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KEEPING UP WITH THE JONESES: EXAMINING COMMUNITY-LEVEL COLLABORATIVE AND COMPETITIVE GAME MECHANICS TO ENHANCE HOUSEHOLD ELECTRICITY-SAVING BEHAVIOUR

Devon Wemyss[1]*, Roberta Castri[2], Vanessa De Luca[2], Francesca Cellina[2], Vivian Frick[1], Evelyn Lobsiger-Kägi[1], Pamela Galbani Bianchi[2], Christian Hertach[1], Tobias Kuehn[1], and Vicente Carabias[1]

1: ZHAW Zurich University of Applied Sciences
CH – 8401 Winterthur, Switzerland
*e-mail: wemy@zhaw.ch, web: http://www.zhaw.ch

2: SUPSI University of Applied Sciences and Arts of Southern Switzerland
CH – 6952 Canobbio, Switzerland
e-mail: roberta.castri@supsi.ch, web: http://www.supsi.ch

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Abstract

To test the effectiveness of competitive and collaborative settings on engaging households, a mobile app, called Social Power, was developed to provide electricity meter feedback in two gamified environments. The project aims at stimulating social engagement and promoting behavioural change to save electricity at the household level by forming teams of neighbours in two Swiss cities. The household participants are assigned to one of two teams: either a collaborative team where citizens in the same city try to reach a fixed, collective 10% electricity savings target together, or a competitive team which tries to save the most electricity in comparison to the other city.

The collaborative and competitive games were run in parallel as a three month field experiment (with long term monitoring after one year, planned for spring 2017) involving 108 recruited households, and 46 who actively played. The experiment complements the process of smart meter roll-outs initiated by the local energy utility in each respective city with the secondary aim of capturing added benefits of smart meters.

Weekly electricity-saving themed challenges are presented to the household member playing on the app. By playing, the participants can change their real-life electricity consumption by interacting differently with their home electricity appliances and at the same time acquire four types of points in the app: electricity saving, electricity efficiency, energy awareness and peak-shifting. New challenges each week and continued interaction aim to improve non-sustainable habits. Tips, quizzes with tangible prizes, and individual badges for accomplishments are used as further incentives for participation. Alongside the app, a blog page and Facebook exist to allow players to interact with each other. An

electricity use interface visualises the household electricity demand at hourly and weekly intervals and shows the change from the historical average, as well as their team's savings performance.
In this paper we introduce preliminary results on the short-term success of the two game environments after the intervention phase completed in May 2016.

1. INTRODUCTION

National governments set national electricity consumption targets with the aim to reduce CO_2 emissions, avoid hazardous nuclear waste products, release the dependencies on foreign imports, or mitigate long-term infrastructure investment in grid expansion and production capacity, amongst other things. This includes Switzerland, the country in focus of this study, where the Federal Office of Energy has set a goal of 13% reduction in electricity demand by 2035 [1]. The responsibility of ultimately reducing consumption falls on citizens, as well as other consumer groups. However, reducing individual electricity use is not driven by the above-mentioned motivations.
Creating real change at the individual level, in order to reach societal level goals, has been studied from various motivational perspectives in order to capture different drivers of decision-making and behaviour adoption [2]. Interventions, which may be in the form of information, a program, measure, or regulation, are designed to incentivize behaviour change along specific motivational lines [3]. Combining different motivational models into one or multiple interventions is most effective, however social and political context, as well as the type of intervention itself play critical roles in the outcome [4].
Interventions can be aimed at the individual to address personal decision-making and behavioural habits. A commonly understood economic incentive, such as a tax or bonus, can punish unwanted behaviour or reward the desired behaviour, respectively, however a long term intervention may be expensive. Alternatively, interventions may try to use social norms to impact behaviour of individuals who belong to a social group, such as sports team or neighbourhood, where expectations create external pressure to change a behaviour (eg. [5]). On the other hand, communities of practice of intrinsically motivated people can form and diffuse new behaviour by engaging households within a pre-existing, or newly forming, social setting [3]. More intrinsically, personal norms drive behavioural change through the perception of one's own responsibility and ability to make an energy-related decision and act out the change.
In particular for interventions that address loosely-tangible topics, such as climate change or electricity consumption in this case, information feedback is critical for increasing recognition and knowledge of a desired behaviour, as well as spurring action, but is not sufficient to change the behaviour [6][7]. Real-time electricity consumption feedback is a necessary baseline for bridging the gap between understanding actual consumption volume and when it is consumed, and thus ultimately being able to connect the electricity use to daily habits [8]–[10]. However, as seen in experiments of in-home electricity feedback monitors that trigger an initial interest and subsequent understanding, the information ultimately becomes quite consistent and the monitors no longer provide new and motivating

information [11], [12]. Thus either the monitor is no longer observed, or, potentially worse, a rebound effect occurs as the consumption information may be interpreted as being not so bad and the monitor reinforces the current behaviour [12]. The challenge is for the intervention to create a new habit, not just a short-term behaviour change [13].

While a desired outcome is the maintenance of the reduced electricity consumption (sufficient or curtailment) behaviour, there are few long-term studies which further monitor behaviour up to a year after the intervention (e.g. [12]). In order to overcome this, Breukers et al. [4] argue for an evolution from one-directional information transfer, to a more participative, interactive, personalized and contextualized intervention.

Many field studies have found that the inclusion of interactive, social, competition-like feedback and peer comparisons proves to be more effective in reducing individual energy consumption [8], [14]–[17] compared to more abstract, impersonalized information [4], [18].

In this context, a relatively recent methodology using game mechanics over internet-enabled smart devices, called "gamification", has emerged [19]. While gamification offers considerable opportunities to design competitive mechanisms, point systems, achievements and rewards in a visual context, its implementation in the context of wider groups and community-based engagement remains less explored [13][20]. However, with increased engagement and multiple interactions through a game, it is hoped to use gamification for sustainable habit creation.

Thus this study draws many of these motivations together and tries to provide insights into designing an effective intervention mechanism for saving electricity.

2. APPROACH

The Social Power project, the focus of this paper, was conceptualized to capture the behaviour change resulting from neighbourhood level competition, set targets, social collaboration, and personalized feedback with high temporal resolution (i.e. frequent measurements) of electricity use in a gamified mobile App. Thus, next to providing individual progression feedback in electricity savings, the Social Power App delivers also social group feedback as a way to make the information more meaningful and effective.

Transposed into a game mechanic, the Social Power App builds on a cooperative game environment that encourages participants to work together in a team to reach a common electricity-savings goal. The team's utility will therefore depend on the actions and choices made by each team member.

In this context, one of the main aims of the project is to determine whether a difference in goal-setting approaches might impact social group performance and better motivate households 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 provides a "competitive" goal-setting to explore whether facing a common 'opponent' in the game makes it a more attractive playing experience, which in turn better motivates players to iterate energy-saving actions over a prolonged period and, thus, ultimately creates a new habit at the individual level. The other form provides a "collaborative" goal-setting. Here the electricity-saving target is set and provided by the game system. Although this form might seem less dynamic than the open, competitive goal, it requires perseverance and determination, factors that might again enhance feedback and contribute to effectively nudging long term changes in everyday habits. The feedback and incentive structure differ between the two game mechanisms, as will be explained in the following sections. Within this field, there are few studies on whether a competitive or collaborative goal set-up induces (more) electricity savings and higher level of short and long-term engagement [13][21].

For each game mechanism, the Social Power App proposes a weekly series of energy-related challenge activities that embrace a bottom-up, personalised approach, empowering the participant to act in the real-world environment, thus contextualising the learning in their lives. Considering that individuals make decisions also according to their willingness to act and a belief that their action will be effective and beneficial [22], this approach avoids impersonal, generic instructions that may be difficult to implement in daily life and becomes more meaningful. Furthermore the challenges are designed to reward the good behaviour at each step, as well as to re-enforce the implementation intention of a new habit [3]. Ultimately, Social Power proposes a model of learning that occurs simply by 'doing' sustainable activities, rather than assuming a lack of awareness and a need to educate the end-users in a top-down manner in terms of energy usage.

2.1 The living lab experiment

Social Power launched a living lab field experiment [23] to complement the process of smart meter roll-outs initiated by two local Swiss energy utilities, with the secondary aim of capturing added benefits of smart meters. The game intervention, lasting three months, took place from February until May 2016 (with a planned long term monitoring into 2017) in the respective cities of Winterthur, Canton Zurich, and Massagno, Canton Ticino, Switzerland. Recruitment aimed at 120 household members with 60 from each city. Ultimately 108 (n = 53 in Massagno and n = 55 in Winterthur) participants voluntarily joined. Control groups (n = 30 per city at the outset), anonymously drawn, were included in the experiment as a benchmark, in order to compare the electricity consumption without the intervention during the same time period. The control groups were created with a stratified sampling approach to create a similar proportion of household types (i.e. single people vs. families, apartments vs. houses) as the participating teams.

The participating household members were provided with the Social Power app, and were randomly placed in one of the two game environments: a collaboration or competition. The collaboration encourages participants from the same city to reach a fixed, collective 10% average electricity-saving target. The second game is an open, dynamic energy competition between the two cities in pursuit of the highest electricity saving result.

To analyse the electricity-saving progress made by the participating households depending on the treatment, electricity consumption patterns are tracked before, during and after the intervention period see Figure 1 for the different tracking periods.

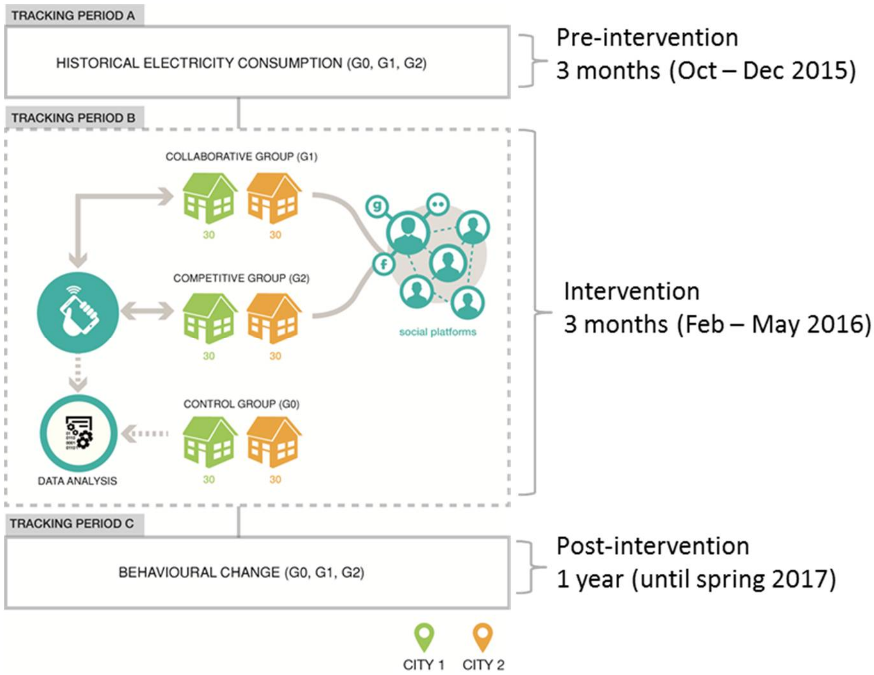

Figure 1 Tracking periods of the Social Power project

Tracking period A represents the "before intervention" phase (no feedback is provided): electricity consumption is compiled from historical data already collected by the electricity utilities. In period B, the intervention phase, the treatment groups are provided with the Social Power App and thus individual electricity feedback from their smart meters. As well, they receive social group feedback based on the competitive or collaborative game environment, and thus receive the additional gamified incentives for behavior change. In the final tracking period C, post-intervention, treatment groups are monitored in order to evaluate long term effects on electricity consumption. After the period B intervention phase, the game is closed and the treatment groups cease to receive gamified social group feedback. However, the Social Power App continues to display personal electricity consumption information from the participant's smart meters until the end of period C.
The choice of the tracking period guarantees comparability between electricity consumptions as length of the day is in fact similar between Autumn and Spring. The effect of different outdoor temperatures, which might influence remaining at home, is not considered in this preliminary analysis.
Prior to the intervention period, baseline energy literacy and psychological factors of the participating household members are characterized through a survey in order for comparison with a follow-up survey after the intervention. In this way, changes in knowledge, reported behavior, and social processes can be observed after the intervention.

2.2 App interface

The Social Power App visualizes two distinct games, collaboration and competition, using the similar visual elements. The design is shown in Figure 2 and consists of five sections.

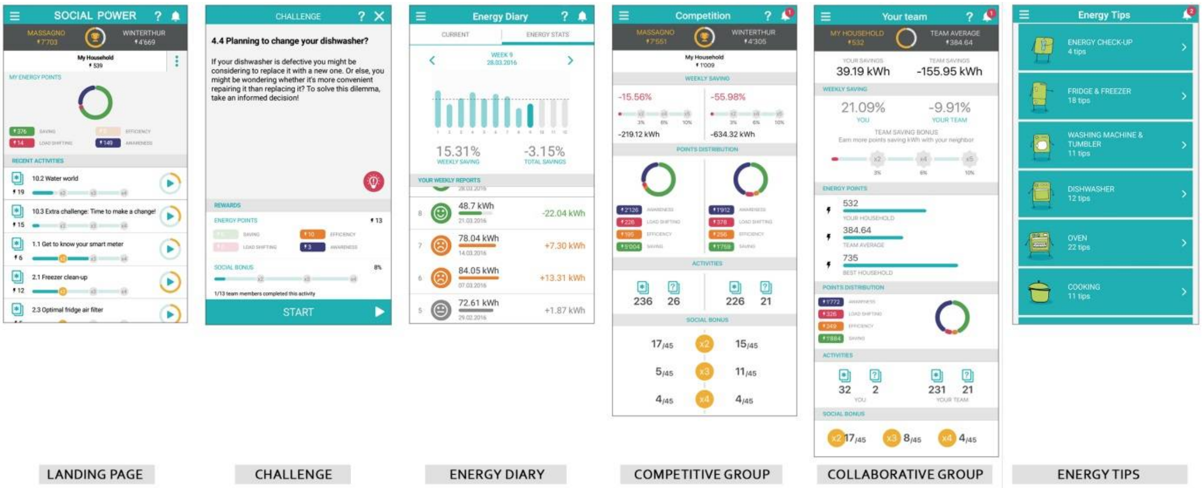

Figure 2 Screenshots of the Social Power App (l-r): Home screen with active challenges list; First step of a challenge, Energy Diary with weekly consumption reports, Competitive team interface, Collaborative team interface, Energy Tips

The electricity use feedback is presented in the Energy Diary with approximately real-time reporting on hourly consumption and weekly comparison with the historical consumption (i.e. the weekly average from Oct – Dec 2015). The competitive team interface compares the progress in savings, points earned, and number of challenge activities completed between the two cities. The collaborative team interface compares the individual household savings progress to their team's, how close they are to milestone targets, as well as the points earned and activities completed.

2.3 Challenge activities

The Social Power game presents a series of 50 electricity-saving related challenges proposed on a weekly base, covering 12 energy-related topics. Activities are the main feature for participant engagement and are composed of a series of different steps including informative steps, multiple choice questions, numeric and text inputs, or a photo upload. They are supplemented by a series of correlated energy tips. Through completing the challenges, participants earn points in the four point categories, as well as add to the social bonus which rewards the team when more people complete the same challenge, and earns the participant personal achievement badges (explained in the following section).
In the Social Power game, challenges largely engage the player in energy conservation measures at home. What is sought here, is to reduce electricity waste by promoting a more rational energy usage in daily life. This kind of action typically involves behavioural changes more than technological improvements (such as turning off lights, optimal fridge temperature, cooking simultaneously in the oven etc.). Some specific challenges draw the player's attention towards load shifting issues, inviting households to transfer some electricity loads during periods of high demand to off-peak periods, typically when running, for example, the dishwasher, oven, washing machine or tumble dryer. In a minor way, also

efficiency measures are promoted. However, since this kind of action results from investment in technology that use less energy while receiving the same level of end service (such as replacing an old oven with a more efficient model), it can be a large one time impact, but it depends on the age of the current installed appliance and whether it truly needs replacement. Lastly, various challenges engage the player in energy awareness-raising. Though this kind of measure does not provide tangible returns, it can be a prerequisite for a possible change towards a more sustainable lifestyle (e.g. getting to know your smart meter, learn about energy efficiency labelling on appliances, etc.).
On a monthly base, In-App quiz competitions are run with prizes promoting a sustainable lifestyle. On one hand these quiz competitions act as an extrinsic motivation to keep player's engagement high throughout the whole game period. On the other hand, they serve as a self-assessment guide to the player to test the acquired game-related energy knowledge.

2.4 Point system

Depending on the game to which the player has been assigned to, the collaboration or competition area of the App displays an overview of individual household and team performance in terms of electricity-saving goals and score. The point system serves as a tool for self-assessment and comparison, further supporting the direct information on electricity savings, thus affecting the gaming experience and hosting a certain degree of competition. The points are broken down into four categories based on the type of challenge: energy reduction, energy efficiency, load shifting and awareness-raising goals.
Table 1 explains the differentiated point system used to reward players' engagement in the corresponding domains.

Table 1 Point system used in the Social Power Game to reward efforts and evaluate achievements

Energy-saving points	Users are rewarded with energy-saving points either when (i) completing dedicated challenges, aimed at reducing personal electricity consumption at home or (ii) when the team's weekly energy consumption hits a 3%, 6% or 10% saving goal.
Energy efficiency points	Users are rewarded with energy efficiency points in case an obsolete appliance at home needs to be substituted and is replaced by a more energy efficient model. In this context, they are supported in the decision-making process of repairing or substituting a unit with a more energy efficient model.
Load shifting points	Users are rewarded with load shifting points when completing challenges aimed to better schedule their use of electrical appliances towards less critical hours.
Awareness points	Users are rewarded with awareness points when they perform activities that, though not having an immediate impact or direct relationship with one of the other three point categories introduced above, contribute to a more conscious use of electricity.

According to social proof theory [24] that predicts that individuals are more likely to engage in behaviors when they perceive others are also engaged, 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 (this can be seen in the left screen shot in Figure 2, as well as in the top quarter of the collaborative

and competitive screen shots), 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'. This works in the way that when a weekly savings goal is reached, or a competitive team saves more than the other city, an additional and significant points bonus is awarded to the team.

3.2 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. Here, players can find more detailed information about the energy-related topic of the week, post tips, offer suggestions, ask questions and can cheer on their own team mates. However few participants were engaged in these traditional communication channels and more interest was shown for the App challenges.

3. PRELIMINARY RESULTS

At the time of writing, the intervention was recently completed therefore preliminary results are presented here. In the first section, the drop-out of players is discussed, which resulted in smaller but active sample of participants who played for the entire intervention period.

3.1 Limitations from participation and data transmission

As is typical with decreasing novelty of something new, some participants lost interest during the intervention and after some weeks no longer participated in completing challenges. Additionally, some registered participants did not download the app, and therefore never played. Since participation by all team members is rewarded in the game through the social bonus, non-active players impact the game play for the active players. The number of active players is seen in Table 2. The control group was therefore adjusted to continue to represent the household distribution of the active players, and for the analysis totalled 46 households (n = 23 from Massagno, n = 23 from Winterthur).

Table 2 Number of active players out of the total recruited during the entire intervention period

Teams	Competitive	Collaborative
Massagno	13 / 26	10 / 27
Winterthur	11 / 28	12 / 27
Total	24 / 54	22 / 54

An additional difficulty impacting the participant's experience was the presence of gaps in the electricity consumption data throughout the intervention period. Due to a technical data transmission problem from some single smart meters to the Social Power game platform for some of the participating households, the transmission of hourly data was either unpredictably delayed or not at all received in the Energy Diary of the app. This resulted in incorrect savings calculations also at team level, until a reset with correct data was made.

Corrections for both of these limitations were made after the first two months of the game play. Thus during the last four weeks of the game, only the active players were still in the game and they had a corrected overview of their electricity. This created a more motivating game environment, as the active players could better use the social bonus with the expectation that other team members were equally engaged. The removed players thus no longer had access to the challenge activities, but still could access their Energy Diary and own electricity consumption.

3.2 Electricity savings

At the time of writing, the authors present data that has been corrected due to the errors with data transmission from the smart metes mentioned previously. However, as this is a preliminary analysis, the presence of further errors and the repercussions of the known errors, are not yet known.

A first analysis without correcting for temperature, which may have an effect of home presence, shows a difference between the participating teams (active participants only) and the respective control groups, see Table 3. Randomization check showed that experimental groups and control groups did not differ significantly in their historical electricity consumption measured over Oct – Dec 2015. That is the collaborative group, $M(SD)$ = 803.2 kWh (560.3) did not initially differ in their electricity use from the control group, $M(SD)$ = 793.3 kWh (527.4), t = 0.07, p = .94, and neither did the collaborative group, $M(SD)$ = 735.4 kWh (622.3), t = 0.41, p = .68.

Both teams playing in the intervention had reduction in their electricity consumption compared to the historical reference, as well as compared to the control group which consumes more electricity during the intervention period, as seen in **Erro! A origem da referência não foi encontrada.**. In the collaborative game approach, the amount of energy saved was higher, $M(SD)$ = 42.2 kWh (83.2), than in the control group where more energy was used during the game period than before, $M(SD)$ = -130.1 kWh (312.5), t = 3.49, p = .01. Also participants in the competitive game saved more energy during the game, $M(SD)$ = 28.0 kWh (112.6), than the same control group, t = 2.39, p = .02. Electricity savings did not differ significantly between collaborative and competitive group, t = 0.48, p = .63.

Further analyses will investigate why members of the control group increased their consumptions and assess the overall statistical significance of the results gathered.

Table 3 Team household consumption savings (active players only)

Teams		n	Total weekly household 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

Comparing the two game approaches against each other, neither of the competitive teams reached the 10% goal, however they both had significant savings. The changes in savings on a weekly basis can be seen for each game type in Figure 3 and Figure 4. Note that a data point below zero, means higher consumption, and no savings.

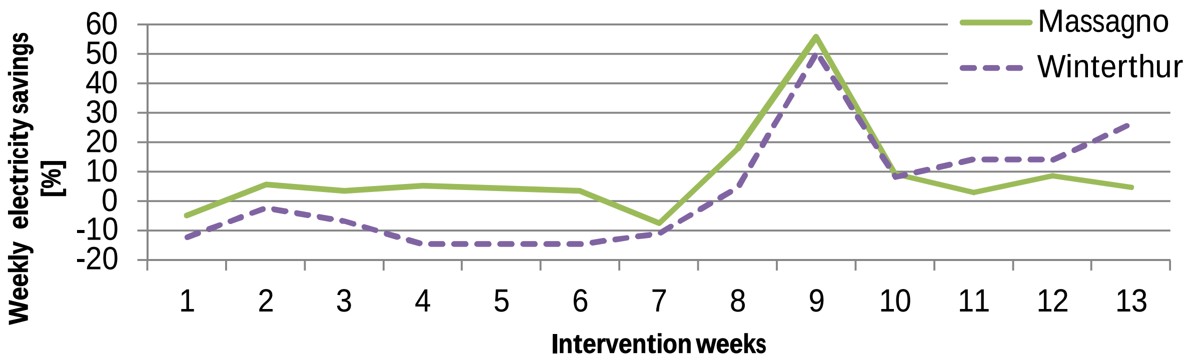

Figure 3 Weekly electricity savings by the collaborative teams (active players only)

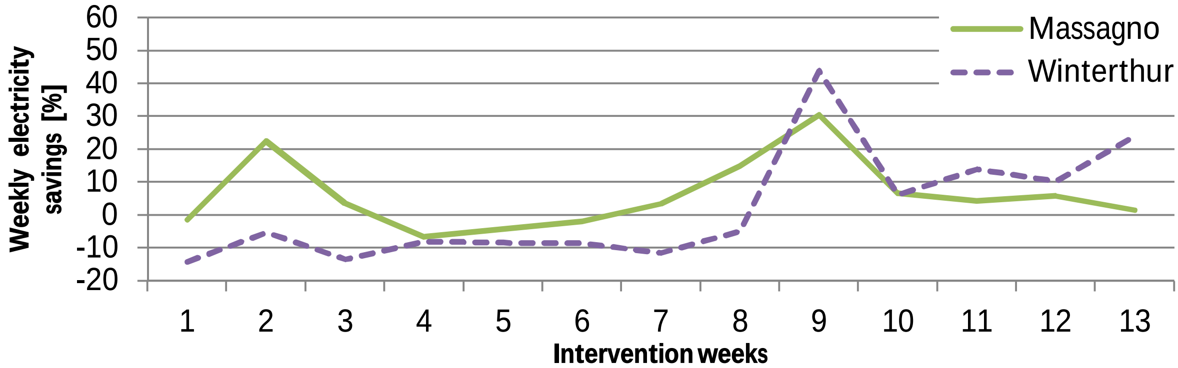

Figure 4 Weekly electricity savings by the competitive teams (active players only)

The peak occurring in week nine corresponds to Easter holidays for both cities. Likely many households were away from home and not consuming electricity, thus savings were high. In later analyses, this will be discussed as non-typical electricity consumption.
In this representation it is possible to see how the Winterthur team appears to have learned over time and gradually saved more electricity over time. Massagno has a more consistent savings pattern.

3.3 Challenge engagement

Each week, on Monday, the participants could access new challenge activities related to a specific theme. The number of challenges completed on each week day, summed over the entire 13 week intervention period, is presented in Figure 5.

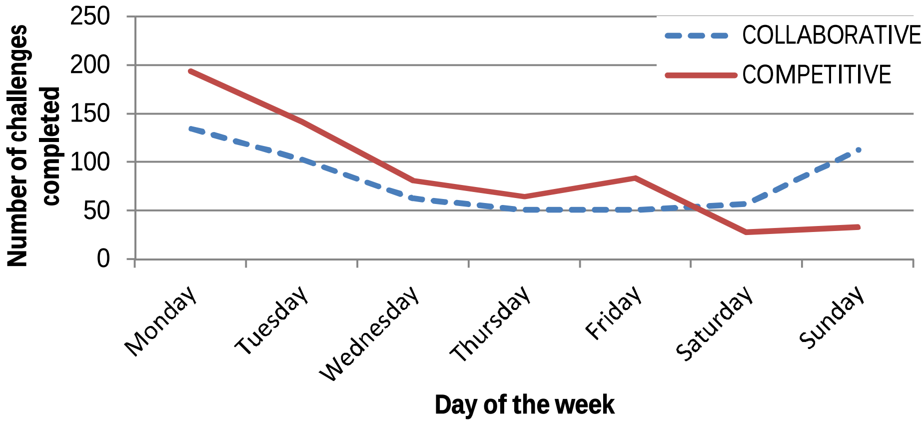

Figure 5 Total number of challenges completed per day of the week (active participants only)

The general tendency is that challenges are completed on Monday, when the challenges are released. It appears that the competitive team is slightly more active at the beginning of the week when the new challenges are released, whereas the collaborative teams finished their challenges on Sundays. This is particularly interesting as not all of the challenges can be completed within one day.

The engagement level in completing the activities does not differ between the collaborative and the competitive teams. In general, engagement was initially high, but reduced and remained low in the second month, as seen in Figure 6**Erro! A origem da referência não foi encontrada.**. In the third month, however, the engagement slightly increases. During this month, there was increased communication between the project team and the participants concerning the removal of the non-active players, a reset of the points, as well as the final quiz.

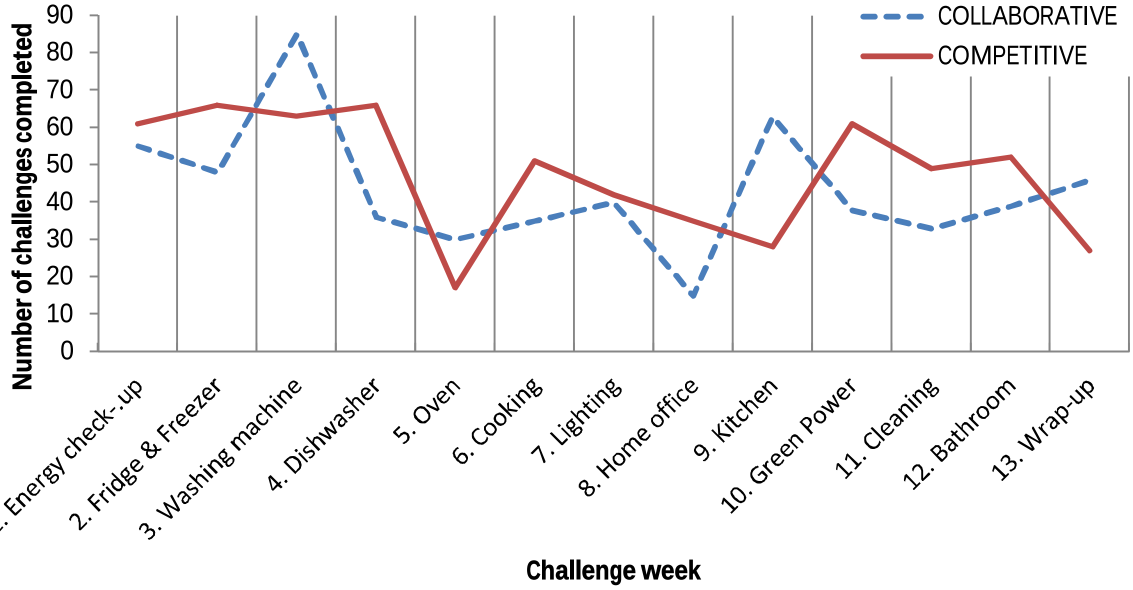

Figure 6 Progression of challenge completion of the competitive vs. collaborative teams (active participants only)

3.4 Effect on electricity behaviour, savings intention and community feeling

Qualitative changes that occurred during the intervention period are determined through the responses to two surveys, pre- and post-intervention. Questions were asked on the categories outlined in Table 4 on a scale of 1 to 7 (4 being the middle value). 7 is the more positive score in this context, thus more sufficient behaviour, and 1 implies a high electricity use behaviour.

Reported electricity use in the collaborative group improved, i.e. became more sufficient, from before the intervention, $M(SD)$ = 5.11(0.80), to after the intervention, $M(SD)$ = 5.60(0.70), t = -4.51, $p < .001$, D = 0.66. Reported electricity use also improved significantly in the competitive game from before the intervention, $M(SD)$ = 5.31(0.77), to after, $M(SD)$ = 5.77(0.65), t = -3.42, $p < .01$, D = 0.66. Both game reported a positive impact of the intervention.

Both games could significantly change the intention to save energy and reported behaviour over the intervention period. Yet, as seen in Table 4, no noticeable differences between the two game settings could be detected. 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. Likewise no statistical differences between the two groups could be found in the perception of injunctive and descriptive norms, however there is tendency that the competitive group feels more influenced by team member’s expectations.

Table 4 Reported behaviour and social process between collaborative and competitive teams (all participants)

Category	Collaborative (n = 31) *M*	*SD*	Competitive (n = 37) *M*	*SD*	Difference *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
Injunctive Norm of Social Power team	4.05	1.54	4.61	1.63	-1.43	0.16
Descriptive Norm of Social Power team	4.43	1.12	4.88	1.16	-1.58	0.12

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

4. DISCUSSION

The results above indicate that the Social Power game succeeded in motivating people to reduce their energy consumption. Both goal-setting approaches (competitive and collaborative) showed these significant positive impacts compared to the control groups, but and no differences between the two groups could be detected, thus both approaches are suitable to engage people. Considering the large increase in consumption of the control group during the intervention period, further analysis needs to be made to consider why this occurred, and whether the small size of the control group (n = 23 in both cities) contained outliers.

Since the differences between the game types are not significant, one can also argue that reaching a goal together or beating another team in energy savings is not what motivates participants, but rather the setup of the App with challenges, tips and quizzes. With this experimental design, it is not possible to differentiate the effect between the individual feedback and social game mechanics.

In a game, where players need to work in a team to achieve a common goal, communication and social interaction are essential. Although mobile game applications offer communication flexibility in the sense that players no longer need to be physically co-located in order to interact, it also has its flaws. Many basic cues of identity, personality, and social roles are absent in the online world [25], making it harder for players to understand each other and agree on plans of action. In addition, there is an increased risk of cheating practices by players. In this context, the Social Power game explicitly designed some features to favor social interaction, providing the game with elements such as the “Social bonus” and “Team Saving Bonus”. However, these seem to not have been enough.

Currently the Social Power game has to rely on out-of-game social media sources (the blog and Facebook page) which were minimally used as communication channels by the players during the game.

The sense of community in the Social Power team was reported as rather low. The strength of this motivation does not appear to be very high, which may be a result of the required anonymity between players and the lack of physical meetings, thus they could not build up the same sense of team inclusivity. Thus, in the future, the communication aspect between team members will probably have to be revised. However, from this preliminary evaluation it is not clear yet whether keeping up with the Joneses was or was not the decisive factor for engaging in electricity saving.

Participants' response to the different engaging elements proposed by Social Power will be investigated by means of interviews and focus group research, involving both the active participants and those who abandoned the game early. Qualitative analyses will allow us to identify the most effective motivational elements, in particular to investigate the real motivational effect of social game mechanics respect to individual activities, and to identify reasons for early drop-out.

The differences in the achieved savings between the two cities may be explained by the fact that in Winterthur quite a large amount of the participants live in a sustainability-oriented housing complex, which attracts environmentally aware people. Additionally, the infrastructure in these houses is already very energy efficient and supports energy sufficiency. Thus, the Winterthur participants had less potential to save in comparison to Massagno. High potential participants should be targeted (e.g. old houses, no minergie- or passive house standard) who can reach more significant savings and are relatively unaware of energy efficient behavior. Further, as the participation in the project was voluntary, the sample of participants was likely one which was electricity-savvy and conscious of electricity use behavior. In further research and app development engaging low-interest groups should be a main goal.

5. CONCLUSION

Overall this paper reports results of a three month long field experiment which gamified household electricity consumption through the implementation of two different goal-settings social game dynamics: a more competitive and a more collaborative one. This approach was taken to make electricity visible and engage people in a 'fun' way on a topic that is typically only indirectly considered through the electricity bill. This technical and social innovation connects consumption data to households habits and strives to maximise feedback efficacy by (1) increasing collective capacity-building for change, (2) supporting mutual improvement in the adoption of a sustainable life style, (3) favouring the viral diffusion of best practices. The comparison of the competitive vs. collaborative approach was preliminarily assessed here. Both approaches were found to be effective in reducing electricity consumption, but neither outperformed the other. The present study demonstrates the effectiveness of combining the field experiment with surveys that measure psychological variables in order to attain more accurate information on the social dynamics, consumption behaviours and psychological effects. Further analyses will be completed

which combine the quantitative savings with qualitative self-reported behaviour and data from the Social Power app. The long-term impacts will be analysed in Spring 2017.
As the active participants demonstrated curiosity toward gamification and interest to learn good electricity-use practices, we recommend to further develop traditional interventions, that today still focus mainly on providing consumers with economic incentives and information, in the direction of socially embedded interventions. It is essential to not neglect the importance of addressing behaviour as a socially-embedded attribute. This is relevant not only for electricity, but also for other sustainability fields where the use or impacts are rather invisible or indirect.

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REFERENCES

[1] Swiss Federal Office, “Botschaft zum ersten Massnahmenpaket der Energiestrategie 2050 und zur Volksinitiative « Für den geordneten Ausstieg aus der Atomenergie (Atomausstiegsinitiative)»,” 2013.

[2] C. Wilson and H. Dowlatabadi, “Models of Decision Making and Residential Energy Use,” *Annu. Rev. Environ. Resour.*, vol. 32, no. 1, pp. 169–203, 2007.

[3] T. Kurz, B. Gardner, B. Verplanken, and C. Abraham, “Habitual behaviors or patterns of practice? Explaining and changing repetitive climate-relevant actions,” *Wiley Interdiscip. Rev. Clim. Chang.*, vol. 6, no. 1, pp. 113–128, 2015.

[4] S. C. Breukers, R. Mourik, and E. Heiskanen, “Changing Energy Demand Behaviour: Potential of Demand-Side Management,” in *Handbook of Sustainable Engineering*, J. Kauffman and K.-M. Lee, Eds. Dordrecht: Springer Science+Business Media, 2013, pp. 773–792.

[5] C. Moser, Y. Blumer, R. Seidl, V. Carabias-Hütter, and B. Furrer, “Multiplying energy-saving behaviour in cities through formal social groups,” in *ECEEE Summer Study Proceedings*, 2015, pp. 2133–2141.

[6] W. Abrahamse, L. Steg, C. Vlek, and T. Rothengatter, “The effect of tailored information, goal setting, and tailored feedback on household energy use, energy-related behaviors, and behavioral antecedents,” *J. Environ. Psychol.*, vol. 27, no. 4, pp. 265–276, 2007.

[7] J. Sabadie, “Technological innovation, human capital and social change for sustainability. Lessons learnt from the Industrial Technologies Theme of the EU’s Research Framework Programme,” *Sci. Total Environ.*, vol. 481, no. 1, pp. 668–673, 2014.

[8] W. Abrahamse, L. Steg, C. Vlek, and T. Rothengatter, “A review of intervention studies aimed at household energy conservation,” *J. Environ. Psychol.*, vol. 25, pp.

273–291, 2005.
[9] D. R. Schley and M. L. DeKay, "Cognitive accessibility in judgments of household energy consumption," *J. Environ. Psychol.*, vol. 43, pp. 30–41, 2015.
[10] S. Attari, "Public perceptions of energy consumption and savings," *Pnas*, pp. 1–16, 2010.
[11] T. Hargreaves, M. Nye, and J. Burgess, "Making energy visible: A qualitative field study of how householders interact with feedback from smart energy monitors," *Energy Policy*, vol. 38, no. 10, pp. 6111–6119, 2010.
[12] T. Hargreaves, M. Nye, and J. Burgess, "Keeping energy visible? Exploring how householders interact with feedback from smart energy monitors in the longer term," *Energy Policy*, vol. 52, pp. 126–134, 2013.
[13] L. T. McCalley and C. J. H. Midden, "Energy conservation through product-integrated feedback: The roles of goal-setting and social orientation," *J. Econ. Psychol.*, vol. 23, pp. 589–603, 2002.
[14] A. R. Carrico and M. Riemer, "Motivating energy conservation in the workplace: An evaluation of the use of group-level feedback and peer education," *J. Environ. Psychol.*, vol. 31, no. 1, pp. 1–13, 2011.
[15] N. D. Sintov and P. W. Schultz, "Unlocking the potential of smart grid technologies with behavioral science," *Front. Psychol.*, vol. 6, no. April, pp. 1–8, 2015.
[16] S. Darby, "the Effectiveness of Feedback on Energy Consumption a Review for Defra of the Literature on Metering , Billing and," 2006.
[17] D. Vine, L. Buys, and P. Morris, "The Effectiveness of Energy Feedback for Conservation and Peak Demand ," *Open J. Energy Effic.*, vol. 2, no. 01, pp. 7–15, 2013.
[18] M. Costanzo, D. Archer, E. Aronson, and T. Pettigrew, "Energy conservation behavior: The difficult path from information to action.," *Am. Psychol.*, vol. 41, no. 5, pp. 521–528, 1986.
[19] S. Deterding, D. Dixon, R. Khaled, and L. Nacke, "From Game Design Elements to Gamefulness: Defining 'Gamification,'" in *Proceedings of the 2011 annual conference extended abstracts on Human factors in computing systems - CHI EA '11*, 2011, pp. 9–16.
[20] P. Weiser, D. Bucher, F. Cellina, and V. De Luca, "A Taxonomy of Motivational Affordances for Meaningful Gamified and Persuasive Technologies," 2015.
[21] D. Foster, S. Lawson, M. Blythe, and P. Cairns, "Wattsup ?: Motivating reductions in domestic energy consumption using social networks," *Nord. 2010*, pp. 178–187, 2010.
[22] P. C. Stern, "Toward a Coherent Theory of Environmentally Significant Behavior," *J. Soc. Issues*, vol. 56, no. 3, pp. 407–424, 2000.
[23] B. Bergvall-Kåreborn, D. Howcroft, A. Ståhlbröst, and A. M. Wikman, "Participation in Living Lab: Designing Systems with Users," in *Human Benefit through the Diffusion of Information Systems Design Science Research: IFIP WG 8.2/8.6 International Working Conference, Perth, Australia, March 30 -- April 1, 2010. Proceedings*, J. Pries-Heje, J. Venable, D. Bunker, N. L. Russo, and J. I.

DeGross, Eds. Berlin, Heidelberg: Springer Berlin Heidelberg, 2010, pp. 317–326.

[24] R. B. Cialdini, "Harnessing the Science of Persuasion. (cover story)," *Harv. Bus. Rev.*, vol. 79, no. 9, pp. 72–79, 2001.

[25] J. S. Donath, "Identity and deception in the virtual community," in *Communities in cyberspace*, 1999, pp. 29–59.