Institution: University of Essex

Unit of Assessment: 4 – Psychology, Psychiatry and Neuroscience

Title of case study: The power of smart metering: improved designs increase user engagement, enhance consumer's experience and shape the UK's smart metering programme

Period when the underpinning research was undertaken: 2012-19

Details of staff conducting the underpinning research from the submitting unit:

Name(s):	Role(s) (e.g. job title):	Period(s) employed by submitting HEI:
Kathryn Buchanan	Senior Research Officer, Psychology Lecturer	01.08.2012 – 31.07.2016, 01.08.2016 - present
Riccardo Russo	Psychology Professor	01.10.1993 – 31.12.2020

Period when the claimed impact occurred: 2016 - 2020

Is this case study continued from a case study submitted in 2014? N

1. Summary of the impact

Essex researchers studied the psychology of consumer engagement with in-home displays (IHDs) in the context of energy use smart metering systems. This work was critical to the commercial success of the leading IHD supplier, Green Energy Options Ltd (geo®) and to the continuation of the UK Government's Smart Metering programme. The research enabled geo® to substantially improve the design of their core smart metering products leading to increased positive customer attitude and sales. [text removed for publication]. Essex research on the importance of effective IHD design to sustain end-user engagement has also shaped UK Government commitment to its Smart Metering programme to help achieve energy consumption reduction targets. Essex research has placed consumer engagement at the heart of smart metering policy.

2. Underpinning research

Buildings account for one-third of global energy consumption. Consequently, the UK government has invested in programmes to promote reductions in long-term energy consumption in Britain's households. As a part of this agenda, smart meters have been identified to contribute to a reduction in Britain's carbon footprint. Smart meters provide real-time data on energy consumption that can be used by *providers* to regulate supply and demand effectively. A smart meter's In-Home Display (IHD) provides *consumers* with information about their gas and electricity consumption. However, installation of an IHD does not lead directly to changes in energy consumption behaviour unless IHDs are engaging and intuitive to use, **ensuring sustained consumer interest** that provides **understanding of usage information** and helps to identify where energy saving behavioural changes can be made to reduce consumers' energy bills. **Essex research determined how householders interpret, use and respond to IHDs**: how their understanding of the information provided affects behavioural changes in their energy use, which psychological factors are associated with effective use of IHDs, and which psychological barriers are linked to lack of engagement and consequently to lack of associated benefits [**R1, R2**].

Essex research funded by the EPSRC [**G1**] investigated psychological aspects of user interaction with IHDs [**R1**- **R3**]. Qualitative analysis of consumers' self-reported experiences showed that IHD feedback increased awareness of energy consumption, prompted users to learn about their energy habits and helped address information deficits about energy usage [**R1**]. However, the research also identified substantial barriers that limit effective user engagement to achieve energy use reduction outcomes: **unsatisfactory analytic skills and lack of motivation to interpret energy use feedback, difficulty in determining what appliances or actions are using energy and consequently what actions to take, time delays between taking actions and receiving a lower bill, and rapid fading of interest in monitoring the capability of IHDs.** The findings complement [**R2**], which also showed that IHD use resulted in a small short-term household energy reduction of 2% that was not

sustained. However, the benefits of IHDs were clearly linked to "human" factors such as consumer engagement, sustained interest, motivation, comprehension, evaluation, and personal characteristics. Unintended paradoxical consequences, including legitimisation of overconsumption, were also revealed. Essex researchers concluded that **smart metering has the capacity to make a substantive contribution to reducing household energy consumption if IHD design is improved to foster users' comprehension and engagement with their IHD.** They proposed a user-centric residential energy management system designed to achieve engagement and long-term behaviour changes leading to energy efficiency. They also suggested **IHDs should be designed through an iterative process incorporating end users' feedback into ongoing product development** [**R3**].

A further research insight [**R4**] was that the implementation of smart meters and IHDs must be premised by clear and transparent communication of their benefits to consumers. For example, automated usage data can provide more precise billing, to the advantage of the consumer, as opposed to the energy provider, and IHDs can offer the consumer the opportunity to maximize their own use of low 'time of use' (TOU) tariffs [**R4**].

These insights were pursued in collaborative work with IHD manufacturer Green Energy Options (geo®). During a year-long **ESRC Impact Acceleration Account funded** [**G2**] **collaboration with geo®**, Buchanan researched the comprehension and usability of geo®'s smart energy management products as well as long-term customer engagement. Results from this research provided recommendations to develop and improve products across geo®'s range that geo® subsequently adopted. **The research provided insights in three key areas: user comprehension, usability and user behaviour.** [text removed for publication]

[text removed for publication] When studying the usability of products Essex research revealed that keyboard designs had to be intuitive and enable rapid simple input by consumers that was not time disruptive, to avoid dissatisfied users disengaging with products. Barriers to adopting products such as smart thermostats were identified as linking to product cost, perceived lack of benefits, and misunderstanding of the functionality and usefulness of a device [text removed for publication].

Two further studies provided insight into the benefits perceived and anticipated by end users if they engage with IHDs. [text removed for publication] Buchanan conducted a further study to examine the benefits prospective users anticipated and sought to obtain if they were to engage with an IHD. The research showed, for example, that prospective users would like IHDs to have easy to understand labels and provide monthly notifications concerning heating use and efficiency [**R6**].

In sum, Essex research evidenced the **crucial role of user engagement to the delivery of energy saving from IHDs** and energy management devices [**R1, R2**], and identified motivational factors, comprehension factors and usability factors that influence user engagement. Subsequent research was instrumental in evidencing the need for a user centred approach to IHDs [**R3, R4**] and providing clear indications on how to do so to maximise the benefits of IHDs to reduce energy consumption [[text removed for publication], **R6**].

3. References to the research [available from HEI on request]

References R1, R2 and R4 are peer reviewed articles published in international journals of high quality. R3 and R6 are published in high standing peer-reviewed proceedings from international conferences on energy efficiency. [text removed for publication] This research output, along with peer-reviewed competitve research grants awarded by the EPSRC and ESRC, evidences the quality of the underpinning research. Impact Factors refer to Web of Science.

R1 Buchanan, K., Russo, R., & Anderson, B. (2014). Feeding Back About Eco-Feedback: How Do Consumers Use and Respond to Energy Monitors? *Energy Policy, 73,* 138-146.

https://doi.org/10.1016/j.enpol.2014.05.008 IF: 4.04
R2 Buchanan, K.E., Russo, R., & Anderson, B. (2015). The Question of Energy Reduction: The Problem(s) with Feedback. *Energy Policy, 77,* 89-96. https://doi.org/10.1016/j.enpol.2014.12.008 IF: 4.04
R3 Vastardis, N., Adjrad, M., Buchanan, K., Liao, Z., Koch, C., Russo, R., & Dudley, S. (2014, November). A user-centric system architecture for residential energy consumption reduction. In 2014 *IEEE Online Conference on Green Communications* (OnlineGreenComm) (pp. 1-7). IEEE. https://doi.org/10.1109/OnlineGreenCom.2014.7114423
R4 Buchanan, K., Banks, N., Preston, I., & Russo, R. (2016). The British public's perception of the UK smart metering initiative: Threats and opportunities. *Energy Policy, 91,* 87-97. https://doi.org/10.1016/j.enpol.2016.01.003 IF: 4.04
R5 [text removed for publication]
R6 Buchanan, K (2017) A Luke-Warm Reception: Why Consumers Aren't Hot for Smart Thermostats, pp 999-1013. In *Proceedings of the 9th international conference on Energy Efficiency in Domestic Appliances and Lighting* (EEDAL '17), Ed: P. Bertoldi, Publications Office of the European Union, Luxembourg, (2017). https://doi.org/10.2760/113534

Research Grants

G1 2012-2017 R. Russo., Yang, K., & Anderson, B. EPSRC. £771, 789. Digital Agent Networking for Customer Energy Reduction (DANCER).
G2 2016-2017 K. Buchanan. ESRC Impact Acceleration Account. £6,776. Engaging end-users with energy: exploring the efficacy of physical and virtual in-home-displays.

4. Details of the impact

Summary: Energy suppliers were expected to take "all reasonable steps" to install smart meters in UK households and business by the end of 2020. One long-term outcome vision of this initiative as outlined by the UK Department for Business Energy and Industrial Strategy (BEIS) is "**for consumers to benefit from smart metering, deliver a market-wide smart meter rollout […] and provide certainty and clarity to the energy industry**" [**S1**]. Essex research was critical to help achieve these goals. **Consumers have benefited** from optimised IHD designs resulting from Essex research with device manufacturers, making it easier for them to understand and engage with the information displayed [**R1, R2**]. IHD manufacturer, geo®**, benefited from improved products that led to commercial success**. UK utility companies **used Essex research insights to modify their communication practices encouraging consumers to install smart meters and the Essex findings** ensured that **user experience plays a vital role in the UK smart meter regulatory framework**.

Essex Research Improved the Design Of geo® IHD Products, Increasing Commercial Success.

geo smart meter. Taken from: geotogether.com/products-services

geo® is a device manufacturer and the UK's leading supplier of IHDs [**S2**] [text removed for publication] with products sold more widely across **Norway, Sweden** and **The Netherlands** [**S3**]. IHDs are integral to the UK's smart metering programme. They provide real-time feedback to consumers, lead to change in behaviours, reductions in energy consumption, energy costs and carbon emission. The success of **consumer's interactions with IHDs strongly affects the UK's smart metering programme's success.** [text removed for publication]

To benefit from Essex research further, geo® worked closely with Buchanan on an **ESRC Impact Acceleration** funded project [**G2**] [text removed for publication]. The CEO of geo® confirms that [text removed for publication] '*without Dr Buchanan's expertise in consumer comprehension and usability,* ***we would have developed less well optimised products and thereby lost a crucial advantage over our competitors*****.**' [**S2**]. [text removed for publication]

Essex Findings Shaped Attitudes Towards IHD and Smart Metering Programmes. [text removed for publication] British Gas' Asset Funding Commercial Manager stated: '*British Gas has been working with geo® since 2013,* ***developing In-home Displays that are essential to our roll-out of smart meters in the UK***' [**S3**]. The geo® CEO notes that Buchanan's research '*enabled us to evidence the merits of our products to our stakeholders such as major customers'* [**S2**]. [text removed for publication]

Essex research was also **instrumental in shaping the communication surrounding smart metering for the *Energywise* partnership led by the UK Power Networks**, a conglomerate of ten organisations including British Gas and the national charity Action for Warm Homes that seeks to promote energy efficiency, particularly amongst vulnerable users. In their 2017 report on customer engagement [**S4**], the group refers to [**R4**] and explains how these findings have **been instrumental in shaping their strategy to encourage citizens to adopt smart meters,** helping achieve the smart meter regulatory framework goal. The report describes for example that [**R4**] was **used as a 'guiding principle' in adopting 'a clear and transparent communication with the public to secure customer acceptance'** of smart metering (p. 102). Findings from [**R4**], led them to include 'Messages about smart meter benefits […] in all recruitment literatures' (p. 22) and to **address the barriers to uptake of smart meters that were identified in Buchanan's research** (p.103)[**S4**].

Essex research informed and shaped the UK' Government's continued deployment of smart meters. Buchanan discussed Essex's findings [**R1, R2**] with a specialist from the House of Commons Select Science and Technology Committee, responding to their direct request for her to input into their *Evidence Check: Smart Metering of Gas and Electricity,* April 2016. Buchanan's research [**R2**] is discussed and cited in Section 2 of the report: Consumer Behaviour (p. 13-20) [**S5**]**:** '*Dr Kathryn Buchanan and colleagues at the University of Essex note that IHDs "do not have the capability to reduce energy consumption by themselves but rather their success is entirely dependent on user engagement"*'. Key insights from [**R2**] are listed including difficulties in identifying appliances and actions responsible for energy consumption, leading to '*the need to consider carefully the design of IHDs in order to maximise the feedback effect*' [paragraph 28, p.15 **S5**]. The report concluded: *'In order* ***to reflect the available evidence the Government should ensure that in its bid to complete the smart meter roll-out by 2020 it does not compromise on consumer engagement*** *before, during and after installation […]. The impact of smart meters will be limited without this support from installers and Smart Energy GB.*' [p.39-40, **S5**]. The Government's November 2016 response emphasised: '***Consumer engagement is at the heart of the smart meter roll-out in Great Britain. It is central to ensuring consumers realise the benefits of smart metering***' [p3 of **S6**]. [text removed for publication]

In sum, the government departments responsible for the promotion of energy efficiency via a smart metering programme, have responded to insights from Essex research by putting consumer engagement at the forefront of UK smart metering policy, noting in particular the importance of ensuring consumer awareness of the potential benefits of using smart meters, and of designs that ensure usability to achieve those benefits.

5. Sources to corroborate the impact

S1 Department for Business Energy and Industrial Strategy (BEIS): Delivering a Smart System Response to a Consultation on a Smart Meter Policy Framework Post 2020 ANNEX B: Impact Assessment. June 2020. Accessed Feb 2021.
S2 [text removed for publication] CEO, geo® (Green Energy Options) from 2018 [text removed for publication].

S3 Website information from Green Energy Options. Accessed Feb 2021.
S4 UK Power Networks Energywise report: *Vulnerable Customers and Energy Efficiency,* SDRC 9.4: Customer Engagement (2017).
S5 House of Commons Science and Technology Committee (September 2016).
S6 House of Commons Science and Technology Committee (November 2016).