Triggering Electricity-Saving Through Smart Meters: Play, Learn And Interact Using Gamification And Social Comparison

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Abstract

The present study tests and compares the efficacy of two different social game modes, collaborative and competitive, as interventions to motivate electricity-saving behaviour at the household level by means of a gamified mobile App, called *Social Power*. The collaborative game has a common savings goal that the team aims to reach collectively. The competitive game compares weekly savings and thus sets two cities against each other to save the most. The App integrates electricity saving challenges, tips, quizzes in order to motivate participants to earn points and reach set consumption reduction goals. Smart meter data complements the user experience by showing hourly and weekly electricity consumption which is directly compared to their own historical consumption and their team's savings performance. While completing challenges on the App, participants learn how to positively improve electricity use in their household. Participants are encouraged to interact with each other over Blog and Facebook pages which provide additional information about the weekly challenge and overall intervention. Overall, there were significant electricity savings in both game modes compared to historical values and the control group, however the feeling of community building and social interaction was minimal. Thus the game approach was successful, but future studies can better integrate interaction elements.

1 Introduction

Due to its enhanced energy feedback capacity, the advent of smart metering has been growingly praised as a potential solution to assist society's collective goal of reducing energy demand and adopting energy-efficient lifestyles. However, for a socio-technical innovation such as smart metering to be effective, the information feedback needs to be embedded into a wider system of communication and awareness-building to create a relation with the end-user, as it is not automation and fine control that hold the promise of improving customer's knowledge and motivation for change spontaneously (Darby, 2010). Like other eco-innovations, smart meters ultimately require the acceptance and action of people and communities to ensure success (Sabadie, 2013).

Hence much research is under way, particularly in the household domain, to test different feedback modes aiming to positively impact energy-related behaviour and enhance the efficacy of smart meter information to engage consumers.

Considering the many limitations of individual decision-making (Heiskanen et al., 2012) and the fact that human behaviour is socially embedded also when it comes to energy-related choices (Welsch & Kuling, 2009), current energy feedback research orients around the social aspects of energy consumption. In general, literature suggests that the inclusion of socially- based, engaging, competitive and comparative feedback is more effective in reducing individual energy consumption (Abrahamse et al, 2005; Carrico & Riemer, 2011; Fischer, 2007; Schultz et al., 2007; Darby, 2006; Degen et al., 2013; Vine et al. 2013) compared to more generalized and non-targeted information (Costanzo et al., 1986; Breukers et al., 2013).

However, as behavioural change also implies educating and guiding consumers towards appropriate actions, motivating engagement in energy-saving practices is very much about finding innovative ways of learning.

In this context, gamification - the use of game design techniques and game mechanics in a real-world context – provides an engaging, self-reinforcing and playful setting in which to raise energy policy and management issues and features the virtue of increasing intrinsic motivation, engagement and learning (Malone and Lepper, 1987; McGonigal, 2011). Considering that learning itself is fundamentally a social process that is "*situated within the practices of the community of practice, rather than something which exists 'out there' in books"* (Lave & Wenger, 1991), gamification techniques turn out to be more effective in motivating behaviour change when the acquired knowledge is coupled with hands-on, everyday life experiences.

In synergy with gamification, social comparison can also effectively trigger motivation (Grevet et al., 2010). Depending on the context in which it is employed, social comparison may enhance collectivism when individuals understand that they are part of a larger picture (Haluza-DeLay, 2007). Or it can lead, for example, to competitive feelings and striving for better performance (Siero et al., 1996). In both cases, social group feedback can lead to a strong personal identification with one's own group, resulting in a more cooperative behaviour within the group (Wit & Wilke, 1988). Thus, both a collaborative and competitive perspective may co-exist and work together with social group feedback contributing to the attainment of a collective goal. Considering that most environmental concerns today are affected by collective behaviour, social group feedback emerges as an opportunity to encourage people to increase individual action in order to attain a more significant collective impact for change.

2 Methodology

A local neighbourhood energy contest acted as the frame for the recruitment of 108 volunteering households, ready to take part in a field experiment on collective electricity-saving in the respective cities of Winterthur (n = 55), Canton Zurich, and Massagno (n = 53), Canton Ticino, Switzerland. The energy contest took place over a period of 13 weeks, between February and May 2016. Out of the 108 recruited households, 46 actively played until the end of the contest period.

The participating households were provided with *Social Power*, a gamified mobile App for smartphones, designed to maximise the efficacy of electricity feedback derived from smart meters by means of a playful, interactive, and social learning narrative.

The pilot project seeks to determine whether a difference in game setting might impact social group performance and better motivate people to manage their electricity consumption at home more sustainably. Thus two *Social Power* game forms are implemented in the mobile App as behavior-change interventions: one is a “collaborative” goal-setting, engaging fellow participants in the same city to reach a fixed, collective 10% electricity-saving goal. The second is a “competitive” goal-setting, where participants are involved in a dynamic energy competition between the two cities in pursuit of the lowest electricity consumption result.

Households were randomly assigned to the different treatment groups. An equivalent control group, anonymously drawn, serves as a benchmark. To examine the differential effects of the two forms of social feedback, electricity consumption in the three experimental conditions (control, collaborative, competitive) is tracked before, during and after the game period (with a planned long term monitoring into 2017).

Shortly before, and immediately after the intervention period, participating households were asked to complete an online survey about their energy awareness, literacy and practices in order to assess changes in reported behaviour. A second post-intervention survey will be run one year later to collect long-term observations.

An evaluation of the motivational and social aspects, and the contextual learning process triggered by the *Social Power* feedback design, is not yet possible, as this qualitative analysis will be carried out in semi-structured interviews and focus groups planned in September 2016.

2.1 Application design

Social Power employs an action-oriented model of social learning to stimulate consumer engagement. A series of 50 electricity-saving related challenges and energy tips are proposed by the game, covering 12 weekly energy-related topics. The challenges contextualise learning by asking the participant to take actions in their real-world environment.
Depending on the game to which the player has been assigned (collaboration or competition), the App displays an overview of individual household and team performance in terms of electricity-saving goals and points earned from completing challenges.

Self-comparison feedback

The App displays hourly, daily and weekly electricity consumption in a user-friendly, meaningful way and compares weekly consumption with a historical reference period (Oct. – Dec. 2015). This information facilitates self-evaluation and learning: the player can view trends in personal consumption, as well as question the cause of a given electricity usage and the context in which it took place.

Social group feedback

Social Power stimulates collective action by visualizing the completion of challenges by other team members. A completion barometer shows what percentage of the team has completed a specific challenge and additional ‘social bonus’ points are rewarded to those players who have completed the challenge when 1/3, 2/3 or the entire team have completed a challenge. Thus, playing strategically with your team through completing challenges together pays off.
Both the collaborative and competitive games are driven by the ‘team saving bonus’, where a significant points bonus is awarded to teams in response to the attainment of set weekly savings goals, thus rewarding collective saving efforts.

Team community

Outside of the app, there is a Social Power blog and Facebook page as a place for participants to interact, share experiences and cooperate to build a creative understanding of how to save electricity at home.

3 PRELIMINARY FINDINGS

3.1 Technical limitations

An unexpected data transmission problem during the experiment caused irregular delays in the electricity consumption data reported in the App for some households. This resulted in incorrect savings calculations at the team level. A game reset with correct data was made in week 10. Further analysis is needed to assess the presence of additional undetected errors after correction, as well as the repercussions of the known errors. The impact of this aspect on participants' understanding and motivation to play the game will be discussed during the interviews planned in September 2016.

3.2 Electricity savings

Compared to the historical consumption, as well as to the control group, there is a significant reduction in electricity consumption in both the collaborative and competitive game modes (Table 1). However, no significant savings difference between the game modes is detected. The control group registers an increase in electricity usage during the same interval. Further analysis is needed to assess the overall statistical significance of the results gathered.

Figure 1 and Figure 2 report the changes in electricity savings on a weekly basis for each game mode. The peak savings occurring in week 9 corresponds to Easter holidays for both cities. Note that a data point below zero means higher consumption, and no savings.

Table 1: Team household consumption savings (active players only)

			Total weekly household			
Teams		n	Historical consumption (kWh)	Intervention consumption (kWh)	Consumption change (kWh)	Consumption change (%)
Competitive	Massagno	13	623.9 (440.8)	586.2 (428.3)	- 37.7 (94.7)	- 6%
	Winterthur	11	867.1 (788.8)	850.5 (866.2)	- 16.7 (134.7)	- 2%
Collaborative	Massagno	10	671.4 (329.3)	615.1 (279.2)	- 56.3 (77.0)	- 8%
	Winterthur	12	913.0 (694.0)	882.6 (719.5)	- 30.4 (89.6)	- 3%
Control	Massagno	23	881.2 (521.6)	1053.7 (835.6)	+ 172.5 (416.8)	+ 20%
	Winterthur	23	705.4 (529.7)	793.1 (607.0)	+ 87.7 (149.5)	+ 12%

Note: Negative consumption means a savings. Comparison made between weekly electricity use during intervention as compared to historical weekly average

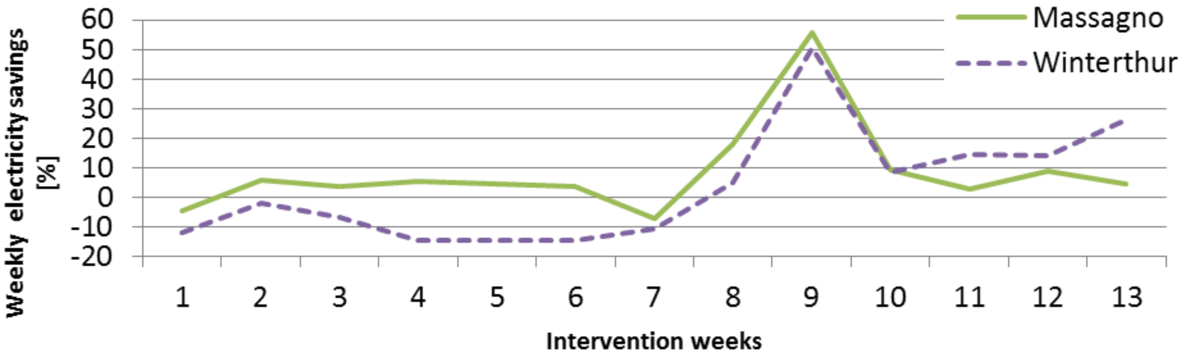

Figure 1: Weekly electricity savings by the collaborative teams (active players only)

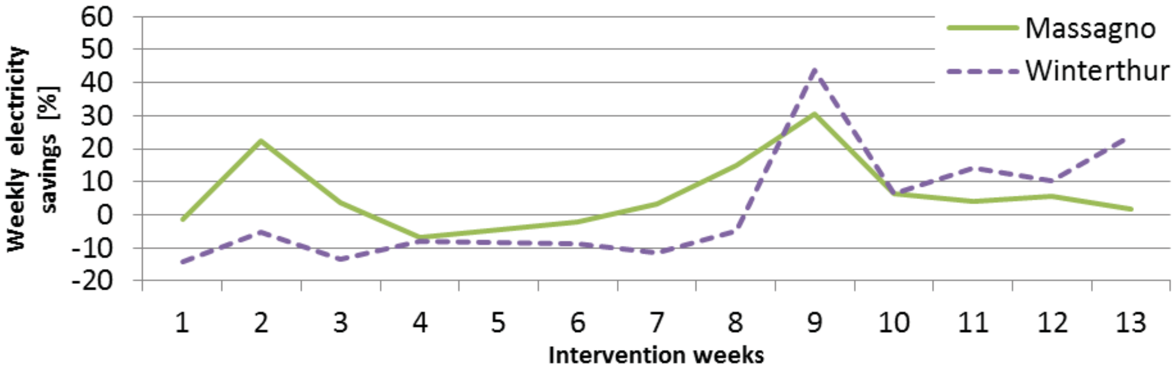

Figure 2 Weekly electricity savings by the competitive teams (active players only)

3.3 Challenge engagement

There is no difference between the game modes in terms of the engagement level for completing challenges. A general drop in commitment after the first month of game occurs for both groups (Fig.3). Engagement levels rise again slightly starting in week 10, likely as a result of increased communication between the project team and the participants concerning the reset of the electricity data.

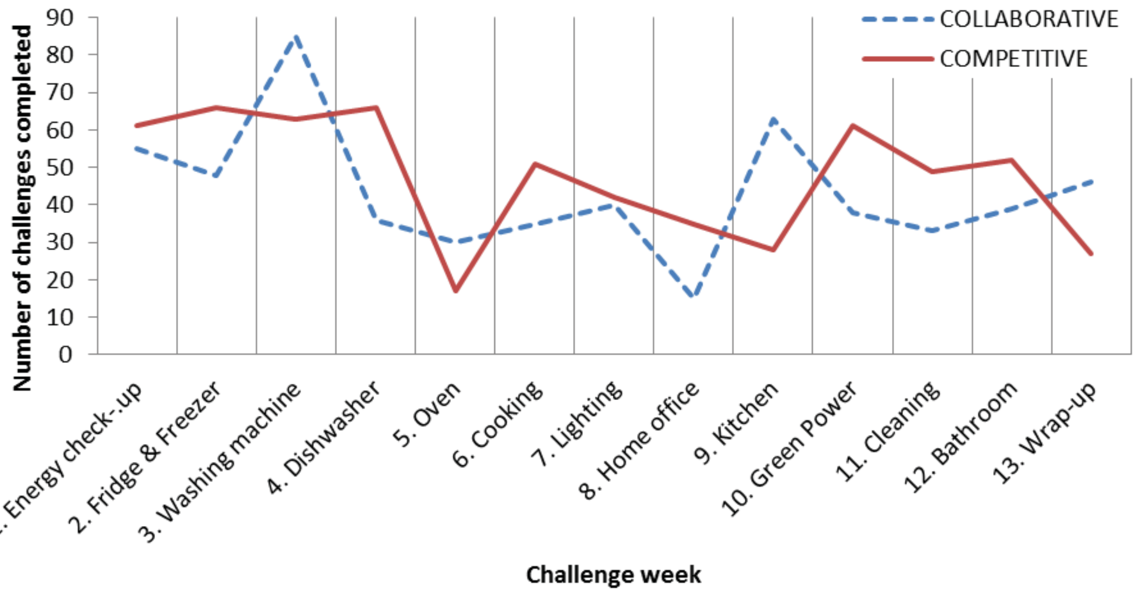

Figure 3: Progression of challenge completion of the competitive vs. collaborative teams (active participants only)

3.4 Behaviour and social processes

Qualitative changes in behaviour are analysed based on the pre- and post-test surveys (see Table 2). Both game modes significantly changed the intention to save energy and the reported behaviour compared to before the intervention, yet there is no difference between the two game modes. However, there is a slight tendency for the competitive game to result in more intention to save energy in the future. Even though the game mechanisms are designed with a focus on community engagement, the sense of community within the Social Power team is relatively low.

Table 2: Reported behaviour and social process between collaborative and competitive teams (all participants)

	Collaborative (n = 31)		Competitive (n = 37)		Difference	
Category	*M*	*SD*	*M*	*SD*	*t*	*p*
Impact and reported behaviour						
Reported impact of the intervention	4.23	1.77	4.65	1.76	-0.95	0.34
Reported electricity use after intervention	5.54	0.76	5.74	0.67	-1.16	0.25
Reported electricity use behaviour change (energy saving after – energy saving before)	0.49	0.6	0.46	0.82	0.18	0.86
Savings Intentions						
Intention to save energy in the future	4.92	0.9	5.25	0.9	-1.52	0.13
Social processes						
Sense of community in the Social Power team	3.25	1.72	3.45	1.83	-0.45	0.66

Note: Values range from 1 ‘does not apply’ to 7 ‘fully applies’, p < .01 = significant difference.

4 Conclusions

This preliminary analysis finds that the deployment of both a competitive and collaborative social game mode is effective in reducing electricity consumption. Neither approach outperformed the other, but long term efficacy of these feedback mechanisms will be examined in 2017.

The sense of community in the Social Power teams has been reported as rather low. Hence, it appears that the reported results are not specifically impacted by the wider social setting of the game, but possibly the self-comparison feedback instead. With the current results and experimental design, it is not possible to differentiate the effect between the individual feedback and social game mechanics, but planned follow-up interviews will help gain deeper insights into the motivational and social processes triggered (or inhibited).

Critical points in the present design might be (1) team formation and (2) anonymity, both of which were modelled as to accommodate a rather large team size (n = 30): players were randomly assigned to teams and did not create their own teams and natural social groups. Also, to preserve single users' privacy, performances were displayed to others only in aggregate form. Since the online world is absent of many basic cues of identity, personality, and social roles, this setting can make it harder for players to collaborate on a common goal.

Here, relying on out-of-game social media sources (Blog, Facebook) to motivate group engagement seems not to be effective. In the future, the communication aspect between team members should be revisited. An interesting field of research might be the integration of game design that facilitates existing real-life relationships over merely network-based virtual communities to maximize intra-group communication and support.

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