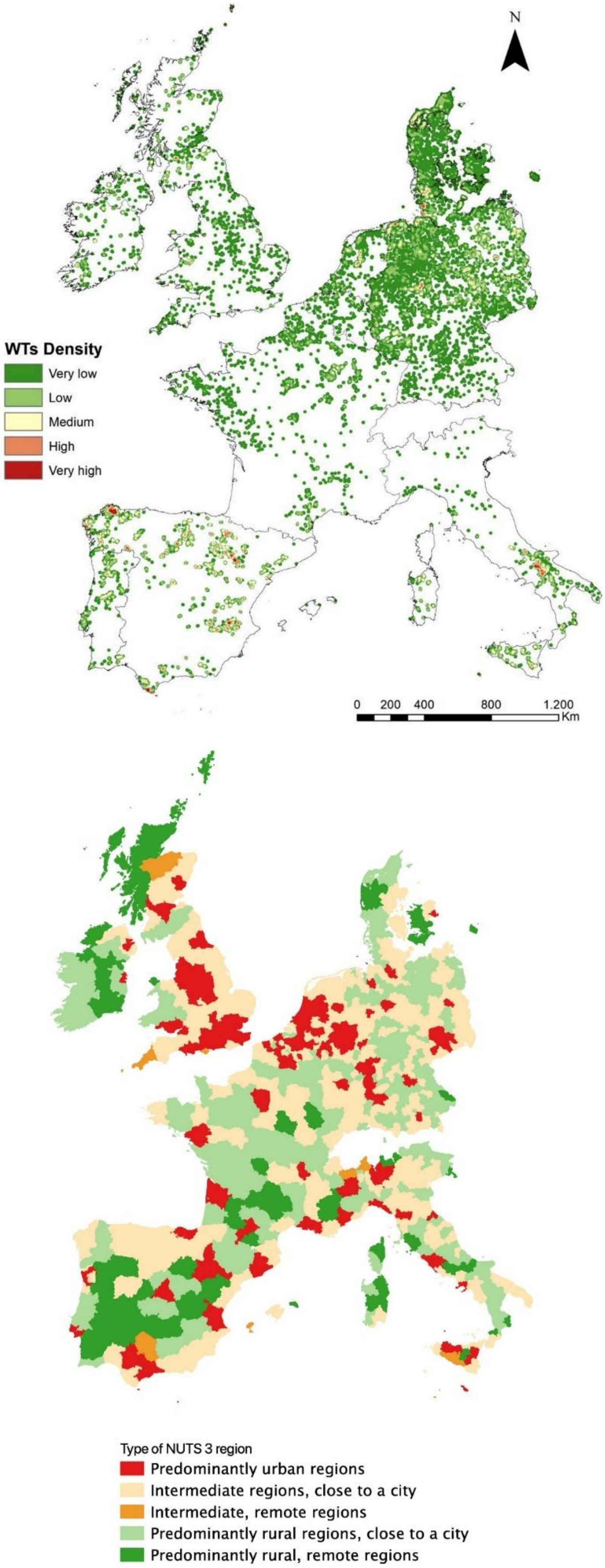
Source: Geels et al. (2016) 'The enactment of socio-technical transition pathways: a reformulated typology and a comparative multi-level analysis of the German and UK low-carbon electricity transitions (1990–2014)', Research Policy 45, 905.

Table 3. Operational renewable energy developments within the UK, 1990-2017

Location	Biomass, Anaerobic Digestion, & Waste		Hydro-electric		Sola
	Units	Capacity	Units	Capacity	Units
Scotland					
Accessible Rural Areas	34	188.8	1	20.0	11
Accessible Small Towns	4	11.4	0	0.0	0
Large Urban Areas	4	19.1	0	0.0	0
Off-shore	0	0.0	0	0.0	0
Other Urban Areas	6	78.9	0	0.0	1
Remote Rural Areas	4	20.5	21	130.0	3
Remote Small Towns	1	5.0	1	1.9	0
Very Remote Rural Areas	0	0.0	53	292.2	0
Very Remote Small Towns	1	3.5	1	1.9	0
All areas Scotland	54	327.2	77	446.0	15
Wales					
Rural hamlets & isolated dwellings in sparse setting	1	2.4	5	22.8	16
Rural hamlets & isolated dwellings	4	8.8	0	0.0	31
Rural village in sparse setting	1	3.2	0	0.0	5
Rural village	7	87.2	1	32	20
Rural town & fringe in sparse	0	0.0	0	0.0	2
Rural town & fringe	3	11.8	0	0.0	6
Urban city & town in sparse setting	0	0.0	0	0.0	0
Urban city and town	11	87.8	0	0.0	33
Urban minor conurbation	0	0.0	0	0.0	0
Urban major conurbation	0	0.0	0	0.0	0
All areas Wales	27	201.2	6	54.8	113

Notes: Units refers to distinct renewable energy developments, whilst capacity refers to potential energy output.
Source: Phillips M. & Dickie J. (2019) 'Post carbon ruralities', in Scott et al. (eds.) Routledge Companion to Rural Planning. London: Routledge, p. 542-3

Figure 6. The distribution of wind turbines and rural areas in the EU



Source: Mauro (2019) 'The new “windscapes” in the time of energy transition: a comparison of ten European countries', Applied Geography 109, 102041; © EuroGeographics for the administrative boundaries (NUTS3 2013); and Urban-Rural Including Remoteness Typology of NUTS3 regions <https://circabc.europa.eu/d/d/ workspace/SpacesStore/ea154527-d900-431f-b5a8-97fbea6e4b08/regtyp.xls>

Table 3 also reveals that within the UK many renewable developments are located in areas classified as rural, with over 93 percent of the units and approaching 97 percent of the installed capacity of renewable energy production above 1 MW in Scotland being located in rural areas, whilst the figures in Northern Ireland lie at around 82 percent and 97 percent respectively. The figures for England and Wales are lower, although a clear rural focus in renewable energy production is still evident, with 77.5 and 74.9 percent of operational units respectively being located in areas classified as rural, while figures for rural capacity are slightly higher at 82.9 and 82.1 percent respectively. In rural areas of England, the number and capacity of solar photovoltaic sites and anaerobic, biomass and waste production sites exceed those of wind power, while in Wales, solar photovoltaics exceeds wind in number of sites but not production capacity. In Northern Ireland and Scotland, wind power remains pre-eminent in both frequency of sites and production capacity.

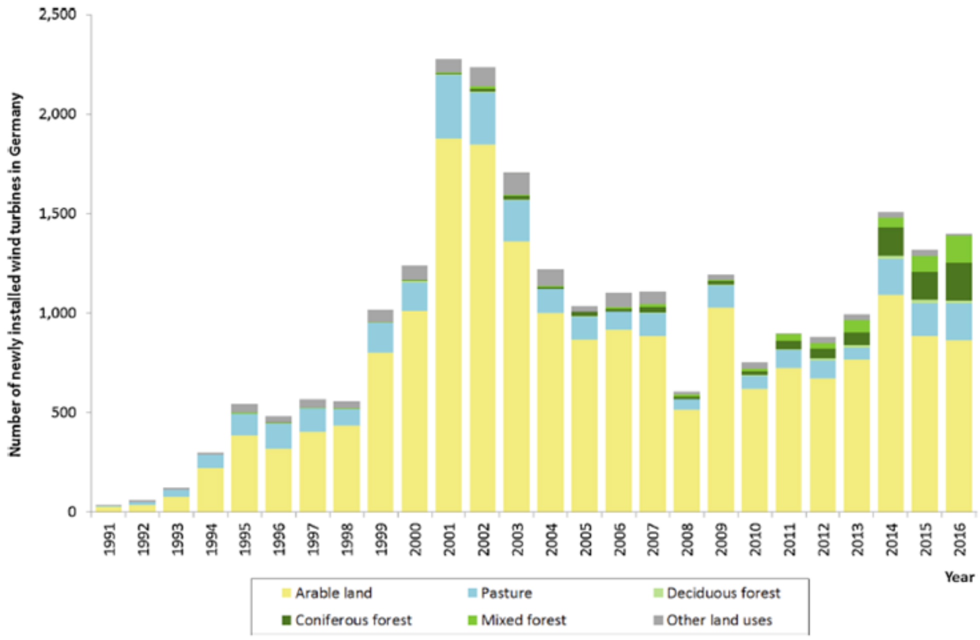
Mauro (2019) has recently constructed a map of wind turbine distribution across the EU (see Figure 6), and comparison with the urban-rural typology of the EU's NUTS3 regions suggests that many of the turbines are located in areas beyond urban regions.

Ruralities and renewable energy production and distribution

Such differences in the distribution of renewable energy can in part be accounted for by spatial variation in the environmental resources employed by particular technologies of renewable energy production. Rural areas, for example, often include elevated and open spaces that enable efficient deployment of wind turbines, as well as being locations for the production of biofuel and biowastes that may be employed within anaerobic, biomass and waste energy production. A second locational influence that has been identified as accounting for a rural focus within renewable energy production is the low population density of such areas, it being claimed that renewable energy developments, particularly large-scale units, tend to be located to areas where a minimal number of people will impacted by their operation (e.g. Hanley and Nevin, 1999). As Liebe and Dobers (2019: 247) comment, "renewable energy does not only have positive effects on the environment", but also has negative consequences, including biodiversity loss and landscape change. The extent of these, and other, environmental impacts has been a subject of considerable contestation (e.g. see Barrios and Rodriguez, 2004; Eltham et al., 2008), and it has been argued that many locations remote from human habitation are also both highly environmentally valued and sensitive areas (Hedger, 1995; Eltham et al., 2008; Warren and McFadyen, 2010). However, the minimization of the number of people potentially impacted has a clear political logic to it, and has been widely adopted as a criterion in decision-making over the siting of renewable energy developments. In Canada and Germany, for instance, planning regulations have specified minimal distances which wind turbines have to be 'set-back' from residential areas (Bunzel et al., 2019; Masurowski et al., 2016; Watson et al., 2012). In Germany this has also been conjoined with a general presumption in favour of wind power developments in so-called 'outlying areas' (Bunzel et al., 2019), although there have also been attempts to focus wind power developments in designated 'wind energy concentration zones' as well as designate a series of exclusionary zones where wind power development is not permitted (Bunzel et al., 2019). Bunzel (2019) calculate that 78 percent of the wind turbines installed in Germany between 1991 to 2016 have been located on agricultural land, and a further 5.5 percent were constructed within forested areas despite tree cover acting to reduce wind speeds and create turbulence (see Figure 7). However, Bunzel argues that the manufacture of taller turbines and placement on hill and ridge tops, alongside the remoteness of forest locations from residential locations, has encouraged an increasing use of forested areas, particularly when 'set-back' requirements are reducing the availability of sites in other, more open, areas.

The significance of remote locations to wind power development is also evident in the UK. Table 3, for instance, indicates that just over half of the on-shore wind power units in Scotland come from sites located in areas classified as remote or very remote rural area, with the latter contributing even more significantly in relation to capacity, reflecting the construction of more extensive wind farms with larger turbines. Table 3 confirms the strong focus in Scotland on on-shore wind energy production observed by Cowell et al. (2017), who also note that onshore wind has been the predominant renewable energy technology employed in Wales and Northern Ireland, an argument also confirmed by Table 3. These figures also indicate that sparsely populated rural areas in Wales are similarly areas of significant wind power development, having significantly higher numbers of sites and levels of production capacity than their less sparse counterparts in both the village and rural hamlet and isolated dwelling categories. On the other hand, accessible rural areas in Scotland and rural town and fringe areas in Wales have also seen extensive wind power developments, and in England it is the non-sparse categories of rural areas that figure most strongly in wind power production, with areas classified as villages and rural hamlets and isolated dwellings being the locations with the largest presence of wind developments. In the case of Northern Ireland, there is a strong predominance of units and production capacity within rural areas, although the classification does not enable differentiation within this category.

Figure 7. Number of newly installed wind turbines in Germany per year and land use category, 1991-2016.



Source: Bunzel et al. (2019) 'Hidden outlaws in the forest? A legal and spatial analysis of onshore wind energy in Germany', Energy Research and Social Science 55,18.

Whilst the selection of rural areas with low population numbers can be viewed as reflective of a desire to minimise the impacts of renewable energy development, it does pose significant problems in relation to energy distribution, particularly if there is an intention to feed in supplies to a spatially extensive distribution grid. As Stevenson and Richardson (2003) remark, whilst remote rural areas may hold clear attractions for renewable energy developers, these areas are also often characterised by 'weak', or even non-existent, grid connection, which necessitates expensive upgrading or construction, often at the developers' expense. The upgrading is in part to enable transmission over extended distance, but also includes localised voltage variations from concentrations of renewable energy producers in certain areas (Alsayegh et al. 2010). Furthermore, the generation of energy within many renewable technologies is intermittent, relying on forces such as wind speed and cloud cover that are often high variable, particularly when compared to the predictabilities associated with modern carbon-based power stations. Responses to weak grids and intermittent supply have included the development localised grids and a range of forms of energy storage, including use of 'coupled storage' whereby electricity is converted to mechanical or thermal energy (e.g. within pumped storage hydro-electric power generation plants or in district heating systems) that can be released when there are reductions in other forms of renewable energy production related to falls in wind speed or light levels (see Alsayegh et al. 2010; Blarke and Jenkins, 2013; Hvelplund et al., 2017). Use has also been made of biofuel and indeed hydro-carbon power generation to provide energy supplemental energy production, and also increasing attention is being paid to grid interconnection and the use of so-called 'super-' and 'smart-' grids to facilitate the flow of electricity between areas where there are temporal differences in levels of energy production. There have also been claims that renewable energy production might be able to address limitations in existing energy distribution systems, most notably with respect to areas which are currently 'off-grid'. Within the EU there have been relatively few instances of the development of localised micro-grids that are disconnected from national grid systems (although see Chmie and Bhattacharyya 2015), although they have been more widely employed in areas in Global South (see Yadoo et al 2010; Bhattacharyya 2013).

Ruralities and social resistance to renewable energy production

Despite the presence of distributional challenges associated with sparsely populated locations, their lack of population concentrations might suggest that social resistance to renewable energy development might be minimised. Table 4, for instance, reveals that in England and Wales, a lower number of planning applications for wind turbine construction have been rejected in sparse areas across all forms of rural settlement, although in relation to solar the influence of sparsity appears only to have been significant within rural town and fringe areas. Across many OECD countries there has been considerable resistance to the siting of renewable energy developments in rural areas (e.g. Bristow et al., 2012; Röder, 2016; Scherhaufer et al., 2017; Toke, 2005; Upreti, 2004; Upreti and van der Horst 2004; van der Horst, 2007; van der Horst and Vermeylen, 2011; Woods, 2003).

There is some evidence that such protests may have significantly impacted renewable energy development in some countries, with the relative lower significance of wind power in England evident in Table 4 being potentially reflective of governmental responses in England to wind power protests, with Cowell et al. (2017: 175) noting a down turn in planning consents for wind power developments in England following the election of a coalition government in which the "dominant Conservative Party contingent" sought to "act on public disquiet about wind energy" (see also Geels et al., 2016). Conversely, there was a rapid expansion in solar photovoltaic installations, which may reflect in part a movement of development capital away from wind due to the difficulties of obtaining planning permission, although there is also evidence that the expansion in solar energy installation was associated with investment of financial capital from institutions who had not previously been investing in renewable energy (Phillips and Dickie 2015b).

Table 4. Solar and wind power related planning applications and rejections, England and Wales, 1990-2017

Locations	Solar			Wind		Wind & Solar	
	Number of applications submitted	Number of applications rejected	Percentage rejected	Number of applications submitted	Number of applications rejected	Percentage rejected	Percentage rejected
Rural village and isolated dwellings in sparse setting	110	16	14.5	150	58	38.7	28.5
Rural village and isolated dwellings	892	170	19.1	393	178	45.3	27.1

Rural town and fringe in sparse setting	9	3	33.3	4	1	25.0	30.8
Rural town and fringe	346	55	15.9	173	56	32.4	21.4
Urban city and town in sparse setting	3	0	0.0	3	0	0.0	0.0
Urban city and town	369	44	11.9	146	38	26.0	15.9
Urban minor conurbation	12	1	8.3	4	1	25.0	12.5
Urban major conurbation	33	7	21.2	24	4	16.7	19.3
All rural areas	1357	244	18.0	720	293	40.7	25.9
All urban areas	417	52	12.5	177	43	36.8	16.0
All areas	1774	296	16.7	897	336	40.1	23.7

Source: Phillips M & Dickie J. (2019) 'Post carbon ruralities', in Scott et al. (eds.) Routledge Companion to Rural Planning. London: Routledge, 534.

Much of this disquiet about wind and solar power developments within the UK, and elsewhere, has centred around their visual impacts (see Devine-Wright, 2005; Warren et al., 2005; Wolsink, 2007). Whilst there has been some debate as to the aesthetics of these technologies themselves, concerns primarily relate to the degree to which they are visually compatible with surrounding landscapes, with particular emphasis often being placed on rural landscapes. The very sparsity that may attract renewable energy developments into rural areas, is also often a key constituent of people's visual appreciation of landscapes. As Woods (2003: 273) remarks, many people adopt a 'natura-ruralist perspective' that,

> *"recognises that rural landscapes have been modified by human agency, but place limits on the extent of acceptable development … Human artefacts are acceptable if they are essentially biological (e.g. crops, forest, pasture, orchards), or employ local natural resources in small-scale developments which conform to the prevailing natural aesthetic of the landscape (e.g. dry stone walls, stone cottages, isolated farm buildings). Modifications which introduce large quantities of alien materials (e.g. tarmac, metal), or modern technology, or which appear disproportionate in scale to the morphology of the landscape, are considered unnatural and 'out of place'".*

Many elements of the carbon energy economy exhibited features that ran counter to the 'natura-ruralist' perspective, and were thereby viewed as non-rural in character, despite being important constituents of life within many areas conceived as being rural. Similarly, much of the infrastructure of a post-carbon economy may also be seen to counter the conceptions of the 'natura-ruralist perspective' and hence be 'out of place' in a rural landscape. Brittan (2001: 169), for example, argues that much of the aesthetic concerns related to wind turbines and solar panels relates to feelings that they are technologies that exhibit un-natural elements which make them appear out-of-place in the countryside (see also Pasqualetti, 2000; 2011; Devine-Wright and Howes, 2010), although Wolsink (1989) has argued that wind turbines have been viewed as improving the visual appearance of landscapes that bear the imprint of industry or modern agriculture.

Woods (2003) highlighted how the 'natura-ruralist' view on nature and renewable energy technologies can stand in some tension with other, more ecological or environmental, perspectives on nature which often inform discussions of global climate change. He outlines how there can be a complex braiding of these discourses, with both proponents and protestors employing notions of sustainability, although the former employ it in association with a "discourse of the rural as a productive space" as well as within global environmental framings, whilst the latter group frequently emphasised a "discourse of the rural as a space of consumption", as well as a concern to retain spaces of wild, unspoilt, nature (see also van der Horst and Vermeylen, 2011). The result, Warren et al. (2005) argue, is 'green on green' conflict, whereby people who are equally concerned about nature and the environment find themselves taking quite different views in relation to renewable energy developments. Whilst in some instances these differences in viewpoint lead to a general resistance to the use of certain renewable energy technologies, there is evidence suggesting that in many instances people reconcile them through differentiating between general support for renewable energy technologies and concerns over particular developments in specific locations. A series of studies within OECD countries have commented on how expressions of support for renewable energy development tends to be high, but proposals to construct specific developments are often opposed, even by people who express support in general for their development (e.g. Bell et al., 2005; Bell et al., 2015; Devine-Wright, 2005; Toke, 2005; van der Horst, 2007; Warren et al., 2005; Wolsink, 1989; 2007).

One widespread reaction to this divergence in attitudes has been to suggest that it is a reflection of NIMBYism, such that there is "a gap between an attitude motivated by concern for the 'common good and behaviour motivated by 'self-interest'" (Bell et al 2005: 460). In other words, people are willing to support in general the idea of developing renewable energy but 'Not in my backyard', because they will experience a series of negative impacts, such as a loss of view, increased noise and a fall in property values should they wish to sell their homes. However, whilst widely enacted across academic, media, policy and public discourses, the concept of NIMBYism has also been widely critiqued in relation to understanding reactions to renewable energy developments (e.g. see Bell et al., 2005; 2015; Burningham et al., 2007; Wolsink, 2000; 2006; 2007). Amongst criticisms levelled at the term is that it is often used in a pejorative way to de-legitimise and dismiss the arguments of people who might be resisting a renewable energy development, frequently viewing them as purely instrumental claims made to protect some form of privileged position. It has also been argued that its presence is often presumed rather than empirically demonstrated, and when studies have sought to identify such attitudes, few instances of its actual expression have been found. Relatedly it has been argued that its use has detracted from detailed examination of the reasons behind resistance to energy development. Wolsink (2000: 57), for example, argued in a study of attitudes to wind farm development, that a NIMBY standpoint, where a positive attitude towards wind power was "combined with opposition to the construction of a wind farm anywhere in one's own neighbourhood", was much less prevalent than three other forms of opposition, namely: a NIABY (not in anyone's backyard) position that opposed a wind farm development in the person's local area because they rejected wind farms generally; a person who had initially had a positive general attitude towards wind power but who came to oppose a development because of what they learnt in discussions about a particular proposal; and people who rejected a particular development proposal but did not reject the "technology as a whole".

Studies such as Devine-Wright (2005; 2009) and van der Horst (2007) have sought to explore particular ideas that might be seen to underlie use of the NIMBY concept. These include the idea that people living closest to a new renewable energy development are most likely to oppose it, because they are the people most directly impacted by it, or what has been described as the 'proximity thesis' (Devine-Wright, 2005). The results of the examination of this idea have been divergent, with studies such as Thayer and Freeman (1987) finding empirical support for the concept, whilst other studies have identified what Warren et al. (2005) describe as an 'inverse NIMBY syndrome', whereby people living closest to wind farms had the most positive attitudes to wind power development. Explanations of this often centre on how direct experience of energy developments leads to a change in attitude as people's initial fears of a project are found to be unrealised, although again this claim has been questioned within empirical studies of temporal changes in attitudes (see Devine-Wright, 2005).

Many of the studies of spatial and temporal changes in attitudes adopt a Cartesian framing, which reduces space and time to abstract points and distances. Devine-Wright (2005: 130) argues that studies need to "go beyond purely physical parameters" to encompass more "'social' distance measures", that pay attention to, what he later describes as "affective and symbolic dimensions of change" (Devine-Wright, 2009: 437). He develops these arguments through suggesting that the study of responses to energy developments might usefully be framed as "place-protective actions, founded upon processes of place attachment and place identity" (ibid. 426). This argument does not focus its concern on accounting for an apparent gap between general expressed attitudes and attitudes to a specific development through some notion of self-interest, but rather concentrates its attention on accounting for why people might wish to prevent renewable energy developments in a locality. Drawing on wider studies of place attachment and place identity, it is argued that resistance to renewable energy development is "particularly likely when restorative places (i.e. those considered to be natural, wild or places to escape from cities) are impacted by development proposals that are interpreted to be 'industrial' or 'technological' in nature", although also "leave[s] open the question as to how large-scale development proposals that affect more than one place are responded to by residents from different places", since there may be different place attachments in different locations as well as different perceptions of the impacts of any development on these places (Devine-Wright and Howes, 2010: 272). Furthermore, it is claimed that the framework has practical implications, implying as it does an expectation of "emotional responses from local residents" and the potential to consider whether it may be possible to design "energy projects and procedures that … enhance rather than disrupt places" (Devine-Wright, 2009: 437).

One aspect of designing for place attachments relates to the visual impacts of renewable energy technologies, and there have been attempts to construct and site these so as to minimise their disjuncture from existing landscapes. Practices such as visual impact assessments and design guidelines have emerged within many countries (e.g see Bishop, 2002; Molina-Ruiz et al., 2011; Manchado et al., 2013; Scottish Natural Heritage, 2017) However, as Layne (2018: 48-9) has argued, visual impacts are not simply "an effect on the aesthetics of the physical landscape" but are always an effect on "the aesthetics of the cultural landscape", which she suggests involves "a socio-temporal merger of experience" that encompasses not only personal interaction but also social, cultural and historical processes that involve, amongst other elements, "local knowledge, beliefs, opinions and attitudes reaching far beyond the individual". These arguments chime closely with those of Devine-Wright (2005: 130) who argues that "explanations of wind farm perceptions must go beyond purely physical parameter, such as proximate distance, turbine size and colour", but also recognise that they are influenced "by symbolic, affective and socially constructed aspects" (ibid. 126).

Layne (2018: 248-9) also suggests that current design practices, through a focus on minimising visual impacts, tend to create bland and homogenous installations that might be viewed as "painfully boring, and worse yet, nearly identical to all other wind farm landscapes" (ibid. 255). Adopting a more performative perspective on wind turbines, which recognizes and seeks to foster, participatory experiences amongst people who live around them, she suggests might foster greater levels of support and acceptance of them. Studies of people's views on wind farm developments amongst people who live in proximity to them clearly provides some evidence that some people do come to engage with them as part of their everyday lives. Warren et al. (2005), for example, record that around a wind farm in Ireland, around 88 per cent of people stated that they looked at them almost every day, with 62 per cent coming to regard their visual impact as positive overall.

Layne (2018: 258) also argues that a performative perspective implies that renewable energy developments such as wind farms need to be "accessible as well as identifiable" if they are be garner support and acceptance, before highlighting that many are located in "closed off" spaces. There are exceptions: Layne, for example, discusses the Whitelee Windfarm that has 215 wind turbines and is located on moorland close to the city of Glasgow, Scotland. Although a very large-scale windfarm, public access to the areas has been provided through 130 kilometres of pathways, bridal ways and cycle paths, along with free entry to a visitor centre. Layne suggests that these act, via "assimilating cultural hobbies and priorities such as walking, biking, and bird watching into the technological site", to establish continuities between the wind farm and local everyday discourses and practices. In addition, exhibitions held in the visitor centre forge associations between the wind farm and the more global ideas of environmental sustainability and a renewable energy, plus provide a space of social interaction and education. Renewable energy facilities have emerged as tourist sites in many rural areas, and this role has been promoted amongst policy makers as a mechanism for the generation of more local economic benefits. Layne's arguments, however, point to the significance of more mundane engagements and how these could potentially be harnessed by developers and policy makers concerned about the social acceptability of renewable energy developments.

Rural community energy and community benefits

Arguments about accessibility have clear connections to a focus of attention amongst policy makers and academics, namely the extent to which people's reactions are influenced by levels of community involvement in decision-making and ownership. As discussed in the section on the evolution of environment, energy and rural development policy-making, there long been calls to connect renewable energy development into rural economic and social development. As Munday et al. (2011: 2) have commented, one driver of such policy calls was the "geographical coincidence" of wind and other forms of renewable energy developments in remote and often economically quite marginalised rural areas. The influx of capital and work associated with large-scale renewable energy projects has not unsurprising been viewed by development agencies in such areas as indicative of potential sources of economic growth and social development (see also Otte et al. 2018) , while even small-scale energy related investments in such areas have often been viewed as providing "the foundations for *locally-based* socio-economic regeneration" (van Veelen 2017: 10). Furthermore, the technological and environmental dimensions of renewable energy production also hold out the prospect of being part of an emergent 'eco-economy' that would enable an economic brighter and environmentally less harsh or degraded future. However, as Munday et al (2011) note, the degree to which contemporary commercial renewable energy operations have been able to deliver substantial long-term benefits to local populations is very questionable, and this questioning has been seen to both be a constituent of growing public resistance to renewable energy production (e.g. Cowell, 2007; Cowell et al., 2017; Bristow et al., 2012; Warren and McFadyen, 2010), and have also acted to stimulate discussion as to how greater developmental benefits might be generated.

Within these discussions there has been frequent examination of different modes of renewable energy development and governance, with contrasts often being drawn to differences between the regimes of renewable energy production that have emerged in comparison to the one employed in the UK, where, as discussed earlier, there has been considerable reliance of the construction of large-scale production facilities and major commercial energy utility companies that have, as Munday et al (2011) note, few economic ties to the locations they are developing. They, like many other commentators (e.g. Geels et al., 2016; Stenzel and Frenzel, 2008; Hvelplund et al., 2017), draw contrasts with Denmark and Germany where governmental policies and incentives, such as publicly funded research and development of small-scale renewable energy technologies, governmental subsidies, feed-in legislation that required energy utilities to connect renewable energy producers to the national grid and buy the electricity they produced at close to the rate to which it was sold to consumers, have encouraged "significant financial participation and co-ownership from farmers and local citizens" (Mynday et al. 2011; see also Breukers and Wolsink, 2007; Jacobsson and Lauber, 2006; Szarka and Bluhdorn, 2006; Szarka, 2007; Toke, 2005). Drawing on such comparisons, there have been calls for the development of more community renewable energy developments, so as to ensure that the interests of people within the area in which the facilities are sited are more fully integrated into its development and operation. Walker and Devine-Wright (2008: 497), for instance, suggest that "renewable energy projects can become more locally divisive and controversial if benefits are not generally shared among local people".

Partly as a response to such issues, and clearly as a means, as Cowell et al. (2011: 540) remarks, to "increase the social acceptability of development" and thereby "expedite the decision-making process" with respect to gaining governmental and planning approval, many energy developers now offer some form of 'community benefit' as part of their developments. As detailed in Cass et al. (2010), these benefit schemes can take a range of forms, including:

- financial payment into some form of 'community fund' that can be used for the benefit of local residents;
- the delivery, either directly or indirectly, of some form of community 'benefit in kind', such as the construction of some community facility or infrastructural improvement;
- 'Share ownership' or 'profit sharing' where residents of an area are given a stake in an energy development such that community benefits are tied to its performance.

The last form of community benefit shades into forms of direct community ownership of energy developments, which itself can take a range of forms, including co-operatives, charitable associations, development trusts and share ownership by residents or a local community organisation in a commercial energy enterprise (Walker, 2008). Walker adds that in the UK nearly all of the activity in community renewables generally, and community ownership in particular, "has taken place in rural areas", although Cass et al. (2010) suggest that a community fund is a "relatively new but increasingly recurrent" form, an argument that finds support in Munday et al.'s (2011) study of community wind farms in Wales, where over 82 percent of those developed after 1999 were found to involve a community benefit fund. In the UK, community benefits very much remain a voluntary activity and there is no obligation on energy developers to provide them, although there have been clear expressions of governmental and energy sector support for their establishment (e.g. Renewable UK; Local Energy Scotland 2015). Concerns have, however, clearly been expressed about the lack of transparency in their development and in the allocations of benefit funds, as well as over the level of community benefits generated (e.g. Aitken 2010; Bristow et al 2012; Macdonald et al, 2017). There are, however, clear instances where considerable local economic benefits are foreseen and community group representatives have activity sought out renewable energy developments, although even in such cases the distribution of the benefits, and indeed costs, of these developments have been identified as issues of critical concern (e.g. Otte et al 2018).

Munday et al. (2011: 1) also claim that the flows of revenue from community benefit funds are "dwarfed, in quantitative terms, by the revenue streams that might be channelled to rural areas through a broader community ownership", a claim that has been reinforced by the findings of other research. Warren and McFadyen (2010, 204), for example, highlighted how community payments of £369 per turbine were being made in the Kintrye region in west Scotland compared to receipts of over £28,000 per turbine generated by the community owned scheme on the Isle of Gigha. However, it can be argued that the value of community ownership lies not just in terms of the balance between costs and benefits, but also who wins the benefits and takes the losses, or what might be viewed as issues of distributive justice (Fraser, 1997), although as Cowell et al. (2011: 540) are, these are often entangled with justice as 'recognition' and 'participation'.

Such arguments connect into the broader discussions of NIMBYism, and calls for greater recognition of the symbolic, emotional and performative dimensions of engagements with renewable energy developments. Walker and Devine-Wright (2008: 499), for example, argue that the justification for public investments in community renewable energy projects should not simply be seen to lie with their direct contribution to climate change mitigation but also involve recognition that such developments "work on the 'hearts and minds' of local people", and can have "wider catalytic effects in promoting positive beliefs and actions about renewable energy". Warren and McFadden (2010) advance similar arguments, suggesting that whilst prevailing strategies of renewable energy development in the UK have fostered the notion that spatial distancing is the best route towards psychological acceptance, such approaches produce a relationship with energy that is simply as 'end-of-wire captive consumers', and that more direct engagement with energy production both increases people's energy literacies that might be helpful in producing acceptance of need for, and demands of, energy transition, and creates more active ‘energy citizenship’(see also Devine-Wright, 2007).

The social and spatial significance of post-carbon transitions

The argument of Walker and Devine-Wright and Warren and McFadden represent a significant challenge to contemporary energy policy-making in countries such as the UK, although may be seen to align well to arguments advanced around Rural Policy 3.0. It has already been argued that this policy strategy may currently be more aspiration than enacted, and that questions surround both its ability to achieve rapid and extensive change and its relationship to existing inequities in rural areas. In relation to the latter, one of the arguments under-pinning much of the NIMBY concept is that it highlights social and power differentiations in rural decision making. Van der Horst and Toke (2010: 217), for example, have examined the social character of areas where planning application for wind farm developments in

England were accepted and rejected, and found that rejections were relatively more prevalent in areas where people were "in a number of respects 'better off'" than were people living in areas where windfarm development was approved, and indeed that wind farm development was significantly more likely to receive planning permission, and thus be built, in relatively more deprived local areas" (see also Roddis et al. 2018).

The analysis of Van der Horst and Toke provides support for the claims of people such as Woods (2003: 312) who has suggested that processes such as counterurbanisation and rural gentrification have played an important role in determining the geographies of renewable energy developments in the countryside, as in-coming middle class residents have a tendency to wish to "protect their financial and emotional investment by opposing developments and activities that threaten the perceived 'rurality of their new home'". Whilst such equation of social position and motivation has been subject to considerable criticism in debates over NIMBYism, a series of studies have highlighted how the distribution of wind farm developments and protests have social dimensions to them. Munday et al. (2011: 2), for example, note how existing and proposed wind power developments in Wales are "often adjacent to smaller rural communities that are characterised by persistent economic disadvantage". This could be viewed as simply the consequence of higher levels of rejection in 'better off' areas as observed by Van der Horst and Toke (2010) and/or a reflection of greater acceptance of these developments within disadvantage areas, where they made be viewed as an opportunity to address economic disadvantage. Other studies have highlighted a tendency for renewable energy developments to receive approval when they are located in areas that are perceived to have low scenic value or have a landscape degraded by pollution. Cowell et al (2012: 6), for example, argue that within the UK, wind energy developments have "gravitated towards places adversely affected by previous environmentally damaging activity". In such areas it is clearly possible to argue that new energy developments will not significantly impact on perceptions of the existing landscape, but it can be argued that the consequences of landscape impact minimisation policy strategies might include an accentuation of processes of place and social stigmatisation, and thereby contribute to the reproduction of social and spatial inequalities and inequities. Indeed, Rudolph and Kirkegaard (2019) have argued that in Denmark renewable energy developers have at times quite strategically mobilised stigmatised representations of rural areas, such that they are places of social and economic weakness, on-going outmigration, and valueless land and buildings, as a means to justify both land acquisition and building demolition for renewable energy production. As Rudolph and Kirkegaard argue, such practices serve to not only reflect, but also to actively reproduce, processes of accumulation, dispossession and destruction of these rural areas of Denmark.

The issue of the scale of renewable energy transitions, and their impacts on rural areas, has recently been raised by Huber and McCarthy (2017) who examine the spatial demands of energy regimes. They argue that the emergence of industrial capitalism involved a transition from a 'horizontal surface-based energy regime', centred around what has earlier been referred to as an organic energy regime in which energy was derived largely from solar energy captured at the surface of the Earth in plants by photosynthesis, "and the muscle power that comes from animals that feed off those plants" (ibid. 659), to a vertical energy regime centred around subterranean energy extraction. This vertical regime made much smaller horizontal surface demands than did its predecessor, with much more energy being produced from an areal unit of land than was achieved within the organic energy regime. However, the transition to a post-carbon transition involves, they argue, a "return to a surface energy regime", albeit one where energy production will "necessarily be enormous, spatially extensive industrial undertakings" (ibid. 655). They add that this much of this energy production will "almost certainly take place in rural areas" and hence will "place intense pressures on rural lands and people", competing with and likely displacing many existing or desired rural land uses. They predict that the transition to a post-carbon/climate neutral economy will "necessarily involve powerful new claims on, struggles over, and massive new deployments of capital and labour in rural spaces in many locations around the world", and will likely produce "contestation, conflicts and resistance" and "many instances of dispossession" (ibid. 665-6). These comments stand in clear contrast to many of the existing discussions of renewable energy and raise serious questions as to whether existing and emerging rural policy frameworks are fit to address the challenges that a post-carbon transition in energy production might create. Rudolph and Kirkegaard (2019) suggest that the whilst acquisition of land for renewable energy development has generated considerable concern within countries of the global South, it is also a major issue for many countries in the global North, particularly amongst those that have relatively small territorial extents, such as Denmark where it has been estimated that meeting its renewable energy targets would require the use of land equivalent to 140 per cent of its land area. Palmer et al. (2019: 202) have explored the land use demands of a range of post-carbon transition strategies, highlighting, for instance, how within Germany, the use of "smaller wind farms with fewer turbines, close involvement of communities, and opportunities for local residents to invest or receive community benefits" enabled a compound annual increase in the area of land used for energy production of over 9 per cent per annum, without wide spread public protest, and also how land use demands might be reduced through the development and employment of 'spatially denser' renewable energy, and indeed the employment of low carbon, vertically rather than horizontally demanding, non-renewable energies such nuclear power and fossil fuel based electricity production using carbon capture. This work clearly highlights the significance of considering the spatial demands of energy production, and indeed distribution technologies, as well as a range of potential strategies and trade-offs that policy-makers might employ.

Bridging carbons in the countryside

Until the reference to the work of Palmer et al (2019), discussion here has largely focused on the idea that post-carbon transitions involve an expansion in renewable energy and reductions in the use of carbon-based energies. However, Palmer et al.'s work recognised that there have been contemporary energy developments that involve a continued use of carbon-based energy resources but have been linked by some their advocates to a transition to a low carbon society. In particular, the exploitation of so-called 'unconventional hydrocarbons' and the development of carbon capture and storage (CCS) have been promoted as 'bridging technologies' that will smooth the transition to a post-carbon society by providing less polluting carbon fuels that can act to supplement renewable energy generation, plus provide technologies for reducing levels of unwanted carbon emissions. Some OECD countries have seen extensive unconventional hydrocarbon development, much of it within rural areas (see Eaton and Kinchy, 2016; Morrone et al., 2015; Schafft et al., 2013; de Rijke et al., 2016; Sherval and Hardiman, 2014), while in other countries, such as the United Kingdom, there have been strong calls for its development. However, the development of unconventional hydrocarbons has generated considerable opposition related to its potential environmental impacts, while the extent to which its development would assist in post-carbon transitioning has also been questioned. Stephenson et al. (2012), for example, draw on research in Canada to argue that the notion that unconventional hydrocarbons can act as a 'bridging fuel' is simply a 'green wash' that acts as a rhetorical justification for continuing carbon energy reliance. Within many OECD countries there is considerable public resistance to the development of unconventional carbon extraction, both at the level of national adoption and at sites of potential extraction. Studies evidence many similarities between resistance to fracking and contestations over renewable energy development, including the significance on people's attitudes of levels of knowledge (e.g. Stedman et al., 2016; Whitmarsh et al., 2016), notions of social equity and the right to participate in decision-making processes (Beebeejaun, 2017; Cotton et al., 2014; Williams et al., 2015; Whitmarsh et al., 2016; Whitton et al., 2017), and the significance of emotional attachments to place (Cotton, 2015; Sangaramoorthy et al., 2016).

Transitions in rural energy consumption

Whilst considerable attention has been paid to changes in energy production as a means of climate change mitigation, and it is clear that the countryside is both playing an important role in an expansion in renewable energy production and will face significant future impacts in relation to its further expansion, it is important to recognise that the countryside is also a space of energy consumption. Reductions in energy consumption, particularly with respect to carbon-based energy sources, have received significantly less attention than transitions in energy production, although they do appear as a component in many climate change mitigation policies and discussions. The EU's 'Energy Efficiency

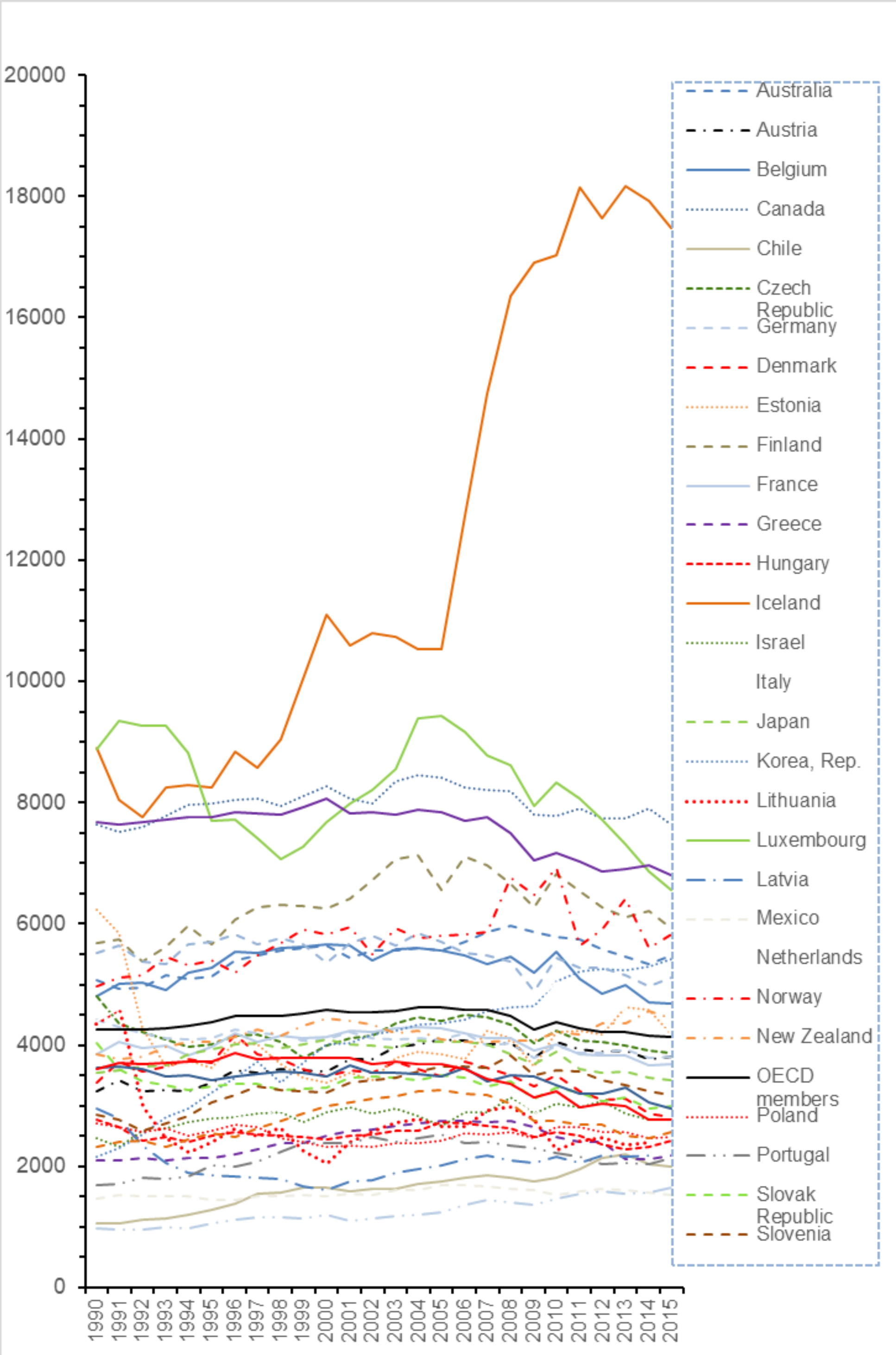
Directive' established in 2012, for example, set a target of a 20 percent 'saving' in energy consumption, based around a reduction from projected energy use in 2020. As outlined in Strambo et al (2015), this Directive has led to member states establishing policies related to energy efficiency standards within new buildings, lighting and consumer products, whilst other Directives have sought to develop minimum levels of energy taxation, emission levels from vehicles. A series of studies have explored the impacts of many of these policy measures and there is evidence of some decline in levels of per capita energy consumption within OECD counties (see Figure 8), although as with energy production there is also considerable variation, both between countries and temporally. The largest annual decline and spatially most extensive falls occurred in 2008-2009, indicating how energy consumption is quite clearly connected to levels of economic activity and personal wealth. Much of the annual variations might also be accounted for by economic variations, and by the myriad factors that contribute to this. However, there is clear overall downward trend in per capita consumption post 2010, with all OECD countries seeing at least one year of decline with the period 2011-2015. It is also evident that EU countries have figured strongly in this decline, with countries such as Denmark, Germany, Estonia, Hungary, Luxembourg and particularly the UK seeing significant falls. This is confirmed by Figure 9 that shows that there have been declines in average levels of electricity and particularly gas consumption across the 2005-2015 period.

Table 5. Electricity consumption, fuel poverty, off gas-grid and low energy efficiency dwellings in rural and urban areas of England and Wales, 2015-2016

Area characteristic	Mean annual electricity consumption 2016 (kWh per household)	Mean annual electricity consumption 2016 (kWh per person)	Percentage of households off gas-grid 2016	Percentage of household in fuel poverty 2015 (Data for England only)	Percentage of dwellings with energy efficiency certificates F & G
Rural village and isolated dwellings in sparse setting	5912.4	2564.3	27.7	18.5	0.32
Rural village and isolated dwellings	6037.0	2467.2	33.1	13.6	0.18
Rural town and fringe in sparse setting	4499.1	2071.2	9.5	11.6	0.13
Rural town and fringe	4408.9	1875.4	8.7	9.4	0.05
Urban city and town in sparse setting	3911.7	1735.1	7.3	11.4	0.06
Urban city and town	3917.4	1651.6	6.0	10.4	0.03
Urban minor conurbation	3542.5	1500.8	5.0	12.6	0.04
Urban major conurbation	3883.1	1592.3	9.1	11.5	0.03
All rural areas	5144.7	2155.5	19.5	11.5	0.12
All urban areas	3887.7	1621.6	7.2	10.9	0.03
All areas	4112.1	1716.9	9.4	11.0	0.05

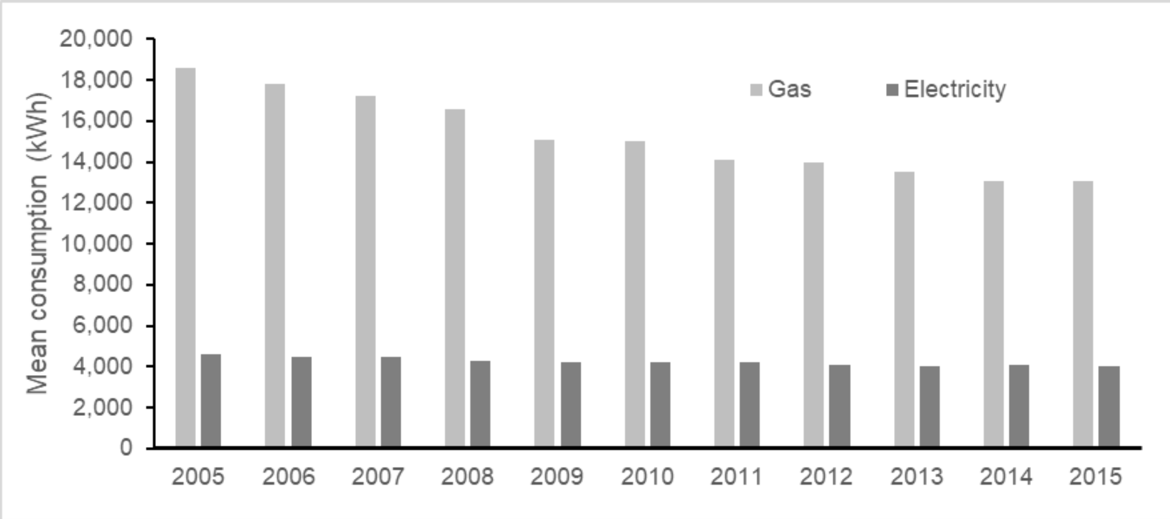
Source: Phillips M and Dickie J. (2019) Post carbon ruralities. In: Scott M, Gallent N and Gkartzios M (eds) Routledge Companion to Rural Planning. London: Routledge, 525.

Figure 8. Energy use (kg of oil equivalent per capita) in OECD countries, 1990-2015



Source: Derived from OECD/IEA (2014) Energy use (kg of oil equivalent per capita) <https://data.worldbank.org/indicator/EG.USE.PCAP.KG.OE>.

Figure 9. Mean gas & electricity consumption, England 2005 -2010, England and Wales, 2011-2015

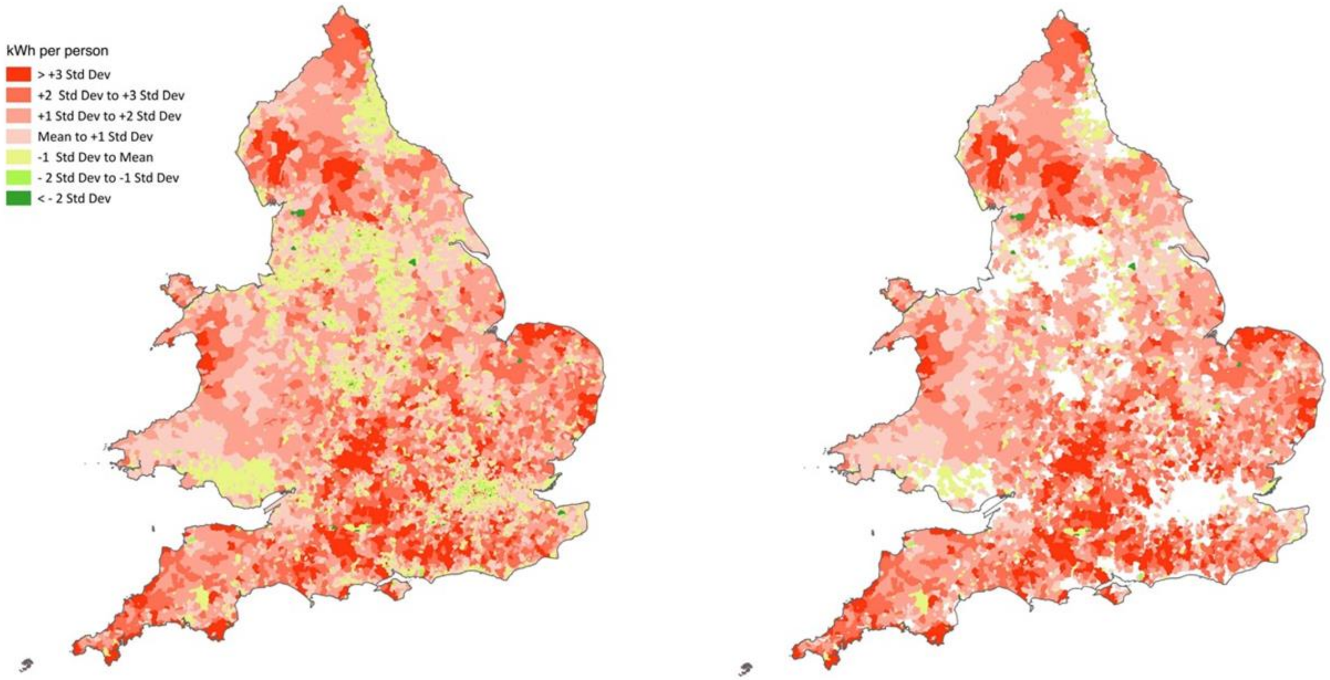


Source: Phillips M and Dickie J. (2019) Post carbon ruralities. In: Scott M, Gallent N and Gkartzios M (eds) Routledge Companion to Rural Planning. London: Routledge, 524. Based on BEIS National Energy Efficiency Data-Framework (NEED): Consumption headline tables, 2015, accessed from https://www.gov.uk/government/ statistics/national-energy-efficiency-data-framework-need-report-summary-of-analysis-2017

While such figures are useful indications of trends, they can obscure significant spatial variations in energy consumption levels, as is illustrated by Figure 10 that shows per-capita domestic electricity consumption in England and Wales in 2016, for all areas and for areas classified as rural. It demonstrates clearly that many rural areas have well-above average levels of domestic electricity consumption, a feature also illustrated in Table 5, which suggests that average rural domestic electricity consumption per capita for 2016 was over 25 percent per cent higher than the overall mean figure, and just under 33 percent above the mean urban figures.

Reasons for higher per-capita electricity consumption in rural areas include the greater presence in rural areas within England and Wales of off-gas-grid properties (see Figure 11) and so-called 'hard-to-heat' (HTH) and 'hard-to-treat' (HTT) homes (BRE Housing, 2008). The lack of gas grid supplies mean that households make greater use of electricity for cooking and heating, while the greater relative presence of HTH and HTT homes reflects the relatively greater presence in rural areas of older properties which may have less insulation when constructed and may have solid as opposed to cavity walls into which insulation can be inserted, and as Figure 12 illustrates, it is clear that rural areas do contain a higher presence of homes in the rates within the lowest two categories of energy efficiency ratings. Rural areas also tend to have higher proportions of large and detached properties which take more energy to heat and may lose relatively more heat to the atmosphere than semi-detached, terraced and apartment properties (see Jones and Lomas, 2015; Schubert et al., 2013; Viggers et al., 2017). There is, however, potential cross-correlation between property characteristics and socioeconomic and demographic variables such as social class, income, household size and tenure (e.g. Commission for Rural Communities, 2007; Department for Environment Food & Rural Affairs (DEFRA), 2008; Büchs and Schnepf, 2013; Huebner et al., 2015). This is important because studies have shown that domestic energy consumption tends to increase with income levels (e.g. Druckman and Jackson, 2008; Büchs and Schnepf, 2013; Phillips and Dickie, 2015a). As a consequence, higher per capita energy consumption might reflect social variations in the population of areas as opposed to the characteristics of properties, an issue which is of considerable significance in countries such as Britain where many rural areas have been subject to processes of gentrification (see Phillips, 2007; Smith et al., 2019), particularly given that it has been argued that increases in property size more than off-set gains in the energy efficiency of residential property created through the higher building standards and the retro-fitting of energy conservation measures (Brecha et al., 2011; Viggers et al., 2017).

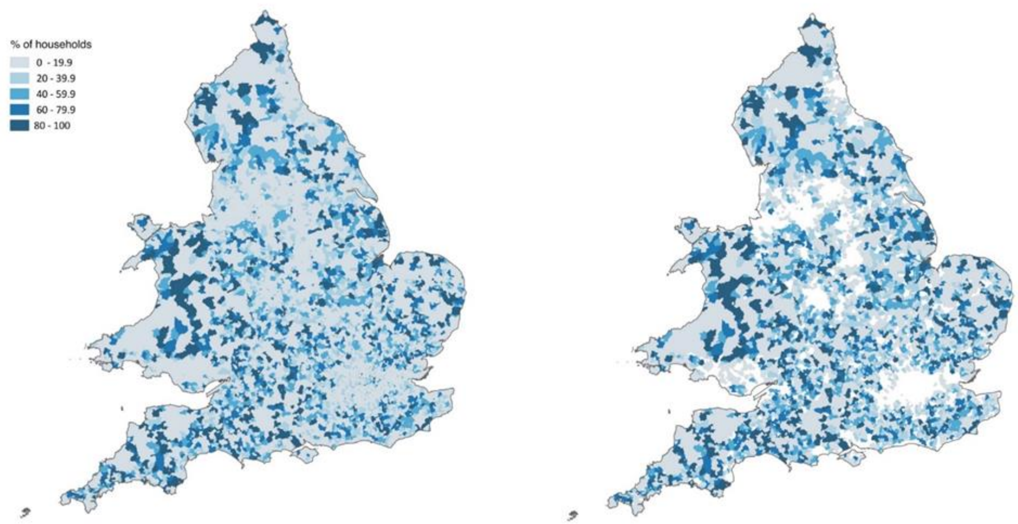
Figure 10. Electricity consumption per capita, England and Wales 2016



Source: Derived from BEIS Lower Layer Super Output Area domestic electricity consumption 2016, available from www.gov.uk/government/collections/sub-national-electricity-consumption-data; Office for National Statistics (2017) 2011 Census aggregate data. UK Data Service DOI: http://dx.doi.org/10.5257/census/aggregate-2011-2 and Office for National Statistics (2013) Rural-urban classification (2011) of lower layer super output areas (https://www.gov.uk/government/statistics/2011-rural-urban-classification).

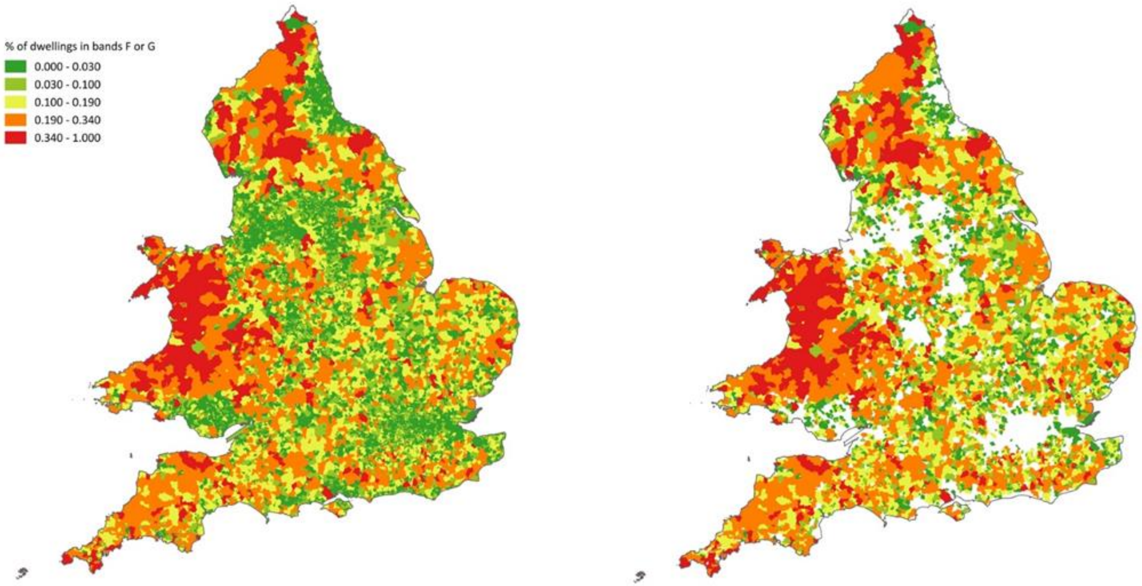
Conversely, as Figure 13 and Table 5 indicate, rural areas across England contain above average levels of 'fuel poverty'. In part this may reflect the presence of higher levels of off-gas-grid and HTH/HTT properties, both of which will act to increase energy fuel bills. However, although Table 5 reveals that areas classified as 'villages' and 'hamlets and isolated dwellings' have the highest proportion of off-gas-grid properties and households in fuel poverty, it is evident that those of these areas which are relatively remote from built up areas (i.e. which are in so-called 'sparse settings') are more likely to have higher proportions of households in fuel poverty, whilst in relation to households with no access to gas-grid access, it is those areas classified as less-sparse that have the highest figures. These differences indicate that lack of gas-grid access is not simply a function of geographical remoteness, and also that fuel poverty levels are not simply a reflection of a lack of accessibility to gas supplies. Fuel poverty levels are clearly also a reflection of other variable, including variations in rural income levels, with many of the areas of fuel poverty being places of marginal agriculture, and hence, low agricultural income.

Figure 11. Percentage of off-grid household, England and Wales, 2016



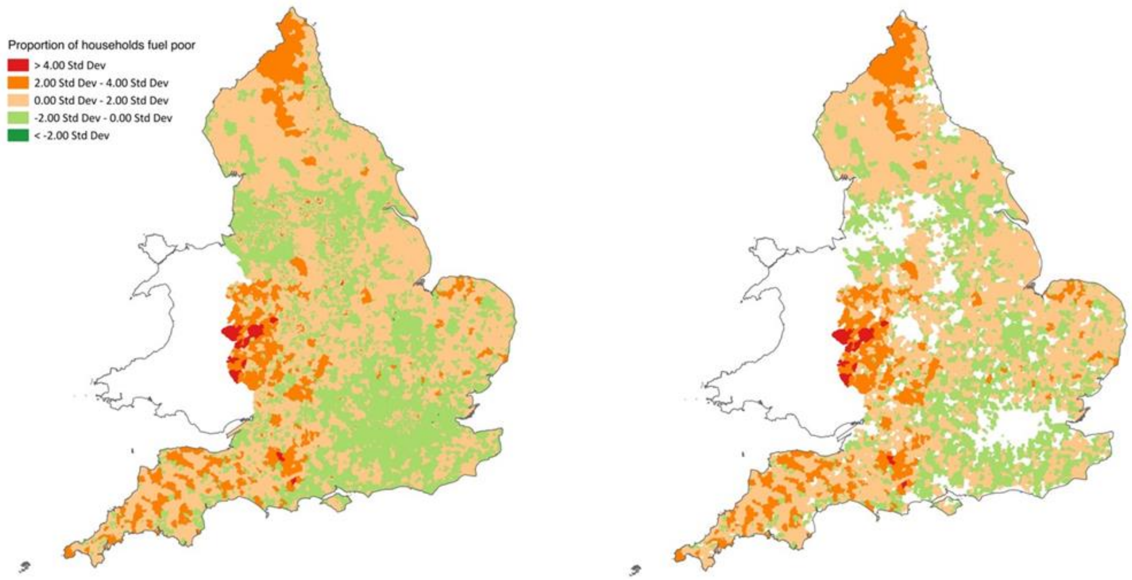
Source: derived from BEIS Lower Layer Super Output Area estimates of households not connected to the gas network 2016, available from www.gov.uk/government/collections/sub-national-electricity-consumption-data; and Office for National Statistics (2013 Rural-urban classification (2011) of lower layer super output areas (https://www.gov.uk/government/statistics/2011-rural-urban-classification).

Figure 12. Percentage of low energy efficiency rated dwellings, England and Wales, 2014



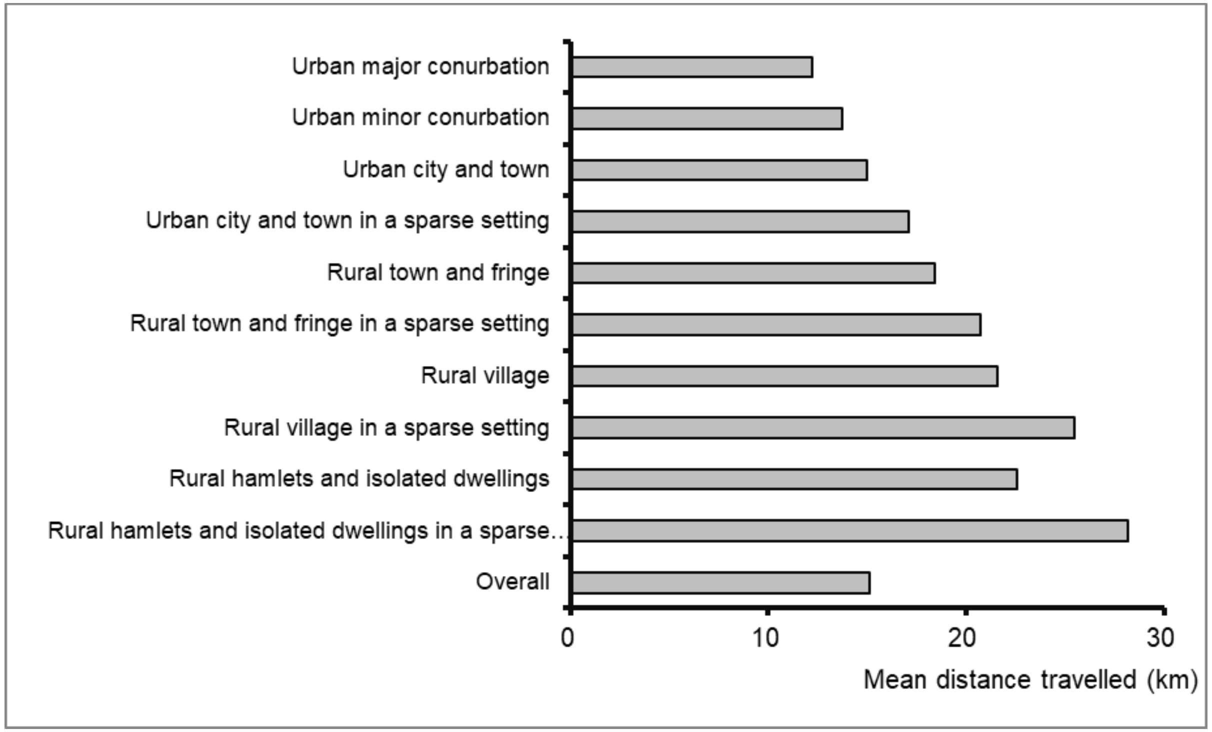
Source: derived from National Energy Efficiency Data-Framework (NEED) Anonymised Dataset – Estimates of Energy Efficiency Rating by LSA < https://www.gov.uk/government/statistics/national-energy-efficiency-data-framework-need-anonymised-data-2014> and Office for National Statistics (2013 Rural-urban classification (2011) of lower layer super output areas (https://www.gov.uk/government/statistics/2011-rural-urban-classification).

Figure 13. Proportion of households in fuel poverty in England, 2015



Source: derived from BEIS (2017) Sub-regional Fuel Poverty England, 2015 data, available from www.gov.uk/government/statistics/sub-regional-fuel-poverty-data-2017; and Office for National Statistics (2013 Rural-urban classification (2011) of lower layer super output areas (https://www.gov.uk/government/statistics/2011-rural-urban-classification).

Figure 14. Travel to work distances England and Wales, 2011 Census



Source: Phillips M and Dickie J. (2019) 'Post carbon ruralities', in Scott, M., Gallent, N. and Gkartzios, M. (eds.) Routledge Companion to Rural Planning. London: Routledge, 528.

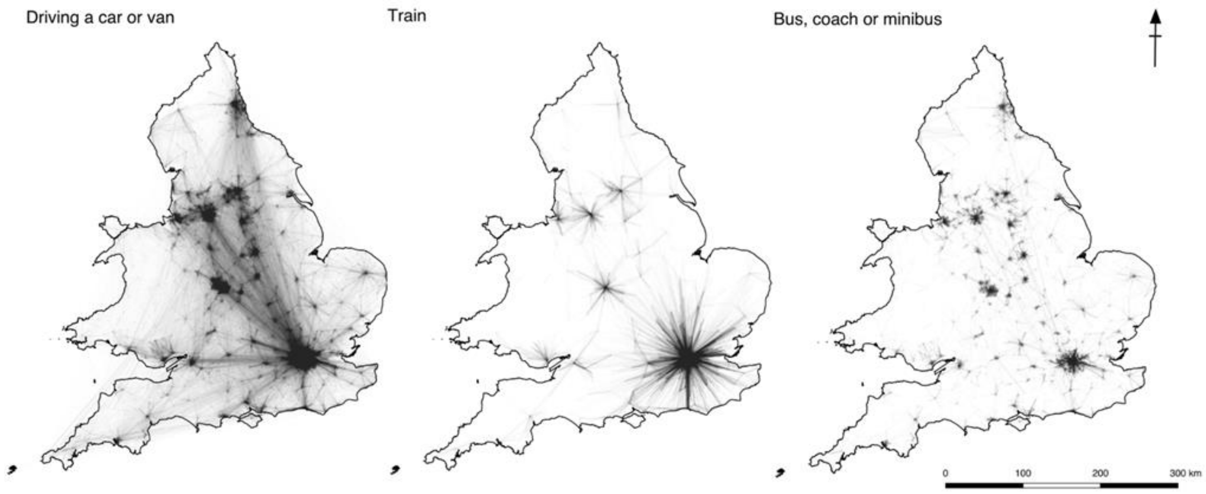
Table 6. Travel to work Distances, 2011

Place of Residence	Work within home MLSOA	Travel to work					
		By driving car		By train		By bus	
	No. of people (,000	No. of people (,000)	Average Distance (km)	No. of people (,000)	Average Distance (km)	No. of people (,000)	Average Distance (km)

Major Conurbations	784	3,829	78.5	734	93.5	1,058	46.9
Minor Conurbations	68	503	71.3	13	104.1	101	35.5
City and Towns	1,110	7,040	66.1	449	114.6	640	36.9
Rural Town & Fringe	314	1,557	72.1	72	134.1	73	41.8
Village & Dispersed Settlement	399	1,315	78.1	57	139.8	35	50.1

Source: based on Phillips M and Dickie J (2019) 'Moving to or from a carbon dependent countryside', Journal of Transport Geography 74, 259; data originally derived from Office for National Statistics, 2011 Census, QS701EW, licensed under the Open Government Licence v.1.

Figure 15. Travel to work distances England and Wales, 2011 Census



Source: Phillips M and Dickie J (2019) 'Moving to or from a carbon dependent countryside', Journal of Transport Geography 74, 259

Energy is not just consumed in the home, but is also used in rural businesses and in transportation, including in commutes to and from work and in journeys to access a series of educational, welfare and retailing services. A series of studies have identified that differences in journey to work distances between rural and urban residents (e.g. Anable et al., 1997; Commission for Rural Communities, 2010; Phillips and Dickie, 2019a; 2019b). An analysis of travel to work distances recorded in the 2011 Census, for example, found that these journeys were 33 per cent higher for people living in rural areas than the overall average, and were, perhaps unsurprisingly, significantly higher across all categories of rural areas within sparse settings and also increased progressively down the settlement hierarchy (see Figure 14). Furthermore, it is clear that there is heavy reliance on the use of private vehicles to undertake these journeys across all categories of rurality (Table 6) and it has also been recorded that rural residents make extensive travel to access a range of services, including education, retailing, health care and financial services (Table 7).

Such analysis highlights the high mobility of contemporary rural living amongst many people, and given the reliance on private transport and low ownership of electric vehicles, implies that there is heavy reliance on carbon-based fuels. One consequence of this is that transition policies such as carbon pricing and taxation can potentially impact rural residents and businesses disproportionally, and particularly impact those in more remote and/or inaccessible locations, with there being clear evidence of resistance to such policies from these groups within several OECD countries (e.g. see Doherty et al. 2002; Wood 2003; Reed 2004; Beck et al. 2016; Kimmelman 2018). There is clearly growing levels of electric vehicle ownership and use, but at present it appears likely to be a highly urbanised phenomena given the location of EV charge points and the evident longer journeys undertaken by rural residents, which may render use of electric vehicles problematic given battery related range limitations. On the other hand, there is clear evidence that much of the current patterns of commute and other journeys undertaken by rural residents is to urban centres (see Figure 13 and Phillips and Dickie, 2019a), so there clearly are opportunities for such residents to make use of urban located EV charge points. There clearly is also potential energy savings related to home-working and for the distribution of employment opportunities into rural areas.

Table 7. Travel distances to obtain access to resources of everyday life

Villages			**Activity**									
	Travel to work		Supermarket		Doctors		Cash		Petrol		Clothes	
	Mean	Max.	Mean	Max.	Mean	Max.	Mean	Max.	Mean	Max.	Mean	Max.
Berkshire Village	23.1	95.2	13.1	95.2	6.1	95.2	15.3	95.2	16.1	128.1	33.5	261.8
Lincolnshire Village 1	22.3	92.9	17.7	242.4	9.1	10.0	15.1	101.8	18.0	96.7	25.9	47.4
Lincolnshire Village 2	24.1	203.9	13.6	45.8	8.3	45.8	15.3	112.5	20.6	112.5	35.1	121.2
Lincolnshire Village 3	21.4	123.7	7.5	18.0	6.7	18.0	7.8	18.0	8.6	18.0	13.2	43.3
Lincolnshire Villages	*24.4*		*15.2*		*8.4*		*13.9*		*17.3*		*28.4*	

Midlands Village 1	22.6	133.8	7.1	34.9	4.1	11.2	8.8	94.0	9.2	53.3	42.6	282.0
Midlands Village 2	46.8	173.7	6.8	19.7	13.0	121.6	13.6	121.6	7.3	25.2	29.1	121.6
Midlands Village 3	15.8	186.4	8.6	47.0	3.4	10.3	4.7	47.0	11.8	47.0	18.3	127.8
Midlands Village 4	11.6	24.7	12.8	18.2	4.3	12.7	11.1	15.7	8.7	18.2	16.5	67.1
Midlands villages	*20.7*			*9.6*		*5.0*		*8.9*		*9.7*		*23.5*
All Study Villages	*21.7*	*203.9*	*12.2*	*242.4*	*6.4*	*121.6*	*12.0*	*121.6*	*13.5*	*128.1*	*26.9*	*282.0*

Source: Phillips M and Dickie J (2019) 'Moving to or from a carbon dependent countryside', Journal of Transport Geography 74, p. 262.

4 Challenges to and opportunities for the formation of post-carbon rural transitions

The previous sections have detailed the significance of energy in rural areas and evidence relating to transitions to a post-carbon energy regime. It has been demonstrated that there has been some significant growth in renewable energy production particularly in the last decade, with much of this energy being generated in rural areas. There have been much smaller declines in energy consumption levels, and although relatively little research has been done on rural energy consumption within OECD countries, it appears that rural areas can have high per capita energy consumption levels related to both high mobility requirements and the condition of rural housing.

Considerable attention has been paid to the presence and causes of resistance to renewable energy developments, and to the impacts that they may have environmentally and on the other land uses in the countryside. There has been little detailed examination of its economic and social benefits, although renewable energy has long been promoted as a means of economic regeneration. The extent to which envisaged benefits have been realised has been questioned, although a series of community benefit arrangements have emerged. It is apparent that quite different strategies for renewable generation have been enacted, with countries such as the UK exhibiting a focus on large-scale private developments established in large part through existing energy players, whilst countries such as Denmark and Germany have placed greater emphasis on smaller-scale developments with higher levels of local ownership, and hence probably greater localised long-term benefits. Both approaches appear to have delivered significant growth in renewable energy production, although questions surround the extent to which further growth can be sustained, particularly at the rate desired to achieve climate change mitigation targets. There is also potentially a tendency to emphasise differences in approach and pay less attention to the mix of approaches that have emerged in many countries: in Denmark and Germany, for instance, it is clear that there has been significant growth in larger-scale private developers in recent years. A mix of agencies may provide a productive development strategy, enabling of both innovative niches and the use of economies of scale. There is, however, also evidence that it can be productive of tensions, not least when criticisms about large-scale externally controlled developments are transferred to more locally based projects (Munday et al 2011). Furthermore, whilst the development of a mixed renewable energy sector might be a productive development policy, in practice its emergence seems to largely stem from divergent policy initiatives that have emerged over time, whereby particular forms of energy development are promoted at in one period, and then a different policy focus is taken, encouraging a different set of actors and developments.

The lack of clear and consistent government policies is an evident feature of renewable energy development across OECD countries. Whilst in most of these countries there are central government policies and commitments relating to climate change mitigation that include reference to the desirability of renewable energy and energy efficiency developments, it is also evident that their energy policies do not always have climate change mitigation as their core focus. Most energy policies also lack strong sub-national territorial components, and indeed are often poorly articulated with regional and rural policy making. Furthermore, climate mitigation policies often have, albeit often implicitly, an urban focus, with cities seen as key spaces and agencies in the delivery of climate change mitigation strategies.

Part of the message of this paper has been to highlight the significance of rural areas to energy related mitigation policies. It is important to energise thinking and policies related to rural areas, recognising that the performance of rural lives and livelihoods is powered by energy, and that rural areas have long played key roles in the formation of wider energy regimes. There is a clear need for environmental, energy, regional and rural development policy makers to recognise the significance of rural energy dynamics. However, whilst local rural development practitioners have often viewed energy developments as being a means to stimulate rural economic growth, such arguments have not been strongly advanced within national and international policy-making, where environmental, energy and regional/rural development policies are still often being developed in relative isolation from each other. A key challenge going forward will be to break down these policy-siloes and develop more integrative approaches, both at the policy development and implementation stages.

In arguing that rural areas have played a key role in the formation of energy regimes, it is also important to recognise that there have been significant shifts in these regimes and that rural areas may be both quite differently integrated and impacted by these regimes. Particular attention has been paid here to the positioning of rural areas to an emergent post-carbon energy regime, although it has also been emphasised that many people living in the countryside are still heavily bound into the consumption of carbon fuels for travel and for heating, lighting and powering their homes. Many rural areas are also heavily bound into the production of carbon-based energy, of both conventional and unconventional forms Transitioning to a post-carbon energy regime will hence clearly impact different rural areas differently. It has been shown, for example, that there is evidence of a tendency for some forms of renewable energy developments to cluster in areas that have already been sites of carbon-based energy production, due at least in part because the landscapes and people of these areas have already experienced the impacts of energy production. This does not mean that all such areas will inevitably become subject to renewable energy development, not least because there may be environmental conditions that might preclude or limit the application of some renewable energy technologies. There may also be areas that have not experienced carbon-based energy production but which are experiencing land devaluation and release that might make them receptive to movements into renewable energy development. Sutherland et al. (2015), for example, have argued that renewable energy developments in Germany and the UK have been, in part, fostered by destabilisations of agricultural production regimes that created impulses for farmers and other agricultural actors to engage with the energy production. Conversely, areas where there are high levels of energy consumption linked to gentrified lifestyles appear in many instances to be able to resist many forms of renewable energy development, a situation that clearly raises issues of social inequities and inequalities that are often deemed to fall outside of the scope of contemporary neoliberal policy making.

Given Huber and McCarthy's (2017) claims about the horizontal space demands of the emergent post-carbon energy regime, it appears likely that many more rural areas will become significantly impacted by renewable energy production and distribution demands. The extent of the spatial demands of the new energy regime appear as yet poorly recognised by policy-makers, in part perhaps because of the fragmentation between energy, environmental and territorial focused policy-making. There are also clear political challenges associated with discussions of extensive land use changes, particularly given the evidence of localised opposition to many renewable energy developments. However, as discussed in the paper, there is evidence to suggest that increased engagement with energy technologies can both increase acceptance about their development and increase more general energy literacies and constructive engagements with the challenges of energy transitioning.

It is important to also acknowledge that there have been significant engagements in post-carbon transition within some OECD countries, although this involvement has hitherto been quite gradual. Incremental developments have already resulted in some significant movements in renewable energy production and CO_2 emissions, and the extent of these changes has arguably remained rather under-appreciated within policy and popular discourses, which have often focused on the problems associated with renewable energy developments.

A range of policy measures have clearly contributed to this growth, including a range of forms of subsidies. There have also been a series of policies pursued in relation to energy consumption, although here the overall impacts appear currently quite limited. Rural areas in particular face significant challenges in reducing their energy demands, in part because of the centrality of mobility to contemporary living in many rural areas. There are also clear technology related challenges in reducing energy consumption in rural areas. Reference has, for instance, been made to the presence of higher per capital domestic energy use related to the character of rural housing and the difficulties of applying energy saving treatment to them. Likewise, reference has also been made to challenges in the application of electric vehicle technologies within rural areas. There is, however, clear scope for localised policy initiatives to assist in the adoption of energy saving technologies, such as the installation of housing insulation, more efficient lighting and heating systems, EV charging points and the improvement and development of public and community-based transport options.

A further area of policy development relates to the need to connect climate change mitigation and energy policies to wider aspects of planning. The need for such connections has long been recognised, but there is a clear tendency for land use planning and development control decisions to be made with insufficient thought being given to their impacts on energy use. Despite efforts to increase energy efficiency standards for new-build constructions, the design and location of these are still often centred around daily access to private vehicles to access work and other facilities of daily life. The rationalisation of public services is still impacting many rural areas and encouraging further reliance on personal mobility, and the consumption of energy that this necessitates. Even settlement protection policies constructed in the name of climate change mitigation and transportation reduction can be seem to have significant, and unexpected energy impacts. It has been argued, for instance, that sustainable settlement policies focused around the concentration of housing development in areas of service provision - what is often described as a 'key settlement policy' – has a consequence of increasing the relative attractiveness of smaller and more distant locations amongst the most mobile, affluent and higher energy consumers (Shucksmith, 2007). Such residents are also often seen to have the highest level of environmental awareness, and be likely early adopters of energy saving technologies, but research has highlighted that they are often highly resistant to contemplating significant behavioural change (Phillip and Dickie 2014, 2015, 2019). Given such findings, it appears that significant changes in patterns of energy consumption will require policies directed at influencing the production of more energy efficient commodities, as well as the integration of energy considerations across a whole series of policy areas. Attention also clearly needs to be paid to social differentiations in energy usage, and also how these connect to the burdens and benefits of changes in energy production. Many of the areas that have seen most renewable energy production are also areas where there are high levels of fuel poverty, and hence issues such as the dispersal of development benefits and distributive, representational and identity related notions of justice are of importance for policy makers to consider. As McCauley et al. (2019) note, such notions of justice have not only enabled more "nuanced analyses" of energy transitions but have also been drawn into "the development of tools to support decision-making and policy-related processes". Sovocal and Dworkin (2015), for instance, promote the value of energy justice checklists and metrics/indicators to assist decision making about energy transition proposals.

5 Concluding comments and points for discussion

This working paper has explored the significance of energy production, distribution and consumption in rural areas, suggesting that the significance of these has not received the attention they deserve, particularly in a time of 'climate emergency'. Urban areas have often been seen as key arenas for climate change mitigation, but it has been argued here that rural areas have been key sites within organic and mineral/carbon energy regimes and are also already playing a key role within an emergent post-carbon energy regime. This role has clearly been influenced by policy initiatives generated by central governments responding to climate change mitigation commitments, although it is also evident that some of the countries that have advanced most strongly into a post-carbon energy regime began movements towards renewable energy and energy conservation before climate change mitigation became a prominent policy driver. Central government policies with respect to energy within many OECD countries still appear to constructed through a range of other policy drivers, and consequently engagements with a post-carbon energy regime have often not flowed from climate mitigation concerns. They have also generally often not been driven by rural development considerations, although there have been some points of connection made between energy, environment and rural development at both general policy levels and in local decision-making related to specific development proposals. A key question to consider is whether this policy fragmentation can continue into the future, particularly given claims about the extensive spatial, economic and social demands that a fully-fledged post-carbon energy regime will create.

This working paper has also highlighted differences between rural areas, and a key issue for policy makers will be how the emergent post-carbon energy regimes will engage and impact various types of rural area. These issues encompass energy production, distribution and consumption, and a further key policy issue will be how these moments in the energy system play out within different rural locations. Will there be a separation in the geographies of post-carbon energy production and consumption, or will the demands and benefits of these fall together on some locations? What would be the justice implications of a separation of the costs and benefits, and how might these implications play out in the acceptance of future energy demands in particular areas?

The geographies of post-carbon production have been shown to have been influenced in some instances by the geographies of social resistance, often described through the concept of NIMBYism. Whilst this notion has been widely criticised it highlights questions about the degree to which some people are able to distance themselves from renewable energy developments, and conversely how other groups do not. The working paper has highlighted how the carbon energy regime often created a distance between energy production and consumption, such that many people's only engagement with energy issues was as an 'end of wire'/end of fuel pump' consumer. The spatial demands of renewable energy production may act to challenge such a separation, as renewable energy production sites come to have a much wider presence than did the earlier sites of carbon energy production, although it has also been highlighted that many sites of renewable energy production are located in rural areas, which implies that there may be continuing separation of urban consumers from energy production. However, whilst rural areas appear likely to be the principal locations for renewable energy production, this does not mean that urban areas will remain completely immunised from energy developments. Urban areas have, for example, been identified as potentially important locations for renewable energy production via roof-top solar panels and wind turbines, as well as major sites for energy conservation measures (e.g. see Abohela et al. 2013; Becchio et al. 2016; Sarralde et al 2015). Even in urban areas, therefore, the transition to post-carbon energy regimes holds the potential of making energy production and consumption a mudane matter of encounter and interest for an increasing number of people (see Throndsen and Ryghaug 2015; Ryghaug et al. 2018). In this working paper, attention has been paid to arguments about the potential benefits of opening up access to sites of energy production to foster connections to everyday practices and discourses related to the countryside, and thereby facilitate the formation of energy literacies and senses of energy citizenship. Such ideas clearly have resonances with arguments about the value of community energy developments, and how they frequently involve much more than simply economic returns. Ryghaug et al. (2018: 298) warn that the concept of energy citizenship is rather under-developed at present and highlight the need to examine both the practices and processes through which it is created, as well as its consequences. There would, however, seem to be scope for policy makers and rural and community development practitioners to consider the extent to which they might seek to harness engagements across a range of energy technologies to foster greater awareness of energy transition issues and possibilities. Questions clearly need to be asked about the potential scalability of community energy given the demands of climate mitigation targets, and also about the degree to which they can reinforce or change existing inequalities, inequities and social identities of superiority and inferiority.

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