EnergyREV

Privacy and data sharing in smart local energy systems: Additional material

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Appendix 3: Methods

1.1 Questions and approach

The recommendations in this report are drawn from a rapid realist review of privacy concerns in the energy sector. This process of reviewing literature is similar the process of primary research but at a higher or 'meta' level. A systematic synthesis uses the results of the primary research studies to answer the research review question(s). A realist review can answer questions not only on what works for whom and under what circumstances, but, in the absence of direct evidence, generate evidence-informed theory on what would most likely work when we understand the barriers and facilitators to good outcomes, and mechanisms that are activated on the steps on the causal pathway.

1.2 Rapid Realist Review search strategy

We developed a search strategy by building search terms connected to the subject of the review which we used to identify relevant documents in databases and grey literature. Initially from systematic reviews of privacy concerns we pearl-grew search terms, and added subject headings and keywords from initial set of included studies. We ran pilot searches and used different search terms in combination (adding, altering or removing terms where necessary) to arrive at a list of documents which is both sufficiently broad and manageable, given the constraints of a rapid review.

We searched for any systematic reviews about privacy that could provide supplemental evidence in related sectors and also in sectors that have faced similar challenges in overcoming privacy concerns.

We searched for supplemental evidence by targeted searches for systematic reviews related to the barriers and facilitators to data sharing, first by the privacy concerns for each topic and then by related energy sectors. We conducted additional searches for systematic reviews for populations at risk of exclusion.

Narrative synthesis

The included studies were not of a study design that allowed for a statistical meta-analysis due to a lack of a comparison group in most of the study designs and a diversity of interventions and outcomes measured. A narrative synthesis was conducted instead, with a particular focus in the barriers and facilitators to data sharing and programme theories of change in each study. These were then grouped into common themes of barriers and facilitators to data sharing based on privacy concerns.

From evidence to recommendations

Direct evidence of effectiveness was weak in the combined studies, as few set out to test how people who had privacy concerns overcame them to share data. This is likely due to a literature that is still emerging as study designs were mainly exploratory and pre-experimental. Instead, we were able to identify the common themes of the different types of privacy concerns that acted as barrier to data sharing from the views and experiences of the participants in the studies. We then aimed to deepen our understanding of the barriers and solutions from lessons learned in other sectors that experienced similar privacy concerns around the gathering of, the use and safety of data collection. We conducted additional searches for systematic review evidence in related sectors to supplement the evidence in energy sectors, to confirm or refute or contextualise the evidence we found. Taken together with the strength of evidence indicated by the assessments of relevance and reliability of the studies, the combined set of studies forms the best available evidence for theory informed interventions to address privacy concerns, and the problems and issues raised in the barriers and facilitators, These were independently reviewed by the review team and comments and suggestions were invited from stakeholders into these early insights.

1.3 Screening studies: applying inclusion and exclusion criteria

Inclusion and exclusion criteria were applied to titles and abstracts. Full papers were obtained for those studies where abstracts suggested that that the studies might meet the inclusion criteria. Where the title and abstract provided insufficient information to be certain, the full paper was obtained and the inclusion and exclusion criteria re-applied. Those that did not meet these criteria were excluded.

1.3.1 Inclusion criteria

- Study is published in English. The review does not currently have the resource to provide translations of studies not published in English. Studies not published in English will not be excluded at the search stage but will be included in the count of published studies and available should resources become available at a later date.

- Study must include consideration of privacy concern and, in particular, the role this plays in choices around to what extent they participate.

- Study must present clear methods for their research.

- Study must report an outcome such as a change in views and experiences, or psychological or behavior outcomes after an intervention.

- Studies with a focus on energy were prioritised for inclusion, and studies in other areas included on the basis of theoretical and practical relevance.

All studies that meet the criteria were entered into the EPPI-Centre systematic EPPI-Reviewer software.

1.4 Characterising included studies

The studies classified as eligible following the initial screening were data-extracted for their characteristics, including the type of study, study aims, type of intervention, detail of the intervention, privacy concerns, outcome measures and findings.

1.5 Identifying and describing studies: quality assurance process

The review team screened a sample of studies separately against the inclusion criteria to compare results and discuss any areas of disagreement until consistency in screening was reached.

Appendix 4: Data extraction checklist

Rapid review: Study characteristics

- **Date of publication**

- **Geographical location**
  Setting of the intervention, programme or activity
  - ADD
  - Not stated

- **Research Centre**

- **Publication type**

- **Aim of study**
  This study aims to…
  evaluate…
  describe…
  compare…
  explore the feasability of…
  learn lessons from…
  - ADD

- **Aim of intervention**
  Broadly speaking – intervention – the change in the usual state of things, this could be a technology, programme, activity or "ways of being"
  - Details

- **Type of study**
  - Review
    - Meta-analysis
    - Systematic
    - Rapid
    - Scoping review
    - Audit
  - Experimental
    - RCT
    - Quasi
  - Observational
    - Activity diary
    - Action research
    - Case study
    - Focus group
    - Interviews
    - Survey
    - Process evaluation

- Secondary data
- Deliberative workshops
- ADD
- Model
  - Adversary model
  - Bayesian
  - Dynamic model
  - Game theory
  - Markov decision tree
  - Mixed strategy Nash Equilibrium game
  - A supply-demand system

- **Theory**
  - Game theory
  - Innovation adoption theory
  - Non-cooperative game theory
  - Risk perception
  - Scripting- in-scription / de-scription
  - Social Contract theory
  - Social norms
  - Social practice
  - Technoethics
  - Technology Acceptance Model
  - Theory of normative conduct
    Theory of "phantom risk"
  - Theory of planned behaviour
  - Theory of procedural justice
  - Theory of social practice
  - Theory of warm glow altruism
  - The Framework of Contextual Integrity
    Theory of Reasoned Action

- **Type of privacy concern**
  Please code for the specific types of privacy concerns the intervention is seeking to address, or is in the study that is describing the types of privacy concerns there are.

  - Agency, choice and autonomy
    customers should be free to make their own choices
  - Anonymity
    identifying features of the individual have been removed from the data. The right to be unknown

- Backward privacy

  backward privacy: search queries should not leak matching entries after they have been deleted.

  Backward privacy guarantees that searches on a keyword "w" do not reveal the file identifiers of the files containing w that have been deleted.

- Data misuse

  concerns that the data collected is not being used for the purpose intended. Concerns over consent over one purpose gradually extending into other areas: digital mission creep

- Data overcollection

  Data is collected, but not used, too much data is collected to analyse, or superfluous data is collected

- Data ownership

- Discrimination

- Identity privacy

- Information privacy

  'information privacy' – that is, 'the concept of privacy in terms of conditions having to do with access to, and control over, personal information' (Tavani 2007, 7).

- Interest privacy

  esp/ for prosumers, to hide one's interest in the marketplace, to prevent the advantage conferred on a competitor by revealing one's interest in the market.

- Location privacy

- Non-Intrusion

  of 'non-intrusion' – the breach of which may be analogous to 'unwarranted intrusion into one's personal space through someone physically accessing one's personal papers, home, and so forth' (Tavani 2007, 6).

- Peaceful enjoyment

  Privacy as a retreat. The right to be left alone.

- Relational privacy

  "consists of people voluntarily limiting their knowledge of one another as they interact in a series of social and commercial roles- selective flow of information" (Sloan & Warner) or Simmel Georg, The Sociology of Secrecy and secret societies 1906. consists of informational norms (Sloan & Walter) or social norms that constrain the collection, use and distribution of information

- Right to rectification

- Reputational privacy

  data could be used to monitor and judge the behaviour of others.

  see also, relational privacy

- Surveillance

  the potential to create an invisible and comprehensive surveillance network" (Bohn et al, 2004.

- Traceability

  often used in the context of social media, that different types of data can be used to locate (physically or virtually) the individual

- Trade off

  where customers balance benefits and harms of participation

- Unauthorised data use

- Not stated

- **Type and Name of intervention or project**
  - Type of intervention
  - Named intervention

- **Components in intervention**

  Components of the intervention – this includes , any training or familiarisation given to the participants, any technology or devices provided , apps etc., as described by the authors

- **Person or organisation delivering intervention**

- **Intervention duration**

- **Number of participants**
  - Total
  - Intervention
  - Control
  - National
  - Not clear
  - ADD

- **Recruitment**

  How were the participants recruited into the study? Was this a random sample from a sampling frame, opportunistic sampling of people known to the author?
  - Sampling frame

    a whole population from which a sample is drawn e.g. a stratified random sample of all residents of a city, or a volunteers sample from a university campus etc.
  - Compulsory
  - Convenience sample

- Not known
- Quota sampling
- Panel members
- Random selection of sample
- Stratified sampling

- **Incentives for participation**
  - Yes
  - No
  - Not known

- **Participant and contextual characteristics**
  add in (if code not there)
  any relevant participant and contextual characteristics.
  - Geographical characteristics
    - City/urban
    - Island
    - Rural
    - Village
    - Advanced economy
  - Setting
    - Homes
    - Home / microbusiness area
    - Large business area
    - Small/medium business area
    - University halls of residence
  - Type of participant

    - Residential
    - Business
    - Expert
    - Internet user
  - Age
    - add
    - 0–15
    - 16–30
    - 31–45
    - 46–60
    - 61–80
    - Plus
    - Children and young people (NS)
      not specified
    - Older people
    - Adults
  - Sex of participants
    - Male
    - Female

- "Race", ethnic group identity
  - Asian
  - African American
  - Mixed
  - Non white categories
  - White
  - Not recorded/reported
  - Political affiliation
  - Conservative
  - Liberal
  - Moderate/ not sure
- Children
  - Yes
  - No
- Housing tenure
  - Home ownership
  - Renting
  - Room
  - Flats
  - Mixed
- Type of home
  - Single family home
  - Farm
  - Multi-family home
  - Single person household
  - Multi-person household
- Work status/ income
  - Below average
  - Low income
  - Professional
  - Retired
  - Service
  - Students
  - Self-employed
  - Sick leave
  - Technical
  - University members
  - Unemployed
  - Wage earner
  - Income bracket
- Time in current residence
  - 0–1 years
  - 2–5 years
  - 6–10 years

INDUSTRIAL STRATEGY

UKRI UK Research and Innovation

- Level of education
  - Average years education
  - Bachelors degree
  - Graduate/ masters level
  - High school/ College
  - Middle school
  - Vocational education
- Own car?
  - Yes
  - No
  - Other characteristics
  - Energy consumption
  - Own vehicle
  - Prior knowledge/ experience
  - Recent news coverage
  - Regulatory context
  - Responsibility for paying bills
  - Smart meter installed?
  - Tarrif
  - Understanding of energy system
  - Married or in a relationship
- Not known

- **Users of data**
  - Numerical Measures
    what types of measures is the study using?
  - Psychological Measures
    beliefs, emotions, attitudes Behaviour measures
  - Social measures
  - Implementation measures
  - Performance measures
  - Environmental measures
  - Economic measures
  - No outcomes

- **Qualitative themes (ie not numerical measures of current status, and hypothetical or real change)**
  These will be descriptions of change, themes from qualitative analysis or narrative summaries of numerical data.
  Code first for descriptive themes that is, summaries that stay close to the original
  - Findings
    - Positive
    - Small positive effect
    - Mixed effects
    - No effect / neutral
    - Negative
    - Adverse events

- **Factors impacting on effectiveness**
  These may be discussed by the authors in the conclusions or discussion section, or may be tested in sub group analysis.
  Non-experimental studies, studies looking at process or implementation, studies looking at associations, will be looking at mechanisms – the why and how of change; what factors do or might impact on (eventual) outcomes
  - Technical Factors
  - Economic factors
  - Environmental factors
  - Social factors
  - Individual/ inter-Personal level factors
  - Organisational factors
  - Methodological factors
  - Authors recommendations
  - (for reviews) Narrative synthesis conclusions
  - Recommendations for future research?

Appendix 5: Table getting from evidence to recommendations

Recommendations	Evidence statement and domain I = individual IP = interpersonal C = community SC = socioeconomic / cultural	Studies that informed the recommendation and quality score Low = – Medium = + High = ++ Internal validity / external validity
Recommendation 1 **SLES service providers should build on existing trust to deliver mutually beneficial outcomes** **C7, C8, C9, SC4**	**C7 Approved third parties / data use** Allowing a trusted third party access to energy data is broadly accepted, particularly where there is a specific benefit or service they can provide (to the consumer or wider society) rather than to serve their own interests.	**S5 ++/++** Energy suppliers using smart meter data to identify and monitor vulnerable consumers 60% Police using your smart meter data to identify some forms of crime 62%. **S3 +/++** Privacy concerns in relation to smart metering have remained low and research has found that the existence of the Framework offers reassurance to some consumers that appropriate safeguards are in place." **S22 ++/++** Consumer organisations (72%), environmental organisations (70%) and energy providers (58%) seem to be in a good position to provide these services. **S23 +/++** Panellists were more trusting of governmental bodies, regulators or parties without a vested interest in energy to handle their data These parties were seen to uphold a certain standard and have an official interest in their data and therefore be less likely to misuse data compared to other organisations. Consumers were generally happy for their supplier to be the sole party responsible for handling smart meter data. Having too many parties involved in the process raised concerns of data breaches and misuse.
	C8 Energy co as Expert "someone to watch over me" Rather than being seen as intrusive, input from experts may be welcomed where this helps with complex or unfamiliar technologies or provides a clear benefit, and could even harm the user experience if absent when expected.	**S11 +/+** Participants reported feeling safer when experts controlled their HP. **S11 +/+** Although the participants expected to have an increased perception of safety as a part of being increasingly monitored, they discovered that this expectation was not always fulfilled, which caused frustration. **S18 +/++** People could receive a warning message in case an appliance (e.g. stove) is not turned off. (12/2) "Checking on whether elderly relatives are still active at home, or whether their behaviour is abnormal, compared to normal days." **S22 ++/++** Welcomes the assistance of experts in sorting out smart meter data, positive about receiving notifications in case of unusual energy use, and 28% (+34% tentatively).

Recommendations	Evidence statement and domain I = individual IP = interpersonal C = community SC = socioeconomic / cultural	Studies that informed the recommendation and quality score Low = – Medium = + High = ++ Internal validity / external validity
Recommendation 1 **SLES service providers should build on existing trust to deliver mutually beneficial outcomes** **C7, C8, C9, SC4**	**C9 Energy co. as Community energy arbiter** While local control and accountability can be appealing, they require time and effort. Some energy users expect this to be part of the service provided by energy companies, particularly enforcement which can lead to ethical issues or unpleasant environments when done by peers.	**S20 –/++** Acceptance of free-riding, and potentially willingness to compensate for those who do not contribute, might be different in a context where the community provided the only mechanism of accountability, rather than an additional layer alongside the contractual relationship of buying energy. Respondents saw mutual monitoring positively as an optional way of mutually supporting each other to choose ethical energy consumption behaviours. **S20 –/++** Clara: Maybe it's time consuming for people and slows the processes down. And I suppose when you… I don't know if we partly pay certain companies like energy companies for making decisions that we don't have to think about. And that's what people, that's maybe part of the premium. **S20 –/++** Respondents' concerns about horizontal privacy point to a fear that community-based enforcement of acceptable energy use behaviour may be unpleasant, and less desirable than the bureaucratic, centrally administrated system of billing and metering currently in place. **S22 ++/++** Several respondents worry about conflict situations that can arise in the absence of formal rules and with "a lack of authority over someone else's roof".
	C9 Energy co. as Community energy arbiter	**S22 ++/++** Local energy cooperatives provided a middle ground between forms of cooperation that are considered either as too personal or as too distant. You need an institution to organise that." Such a facilitating role, they argued, requires "another type of service provider" that better understands how to "work based on the power of people". So, rather than outright antipathy towards service providers and striving for radical autonomy. Participants were looking for "a new balance" that allows for more decentralised and democratic control over energy production. **S33 +/+** Hau'oli mentioned that she would not have any concern if the information was "in the right hands… People who specifically need to evaluate, maybe the cost of the electricity or energy that we use." (it) would be appropriate to analyse this data as a way for HECO to offer improved service to consumers.

Recommendations	Evidence statement and domain I = individual IP = interpersonal C = community SC = socioeconomic / cultural	Studies that informed the recommendation and quality score Low = – Medium = + High = ++ Internal validity / external validity
Recommendation 1 **SLES service providers should build on existing trust to deliver mutually beneficial outcomes** **C7, C8, C9, SC4**	**SC4 Trust in corporations** With regards to data sharing, companies tend to be trusted less (by default or due to experience) than other data users [governments, energy companies – see elsewhere]	**S23** +/++ Many took a stance of automatic distrust of companies when sharing or handling their data, feeling it was safer to assume that it may be misused unless they had read details about the companies' use of their data in more depth. **S30**++/++ There have also been data leaks where an ISP or energy supplier accidentally or deliberately abused their access to data kept by EDSN (EDSN's responsibilities include providing metering data to energy suppliers and ISPs) Netherlands. S32+/++ participants declined data sharing with third parties: insurance and app providers (were the least trusted parties (for EDR vehicle data).
Recommendation 2 **SLES service providers should ensure people feel in control of their data and environment** **I7, I9, I10, I11**	**I7 Privacy controls are a part of life** Several studies show that people are already familiar with settings and controls over their data sharing (but not knowledge about smart meters. How they work and what they do, was low in the studies but interest in how they worked was high). People who do not have smart meters believe them to collect intrusive data. People who have smart meters are less likely to believe this. Either privacy concerns are a barrier to participation, or privacy concerns are allayed once they know more about them and get to see for themselves. Having some control over data sharing shares responsibility of what happens to the data. **Limitations to this evidence** Participants in studies that are self-selecting are likely to be tech-savvy and familiar with such privacy preserving measures. This may not be representative of all groups.	**S8** +/++ Regarding privacy concern, 69% and 70% of people had respectively opted not to provide personal information and asked for personal information to be removed from a database, while 55% said they had signed up to the Telephone Preference Service. **S33** +/+ Consent: "Ideally, I hope there are constraints on the sharing of this information, that there is this wall of consent that you have to go through, even though it's annoying… but who knows? **S22** ++/++ Many survey respondents have engaged in information sharing practices before, for instance by comparing energy consumption levels with family members (57%) or with neighbours (34%). **S16** ++/+ Related to system awareness, users showed relatively little concerns in privacy, though some users wanted to know what information was being transferred to the vendor (or 3rd parties). That is, they demanded a degree of awareness: "For now, I don't see any way of misusing my data that could turn out to be my downfall. […] It would be nice, however, to see what data is transferred or stored. If I can control this, it's on me to decide what may be transferred or used." (single-person household).

Recommendations	Evidence statement and domain I = individual IP = interpersonal C = community SC = socioeconomic / cultural	Studies that informed the recommendation and quality score Low = – Medium = + High = ++ Internal validity / external validity
Recommendation 2 **SLES service providers should ensure people feel in control of their data and environment** **I7, I9, I10, I11**	**I9 the choice to opt out, is a condition of opting in** Even where privacy concerns are low, the lack of control over data sharing itself creates concerns. Consent to share data shares responsibility as well as control	**S9 +/+** Most projects highlight the need to involve consumers at the early stages of project development, to give consumers the freedom to choose their level of involvement. **S5 ++/++** 9 in 10 people think opt-outs are important. Without consent to data sharing, the number of people who want a smart meter drop by almost third. The right protections can reassure people that their data will not be misused. **S18 +/++** given the choice, participants chose to change their disclosure settings or cancel their subscriptions in more than 86% of the cases, strong support for the relevance and usefulness of the implications we included to facilitate more informed privacy decision making. **S23 +/++** Offering control: Positives of using opt-out approach to data sharing here: More likely to get more consumers' data Consumers don't have to take an action and give their data passively without doing any 'work.' **Negatives:** Concerned about a lack of clarity in why the data is being used and what for.
	I10 Losing control over what happens after sharing data People can be incentivised to trade privacy for cost savings. However, the flexibility required to qualify for cheaper tariffs, in terms of allowing automatic management of some devices in the home was felt by some to be too intrusive and disempowering. On the other hand, being able to set some boundaries around the flexibility gave participants back a sense of control.	**S2 –/++** Agency, choice and autonomy. Loss of control =a sense of helplessness. **S6 –/++** Around 94% of respondents were "willing to allow automatic management of devices as far as this does not affect any loss of comfort" only around 49% were willing to allow third party control. The significance of the home and the importance of residents in the trial to feel in control, as the setting for the smart grid and the remote-control access is the home. **S11 +/+** The remote control of the EV was linked to a decrease in reliability. Consumers felt that they lost control over something on which they were entirely dependent. **S11 +/+** The informants were dissatisfied with the issue of not being able to control the EV according to the PV's production of electricity. **S9 +/+** Customers would not allow the utility to control thermostats in their homes at any price.

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Recommendation 2 **SLES service providers should ensure people feel in control of their data and environment** I7, I9, I10, I11	**I10 Losing control over what happens after sharing data**	**S15** +/– The utility company's ability to control appliances in the home had a strong negative effect. **S22** ++/++ Respondents who selected the 'full control' option value the "freedom of choice" or do not entrust energy providers with this task. **S28** ++/– There is a loss of control by being flexible: from study: for participants who had adopted SGT for a trial period: loss of comfort in terms of too low indoor temperature and not enough hot shower water: **Overcoming loss of control by:** **S8** +/++ Is probable that the benign nature of the DLC tariff presented (with unlimited overrides and only a small possible effect on temperature) allayed concerns. **S11** +/+ …the setting of the boundaries seemed to give many of the participants the feeling of being in control. **S22** ++/++ Respondents mention a wide range of requirements including the possibility to exclude times of the day or practices that are deemed "essential", an obligation to provide early notifications and "proof of environmental gains", and a guarantee to not use the mechanism "to the advantage of customers that generate most profit".
	I11 Control over access to data Participants indicated a principled desire to be in control of their data sharing such that they would be able to decide, for instance, which parties could access the data under which circumstances. Setting the boundaries around control over who has access to data shared both control and responsibility for data sharing.	**S3** +/++ The authors find that information provision is important for giving consumers control but not for overcoming privacy concerns as these are low already. **S5** ++/++ 9 in 10 people think opt-outs are important. Without consent to data sharing, the number of people who want a smart meter drop by almost third. **S18** +/++ Participants indicated a principled desire to be in control of their Smart Metering data such that they would be able to decide, for instance, which parties could access the data under which circumstances. **S9** +/+ Most projects highlight the need to involve consumers at the early stages of project development, to give consumers the freedom to choose their level of involvement.

Recommendations	Evidence statement and domain I = individual IP = interpersonal C = community SC = socioeconomic / cultural	Studies that informed the recommendation and quality score Low = – Medium = + High = ++ Internal validity / external validity
Recommendation 2 **SLES service providers should ensure people feel in control of their data and environment** **I7, I9, I10, I11**	**I11 Control over access to data** Participants indicated a principled desire to be in control of their data sharing such that they would be able to decide, for instance, which parties could access the data under which circumstances. Setting the boundaries around control over who has access to data shared both control and responsibility for data sharing.	**Overcoming loss of control over who can access data** **S5 ++/++** People need to be able to control their data. People vary in how frequently they want to share their data, and what they want to share it for. Being able to choose settings that reflect their preferences can improve trust and encourage people to engage. **S16 ++/+** Related to system awareness, users showed relatively little concerns in privacy, though some users wanted to know what information was being transferred to the vendor (or 3rd parties). That is, they demanded a degree of awareness: "For now, I don't see any way of misusing my data that could turn out to be my downfall. […] It would be nice, however, to see what data is transferred or stored. If I can control this, it's on me to decide what may be transferred or used." (single-person household). **S18 +/++** About one-third of the participants made privacy decisions based primarily on the options for setting the temporal granularity of data disclosure. "I really kept my mind on the intervals in question. Annually or monthly would be okay, or maybe semi-annual or quarterly, but certainly not more often." **S18 +/++** Given the choice, participants chose to change their disclosure settings or cancel their subscriptions in more than 86% of the cases, strong support for the relevance and usefulness of the implications we included to facilitate more informed privacy decision making. **S23 +/++** Offering control: Positives of using opt-out approach to data sharing here: More likely to get more consumers' data Consumers don't have to take an action and give their data passively without doing any 'work.' **Negatives:** Concerned about a lack of clarity in why the data is being used and what for. **S25 –/–** Role that the home played as a physical boundary between public and private information; between controlled and uncontrolled. Information is not often considered private unless it exposes actions or patterns of living that are considered private by specific users.

Recommendations	Evidence statement and domain I = individual IP = interpersonal C = community SC = socioeconomic / cultural	Studies that informed the recommendation and quality score Low = – Medium = + High = ++ Internal validity / external validity
Recommendation 3 SLES service providers should help people to understand new products and services **I2, I3, I7**	**I2 Demographic factors that impact on data sharing** There were no demographic factors that were more likely to share data than others, Prior knowledge and experiences of data violations indicated reluctance to share data, or beliefs that sharing data would be intrusive was across all social groups. All groups were expressed concerns over privacy. **Limitations of this evidence:** Most of the participants in the studies were well-informed in technology, "tech-savvy" and already engaged in technology use and data sharing, often this was a condition of participation or participants self-selected into the study based on their prior knowledge and interest in the topic. Hard to reach groups were under-represented in the sample of participants.	**S5 ++/++** Higher socio-eco groups more like to think Smart meters collect intrusive data , like the time they are at home or what appliances they use. **S1 ++/++** Higher Level of education were more pro UCC (Utility controlled charging of vehicles). **S5 ++/++** People from lower socio-economic groups were less likely to be aware of choices around data when getting a smart meter. **S13 ++/++** Demographics do not seem to play a critical role relative to support for this technology among our sample of people living in states with higher numbers of smart meters.
	I3 Older people and privacy concerns over smart technology Evidence from related sectors show that families are often involved in decisions making using home-based technologies. On the other hand, Older people's incentives to share data may differ to younger people priorities, e.g. families may welcome the opportunity to remote monitor their loved one to alert them to safety or health issues.	**S15 +/–** Older participants expressed more demand for and expectations of (social) norms against smart meters, **S18 +/++** Relatives saw the value of Checking on whether elderly relatives are still active at home, or whether their behaviour is abnormal, compared to normal days **Evidence from other sectors** Pal et al, 2017: "overall these elderly people have a positive attitude towards a smart-home, especially for the purpose of health-monitoring and independent assisted living. However, they also have serious concerns regarding their privacy and the security provided by such smart systems along with the fear of social-isolation that might happen due to an increased dependence on technology."

INDUSTRIAL STRATEGY

UKRI UK Research and Innovation

Recommendations	Evidence statement and domain I = individual IP = interpersonal C = community SC = socioeconomic / cultural	Studies that informed the recommendation and quality score Low = – Medium = + High = ++ Internal validity / external validity
Recommendation 3 SLES service providers should help people to understand new products and services **I2, I3, I7**	**I3 Older people and privacy concerns over smart technology** Older people had mixed feelings about data sharing for health monitoring from not wanting to be a burden, to positive views on the use of data sharing for health monitoring to feelings that an over reliance on technology could replace human contact.	Klobas, 2019: "Older … people are more likely to take their own assessments of security risk into account when they make decisions about adoption of smart home devices." Abrilahij & Boll, 2019: "Other persons, in particular family members, are also involved in decision making about the older individual's (assistive technology) AT use or non-use."
	I7 Privacy controls are a part of life Several studies show that people are already familiar with settings and controls over their data sharing (but not knowledge about smart meters. How they work and what they do, was low in the studies but interest in how they worked was high). People who do not have smart meters believe them to collect intrusive data. People who have smart meters are less likely to believe this. Either privacy concerns are a barrier to participation, or privacy concerns are allayed once they know more about them and get to see for themselves. Having some control over data sharing shares responsibility of what happens to the data. **Limitations to this evidence** Participants in studies that are self-selecting are likely to be tech-savvy and familiar with such privacy preserving measures. This may not be representative of all groups.	**S8 +/++** Regarding privacy concern, 69% and 70% of people had respectively opted not to provide personal information and asked for personal information to be removed from a database, while 55 % said they had signed up to the Telephone Preference Service. **S33 +/+** Consent: "Ideally, I hope there are constraints on the sharing of this information, that there is this wall of consent that you have to go through, even though it's annoying… but who knows?" **S22 ++/++** Many survey respondents have engaged in information sharing practices before, for instance by comparing energy consumption levels with family members (57%) or with neighbours (34%). **S16 ++/+** Related to system awareness, users showed relatively little concerns in privacy, though some users wanted to know what information was being transferred to the vendor (or 3rd parties). That is, they demanded a degree of awareness: "For now, I don't see any way of misusing my data that could turn out to be my downfall. […] It would be nice, however, to see what data is transferred or stored. If I can control this, it's on me to decide what may be transferred or used." (single-person household).

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Recommendation 4 SLES service providers should design SLES around user priorities and make these benefits clear **I1, I8, I13, I15, C1, C3, C4, SC1**	**I1 Values and beliefs** People who were concerned for the environment were more likely to engage in data sharing and were less concerned about privacy and less motivated by price Such individuals were sometimes described as intrinsically motivated, that participating towards the benefit of the environment was its own reward, but also respond to seeing environmental gains, and being seen to "do the right thing". Evidence from other sectors suggest that there is a value action gap between the concern for the environment and sustained behaviour change.	**S1 ++/++** People who are concerned for the environment were less price sensitive and less concerned about privacy. The Renewable-focused class had a consistently high enrolment rate (79–94%), even with a UCC program that includes 0% renewable electricity – showing that this class is largely in favour of UCC in general. **S7+/++** (being a) Member of an environmental organisation was associated with using significantly less electricity than non- environmentalists in the study comparing consumption data made public compared to private. Private consumption data made little difference to consumption for any group. **S21 –/+** During the pre-study interviews, all households stated they were well aware of the climate crisis. Everyone expressed some opinion on global warming and most participants stated that they were trying "to do their bit", **S13 ++/++** Concern about environmental issues significantly associated with acceptance of smart meters, in all models **S22 ++/++** Respondents mention a wide range of requirements including… an obligation to provide early notifications and "proof of environmental gains" **Other systematic review evidence** Barr, S. 2006. Environmental action in the home: investigating the value-action gap. *Geography,* 91:43–54 Chan, K. 1996. Environmental attitudes and behaviours of secondary schools' students in Hong Kong. *The Environmentalist*, 16: 279–306 Bogo, J. 1999. Sustainability 101: using the community as a classroom, colleges are rewriting the standards for environmental education. *The Environmental Magazine,* 10: 36–40 Blake, J. 1999. Overcoming the "value-action gap" in environmental policy: tensions between national policy and local experience. *Local Environment*, 4: 257–278 Flynn et al. 2009. The 'value-action gap' in public attitudes towards sustainable energy: the case of hydrogen energy. YouGov, 2017. Environmentalism and the value-action gap. Anable, J., Lane, B. and Kelay, T. 2006. An evidence base review of public attitudes to climate change and transport behaviour. Final Report to Department of Transport.

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Recommendation 4 SLES service providers should design SLES around user priorities and make these benefits clear **I1, I8, I13, I15, C1, C3, C4, SC1**	**I8 Information overload** When people are given broad information about all potential privacy risks for all situations, this can seem overwhelming, create a sense of lack of personal control, and they then withdraw consent.	**S15 +/–** When people are aware of the kind of information that might be gleaned from their electricity use patterns, demand for and expectations of norms against Smart Meters increase. Information aimed at increasing participants' understanding of the relevance of the technology for mutual goals, led to weaker demand for norms against the technology. …as consumers become more informed about the potential uses of Smart Meter data for analysis and control, negative reactions are likely to increase. **S18 +/++** For most of the services, between 7% and 9% of the initial subscribers decided to cancel the service altogether during the subsequent step of examining the disclosure implications. **S3 +/++** The authors find that information provision is important for giving consumers control but not for overcoming privacy concerns as these are low already.
	I13 Trading privacy risks for rewards: ambivalence Many studies showed that that there is ambivalence as to whether the energy savings or benefits of greater efficiency in energy use will be transferred to the customer. Not everyone is likely to benefit financially, and not all incentives are financial (see also Environmental concerns vs. Privacy)	**S12 +/++** People supported the claimed benefits of smart meters but were often sceptical that they would see the benefits (Lineweber 2011). **S28 ++/–** I doubt that it will involve any real saving for us. It depends on how much the price of electricity is going to fluctuate; if it's only 2 or 3 øre or 5 per kWh then it isn't that interesting. If there were real savings in it, something with a real impact, but I doubt that is the case. HP1 (male). **S30 ++/++** The debate surrounding smart meters has not only been about security and privacy, but also about whether the costs outweigh the benefits. The benefits of smart meters (outweighing the privacy costs) are not clear. **S23 +/++** Consumers felt that sharing their data for billing purposes could lead to a positive change in their energy behaviour, which some had begun to change upon having a smart meter. Some consumers who already had a smart meter were already changing their consumption behaviour and didn't mind the notion of billing on half-hourly data, as they felt they could save money. **S23 +/++** Sharing data was deemed 'okay' by consumers if there was some benefit to them in the long run e.g. specialised services and offers.

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Recommendation 4 SLES service providers should design SLES around user priorities and make these benefits clear **I1, I8, I13, I15, C1, C3, C4, SC1**	**I15 Privacy trade for Behaviour change: intentions versus reality** Evidence is scant what translates intentions into sustained behaviour change at the individual level. People think that real time data will change their energy use behaviour, but the evidence for this is mixed and limited to studies of people's future intentions and hypothetical scenarios. The small amount of evidence that did report change in behaviour showed that there was little change when feedback on energy use was kept private. Being seen to conserve energy has a greater effect on behaviour change than individual intentions. On the other hand, competitive data sharing of energy use data to reduce energy consumption may distract from private energy use monitoring, and savings from public information sharing are not sustained in the longer term	**S2 –/+** User behaviour: People's declarations, wills, and stated figures do not always translate into real practices. Respondents know how they should act but they do not for some reasons, mostly of an economic nature. **S7 +/++** (being a) Member of an environmental organisation was associated with using significantly less electricity than non- environmentalists in the study comparing consumption data made public compared to private. **S7 +/++** No effect for private information can induce conservation. No significant differences for Plug load and lighting. **S4 +/+** some participants were excited about the idea of real time feedback (on electricity use) so they could experiment with energy efficiency of competing behaviours – such as handwashing dishes vs. dishwasher, or to decide when to replace an appliance.(hypothetical scenario from a simulated home sensor environment). **S21 –/+** During the post-study interviews, households generally stated that they perceived the private display as more influential to their behavioural changes than the public display, mostly because of its real-time nature. **but** None of the households was regularly checking their electricity meter to monitor consumption (compared to the neighbourhood position/ ranking). **S23 +/++** Consumers felt that sharing their data for billing purposes could lead to a positive change in their energy behaviour, which some had begun to change upon having a smart meter. Some consumers who already had a smart meter were already changing their consumption behaviour and didn't mind the notion of billing on half-hourly data, as they felt they could save money. **S31 ++/+** CMP About 70% of participating customers stated that bill alerts caused them to act to manage their electricity usage, and participants reduced their annual electricity usage by 1.8%. **S31 ++/+** Reliant- customers do not express a high level of interest in their load control devices or concepts like load management or demand response, but do participate and reduce demand when incentives are financially attractive.

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Recommendation 4 SLES service providers should design SLES around user priorities and make these benefits clear **I1, I8, I13, I15, C1, C3, C4, SC1**	**C1 Positive peer pressure** People tend to be willing to share energy data with family, friends and neighbours through common, popular platforms. Doing so can foster a supportive environment where individuals learn and get recognition from their peers, and feel part of a collective good. [This willingness to participate could lead to unintended consequences: real privacy threats being ignored, adopting energy behaviours that either 'game the system' or harm other objectives such as comfort or health]	**S7 +/++** "Once the poster got up, it became serious…" "I liked the poster, it made us want to get green dots." "We want to make it green because red looks bad." "I thought the posters were pretty crucial to the whole process. It gets everyone else involved." "We did not want to attract attention because we were red." "I turned off all the lights and wear a lot of sweaters so I could get a green dot." "When I got a green dot, I received high five." **S20 −/++** Clara: sometimes it feels a bit futile if you don't think anyone else is doing it. So, I think if you know that other people are doing it, it makes you feel you're having a bigger impact. **S20 −/++** Regarding community accountability and mutual monitoring, respondents expressed "hope for mutual support and sharing of knowledge" [alongside negative concerns]. **S22 ++/++** Many respondents would share their energy-performance through social media, with family and friends (60%) and with neighbours (59%) in case they were asked to do so. 69% would enrol in a local energy-saving program, while participation in an online discussion forum (51%) or an energy saving competition (32%) is less appealing. **S25 −/−** Many participants enthusiastically discussed their electrical appliances without inhibition. Where appliances were discussed, it was not their energy consumption that was important, but their functionality, aesthetic appeal and other people's experiences of them. This research also found that sharing energy-related information among friends in a trusted environment represented a source of learning and enjoyment among participants. "Yeah, I guess I wouldn't want people to know how much the bill cost, but I wouldn't mind them knowing around about how much energy we use". **S25 [Info]** a "conversation starter" or something to "show off": When we had our eco-system installed we had it installed centrally located to the front door, so it captivates the visitor's eye as they come on in and we explain the system to them. They're pretty impressed that it can read the power sources. We give them a little bit of a demonstration.

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Recommendation 4 SLES service providers should design SLES around user priorities and make these benefits clear **I1, I8, I13, I15, C1, C3, C4, SC1**		**S27** Popularity (of app) has a statistically significant, positive effect on normative expectations (As app popularity increased, people expected others to be more approving of privacy violations. app popularity also has a statistically significant, positive effect on trustworthiness expectations – the more popular the app, the more participants trusted the app provider in the face of such uncertainty, other consumers' behaviours are a concrete source of information. If others use a technology, then that is good evidence that the downsides are not that big.
	C3 Negative peer pressure There are concerns that allowing peers to access your energy data allows them to judge and influence your energy behaviour.	**S18 +/++** The most subscribed service (N=137) was Smart Control, followed Family Comparison (N=85). Few respondents mentioned issues of trust within the family context, though some were concerned with surveillance by others in the neighbourhood. **S22 ++/++** One participant illustrated the type of drawbacks that peer-involvement can elicit: "You can also see it as an invasion of your privacy. Someone is going to meddle in. You might experience some sort of social pressure on the way you do your housekeeping."
	C4 Community accountability While the option for a community to take responsibility for its energy use may appeal to those wanting to share less data with energy companies, there is uncertainty over the environment this mutual monitoring would create: supportive and collaborative or unpleasant and judgemental.	**S20 –/++** How respondents' sense of community and level of social trust affected their concern about free riding behaviour and desire to monitor others' participation, and their energy consumption patterns and perceptions of time of use flexibility. Most respondents had mixed feelings about the idea of mutual monitoring, expressing concerns about embarrassment and fear of retribution, and hope for mutual support and sharing of knowledge. **S20 –/++** Clara: I think I preferred the anonymity of it. I think if people were identified by house number it would be a bit, not voyeuristic but a bit too much information almost. Interviewer **S20 –/++** Respondents' views on sharing individual energy consumption data with their neighbours were mostly negative (with some ambivalent or neutral), particularly if this was for the purposes of holding each other accountable.

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Recommendation 4 SLES service providers should design SLES around user priorities and make these benefits clear **I1, I8, I13, I15, C1, C3, C4, SC1**	**C4 Community accountability**	**S20 –/++** Interviewer: If there was a blackout, would you want to know who did it? Clara: No, because if it had been us then I would be terrified of being lynched. Interviewer: And if it tells you the names of people? Anna: I think that'd be horrible. I'd hate that I wouldn't want to participate if that was how it was going on, it would be a bit like Hitler Youth or something wouldn't it? Louise: Oh no, that's a local witch-hunt! We're far too nice round here. **S20 –/++** Regarding the applicability and usefulness of a commons approach to electricity in urban settings, this study is inconclusive." [Benefits found in social interaction and support, negatives in creating a potentially unfair and unpleasant mutual monitoring environment.]
	SC1 Social norms Social norms are not seen to affect participation, although widespread adoption may help establish a positive norm. Current concerns are based more on individual beliefs and experiences but anti-technology norms would be expected to arise if smart meters etc were used to reveal home life details, sell info or externally control appliances.	**S13 ++/++** Results suggest that norms may not play an important role in people's support for smart meter technology (individual beliefs and characteristics instead) and then says demographics do not seem to play a critical role relative to support for this technology among our sample of people living in states with higher numbers of smart meters. Of particular note is the weak relationship between ideology and support for smart meter installation. **S13 ++/++** People's perceptions of what others think regarding new technologies (injunctive norms) has not impacted perceptions of smart meter installation." **S15 +/–** Results suggest that utility ability to collect detailed information about electricity use does not produce demand for or expectations of norms against Smart Meters. BUT – if power use information can be analysed to reveal details about home life (crossing domains), if that information can be sold to third parties, or if utility companies can remotely control appliances within the home, then demand for and expectations of anti-technology norms increase. **S22 ++/++** They felt that that, to some extent, "privacy has already disappeared" with the widespread use of social media. The use of smart meter information for what is considered to be a public benefit (balancing demand and supply) is thus seen in a different light than the use of the same information for commercial purposes. **S24 +/+** Discriminatory actions that may result in segregation phenomena in society.

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Recommendation 4 SLES service providers should design SLES around user priorities and make these benefits clear **I1, I8, I13, I15, C1, C3, C4, SC1**	**SC1 Social norms**	**S27 +/++** Widespread adoption of ICT changes people's normative expectations about the social acceptability of privacy invasions and affects people's trust in technology providers." **S29 –/–** Domestic displays should include the privacy policy and specify the use given to the different levels of disaggregation of in- formation, express consent and revocable consent. Stricter policies may be necessary in certain cultural settings. **S33 +/+** (USA) From what I have seen in the past, companies that collect information tend to share information with other companies. The selling of data -- particularly companies that are attempting to market certain things to people. So, if HECO were to sell their demographic information to marketing firms who would do things like send ads based on personal information that would disturb me. Hau'oli added that "I think when you do have data that's not restricted to paper documents, but things that are online, other people definitely have access to it, unfortunately."
Recommendation 5 SLES service providers should widen engagement **I2, I3, I4, I5, IP2, C14**	**I2 Demographic factors that impact on data sharing** There were no demographic factors that were more likely to share data than others, Prior knowledge and experiences of data violations indicated reluctance to share data, or beliefs that sharing data would be intrusive was across all social groups. All groups were expressed concerns over privacy. **Limitations of this evidence** Most of the participants in the studies were well-informed in technology, "tech-savvy" and already engaged in technology use and data sharing, often this was a condition of participation or participants self-selected into the study based on their prior knowledge and interest in the topic. Hard to reach groups were under-represented in the sample of participants.	**S5 ++/++** Higher socio-eco groups more like to think Smart meters collect intrusive data , like the time they are at home or what appliances they use. **S1 ++/++** Higher Level of education were more pro UCC (Utility controlled charging of vehicles). **S5 ++/++** People from lower socio-economic groups were less likely to be aware of choices around data when getting a smart meter. **S13 ++/++** Demographics do not seem to play a critical role relative to support for this technology among our sample of people living in states with higher numbers of smart meters.

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Recommendation 5 SLES service providers should widen engagement **I2, I3, I4, I5, IP2, C14**	**I3 Older people and privacy concerns over smart technology** Evidence from related sectors show that families are often involved in decisions making using home-based technologies. On the other hand, older people's incentives to share data may differ to younger people priorities, e.g. families may welcome the opportunity to remote monitor their loved one to alert them to safety or health issues. Older people had mixed feelings about data sharing for health monitoring from not wanting to be a burden, to positive views on the use of data sharing for health monitoring to feelings that an over reliance on technology could replace human contact.	**S15 +/–** Older participants expressed more demand for and expectations of (social) norms against smart meters, **S18 +/++** Relatives saw the value of Checking on whether elderly relatives are still active at home, or whether their behaviour is abnormal, compared to normal days **Evidence from other sectors** Pal et al. 2017: "Overall these elderly people have a positive attitude towards a smart-home, especially for the purpose of health-monitoring and independent assisted living. However, they also have serious concerns regarding their privacy and the security provided by such smart systems along with the fear of social-isolation that might happen due to an increased dependence on technology." Klobas, 2019: "Older… people are more likely to take their own assessments of security risk into account when they make decisions about adoption of smart home devices." Abrilahij & Boll, 2019: "Other persons, in particular family members, are also involved in decision-making about the older individual's (assistive technology) AT use or non-use."
	I4 Older people may be incentivised to share energy use data by lower bills rather than concerns over the environment	**S2 –/++** Elderly people emphasise their need to receive lower bills instead of lower emission of CO_2. **S8 +/++** There are significant associations between age and acceptance only for the unautomated static and dynamic TOU tariffs. In both cases the tariffs are less popular with people aged 65–74.
	I5 Sharing the benefits: "Far to reach" groups People on lower socioeconomic groups were less likely to be aware of the data sharing choices available when it comes to smart meters. I6 People who rent their homes we often unaware of the choices available for sharing data. This may be that discussions of installations and costs incurred will take place with the landlord rather than the tenant.	**S8 +/++** Tenure: Tenure is significant for both dynamic TOU tariffs, where being a private tenant is positively associated with acceptance of dynamic TOU without automation. **S5 ++/++** People from lower socio-economic groups were less likely to be aware of choices around data when getting a smart meter (25% AB vs 44% DE not aware). **S3 +/++** Whilst overall concerns are low, variations in attitudes do exist between consumers – for example, on the basis of age.

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Recommendation 5 SLES service providers should widen engagement **I2, I3, I4, I5, IP2, C14**	**Evidence from other studies** Social housing tenants can have their needs for help with meeting energy costs override their privacy concerns as social housing landlords implement and benefit from economies of scale of energy use management. However, Social housing tenants can disengage by not participating in the monitoring of energy use and behaviour change to maximise the benefit of data sharing on a wide scale. On the other hand, private landlords are less enthusiastic as there may be a mismatch of interests if the landlord incurs costs but does not directly benefit. Technologies may fall out of use over time with turnover of tenancies also acts as a disincentive for investment.	**S8 +/++** There are significant associations between age and acceptance only for the unautomated static and dynamic time-of-use tariff (TOU tariff). In both cases the tariffs are less popular with people aged 65–74, the static TOU tariff is also more popular amongst people under 45, Dynamic TOU: Age 65–74. **S5++/++** Younger people slightly more likely to be comfortable (with data sharing) (61 % 18-24, 50% 75+). **Evidence from other studies** Coe, C., Gibson, A., Spencer, N. and Stuttaford. M. 2008. Sure Start: Voices of the hard-to-reach. *Child: Care, Health and Development,* 34 (4): 447–53 Johnson, C.Y., Bowker, J.M., and Cordell, H.K. 2004. Ethnic variation in environmental belief and behavior: An examination of the new ecological paradigm in a social psychological context. *Environment and Behavior*, 36(2):157–186 Mccarthy, I., Ambrose, A. and Pinder, J. 2016, Energy (In) Efficiency: Exploring what tenants expect and endure in the private rented sector in England. Making the case for more research into the tenant's perspective. An evidence review. Blankenberg, A.k. and Alhusen, H. 2019. On the determinants of pro-environmental behavior: A literature review and guide for the empirical economist, CEGE Discussion Papers, No. 350 Jane Burns, Anthony Collins solicitors, Marianne Hood OBE (2017). Transparency and Trust: A guide to data protection and privacy for landlords and tenants. HouseMark associates.
	IP2 Family dynamics There is recognition of, and some concern about, the potential for privacy issues to arise when data on activities etc. are shared within households.	**S26 ++/++** In this family, the energy-conscious father enjoyed being able to better attribute energy use and "educate the rest of the family" (Father, SG2P7). What was a useful analytical tool for the father, was an unwelcome breach of privacy for his daughter. **S26 ++/++** One participant from Group 1 spoke of the distress her friend Kay (name changed) had experienced due to a loss of control over her electricity information data. In this case, KayÕs husband had improvised a system such that he could monitor the household electricity consumption real time from his computer at work.

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Recommendation 5 SLES service providers should widen engagement **I2, I3, I4, I5, IP2, C14**	**IP2 Family dynamics**	**S26** ++/++ New technology such as eco-feedback into a family constitutes a breach of the order of the home and something that will be used and appropriated in different and potentially conflicting ways by different household members. **S26** ++/++ new technology such as eco-feedback into a family constitutes a breach of the order of the home and something that will be used and appropriated in different and potentially conflicting ways by different household members **S34**: Authentication of multiple users. Eleven participants (P1, 4–5, 10–13, 17, 21–23) spoke to the social relationships and power dynamics in homes where there could be multiple users sharing one device. They emphasised the importance of enabling proper authentication in order to protect each family member's privacy. For example, P13 was concerned that other members in the household might be able to access her credit card information and order food from the smart fridge. To address this concern, she incorporated voice recognition in her design as an authentication mechanism for the smart fridge. See also Hargreaves, Making Energy Visible.
	C14 Pro-active communication Customers want simple, easy to use web portals and timely and tailored communications (e.g. weekly emails about bills).	**S31**++/+ CMP email communication preferred. CMP's customer engagement strategy also included proactive communications with customers before smart meters were deployed and "rapid response" communications when customers raised questions and concerns during and after the deployment process. **S31** ++/+ Many utilities deploying smart meters with web portals have experienced difficulties attracting customers to access and use their web portals, and the ultimate value of these tools is still an open question. **S31**++/+ Reliant is continuously refining its web portal offerings and boosting the site's capabilities for attracting new and retaining existing customers. A major aim is simplicity and ease-of-use, which is what customers say they want. **S31** ++/+ Reliant: customers report that weekly emails are valuable because it helps avoid "bill shock" at the end of the month and gives them a sense of control over their consumption and costs.

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Recommendation 5 SLES service providers should widen engagement **I2, I3, I4, I5, IP2, C14**	**C14 Pro-active communication**	**S31++/+** Customers do not want to spend a long time getting answers to their questions. Reliant's customer service representatives are trained to anticipate questions and customise responses to address specific concerns. **S31++/+** Reliant: One size does not fit all when it comes to sending information to customers; multiple approaches are almost always required some customers prefer self-guided channels and that customers often enjoy looking up their own information or accessing communications on their own schedules. **S31 ++/+** ENO's proactive customer education. About two-thirds of all calls were outbound. Reasons for call were: 2011 – enrolment and training – event notifications – schedule and to assess effectiveness of field visits – ensure customers know how to adjust thermostat controls 2012 – calls regarding swap out of thermostat – courtesy and reminders and check ins regarding device functioning – notification of events – encouragement to groups to complete post-pilot survey (toll free, 24 hrs a day).
Recommendation 6 SLES service providers should provide clarity on the use and misuse of data **C7, C10, C11, C12, C13**	**C7 Approved third parties / data use** Allowing a trusted third party access to energy data is broadly accepted, particularly where there is a specific benefit or service they can provide (to the consumer or wider society) rather than to serve their own interests.	**S5 ++/++** Energy suppliers using smart meter data to identify and monitor vulnerable consumers 60% Police using your smart meter data to identify some forms of crime 62% **S3 +/++** Privacy concerns in relation to smart metering have remained low and research has found that the existence of the Framework offers reassurance to some consumers that appropriate safeguards are in place." **S22 ++/++** Consumer organisations (72%), environmental organisations (70%) and energy providers (58%) seem to be in a good position to provide these services. **S23 +/++** Panelists were more trusting of governmental bodies, regulators or parties without a vested interest in energy to handle their data These parties were seen to uphold a certain standard and have an official interest in their data and therefore be less likely to misuse data compared to other organisations. Consumers were generally happy for their supplier to be the sole party responsible for handling smart meter data. Having too many parties involved in the process raised concerns of data breaches and misuse.

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Recommendation 6 SLES service providers should provide clarity on the use and misuse of data **C7, C10, C11, C12, C13**	**C10 Transparency- Trust** [Links to Trust issues at other levels – micro etc]	**S9 +/+** Lack of transparency on privacy issues might severely hinder the participation of consumers and consequently the profitability of the Demand Response platform.
	C11 Aligning interests Without the right incentives or regulation, companies will prioritise their interests at the expense of their customers' interests, which may have a self-defeating impact on uptake.	**S11 +/+** With the current structure of the energy system, the increased desire to control the technologies due to the PVs is not compatible with the planned remote control that Insero had inscripted. Some participants became more aware of the actions required to consume their generated electricity, which enforced their desire to gain control of the timing of the consumption. This finding was counterproductive to the main idea of the remote control and the aggregator in Insero Live Lab, who preferred that consumers not be concerned with their energy consumption. **S14 +/+** Mostly the main driver in standardisation is commercial benefit for the companies involved. Without a framework to support the safeguarding of public interests, it will be highly unlikely that the standard for smart meters actually express a balancing of interests in which the interests of the market stand in proportion with the public interest. **S16 ++/+** The proposed mechanism can successfully incentivise data sharing from privacy-sensitive consumers to both increase net profit of the electricity provider and reduce loss incurred by supply-demand imbalance. **S18 +/++** With regard to third parties, institutions like grid operators, utility providers, and appliance manufacturers were believed to gain the most from the rollout of Smart Meters." **S30 ++/++** Analysis recognises that large deviations are possible in benefits (to energy co./s), for example if more than 20% of consumers refuses the remote meter reading, or if the energy savings turn out significantly lower than projected. Consumer support is therefore a crucial aspect.
	C12 Market position Energy users fear that their data will be used to financially benefit energy companies at their expense: e.g. identifying behaviours in order to target marketing or alter prices accordingly.	**S8 +/++** In the case of DSR, privacy issues are at stake not only in the energy data which may be shared but around control signals and consumers' responses to them. For example, consumers' financial rationality could be deduced from their response to TOU price changes (Li et al., 2014).

| Recommendations	Evidence statement and domain I = individual IP = interpersonal C = community SC = socioeconomic / cultural	Studies that informed the recommendation and quality score Low = – Medium = + High = ++ Internal validity / external validity
Recommendation 6 SLES service providers should provide clarity on the use and misuse of data **C7, C10, C11, C12, C13**	**C12 Market position**	**S18 +/++** Participants feared that they could face price discrimination without their knowledge or have their electricity bills go up if their power consumption patterns lacked flexibility. "Less flexible households must consume power at peak price times." "[…] One could see who is lying in front of the TV all day… that guy could maybe receive a higher bill or something." **S18 +/++** Smart Metering in relation to what third parties could know or infer about their everyday lives. "I don't want my power consumption information or customer data to be passed on in any way, used for advertising purposes, or the amount or time of consumption passed on to third parties. I do not want any kind of 'offers" due to my consumption data." **S20 –/++** For targeted marketing or research, and potentially creating unequal power relations (through big data).
	C13 Work life Privacy concerns are context-specific. Employers could use energy data to monitor employees although a greater level of surveillance would be expected than in private life.	**S18 +/++** Employers could engage in employee surveillance (e.g. coffee maker/computer use). **S32 +/++** Social context is an important predictor of acceptability of EDR systems… most respondents accepted an implementation of EDR in their professional vehicles, most refused to equip their private car as they perceived this to be an invasion of privacy.
Recommendation 7 SLES service providers should wherever possible, leverage 'horizontal sharing' **C1, C2, C3, C4, C5, C7, C8, C9**	**C1 Positive peer pressure** People tend to be willing to share energy data with family, friends and neighbours through common, popular platforms. Doing so can foster a supportive environment where individuals learn and get recognition from their peers, and feel part of a collective good. [This willingness to participate could lead to unintended consequences: real privacy threats being ignored, adopting energy behaviours that either 'game the system' or harm other objectives such as comfort or health]	**S7 +/++** "Once the poster got up, it became serious…" "I liked the poster, it made us want to get green dots." "We want to make it green because red looks bad." "I thought the posters were pretty crucial to the whole process. It gets everyone else involved." "We did not want to attract attention because we were red." "I turned off all the lights and wear a lot of sweaters so I could get a green dot." "When I got a green dot, I received high five." **S20 –/++** Clara: sometimes it feels a bit futile if you don't think anyone else is doing it. So, I think if you know that other people are doing it, it makes you feel you're having a bigger impact. **S20 –/++** Regarding community accountability and mutual monitoring, respondents expressed "hope for mutual support and sharing of knowledge" [alongside negative concerns].

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Recommendation 7 SLES service providers should wherever possible, leverage 'horizontal sharing' **C1, C2, C3, C4, C5, C7, C8, C9**	**C1 Positive peer pressure**	**S22** ++/++ Many respondents would share their energy-performance through social media, with family and friends (60%) and with neighbours (59%) in case they were asked to do so. 69% would enrol in a local energy-saving program, while participation in an online discussion forum (51%) or an energy saving competition (32%) is less appealing. **S25** –/– Many participants enthusiastically discussed their electrical appliances without inhibition. Where appliances were discussed, it was not their energy consumption that was important, but their functionality, aesthetic appeal and other people's experiences of them. This research also found that sharing energy-related information among friends in a trusted environment represented a source of learning and enjoyment among participants. "Yeah, I guess I wouldn't want people to know how much the bill cost, but I wouldn't mind them knowing around about how much energy we use". **S25** –/– [Info] a "conversation starter" or something to "show off": When we had our eco-system installed we had it installed centrally located to the front door, so it captivates the visitors eye as they come on in and we explain the system to them. They're pretty impressed that it can read the power sources. We give them a little bit of a demonstration. **S27** +/++ Popularity (of app) has a statistically significant, positive effect on normative expectations (As app popularity increased, people expected others to be more approving of privacy violations. app popularity also has a statistically significant, positive effect on trustworthiness expectations – the more popular the app, the more participants trusted the app provider In the face of such uncertainty, other consumers' behaviours are a concrete source of information. If others use a technology, then that is good evidence that the downsides are not that big.
	C2 Data encourages behaviour change People are willing to trade privacy and make data-informed changes to their energy behaviours for cost savings.	**S7**+/++ When private feedback was combined with public information (posters showing above or below average use) there was a saving of around 20% mainly from high energy users. **S20** –/++ In order to learn how to adjust their behaviour: "being able to see your own usage and when your own peak times are and make adjustments"

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Recommendation 7 SLES service providers should wherever possible, leverage 'horizontal sharing' **C1, C2, C3, C4, C5, C7, C8, C9**	**C3 Negative peer pressure** There are concerns that allowing peers to access your energy data allows them to judge and influence your energy behaviour.	**S18 +/++** The most subscribed service (N=137) was Smart Control, followed Family Comparison (N=85). Few respondents mentioned issues of trust within the family context, though some were concerned with surveillance by others in the neighbourhood. **S22 ++/++** One participant illustrated the type of drawbacks that peer-involvement can elicit: "You can also see it as an invasion of your privacy. Someone is going to meddle in. You might experience some sort of social pressure on the way you do your housekeeping."
	C4 Community accountability While the option for a community to take responsibility for its energy use may appeal to those wanting to share less data with energy companies, there is uncertainty over the environment this mutual monitoring would create: supportive and collaborative or unpleasant and judgemental.	**S20 –/++** How respondents' sense of community and level of social trust affected their concern about free riding behaviour and desire to monitor others' participation, and their energy consumption patterns and perceptions of time of use flexibility. Most respondents had mixed feelings about the idea of mutual monitoring, expressing concerns about embarrassment and fear of retribution, and hope for mutual support and sharing of knowledge. **S20 –/++** Clara: I think I preferred the anonymity of it. I think if people were identified by house number it would be a bit, not voyeuristic but a bit too much information almost. **S20 –/++** Interviewer: Respondents' views on sharing individual energy consumption data with their neighbours were mostly negative (with some ambivalent or neutral), particularly if this was for the purposes of holding each other accountable. **S20 –/++** Interviewer: If there was a blackout, would you want to know who did it? Clara: No, because if it had been us then I would be terrified of being lynched. Interviewer: And if it tells you the names of people? Anna: I think that'd be horrible. I'd hate that I wouldn't want to participate if that was how it was going on, it would be a bit like Hitler Youth or something wouldn't it? Louise: Oh no, that's a local witch-hunt! We're far too nice round here. **S20 –/++** "Regarding the applicability and usefulness of a commons approach to electricity in urban settings, this study is inconclusive." [Benefits found in social interaction and support, negatives in creating a potentially unfair and unpleasant mutual monitoring environment.]

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Recommendation 7 SLES service providers should wherever possible, leverage 'horizontal sharing' **C1, C2, C3, C4, C5, C7, C8, C9**	**C5 Ambivalence – community level** Willingness to share energy use data with neighbours declines as individuals consider how this data might be used.	**S22 ++/++** initial enthusiasms for sharing information with people in close proximity declines: Participant 1: "The ideal situation, I think, is that everyone has a [carbon] footprint [that is visualised] near the front door of their house. Then everyone can see: this is how I did today" Researcher: "Visible for others as well or…" Participant 2: (laughing) "A big cross; misbehaving household!"(laughing)Participant 1: (laughing) "No, not on the outside! No, no. Only when you enter your house… Only for yourself." On second thought, practices of information sharing became subject to discussions about peer pressure, The potential for social judgement that comes along with information sharing is thus seen as an undesirable side-effect or even limiting feature to such practices, especially for those householders with a relatively high carbon footprint. **S5 UK ++/++** The more detailed data is the less comfortable people are sharing it Over 6 in 10 people are comfortable sharing data on a monthly basis. This declines to 5 in 10 for daily data and just over 4 in 10 for more frequent data sharing. The same number of people are comfortable with sharing data on a half-hourly or near real-time. However, the number who are very uncomfortable increases with near-real time sharing (at community level as this doesn't say exactly what they are uncomfortable about).
	C7 Approved third parties / data use Allowing a trusted third party access to energy data is broadly accepted, particularly where there is a specific benefit or service they can provide (to the consumer or wider society) rather than to serve their own interests.	**S5 ++/++** Energy suppliers using smart meter data to identify and monitor vulnerable consumers 60% Police using your smart meter data to identify some forms of crime 62%. **S3 +/++** Privacy concerns in relation to smart metering have remained low and research has found that the existence of the Framework offers reassurance to some consumers that appropriate safeguards are in place." **S22 ++/++** Consumer organisations (72%), environmental organisations (70%) and energy providers (58%) seem to be in a good position to provide these services.

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Recommendation 7 SLES service providers should wherever possible, leverage 'horizontal sharing' **C1, C2, C3, C4, C5, C7, C8, C9**	**C7 Approved third parties / data use** Allowing a trusted third party access to energy data is broadly accepted, particularly where there is a specific benefit or service they can provide (to the consumer or wider society) rather than to serve their own interests.	**S23 +/++** Panellists were more trusting of governmental bodies, regulators or parties without a vested interest in energy to handle their data These parties were seen to uphold a certain standard and have an official interest in their data and therefore be less likely to misuse data compared to other organisations. Consumers were generally happy for their supplier to be the sole party responsible for handling smart meter data. Having too many parties involved in the process raised concerns of data breaches and misuse.
	C8 Energy co as Expert "someone to watch over me" Rather than being seen as intrusive, input from experts may be welcomed where this helps with complex or unfamiliar technologies or provides a clear benefit, and could even harm the user experience if absent when expected.	**S11 +/+** Participants reported feeling safer when experts controlled their HP. **S11 +/+** Although the participants expected to have an increased perception of safety as a part of being increasingly monitored, they discovered that this expectation was not always fulfilled, which caused frustration. **S18 +/++** People could receive a warning message in case an appliance (e.g. stove) is not turned off. (12/2) "Checking on whether elderly relatives are still active at home, or whether their behaviour is abnormal, compared to normal days." **S22 ++/++** Welcomes the assistance of experts in sorting out smart meter data, positive about receiving notifications in case of unusual energy use, and 28% (+34% tentatively)
	C9 Energy co as Community energy arbiter While local control and accountability can be appealing, they require time and effort. Some energy users expect this to be part of the service provided by energy companies, particularly enforcement which can lead to ethical issues or unpleasant environments when done by peers.	**S20 –/++** Acceptance of free-riding, and potentially willingness to compensate for those who do not contribute, might be different in a context where the community provided the only mechanism of accountability, rather than an additional layer alongside the contractual relationship of buying energy. Respondents saw mutual monitoring positively as an optional way of mutually supporting each other to choose ethical energy consumption behaviours. **S20 –/++** Clara: Maybe it's time consuming for people and slows the processes down. And I suppose when you… I don't know if we partly pay certain companies like energy companies for making decisions that we don't have to think about. And that's what people, that's maybe part of the premium.

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Recommendation 7 SLES service providers should wherever possible, leverage 'horizontal sharing' **C1, C2, C3, C4, C5, C7, C8, C9**	**C9 Energy co as Community energy arbiter**	**S20 –/++** Respondents' concerns about horizontal privacy point to a fear that community-based enforcement of acceptable energy use behaviour may be unpleasant, and less desirable than the bureaucratic, centrally administrated system of billing and metering currently in place **S22 ++/++** Several respondents worry about conflict situations that can arise in the absence of formal rules and with "a lack of authority over someone else's roof". **S22 ++/++** Local energy cooperatives provided a middle ground between forms of cooperation that are considered either as too personal or as too distant. You need an institution to organise that." Such a facilitating role, they argued, requires "another type of service provider" that better understands how to "work based on the power of people". So, rather than outright antipathy towards service providers and striving for radical autonomy. Participants were looking for "a new balance" that allows for more decentralised and democratic control over energy production **S33 +/+** Hau'oli mentioned that she would not have any concern if the information was "in the right hands… People who specifically need to evaluate, maybe the cost of the electricity or energy that we use." (it) would be appropriate to analyze this data as a way for HECO to offer improved service to consumers.
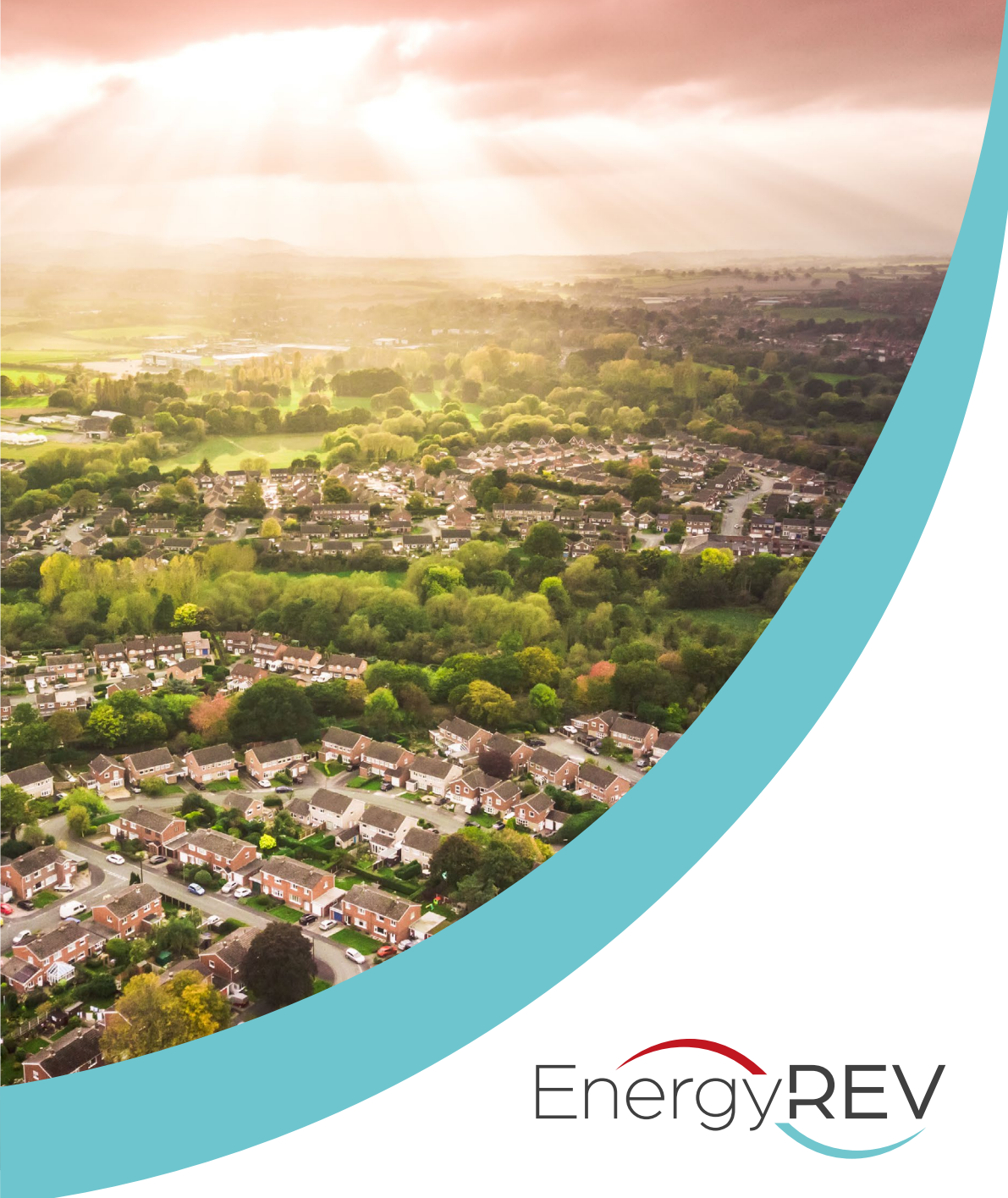
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About EnergyREV

EnergyREV was established in 2018 (December) under the UK's Industrial Strategy Challenge Fund Prospering from the Energy Revolution programme. It brings together a team of over 50 people across 22 UK universities to help drive forward research and innovation in Smart Local Energy Systems.

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