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**Journal:** Energy Policy

**Paper title:** Uneven energy transitions: Understanding continued energy peripheralization in rural communities

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**Abstract:** This paper problematizes the uneven nature of low carbon energy transitions in the context of uneven geographical development and core/periphery asymmetries. It explores the impacts of transition for peripheral communities lacking political power and agglomerative advantages. While decentralised developments that emerge with energy transition promise to bring new opportunities to remote areas, factors of economic and political inequalities render those opportunities socially and spatially segregated. Exploring experiences of rural and exurban communities in South Wales, the paper establishes links between low carbon transition and its actually existing implications on the ground. It demonstrates that even if having an abundance of natural resource and physical space to harness low carbon energy, many rural communities are trapped in the chronic positions of energy peripheralization.

**Keywords:** energy justice; spatial justice; energy transition; uneven development; Wales; United Kingdom

## 1. Introduction

Driven by international agreements to limit the effects of climate change, transition to low carbon and clean energy is perceived to be offering many new opportunities. For example, it is argued to be a mechanism to liberate the traditional ‘lock-ins’ to carbon-heavy energy and de-monopolise and de-centralise systems of energy production and distribution (Foxton, 2013), while also bringing elements of so-called “energy democracy” (Szulecki, 2018, p.21). Additionally, local ownership of energy production is recognised as a means of retaining economic benefit within a local economy (Benedek et al., 2018).

However, transition holds costs as well as benefits and as is being evidenced in multiple places at varying scales, the distribution of these costs and benefits is not necessarily even. Thus, the challenge of low-carbon energy transition is not just one of shifting to a new and less carbon intensive socio-technical regime. It is also a challenge in terms of making sure societal costs, risks and benefits of that shift are distributed in a way that can be considered ‘just’ (Sareen and Haarstad 2018, p. 624).

A “just transition” is not something that “automatically” emerges from low carbon plans. Since social outcomes are not technologically determined, the changes that low carbon transition may bring could be more exploitative and socially detrimental than pre-transition systems. In other words, the ontological problems of many proponents of transition lie within the ideas that distributed systems are somehow “by default” more inclusive, democratic and benevolent. Indeed, such views have been already problematized by combining socio-technical transition theory with energy justice (Hall et al., 2013; Heffron et al., 2015; Sovacool and Dworkin, 2015; Jenkins et al., 2016) and emphasising energy justice of transition, and how transition risks replicating, if not worsening, uneven socio-economic and

political distributions of power, opportunity and representation. Additionally, the spatial bounding of each part of the energy system suggests that injustices are also spatially bound. Thus, research has emerged that also considers the interplay of spatial justice and energy justice (Yenneti et al., 2016; Sareen and Haarstad, 2018).

Related to this are also the links between uneven geographical development and energy transition (Bridge et al., 2013). Uneven geographical development takes place at multiple scales through processes shaped by physical, historical, cultural, economic and political conditions that produce and reproduce spatial differentiation and inequalities (Smith, 1990; Harvey, 1996; Soja, 2010). Consequently, places have differing ability to engage with energy projects and innovations (Baker and Mehmood, 2015) so that pre-existing inequalities may be reinforced rather than rectified by low carbon transition. In addition, depending on their pre-existing energy mixes, dominant industries, infrastructures, built forms, or socio-economic factors, places may be more or less vulnerable to new energy modalities (Haag et al., 2012; Baker et al., 2014; Weller et al., 2018). A more nuanced understanding of the processes pertaining to actually-existing socio-spatial transitions must be garnered accounting for complex and diverse spatiality, away from linear “multi-win” assumptions, which underlie the deployment of low carbon policies (Golubchikov and Deda, 2012).

In this paper, we address the links between energy transitions and uneven geographical development by considering the experiences of transition in economically fragile rural communities, exploring these in the context of the asymmetric relationships between core and periphery. The division between core and periphery is one of the key dimensions in the dynamics of uneven geographical development and yet it is little explored in relation to transition, especially at a sub-national or sub-regional level (Murphy and Smith, 2013). Understanding the concept of periphery can explicitly link the inherent disadvantages of peripheralization with inhibited ability to participate in low carbon transition.

Empirically, our study is grounded in the context of Wales, a predominantly rural country, already considered economically peripheral within the UK (Owen et al., 2000; Henderson, 2019). Wales itself, in turn, represents a mosaic of economic centrality and peripherality. In socio-economic terms, peripheral places in Wales are considered to be those that have limited access to services and employment possibilities, such as sparsely populated areas distal from larger urban centres (Heley et al., 2011; Kitchen, 2012). Indeed, as observed by Fischer-Tahir and Nauman (2013), peripherality often coincides with rurality. Thus, our field research focussed predominantly on communities in rural areas; however, experiences were also gleaned from communities in exurban post-industrial areas located near to those of our rural focus in South Wales.

The key question driving the empirical investigation was to understand how rural communities engage or not with energy transition and what benefits and costs they experience in that regard. We employed a qualitative case study methodology, with a mix of research methods that included interviews, observations, document and secondary data analysis. Within this recruitment strategy, purposeful, contingent and snowball recruitment methods were adopted. As a result, over 60 semi-structured in-depth interviews were carried out with households, community groups, third sector, governance institutions, and energy related experts. Data collection took place in 2016–2019 and spatially encompassed the local authority areas of Carmarthenshire, Merthyr Tydfil, Monmouthshire, Neath Port Talbot and Powys, as well as pan-Wales perspectives.

The rest of the paper is structured as follows. The next few sections outline low carbon transition frameworks and the opportunities for justice within transition processes. Following on from this, we outline the emergence of “uneven low carbon transition”, highlighting how energy transition is progressing differently in different places. We then link such discussions to our empirical research. What emerges is that despite the presence of many new opportunities that rural areas have with regard to low-carbon energy transition, socially these communities are rarely able to engage with those opportunities and have a little uptake or ownership of energy transition measures. Because of a host of socio-economic and political disadvantages, they are also trapped in the chronic positions of energy peripheralization and energy fragility. The potential of ‘their’ areas is more easily exploited by external actors with limited circulation of benefits locally. This ‘paradox’ of rural energy transition suggests continuing energy peripheralization underpinned by exclusionary socio-economic practices.

## **2. Low carbon transition: benefit or cost?**

Energy transition demands divergence from high-carbon fossil fuels to more sustainable, renewable and other low carbon energy sources of energy production. The move towards such transition is primarily driven by the efforts to mitigate the impacts of climate change, reduce greenhouse gas emissions and improve the quality of air in the built environment (IPCC, 2014; Turnheim et al., 2015). The energy system traditionally consisted of few carbon-heavy technologies such as gas or coal fired power stations, and few large-scale commercial actors generating and selling energy (Foxon, 2013). Low carbon transition is altering some aspects of this system; diversity in energy source and technology in energy production is increasing the physical distribution of locations of energy production. This already decentralises the previous arrangement from a limited number of power stations to a vast number of new production sites. Facilitated through regulatory change, this has opened the energy market, in theory at least, to myriads of actors that can now serve as new energy producers: individuals, groups, public and third sectors as well as new commercial developers.

Thus, the scale of production can vary greatly from large-scale, down to micro or domestic scale. Supported by bi-directional energy flow this is also altering the role of traditional consumers to energy “prosumers”. In this way, transition can offer increased “energy democracy” as new and diverse ranges of energy production modes and ownership are developed (Szulecki, 2018, p.21). Ownership of energy production generally infers ownership of profit from sale; increased “local ownership” is recognised as a means of retaining economic benefit within a local economy (Benedek et al., 2018, p.517). It is argued that locally owned large-scale developments generate more long-term local employment and 1–3 times higher economic impact than the same externally owned developments (Benedek et al., 2018). Even commercially owned energy developments now routinely offer “community benefit funds”, typically managed by community groups and channelled towards community wants and needs (Cowell et al. 2011, 2012). Transition within this framing appears to somewhat reshuffle existing capitalist structures that gravitate towards agglomeration and centralisation due to profit maximization strategies.

However, transition holds costs as much as benefits. Low carbon transition has been originally dominated conceptually by the Multi-level Perspective (MLP) framework pioneered by Rip and Kemp (1998), Schot (1998) and Geels (2005). Energy transition in MLP requires changes to a three-tiered socio-political structure of niche, regime and landscape, in which technical innovations developed at niche level break into the regime as

gaps emerge which are brought on by pressure from the landscape level. MLP is recognised for the advancements it has made to transition theory; however, the rigid and isolated structure it imposes – which focuses on technical innovations (Turnheim et al., 2015) – commands little attention to the social origin, contexts and implications of transition. The gap in understanding uneven transitions has been addressed by combining socio-technical transition theory with energy justice (Hall et al., 2013; Heffron et al., 2015; Sovacool and Dworkin, 2015; Jenkins et al., 2016). Energy justice offers a critical framework to explore social and structural factors that contribute to the uneven distribution of costs, benefits, vulnerabilities and influences relating to energy systems (Heffron et al., 2015; Sovacool and Dworkin, 2015; Jenkins et al., 2016). Transition frameworks that include energy justice have focused on “humanising” the existing socio-technical frameworks (Jenkins et al., 2018, p. 66) and emphasising the social and material structures and processes shaping transition (Bridge et al., 2013; Bouzarovski and Simcock, 2017; Healy and John, 2017; Monyei et al., 2018).

While approaches to conceptualising a just energy transition differ, they share a strong premise: that without integrating energy justice in transition, the latter risks replicating uneven socio-economic and political distributions of power, opportunity and representation. This can occur by disenfranchisement, exclusion, increased socio-economic gaps and causing those with the least resources and power to be disproportionately negatively affected by distributions of costs and benefits. Additionally, they highlight the role of powerful incumbent actors in slowing and diverting transition. Jenkins et al. (2018), for example, point to the landscape level of the MLP, while Healy and John (2017) trace back injustice to its root causes within the energy system as a whole. To further these emerging understandings, a geographical lens is needed that makes clearer the impact of existing uneven *spatial* distributions of socio-economic and political power, opportunity and representation on low carbon transition.

### **3. Uneven energy transitions**

The spatial bounding of each part of the energy system suggests that injustices incurred within each process are also spatially bound. Indeed, the progression of transition evidences uneven spatial distributions of transitional technologies, ownerships and carbon emission reductions (Cowell, 2010; Balta-Ozkan et al., 2015). In addition, to grasp the trajectory and distribution of transition within any given place, consideration must first be given to its current social, economic and political position relative to other places as well as local histories, cultures and socioeconomics - all of which may hold influences over abilities of places to transition and their receptibility to different transition pathways.  
their receptibility to different transition pathways.

Theorizations of the reasons for uneven development and distribution based on inequality, competition and accumulation broadly retain focus on core-periphery models. Core-periphery development is recognised as more than “just a product of the uneven distribution of natural resources and the influences of nature on economic geographies, but [arising] out of the constitutive social relations of capital” (Hudson, 2015, p. 29). Spatial categories and territorial divides are therefore a product of their history and culture (Massey, 1992) in addition to other social forces of politics, economics and culture, articulated through the influence of the spatial (Soja, 2010). Here, the configurations of uneven development and dependency, like those of space more generally, are understood to be the product of the dominant politico-economic system, specific to that system (Harvey, 1996). Thus, under capitalism, the production of uneven development is seen as inherent to capitalism. This is

due to its concentration and self-reinforcing tendencies in the accumulation of capital, restless profit-seeking in Schumpeterian entrepreneurial creative destruction, requiring investment and disinvestment in different areas (Smith, 1990), in addition to requisites for the spatial division of labour (Massey, 2005). As political, economic and cultural forces are unevenly distributed within society, geographic distribution is also unevenly experienced and creates places of domination, exploitation and marginalization (Lefebvre, 1991; Hayter et al., 2003).

The core-periphery concept can then be used to understand spatial differences and imbalance in economic, political and social power and thus recognize places that are at risk of exploitation and marginalization. The dichotomy of core-periphery infers that economically peripheral places are also symbolically peripheral. These differences are reinforced via political rhetoric and media representations from a core perspective (Cresswell, 2015). Thus, in a relatively weaker position to cores, peripheries are likely to experience social, economic and political marginalization, with less power to influence decisions over resource access and allocation. Overall, peripheralization can be understood as “a spatially organized inequity of power relations and access to material and symbolic goods that constructs and perpetuates the precedents of the centre over the marginalized” (Fischer-Tahir and Nauman, 2013, p. 18).

Energy has always had intricate relationships with space. Taking a wider view it is clear that the “built environment, geo-political relationships, and flows of social and financial capital are organized in relation to the quality and location of the energy resources that are available and valued by a society” (Calvert, 2016, p. 105–106). In this way, energy has played a role in not only configuring material spatiality, but also the spatial clustering of social, economic and political power. Relative positions of power, in turn, hold many implications for spatial development and energy transition. Each stage of the energy system is taken forward and contested by multiple actors, all of which vary in composition, scale and power. Also, each stage is spatially bound, due to the materiality of energy resource, the energy itself and its consumers; but the spatial distribution of each stage is also influenced by the power dynamics embedded within different space.

Milbourne and Mason (2017) highlight that in the UK the same peripheries have for many years been exploited for their national resources, such as water, wood and carbon-heavy resource extraction required for traditional energy production. Resource peripheries are conceptualised as places of relatively poor economic, social and political power, yet rich in resource. Places of resource peripherality often align with places of rurality (Fischer-Tahir and Nauman, 2013), vulnerable to dependence on external core economic investment, with limited stake in decision-making processes and holding on to economic profits gained from this investment. Such arrangements usually inhibit the rise in relative economic position for the rural periphery. Resource peripheries include places of resource extraction for energy production, and as low carbon transition unfolds, increasingly energy resource extraction and energy production are also occurring simultaneously - in the rural resource periphery. However, greater economic benefits are retained in core places where ownership of higher value outputs such as technical supply chains and R&D are concentrated (Baker et al., 2014; Jones, 2015). Thus, the costs incurred within the energy system are experienced by people and places who lack the social, economic and political power to participate in energy discussions, to challenge energy decisions or to demand recompense.

The cost of low-carbon energy development are not limited to unequitable resource extraction, there is a growing body of research that highlights injustices experienced in low carbon transition - for instance, as a result of culturally demonization of development

opponents (Wolsink, 2007; Aitken, 2010; Walker et al., 2010), landscape impacts (Woods, 2003; Pasqualetti, 2011) and even social divisions forming within communities (Gross, 2007; Maillé and Saint-Charles, 2012). In Wales, for example, there has been much disquiet in rural peripheries regarding the development of large windfarms. As Mason and Milbourne (2014) highlight in their research of the proposed Nant y Moch windfarm in Ceredigion, opposition to the development was based on multiple perceived injustices. The community's opinions and the value placed on their landscape was unrecognised or treated with “indifference”; this exacerbated feelings of inequity due to hosting a development for the national good, but for which they said they had to “put our head on the block” (Mason and Milbourne, 2014, pp. 109). These negative perceptions were further compounded by the development being owned by SSE, one of the largest energy suppliers in the UK and decision making (due to the scale of the development) being taken in Westminster.

#### **4. Energy peripheries**

As low carbon transition progresses, its uneven geographies and injustices are starting to be revealed. Research is highlighting how not only is the materiality of transition spatially bound but so too are the wider social, economic and political outcomes, which themselves appear tied in and influenced by the existing structures. We must acknowledge that peripheries are both relative and of multiple scales, thus the interplay between uneven geographical development and energy are subject to the same relativity and variety in scale. Therefore, while this paper retains focus on rural peripheries, we can also briefly widen the focus to explore higher scale examples of such interplay. For example, research by Baker et al. (2014) of economic and energy policy in South Africa highlights that due to its already economically peripheral position within a global context, the country has limited ownership of renewable technology R&D processes and supply chain development. This means that economic benefits of renewable energy for the country are limited to carbon reductions and low levels of employment. The greater financial gains associated with technological innovation “rather than being retained and reinvested into the local or national economy [...] is likely to leave the country” (Baker et al., 2014, p. 21). Indeed, renewable energy's employment holds the lowest employment opportunities of all types of energy (Bryan et al., 2017). In South Africa, despite progressive renewable energy policies in place and recognition that innovation and supply chains need to be developed within the country for maximum and longer-term benefit, its existing economic peripherality has curtailed the financial investment required to create such opportunities. Scaling down to a regional perspective, research by Haag et al. (2012) highlights that similar difficulties are faced in Arizona, US, where, despite an excellent solar resource, the state has been unable to generate meaningful economic benefits. They attribute this to a lack of local supply chains and skilled labour (Haag et al., 2012).

Scaling down even further, research by Weller (2018) with a focus on the political framing of energy transition in the Latrobe Valley in Australia, illuminates the interplay between existing spatial and energy injustices and more contemporary transition processes. The Valley can be characterised as a resource periphery due to its dependence upon energy resource extraction (lignite) and production as “the wealth created by the Valley's coal-based industry had always been captured elsewhere [...] which meant capital resources had never accumulated locally to fuel other forms of industrial development” (Weller, 2018, p. 7). Low carbon transition necessitated the closure of the coal-fired power-station which was the largest employer in the area. But due to their marginalized position, economically and politically, further enhanced by social representations of deprivation and resistance to transition in the media, the voices of the community were either unheard or misrecognised.

This also meant that retribution funds to compensate the area for losses were mostly distributed elsewhere. While the communities challenged this and were eventually recognised, the situation highlights how transition can be positioned as a greater good, but that its costs are paid by already peripheralized places.

Research such as those noted is critical in highlighting the spatial contingency in how transition occurs and informed by existing spatial structures. However, the uneven geographies of energy transition may be better illustrated and more explicitly linked by considering spatial justice. A spatial justice lens indicates the dialectic of space and society and the role of space as a key reinforcement mechanism for social, economic and political processes, such as with respect to inequities in wealth and power (Lefebvre, 1991; Harvey, 1996; Soja, 2010). Recent attempts to more explicitly link energy and spatial justice are critically important (Yenneti et al., 2016; Bouzarovski and Simcock, 2017). Such works consider the influence of various scales (of places, actors and energy developments) and spatial difference exerted on transition trajectory, including how ‘just’ it is or is not. Sareen and Haarstad (2018) argue that socio-technical transitions are “entangled” with justice concerns which “play out in different ways across contexts and scales” (Sareen and Haarstad, 2018, p. 630). [Yenneti et al. \(2016, p. 96\)](#) clearly demonstrate how low carbon transition, whilst conceptualised as “progressive development”, can actually be used to disenfranchise places with little socio-economic or political power. This disenfranchisement is carried out for the benefit of the nation (large scale) at the spatial core, where the costs are paid by the villagers (small scale) in the periphery exposed to dispossession by low-carbon accumulation.

Such ‘entanglements’ of spatial and energy injustices result in messy webs of disadvantage which create “energy peripheries” (Golubchikov and O’Sullivan forthcoming). Energy periphery encapsulates “place-bound conditions of systematic vulnerabilities and disadvantages experienced through the entire energy system by (some) non-core communities in the broader context of spatially asymmetrical distribution of political, material, economic, symbolic and other resources and capabilities” (Golubchikov and O’Sullivan, 2020). The concept illuminates how webs of mutually-reinforcing place-bound disadvantages in certain already marginalized areas in the dominant politico-economic systems are further articulated with, and articulate, a vulnerable position in the energy system. This produces a whole distinctive and systematic class of energy inequities. The same constellation of factors will also hold influence over places’ vulnerability to unjust energy transition.

The lens of energy periphery can reconcile the paradox that the ‘burden’ of primary energy production lies predominantly with the periphery, but the same periphery may still experience energy precarity. Peripheries with the availability of natural resources for energy generation are the least problematic locations for new energy projects in part because of low population numbers but also in terms of the social economic and political capacity within peripheries to assert themselves in energy decisions. As such, profits extracted from such projects as well as the orientation of the distributing infrastructure gravitate towards high-consumption places with their economies of scale. Additionally, in weaker economic positions and largely dependent on external investments, peripheries can hardly refuse economic investment, especially those which hold the promise of employment, even if such promises are overstated or only beneficial in the short-term. The knowledge of such place-bound situations is important also because it helps to better understand (uneven) energy geography and (fragmented) landscapes of transition. Below we contextualise these thoughts and highlight similar interplay between energy, space and transition through our case study in rural Wales.



## **5. Energy transition in Welsh communities**

Wales is known for its rurality; in 2015, 88% of its land area was used for agricultural production (National Assembly for Wales, 2016). Compared to other regions in the UK, Welsh gross value added (GVA) and employment levels “languish[es] at the bottom” (Dickins, 2016, para 24; also National Assembly for Wales, 2018). While in terms of GDP per capita, the UK as a whole is above the EU average (108%), Wales is only 76% of the EU levels, making it among the weakest regional economies in Europe (Eurostat, 2017). The low economic output and high level of unemployment, along with underdeveloped facilities, poor housing and health that are often associated with Wales are often attributed to the enduring effects of the decline of coal and metal industries (Botterill et al., 2000).

While the establishment of the autonomous Welsh Assembly Government (WAG) in 1999 has brought political powers to Wales, the devolution has not been as comprehensive as in Scotland. For example, the Welsh Government has continuously voiced its discontent at constraints over its energy policy, which is seen to limit energy developments in addition to disjointed and cumbersome planning and consenting procedures (Welsh Government, 2014; Cowell et al., 2017; Haf et al., 2017). The Wales Act 2017 extends Wales's energy policy remit to include the licencing and granting of consent for onshore oil and gas projects; all onshore wind projects; renewable energy projects under 350 MW that are developed inshore and offshore; and the promotion of energy efficiency. Wales have also increased its powers indirectly via the Planning (Wales) Act 2015, the Wellbeing of Future Generations (Wales) Act 2015 and the Environment Act (Wales) 2016, which provide a range of criteria to be satisfied in future developments that include energy. The Wellbeing of Future Generations (Wales) Act in particular, refers to “An innovative, productive and low carbon society which recognises the limits of the global environment and uses resources efficiently and proportionately” as first of the seven Wellbeing Goals. The Act places a requirement on all public bodies to ensure that ways of working and decision making are of benefit now and in the future. It also requires holistic approach to decision making whereby policy areas are not considered in isolation. Thus, decisions that affect energy regime change will be affected within multiple policy areas (not just energy policy) holding direct and indirect change.

Against this backdrop, while UK Government decisions have reduced subsidies for low carbon renewable energy and increased support for nuclear energy, Wales retains its strong commitment to renewable energy. It has set an annual reduction target of 3% on greenhouse gas emissions in areas of devolved competence and at least a 40% reduction in total emissions in Wales by 2020, rising to 70% by 2030 on a 1990 baseline (Welsh Assembly Government, 2010; Welsh Government, 2017). There is the ambition to be a world leader in low carbon renewable energy generation (Welsh Government, 2017). However, despite enjoying greater power over its energy policy, there are limits to what the Welsh Government can approve and how much it can afford to fund itself without UK Government permission; this is for example the case of new installations larger than 350 MW.

The highest levels of GVA within Wales are predominantly attributed to the core cities, which concentrate employment, capital and value generation, influencing commuting practices within surrounding rural areas and constraining household budgets for those who commute. Urban areas of Wales also have the more extensive and reliable energy networks (National Assembly for Wales, 2014) and lower proportions of energy inefficient houses than rural and peri-urban areas (Centre for Sustainable Energy, 2015). These spatial and energy factors directly and indirectly influence the spatial variegations in energy vulnerability in terms of spatially contingent difficulties in accessing and affording energy and energy

efficiency. However, they also directly and indirectly influence the spatial variations in energy transition. For example, restricted load capacity of the electricity grid in rural peripheries means that new energy production is increasingly limited to micro scale (domestic) or very large scale, which in Wales are currently commercially owned. For other prospective energy producers, such as community groups or Small and Medium Enterprises (SMEs) the cost of expanding grid capacity is prohibitive:

*Part of the problem is the grid in mid-Wales is not great; certainly, some parts of it. So, if you're talking south Powys, there were some schemes that needed to upgrade the whole line to enable any more connections, for even a very small hydro... It just meant that the project couldn't happen... Yes it was just ridiculous: this 15-kilowatt hydro had to develop £2 million for the grid connection (Expert interview).*

Historical processes of energy resource extraction, socio-political and economic dynamics combine with and inform present day contexts reinforcing Wales' position as a 'slippery' resource periphery (Arden, 2013). While energy production in Wales has traditionally been in urban based power-stations, the resource required for that production has been sourced from the periphery via mining. Such industry held little concern for environmental and socio-economic impacts for the periphery that occurred at the time and which linger on in the form of un-reclaimed landscapes and socio-economic deprivation (Milbourne and Mason, 2017).

While low carbon transition alters this process as energy production can now take place at the point of resource extraction, it is generally a consensus that in order to gain the maximum benefit from low carbon transition, the process requires ownership within Wales. However, this needs not be restricted to profits from energy per se. Indeed, as other studies have identified, such a focus is narrow and the most benefit is gained when this is combined with established indigenous R&D industries and supply chains where more and higher paid employment is secured (Baker et al., 2014; Jones, 2015). In addition, access to cheaper and more affordable electricity is what would benefit the varieties of local industries most:

*If you look at our dairy sector, it's really struggling. Their biggest cost is electricity, for heating and cooling water ... So if you talk to our neighbours, they've got a dairy farm up the road and their electricity bill is about £1000 a month, and they're really efficient. A lot of places would spend a lot more than that. Through investment in renewables, if they weren't paying for that electric, they suddenly become more viable. It means they can actually sustain a living there on a smaller unit. The whole rural economy could be really helped out by that (Expert interview).*

Our research did find examples of peripheral transition, which were taken forward by indigenous organisations which secured localized economic benefit. In the cases of Small Medium Enterprises (SME's) which were farms and tourist attractions, holding seasonal and insecure work, transition represented significant economic savings and security of business income. This increased business economic viability overall and as in the instance below, enabled some business diversification and retention of staff for longer periods:

*We're saving £1000 a week ... It's helped us a lot on the environmental side of things. But on the business side of things it's also made the business more viable because not having to spend £4000 a month on electricity. That's made us able to open a little more ... It also allows us to keep staff on for longer (Business interview).*

However, as most large-scale low-carbon developments in Wales are commercially owned, this led to a sense of concern to communities living close by that profits and wider economic benefits generated from the commercial developments were leaving their local area and even the country. In addition, at large scales, electricity produced is higher voltage and must be fed into the National Grid, thus is not directly accessible to local communities. These frustrations are compounded by perceptions of ‘undemocratic’ political and planning processes, and that the energy produced was not directly accessible to residents. Thus, many felt that the benefits offered from the developments were not shared by the community, instead they were left with altered landscapes and continued peripherality.

At a community level, low carbon transition can offer opportunity to address wider peripheral disadvantages. Energy generation coupled with increased energy efficiency can help sustain village halls and community centres, which are increasingly un-economical to maintain for local authorities. Such places hold numerous local social benefits, especially in peripheries where few other facilities for socialization are present. Income generated from low carbon energy production and export is also reinvested in further low carbon measures. In the same community, electric vehicle charging points were installed at the community hall and a community car-share was initiated. This could potentially address localised issues of transport poverty but also position peripheral rural places more favourably when UK-wide policy ending the sale of carbon heavy vehicles comes into effect (Department for Environment, Food & Rural Affairs and Department for Transport, 2017):

While the above examples highlight that low carbon transition can actualise economic and social benefits and further decentralise and democratise the energy system, such instances were only viable when grid capacity was available and when Feed-in-Tariff (FIT) payments were high. If the same SME and community energy developments were to progress now, the reduced FIT would mean economic returns would barely cover the cost of installation, thus reinvestment opportunities are limited. Elements of disadvantage associated with peripheralization can present ‘barriers’ to smaller scale locally owned energy transition within the periphery. As highlighted above some are infrastructural constraints, not confined to just poorer electricity grid connection, but also to lack of access to gas mains and poor transportation infrastructure.

Political power and regulation over such areas have not been de-centralised, and private economic investment to improve infrastructures necessitates economic returns, which due to low population mass are unlikely to be achieved within the periphery (at least in the timeframes required). Just considering peripheral energy infrastructure and central regulation reveals the connection between energy injustice and spatial injustice. Regulation stipulates that electricity produced must be (with exceptions) fed into the National Grid in order that UK-wide energy demand can be met. This is true for electricity produced in Wales, where energy is then re-distributed to Welsh customers. However, the poor energy infrastructure in Wales combined with the distance energy must be transmitted incurs ‘losses’ which are the source of higher energy costs compared to most other UK energy region. Thus, the spatial injustice of poor energy networks is also an energy injustice which can lead to energy vulnerabilities in the form of energy access and affordability. While these higher costs are not confined to rural peripheries in Wales, transition is adding to energy injustices as increasingly large-scale low-carbon energy production is hosted in rural peripheries (Welsh Government, 2018) but is not altering energy distribution or costs. Thus, even though rural peripheries are increasingly producing more electricity, access and affordability of the same energy is not made any better for such areas.

Inaccessibility to gas mains creates a necessity to source heat energy from alternate sources. While this can prompt transition to renewable energy heat, more often traditional carbon heavy and expensive to run options such as oil are chosen. Poor transportation infrastructure not only compounds the wider disadvantages effects of peripheralization and limiting local economic growth (Copus, 2001), but also creates additional strain to budgets. This strain is not only attributed to distances of travel which are high for remote peripheries, but also to the necessity of vehicle ownership and the need to use such vehicles to access most services and facilities or even conduct business. Combined, poor energy and transport infrastructures create additional expense which consequently can limit spare finance to invest in transitional technologies.

What differentiates rural peripheries from other places such as core urban settings is that many of the vulnerabilities experienced within peripheries can be linked back directly to their spatio-structural disadvantages. Such disadvantages impact many aspects of peripheral life in addition to aspects of energy. For example, in a UK setting it is unlikely that even an urban periphery will experience energy vulnerability due to a lack of access to the energy network, in this way they also avoid the greater costs associated with accessing non-mains energy. The co-occurrence of the generic vulnerabilities in a peripheral context with other socio-economic vulnerabilities makes their effect compound, creating a landscape of precariousness specific to peripherality.

Within our study area, peripheral rural economies are typically more seasonally based, more dependent on external investment and offer lower incomes. For households and SMEs this constrains budgets available to invest in transition and also means transition can be perceived as a high financial risk. For communities and public sector organisations such as local authorities the impacts of austerity are ongoing, indeed the rural local authorities within our study area receive less public funding than urban authority areas (Stats Wales, 2018a; Stats Wales, 2018b). This has multiple impacts, affecting ability to support public buildings and services such as community centres or subsidies for public transport, both of which feed into wider peripheralization effects and abilities for households and communities to transition. More directly, reduced funding also impedes local authority's ability to achieve transition themselves or to assist other organisations including community groups. Capacity issues in the Welsh public sector have been highlighted in other research, for example, the Institute of Welsh Affairs (2019). Here limited numbers of staff assigned to energy policy, lack of understanding and support from internal decision makers for transitional energy projects and a general lack of knowledge of energy and planning systems were noted as “barriers” to transition (Institute of Welsh Affairs, 2019, p. 2). Within our research, limited staff and budget capacity fed into strategic decisions being taken that prioritized some locations over others for allocation of public sector led transition activities. Such transition activities included funding for community energy developments and domestic energy systems, or insulation retrofit. To inform decisions, area-based tools such as the Welsh Index of Multiple Deprivation were often utilised which provides spatial statistical outputs at Lower Super Output Area (LSOA) scale, with each LSOA derived from a mean population of 1500. Such tools identify places of relative deprivation and thus, places perceived to be in most need of assistance. However, as such tools hold bias towards more populated urban locations (Fecht et al., 2018), these strategic decisions were often taken to the detriment of less populated rural places:

*I think we're afraid of failure. [...] I would always try to hit an area where it looks as if we're likely to get a good return if possible. However, it's not as easy as that when you're working for an authority which has to be seen to be fair and above board [...] We've done a lot of work in Llanelli and we're doing more work in Llanelli but the council from Carmarthen comes on the phone and say, 'when are you going to do Carmarthen?' But it is unfortunate to a certain degree that the LSOA areas that we've been looking at, the highest scoring tend to be in Llanelli (Local authority interview)*

The planning regime and energy regime more generally hold few concessions for the different capacities of smaller scale energy developers such as local authorities or community groups comparative to larger-scale commercial developers. Thus, small scale developments, taken forward by less knowledgeable individuals and groups with less financial capacity must go through the same complex, lengthy and sometimes costly planning process. This is despite such groups in our research operating differently and to alternative outcomes than capitalist drivers usually associated with larger scale commercial ventures. Additionally, the same regimes, while informally recognising the non-economic social and environmental benefits that transition at smaller scale by community or public sector organisations can offer, do not adequately weight such benefits within their decision-making. As such, the planning and regulatory regime currently presents a significant barrier to locally owned small-scale transitions. Thus, the challenge presented by such developments to existing capitalist structures is similarly curtailed.

## **6. A continued energy peripheralization?**

Low carbon energy transition highlights how energy is interwoven within spatially organised uneven power relations, playing a part in their continued reproduction in space (Castán Broto and Baker, 2018). Furthermore, it also highlights how uneven power relations over land and territory shape renewable energy developments (Castán Broto and Baker, 2018; Pasqualetti, 2011) informing ownership, scale, technology in addition to local economic impacts (Haag et al., 2012; Healy and Barry, 2017). Thus, as Yenneti et al. (2016) point out, a spatial justice lens highlights how such even distributions of the costs and benefits of transition are reflective of already uneven spatial distributions of social, economic and political power. Low carbon transition has increased diversity in ownership of energy production and of 'locally owned' energy put towards local needs, but the scale of such ownership is largely limited to small-scale (for example 1 MW generation capacity or below). Thus, local economic benefits are likely to be small and recognition outside of the local area limited. Larger-scale energy production in energy peripheries of Wales are still dominated by large commercial developments which although have a growing social conscience and community benefit budgets, are externally owned and retain the higher value components (R&D, supply chain and ownership) elsewhere. Thus, without the wider "value added" elements of the energy system being brought to rural peripheries with the siting of energy generation, while the economy may improve and low carbon targets may be met, the impact on rural development and the growth of rural eco-economies will be "detrimental" (van Der Ploeg and Marsden, 2008, p.7). However, due to the dominant capitalist and neoliberal frame that low carbon transition is progressing within, the process is also imbued with risks of marginalization for the same places. Consequently, peripheries characterised by social, economic and political disadvantage and the multitude of wider problematics each brings, low carbon transition also poses risk of "reflect and reinforce existing power relations" (Gailing, 2016, p. 244). In this way, transition risks repeating prior patterns of resource peripheralization.

To alter such dynamics and ensure that the benefits of new energy processes are enjoyed in the periphery, transition has to generate new forms of economic activities that create both development and sustainable economic growth. Drawing on Marsden (2010) and van Der Ploeg and Marsden (2008) who focus on rural peripheries, rural development aims to “reposition the rural within wider society” by the recognition and use of rural resources by rural and non-rural communities. Such exploitation of natural or ecological rural resources should be realised in ways that benefits the place they are sourced from, however, this is determined by assemblages of place-specific “rural webs” (van Der Ploeg and Marsden, 2008, p. 7). Such webs involve the relative positioning of interrelationships and interactions between a range of actors both within, without and between rural and other places which “shapes the relative attractiveness and competitiveness of rural spaces economically, socially, culturally and environmentally” (Marsden, 2010, p. 225). Energy, as a social product of natural resource which due to transition is increasingly sourced and produced in rural peripheries is subject to such rural webs. Thus, it holds the opportunity to contribute to an ‘eco-economy’, boosting the economy it is within while also increasing recognition of the role rural peripheries play in sustaining the core.

Overall, we can argue that while low carbon transition does offer opportunities of energy decentralization and democratization in addition to opportunity for localised economic development, for places socially, economically and political peripheralized such opportunities are hard to grasp. Our paper consequently bridges the analytical lens of uneven development and its consequential spatial injustices with that of energy justice to discuss factors that inhibit peripheral energy transition in ways that embody concepts of democracy, development and justice. Weaker social, economic and political power held by rural peripheral places are interconnected with energy processes creating a web of circumstances that means rural peripheries are vulnerable to continued resource exploitation.

Injustices inherent in the current energy systems are illuminated by low carbon transition, raising further concerns for their persistence as the system changes. A potential mechanism for altering such injustices, low carbon transition could be the decentralising of physical energy systems and markets. However, continued dominance of market logics that prioritise central needs over the periphery, the structural weaknesses of rural peripheries remain. Consequently, energy peripheries remain dependent on external decisions over what technologies are pursued, in what locations, and what impacts there may be on local landscapes and economies. Different communities and places (and not only social groups) experience low carbon transition, including locations and modes of deployment, costs and benefits in fundamentally uneven ways. Addressing rural peripheral circumstances in their entirety, including (but not limited to) integrating spatial justice considerations through the entirety of energy system decisions, as opposed to a focus on the distribution of renewable installation and modalities, may hold some resolution to spatially bound energy injustices of low carbon transition.

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