Objectives of this rapid review

As new digital technologies, appliances and sensors enter the home, and as a new generation of digitally savvy consumers enter the energy marketplace, power utility companies are being presented with fresh opportunities for customer engagement.

The Internet and mobile phone apps, as well as other digital devices such as in-home displays, can help improve customer education, provide new energy monitoring possibilities, and offer greater options for consumer control. Information flows can be two-way in nature, both to and from the consumer.

Drawing on primary and secondary academic literature, this rapid review examines what is currently known about digital services and communication platforms that allow for residential customer engagement and interaction with the energy system, specifically in the Australian context.

This rapid review is the second of two parts, and follows a review of international systematic studies in Part 1. Similar to Part 1, this review is a scoping study of the relevant literature. It is not a meta-analysis, nor an attempt to systematically compare the effectiveness of different modes of engagement. However, the review does point towards findings and insights that may help to improve customer engagement in the energy domain.

Key findings of this rapid review

This rapid review identified a total of 24 papers that fulfilled the inclusion criteria. In terms of research focus, the studies were classified into two categories: those focusing on digital technologies to provide customers with feedback on energy consumption (17 papers), and those focusing on digital education around energy conservation (7 papers). Below, we highlight some selected findings and insights from these two categories.

Effects of feedback on energy consumption

Providing householders with feedback on residential electricity consumption has typically been viewed as beneficial for encouraging energy conservation. However, the magnitude of the benefits is debated as many studies have design and/or methodological limitations and the results may be prone to biases.

In terms of providing customers with real-time feedback on electricity usage (e.g., via dedicated display devices), one meta-analysis of 27 trials across the globe was used to estimate expected conservation effect from large-scale deployment of real-time feedback for Australian states [14]. The implied carbon reduction cost was calculated to be $61/tCO$_2$e, suggesting that feedback may be a relatively costly strategy for reducing carbon...
emissions in Australia. However, there are also likely to be other positive effects, such as increased customer loyalty and peak-load shifting.

This meta-analysis also found that early studies have likely over-estimated the extent of reductions in household energy use in response to feedback. Studies with larger sample sizes, as well as more representative sample selection and recruitment methods, have noted reductions in electricity consumption in the range of 3–5% (versus claims of 6–10% from earlier and smaller studies).

**Feedback interventions and household types**

The effectiveness of feedback interventions may be improved by tailoring the feedback to different types of households and customer segments.

One study examined a dataset of 3666 Greater Sydney households, of which 2814 had installed different types of energy feedback technologies [3]. This included in-home displays allowing real-time energy monitoring, online tools and ability to automatically turn on and off some of the household appliances. The electricity consumption of all sampled households was recorded and household characteristics were also measured via surveys.

The findings revealed that high-income households were more responsive to energy feedback than low-income households (e.g., relative to no-feedback control households, reductions in daily electricity demand were 17% versus 3%, respectively) [3]. Moreover, those living in separate houses reduced average daily electricity demand by 12%, whereas there was little effect for those living in apartments or units. Together, these results suggest that the precise impact of feedback on energy consumption can vary for different types of households and customers.

**in response to feedback, high-income households can reduce their energy use to a larger degree than low-income households (17% vs 3% reduction)**

**Designing feedback for prosumers**

A significant and growing class of households are so-called ‘prosumers’ – those who produce energy (e.g., via solar panels) in addition to consuming it. One study identified in this rapid review explored the real-time feedback needs of such households, in the context of informing their choices on how to change their energy usage, rooftop solar generation and feed into or from the electricity grid [14].

Using case studies, the authors noted that many of the current technologies are not meeting the needs of prosumers. There are a number of implications for additional functions and improving the feedback to prosumers. For example, providing information in different time units and different visualisations may better suit the needs of this customer group.

**Effects of combined interventions**

Feedback can be combined with other interventions in an effort to influence energy consumer behaviour, and this may lead to potential interactive effects depending on the type of customer or household. For example, one study assessed the impact of three different interventions on the energy conservation in the households of low-income, elderly people [17]. In a trial conducted with 127 Western Australian households in 2015 (with baseline data collected in 2014), three interventions were tested:

- Behaviour change energy conversation tips sent weekly via SMS,
- Personalised feedback with the SMS energy conversation tips, and
- Voltage optimisation units (a transformer designed to reduce energy supply through adjusting the voltage to a constant 222V) in addition to tips and feedback.

Results showed no effect of interventions on electricity usage in the households without solar PV. However, for households with solar PV, the response varied by intervention. Within this group, energy tips alone were ineffective and electricity consumption actually increased by 23.3%. It was suggested that people might already see themselves as doing their “green effort” by generating and using renewable energy and, therefore, feel it is fine to consume more (i.e. there is a “moral licensing” effect). However, with all three interventions, households with solar PV reduced power usage by 25%. The results also suggested that senior citizens preferred to receive energy efficiency information via technology-based channels (e.g., SMS and email).
rather than other traditional forms of communication (e.g., bills and via post).

**Gamification**

With the growing availability of digital platforms, the use of games as a form of behavioural intervention has gained attention as a potentially fruitful way to encourage energy efficiency and conservation among residential consumers. In a recent qualitative study [23] of six low-income households in Brisbane, participants engaged in three mobile phone games for one week. The games focused on energy practices, such as:

- heating and cooling using temperature-based appliances,
- washing clothes in cooler than usual temperatures, and
- turning unused lights and other electrical appliances completely off (at the wall).

The findings from group interviews with the households suggest that mobile phone games may have the potential to motivate, educate, and persuade consumers to engage in energy-efficient behaviours promoted in the games. However, these results must be treated with caution due to the very small sample of participants and the qualitative nature of the research. However, further quantitative research is recommended to confirm and extend qualitative findings from this study.

**Persistence of observed effects**

For behavioural interventions in the energy domain, a crucial issue is whether the observed effects on household energy consumption are sustained over time, especially following cessation of the intervention. It might be that intervention has a noticeable effect on behaviour when it is new or novel, but the effect gradually decreases (or diminishes entirely) with time.

In one qualitative study based on 23 semi-structured interviews with households that had feedback devices installed, it was observed that over time the customer engagement significantly declined [19]. This study also found that the marketing and installation process for energy feedback devices might affect householders’ preconceptions of the device’s purpose, with implications for long-term engagement with the device.

**Tapping into intrinsic motivation**

When it comes to the effectiveness of energy feedback, another interesting question is whether behaviour change is driven purely by extrinsic motivation (such as saving money) or whether intrinsic motivation (such as the desire to help society and/or the environment) also plays an important role.

One study explored this question by examining the efficacy of in-home displays providing real-time feedback on the energy consumption to groups of university students [2]. The students did not pay their energy bills, as these were included in the fixed residence accommodation fees, so there were no financial incentives for them to save energy. The two interventions tested were: 1) a social marketing program alone and 2) a combined strategy of social marketing plus an in-house energy consumption feedback via displays installed in the residences. Across the different phases of the study, the energy usage data revealed a generally consistent pattern of lower energy consumption in the intervention groups than in the control group. For social marketing alone, there was a 17% to 28% reduction in electricity consumption. For the combined strategy of social marketing and an eco-meter, there was a 22% to 26% reduction. However, the study’s sample size was very small and limited to university students, so the results may lack generalisability and should be interpreted with due caution.

**Energy activities as social and situated practices**

A broader critique of the implicit economic assumption that householders are always cost-benefit micro-resources managers has been conducted in a series of papers by Strengers [20,21,22]. This work explores the implications for designing feedback systems by taking into account everyday household activities and practices. It has been suggested that householders do not always make efficient and economically rational decisions, and understanding high consumption practices should also be considered in terms of social, cultural, technical and institutional dynamics.

For example, one study found that energy demand-management trials can influence, and are also influenced by, what is considered a comfortable temperature range [20]. That is, trials themselves can accelerate and legitimise the trend towards...
exclusively using air conditioning to achieve ‘comfortable’ indoor temperatures at the expense of other, often more traditional, ways of achieving comfort, such as building thermally efficient housing, passive ventilation, showering and choosing appropriate clothing.

... energy demand-management trials can influence, and are also influenced by, what is considered a comfortable temperature range ... at the expense of other, often more traditional, ways of achieving comfort, such as building thermally efficient housing, passive ventilation, showering and choosing appropriate clothing ...

Narrative frameworks and video storytelling

An example of adopting a more interdisciplinary approach for shaping domestic energy behaviours is the use of narrative frameworks and storytelling.

This method was adopted as part of a community energy efficiency program in regional New South Wales [4]. The storytelling combined lay narratives with technical narratives from energy professionals. Ten narrative videos on household energy practices were produced and were then incorporated in a community-wide education and behaviour change program aimed at improving energy efficiency in the region. The social marketing program involved multiple components in addition to the narrative videos (e.g., newsletters, brochures, website, social media, advertising, etc.), and some households also received customised energy efficiency retrofits. Evaluation of the programme suggested overall positive impacts on energy-related knowledge, values, attitudes, perceptions (e.g. thermal comfort) and self-reported behaviour.

Studies reviewed


Studies reviewed (cont.)


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