Energy demand policymaking attention in the context of a just transition to net zero: results of a UK survey

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Abstract

Energy demand reductions, which come from both measures to improve energy efficiency and changes in the underlying demand for services, have contributed more to carbon emissions reduction than the combined effects of deploying low-carbon generation technology. Yet energy demand appears to receive less policymaking attention than energy supply, even where demand side change could secure similar policy objectives more cost effectively. This hypothesis is tested through a survey of UK energy experts and stakeholders (n=71). Findings suggest that energy experts and stakeholders currently hold an unfavourable view of energy policy outcomes in the UK. Target setting, technologies and market-based instruments receive most policymaking attention while energy demand solutions, changing practices, regulation and finance do not receive the attention they deserve. To achieve a just transition to net zero, respondents favour more radical innovations. These include a modal shift towards active travel and demand-side response, which are expected to diffuse before 2030, changing work practices, which are expected to diffuse widely between now and 2025, and circular material and product economies, which might diffuse from 2030 onwards in unsubsidised markets. Such markets for high-standard whole-house retrofits, which respondents deem of paramount importance for a just transition to net zero, are also expected emerge around 2030 although nearly a sixth of the respondents suggest this will only happen after 2050, if ever. Diffusion and emergence of unsubsidised markets or such radical innovations hinges upon fundamental changes in how we approach energy. While shifting the focus to energy demand solutions and policy support for existing technologies are within the remit of energy policy, regulatory and institutional change for more human-focused energy system operation, and, most importantly, education and public awareness, are not. These require systemic transformation of policy and practice to achieve a just transition to net zero.

Introduction

On 27 June 2019, the UK government set a legally binding target to achieve net zero greenhouse gas (GHG) emissions from across the UK economy by 2050. This decision encapsulates the widespread agreement in UK policymaking of the need to decarbonise. However, there are differing opinions on the preferred pathway to net zero, the scenarios outlining these pathways, the assumptions underpinning such scenarios and how 'unexpected unknowns' are factored in (see Trutnevyte et al. 2016 for an historical overview of UK energy scenario choices).

At international level, scenarios developed by the International Energy Agency (IEA) carry a lot of weight (see BEIS 2017). At national level, the UK's Climate Change Committee (CCC), an independent, statutory body established under the Climate Change Act 2008, provides scenarios for the UK to reach net zero GHG emissions by 2050 (CCC 2019). Relevant organisations in specific sectors have been developing their own scenarios, such as National Grid for the electricity sector (National Grid 2020).

What such scenarios have in common is a reliance on immature energy supply technologies, such as Carbon Capture and Storage (CCUS), as well as untested technologies, such as

Greenhouse Gas Removal Technologies (GRTs). The IEA argues "reaching net zero will be virtually impossible without CCUS" (IEA 2020: 13) and all scenarios developed by both the CCC and National Grid rely on it to reach net zero by 2050, with more ambitious scenarios assuming greater usage (CCC 2019, National Grid 2020). Some also include GRTs (CCC 2019). Simultaneously, such organisations stress the need for public engagement, participation and behaviour change. The CCC suggests "a broader strategy will also be needed to ensure a just transition across society, with vulnerable workers and consumers protected" (CCC 2019: 15). Alongside "immediate action across all key technologies and policy areas", National Grid calls for "full engagement across society and end consumers" (National Grid 2020: 6).

The UK government scenarios suggest a similar reliance on CCUS alongside technological substitution and supply side flexibility (BEIS 2020). It also uses CCC scenarios to justify investment into GHG removal technologies in its "Clean Growth Strategy" (BEIS 2017). Alternative perspectives, on the other hand, suggest that such scenarios and their underpinning assumptions are biased towards supply-side solutions, focus too much on technological substitution rather than socio-technical innovation and place too much emphasis on negative emissions technologies which are unproven, risky and conflictual (Grubler et al. 2018; Eyre and Killip 2019).

Low demand scenarios, in contrast, suggest that a rapid transformation of energy services through a combination of social, organisational and technological innovation and a focus on end-user engagement and decent living standards can significantly downsize energy use. This builds on extensive evidence which indicates that the decoupling of energy demand from economic activity (reduction of the energy intensity by improving efficiency) has been the main driver of carbon emissions reduction (IPCC 2014). Decarbonising energy supply in such downsized systems is feasible without negative emission technologies (Grubler et al. 2018; Eyre and Killip 2019).

Recent UK energy policy, however, appears to still focus disproportionately on the expansion of the energy system. Most of the points of 'The Ten Point Plan for a Green Industrial Revolution' focus on expanding energy supply. Only 'Accelerating the Shift to Zero Emissions Vehicles' and 'Greener Buildings' include energy efficient approaches, while the latter is only point which explicitly mentions energy efficiency (BEIS 2020). Although the UK government claims that it is "not targeting a particular generation mix for 2050" (BEIS 2020: 42), the 'Ten Point Plan' suggests that UK policymaking is currently pursuing a decarbonisation trajectory akin to National Grid's 'System Transformation' scenario (National Grid 2020). Aside from the 'Steady Progression' (business-as-usual) scenario, this scenario runs the highest risk of failing to accelerate decarbonisation and engender societal change while paying too little attention to the central role of energy demand reductions in achieving the net zero (National Grid 2020).

Amidst changing priorities, energy security has dropped off the radar. While it was deemed the biggest challenge for the energy industry in 2015, the recent Energy Barometer (Energy Institute 2020) suggests that it has been overshadowed by low-carbon energy, energy policy, sustainability and climate change and public engagement. This paper suggests net zero requires a further shift away from the energy trilemma mindset towards a just transition which addresses inequality, the loss of jobs and the need to live well through rapid decarbonisation centred on energy demand reductions (Grubler et al. 2018). The need for a just and fair transition to net zero is also increasingly recognised at both national (CCC 2019) and international level (UNFCCC 2016). Particular focus needs to be placed on the distribution of benefits and burdens resulting from zero-carbon transition approaches, which includes developing skills and retraining for green jobs while ensuring that social dialogue among all stakeholders can help create appropriate public policies to both minimise hardship and address needs.

To gain a better understanding of the nature of the policy asymmetry between supply and demand in the context of a just transition to net zero, this paper analyses a survey of UK energy experts and stakeholders (n=71). Eliciting expert opinions on the subject of energy demand assumes predictive capability among experts (Morgan 2014). Given the UK government's net zero target and the need to align public policy with this target, it was deemed appropriate to ask experts and stakeholders questions about current policymaking, questions that entail an assessment of how policymaking and net-zero approaches might evolve between new and 2050, their preference to achieve a just transition to net zero, and questions on potential trade-offs between just transition and net zero objectives for various systemic determinants of sustainable energy.

In doing so, this paper tests the hypothesis that energy demand receives less policymaking attention than energy supply, even where demand side change could secure similar policy objectives more cost effectively. It is structured as follows. Section 2 reviews the literature. Section 3 introduces the analytical framework and the methodology. Section 4 reports the result of the survey. Section 5 discusses these results. Section 6 concludes.

Literature review

ENERGY DEMAND POLICYMAKING IN THE UK

The strategic role for government in managing energy demand emerged with the first oil crisis in the early 1970s (Mallaburn and Eyre 2014). In the 50 years since, governments have sought to reduce energy demand through both energy efficiency policy, the establishment of dedicated agencies and outsourcing responsibility to these agencies.

Between 1974 and 1992 energy efficiency policy was linked to general energy policy in the Department of Energy. In 1990, the UK's first environmental White Paper positioned energy efficiency as the central means to reduce emissions (Mallaburn and Eyre 2014). It was subsequently linked to climate policy in the Department of the Environment, Transport and the Regions (DETR).

This coincided with an increasing shift towards the free-market paradigm. It suggested that competitive energy markets would deliver the optimal allocation of resources, thereby exploiting huge energy demand reduction potentials. In practice, however, competing utilities sought to maximise sales and cut costs rather than reduce demand. Consequently, the economically optimum level of efficiency did not (de-)materialise (Grubb et al. 2014; Mallaburn and Eyre 2014).

As part of this shift, energy efficiency was gradually separated out from government with the outsourcing of programmes to the Energy Saving Trust, founded in 1992, and the Carbon Trust, founded in 2001. In 2008, the founding of the Department of Energy and Climate Change marked the end of this split between energy supply and demand. This realignment with central government control was marked by the establishment of the Energy Efficiency Deployment Office and the withdrawal of government financial support from both the Energy Saving Trust and the Carbon Trust in 2012 (Mallaburn and Eyre 2014).

In its first 40 years of energy efficiency policy between 1973 and 2012, the UK arguably led the world on energy efficiency policy (Grubb et al. 2014). It was the first EU country to use the Standards of Performance model to fund energy efficiency programmes in competitive markets, the first to pilot carbon emissions trading and the first country to set legally binding carbon emission targets through its Climate Change Act 2008 (Mallaburn and Eyre 2014).

Ironically, realignment with central government in 2012 coincided with the reorganisation of energy efficiency policy towards a reliance on markets to deliver outcomes. As a result, reductions in UK energy demand have slowed significantly (CCC 2019). The Green Deal, a programme intended to overcome financial barriers to energy efficiency measures, was predicated on overcoming barriers using loans which were to be repaid using energy savings. However, this market-based, demand-led financial mechanism was a complete failure. By mid-2015, average delivery rate for loft insulation had dropped by 90 %, cavity wall insulation by 62 % and solid wall insulation by 57 % compared to 2012, and the scheme was scrapped (Rosenow and Eyre 2016).

Average UK decarbonisation rates per capita in the buildings and transport sectors were 0.8 %/a and 0.2 %/a respectively between 2011 and 2016 compared to average EU figures of 1.6 %/a and 2.4 %/a respectively (CCC 2019). More recently, the Green Homes Grant scheme, especially the household voucher scheme launched in 2020, is on track to become the second government home energy efficiency scheme to fail in a decade. It started off as a £2bn programme between September 2020 and March 2021 to rapidly deliver energy efficiency improvements at household level (voucher scheme, £1.5bn) and local authority level (Local Authority Scheme, £500m) based on the understanding that such projects are 'shovel-ready', capable of creating new jobs and supporting economic recovery (BEIS 2020).

It was assumed that funds would be spent at a rate of £300m/month, which is six times the current spending rate under the Energy Company Obligation originally launched alongside the Green Deal and now represents the largest remaining UK energy efficiency programme. By the end of January 2021, however, only around 20,000 of the targeted 600,000 homes had received support. Government has extended the programme by a year until March 2022. However, while the Local Authority Scheme budget has been retained, the household voucher budget has been reduced to £320m (nearly 80 % reduction) (Rosenow and Sunderland 2021).

SUPPLY VS DEMAND IN UK ENERGY POLICYMAKING

On the supply side, the change in UK electricity mix has been remarkable in recent years. Between 2011 and 2016, the UK achieved a 10 %/a reduction in the carbon intensity of electricity generation. As a result of both supply and demand-side effects, per capita carbon emissions from the energy sector reduced by 5 %/a during this period compared to global average of 0.5 %/a (CCC 2019). Overall, the UK has been most effective at reducing emissions through (CCC 2019):

- Regulating out high-carbon products (such as inefficient boilers, lights and appliances)
- Subsidising in low-carbon technologies to drive cost reduction through learning-by-doing (such as the Renewables Obligation (RO), the Feed-in Tariff (FIT) and Contracts for Difference (CfD))
- Taxing out high-carbon activities (such as landfill and coal-fired power generation)

To achieve its net zero target, however, the Climate Change Committee stresses the need for resource and energy efficiency to reduce demand for energy across the economy ahead of societal choices that lead to lower demand for carbon-intensive activities. This is followed by electrification through major expansion of renewable and low-carbon power generation, all of which need to be embedded in a just transition strategy to ensure that vulnerable consumers and workers are protected (CCC 2019).

However, the continuing policy focus on supply (BEIS 2020) fails to recognise the multiple benefits inherent in energy demand reductions (Grubler et al. 2018). It also fails to recognise that 85 % of the energy used to provide current levels of comfort is wasted (Cullen et al. 2011). Energy demand reductions therefore encompass the broadest range of opportunities to reduce energy use and emissions. Yet huge gaps exist between this theoretical potential and actual levels of efficiency and demand. An issue for energy demand policymaking lies in the difficulty substantiating whether energy efficiency and associated policy actually reduces energy demand while the cost-effectiveness of energy efficiency improvements hinges on the price of energy (Grubb et al. 2014). To complicate matters, ex-post evaluation of energy demand reduction policies is usually not possible because different metrics apply to different programmes (Mallaburn and Eyre 2014).

The invisibility of improvements and associated carbon emissions reduction adds to the difficulty of creating market mechanisms targeting such savings. This has resulted in a fairly consistent 'efficiency gap' of 10-30% between the market potential for efficiency and what is delivered (Lucon et al. 2014). This gap relates to the following market barriers and failures that reduce economic efficiency (Grubb et al. 2014):

- Monetary (financing barriers, fiscal barriers, capital constraints and discounting)
- Organisational (hidden costs, transaction costs and endowment effects)
- Market-based (split incentives and institutional failures)
- Behavioural barriers (suboptimal choices and risk aversity)

Overcoming these barriers by tapping into negative costs depends on technological, economic and regulatory factors. However, such market barriers are accompanied by many non-market barriers which require more substantial policy and in-

stitutional change to address (Eyre and Killip 2019). Capacity building and a reform of market structures are necessary to address the highly diffuse nature of energy demand reduction opportunities and their embeddedness within socio-technical systems including user practices, business models, institutions and infrastructures (Foxon 2011).

Methodology

EXPERT SURVEYS

This survey was designed to test the hypothesis that energy demand receives less policymaking attention than energy supply, even where demand side change could secure similar policy objectives more cost effectively. It follows on from similar UK and international surveys which suggest that energy experts and stakeholders recognise the need for greater emphasis on energy demand in policymaking to decarbonise our energy systems (Grafkos and Flamos 2017; IEA 2019; Energy Institute 2020; Winskel and Kattirtzi 2020).

The Energy Institute's (2020) annual Energy Barometer captures opinions and preferences from their membership of energy professionals. Out of 355 respondents, 54.4 % consider 'Increasing the proportion of electricity provided by renewables' the greatest success in lowering GHG emission in the UK in 2010–2020. This is followed by 'Switching from coal to gas-based electricity generation' with 31 %. At the same time, energy efficiency tops the responses with 18.4 % as the 'greatest missed opportunity [in terms of lowering GHG emissions] in UK energy over the past decade. Beyond emission targets, respondents consider 'Consumer/citizen pressure' (17.88 %) ahead of 'International climate actions and policies' (13.35 %) the main drivers of the transition to low-carbon energy systems. 'Affordable low-carbon energy' (19.66 %) tops the list of measures 'to ensure that the transition to net zero does not leave vulnerable consumers worse off'.

Winskel and Kattirtzi's (2020) Policy Delphi study covered aspects of transition, disruption and revolution with a particular focus on centralisation vs decentralisation in the UK energy transition using primarily 4-point Likert-scale questions (from 'highly likely to 'highly unlikely'). Among its explorative scenarios, 'Greater spread of powers, but centralised system strategists' was deemed the most likely governance arrangement for the UK energy system in 2040 by the respondents. 'Decarbonisation and a green economy' emerged as the single most important policy priority and 'energy demand reductions as an energy policy priority' the most popular approach for meeting this priority. This is followed by 'using the competitive market/auctions to support low carbon technologies, 'supporting greater citizen involvement in regional and local planning for energy projects' and 'supporting and accelerate the transition towards distributed energy generation and storage across the UK' (Winskel and Kattirtzi 2020).

A survey undertaken by the International Energy Agency's Global Commission for Urgent Action on Energy Efficiency (N=750 from 80 countries) suggests that cost-effective potentials to improve energy efficiency are not being realised because 'governments do not place efficiency high enough on their agendas'. This is followed by 'lack of skills and capacity to implement efficiency measures at the required scale' and 'key stakeholders – business, consumers, interest groups – not strongly supporting action on efficiency' (IEA 2019). Grafkos and Flamos (2017), on the other hand, sought to quantify the extent of agreement or disagreement regarding specific supply technologies with a particular focus on sustainability vs resilience. Their study suggest that solar PV ranks top and offshore wind ranks second for both sustainability and resilience.

SURVEY DESIGN

These surveys suggest that demand is underserved by both previous research and current policy and their methodologies and findings provide the basis for this expert survey. The focus on a 'just transition' and 'net zero' alongside demand is linked to the increasing recognition of a need for holistic societal transformation to achieve the Sustainable Development Goals (Grubler et al. 2018). To this end, this survey elicits opinion on (Börjeson 2006):

- Predictive (probable) scenarios – what-if scenarios that address the question what *will* happen:

  1. Do policymakers understand the contribution of energy demand solutions to a zero carbon future?

  2. How should energy demand be mainly financed?

  3. Which approaches to sustainable energy receive the most policymaking attention?

  5. What changes will net-zero policies bring about?

- Explorative (possible) scenarios – strategic scenarios that address the question what *can* happen:

  7. From which point onwards might we see diffusion or the emergence of unsubsidised markets for the following?

  8. To what extent do you think the following are important for a just transition to net-zero?

- Normative (preferable) scenarios – transforming scenarios that address the question *how* it will happen:

  4. And which approaches to sustainable energy require more policymaking attention for a just transition to net zero?

  6. And what changes should be prioritised for a just transition to net zero?

This approach seeks qualitative and subjective answers, ranging from probabilistic assessments to judgements, by balancing predictive questions with explorative and normative questions. They were developed through an iterative process with the help of colleagues to counterpose views on current energy policymaking with possible/likely approaches to achieve net-zero as well as preferable approaches for a just transition to net zero.

Views on current policymaking are addressed in questions 1–2. The first elicits expert and stakeholder perspectives on policymakers' understanding of energy demand (1, single choice). The second establishes their opinion on how energy solutions should be financed (2, single choice). This is contextualised by comparing the respondents' perception of energy policy priorities (3, choice of three) with their preferred policy priorities for a just transition to net-zero (4, choice of three). These priorities (changing practices; funding/finance; market-based instru-

ments; regulation; target setting) were informed by previous research which pointed towards the importance of regulation, standards and financial incentives (alongside information) to help reduce energy demand (Grubb et al. 2014), research which suggest that technologies and market-based instruments have been receiving a lot of attention (Fawcett et al. 2018, Eyre and Killip 2019), and research which suggests that changing practices receives too little policymaking attention (Shove 2017).

This survey also compares respondents' perceptions of likely innovations and outcome of net zero policymaking (5, choice of three) with their preferred innovations and outcomes of net zero policymaking for a just transition to net zero (6, choice of three). The choice of innovations and outcomes on the supply side was informed by Grafkos and Flamos' research on sustainability vs resilience on energy supply technologies and government's continuing support for nuclear power (Johnstone and Stirling 2020). The choice of innovations and outcomes regarding infrastructure (EV charging and hydrogen) was informed by increasing policy attention (BEIS 2020). The choice of energy demand approaches was informed by research on their importance for decarbonisation and net zero (Shove 2017; Grubler et al. 2018; Eyre and Killip 2019).

Multiple choice questions 3–4 and 5–6 contrast current views on energy policy with expectations as well as preferences for a just transition to net zero regarding policymaking priorities (3 and 4) and outcomes and innovations (5 and 6). The do so by repeating questions on the same topic with the same choice of answers but with a shift from expectation (3: " which approaches … receive …"; 5: "what … will bring about") to preference (4: "which approaches … require …"; 6: "what … should …"). The survey subsequently establishes scenarios by determining the respondent's opinions on the diffusion and emergence of unsubsidised markets for such innovations and outcomes using a Likert-scale regarding the diffusion and emergence of unsubsidised markets (7). It includes five-year ranges between 2020 (low value of 0) and after 2050 or never (high value of 7) for the same innovations and outcomes in questions 5 and 6.

The final question (8) establishes whether respondents foresee any trade-offs between just transition and net zero objectives for various systemic determinants of sustainable energy, ranging from education to carbon markets. These choices are informed by research pointing towards the need for deep societal transformation to achieve net zero which goes well beyond energy system decarbonisation (Grubler et al. 2018; Eyre and Killip 2019). It uses a 4-point Likert-scale on 'Just transition importance' and 'Net zero importance' from 'very low' (low value of 0) to 'very high' (high value of 3).

Data was collected in four phases. The first was during a Whole Centre Meeting of the Centre for Research into Energy Demand Solutions (CREDS) on 17 June 2020 (N=45–52 – minimum number of answers 45 – highest 52). The second was during Community Energy England's Community Energy Conference 2020 on 29 June 2020 (N=19–27). The third phase took place between July 2020 and November 2020 and included responses linked to interviews (N=7–8) which are being evaluated alongside additional data from a survey in Germany. Each question allowed participants to skip the answer, which has resulted in the number of respondents fluctuating between 71 and 89. In total, just over half the respondents were academics working in the CREDS research community.

CREDS interdisciplinary mission nevertheless ensures a good mix of interdisciplinary backgrounds, including engineering, social and environmental sciences. Community Energy England's focus on finance, business models and innovation ensured a good mix of business and market representation. The follow-up interviews targeted policy advisors and policymakers. Overall, the survey is biased towards energy demand expertise while representing the views of a mix of generalists and specialist.

Findings

ENERGY DEMAND POLICYMAKING AND FINANCING

The first set of questions addressed the role of energy demand and financing in policymaking. Firstly, we asked whether policymakers understand the potential contribution of energy demand solutions to a zero carbon future (single choice question, Figure 1).

The respondents suggest that the contribution of energy demand solutions to a zero carbon future are poorly understood by policymakers (see Figure 1). Even where the contribution of energy demand solutions are understood there appears to be little appetite for developing a supportive policy environment. These findings reflect previous research findings which has provided plenty of evidence in support of energy demand solutions and decreasing evidence of supportive policies to achieve net-zero (Grubb et al. 2014; Eyre and Killip 2019; Winskel and Kattirtzi 2020; Rosenow et al. 2020). Secondly, we asked how energy demand solutions should be mainly financed (single choice question, Figure 2).

Regarding the financing of energy demand solutions, the respondents favour general taxation over private investments and energy bills (Figure 2). This reflects research findings and experience indicating the regressive nature of paying for energy policies through energy bills, the difficulty of convincing private financiers of the cost-effectiveness of many energy demand solutions, and the need for government interventions where

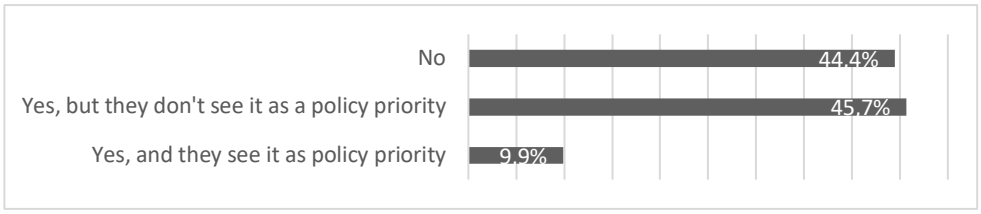


Figure 1. Policymakers' understanding of the potential contribution of energy demand solutions to net zero.

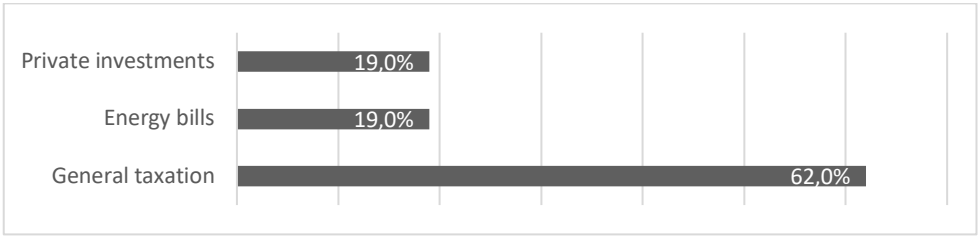


Figure 2. How energy demand solutions should be financed.

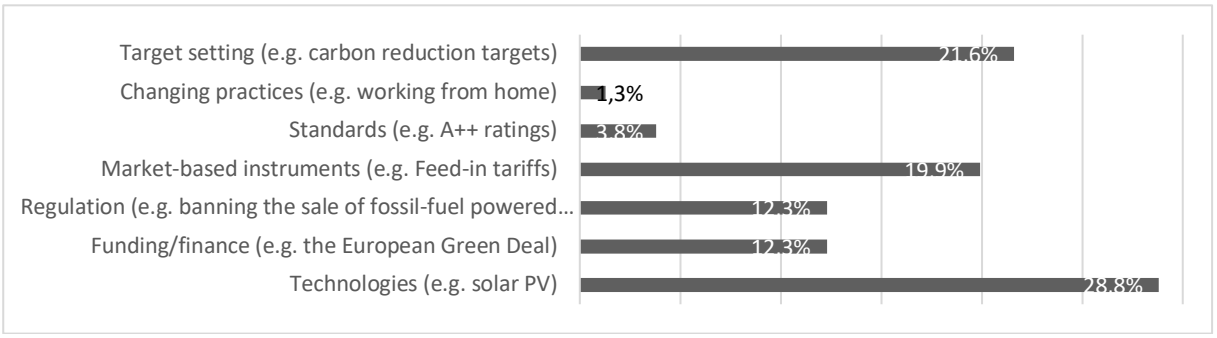


Figure 3. Which approaches to sustainable energy receive the most policymaking attention.

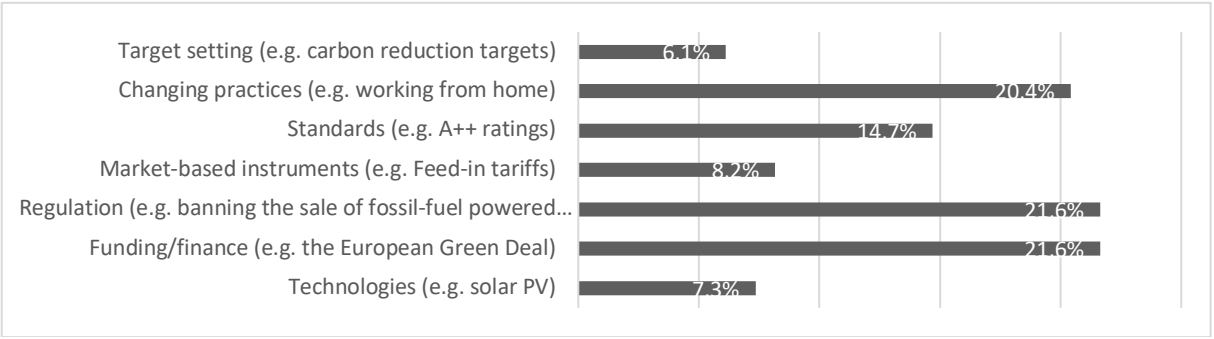


Figure 4. Which approaches require more policymaking attention for a just transition to net zero.

such solutions are not cost effective but entail multiple benefits (Fawcett and Killip 2018).

POLICYMAKING ATTENTION

The next set of questions compared the respondents' perception of energy policy priorities (multiple choice of three question, Figure 3) with their preferred policy priorities for a just transition to net-zero (multiple choice of three question, Figure 4).

Respondents suggest that technologies receive the most policymaking attention (see Figure 3). This is indicative of an energy policy landscape which has succeeded in decarbonising its electricity supply at the fastest rate globally (CCC 2019). Market-based instruments, as the main drivers of technology diffusion according to the respondents, also receive lots of policymaking attention (CCC 2019). The same holds true for target setting, with politicians and policymakers rightfully taking pride in the UK's vanguard in embracing a legal obligation to achieve net zero by 2050 (BEIS 2020).

In contrast, the respondents' views on what should receive more policymaking attention sees regulation, finance and changing practices top the list (Figure 4). The importance of regulation and finance for energy demand reductions compared to the policymaking focus on technologies, market-based instruments and target setting reflects the overall neglect of such policy objectives in current energy policymaking (Grubb et al. 2014; CCC 2019; Eyre and Killip 2019). The huge gap between the lack of policymaking attention that changing practices currently receive compared to their importance for a just transition to net zero is discussed below.

Overall, this data in Figures 3 and 4 indicates that the energy experts and stakeholders who responded to this survey favour a complete refocus of policymaking to achieve a just transition to net zero. It requires a fundamental shift away from prioritising technologies, target setting and market-based instruments towards regulation, finance, standards and changing practices.

NET ZERO VS JUST TRANSITION

A similar trend can be observed when contrasting the respondents' views on changes and innovation that the net zero will bring about (multiple choice of three question, Figure 5) and their preferred changes for a just transition to net zero (multiple choice of three question, Figure 6).

The most likely changes the UK will experience moving towards net zero, according to the respondents, are more offshore wind and more electric vehicle infrastructure (Figure 5). This is supported by the UK's effective policy strategy for offshore wind and its ambitious policies supporting electric vehicles, which include ending the sale of new fossil-fuel powered cars and vans by 2030 (BEIS 2020). It also mirrors findings in Figure 3 and those from another study where energy experts and stakeholders suggested that the UK's energy transition will be dominated by technological substitution (see Methodology section; Winskel and Kattirtzi 2020).

The respondents' expectation that we will see more high-standard whole-house retrofits, more household solar PV and more demand-side response points towards an expectation that policies encouraging technological substitution and large-scale supply will be increasingly supported by policies decarbonising our living arrangements. Many studies point towards the need to prioritise such solutions (Grubb et al. 2014; Eyre and Killip 2019; Rosenow et al. 2020) while cautioning that such a change is not a given in our current policy environment (Winskel and Kattritzi 2019; Rosenow et al. 2020).

The development of a hydrogen infrastructure, according to the respondents, appears more likely than a modal shift to active travel, changing work practices and circular material and product economies. This again mirrors findings from previous studies pointing towards a policy environment prioritising technological substitution (Winskel and Kattritzi 2020). Despite ongoing construction of a nuclear power station and intent to build more, the overall picture for nuclear power does not appear to have changed as a result of the net zero announcement. Regarding the priorities for a just transition to net zero, however, both more nuclear and the development of a hydrogen infrastructure rank among the least favourable options (Figure 6).

DIFFUSION AND EMERGENCE OF UNSUBSIDISED MARKETS

The respondents were also asked about their expectations regarding the diffusion of, or emergence of unsubsidised markets, for such changes and innovations (likert-scale question, Figure 7). These findings (Figure 7) suggest that changing work practices, offshore wind and solar PV are widely diffusing, with around 75 %, 70 % and 68 % respectively placing widespread diffusion between now and 2025. The respondents suggest that demand-side response will follow around 2025, with over 50 % suggesting that unsubsidised markets will emerge between now and 2025 and over 80 % between now and 2030. 60 % of respondents expect a modal shift towards active travel between now and 2030 while around 37 % of respondents place the emergence of unsubsidised markets for hydrogen between 2035–2040 and around 34 % place it on or after 2050, if ever.

Taking into account the findings in Figure 5, this suggests that other forces beyond net zero energy policymaking will determine the evolution of energy demanding practices (changing work practices, modal shift towards active travel and demand side response) and potential high-risk-high-reward options (hydrogen infrastructure). EV infrastructure, in contrast, benefits from firm policy commitments (ban of the sale of fossil-fuel powered cars from 2030 onwards) and nearly 75 %

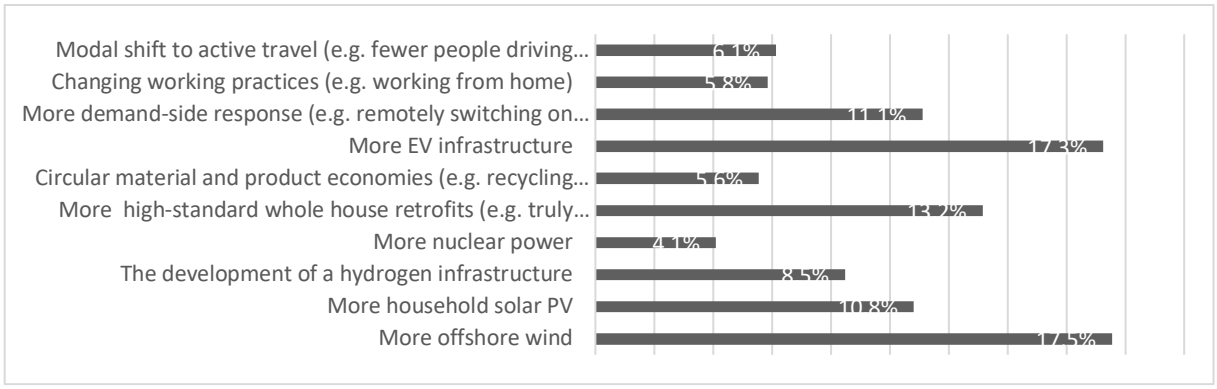


Figure 5. What changes with net zero policies bring about.

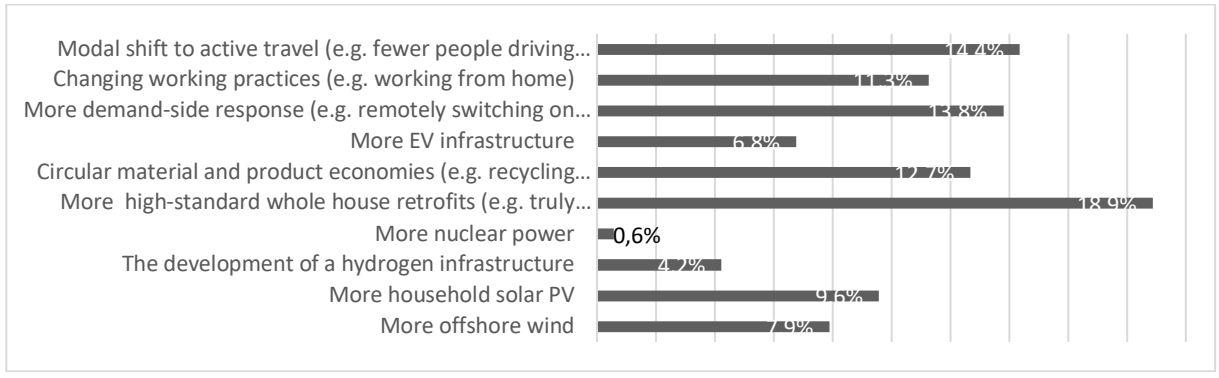
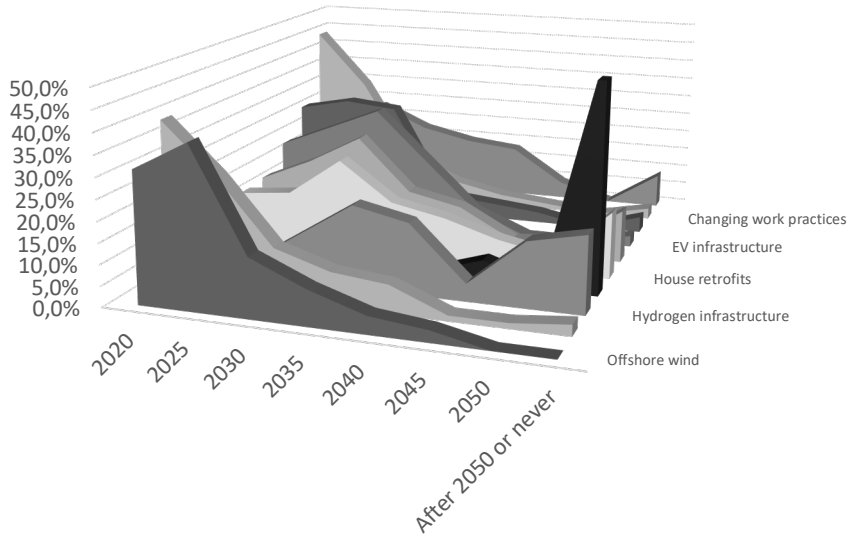


Figure 6. What changes should be prioritized for a just transition to zero carbon.



	2020	2025	2030	2035	2040	2045	2050	After 2050 or never
Offshore wind	31,4%	38,6%	14,3%	8,6%	4,3%	2,9%	0,0%	0,0%
Household solar PV	39,7%	27,4%	12,3%	8,2%	6,8%	1,4%	1,4%	2,7%
Hydrogen infrastructure	10,0%	2,9%	11,4%	20,0%	17,1%	4,3%	15,7%	18,6%
Nuclear power	17,1%	0,0%	7,1%	8,6%	1,4%	5,7%	1,4%	58,6%
House retrofits	12,2%	13,5%	23,0%	13,5%	10,8%	6,8%	4,1%	16,2%
Circular economies	12,9%	18,6%	25,7%	12,9%	10,0%	2,9%	4,3%	12,9%
EV infrastructure	19,2%	24,7%	30,1%	17,8%	5,5%	0,0%	0,0%	2,7%
Demand-side response	26,7%	29,3%	28,0%	5,3%	4,0%	2,7%	0,0%	4,0%
Changing work practices	45,2%	31,5%	11,0%	5,5%	2,7%	1,4%	0,0%	2,7%
Modal shift	20,0%	22,9%	17,1%	14,3%	12,9%	4,3%	0,0%	8,6%

Figure 7. From which point onwards we might see diffusion or emergence of unsubsidized markets.

of respondents place the emergence of unsubsidised markets before 2030.

Most respondents suggest that unsubsidised markets for circular economies and whole house retrofits will probably emerge around 2030, although over 12 % and over 16 % of respondents respectively expect this to happen after 2050, if ever. This uncertainty regarding both circular economies and retrofits is concerning as both are fundamentally important for the material transformation of our entire socio-technical system which is deemed necessary to both reduce our carbon emissions and achieve our sustainable development goals (Grubler et al. 2018; IPCC 2018).

The respondents are most uncertain about the emergence of unsubsidised markets for nuclear power and a hydrogen infrastructure. While over 17 % suggest that nuclear power is already unsubsidised, nearly 60 % suggest that unsubsidised markets for nuclear will only emerge after 2050, if ever. These findings reflect evidence which suggests that while nuclear power has reached technological maturity, it is inherently risky (Grubler et al. 2018; Johnstone et al. 2016).

This suggests that a firmer commitment by government is necessary to build confidence in a hydrogen economy which plays a significant role in many decarbonisation scenarios (CCC 2019; National Grid 2020).

NET ZERO AND JUST TRANSITION TRADE-OFF

The last question addressed the importance and potential trade-offs for achieving net zero (Figure 8) and for achieving a just transition (Figure 9) among potential systemic energy and non-energy determinants of sustainability.

Figure 8 and 9 suggest that education and awareness of the public are deemed the most important for achieving both net zero and a just transition. Regulatory and institutional change is deemed more important for a just transition than for achieving the net zero target. Even though policy support for existing technologies is deemed less important than regulatory and institutional change for a just transition, it nevertheless represents a no-regrets option because nobody ranked its net zero importance as very low and it scores the second lowest very low ranking regarding just transition importance. It is a similar case for shifting the focus on energy demand. It has an average ranking for very high just transition importance but the highest ranking for high just transition importance. This suggests that shifting the focus towards energy demand is important but only in the context of other energy and non-energy policies.

Research and development support for new technologies is deemed very important for achieving net zero by nearly 50 % of the respondents while less than a quarter deem it very important for a just transition. Opinions are divided regarding the

net zero importance of UK participation in international carbon markets and the just transition importance of assigning monetary value to carbon emissions reductions. These responses align with research which points to the need to move beyond a focus on technological substitution and conversion efficiency towards combined technological, organisational/business model, behavioural and social/institutional innovation (Grubler et al. 2018; Eyre and Killip 2019; Winskel and Kattirtzi 2020). They also suggest a disconnect between international climate markets and a just transition to net zero at a national level.

Overall, it is noteworthy that all of these systemic energy and non-energy determinants of sustainability rank lower for 'just transition importance' than 'net-zero importance', with the exception of a shared understanding of the energy system as a socio-technical system. This suggests that more radical approaches than the ones chosen for expert elicitation in this survey are necessary to ensure that the injustices that our energy systems perpetuate are addressed through an equal distribution of benefits and burdens resulting from the transition to net-zero.

Discussion

This snapshot of opinions regarding the current energy transition trajectory, the likely trajectory towards net zero and the preferable trajectory for a just transition to net zero is used in this paper to test the hypothesis that energy demand receives less policymaking attention than energy supply. It confirms this hypothesis and points towards approaches to address this asymmetry to achieve a just transition to net zero.

Addressing this policy asymmetry by shifting energy policy focus towards energy demand reduction in the hope of achieving quick wins, however, is insufficient (Eyre and Killip 2019). Although this shift is important (see Winskel and Kattirtzi 2020), energy demand solutions need to be embedded both in a policy mix which can deliver multiple benefits (see Rosenow et al. 2016; Fawcett and Killip 2018) and in a deep transformation of practices and systemic injustices (UNFCCC 2016; Grubler et al. 2018; Eyre and Killip 2019).

The respondents' preference for education and awareness, regulatory and institutional change of energy system operation to focus on humans rather than technology and policy support for existing technologies suggests overall support for the former. Regarding the need for a just transition, on the other hand, current approaches as well as more radical ones referred to in the survey are not sufficient, least of all the current focus on technological substitution and innovation through target setting and market-based instruments.

A just transition thus requires more than a shift in policy towards regulation, funding/finance and changing practices, and standards. Although there is a technological element to such a shift around support for existing technologies, especially high-standard whole-house retrofits, the overall preference is for policies and approaches to support a more fundamental so-

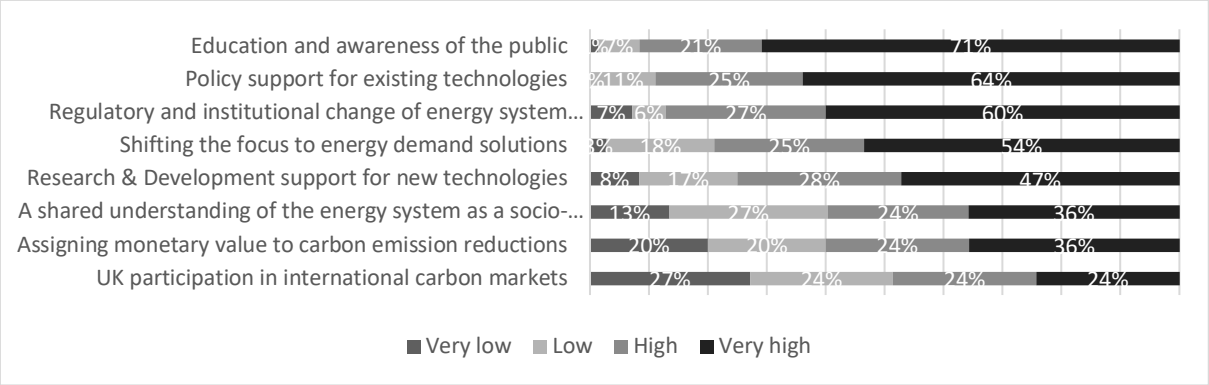


Figure 8. Decarbonisation importance.

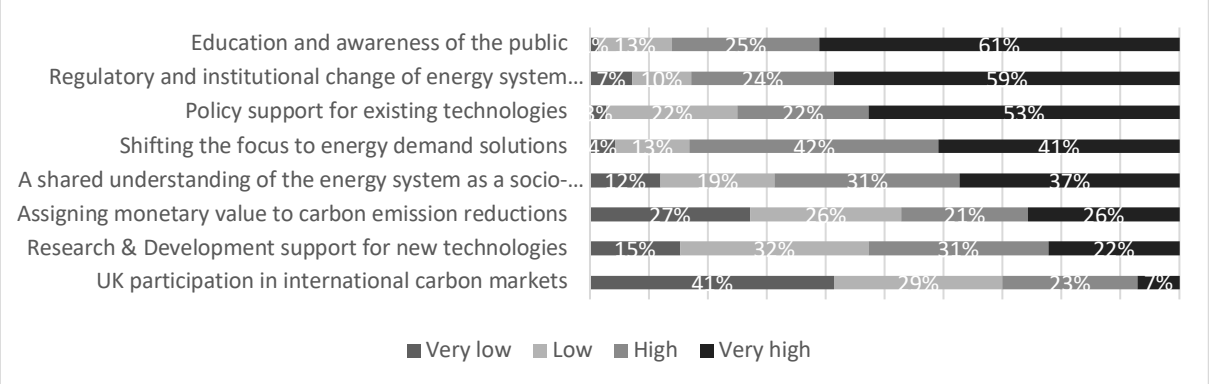


Figure 9. Just transition importance.

cietal shift which goes beyond energy supply and conversion. Many of these, such as a modal shift to active travel, more demand-side response, circular material and product economies and changing working practices, are outside the traditional remit of energy policy.

This does not suggest that more conventional energy policy supporting low-carbon power generation and efficiency improvements are irrelevant (see Rosenow and Eyre 2016; Rosenow and Sunderland 2021). But for a just transition, such policies need to be embedded in a holistic framework which supports changing energy demand practices and creates circular economies by creating jobs, skills and engagement through social dialogue and the appropriate public policies (UNFCCC 2016; Grubler et al. 2018).

To achieve this, large-scale like-for-like infrastructure substitutions and lock-ins around 'lumpy' hydrogen and nuclear technology with large unit sizes and high unit costs, appear counterproductive (see Grubler et al. 2018). The challenge thus lies in addressing both the 'persistent incumbency' (Johnstone and Stirling 2020) of such technologies while providing alternatives to the ever-increasing energy and material demand of our lifestyles.

Conclusion

While energy demand has played a more significant role in UK energy policymaking in the past, energy supply currently receives a lot more policy attention than energy demand. This policy environment has led the world on electricity supply decarbonisation through large-scale technology substitution. However, as important as market mechanisms and standards are in driving such change, they have assigned decarbonisation responsibility primarily to experts while perpetuating systemic injustices. A just transition to net zero, which entails much more significant changes than electricity grid decarbonisation, requires a shift in focus from technological substitution and conversion efficiency towards greater end-user engagement on the demand side.

Most UK policy targeted at energy efficiency and energy demand reduction focuses on products ('things'). The same holds true for policies aimed at patterns of use which rarely extended beyond smart meters. For a just transition to net zero, we need to start with more human focus through education and awareness as well as regulatory and institutional change of energy system operation. This needs to be coupled with policy support for existing technologies and a shift in focus to energy demand reduction to lay the foundations for an inclusive transformation which extends beyond the decarbonisation of electricity supply.

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