Using qualitative social science to investigate the desirability of decarbonisation pathways: evidence from the FLEXIS project

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Abstract

Decarbonisation of energy systems is an urgent global social goal, to which technological innovation to address the need for flexible energy systems will make a major contribution. In addition, though, innovation in energy system governance and models of ownership is required to support transition from a centralised 'one-to-many' system to one in which 'many-to-many' production and distribution, based on distributed renewable energy generation, will play an increasing role. Anticipating and understanding the broader societal impacts of such a broad programme of 'socio-technical' innovation is also therefore a priority. This contribution from social scientists, based at Cardiff University and working alongside engineers as part of the multi-institution FLEXIS project in South Wales explores how qualitative social science research can contribute to this goal.

The research addresses directly questions about the broader potential impacts of decarbonisation for present as well as future generations in an original fashion, distinct from standard approaches to intergenerational distributive impacts in e.g. welfare economics. It focuses on detailed explorations of intergenerational patterns of change in everyday practices and their ethical implications for present and future generations, and explores creative ways to engage publics with decarbonisation trajectories to promote citizen participation in energy system change.

Three work packages represent an integrated methodology using qualitative methods to investigate expert and lay expectations surrounding the potential future impacts of decarbonisation in Wales. In 2016-17, expert interviews were carried out with FLEXIS engineering researchers and key stakeholders Three rounds of longitudinal interviews in Caerau, South Wales were carried out in 2017-2020 to investigate experiences of energy challenges and expectations about new energy technologies. Five community workshops in Port Talbot, South Wales were undertaken in 2019 to explore community responses to four decarbonisation scenarios developed from the earlier expert interviews, and to relate potential future changes to community narratives about the past and present.

Qualitative social research that investigates everyday experience of energy challenges and community knowledge of place has an important role in contributing to understanding potential impacts of decarbonisation pathways and their wider implications for intergenerational dynamics of change. While much energy futures research focuses on system level dynamics, paying detailed attention to everyday experience and place has also contributed in more depth and detail to investigating the desirability of particular socio-technical pathways for energy system change. Such research underpins ongoing work with international colleagues to develop a responsible research and innovation framework to inform energy technology research and social technology assessment, and to support energy policy both within UK government and within the devolved administrations.

Introduction

Decarbonisation of energy systems is an urgent global social goal, to which technological innovation to address the need for flexible energy systems will make a major contribution. In addition, though, innovation in energy system governance and models of ownership is required to support transition from a centralised 'one-to-many' system to one in which 'many-to-many' production and distribution, based on distributed renewable energy generation, will play an increasing role. Anticipating and understanding the broader societal impacts of such a broad programme of 'socio-technical' innovation for the goal of net zero is also therefore a priority (Miller et al., 2015). We report on research by social scientists, based at Cardiff University and working alongside engineers as part of the multi-institution FLEXIS project in South Wales (http://flexis.wales), which has explored how qualitative social science research can contribute to this goal.

Introducing new innovations always initiates a process of mutual adjustment in which societies and new technologies are transformed alongside and in interaction with each other. Social practices, structures and relationships at a variety of scales from local to global are transformed, as is evident with a variety of technologies from shipping containers to smartphones. At the same time, technologies are adapted in use and find employments for which they were never intended with sometimes surprising consequences. Understanding how these processes might play out requires more than technical expertise. Over the last several decades, social scientists interested in the 'social contract' between technoscience and society have explored these issues (Kimbrell, 2009; Wilsdon & Willis, 2004). The importance of 'societal intelligence' as a resource for helping anticipate the social impacts of new technologies has been stressed by researchers (Butler et al., 2015). This has contributed to policy agendas that have re-emphasised the importance of social technology assessment as a key part of regulatory systems. In addition, studies of the relationship between people's attitudes to place and their perspectives on environmental risk and infrastructure siting have become relevant (Henwood et al., 2011; Walker et al., 2011), as a focus on large-scale infrastructural change for decarbonisation raises questions about the localised impacts of systemic technological change.

A transition as fundamental as that of decarbonising energy systems will also be highly complex. Understanding the interactions between society and changing infrastructures in such a transition will require interdisciplinary collaboration in order to understand e.g. how social inequalities, economic relationships and regulatory frameworks may be impacted by infrastructural change, and also how societal responses may affect what kinds of infrastructural change are possible and desirable. The FLEXIS project represents a unique collaboration of this kind, based on a whole systems perspective that both incorporates a wide range of technical work packages looking at the future of energy distribution, and social science research examining the social conditions in which such innovations will be developed and how members of communities that may host demonstrator projects make sense of potential future developments and their impact on everyday life. Working in close contact with engineering colleagues for knowledge transfer, the social science team is leading on developing a responsible research and innovation framework for energy system transition, in dialogue with international colleagues from TU Delft, the University of Leiden, and the University of Basel .

Methodology

The FLEXIS social science team has developed three interlinked workstreams (WS) that employ qualitative methods to investigate expert and lay expectations surrounding the potential future impacts of decarbonisation in Wales, together with the ways in which everyday energy use may be affected by smart energy systems. In 2016-17, expert interviews were carried out with 20 FLEXIS engineering researchers and key stakeholders (WS1) to explore what drivers of change interviewees

expected to have decisive influence on energy system decarbonisation in Wales, and how they envisioned the mid-term future of the energy system in Wales. Three rounds of longitudinal interviews in Caerau, South Wales (18 interviews with 23 participants, repeating interviews every 12 months over 4 rounds to date) were carried out in 2017-2020 to investigate experiences of energy challenges and expectations about the benefits and drawbacks of new energy technologies in a community hosting a new smart heating network, utilising minewater as a low-temperature resource (WS2). From data collected through these two WSs, four scenarios constructing depicting future transformations (through to 2040) to the energy system in the industrial town of Port Talbot in south Wales were constructed. These included materials that represented infrastructure change as well as societal change – from regulatory transformation to everyday life. Five community workshops (6-8 participants in each) in Port Talbot, South Wales were undertaken in 2019 to explore community responses to these scenarios, employing a series of different activities, including a community mapping task to identify local challenges and issues, a scenario evaluation task, and a personas task. Through these activities, participants assessed these four decarbonised futures through imaginative reflection on the lives of future residents of Port Talbot. This enabled the team and participants to explore concerns and aspirations relating to the interactions between social and technological aspects of different potential pathways towards energy system change. In addition, linking this exercise to a particular place made it possible to bring considerations relating to socio-economic and cultural history as well as geography into focus.

Results: Key and ancillary findings

WS1

A central theme within the WS1 interview data concerns the legacy of past transformations of the energy system and the problems they pose for the present and future. In particular, interviewees identified the growth of onshore wind in the UK as pointing up problems in the current system that would need to be solved in order for a decarbonised system to gradually emerge. To replace a system based on centralised fossil fuel power generation with intermittent renewable energy generation requires greater distribution of generating capacity to provide resilience across the system. The surge in onshore wind development which began in the UK in the early 2000s represented an example of this trajectory. At the same time, this created instabilities within the system which were left largely unaddressed (Groves et al., 2021).

> *'A lot of the areas in Wales […] are at capacity so if you want to connect to the Grid you have to reinforce the Grid and that takes… it's very difficult to get industry into parts of Wales because they can't get the power supply.'*
> (Interviewee 13)

The problem of electricity grid capacity was identified as a key obstacle to further development of distributed renewable energy generation. Moving from centralised fossil fuel power generation to distributed RE had been seen in the early 2000s as an incremental process.

> *'[…] part of the argument in those earlier days of the establishment of the wind electricity industry was we're not going to cause problems with the system'*
> (Interviewee 20)

Interviewees saw an urgent need for demonstrator projects to be constructed that represented more radical departures from the incumbent system. In particular, the need to move from a homogeneous system characterised by fossil fuel electricity and (largely) gas central heating to one in which localised geographical and social conditions required a more heterogeneous system

characterised by a variety of localised forms of energy storage and the use of a range of vectors for storage as well as heating (including for example hydrogen, ammonia, minewater for low temperature geothermal heating, and so on). Since the period when the interviews were conducted, the need for the UK Government and devolved administrations to set strategic directions for the development of new distribution infrastructure has been set out in advice from the Committee on Climate Change (Committee on Climate Change, 2018) and subsequent publications setting out UK Government priorities (Department for Business, Energy and Industrial Strategy, 2018, 2020). These documents attribute a vital role to demonstration projects in helping drive technology development, particularly for renewable heat and energy storage. Choice of technologies was seen as likely to be influenced, in part, by local priorities which go beyond decarbonisation and the cost of energy to consumers. The scope for local employment opportunities and broader benefits to well-being of different technology options were seen as examples of such priorities. These developments were expected to require a large degree of restructuring of local power distribution networks, backed up by a national transmission system. As well as changes to the distribution network, the use of demand side response technologies within households and businesses was expected to grow, changing people's relationship with the energy system by making it more tangible and rendering consumption subject to a greater degree of control.

WS2

The study site for this WS was the village of Caerau near Bridgend, south Wales, an ex-mining community with high levels of deprivation, ill health, and unemployment. Thanks to its mining heritage, with several decommissioned pits nearby, it was selected as a potential host for a minewater based 'smart heating' district heating demonstrator, with participation from FLEXIS WP9, 'Smart Thermal Energy Grids'. Power for the infrastructure associated with the project was planned to be provided by a local windfarm, with smart heating controls installed within homes in the village.

Across the timespan covered by the interviews, interviewees described their experiences of a number of challenges related to energy. As has been documented elsewhere (Middlemiss & Gillard, 2015) research on energy poverty, such challenges typically their roots in the material and social conditions in which people live, which includes the level and stability of household income, but also the quality of housing and people's social relationships (particularly with landlords). Many respondents were unemployed, in receipt of disability-related benefits or retired, and thus on low incomes. The rising cost of electricity and gas was thus a concern. Located at a point high up in the Llynfi Valley, interviewees pointed out that the village was significantly colder that Maesteg further down the valley. These conditions exacerbated higher heating costs associated with poorly insulated, older terraced houses in which many interviewees lived (Groves et al., 2020). Respondents were either owner occupiers (house prices being low for south Wales), renting privately or from social landlords. While some owner occupiers were able to save up for home improvements, residents living in rented accommodation often found it difficult to persuade landlords to undertake necessary improvements.

> *"Me asking them [social landlord] to do something is always 'no, can't do this, we haven't got enough money for that' … […] In the end, I said 'I've had enough. You coming out to do my walls, I've had enough, I'm phoning environmental health'"*
> (Amanda, 30s, Interview 1)

While the council had undertaken fitting of external wall insulation with Welsh Government funds often to residents' satisfaction, some had been unable to take advantage of it and others had found the work done to a poor standard. Poor housing conditions pose a challenge for attempts to install

low-carbon heating, particularly based on lower temperature energy sources. In combination with low or unstable incomes, it makes householders vulnerable to falling into energy poverty. Interviewees living in rented housing described how, for them, budgeting is often reduced to week-to-week cash flow management. The thorough dependence of many aspects of everyday life on energy services (from heating and lighting to cooking and internet use) mean that 'the bills are like a brick wall[…] it doesn't matter how little income you're on, you've still got to pay your bills' (Terry, 60s, Interview 2). This was particularly the case for some interviewees on prepayment tariffs, though some also found prepayment meters useful in helping to budget. A major theme among those respondents who found themselves in significant difficulty with energy expenditure was that they dealt with their situation by 'prioritising, I suppose you can say' (Jessica, 30s, Interview 1), spending on energy: which meant severely trimming other areas of expenditure, including food – particularly given that two foodbanks operated locally which could serve as alternative sources of essentials.

As respondents who reported challenges in obtaining necessary levels of energy services were engaged in reducing energy use as much as possible, several suggested that a move to greater use of renewables could, on the one hand, see the costs of new infrastructure be passed on to end users, and on the other, fail to (via 'smart' in-home energy management systems) do anything that users were not already doing themselves: 'I'm the smart meter' (Terry, 60s, I1) (Shirani et al., 2020).

Overall, whereas experts tended to expect new demand management technologies to provide end users with a degree of control over their own energy use that was seen as beneficial, particularly in the sense of reducing costs, WS2 interviewees tended to cast doubt on this. The price of energy, together with local conditions (including the quality of housing) and relationships with landlords were all seen as far more consequential in determining whether households could afford access to adequate energy services (Shirani et al., 2021).

WS3

The findings from WS2 influenced how social aspects of change were included in the four scenarios developed for our workshops held in Port Talbot. Across the five workshops, participants identified a series of concerns relating to the four scenarios. Like findings from the WS2 interviews, these related to the broader social impacts of energy system change but also to the social conditions in which such change will be embedded (Pidgeon et al., 2021). Some of these concerns concerned dynamics that may unfold at whole energy system level. Others concerned the specific effects that might play out in Port Talbot, given its place character and socio-economic history.

Two of the scenarios ('Virtual Marketplace' and 'Energy Island') represented radical pathways of change through to the 2040s. Virtual Marketplace featured peer-to-peer energy sharing over microgrids as a key socio-technical development for balancing supply and demand for intermittent renewables in real time. Energy Island explored the use of green hydrogen (produced locally via electrolysis) as a means of interseasonal energy storage, together with the regulatory and ownership implications of community or council-owned energy companies. In response to both scenarios, participants registered concern at the reliability of new technologies as well as the possibility that their introduction might impose high costs on consumers in general, as decarbonisation increased momentum. In addition, technologies like peer-to-peer trading and new forms of demand side technologies more generally were expected to increase difficulties for vulnerable end-users in accessing energy services, without careful design and consultation. Further, inequalities in people's capacity to take advantage of new technologies in scenarios like Virtual Marketplace – such as privately owned solar PV panels – were seen as leading to new forms of social exclusion and stigma, thanks to the visibility of such infrastructure.

Such concerns apply to societal aspects of energy system change as a whole. Other concerns were specific to social conditions within Port Talbot and to potential local social impacts. For example, people often expressed significant distrust in or concern about the reliability of social actors who could potentially become significant players in a decarbonising energy system. Some saw the local authority as lacking the capability to set up and manage a local energy company, or as being likely to regulate community energy companies unfairly. Similarly, the idea in Industrial Hearth of using waste heat from the local steelworks as the main source of heat for a district heating network was seen as ceding too much power to a company whose future in the town was widely perceived as uncertain and dependent on global economic forces. Other concerns related to how different scenarios could shape the economic base of the town as well as its identity. Tying the future of Port Talbot, with a past rooted in industry, to heavy industry once more (in the Grid Town and Industrial Hearth scenarios) was seen as undesirable, given the legacy of pollution industry had brought, together with the ongoing influence of industrial development over the character of the town.

As well as these more place-related concerns, people also expressed notable aspirations for the future of the town related to the different scenarios (Thomas et al., 2021). Some saw environmentally 'cleaner' scenarios like Energy Island as representing a future in which the value attached to tourism and environmental amenities would help regenerate the town and take it along a new economic and social trajectory. In addition, utilising local resources for local benefit was seen as moving away from a historical pathway (exemplified by the coal industry in south Wales) which saw resources exploited by distant actors. Moving to aspirations relevant to the energy system as a whole, people saw in scenarios other than Grid Town (the most 'business as usual' scenario, more dependent on large scale renewables such as off-shore wind, altering the character of the town the least) more scope for improving environmental indicators beyond greenhouse gas emissions (including air quality and biodiversity), and also more scope for community-level ownership of energy resources, which was associated with marked economic and social benefits for deprived communities (Pidgeon et al., 2021).

Conclusions

The primary message coming out of this research concerns the importance of a fuller understanding of the social impacts of energy system change, and how social conditions may make particular developmental pathways more or less viable. Qualitative research, we propose, has a significant contribution to make to improving this understanding, enhancing debates about which directions for decarbonising the energy system may be more socially desirable, with an eye both on the whole system level and on particular places where demonstrator projects may be sited.

Overall, WS1 helped us identify significant problems within the current energy system which are partially a legacy of previous attempts to move away from a centralised, fossil fuel based system, and to identify also possible future trajectories along which heat and power grids may develop, leading to more heterogeneous solutions for providing energy services in increasingly localised systems. WS2 signposted how the importance of social conditions generally in influencing how energy system change may reinforce inequalities in access to adequate energy services, or create new ones, and how the social impacts of decarbonisation may be differentially distributed. Further, it underlined how the geographical and socio-economic character of particular places will influence these change dynamics. Finally, WS3 drew on these findings in presenting four potential scenarios for the future of the Port Talbot, tied to distinct trajectories for energy system decarbonisation. Responses from participants underlined the potential contributions energy system change could make to exacerbating material deprivation and social exclusion, while also possibly being associated with benefits that could best be understood through careful attention to the history of particular

places. Trust in energy system actors was seen as a significant condition that would affect the viability of particular options. The general environmental benefits of decarbonisation were seen as rendering it socially desirable across the UK, while the possibility that energy system change could catalyse wider social change in towns like Port Talbot was also seen as important for communities shaped by previous economic and energy systems transformations, such as industrial manufacturing and the growth and relatively sudden decline of coal.

The research on which we have reported here underpins ongoing work with international colleagues (from TU Delft and Leiden University in the Netherlands, and the University of Basel in Switzerland) to develop responsible research and innovation approaches (Stilgoe et al., 2013) and further work on energy citizenship, employing innovative combinations of qualitative methods. The goal of this ongoing work, as well as demonstrating the relevance of qualitative research to our understanding of energy system change processes, is to provide societal intelligence for energy technology research and to support energy policy both within UK government and within the devolved administrations.

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Keyword Set

Energy Policy, Smart Energy, Energy Demand, Decarbonisation, energy futures, place, responsible research and innovation, social technology assessment.