



Just Transition to Net Zero Wales: Call for Evidence

Joint submission by the Understanding Risk Research Group at Cardiff University and the UK Energy Research Centre

March 2023

The UK Energy Research Centre (UKERC) carries out world-class, interdisciplinary research into sustainable future energy systems. Our whole systems research informs UK policy development and research strategy. UKERC is funded by the UK Research and Innovation, Energy Programme.

The Understanding Risk Research Group at Cardiff University conducts interdisciplinary research into risk perception, communication, and methods for public engagement with new technologies and the environment. Current projects include on energy system transitions and greenhouse gas removal.

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Questions

Governance

- 1. Do you have any evidence to show how the Well-being of Future Generations (Wales) Act 2015 has, or could be, used to inform a just transition?**

Rapid environmental change, and in particular climate change, forces us to confront the ways in which potential harms to future generations will need to be taken into account when deciding upon the needs of the current generation¹. The recently published Synthesis Report of the IPCC 6th assessment² outlines the urgency of the climate and biodiversity crisis that we face. Achieving net zero will require wide ranging and large-scale changes in how the energy system in Wales and the UK works, in changes to everyday life as we reduce our consumption of products and use of energy, in the economy and patterns of work and travel, and the accelerated deployment of nature-based carbon sinks in rural Wales, and the use of novel technologies, to remove greenhouse gasses from the atmosphere. The IPCC report also concludes with high confidence that “prioritising equity, climate justice, social justice, inclusion and just transition processes can enable adaptation and ambitious mitigation actions and climate resilient development.” The Wales Centre for Public Policy report points out that the Well-being of Future Generations (Wales) Act 2015 can provide the core principles for the approach taken in Wales to a just transition to net zero³. In the

¹ Okrent, D. and Pidgeon, N.F. (eds.) (2000) Special Collection on intergenerational versus intragenerational equity and risk policy. *Risk Analysis*, 20(6), 759-929.

² Synthesis Report (SYR) of the IPCC Sixth Assessment Report (AR6). UN

³ Wales Centre for Public Policy (2022) International Approaches to a Just Transition. Cardiff University.

transport sector, the decision to reject the Newport M4 relief scheme on the grounds of its future sustainability was a clear example of the Act in operation. We simply note here that the scale of the net zero challenge is such that Wales will face decisions of equal or even greater magnitude over the coming 10-15 years, affecting the future wellbeing of communities and the health of our environment, particularly as the 'harder to decarbonise' or more costly sectors and issues are faced. Hence, further work to strengthen the Act in all areas of Welsh Government policy would seem desirable. Given that many net zero infrastructure decisions (e.g. electricity grid strengthening), alongside necessary developments, such as major energy efficiency and demand reduction measures, will involve aspects of both reserved and devolved powers there is also a need for Wales to lobby Westminster vigorously both to achieve an alignment of principles around the just transition as well as much closer partnership working in many areas of energy and environmental policy.

At Cardiff University we have recently completed the Living Well in Low Carbon Homes (LWLCH) research project (2018-2022), which formed a part of the UKRI-funded Active Building Centre Research Programme. Stakeholders interviewed identified the supportive funding and legislative environment in Wales as key to the development of innovative low-carbon housing incorporating solar generation, active grid connection, and energy storage. All of our project case sites studied had received funding from the Welsh Government's Innovative Housing Programme (IHP), which was crucial to enabling these innovative developments as they were more costly than standard housebuilding. Broader political support in terms of legislation including the Wellbeing of Future Generations Act was also reported by stakeholders to be conducive to such low carbon development. Because of this supportive policy and funding context, Wales was described by several stakeholders as a particular locus of innovation in housing⁴.

Cardiff work on low-income households from the Welsh European Funding Office funded Flexible Integrated Energy Systems (FLEXIS) project (2016-2022), again undertaken by members of the Understanding Risk research group at Cardiff University. Within FLEXIS the Cardiff team explored energy system change and everyday life through qualitative longitudinal interviews with residents in a low-income Welsh Valleys community in Caerau near Maesteg. Residents were interviewed annually over five years to ascertain their views of energy use, of a planned geothermal mine-water district heating scheme, and regarding experiences of fuel poverty and energy vulnerability. In the third year of interviews (2019) participants were explicitly asked about the Wellbeing of Future Generations (Wales) Act. Residents were largely supportive of the aims of the Act and the longer-term thinking that it encouraged, with some mentioning the importance of governments making this commitment explicit in light of efforts that the general public were making to live more sustainably. Whilst generally supportive of the aim to consider the long-term, some participants who were experiencing current pressures – such as unaffordable energy bills – spoke of living 'day to day' and found it challenging to think long-term⁵. This

⁴ Henwood, K., Pidgeon, N., Shirani, F., O'Sullivan, K., and Hale, R. (2023) Living Well in Low Carbon Homes Project Report. Cardiff University: Cardiff. <https://orca.cardiff.ac.uk/id/eprint/157428/>

⁵ Shirani, F., Groves, C., Henwood, K., Pidgeon, N. and Roberts, E. 2020. 'I'm the smart meter': Perceptions and experiences of smart technology amongst vulnerable consumers.. Energy Policy 144, article number: 111637. (10.1016/j.enpol.2020.111637)

supports findings we have previously published as part of the ESRC funded Energy Biographies⁶ and Timescapes projects⁷.

A major study conducted in 2010-13 by Cardiff University as part of UKERC investigated citizen views on the energy transition, including views within Wales⁸. This project concluded that British publics hold a set of values which they hoped would be met by the energy transition: including the conservation of finite resources, avoidance of waste, justice and fairness especially for vulnerable groups, protection of the environment, energy affordability, and taking a long term view to plan the transition. These values are also consistent with the findings of the Wales We Want consultation organised in 2014 by Cynnal Cymru⁹, and the provisions of the subsequent Wellbeing of Future Generations (Wales) Act 2015.

Taken as a whole, Cardiff University and UKERC research in Wales indicates that public views here on the net zero transition align well with the Wellbeing of Future Generations (Wales) Act 2015 as legislation that informs government decision making on the energy transition, but acknowledges the tensions between people's current circumstances and priorities and action towards the future.

2. What examples do you have of decision-making processes or guiding principles that could be used across public, private and third sectors to plan for and ensure a just transition?

In the FLEXIS project¹⁰, in Cardiff University work conducted as part of UKERC^{11 12}, and in other UKRI funded research¹³, we have consistently found significant mistrust of both private and public sectors. This relates both to the competence of public authorities tasked with commissioning low carbon infrastructure, and the integrity of public and private sector actors involved in infrastructure and service delivery. Such mistrust risks hampering uptake of low carbon technologies and practices, and may also serve to exacerbate opposition to new infrastructure siting (e.g. the Tan-8

⁶ Shirani, F. J., Butler, C., Henwood, K. L., Parkhill, K. and Pidgeon, N. F. 2013. Disconnected futures: exploring notions of ethical responsibility in energy practices. *Local Environment: The International Journal of Justice and Sustainability* 18(4), pp. 455-468. (10.1080/13549839.2013.779236)

⁷ Shirani, F. J. and Henwood, K. L. 2011. Taking one day at a time: temporal experiences in the context of unexpected life course transitions. *Time & Society* 20(1), pp. 49-68. (10.1177/0961463X10374906)

⁸ Pidgeon, N.F., Demski, C.C., Butler, C., Parkhill, K.A. and Spence, A. (2014) Creating a national citizen engagement process for energy policy. *Proceedings of the National Academy of Sciences of the USA*, 111 (Sup 4), 13606-13613. DOI: 10.1073/pnas.1317512111.

⁹ See <https://cynnalcyrmru.com/the-wales-we-want-national-conversation/>

¹⁰ Thomas, Gareth, Catherine Cherry, Chris Groves, Karen Henwood, Nick Pidgeon, and Erin Roberts, 2022. "It's not a very certain future": Emotion and infrastructure change in an industrial town, *Geoforum* 132, 81-91.

¹¹ Parkhill, K.A., Demski, C.C., Butler, C., Spence, A., Pidgeon, N., 2013. Transforming the UK Energy System: Public Values, Attitudes and Acceptability—Synthesis Report. UKERC, London. <https://ukerc.ac.uk/publications/transforming-the-uk-energy-system-public-values-attitudes-and-acceptability/>

¹² Demski, C.C., Pidgeon, N.F., Evensen, D. and Becker, S. (2019) Paying for energy transitions: public perspectives and acceptability. UKERC Policy Briefing. <https://ukerc.ac.uk/publications/paying-for-energy-transitions/>

¹³ Thomas, Gareth, Christina Demski, and Nick Pidgeon, 2019. Deliberating the social acceptability of energy storage in the UK, *Energy Policy* 133, 110908.

controversies regarding onshore wind in mid-Wales over 10 years ago). Involvement of trusted civil society organisations such as National Energy Action Cymru or Citizens Advice Cymru, independent agencies and parties, and of more local grassroots organisations in early planning and decision making around novel energy infrastructure and services may be of assistance in enhancing procedural legitimacy and hence trust in decision making. Fair distribution of the risks and benefits of energy infrastructure are also important, and here community ownership (or part ownership) of energy assets may offer an alternative route for generating trust and fairness in transition processes, particularly in communities already burdened by significant infrastructure development. However, here we would note that the sheer scale of energy infrastructure transition required to meet net zero means that community ownership can only ever comprise a small fraction (albeit an important one) of total future energy generation capacity for Wales, while the financial and social capabilities required for participation vary widely between community energy initiatives and such capabilities are not evenly distributed across groups in society. An emphasis on community participation and ownership could well lead to new forms of exclusion and inequality if this is not recognised. In particular older or minority group residents, those with insecure housing tenure or lacking financial assets, may struggle to access the benefits of community energy schemes.

Scotland's Just Transition Commission¹⁴ was the first UK institutional mechanism convened to consider and advise on decisions regarding the transition of jobs away from the large Scottish oil and gas sector into new industries. We note here that 'just transition' towards net zero has to mean much more than the changes anticipated for any single industry or employment sector. A fair sharing of the costs and benefits of transition across the whole of society, as well as with future generations, is an equally important principle on which to base decisions, reinforcing once again the role that the Well-being of Future Generations (Wales) Act 2015 can play for Wales. The recent Scotland Just Transition Plan¹⁵ has 3 legs: to maximise the economic benefits of Scotland's transition to net zero, including ensuring a pipeline of skills for net zero jobs; ensure fair distribution of opportunities, benefits and risks, including consideration of community benefits, and how to adapt to the impacts of climate change; and to ensure an inclusive and fair process via co-design with stakeholders, trade unions and the public. While the transition of the energy intensive industries in Wales will indeed require close attention, in other instances impacts on employment patterns in Wales may be more subtle. For example, if the proposals for floating offshore wind in the Celtic Sea disrupt long established fishing activities and employment patterns in that sector.

3. Do you have any evidence on how we can best fulfil the public sector equality duty in pursuing a just transition?

¹⁴ <https://www.gov.scot/groups/just-transition-commission/>

¹⁵ Draft Energy Strategy and Just Transition Plan – delivering a fair and secure zero carbon energy system for Scotland. Scottish Government, January 2023.

Impacts and Opportunities

4. What evidence do you have on the main impacts and opportunities associated with meeting Wales's transition to net zero? Please provide evidence (or identify evidence gaps) for the short (2022 to 2025), medium (2026 to 2035) and long term (2036 to 2050).

The Cardiff University Living Well in Low Carbon Homes (LWLCH) research has identified that while contributing to decarbonisation is a key concern a number of other aims were also central to the homes' designs¹⁶. Four dominant ambitions were held by stakeholders and developers within Active Home developments in addition to decarbonising the homes. These included:

- 'System Change', which included ambitions to disrupt existing dominant systems such as the housing construction and retail market, and the energy system;
- Addressing energy vulnerability/fuel poverty through the improvement of occupant 'Energy Sufficiency';
- Minimising 'Environmental' harm through the life-course of the building;
- Improvement of occupant 'Health and Wellbeing' directly through providing high quality living environments (within the home and broader neighbourhood), and indirectly through a combination of the above three themes.

This highlights that working towards the net zero transition is not a siloed activity and that it can present multiple other opportunities to achieve social, environmental and indeed economic benefits. While such outcomes can be worked towards and realised through the short, medium and longer term, it is essential that any experiences and knowledge gained in the shorter term inform future (medium and longer term) decisions about pathways.

The word 'skills' appears multiple times in the 'Working Together to Reach Net Zero' document. We see a skills gap in the short/medium term. The transition will require skills across areas such as the installation of heat pumps, deployment of renewable technologies and insulation of homes. The UK's heat pump skills gap was laid bare by a survey commissioned by Energy Efficiency at City Plumbing. It revealed only 18% of engineers are currently installing heat pumps and 44% don't know where to go to get trained. There is lack of a similar study in Wales, but the gap challenge is expected to be similar. UKERC has also commissioned work in this area¹⁷.

In the transition to net zero, in generation and heat there are opportunities in the development of new nuclear stations and hydrogen production. Work at Cardiff University on EPCs showcased the impact of poorly insulated homes on the energy

¹⁶ O'Sullivan, K., Shirani, F., Pidgeon, N., Henwood, K. 2022. Why Active Buildings? Realising the Potentials of Energy Networked Homes: A Social Scientific Perspective. In: Vahidinasab, V., Mohammadi-Ivatloo, B. (eds) Active Building Energy Systems. Green Energy and Technology. Springer, Cham. https://doi.org/10.1007/978-3-030-79742-3_2

¹⁷ <https://ukerc.ac.uk/news/social-justice-implications-of-the-skills/>

system¹⁸. Thus, home retrofits are a large sector for job creation as we pursue insulation, heat pump and heat network installations. Also, industry such as steel production will require new processes and technologies alongside people with the relevant skills.

5. Do you have any evidence to show what the well-being benefits and challenges for each sector could be?

As discussed above in (4) the Cardiff LWLCH research highlights that one motivation behind the development of new-build Active Homes is to improve the health and wellbeing of residents¹⁹ ²⁰. For example, experts expect that benefits derived from thermally efficient fabric and energy generation technology would result in reduced energy use and costs, as well as a more comfortable living environment. In addition, connection to nature through the provision of green spaces was expected to improve health and wellbeing and create cohesive communities²¹ ²². Longitudinal interviews with Active Home residents were designed to explore whether these aims were realised or experienced by residents. Several residents self-reported health improvements – such as improvements in respiratory conditions – since moving to an Active Home. Participants attributed this to living in high-quality homes without draughts, damp or mould. Where the homes were able to provide affordable thermal comfort, residents also described alleviation of worry. However, in some cases, higher than anticipated energy bills led to several participants expressing concerns regarding negative impacts on their health and wellbeing due to self-rationing heating, ongoing anxiety and new situations of energy debt²³. Important also were the relationships between Active Home residents and housing developers or energy service providers. Where positive relationships were established and maintained throughout a household's move into and life in an Active Home, participants were able to gain advice and reassurance about the workings of the home and energy costs. This impacted participants' sense of home, underpinning their sense of control, autonomy and safety, with positive impacts on their wellbeing²⁴. Finally, participants described the need for

¹⁸ Canet, A., Qadrdan, M., Jenkins, N. *et al.* Spatial and temporal data to study residential heat decarbonisation pathways in England and Wales. *Sci Data* **9**, 246 (2022). <https://doi.org/10.1038/s41597-022-01356-9>

¹⁹ O'Sullivan, K., Shirani, F., Pidgeon, N., Henwood, K. 2022. Why Active Buildings? Realising the Potentials of Energy Networked Homes: A Social Scientific Perspective. In: Vahidinasab, V., Mohammadi-Ivatloo, B. (eds) *Active Building Energy Systems*. Green Energy and Technology. Springer, Cham. https://doi.org/10.1007/978-3-030-79742-3_2

²⁰ Shirani, F., O'Sullivan, K., Hale, R., Pidgeon, N., and Henwood, K. 2022a. From Active Houses to Active Homes: Understanding Resident Experiences of Transformational Design and Social Innovation. *Energies* **15**. DOI: <https://doi.org/10.3390/en15197441>

²¹ O'Sullivan, K., Shirani, F., Henwood, K. and Pidgeon, N. 2023. New communities and new values? Exploring the role of green spaces in low carbon neighbourhoods. *Architecture, Media, Politics and Society*. Cultures, Communities and Design, [Online], Calgary Canada, June 28-30. Available: [Amps-Proceedings-Series-30..pdf](https://amps-research.com/Amps-Proceedings-Series-30..pdf) (amps-research.com)

²² Shirani, F., O'Sullivan, K., Hale, R., Pidgeon, N., and Henwood, K. 2022a. From Active Houses to Active Homes: Understanding Resident Experiences of Transformational Design and Social Innovation. *Energies* **15**. DOI: <https://doi.org/10.3390/en15197441>

²³ Shirani, F., O'Sullivan, K., Hale, R., Pidgeon, N., and Henwood, K. 2022a. From Active Houses to Active Homes: Understanding Resident Experiences of Transformational Design and Social Innovation. *Energies* **15**. DOI: <https://doi.org/10.3390/en15197441>

²⁴ O'Sullivan et al., Health and Wellbeing paper currently being developed. Cardiff University

Active Home technologies to be tried and tested prior to resident occupation, otherwise vulnerable consumers could be compromised if the homes and technology did not work as anticipated. This reinforces concerns also raised by FLEXIS participants about vulnerable consumers being ‘guinea pigs’ for innovative technology²⁵. Our research therefore shows a clear potential for health and wellbeing benefits to be realised through home fabric energy system transition, but also the need to guard against worsening inequalities and perpetuating existing disadvantages, especially during demonstrator or early roll-out phases of development.

Decarbonising heat in the existing residential sector may also carry significant wellbeing benefits such as enhanced health, comfort and financial security deriving from improvements to building fabric. However, very recent research conducted by the Understanding Risk Research Group in Cardiff jointly with Imperial College and Strathclyde University suggests that residential decarbonisation in Wales, as across the UK, may currently prove harmful to wellbeing given the present high costs of low-carbon heating and fabric retrofit, and lack of quality assurance for such work²⁶. Uncertainty over whether anticipated cost reductions would be realised in practice was seen as a particular barrier for low-income households to invest in retrofit measures, and was a particular source of anxiety for study participants in the private rental sector who feared rent increases may be used to fund residential decarbonisation. Participants were particularly concerned that pressure to decarbonise coupled with inadequate information and grant support could lead to unmanageable disruptions to already fragile homes and finances.

6. What evidence do you have on how the transition in one sector may either accentuate or diminish a risk or opportunity in another sector?

Industrial decarbonisation holds considerable promise for regenerating towns and regions, bringing economic opportunities that may alleviate or reverse historic patterns of industrial decline in particular regions of Wales. These benefits cannot be taken for granted however. FLEXIS citizen engagement research in Port Talbot ^{27,28} has indicated significant unease over the perceived prioritisation of heavy industry over other patterns of local development. Many residents in our study felt this to be risky in light of the challenges facing the steel industry; potentially this risky situation could reinforce procedural injustices where communities feel locked out of key decisions over local infrastructure and productive assets. Building on the industrial heritage of places like Port Talbot in forging the net zero industries and energy system of the future may well enhance the legitimacy of acceptability if communities have confidence that industrial decarbonisation will deliver a range of local benefits (both financial and,

²⁵ Shirani, F., Groves, C., Henwood, K., Pidgeon, N., Roberts, E. and Thomas, G. 2021a. Mine water heating in Caerau: Thoughts from local residents. 2020 Report. Project Report. FLEXIS.

²⁶ Findings from unpublished EPSRC funded deliberative research in Cardiff (x2), Gloucester, Liverpool (x2) and the Scottish Borders, covering a broad range of housing, socioeconomic and tenure archetypes.

²⁷ Thomas, Gareth, Catherine Cherry, Chris Groves, Karen Henwood, Nick Pidgeon, and Erin Roberts, 2022. “It’s not a very certain future”: Emotion and infrastructure change in an industrial town, *Geoforum* 132, 81-91.

²⁸ Pidgeon, Nick, Chris Groves, Catherine Cherry, Gareth Thomas, Fiona Shirani, and Karen Henwood, 2021. ‘A little self sufficient town close to the beach’: local energy system transformation through the lens of place and public things (Edward Elgar, Cheltenham).

crucially, non-financial), but care will be needed to ensure new developments are not seen as continuing historic patterns of extraction and environmental damage, industrial decline, or as closing off desires for alternative economic trajectories, for example in tourism. Industrial decarbonisation can be aligned with such desires, but for this to happen communities need to be actively involved in the conception and design of new projects and industrial infrastructure.

The TUC produced research that quoted ~26,000 jobs (directly employed; does not include impact on supply chains) in the steel industry would be at risk if the UK did not transition to cleaner technologies and meet binding carbon targets²⁹. Many of these job losses are potentially in Wales (Port Talbot). Also as renewables, smarter technologies, AI and robotics appear, one must be mindful of the impact on existing industries, such as potential job losses (less manpower needed).

7. What evidence do you have on the spatial impacts and opportunities across Wales?

Decarbonisation is strongly tied to geography and resources, with few 'one size fits all' solutions. Wales has particular advantages for the net zero transition – these include abundant renewable energy potential at sea and on land, pockets of high technology and skills including in some of the heavy industries necessary for building net zero infrastructure of the future, and a large land area capable of significant nature-based carbon sequestration. However, geography also dictates a lack of readily accessible carbon storage sites in the south of the country. This could necessitate costly shipping of captured carbon e.g. to North Sea storage locations if south Wales industry is to decarbonise fully. Rural communities, businesses and biodiversity might suffer disproportionately under the wrong types of land use change, such as overreliance upon intensive forestry as a potential carbon sink³⁰. Finally, the electricity grid is currently not fit for the major expansion (x2-3) in electricity use that net zero will require and is largely absent or insufficient in the areas where on- and offshore wind potential is greatest in mid- and west-Wales. This spatially uneven grid coverage means that communities in such locations may be unable to benefit fully from the energy transition. Lack of electricity grid capacity in Wales and many other parts of the UK remains one of the most important issues facing the Welsh and Westminster administrations, and one that they must ultimately resolve together.

It is important that the net zero industrial transition should not simply become a reprise of the pattern of decline experienced in many of the traditional coal mining areas of Wales. The FLEXIS work in Port Talbot has highlighted a perceived tendency for new forms of industrial employment to take the form of insecure contract work, often undertaken by transient populations from outside the regions hosting industrial infrastructure, exacerbating experiences of injustice over the geographical allocation of risks and benefits associated with earlier industrial development³¹. As industrial

²⁹ <https://www.tuc.org.uk/news/600000-jobs-risk-government-inaction-reaching-net-zero>

³⁰ See e.g. <https://www.bbc.co.uk/news/uk-wales-58103603>

³¹ Thomas, Gareth, Catherine Cherry, Chris Groves, Karen Henwood, Nick Pidgeon, and Erin Roberts, 2022. "It's not a very certain future": Emotion and infrastructure change in an industrial town, *Geoforum* 132, 81-91.

decarbonisation proceeds, care will be required to ensure shifts in skills and industrial knowhow operate to the benefit and not the detriment of local Welsh communities.

Shifts to more localised or regionalised patterns of residential heating, for example through the creation of waste heat networks from local industries (as is currently occurring in parts of Cardiff Bay), should create new opportunities for reliable low-cost heating. However, the geographically restricted nature of such networks will potentially enact new inequalities at their boundaries³², with inequalities arising between those with access to secure alternative forms of heat provision and those left to fend for themselves. However, there is also a risk that those subject to new forms of heat provision may find themselves subject to higher costs or new forms of monopoly power^{33,34}, pointing to the need for close scrutiny of regulatory powers in the general area of heat decarbonisation.

Cardiff University are conducting longstanding work into the ethics of and public responses to greenhouse gas removal technologies through large Leverhulme Trust³⁵ and UKRI³⁶ funded research programmes. Regarding rural land use change for achieving net zero, the UK CCC argues that a significant proportion of UK emissions will need to be removed by 2050 to balance residual emissions from very hard to abate sectors (e.g. air transport, agricultural emissions, and some chemicals production). From the portfolio of potential nature-based removal solutions, a range of approaches are applicable to Wales: from tree planting, growing bioenergy crops, enhanced weathering on agricultural land, to peatland restoration³⁷. The extensive rural areas of Wales present opportunities as major new carbon sinks. This may in turn provide e.g. community and/or rural economy benefits, but also risks e.g. to biodiversity or to the traditional patterns of farming and employment across rural Wales. Hence, careful consideration needs to be given to (1) the appropriate deployment of nature-based carbon removal methods (i.e. the right methods in the right places in Wales), (2) their contribution to the future wellbeing and economic vitality of rural communities, (3) the protection of ecosystems, (4) appropriate financing mechanisms, and (5) a fair distribution of both risks and benefits of nature-based carbon removal. There is currently little discussion in Wales of this critical facet of a just net zero transition. Because these issues often fall between conventional government portfolios the Green Alliance have recommended the formation of an Office for Carbon Removal at UK level³⁸, and we would suggest that the Welsh Government together with Natural Resources Wales likewise consider establishing an equivalent function at devolved level.

³² Pidgeon, Nick, Chris Groves, Catherine Cherry, Gareth Thomas, Fiona Shirani, and Karen Henwood, 2021. *'A little self sufficient town close to the beach': local energy system transformation through the lens of place and public things* (Edward Elgar, Cheltenham).

³³ Thomas, Gareth, Christina Demski, and Nick Pidgeon, 2019. Deliberating the social acceptability of energy storage in the UK, *Energy Policy* 133, 110908.

³⁴ Findings from unpublished EPSRC funded deliberative research in Cardiff (x2), Gloucester, Liverpool (x2) and the Scottish Borders, covering a broad range of housing, socioeconomic and tenure archetypes.

³⁵ See <https://www.sheffield.ac.uk/lc3m>

³⁶ <https://www.sheffield.ac.uk/uk-enhanced-weathering>

³⁷ <https://www.deliveringnetzero.org/greenhouse-gas>

³⁸ <https://green-alliance.org.uk/project/greenhouse-gas-removal/>

8. What evidence do you have on the equality impacts of the transition? Where is there existing disparity which could be addressed via transition? What are the risks which need to be managed?

Drawing on longitudinal data collected as part of the FLEXIS project, Cardiff work on the Better Energy Futures project for Welsh Government explored some of the challenges of decarbonisation for vulnerable consumers. The project was undertaken as part of a collaboration between researchers from the Understanding Risk Group at Cardiff University, and the Consumer Insights team at the Energy Systems Catapult (ESC). It was funded by the Welsh Government, and forms part of the ESC's Fair Futures programme, providing an initial basis for future work by ESC in developing design solutions for fuel poverty. Findings from the project were featured in the Welsh Government's Smart Living Initiative Annual Review of Progress and Learnings 2018-19³⁹. The research highlighted the important message of social inclusion, using the phrase 'no one left behind', to emphasise the need for innovative technologies and smart solutions to not worsen existing inequalities. Publications from the FLEXIS project have also highlighted potential challenges for vulnerable consumers in the transition towards smart technology, such as installation of smart meters, which could negatively impact upon health and wellbeing⁴⁰. Relatedly, we have also highlighted the significance of local place context in relation to experiences of energy vulnerability, which have implications for changes to local energy systems⁴¹. Taken as a whole, this work highlights the importance of a place sensitive approach to energy system transition that addresses the needs and priorities of local people and avoids worsening or perpetuating existing inequalities.

Anticipating the complex impacts of a deep and broad transition such as that expected to be required to achieve net zero is difficult, given the uncertainties about what forms of social and technological change will ultimately be needed. However, several considerations will help determine what approaches are best suited to anticipate them and their potential risks. For example, assessing impacts of transition in terms of their effects on the 'capabilities' that make up socially-valued ways of living is likely to be particularly important, where by capabilities we mean; bodily and mental health, social affiliations, education, political participation, control over one's environment, access to nature and so on⁴². People living in different circumstances and facing distinct challenges require varying levels of resources and different supportive social relationship to attain such capabilities. Historical shifts in circumstances in particular places (e.g. in the Valleys and other deindustrialised Welsh communities) can be particularly important for understanding where inequalities in capabilities are likely to

³⁹ See <https://www.cse.org.uk/downloads/file/welsh-govt-smart-living-initiative-english-july-2019-for-web.pdf>

⁴⁰ Shirani, F., Groves, C., Henwood, K., Pidgeon, N. and Roberts, E. 2020. 'I'm the smart meter': Perceptions and experiences of smart technology amongst vulnerable consumers.. *Energy Policy* 144, article number: 111637. (10.1016/j.enpol.2020.111637)

⁴¹ Shirani, F., Groves, C., Henwood, K., Roberts, E., Thomas, G., Cherry, C. and Pidgeon, N. 2021b. 'Who cares about valley people?' – lived experiences of energy vulnerability in the South Wales valleys. *Journal of Poverty and Social Justice* 29(1), pp. 103-120. (10.1332/175982720X16074511160827)

⁴² Groves, Christopher, Fiona Shirani, Nick Pidgeon, Catherine Cherry, Gareth Thomas, Erin Roberts, and Karen Henwood, 2021. A Missing Link? Capabilities, the Ethics of Care and the Relational Context of Energy Justice, *Journal of Human Development and Capabilities* 22, 249-269.

be felt. Given that energy system decarbonization is increasingly seen through a lens of localization, meaning that energy systems for net zero are likely to be scaled in a much more decentralized way than at present, understanding the ways in which particular places might differ in their experiences of its impacts is crucial.⁴³

Where access to capabilities is lacking, the potential negative impacts of energy transition may be significant, as findings from a range of projects we have undertaken indicate. For example, less-affluent households typically experience a lack of control over both their energy use and the social and material conditions which affect how they use energy. A lack of financial capability in low-income communities may hamper access to cost saving smart and low-carbon technologies and services. A lack of flexibility in when a household uses energy may also bring inequalities. For example, households reliant on shift work or on pre-payment meters may struggle to access low-cost time-of use energy tariffs⁴⁴, and residents in the private rented sector have limited control over improvements to the thermal efficiency of their homes or the types of heating technologies used within them⁴⁵. Citizens in our studies frequently express concerns that older people may struggle to develop the digital and technological capabilities needed to adopt low-carbon technologies and consumption practices⁴⁶. However, our research also suggests that working parents and individuals struggling with their mental health may be disproportionately impacted by the time, intellectual and emotional burdens associated with the uptake of new technologies, consumption, and billing practices⁴⁷. Managing these risks will require a variety of provisions. For example, targeted financial support may help enable the uptake of cost saving technologies, and an array of 'trusted advisor' services might support vulnerable households through the process of retrofitting homes and adopting new consumption practices. Additional regulation of social and private rental markets may be needed here, to ensure that tenants do not suffer detriment as a result of landlords' practices in transitioning domestic energy systems. To ensure that vulnerable groups are not left behind by this process support could be proactively offered through trusted intermediaries rather than being something individuals are expected to apply for. This is something that the Welsh Government's wide ranging and well attended Fuel Poverty Advisory Panel already considers and could contribute further to in the future.

⁴³ Groves, C., Henwood, K., Pidgeon, N., Cherry, C., Roberts, E., Shirani, F., & Thomas, G. (2021). The future is flexible? Exploring expert visions of energy system decarbonisation. *Futures*, 130, 102753. <https://doi.org/10.1016/j.futures.2021.102753>

⁴⁴ Thomas, Gareth, Christina Demski, and Nick Pidgeon, 2020. Energy justice discourses in citizen deliberations on systems flexibility in the United Kingdom: Vulnerability, compensation and empowerment, *Energy Research & Social Science* 66, 101494.

⁴⁵ Shirani, Fiona, Christopher Groves, Karen Henwood, Erin Roberts, Gareth Thomas, Catherine Cherry, and Nick Pidgeon, 2021. Who cares about Valley people? Lived experiences of energy vulnerability in the South Wales Valleys, *Journal of Poverty and Social Justice* 29, 103-120.

⁴⁶ Thomas, Gareth, Christina Demski, and Nick Pidgeon, 2020. Energy justice discourses in citizen deliberations on systems flexibility in the United Kingdom: Vulnerability, compensation and empowerment, *Energy Research & Social Science* 66, 101494.

⁴⁷ Cherry, Catherine, Gareth Thomas, Chris Groves, Erin Roberts, Fiona Shirani, Karen Henwood, and Nick Pidgeon, 2022. A personas-based approach to deliberating local decarbonisation scenarios: Findings and methodological insights. *ibid.* 87, 102455.

9. What evidence do you have on who is likely to be most affected by the transition?

See response to Q8

As above, our FLEXIS research has highlighted particular challenges for vulnerable consumers, with concerns expressed that energy system transitions will worsen existing inequalities. Some participants described feeling that sustainable choices were often more expensive and that they 'can't afford to be green'⁴⁸. Certain technologies – such as smart heating control systems – were also seen as designed with particular consumers in mind; for example, affluent households who had technological competence and worked outside the home. Subsequently, participants did not feel that this technology would necessarily benefit vulnerable consumers⁴⁹. FLEXIS participants spoke of how schemes that required an initial financial outlay, such as the installation of a heat pump, would be beyond the reach of many consumers as simply unaffordable.

Similar issues were raised by LWLCH participants, particularly in relation to uptake of electric vehicles (EVs). Whilst many liked the idea of EVs, they were seen as too expensive in comparison to petrol and diesel cars, and therefore not a viable option for many households, who could not afford the initial outlay. However, some participants spoke of Active Homes as a more affordable and convenient option than attempting to retrofit an existing property and therefore saw this as a beneficial housing model for future developments. Indeed, many LWLCH participants suggested that installation of low carbon technologies (such as solar PV panels and heat pumps) should be mandatory in new homes and gas boilers should no longer be installed, given that this would create future challenges for residents when properties needed to be retrofitted in the medium term. Whilst many of our stakeholder participants hoped to pursue further Active Home developments, some expressed concern about their ability to compete financially with mainstream housebuilders and suggested a different approach to valuing homes, which recognised the benefits of the energy generation and storage technologies included in Active Homes, was needed⁵⁰.

The steel producing plant at Port Talbot employs ~4000 people and emits as much as 15% of Wales' carbon emissions. The plant will be impacted by the transition as CO₂ emissions in Wales need to be cut by 63% by 2030 as we move towards net zero by 2050. Heavy industries need assistance, infrastructure, and financial incentives to help decarbonise their businesses over next decade and beyond^{51 52}.

⁴⁸ Shirani, F., Groves, C., Henwood, K., Pidgeon, N., Roberts, E. and Thomas, G. 2021a. Mine water heating in Caerau: Thoughts from local residents. 2020 Report. Project Report. FLEXIS.

⁴⁹ Shirani, F., Groves, C., Henwood, K., Pidgeon, N. and Roberts, E. 2020. 'I'm the smart meter': Perceptions and experiences of smart technology amongst vulnerable consumers.. Energy Policy 144, article number: 111637. (10.1016/j.enpol.2020.111637)

⁵⁰ Henwood, K., Pidgeon, N., Shirani, F., O'Sullivan, K., and Hale, R. (2023) Living Well in Low Carbon Homes Project Report. Cardiff University: Cardiff. <https://orca.cardiff.ac.uk/id/eprint/157428/>

⁵¹ <https://www.bbc.co.uk/news/uk-wales-61648676>

⁵² <https://www.bbc.co.uk/news/uk-wales-59010674>

Also, decarbonisation is happening as technologies are evolving rapidly with increasing digitalisation and use of robotics and AI, this is a real pressing issue for job security in the area around Port Talbot.

10. Who are the key actors, governance, regulatory/policy, and technological drivers and inhibitors for transition of each sector?

Policy work within UKERC has shown that implementing climate protection in accordance with a just transition requires consistent, coordinated and stable policy, including published timelines for implementation, progress reporting and updating. Government performance metrics need to be revised accordingly. The [Infrastructure Commission Scotland 2020](#)⁵³ concluded that current metrics and instruments for capital planning generally prioritise short term cost using conventional economic GVA indicators. An urgent task now is for all UK Governments to develop cost-benefit assessment methodology to prioritise spending on the basis of system-wide contribution to socially inclusive net zero carbon outcomes.

Wales, alongside other parts of the UK, has considerable experience of industrial transitions, with long-lasting impacts from closure of coal mines and related heavy industry, inequalities in life chances, income, housing and health. An effective just transition policy needs to use this experience to engage across state, business and civil sectors of society to develop viable, inter-linked plans for workers, business and industry, and communities.

The detailed sectoral plans for achieving a socially just net zero economy and society, need to be customised to the economic and social differentials across Wales, notably between South Wales with its history of coal and heavy industry, and North Wales slate mining, agriculture and marine industries. Plans therefore need to be informed by, and linked with, public debate through regional Citizens Assemblies and related public and community forums. Such fora might be linked to the development of Local Area Energy plans to gain genuine influence and as a form of deep community consultation on energy system change.

The division of powers across UK Governments also means that Welsh government needs to continue negotiations with Westminster to identify areas of common interest in a socially just net zero transition and economic regeneration. A particular example is in relation to decarbonising heavy industry, with UK and devolved governments needing to engage businesses in clean technology investment and the associated skills and knowledge to increase levels of economic activity⁵⁴.

Achieving the desired outcomes requires appropriate public sector technical and organisational resources and expertise. Two governance options are:

- To establish an *independent delivery authority*, reporting to government, and accountable to the Senedd, with a statutory requirement to focus on

⁵³ Professor Jan Webb, UKERC Co-Director, was a member of the Commission.

⁵⁴ <https://ukerc.ac.uk/research/industry/>

outcomes against carbon budget, social justice and net zero timescales.

- To establish a dedicated *directorate* at Cabinet Office level.

In either case, expertise in climate science, clean technology R&D, circular economy, eco-systems, economic inclusion and public engagement in net zero is needed.

Each option has pros and cons. An integrated government directorate may enable faster, lower cost strategy development and implementation, with direct access to Ministers. On the other hand, internal directorates may struggle to maintain independence and freedom from short-term political influence, and progress may be disrupted by electoral cycles and change in political control. See for example review of options for a delivery body for the Energy Efficient Scotland programme⁵⁵.

Whether an internal directorate or an arms-length body, the organisation would benefit from working interdependently with the UK CCC, as well as energy market regulator Ofgem, the (Energy) Future System Operator, the National Infrastructure Commission, UK Treasury, the UK Infrastructure Bank and environmental regulators. The Infrastructure Bank in particular is expected to focus on investing for net zero emissions, and supporting regional and local economies, and will hence be central to a socially just transition.

Governance across scales can be reinforced by public sector procurement practices. As one of the largest employers, with significant estates and transport, action on public procurement criteria and metrics can make supply chains and employment practices fairer, and reduce GHG emissions, while avoiding 'off shoring' environmental and social damage. In addition, public sector employers can coordinate skills and training for a fair, clean economy, and demonstrate the energy and carbon savings from investment in public infrastructure and transport, particularly at local and regional scale, where there is significant evidence about socio-economic opportunities and benefits of place-based action⁵⁶.

Local authorities can contribute substantively to delivering socially just net zero commitments in their area, easing the job of central government in meeting nationally determined targets, as well as regenerating local and regional economies⁵⁷. Welsh government has commissioned Local Area Energy plans for every local authority. However, local governments need the resources and powers to enable those plans to be implemented. The UKERC research concluded that considerable economic, social and environmental value would be secured from the following changes to empower local authorities:

1. A policy mandate for net zero carbon localities

⁵⁵ <https://www.gov.scot/publications/energy-efficient-scotland-strategic-outline-case-proposed-development-national-delivery-mechanism/pages/4/>

⁵⁶ See for example <https://pcancities.org.uk>; <https://www.ukri.org/what-we-offer/browse-our-areas-of-investment-and-support/prospering-from-the-energy-revolution/>; <https://www.ukri.org/publications/accelerating-net-zero-delivery/>

⁵⁷ M Tingey & J Webb 2020, [Making LA Net Zero ambition a reality](#).

2. Institutionalised local net zero carbon planning & implementation through statutory powers and devolved resources
3. Investment in local authority net zero teams
4. Evaluation of *all* local & regional public expenditure using net zero principles
5. Directing local and regional economic strategies to investment in net zero carbon infrastructures.

These recommendations are derived from examining the evidence about the public value of investment to rebuild local authority skills and capacities: 1,2 & 3 address unresolved questions about policy clarity, responsibilities, resourcing & capacity; 4 & 5 are system wide from an institutional and economic perspective.

If appropriately supported (as above), local governments can capitalise on:

- **Local knowledge:** Local Government and local actors (such as community groups and distribution network operators) hold data, knowledge and assets that can inform green and resilient recovery strategies that deliver on multiple local and national objectives. Smart technologies expand the potential to collect and update local data.
- **Effective engagement and trust:** Local government and local actors have significant local trust. It can be easier for parties to interact and collaborate when all the actors are in the same spatial scale, and trust can support participation in and uptake of smart products and services.
- **Coordinated local planning:** Considering a green and resilient recovery from a local perspective makes sense in that it is possible to adopt a whole (local) system planning approach, combining energy generation, mobility, heat, wider environmental and other objectives (for example economic objectives). Smart technologies support efficient management of these linked systems.
- **Unlocking co-benefits:** Local actors, particularly local government, have multiple objectives and thus are motivated (and able) to capture the co-benefits of smart local energy systems. Smart systems can help evidence these co-benefits.
- **Economic strategy:** A local focus on green and resilient economic regeneration enables alignment with local business, development of workforce skills and training needs, (local and national) supply chain development and innovation strategy.

In the residential sector, recent research by Cardiff University has illustrated a distinct lack of agencies or institutions needed to give householders the confidence needed to undertake significant decarbonisation actions⁵⁸. Awareness of the need and options for decarbonising residential heating is low, and members of the public expressed significant uncertainty over where they might get advice and financing on low carbon heating installation. Trust was a significant issue here, while in some instances legacy energy brands such as British Gas were seen as valuable sources of advice and quality work, participants identified a need for independent advisory services operating at arm's length from industry and government. Regulated accreditation of equivalent status to Gas Safe registration was seen by many as a pre-requisite for agreeing to

⁵⁸ Findings from unpublished EPSRC funded deliberative research in Cardiff (x2), Gloucester, Liverpool (x2) and the Scottish Borders, covering a broad range of housing, socioeconomic and tenure archetypes.

heat pump installation and other major retrofit work. Participants also identified a role for government in providing grants for more costly retrofit actions such as heat pumps and insulation upgrades, above and beyond what is currently available through the UK Boiler Upgrade Grant and other schemes. Such support is likely to be essential to enable most households, currently struggling with the cost of living to access low carbon heating. Residential decarbonisation was seen as a particularly alarming prospect for participants in the private rental sector due to insecure tenancies and limited enforcement of tenants' rights. Participants in this sector expressed concerns that without better regulation, they could either be left with more expensive legacy heating technologies, or bear the costs of heating upgrade through increased rents.

In terms of the industrial base of Wales, this is a very difficult questions to address. Each industry will have its own set of technological drivers, regulatory bodies, and policies. For instance, in decarbonising steel production you would need to re-invent the whole assembly line, move to electric arcs in short/medium term before hydrogen is a possibility. This would require huge infrastructural change and support from national and local governments. Additionally, unions and employers will have to cooperate as the (steel) industry goes through a difficult process in reskilling the workforce to take advantage of new technologies and work processes.

11. Do you have any other evidence that will help identify the impacts opportunities across our emission pathways or are there evidence gaps?

At present there are significant evidence gaps over how the private rental sector will respond to pressures to decarbonise its housing stock, in particular how the burdens of costs and benefits will be distributed between landlords and tenants.

With national scenarios it is difficult to capture the full impact of emission reductions across the technologies modelled. Regional or more local modelling of scenarios such as the work performed by Cardiff University envisage multi-vector energy solutions that show benefits with regards to emissions reduction and costs. For example, the use of waste heat for steel production is used to heat domestic homes. These type of analysis across Wales would open the door to technologies that are discounted by non-spatial national models.

Support for Just Transition

12. What evidence do you have that demonstrates the role of finance and/or social infrastructure in facilitating or delivering a just transition?

13. What evidence and information is there across Wales to identify and develop required net zero skills?

In some sectors the pathway for skills is clearer than others. For instance, in the steel industry the challenge is clear, the requirement for technologies and infrastructure is well defined and there is an awareness of the skills needed in the transition. In the energy sector transferrable skills for instance in the oil and gas sector can be used for cleaner energy with the proviso that workers are supported. The large number of engineers needed to retrofit homes with heat pumps/hydrogen boilers and add insulation to homes is an unknown quantity especially with regards to who retrain these engineers (who pays) and how do you accelerate the throughput of engineers (more colleges, qualifications etc).⁵⁹

14. What evidence is there to demonstrate the additional support and information needed to identify and develop required net zero skills?

Various studies suggest that green jobs in general tend to be more highly skilled compared to higher carbon occupations. However, a review published by UKERC last year⁶⁰ observes that renewable energy or energy efficiency jobs are not always or necessarily more skilled than jobs in higher carbon energy sectors. Most jobs in the operation and maintenance of wind power and solar PV are indeed in highly skilled, professional occupations, but there is also demand for lower-skilled, manual occupations which comprise significant shares of solar PV installation and offshore wind construction activities^{61 62}.

There is a need to co-ordinate the development and supply of training so that it takes full account of the wide range of occupational functions required for manufacturing, building and installing, operating and maintaining renewable energy technologies and infrastructure. Sequential planning will be required to train and coordinate local workforces required for renewables expansion, minimising time gaps between projects and the need for construction workers to relocate.

⁵⁹ <https://www.wcpp.org.uk/publication/net-zero-skills-insights-and-evidence-from-emissions-sectors-in-wales/>

⁶⁰ Hanna R, Heptonstall P, Gross R, 2022, [Green job creation, quality and skills: A review of the evidence on low carbon energy. UKERC Technology and Policy Assessment.](#)

⁶¹ Allan, G. J. and Ross, A. G. (2019) 'The characteristics of energy employment in a system-wide context', *Energy Economics*, 81, pp. 238–258.

⁶² Dominish, E. et al. (2019) 'Just Transition: Employment Projections for the 2.0 °C and 1.5 °C Scenarios BT - Achieving the Paris Climate Agreement Goals: Global and Regional 100% Renewable Energy Scenarios with Non-energy GHG Pathways for +1.5°C and +2°C', in Teske, S. (ed.). Cham: Springer International Publishing, pp. 413–435.

In order to facilitate a just transition to a low carbon energy system, the International Renewable Energy Agency with the International Labour Organisation ⁶³ emphasise the need for proactive policy which sets out to anticipate and plan for a series of misalignments that are likely to occur. These include: temporal misalignments between the pace and scale of job losses and the rate and capacity of job gains required to compensate them; geographic misalignments between the location of new jobs and the regions in which displaced workers live; skills and job role misalignments between outgoing and incoming energy industries; and value chain misalignments as transitions away from fossil fuels create a shift from conventional mining and fuel extraction to sourcing of renewable energy components and materials.

Rigorous training and well publicised certification for heat pump installers and those conducting other in-home retrofit actions is a prerequisite for public confidence in residential sector decarbonisation⁶⁴. In the case of smart energy technologies and fostering sustainable demand response practices in the home, system automation will often need to be supported by intermediary energy service companies with new skills aimed at supporting the consumer-technology interface.

15. Are there any particular gaps in supporting a just transition?

Insecurity in the private rental sector leaves a large section of the population exposed to significant risks from residential decarbonisation. At present this population is disproportionately likely to live in low quality housing, and to be using more costly heating technologies. Improvements to building fabric and more efficient heating technologies should assist this population, but without better safeguards there is a risk that the cost of installing these measures will fall on tenants already struggling on limited assets and incomes⁶⁵.

16. What evidence do you have to show effective involvement of people, communities and organisations to enable their participation in developing and implementing a just transition? Including, enabling participation that fully represents the perspectives of diverse communities in Wales and specifically those with protected characteristics?

Multidisciplinary evidence for effective involvement and public participation in implementing a just, low carbon (now net zero) transition is supported in key respects by the development of a digital platform at the UKERC public engagement observatory⁶⁶. It is a misnomer to think that public engagement is something only initiated as 'consultation exercises' by institutions such as government, corporations,

⁶³ IRENA and ILO (2021) [Renewable energy and jobs – Annual review 2021. International Renewable Energy Agency, International Labour Organization, Abu Dhabi, Geneva.](#)

⁶⁴ Findings from unpublished EPSRC funded deliberative research in Cardiff (x2), Gloucester, Liverpool (x2) and the Scottish Borders, covering a broad range of housing, socioeconomic and tenure archetypes.

⁶⁵ *ibid*

⁶⁶ <https://ukerc.ac.uk/research/observatory/>

or third sector organisations. Much of the work of the UKERC observatory documents a rich ecosystem of case-studies, including a number from Wales, where communities and citizen groups have themselves organised to engage, and bring about local change regarding issues of sustainable energy and a just transition. The current trend for Citizen Juries and Climate Assemblies is just one manifestation of this. These case studies are also a way to understand the perspectives and concerns of some ‘hard to reach’ groups.

At Cardiff University we have specialised, over many years, in multi-modal social sciences research which itself engages various public(s) with issues of science, energy technologies and the environment. This includes development of methods which have enabled reflections on everyday practices and the articulation of ordinary cultural values^{67 68 69}. Such reflective methodologies are particularly beneficial when undertaken with a temporally extended focus, as is necessary if research is to be informative for policy decision making in ways that anticipate changes and their impacts across the short- and longer-term. Similar concerns are taken up in the major project conducted jointly with UKERC on public views on energy system change⁷⁰, the subsequent FLEXIS work in Port Talbot⁷¹, and studies of a range of other issues⁷². As part of this Cardiff University has developed bespoke approaches and methodologies capable of harnessing insights in support of the kind of proactive policy that is needed to anticipate and plan for “a series of misalignments that are likely to occur” and where “it is possible to adopt a whole (local) system planning approach” (quotations from Q 10 above). The conclusion that comes from all of this work is that people are perfectly capable of deliberating upon complex energy and environmental issues when given the proper resources and space to do so, and often raise issues (about social or community impacts, important cultural values, or aspects of key local context) that might get missed in formal energy modelling. In the further roll out of citizen engagement initiatives (e.g. future Citizen Assemblies in Wales, or public engagement for mandated Local Area Energy plans – see 10 above) we would argue for bringing this unique Welsh capability to bear upon aspects of engagement process design.

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⁶⁷ Henwood, K. (2019) Investigating risk – Methodological insights from interpretive social science and sustainable energy transitions research. In A. Olofsson and J. Zinn (eds) Researching Risk and Uncertainty: Methodologies, Methods and Research Strategies. Basingstoke: Palgrave MacMillan pp129-152

⁶⁸ Henwood, K., Shirani, F. and Groves, C.(2018). Using photographs in interviews: When we lack the words to say what practice means. Chapter 38 n U. Flick (ed) The Sage Handbook of Qualitative Data Collection London: Sage, pp599-614

⁶⁹ Henwood, K.L. (2022) Interpretive risk ethnography as a means of understanding risk problems: Encounters with the ordinary-extraordinary and what comes after? In B. Switek and Abramson, A., Swee, H. (eds) *Extraordinary Risks, Ordinary Lives: Logics of Precariousness in Everyday Contexts*. London, Palgrave Macmillan (10.1007/978-3-030-83962-8_12)

⁷⁰ Pidgeon, N.F., Demski, C.C, Butler, C., Parkhill, K.A. and Spence, A. (2014) Creating a national citizen engagement process for energy policy. *Proceedings of the National Academy of Sciences of the USA*, 111 (Sup 4), 13606-13613. DOI: 10.1073/pnas.1317512111.

⁷¹ Thomas, G., Cherry, C., Groves, C., Henwood, K.L., Pidgeon N.F. and Roberts, E. (2022) “It’s not a very certain future”: Emotion and infrastructure change in an industrial town. *Geoforum*, 132, 81-91.

⁷² Pidgeon, N.F. (2020) Engaging publics about environmental and technology risks: frames, values and deliberation. *Journal of Risk Research* doi.org/ 10.1080/13669877.2020.1749118