UK Energy Research Centre

UK Energy Security: Making the Most of Demand-Side Measures

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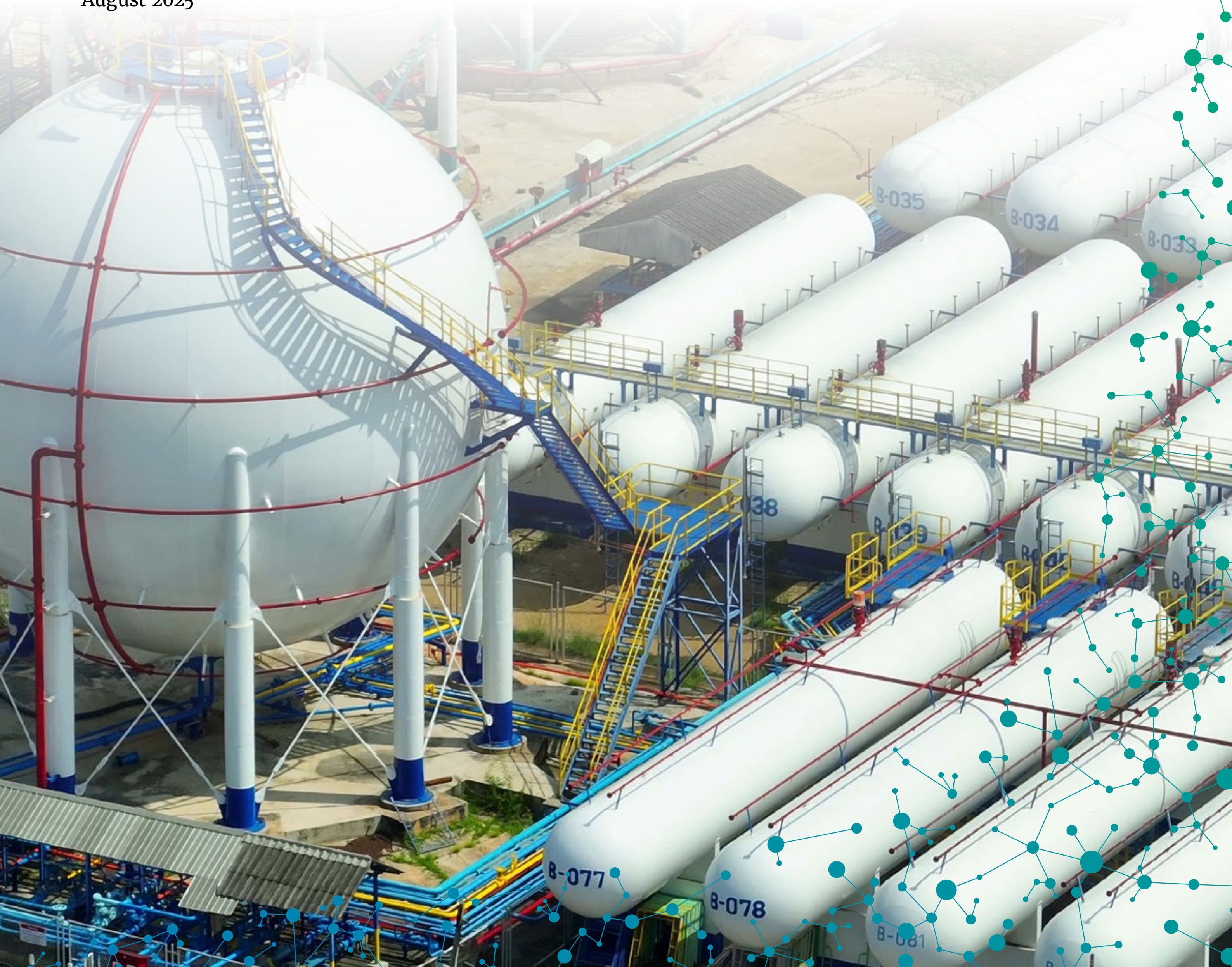

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Key messages for policymakers

This Paper:

Argues that pursuing a more proactive and coordinated demand-side strategy can contribute towards improving energy security.

Explains why this is the case with reference to examples.

Redefines energy security as balancing energy demand with supply in ways that are reliable, affordable, and sustainable for consumers.

Sets out a broad and inclusive account of demand-side measures.

1. Introduction

Uninterrupted availability of energy at an affordable price has long been understood as a key basis for economic growth. In the past few years, however, energy security has taken on new meaning and significance for the UK, and Europe, in the context of climate mitigation goals, Russia's invasion of Ukraine, energy crises and supply chain risks, and worsening global trade relations.

As a result, the UK Government now prioritises the expansion of domestic, low carbon energy production to reduce exposure to volatile international fossil fuel markets.[1] This updated reading of energy security necessarily entails an orderly transition to affordable, clean British energy.[2] Low carbon transitions demand rapid expansions of renewable generation and transmission grids, whilst the material make-up of energy systems is changing.[2; 4] Further, transitions need to be achieved amidst widespread cost-of-living concerns, growing political contestations of net zero, and debates over potential supply chain vulnerabilities of low carbon technologies. A tricky balancing act for any Government.

Despite recent changes in how energy security is understood, one anachronism remains: the focus on questions of supply. By contrast, this policy brief highlights the potential of demand-side measures in better supporting UK energy security. This is in line with a basic principle, which is that the cleanest, most secure and affordable unit of energy is that which is not needed or consumed.[3]

Although demand-side policies in support of energy security are not uncommon, particularly at times of crisis, they have been limited and reactive in their deployment. This relates to tendencies to frame energy security as obtaining whatever supply is sufficient to meet given levels of demand, without acknowledging that energy demand itself is mutable and shaped by policy choices. This asymmetry is encapsulated in the UK's *Clean Power 2030 Action Plan*, which defines energy security as the energy system "*meeting demand, while protecting families and businesses from global supply shocks and volatile prices*".[1]

Relatedly, the comparative neglect of demand-side opportunities is also reflected in the integrated assessment models (IAMs) and scenarios that dominate how policy-makers understand energy futures. Indeed, most energy-modelling approaches focus on representing the energy system as meeting a set of exogenous energy service-demand projections.[4;5] Often, any role for demand-side policy in ensuring energy security is acknowledged in a reactive manner, during and post crises, including by the International Energy Agency (IEA), European Union (EU), and UK Government.[6;7;8]

2. Redefining Energy Security

In this policy brief we define energy security as 'balancing energy demand with supply', in ways that are reliable, affordable, and sustainable for consumers. Our recommendation, simply put, is to adopt a more proactive and coordinated demand-centred approach – rather than focusing on ensuring supplies to meet 'given' demand levels.[9]

This might include first asking questions about the range of ways in which UK energy systems can be optimised, such that energy demand (including peak) is lower as part of the process of deciding how much new low carbon generation, grid expansion, or back-up generation, is required. Our approach also recognises that the Government has agency to shape the UK's energy demand in ways that improve energy security, net zero, and other policy outcomes. This infers more coordinated thinking across policy areas, partly because policy choices in a variety of sectors (e.g., housing, transportation, industry), and associated departments of government, also have energy demand implications.[10]

3. Advances in Demand-Side Measures

Demand-side measures are more often discussed in relation to reducing emissions. Given global commitments to net zero they now extend significantly beyond historic foci on energy efficiency.[9;11;12;13;14]

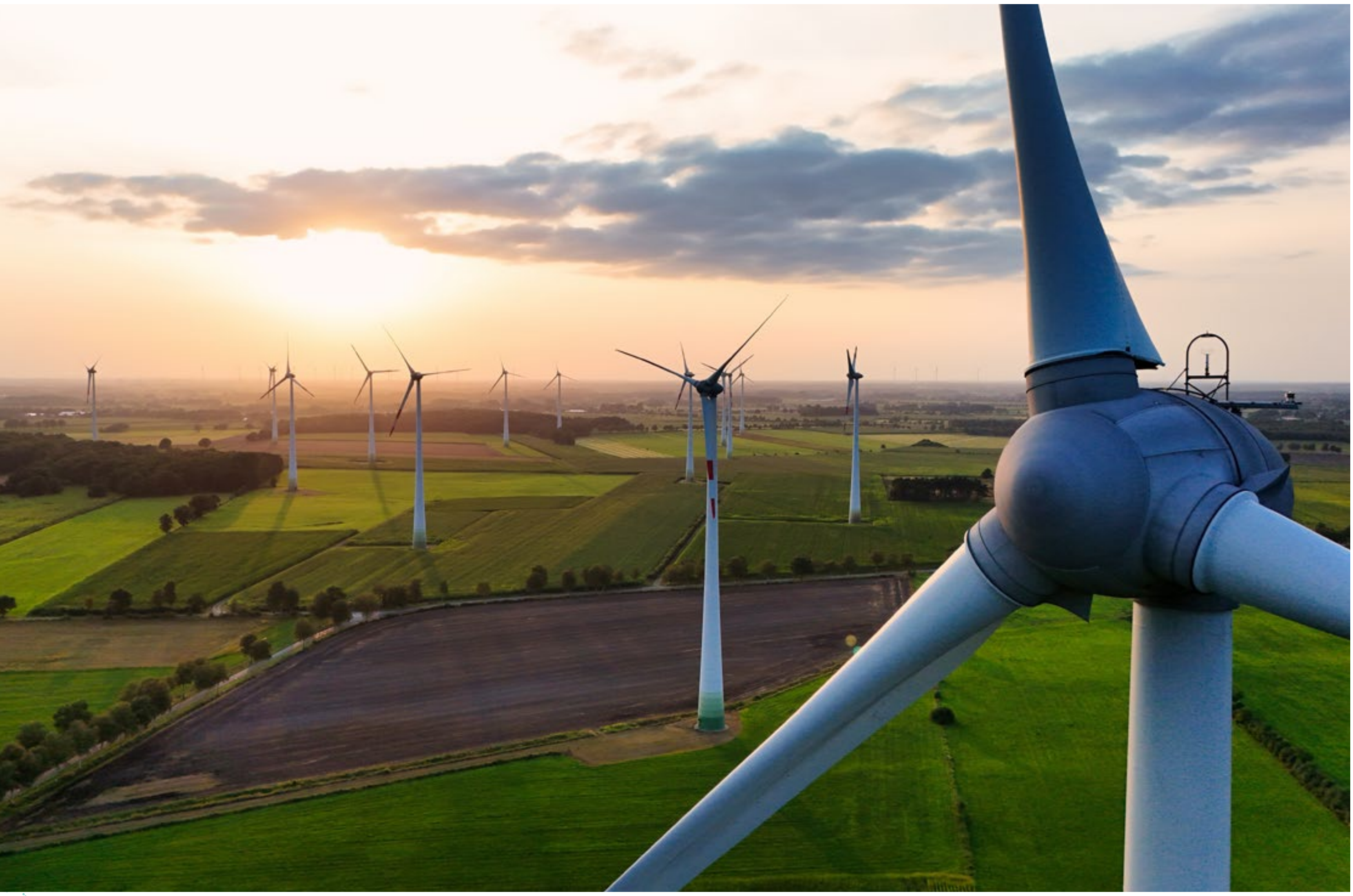
Reflecting these advances, and in the spirit of making the most of new evidence and innovations,[15] we set out energy demand-side measures under four inter-related categories: demand reduction; distributed energy; demand-side response (DSR); and circularity. We do so because providing a more inclusive and up-to-date definition reveals more possibilities for ensuring energy security.

Demand reduction measures, like improvements in appliance or household energy efficiency or enabling shifts towards public transportation and away from car use, are designed to reduce levels of energy consumption.[10;16] Historically, enthusiasm for energy efficiency as an emissions reduction measure has been tempered by arguments about 'rebound effects' from behaviour changes.[17] Recent research, however, has found that the size of rebound effects varies widely depending on the behaviour in focus, design of mitigating policies, and social norms and expectations.[18] Here, we are more interested in demand reduction in relation to energy security outcomes. Demand reduction policies have been used to reduce relative household and national exposure to energy shocks.[46] As part of ongoing low carbon transitions, the electrification of heat and transport sectors has started to deliver relative demand reduction improvements, given that electric vehicles and heat pumps are more energy efficient than their fossil fuel equivalents.[13]

Clean distributed energy has been considered a demand-side policy for a around a decade.[19] Distributed energy can reduce pressures on transmission and distribution networks, and reduce requirements for expensive system back-up generation.[13] On-site renewables allow consumers to become 'prosumers', thereby both including them as actors within energy systems and improving relative levels of independence.[20] A comprehensive focus on demand-side management and distributed energy can also unlock significant flexibility.[15] Distributed energy has become more economically viable and reliable due to recent policies, technological advances, and cost reductions in information and communication technologies (ICT), as well as infrastructure, sensors, and power electronics.[21]

Increasingly, of course, demand-side measures also include DSR. DSR actions focus on increasing the flexibility and responsiveness of energy demand, partly to smooth the demand peaks that drive system-wide electricity generation capacity requirements. Many measures are targeted at the demand-side of energy meters and include incentives for business and household consumers to vary their usage and/or install on-site energy backup, like storage.[10;15] Greater demand flexibility is crucial to maintaining electricity system security in the context of the shift towards renewables.[15] DSR can be about incentivising consumers to behave differently, but it is also about delivering improved energy system optimisation.

The last demand-side category, circularity, is more embryonic, albeit policies have already been implemented in the EU, China, the UK, US, in Canadian provinces, states and cities, and by companies like Apple.[22;23] Put simply, circularity policies seek to make the most of reuse, repurposing and recycling, which can reduce resource dependencies and extraction.[23;38] Whilst actions are often focused on manufacturing sectors, there is considerable scope for circular approaches in energy sectors to contribute towards energy security. For example, solar PV and wind energy systems are constructed using component materials that can be reused and repurposed, as opposed to fossil fuels that are burnt on consumption.[24;25] Circularity is not just about reducing exposure to fossil fuel or critical material inputs to energy systems, but making energy use less linear and wasteful.



4. Improving Energy Security Through Demand-side Measures

Although most often researched in relation to reducing emissions, there are a number of other societal implications of demand-side measures. These include contributions towards other UK public policy goals, like economic growth and new jobs,[12;26;27;57] energy poverty reduction,[28] and improved health and lower NHS costs.[29;30;31;57]

Each of these sets of positive outcomes can be linked to the UK Government's 'Missions': growing the economy; clean energy; improving the NHS; and opportunity for all. In this section, however, we focus on exploring links between adopting a more proactive and coordinated demand-side approach and improvements in UK energy security.

4.1 Reducing International Exposures

In 2024, UK fossil fuel dependency was still at 75%, despite growth in renewables, coal no longer part of the power generation mix, and falls in gas demand.[32] At the same time, however, global fossil fuel markets have become more volatile, and some exporters have been deemed less reliable. UK energy policy, as a result, aims to reduce economic and fiscal exposure to fossil fuel markets by expanding clean, domestic power supplies, alongside electrification.[1] This coincides, of course, with net zero energy policy. As a complement to supply-focused actions, however, a lower demand, more flexible energy system can further contribute towards reducing fossil fuel import requirements.[9;33;48]

A lower demand energy system becomes even more important within the context of growing UK exposure to critical material and low carbon manufactured goods markets,[22;23] and related concerns about 'materials security'.[34] Current measures, in response, in OECD countries to 'onshore' critical material mining and refining and manufacturing of low carbon goods risk increasing the costs of the technologies needed to transition.[35;36] At the same time, global energy supply chains and mining, nuclear and hydroelectricity sectors are also vulnerable to climate change shocks.[22] It makes sense, then, within this context, to concentrate greater efforts on reducing relative levels of demand for critical materials and low carbon goods. This also makes sense to the extent that the UK Government has more influence over domestic demand than it does over climate change impacts, geopolitical conflict, or global trade uncertainties.

Recent research has found that demand-side measures can reduce material resource requirements of low carbon energy transitions and mitigate against technological challenges, such as scaling up renewables.[37;51] Others, focused on batteries, find that demand reduction and recycling can reduce lithium extraction pressures and competition for resources.[38] Circular economy and other repair and reuse strategies have other implications for reducing relative exposures. For example, it is estimated that recovery of biodegradable waste (biogas and biomethane) could meet 10% of EU natural gas demand by 2030.[22] Others find that extending the duration of use and reuse of materials, and reducing resource demand from the start, allows for faster de-risking from competitive and sometimes volatile global markets.[23]

4.2 Lower Cost Low Carbon Transitions

Rapid low carbon transitions imply considerable investments in new generation and grid infrastructures. NESO, for example, estimates that the transmission network build programme to 2030 will cost up to £60bn.[39] Evidence increasingly suggests, however, that demand reduction, distributed energy and DSR can contribute towards more cost-effective energy systems.[7;15;29;40;41] If system cost savings are passed on to consumers, this can contribute toward improving the affordability aspect of energy security. Implemented in a coordinated way, solutions like shifts from private automobility to public and active transit,[42] energy efficient homes and businesses with onsite generation,[9] grid-scale storage,[34] and responsive demand,[15] can contribute towards less peaky, lower cost, smaller electricity systems. For example, experiences in California demonstrate that recently developed grid-scale storage has resulted in a smoothing of the electricity demand curve and lower evening peaks.[34] Lower demand, distributed, and less 'peaky' energy systems, in turn, require less costly back-up generation,[10] less need to build out grids,[20] and, partly as a result, lower net zero transition costs.[9] Others claim that increased demand flexibility alone could reduce UK network investment requirements to 2050 by 50%.[43]

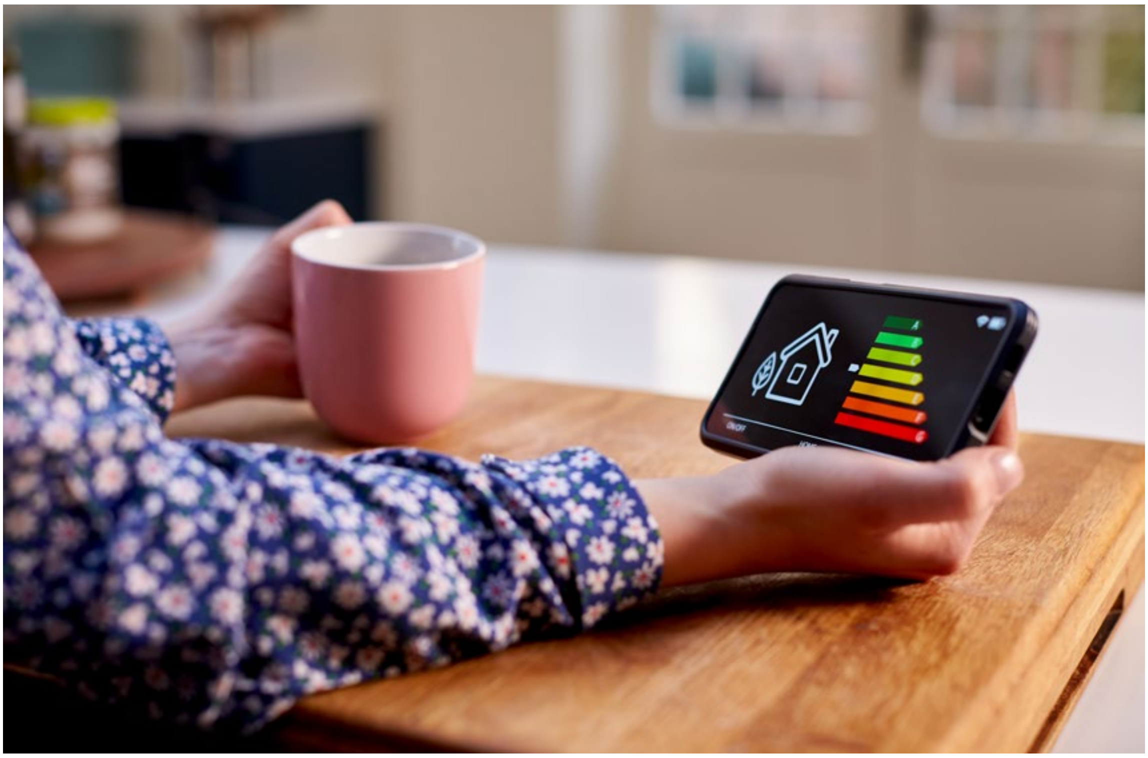
The potential of demand-side measures to contribute towards lower energy system and net zero transition costs really matters, especially within the context of high energy prices, poorly insulated housing stock, the cost-of-living crisis, and increased contestations of net zero. Estimated costs of low carbon transitions are higher than necessary if a coordinated demand-side approach is not pursued,[9] whilst much of any additional burden will be paid for by consumers. Asking them to shoulder a higher-than-necessary burden is a politically more challenging route towards net zero. Further, planned UK transmission grid expansions are associated with various land use and planning issues, making them also socially contested.[44;45]

Pursuing a coordinated demand-side approach is also more in line with Committee on Climate Change (CCC) calls for a more just, affordable and inclusive transition – one that limits the social costs of change and, just as importantly, shelters citizens and businesses from the considerable costs of climate change.[46]

4.3 Protecting Domestic Consumers

During the recent energy crisis, typical UK household energy bills were high, but would have peaked at £3,500 if it were not for Government support programmes, which, in turn, cost £51.1 billion in 2022-23.[47] At times of volatile energy prices, households and businesses would be far better protected if buildings were well-insulated and if they had onsite generation and storage as back-up.[48;49;50] At the same time, a UK energy consumer base that is less vulnerable to price shocks would cost less in terms of Government support, whilst electoral risks can be lowered if affordability issues are addressed. Put another way, the £51.1bn cost of protecting UK bill payers could have been better spent on demand-side measures to reduce the relative exposure of businesses and households to energy crises. This comes back to our earlier point about the value of proactive, rather than reactive, demand-side approaches.

As outlined in section 4.1, circularity approaches, including 'reuse, repurpose, and recycle' measures, can allow for faster de-risking from exposure to volatile fossil fuel and critical resources markets.[22] This is about avoiding wasteful use of materials and energy to reduce levels of import dependencies across the economy as a whole. It is also worth noting that whilst energy transitions rely on low carbon manufactured goods inputs, like batteries, solar panels, and turbine blades, many of the materials used in making such goods are reusable.[23] What this means is that demand-side measures that centre on building systems for efficient reuse and recycling of materials back into new goods make more sense in low carbon energy systems.



5. Conclusions

Energy policymakers are increasingly having to devise and deliver policies at times of change. This means that the UK faces an urgent need for innovative solutions.[15] In parallel, the evidence base on demand-side measures has grown.

This means that we have been able to outline several ways in which innovative actions can contribute towards better balancing demand with supply in ways that improve energy reliability, affordability, and sustainability. The bottom line remains that the most secure and affordable unit of energy is the one not consumed, whilst the smaller the low carbon electricity system that needs to be built, the lower the cost. We recommend actively planning for a lower demand energy system and realising it through a coordinated demand-side approach that makes the most of the many innovations in collective understandings of the demand side.

Although energy intensity in the UK has improved over the past few decades, largely due to energy efficiency, demand-side policy design and implementation has a mixed track record. Indeed, the UK has no clearly defined overarching strategy to reduce energy demand.[51] A recent review of twelve UK-based scenarios found that reductions in total final demand of up to 52% by 2050 are possible.[51] This leaves ample room for improvement, whilst research offers a number of ideas: improved urban transport planning to enable transport demand shifts;[40] practical measures for improving household retrofit policy;[52] data centres as sources for flexibility;[53] regional-based forecasting on skills and jobs in energy demand-related activities;[54] and policy and regulation to support DSR and distributed energy.[15] It is also vital to ensure that the benefits of a proactive demand-side approach are widely accessible, not just captured by the wealthiest in society,[55;56] and that reductions in energy system costs are passed on to consumers.

Although this policy brief has focused on energy security at times of transition, it is also increasingly clear that a coordinated demand-side approach can contribute towards the delivery of other key policy goals, like health, employment, and growth. At the same time, policies in other sectors affect demand for energy – both of which suggest the need for greater cross-departmental coordination if a proactive demand-side approach were to be built. Coordination across Government departments requires certain levels of buy-in, but might be incentivised on energy security, cost effectiveness, affordability, and net zero grounds. Incentivising collaboration across silos of government by focusing on the co-benefits of particular policy areas is an approach that has already been adopted by a number of UK local authorities.[57]

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