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Perspective on Infrastructure issues - State of energy infrastructure / Access to technology/ Smart-metering in the UK

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Supply networks, domestic energy infrastructure and smart meters in the UK policy debate

UK Government literature indicates that since the 1970s, there has been a dramatic increase in the number of households in the UK with central heating in their homes (Palmer and Cooper, 2013). In 1970 just 30% of homes had central heating, this grew to 79% by 1990, with a 95% installation rate recorded in 2018 (Holst, 2020). The main fuel source for UK central heating is gas (Palmer and Cooper, 2013).

These increases run parallel if not slightly ahead of global changes in expectations regarding indoor temperatures, with a shift away from climatic coping mechanisms (e.g., extra clothing) and an increased reliance on heating and cooling systems to improve comfort in the home (Shove, 2003). Contemporary evidence in the UK demonstrates a strong reliance on heating systems, particularly in the early morning (Hanmer et al., 2016). UK energy infrastructure and technologies have been key factors in the realization of these changes (Palmer and Cooper, 2013). The UK has the second largest liquified national gas network in Europe, just after Spain (BEIS, 2019a), while the land area of the UK is approximately 241,930 square kilometres (World Bank, 2020) compared to 505,944 square kilometres in Spain (EU, 2020).

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The liberalization of the energy market in the UK has had different impacts in rural areas than in urban ones, with more extensive development of the gas distribution network in urban areas (Roberts et al, 2015). Only 40% of rural homes are connected to the gas infrastructure, in comparison with 90% in urban areas (BEIS, 2019a).

UK policy documentation recognizes that while energy efficiency in rural homes tends to be lower than in urban areas, generally higher incomes in these rural areas mean that rurality does not necessarily result in higher levels of fuel poverty (BEIS, 2019a). Homes which are "off-grid" (unconnected to the gas grid), however, are recognized to be at increased risk of fuel poverty, where 15.9% of off- gas grid homes are in fuel poverty compared to 10.1% of homes on the gas grid (BEIS, 2019a). Figure 1 demonstrates that the proportion of off- gas grid homes in Scotland and Wales is higher than in England, with rates in western mainland Scotland being particularly high. Additionally, the Scottish Isles with "No data" coincide with areas which have high rates of fuel poverty (Changeworks, 2015). In Northern Ireland 82% of rural homes are dependent on home heating oil, a costly heating source which is thought to contribute to fuel poverty (Consumer Council, 2011).

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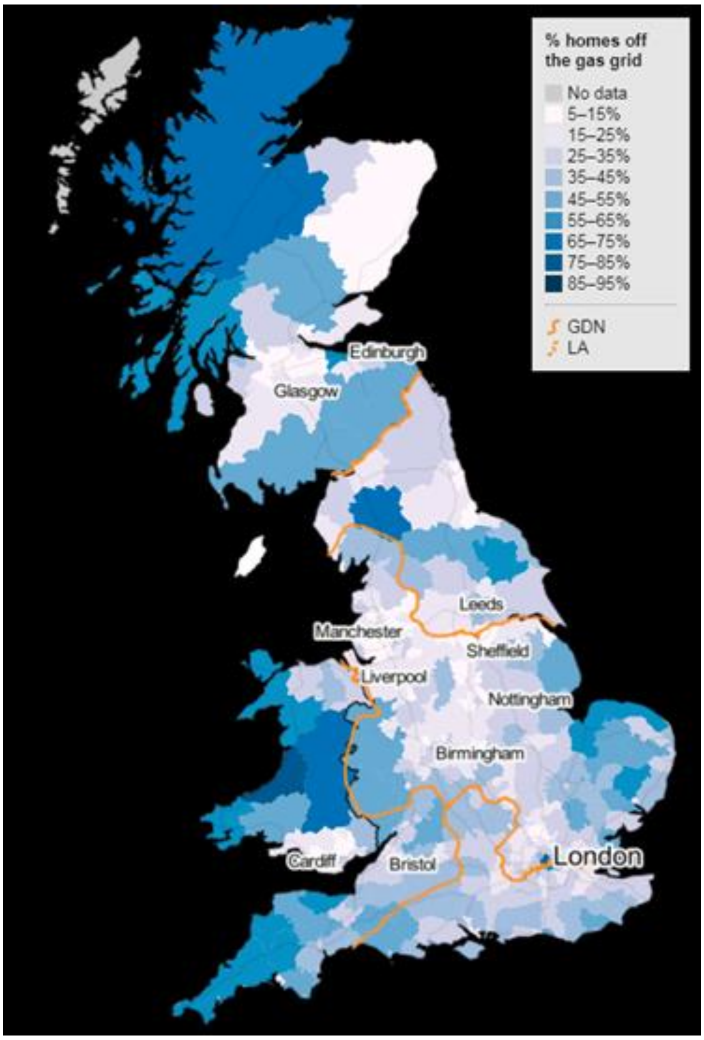

Figure 1. The non-gas map (image reproduced from Kiln and Affordable Warmth Solutions, 2015)

The policy focus of energy infrustructure development in the UK reflects the potential of low carbon technologies to protect businesses and domestic energy consumers from high energy costs . This would principally be achieved through a planned carbon neutrality transition, which represents a series of opportunities and challenges in terms of innovation, energy storage and energy security. Government sources argue a link between decarbonisation and the reduction of fuel poverty through lower energy prices, changes to household energy needs, and new heating sources. Despite this clearly defined ambition, analysis of UK policy documentation demonstrated that the favoured method of reducing fuel poverty remains energy efficiency improvements. This may be due to the passing on of costs associated with renewable infrustructure development to the consumer, although methods have been put in place to try to mitigate this effect (HM GOV, 2017).

European structural funds have contribued signficantly to the energy sectors in both Scotland and Wales, and UK policy makers have recognised the importance of this contribution in each case. In Scotland this funding has been used to develop low carbon technologies, offshore wind, marine renewables and integrated hydrogen soulutions. In Wales this has been directed into capacity building at universities, the facilitation of research and development, and for investment in renewables (BEIS, 2019b). Specific examples of clean energy infrastructure include the installation of the first smart grid in the UK- implemented in Orkney - which facilitates network distribution at a noteably lower rate than coventional network connection (BEIS, 2019b). This is pertinent given the higher vulnerability of these countries to fuel poverty, as outlined above. It is therefore important that this investment in clean energy infrastructure is supplemented in the Post-Brexit era.

The UK is in the midst of the smart meter roll out programme aiming to equip 53 million homes with smart meters by the conclusion of 2020 (Ofgem, 2020a). Smart meters are available for electricity and gas as UK homes are often powered by a combination of the two (Hamilton et al., 2013). The latest figures suggest that approximately 20 million smart meters have been installed to date (BEIS, 2019c). The general policy perspective is that smart meters offer accurate information regarding levels of household energy consumption, lower energy costs and will reduce carbon emissions (Ofgem, 2020b). The idea that smart meters will help consumers manage their energy consumption is strongly entrenched in UK policy (HM GOV, 2017; Ofgem, 2020b). Smart meter installations are administered by energy suppliers, where consumers should receive a smart electricity meter, a smart gas meter, and an in-home display unit ; the installation should not involve any upfront costs to energy consumers. The smart meter scheme will end the estimation of energy bills, resulting in customers being billed only for the energy they consume (Ofgem, 2020b).

The smart meter installation initiative is also supported by Smart Energy GB, the "voice" of the rollout scheme. Smart Energy GB presents itself as being a "government backed organisation" responsible for informing energy consumers about the benefits of the roll-out, Smart Energy GB addresses privacy and data sharing concerns which arise commonly in the UK with regard to smart meters (Smart Energy GB, 2021).Within UK policy there is an acknowledgement that the low carbon transition will lead to changes in the way in which power supply, demand and storage are managed; from a policy perspective smart meters will be essential tools in the management of these challenges (HM GOV, 2017).

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Research perspective on infrastructure issues in the UK

UK research perspectives generally coincide with the UK Government's viewpoint that vulnerability to fuel poverty can be exacerbated by living in an off- gas grid home. Rural homes are more likely to be off the gas grid and to have "hard-to-treat" characteristics than urban homes, both known fuel poverty risk factors (Baker et al, 2008). A key impact of being off the gas grid is that fuel choices tend to be limited, costlier and less efficient (The Marmot Review Team, 2011). Residents in rural areas are thus more susceptible to energy price increases (Roberts et al, 2015). Furthermore, residents with limited fuel choices can be vulnerable to fuel shortages during extreme weather events. During the winter of 2017-18, a number of residents not connected to the gas grid in the UK were unable to obtain fuel for their homes for extended periods (NEA, 2018).

Homes in rural areas of the UK tend to be older and larger than urban dwellings, making them harder to keep warm and energy efficiency improvements more challenging (The Marmot Review Team, 2011; Roberts et al, 2015).The previous section highlighted that higher incomes somewhat mitigated the discrepancy between rural and urban energy prices in the UK, however, government statistics also suggest that the "fuel poverty gap" is more significant in rural areas (BEIS, 2019a). Financial losses resulting from 2016 welfare cuts have hit rural areas particularly hard, with a corresponding increase in reliance on food banks in some of the poorest UK communities (May et al., 2020). Austerity measures have also reduced the availability of services such as libraries and bus routes, this coincides with a concentration of "double energy poverty" (when domestic energy poverty and transport energy poverty overlap) in isolated rural areas (Robinson et al, 2020). Community energy schemes are gaining popularity as a means of addressing the energy challenges faced by rural communities in the UK (Kelly, 2016).

These vulnerabilities, however, are not limited to rural areas alone. UK research demonstrates that patterns of fuel poverty are complex and that even within large cities pre-payment meters create divides between the level of access to energy consumers have (Robinson et al, 2018). Prepayment meters are often associated with low-income households and work on a "pay as you go" basis. This facility can be perceived as beneficial, particularly to householders who have difficulty controlling their spending. Updates to the prepayment system also reduce the risk of power disconnection through an "emergency credit " system which allows extra time to top up and through a "no disconnect" function prevents the meter from cutting out at inconvenient times, such as late at night or when payment outlets are closed (UKPower, 2021). The price per unit for energy supplied through a prepayment meter is, however, typically higher than other alternatives making it a controversial solution for low-income homes (Walker and Day, 2012).The type of network connection available (either due to geographical or social circumstances is therefore a highly relevant factor in the condition of fuel poverty. Given that the low carbon transition will involve significant changes to energy infrastructure, an opportunity has been identified to employ area-based targeting to develop energy infrastructure, resulting in the alleviation of fuel poverty and reduction of carbon emissions (Bouzarovski, 2019).

One of the potentially beneficial methods of infrastructure development is district heating. Currently district heating is not as widespread throughout the UK as it is in other European countries (Bolton et al, 2015), accounting for merely 2% of the water and heating market (Hawkey, 2012). District heating in Scandinavia, where systems were developed with strong levels of government involvement, coincides with low rates of energy poverty in these countries. The Scandinavian political strategy has been to invest in district heating systems and the expansion of modern smart grids (Simon, 2017).. In the UK, however, the national government has a lesser role in energy planning (Bolton et al, 2015). Increased uptake of district heating could offer solutions to emissions challenges, but there are a range of UK-specific barriers to its implementation (Wang, 2018). These barriers include low-cost natural gas and a large market share of individual boilers (Wang, 2018).

The research perspective on smart meters in the UK presents a more balanced and critical overview of the potential benefits and drawbacks with regard to the rollout programme. There is a prominent concern regarding the utility of the scheme to the most vulnerable, specifically the accessibility of the smart meter scheme to the elderly and the exclusion of people with long term illnesses (Sovacool et al, 2017). There is also recognition from non-Governmental organisations that with appropriate management, the rollout could benefit both vulnerable consumers and carbon neutrality targets (NEA, 2020).

The smart meter roll-out has incurred a number of delays and high costs which have been attributed in part to the underestimation by energy companies and government of the social aspects of the scheme (Buchanan et al., 2016). Themes of defiance, mistrust and privacy concern have been identified among consumers, these elements were not anticipated ahead of the roll-out and have caused significant challenges (Sovacool et al*.*, 2017). Analysis of media discourse has identified themes such as "big brother" and "hacked and vulnerable grid" being associated with smart meters for gas and electricity (Hielscher et al, 2018). There are also fears that the format of publicity is not accessible to groups such as the elderly (Sovacool et al*.*, 2017). Some sources argue that a lack of support at the

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level of the individual consumer will result in increased "energy rationing" or in consumers not realizing the full benefit of personalized energy data (NEA, 2020).

The potential benefits of smart meters include insights for the improved design of district heating networks in the UK (Wang et al, 2020), facilitating the shift from Energy Performance Certificate data based on surveys to data based on monitored energy use (Chambers et al, 2019) and benefits for low-income homes. In particular, the ability of smart meters to bring about the end of estimated billing has been praised. The installation of smart meters will also update the antiquated and inaccurate energy use monitoring data which still exist in many UK homes (NEA, 2020).

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