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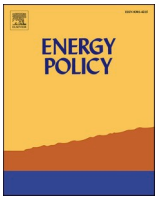

Net Zero and the potential of consumer data - United Kingdom energy sector case study: The need for cross-sectoral best data practice principles

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ABSTRACT

The nationwide rollout of smart meters marks a significant milestone in the digitalisation of the UK energy sector. It has allowed the collection of unprecedented amounts of consumer energy consumption and behavioural data. Providing real-time, spatially explicit, bi-directional connectivity between service providers and consumers, this data is expected to provide benefits of over £40B and contribute to behavioural nudges - which are integral to 62% of all initiatives required to achieve Net Zero by 2050. Concurrently, consumers are leaving behind digital trails across a broader spectrum of their lives through their smartphones and in-home devices. This data could also be used to accelerate digitalisation within the energy sector and yet the energy sector has limited or no visibility of it. While greater access to consumer data is expected to provide substantial opportunities for economic growth and the realisation of Net Zero both in the energy sector and across the UK economy, it also risks consumer exploitation.

This policy perspectives seeks to provide insights from data and digital specialists in the UK rather than just actors within the energy sector. It uses psychographics as a use case to highlight the tension where data, particularly consumer data, is under regulated and siloed across the UK economy. The potential to use consumer data to change consumer behaviour to enable net zero opportunities is explored.

The analysis strongly indicates that the ability for high fidelity consumer data to elicit behavioural insight is expected to become an increasingly valuable tool to inform both policy and business decisions in the energy transition - particularly around innovation and enhanced competition. These opportunities are balanced by the fact that high-definition consumer data collection practices are already perceived as exploitative. The lack of data sharing infrastructure across the economy has allowed incumbent technology companies to establish monopoly power thereby stifling competition and raising barriers to entry. The analysis makes a series of high-level recommendations around cross-economy data principles to enhance sharing and stimulate innovation whilst protecting consumer privacy to build digital trust. Options as to how these might be realised are also proposed and should form the basis of future research.

1. Introduction

Decarbonisation, digitalisation and decentralisation have transformed the role of consumers from passive users to active participants in the modern energy industry. With the ability to generate renewable energy from rooftops, shift demand according to price signals and switch suppliers online, residential consumers have been recognised as a valuable source to provide flexibility, promote competition, and stimulate innovation in the energy industry (Palensky and Dietrich, 2011; BEIS, 2011). These benefits are estimated to be worth more than £40 billion in the UK but are largely unrealised because consumer engagement remains low with existing market incentives and policies. Disengaged consumers not only reduces the impact of smart meters but can potentially create further stress to the grid as electrification of heat and transport continues to add to grid load (BEIS, 2011; Martiskainen, 2014; Cosmo et al., 2014; Nicolson and Moon, 2019; and Ofgem, 2020a).

Concurrently, consumers are leaving digital trails across a broader spectrum of their lives through browser cookies, social networks, and

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smart phone interactions with GPS centric applications. Methods to generate consumer insights from such high-fidelity consumer data are becoming increasingly sophisticated and are currently used to anticipate consumer susceptibility to value propositions and shape behaviours across a number of applications such as consumer products, services and even political voting patterns (Espir, 2019; and Kriel, 2016). Digitalisation has enabled real time connectivity between consumers and the grid via smart meters, smart appliances, and Internet of Things (IoT). However, the heavily regulated nature of the energy sector in the UK and existing privacy concerns across the digital landscape globally have caused high-fidelity consumer data to be underutilised (BEIS, 2018a).

With the urgent need to decarbonise the electricity grid, this paper seeks to develop perspectives as to the opportunities and risks of utilising high-fidelity data in the energy sector to unlock demand side and system wide benefits. As electricity market structures and regulations are often unique to their geographic locations, this paper has selected UK to conduct the case study for the following reasons:

- It is the first major economy to legislate a net zero transition by 2050;
- The UK is currently collecting a significant amount of highly granular electricity consumption data with binding smart meter roll out targets for all suppliers (Ofgem, 2020b) and installation standing at 47% of domestic households as at Q4, 2021 (BEIS, 2021); and
- Lastly, the recently launched National Data Strategy looks to establish the UK as a world-leading data economy, within which, public trust in data use was recognised as the underpinning factor for a thriving digital sector (DCMS, 2020). The value of smart energy data is generally recognised within the data ecosystem in the UK, namely Open Data Institute (ODI) and the Data Communications Company (DCC) (DCC, 2021; Delta, 2020).

This policy perspective is developed by building on the insights of data and digitalisation emerging in literature with themes and ideas developed around understanding the implication and the impact of applying methods to generate psychographic profiles using digital consumer data in the energy industry (Liu, 2020). Psychographics is the study of consumers based on these cognitive traits and provides consumer insights regarding how, and which cognitive traits drive behaviours and this, in turn can be used to anticipate consumers' susceptibility to value propositions (CB Insights, 2018).

Section 2, introduces the uptick in data availability both in the energy sector and across the economy. The wider discourse surrounding personal data harvesting and the application of psychographics as a use case are considered in section 3. Opportunities digital based psychographics can enable in energy, as well as the key policy strategy implications presented in section 4 are developed from an in-depth analysis of existing applications of high-fidelity data both within and outside of the energy sector. From this, high level data principles and governance are recommended in section 5, followed by conclusion in section 6.

It seeks to benchmark the ongoing tension in the current digital landscape of how to unlock the value of digitalisation whilst upholding consumer privacy and digital trust in the energy sector from more of an outside looking in perspective of the role of data and digitalisation on the energy sector than other contributions e.g. Rhodes, 2020. As such, it is important to note that while the discussions within the paper take an UK centric perspective, the overarching conclusion and recommendations are applicable to the broader digital landscape that extends beyond geographical borders.

2. Digitalisation in the energy industry

Digitalisation, while identified as a part of the driving forces of the Net Zero transition, should also be seen as the underlying enabler and accelerator of more efficient and strategically important decarbonisation and decentralisation solutions. Driven by cost reduction incentives, the energy industry as it stands, has been a proficient user of analytical tools to improve operational efficiency. This level of digitalisation has been sufficient in the conventional unidirectional energy provision supply chain, data connectivity across the sector can increase asset visibility, enable efficient system management, maintain grid resiliency and ultimately reduce system cost in a decarbonised and decentralised energy future (Energy Data Taskforce, 2019).

The Energy Data Taskforce (2019) and Rhodes (2020) categorised data generated within the energy industry into two groups - Energy System Data and Consumer Data. Energy System Data is produced by assets and infrastructures and has been pre-eminent in the digitalisation discourse with an increasing desire to enhance data connectivity with actors from government, regulation and individual businesses (Energy Data Taskforce, 2019; Ofgem, 2019d). Consumer Data on the other hand, has been largely excluded from such initiatives due to the complication of privacy. Under the General Data Protection Regulation (GDPR), consumers have ownership over the data they generate across the economy, which has left the opportunity for higher data connectivity within the hands of individuals. However, as residential consumers' roles become increasingly dynamic in the energy system's transition to Net Zero, the benefits and opportunities which might be realised by their data becomes increasingly valuable in a digitalised energy industry.

2.1. Smart meter data

In the energy sector, digitalisation of the demand side is being led by smart meters that collect energy (electricity and gas) consumption data over half-hour intervals. Since the beginning of the roll out, smart meters have generated an unprecedent amount of accurate and granular residential consumer data at high spatial and temporal levels. This data is expected to generate significant savings for both consumers which could help to meet Net Zero goals through enabling flexibility, increased competition and enhancing policy development.

Smart meter data has enabled demand side response (DSR) programs through Time-of-Use (ToU) tariffs. These dynamic pricing schemes garner residential flexibility essential in achieving a Net Zero electricity system as more intermittent renewable generation is integrated to meet the growing demand from the electrification of heat and transport. By delaying or avoiding infrastructure upgrades, flexibility in demand can increase efficiency in the energy system, thus potentially bringing benefits of up to £40 billion over the next few decades. It is therefore, recognised as a key enabler to achieve an efficient and resilient grid (BEIS, 2018c and Strbac et al., 2015).

Smart meter data also stimulates competition within the energy industry by allowing consumers to compare tariffs and enabling new energy services and business models to emerge. Innovation opportunities such as load automation can provide savings of up to £272 million/year for consumers, but more effective competition overall, can bring benefit valued at £1.2 billion/year for the entire industry (Hledik et al., 2017; CMA, 2015). Lastly, smart meter data is also an extremely valuable resource to support evident-based policy and academic research for Net Zero and other public good purposes both within and outside of the energy industry (Elam, 2016).

While smart meter data in itself have enabled substantial opportunities for new technologies and services to emerge in energy, innovations alone cannot actualise value. Instead, benefits are only realised when such innovations are adopted, and this requires large scale societal and behavioural change. For example, exploitation of ToU tariffs requires active engagement from consumers to shift their daily schedules. Even automated load controlling technologies require consumers to make hardware investments. While it has been estimated that 62% of Net Zero solutions involve levels of societal and behavioural change, methods used by the energy industry, which have mainly relied on financial incentives to change consumption behaviours have created limited impacts (Committe on Climate Change, 2019; Martiskainen, 2014; Cosmo et al., 2014; and Nicolson and Moon, 2019). In contrast, digital industries have adopted data driven innovation to not only

generate highly intimate consumer insights, but also facilitate large-scale behavioural change.

2.2. Cross-sectoral consumer data to realise value in digitalisation

Aside from smart meter data, higher integration of smart phones and other wearable devices have connected an estimated 5.3 billion users to the internet globally (REPHRAIN, 2020). As individual's daily activities become more digitalised, data they generate across platforms can be used to predict intimate insights regarding attitude, lifestyle, interest, personality and other psychological traits better than their friends or colleagues (Sgaier et al., 2018).

This process is demonstrated in a large-scale experiment involving 3.5 million participants (Matz et al., 2017). Through a process called psychographic profiling, this research first used Facebook likes to accurately predict personality traits and then used such traits in a targeted manner to alter purchasing behaviours. The results showed an increased product engagement by 40–50%, showcasing both the effectiveness of using high-fidelity consumer digital footprints to infer psychographic traits and the impact of psychographic intervention.

As illustrated in Table 1, data generated through this high-fidelity connectivity across platforms can bring additional insights to help the energy industry deliver the large-scale behavioural shift needed to meet Net Zero. Furthermore, access to cross-sectoral high-fidelity consumer data, both energy and non-energy, can provide local authorities with the ability to engage, target, monitor and evaluate range of community energy projects. From engaging vulnerable groups in energy efficiency programmes to planning community generation programmes, data can provide valuable insights to accelerate decarbonisation and decentralisation at a sub-national level (Britton, 2016). At a national level, consumer data can enable decision makers to move away from relying on market forces that have led previous energy transitions, to psychological interventions in order to more effectively engage consumers, influence energy behaviours and facilitate cross-sectoral transition to Net-Zero (Fri and Savitz, 2014; Martiskainen, 2014; European Environment Agency, 2013; Richard Carmichael, 2019; Ofgem, 2019c; and Frederiks et al., 2015a).

3. A data and digitisation perspective - psychographics as a use case

When designing data policy, it will be important to consider issues relevant to the sector within which it is generated. However, the issues that are salient to the use of psychographics in the energy sector raise the same high-level questions in the broader digital landscape, spanning across industries that collects and processes high-fidelity personal data. Therefore, it is argued that the application of psychographics in the energy sector serves as a useful illustrative case study to develop broader understanding and principles around high-fidelity personal data, its application, the integrative policy and regulatory requirements in addressing Net Zero across the whole economy.

3.1. Psychographics and its application across sectors

With progress in big data and predictive analytics using AI and machine learning capabilities, psychographics profiling in a digitalised world has become increasingly sophisticated with the integration of automated algorithms. As a result, consumer data has enabled the large-scale provision of personalised products, services and perhaps more significantly, the ability to influence consumer behaviours from purchasing to even political voting patterns (Sgaier et al., 2018; Matz et al., 2017; and Kriel, 2016). This method to elicit consumer insight on a large-scale has disrupted sectors such commercial marketing, public health, political science, travel, finance and many more to provide increasingly consumer-centric services. However, the ability to influence behaviour has also created substantial consumer harm as

Table 1
Types of data generated by consumers across the economy and their utility in the energy industry (Jo and Yoon, 2018; Machorro-Cano et al., 2020; Al-Ali et al., 2017; Gupta et al., 2009; Ashcroft, 2019; and Sgaier et al., 2018).

	Types of Personal Data	Data Source	Application in Energy Sector
Energy Specific Data	Smart Meter Data	• Smart meter collects energy (electricity and gas) consumption data over half-hour intervals	• Two-way communication between energy supplier and consumer enables demand side response (DSR) programs to elicit grid flexibility • Stimulates competition by allowing consumers to compare tariffs and switch energy suppliers • Enables new energy services and business models that better align with Net Zero goals to emerge
	Internet-of-Things	• From light bulbs to refrigerators, more and more home devices can now be connected and controlled wirelessly through a central hub such as smart phones, Google homes, Alexa and more • These smart appliances largely operate and collects data outside of the energy industry	• Consumer data generated by IoT sensors are highly disaggregated and granular • Enable Home Energy Management Systems (HEMS) to generate cost savings by providing energy saving recommendations or automate controls service that help household minimise consumption and participate in DSM programs while maintaining desired level of comforts • The fidelity in IoT data that can reveal household habits, preferences, lifestyle and living environment that cannot be easily detected from smart meter data • Reveal consumer insights that can be used by the energy industry to accelerate digitalisation and unlock demand side benefits by offering consumer-centric services and experiences
Non-Energy Specific Data	GPS Data	• Smart phones and other GPS systems	• Enable HEMS to provide just-in-time temperature control functionalities that is capable of producing savings of up to 7% • Dynamic charging costs for electric vehicle (EV) by integrating GPS with real-time grid status. Different charging options can be offered to drivers as a way to reduce grid congestion
	Other High-Fidelity Consumer Data	• Online interactions via smart phone or other personal devices	• Predict intimate insights regarding attitude, lifestyle, interest, personality and other psychological traits that

(continued on next page)

Table 1 (*continued*)

	Types of Personal Data	Data Source	Application in Energy Sector
			can be used to anticipate and influence consumers' susceptibility to value propositions

exemplified in the Cambridge Analytica (CA) scandal.

While the Matz et al. (2017) experiment was able to only use publicly available Facebook data to predict personality traits, more data will generally yield more accurate profiles (Bennett Institue, 2020). CA's then-CEO Alexander Nix revealed that the company had acquired four to five thousand data points on each American citizen for a Ted Cruz campaign (CB Insights, 2018). In the 2016 US presidential election campaign, CA illegally accessed 50 million or more Facebook users' raw and private data to predict voter's personalities and political leanings (Hern, 2018a). Doing so allowed CA to identify and nudge swing voters with targeted ads and highly personalised messages to vote in the desired direction. As the campaign progressed, the effectiveness of each advert was measured and used to continuously update and refine voter profiles and interventions methods. This process was proven to be extremely successful at influencing voter decisions and behaviours as CA claimed their interference helped to secure 90% of the election's targeted seats (Kriel, 2016). This extreme example not only shows the risk of large-scale privacy infringement psychographic profiling could instigate, but also its threats to democracy.

The energy industry, in contrast, has not been able to capitalise on these existing data resources as consumer data generated both within and outside of the industry are stored in silos. While this may reduce consumer privacy risks, it comes at the expense of unrealised benefits of digitalisation. Recognising the tension between risks and opportunities, BEIS has begun a consultation to identify where and how consumer data can support innovation and growth under the Smart Data project (BEIS, 2020b).

3.2. Application of psychographics as a use case in the energy sector

Psychographics, its requirement to harvest substantive amounts of consumer data across a range of digital data sources and its potential application in the energy sector offers insights as to the opportunities and risks of acquiring high fidelity personal consumer data. This perspectives contribution therefore assesses the application of psychographics as a tool to explore:

- the implications of data and digital technology to unlock consumer insights;
- the applications of detailed consumer insights in the UK energy sector for the generation of public goods, commercial opportunities and for individual benefit to realise Net Zero; and
- the risks of data exploitation and consumer privacy concerns within the UK energy landscape.

4. Digitalised psychographic profiling in energy

In addition to socio-demographic factors, an individual's relationship with energy is also heavily influenced by a combination of their attitude, lifestyle, interests and other psychological traits (Frederiks et al., 2015b). Where socio-demographic factors reveal who the consumers are, psychographics profiles will provide insight into user motivation as to why decisions are made around the products they purchase, the causes they support, the way they vote and consume energy, etc.

4.1. Opportunities for energy system optimisation and consumer behaviour change

Methods to synthesise psychographic profiles has been normalised in many industries as an increasing amount of consumer data can now be collected and analysed to provide real-time behavioural insights. Benchmarking existing examples of psychographic profiling, opportunities in which high-fidelity consumer data can be used to help the energy industry achieve Net Zero are summarised in Table 2, below. While Table 2 focuses on the roles of policymakers, distributed network operators and energy services providers, opportunities listed below are by no means exhaustive.

4.1.1. Behavioural intervention in policymaking

Policymakers in energy often rely on financial incentives to elicit behavioural change based on the underlying assumption that consumers are rational in their responses to price signal (Zhou and Yang, 2016). This is ill-founded, as an Ofgem (2021) survey revealed that although 50% of the consumers expects a financial reward of £129 to shift behaviours, only 24% of consumers switched energy suppliers in 2018 despite a typical saving of £200–300 per year (Octopus Energy, 2018; and Ofgem, 2019a).

Given the limitations of price driven policies and incentives, recent policy developments, notably in environmental policy have shown that consumer behavioural insights can both improve the effectiveness of traditional pricing policies and help create new policy instruments (OECD, 2017). As individuals are motivated by different factors, behavioural insights are critical in enabling policymakers to move away from the traditional one-size-fits-all energy policy models to promote energy conservation and other Net Zero solutions through targeted narratives, incentives and choices (Frederiks et al., 2015c).

The potential of psychographic applications is slowly being understood by the energy sector. For example, psychographic segmentation trials have been conducted to better understand energy related issues such as supplier switching (Williams et al., 2017), climate change public engagement campaigns (Maibach et al., 2011), energy conservation (Sütterlin et al., 2011) and so on. The results from these studies, however, have not led to any large-scale implementation due to data access barriers (Kosinski et al., 2013).

Increasing volumes of high-fidelity consumer data at zero marginal cost have, however, recently provided opportunities to overcome these barriers, enabling policymakers to better decide how, when, where to intervene and with whom in an efficient and cost effective manner on a large-scale (CB Insights, 2018; Zabkar and Hosta, 2013; and Matz et al., 2017). Access to real-time consumer data also provides the opportunity to monitor and evaluate programs over time and space, allowing psychographic profiles and intervention methods to be updated and calibrated overtime to increase impact (Matz et al., 2017; and Sgaier et al., 2018).

4.1.2. Deliver system flexibility

To meet Net Zero goals, future energy infrastructure upgrades must provide sustainable, reliable and affordable energy to meet the rising demand that comes with the growing population and large-scale electrification. Without flexibility, it is estimated that rapid electric vehicles (EVs) and hybrid heat pumps (HHP) can potentially increase the total expenditure of distribution networks by £1.8 billion/year (Vivid Economics, 2019).

Similar to traditional energy policies, existing flexibility programs are also mainly driven by financial incentives and have garnered limited impacts. In contrast, a number of ToU trials have shown that price signals combined with other intervention methods such as tailored information, personal feedback and/or community-based incentives were able to better engage consumers, thus leading to more significant load shifting and reduction (Nicolson and Moon, 2019; Cosmo et al., 2014; Abrahamse et al. 2005; and R Carmichael et al., 2018). Furthermore,

Table 2
Mapping the behavioural insights opportunities provided by high-fidelity detailed consumer data for the energy sector to achieve Net Zero as exemplified by the application of psychographics in other sectors (Open Banking, 2020; Kumire, 2019; Hern, 2018b).

Purpose of Psychographic Profiling	Existing Examples	Opportunities in Energy Policy	Opportunities for DNOs	Opportunities for New Energy Products and/or Services
Infer or predict consumer behaviour	• Cambridge Analytica – Inferred an individual's personality and political leanings through Facebook data. • Netflix – Use consumer clicks, browsing history and location to predict trends to future shows. • Airlines – References consumer historic travel patterns to model demand forecast and dynamic pricing.	Identify drivers for pro-environmental and other energy consumption behaviours to inform climate and energy policy design.	Understanding drivers for adopting EV, heat pump and other clean technologies to forecasting areas of high electrification and other demand needs.	Identify consumer trends such as interest and engagement in innovative developments to predict and aggregate pioneer consumers and catalyse energy market transitions.
Profiling consumers	• Cambridge Analytica – Identified target audiences that are prone to political influence. • Airlines – Uses customer's flying preference information to recommend add-on services. For example, offering priority boarding for business trips. • Banking – Identifies fraudulent activities if abnormal purchases are registered.	Consumers can be segmented based on their psychographic drivers and/or other relevant qualities. For example, being able to identify vulnerable customers can ensure timely protection from both energy and other sectors.	Psychographic insights can potentially allow DNOs to identify consumers groups who are more likely to adopt clean technologies. For example, identifying range anxiety can be used to predict if an EV owner will participate in flexibility programs.	Energy providers can create and recommend tariffs, value-added services, energy as a services business models and other innovations based on consumer lifestyle.
Targeting consumers	• Cambridge Analytica - Created advertisements where both the contents and the tone of political statements were personalised to individuals. • Google – Provides platforms to match adverts to consumers using their psychographic profiles created from user browsing history, cookies, location, likes, clicks, follows, etc. across devices such as Google, YouTube, Android and Google Home etc. • Banking – Open banking has allowed third parties to compare and recommend services best suited for an individual's spending needs and enabled personal finance management tools.	Tailored policies can be marketed towards targeted segments and implemented in a localised manner. For example, energy efficiency programs will emphasis financial incentives for those driven by monetary values and carbon emission savings for environmental conscious audiences. Longitudinal visibility reveals changes in consumer psychographic profiles, therefore allowing the impact of targeted programs to be monitored, measured and analysed in order to refine and improve the effectiveness of programs from consumers at a young age.	Consumer insights can be used to design, facilitate and manage flexibility programs. For example, flexibility packages can be personalised according to levels of range anxiety to garner higher levels of participation in DSR programs.	Energy consumption patterns combined with behavioural insights can be used to improve user experiences through personalised User Experience (UX) design and engagement by providing energy saving advices that are both tailored in content and tone.

psychographic insights can also improve the accuracy of electrification load forecast, both of which can contribute to reducing investment cost and therefore, allowing the £40 billion in potential benefits to be realised in the following decades (BEIS, 2018c; and Strbac et al., 2015).

With increasingly decentralised energy distribution, DNOs are expected to play an important role in facilitating ancillary services, including grid flexibility from residential DSR. This will likely result in an increase in consumer interactions and a change in dynamics with current customer relationship. The ability to understand consumers through the development of psychographic profiles will ensure network resiliency and the provision of high-quality customer service as more and more energy services are electrified.

4.1.3. Stimulating competition

Low energy consumer engagement rate in the UK is recognised to be one of the biggest barriers to unlock demand side benefits. Methods to reveal consumer insights through digital connectivity are commonly adopted in other industries to improve user experiences and engagement and these tools are now beginning to gain traction in energy as consumer interaction becomes increasingly digitalised. Similar to designing tailored flexibility packages, psychographic insights can help companies deliver bespoke services and predict future trends, thus allowing new business models to emerge.

For example, AI and machine-learning have the capacity to optimise and control individual's energy consumption patterns, allowing profits to be generated by balancing consumers' preferences and behaviours with DR signals (Cleary and Palmer, 2019). Currently, many of these models are oriented towards industries and commercial businesses but psychographics insights can help reduce the risks to entering the residential market (Morris et al., 2020). Emerging models that are better aligned with Net Zero goals such as energy subscription, energy-as-a-service and energy savings-as-a-service can potentially remove pricing risks for consumers, increase energy efficiency market penetration and provide grid flexibility in the industry without adding complexity and hassle to customers. High-fidelity consumer data provides resources for energy services to become more consumer centric, thereby increasing competition to disrupt the commodity-based business model and bringing values for both the consumers, the wider energy system and the broader net zero agenda (Finisterra Do Paço et al., 2009; Ibrahim et al., 2018).

4.2. Risks created by prioritising commercial needs above privacy

Despite the potential value of psychographics, instead of being used to unlock potential societal and environmental benefits, consumer data has predominately been monetised by organisations at the expense of customer privacy, human rights and even democratic values (Ada Lovelace Institute, 2020). Currently, 45% of consumers in the EU had

expressed concerns about data privacy, revealing low levels of trust in the current data economy (Sobers, 2020). This section looks to benchmark issues currently prevalent in the digital economy to draw attention to such risks of using high-fidelity data in energy.

4.2.1. Grounds for increased levels of data collection

The use of psychographics in energy will likely increase the demand for high-fidelity consumer data as those currently collected in the industry are limited to billing purposes. Whether it is energy specific data from smart appliances, Home Energy Management Systems (HEMS), or non-energy specific data such as personality and attitudes, existing consumer data that can be used to elicit energy consumption behaviours is largely generated across industry silos. This creates risks for consumers as data collection behaviours observed in other industries have shown exploitative tendencies.

Before the implementation of GDPR, technology giants such as Facebook, Amazon, Google etc. had collected and processed large amounts of data through their products and services where business interests were prioritised over consumer privacy. The success of these companies has been the main driving force of the modern digital economy and demonstrated the value of high-fidelity consumer data. Consequently, this has led to mass data collection practices that have become increasingly sophisticated whereby benefits are being reaped disproportionally by technology giants leaving consumers disempowered.

Under GDPR, consumers' explicit consent is required when personal data collection and processing is involved, but so far, this has not stopped companies to continue adopting business-centric data practices. Consumers are bombarded with privacy policies that are often lengthy, complex, convoluted and misleading, which not only causes consent-fatigue but are also difficult to understand even when users take the time to read it (Nouwens et al., 2020; Utz et al., 2019). This hinders the ability for consumers to make informed decisions, casting doubt on the effectiveness of consumer consent. In addition, organisations have created network externalities to remove the choice for consumers to consent and can also use the self-proclaimed legitimate interest clause to bypass consent all together (Madge, 2017). Both can create challenges for authorities to prove data mishandling as psychographic profiles can be created using data from disparate sources.

A study conducted by Britain Thinks (2018) to understand consumers' attitudes on data collection and use revealed that most consumers consider data collection by 3rd parties as a part of modern life. In some cases, consumers feel that they don't have a choice because data collection is simply '*how it is*'. Without effective means of enforcement to combat data malpractices, an increase in data collection in energy and the overall digital landscape will inherently increase the risks of data exploitation, thereby forming a vicious cycle that further increases power asymmetries between people and the data collectors (Ada Lovelace Institute, 2020).

4.2.2. Intended and unintended consequence of profiling

From seemingly harmless targeted adverts on social media to vote manipulation, personal data has fuelled the development and refinement of algorithms used to analyse, predict and influence what consumers see, think, feel and even do for commercial gains (Ziburski, 2019). While most consumers appreciate the tailored services they receive on Netflix, most consumers are unaware of the insights profiling is able to reveal, let alone the consequences it can bring and therefore, further intensifying the information and power asymmetry between data subjects and collectors (Britain Thinks, 2018).

Intentional exploitative behaviour such as price discrimination and predatory advertising are examples where profiling could be used to harm consumers in energy. For example, psychographics can be used to target vulnerable consumers such as ones that are less engaged and less likely to switch suppliers to perpetuate anti-competitive behaviour.

It is important to note that even in the absence of malicious intent discrimination can still occur. This happens because decisions inferred about a user through profiling are not only based on that particular individual's personal data but also data about others, which means that the accuracy of automated decisions are inherently dictated by existing biases in that dataset (Privacy International, 2017). Considering that data generated largely reflect the accepted social norms and are never fully representative, profiling will inevitably favour the majority and further marginalise the under-represented (Ada Lovelace Institute, 2020). Although GDPR prohibits a special category of personal data such as, race, gender, political opinions, genetics etc, both collected or inferred, to be used in a discriminative manner, the impacts of other less apparent biases are largely unknown (ICO, 2020). It is certain, however, that GDPR does not prohibit profiling, meaning that for many businesses, profiling can still be used as a common practice (Privacy International, 2017).

4.2.3. Data silos create monopolies

Despite opportunities created by digitalisation, more than half of data generated through online interactions are collected by fewer than 100 companies, and this high concentration of data has created concerning impacts (Yokoyama, 2020; Rajadhyaksha, 2019; and Kelly, 2020). For example, Google, Amazon and Facebook over the years have collected a substantive amounts of consumer data through digital services they provide, as well as a range of technology start-ups that they have acquired - this has helped them stifle competition in a number of ways (Rajadhyaksha, 2019).

A data monopoly has the ability to create better services (Srnicek, 2020). An initial lead in data access have perpetuated these tech giants to extend dominance from their respective digital services to the market of algorithm and AI across industries. Their successes have caused network externalities and enabled them to invest in capital extensive computation resources to stay ahead (Rajadhyaksha, 2019; and Srnicek, 2020). By doing this, these companies have continuously raised barriers to entry for competitors from both a market and technology point of view.

GDPR's Right to Data Portability enables consumers to freely transfer their existing digital data and is expected to level the playing field between digital service providers and unlocking competition (Sterling, 2019). Despite the powerful nature of the principle, it has encountered practical challenges that have undermined its potential impact. After 2 years of implementation, a survey showed only 5% of UK consumers have requested access to their personal data and 3% have requested for a transfer (Sterling, 2019). As a result, data monopolies continue to thrive in the vacuum of market drivers, creating "*a vicious cycle of apathy, disempowerment and disengagement*" that further deters consumers from actively participating in the data economy (Ada Lovelace Institute, 2020). The Competition and Market Authority (CMA) recently recognised this failure in the digital market by saying the problems they've identified were "*so wide ranging and self-reinforcing that our existing powers are not sufficient to address them*" (The Economist, 2020a).

It is important to appreciate the domino effect data concentration can perpetuate. Under the current Supplier Hub model, energy suppliers, compared to the upstream service providers are in the best position to access consumer data (Ofgem, 2018). Whether it is granular smart meter data or other personal data, having a monopoly over consumer experience undoubtedly gives utility companies a competitive edge in a digitalised energy future. Compounded by current levels of disengagement in energy, this uneven distribution of consumer data pose risks for similar market failure to occur in the digitalised energy industry.

4.3. Data risks create tension between public good and personal privacy

While derived from the use case of psychographic applications in the energy industry, these risks are not unique to energy but rather widespread across the digital landscape. Though GDPR was set out to correct

the power asymmetry by declaring ownership of data to consumers, many have raised doubts regarding the effectiveness in the way it has been enforced, as seen by the 75% increase in complaints under GDPR in 2019 (Commission, 2020; EDRi, 2020). Despite rising concerns, regulation enforcement has been sparse and fines remained light against tech giants, leaving possible violations left unchecked (Lomas, 2020a). This may well be a result of both organisations and authorities going through learning curves as GDPR is still a fairly new regulation. However, those who place commercial gains above consumer privacy continue to decrease digital trust and disfranchise individuals from participating in the data economy. The impact of this has spilled across the digital landscape and as a result, has undermined efforts where data is used for the public good.

On a national level, the "techlash" received by the National Identify Card and the COVID-19 Track and Trace programmes are clear indications that UK citizens have very little confidence, even in the government at protecting the privacy of their data as well as revealing the population's sensitivity towards sharing personal data even when benefits are explicit (BBC, 2002; Lomas, 2020b).

Currently, many emerging digital energy services largely operate in an un-regulated space, leaving room for uncertainty in the way energy organisations carry out their data practices (Ofgem, 2019b). Learning from market failures in other industries, it is critical that digitalisation in energy industry adopts a data culture where consumer privacy is better balanced with business needs in order to allow psychographic and other digital innovations to flourish in a responsible and sustainable manner. Given the limitations of GDPR, market forces alone are unlikely to negate business-centric data practices which means that further intervention is likely required to address aforementioned risks, strengthen public trust and restore consumer agency over the governance of their data in order to realise the benefit of data for the public good (BEIS, 2020a; Ada Lovelace Institute, 2020; ODI, 2019; Furman et al., 2019; DCMS, 2020).

This analysis points to the need to prioritise net zero objectives above commercial interests. Strategies which prioritise commercial interests over net zero objectives will be unsustainable. A relationship of trust can only be built incrementally where net zero objectives are explicit and shared. Suppliers will need to seek the consent of consumers to use personal energy data to optimise UK citizen's consumption of energy in a way that sets the path to net zero. The case is made that the obtaining of this consent and the way that the data is used needs to be closely monitored by an independent data regulator.

5. Cross-Sectoral Best Data Practice Principles and Data Governance

Focusing on privacy risks mentioned above will require cross-sectoral coordination and governance in the form of *'Cross-Sectoral Best Data Practice Principles'*. Such principles would allow a data culture where the benefits of digitalisation can be harnessed to achieve Net Zero whilst protecting consumers from exploitation. The principles include:

- ***Rethinking Consent.*** As the level of complexity in data processing increases, the responsibility to protect data privacy should be considered by data authorities who have the technical knowledge to balance the interests of data subjects and collectors. Consumers need to be empowered to extract value from their own data for personal and public good.
- ***Maximise Data Sharing without Compromising Privacy.*** Enhancing access to consumer data through anonymisation and data sharing which can prevent data concentration, increase competition and realise value from using data for the public good *with* consumer consent.
- ***Evolving Standards.*** Best data practices should be flexible to adapt to the dynamic digital landscape and protect consumers from harm without limiting the opportunities to realise the benefits of innovation.

Data Governance. While this analysis began with a focus in the energy industry, these best data practice principles developed from the psychographic use case can provide guidance for additional intervention to help consumers build agency and confidence in the boarder digital landscape beyond energy. In fact, as consumer data is generated across the economy, cultivating a healthy data culture cannot be achieved by the energy industry alone, but instead requires cross-sectoral coordination and governance in order to unlock environmental and societal values both within and outside of energy.

In the current UK economy, the digital sector accounts for 7.7% of GVA that is worth £400 m/day and *"is growing six times faster than all other sectors combined"* (REPHRAIN, 2020). As the disruptive power of digitalisation permeates across the economy, a number of organisations, both in the public and private sectors, are currently active in the data policy and strategy landscape to help their respective industries navigate the rapid changes it brings. Table 3, therefore provides a high-level review of these actors and their abilities in providing governance over high-fidelity consumer data using the best data practice principles suggested above. Displayed in the order of progressively broader cross-sectoral extent of jurisdictional coverage whereby the last option – an independent data regulator is favoured by the authors but does not yet exist.

This is because currently, overall regulatory efforts specifically targeted towards digital platforms and personal data are described to have "*little coordination between efforts, nor is anyone in government tasked with bringing them together*" (The Economist, 2020a). So though Ofgem published Data Best Practice Principles in May 2021 which helps to move the energy sector in the right direction. (Data Best Practice Guidance, 2021 (ofgem.gov.uk)). While the emergence of various data initiatives indicates that data issues and benefits are being recognised across the economy, a lack of coordination between concurrent developments can result in inconsistent standards, regulatory underreach and unnecessary complications which can further delay progress. This policy perspective strongly suggests a greater need for a broader economy wide systemic perspective regarding personal data.

6. Conclusion: implications on energy policy and research

The legally binding UK Net Zero commitment has transformative implications on the energy market - which need to be achieved effectively and efficiently by active participation from consumers. Digitalisation has enabled the generation of psychographic insights through individual's digital footprint in other sectors of the economy. The hypothetical application of psychographics to the energy sector has revealed a number of insights as to how consumer data might assist in achieving net zero.

The application of psychographics could reveal consumer insights to inform policy and commercial decisions regarding infrastructure planning, flexibility, energy conservation and efficiency as well as allowing innovative business models to be developed. These opportunities have the potential to allow policies and businesses that align with the realisation of net zero, increase consumer engagement and enhance competition within the energy industry.

It also, however, comes with a list of serious privacy concerns. This stems from the current asymmetry that exists between disempowered consumers and data platforms. Data platform businesses have focused on data practices which have created a self-perpetuating cycle that has fuelled data monopolies. This has stifled competition by restricting access to data and raising barriers to entry for digital innovations across the economy.

This policy perspectives contribution strongly indicates that cross-sectoral best practice data principles are needed to maximise value of data while protecting consumer privacy and ensuring engagement both

Table 3
Comparison between possible candidates for data governance and their ability to deliver the provide cross-sectoral data governance (Ofgem, 2018; Energy Data Taskforce, 2019; ICO, 2018; GOV.UK, 2020; CMA, 2020; Kemp, 2019; ODI, 2018; Ofgem, 2020c; UKRN, 2020; and Furman et al., 2019).

Potential Data Stewards	Institutional Role	Advantages	Disadvantages
Ofgem	Independent regulator of the energy (electricity and gas) market	• The ability to exercise regulatory power to oversee and coordinate digitalisation in the energy industry	• Current regulation tools hinder digital innovation • Jurisdiction is limited to the energy industry • Digitalisation has mainly focused on energy system data
UK Regulator Networks (UKRN)	Association that facilitates cooperation and communication between member regulators	• Cross-sectoral influence over regulated industries	• Data sharing initiatives focus on infrastructure data • Influence is limited to regulated sectors and lacks the authority to exert cross-sectoral duty of care
Competition and Markets Authority (CMA)	Strengthen business competition and prevent anti-competitive activities	• Digital Market Unit to support innovation through pro-competitive regime for online platforms • Targeting tech giants, legislative power could be expanded to allow additional intervention such as data sharing mandates	• Scope of regulation focuses on increasing competition between market competitors • Tools used increase competition are likely market driven and based on economic rules instead of adopting data strategies
ICO	Upholds and enforce GDPR and the complimentary Data Protection Act 2018	• Investigative and enforcement power across the economy • Has international influence and can work across borders to address concerns with data processed overseas	• Data Protection Act 2018 is largely based on GDPR, therefore shares many shortcomings mentioned above • Upholding information rights and protect consumer privacy over using data is prioritised above using data to create innovation opportunities
Data Trust	Currently under development by the Open Data Institute	• As an independent institution to enhance data sharing between both private and public organisations through fiduciary duty, thereby creating opportunities for innovation following a "privacy by design" approach • Applicable in AI and across the data science field	• Framework still under development • Novel concept can create uncertainties in its impact • Main focus on data sharing elements, leaving the aspects of additional consumer privacy intervention unaddressed
Independent Data Regulator	Does not currently exist	• A new entity can develop synergy between existing data bodies to centralise accountability in the management and delivery of the national data strategy that prioritises establishing a balance between consumer privacy and innovation • The capacity for cross-sectoral oversight will allow an independent data regulator to co-ordinate digitalisation efforts across the economy efficiently by developing and enforcing unifying data regulations, standards and strategies	• The process of creating and integrating a new entity involves institutional changes that can be both capital and time consuming

within and beyond the energy industry in the UK. As digitalisation disrupts traditionally siloed sectors, data will become a critical resource in driving future developments and it is imperative that access to this resource is well protected, managed and democratised to maximise its potential value to individuals, society, and the economy. It is recommended that these be considered integral to research, policy and regulation regarding the role of data and digitalisation in the energy sector and in addressing net zero across the economy more broadly.

CRediT authorship contribution statement

Lucy Liu: Conceptualization, Methodology, Investigation, Data curation, Writing - original draft preparation. **Mark Workman:** Supervision, Conceptualization, Methodology, Validation, Writing – review & editing. **Sarah Hayes:** Supervision, Validation, Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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