A Case Study on the Use of Social Electricity by Cypriot Residents

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Abstract

This technical report describes the analysis of results gathered through a large questionnaire-based survey combined with mini focus group studies, focusing on the investigation of user perceptions related to several aspects of Social Electricity, six months after its official release. This study provides interesting insights about the usefulness and acceptance of large-scale, green ICT social applications, as well as their potential for affecting energy awareness and encouraging users to become more sensitive about the environment.

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Chapter 1

Introduction

According to various scientific studies, such as [3], energy awareness through timely electrical consumption feedback can influence residents to reduce their electrical consumption by a fraction of 5-15%. However, still, people may not clearly consider quantitatively how much energy they consume. They do not possess the proper metrics to define whether their total consumption is low, average or high. Besides, in most countries around the world, people receive an electricity bill only once every month, and they cannot realize the *semantics* of their electricity footprint. Feedback alone is not enough, since people tend to lose their interest after some weeks [2].

A promising way for consumers to perceive their consumed energy is to compare it with the amount consumed by relatives, friends and neighbors. Comparative feedback is an effective approach for engaging people in sustainable actions and practices [4]. Comparative feedback exploits the phenomenon of social norms, and in particular normative social influence, according to which people have a tendency to agree on the values, beliefs, attitudes or behaviors of others [1]. Applying social norms in the energy use behavior of consumers, they may affect them to reduce their consumption in case they understand that it is "not normal".

For developing green online applications, social networking sites are suitable platforms for offering comparative feedback, as they maintain a highly accurate graph of users' social networks and friends. Online social networks are easy to access, widely used and largely accepted by users.

Having these in mind, we have developed Social Electricity, which is a Facebook application[1] that allows people to perform comparisons of their electrical consumption. By effective and realistic comparisons with friends and neighbors, consumers may perceive their energy behavior and take steps to reduce their electricity and carbon footprint.

We collaborated with the Electricity Authority of Cyprus[2] (EAC), which is the only electric utility in Cyprus. EAC gave us access to the consumption data of around 300,000 domestic premises of the country, collected every two months. More frequent updates are not yet possible, because EAC has still not upgraded its electrical meters to smart meters. Respecting the privacy of Cypriot citizens, the electricity measurements were aggregated at street level (address, postal code, city). Thus, it could not possible to derive the analytic consumption of some residence. Of course, residents are encouraged to add by themselves their exact monthly consumption, and compare it with their local neighborhood or their friends.

In detail, Social Electricity supports the following features:

[1] https://apps.facebook.com/socialelectricity/
[2] http://www.eac.com.cy/

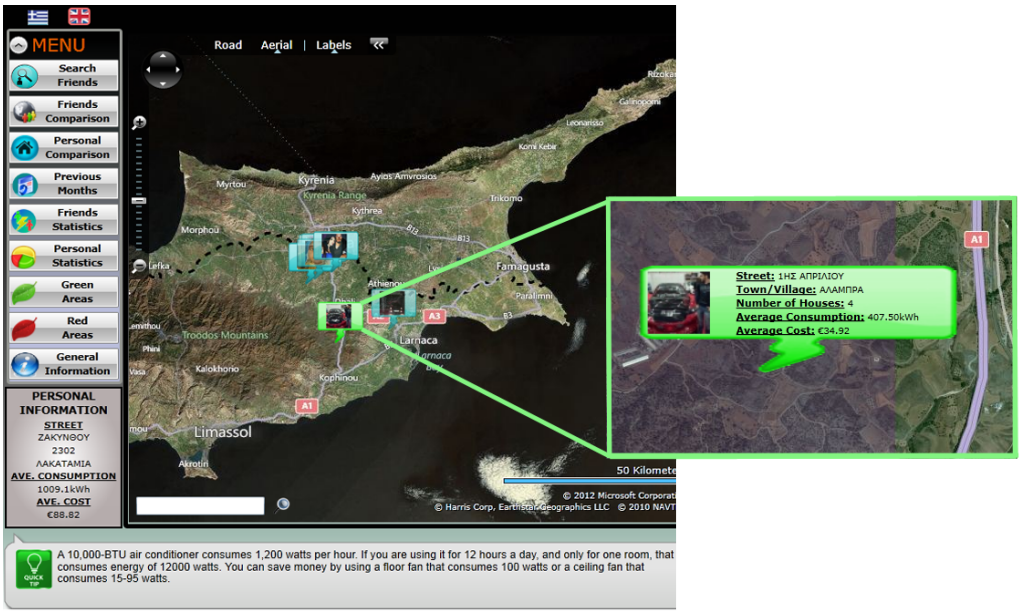

Figure 1.1: Snapshot of Social Electricity showing user's friends/their consumptions on the map.

- It allows people to compare their electricity footprint with that of their neighborhood, village or town, to perceive if their own consumption is low, average or high.
- It associates electrical consumption with actual costs, enabling users to have a more meaningful view of their energy profile.
- It promotes sharing of peoples' electricity consumption figures with their friends at a street level.
- It gives useful tips to people to reduce their consumption and be educated about best energy-saving practices.
- It provides statistics about the most energy-efficient streets, villages and cities near the user's location.
- It offers statistics about the least/most energy-efficient areas near the user's place of stay.
- Statistics are given concerning the areas with the least/most energy consumption in the whole of Cyprus.
- Users may observe the electrical consumption of their street in previous months (or in the same month in previous years) and compare it with the present street consumption. This comparison may also include the energy behavior of their friends' streets.

Snapshots of the application are provided in Figures 1.1, 1.2 and 1.3.

The following chapters present an extensive analysis of results, gathered through a questionnaire-based survey combined with mini focus group studies, aiming to investigate end user perceptions related to several aspects of Social Electricity.

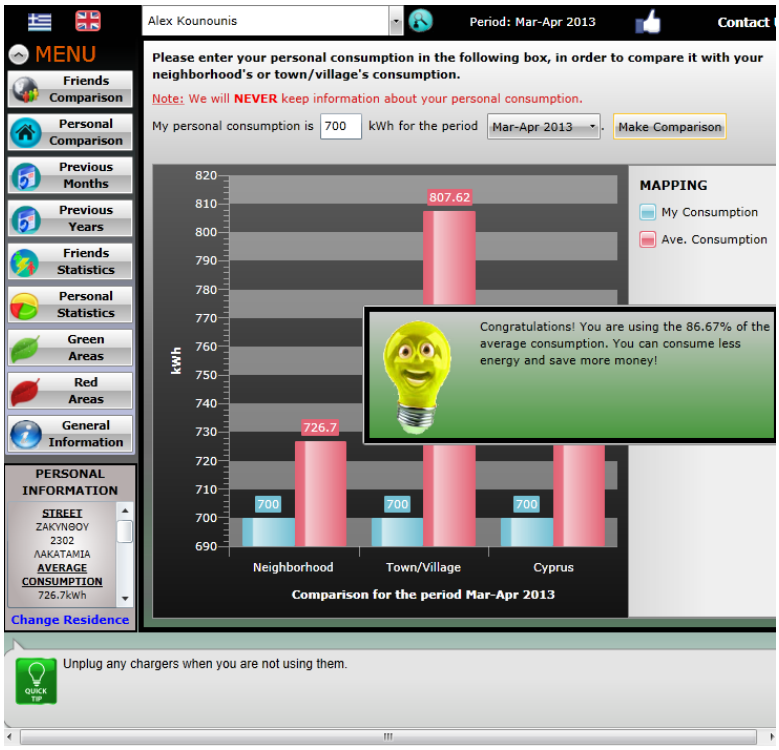

Figure 1.2: Comparison of the personal electrical consumption of the user with his neigborhood, city and with the whole of Cyprus.

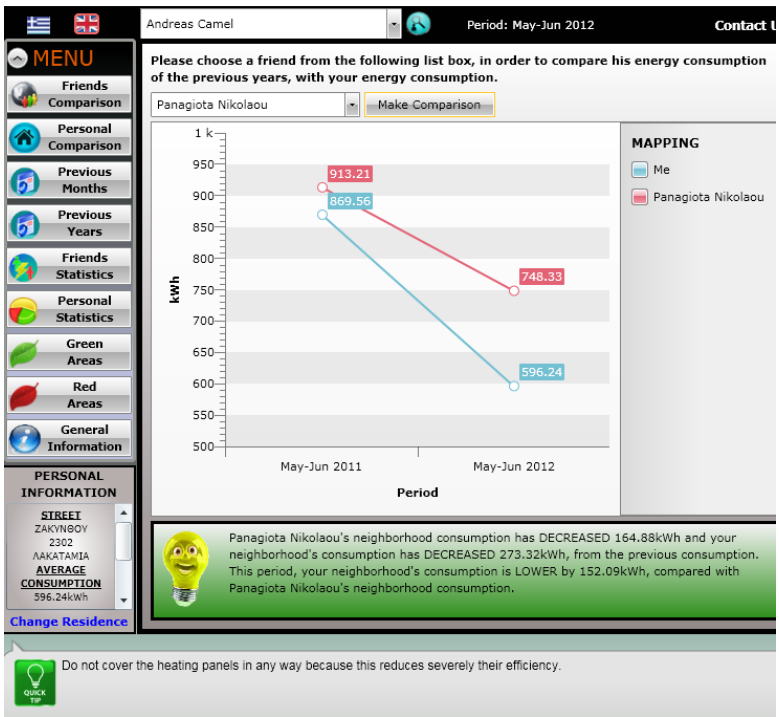

Figure 1.3: Comparison of electrical consumption with previous months or the same month in previous years, including also the energy figures of the online friends of the user.

Chapter 2

Method of Study

In this chapter, we present a user study aiming to investigate users' perceptions relating to various aspects of Social Electricity, along with the effects of performing comparative feedback to affect citizens towards energy conservation. Our study aimed to address the following research questions:

- How effective and useful is the concept of Social Electricity for raising energy awareness?
- What are the motivations influencing people to reduce their consumption?
- Which are the privacy concerns and the limits for sharing electricity consumption data in a large-scale social application?
- What is the potential of ICT applications that employ normative social influence?

2.1 Procedure

A survey was conducted to collect empirical evidence on the importance of quality factors relating to the usage of the application. We formed an online questionnaire consisting of 65 questions. The research questions were grouped in five categories: demographics (sex, age, education, income), usefulness and influence, motivations, privacy and potential. A five-point Likert scale was used to rank the level of importance from "Not Important (1)" up to "Most Important (5)".

Furthermore, semi-structured mini focus group sessions [5] were conducted with the participants' subjective preferences and perceptions of the provided features, and their influence towards energy awareness. The sessions have been directed by one objective interviewer and minutes were recorded by one observer. The focus group sessions have been organized in two phases. The first phase consisted of a discussion around the research questions of the evaluation. The second phase involved free brainstorming, in which the groups were encouraged to suggest enhancements for further engaging users towards energy savings.

The participants were recruited by sending an invitation through email to users who were using the application for more then two months. To increase the overall participation, we offered six energy meters to some of our subjects after a lottery.

	Male	Female	18-24	25-34	35-49	50-64
N	125	72	62	98	32	5
%	63.4	36.6	31.4	49.7	16.2	2.5

Table 2.1: Demographics of the sample.

2.2 Demographics of Participants

A total of 197 people participated in the survey. The distribution in age groups is depicted in Table 2.1 and is graphically displayed in Figure 2.1, showing the sex of each age category as well. The most popular age group was 25-34 years old (N=98, freq=49.7%), mostly young couples. In terms of the sex of the participants, males outnumbered females by 63.4%.

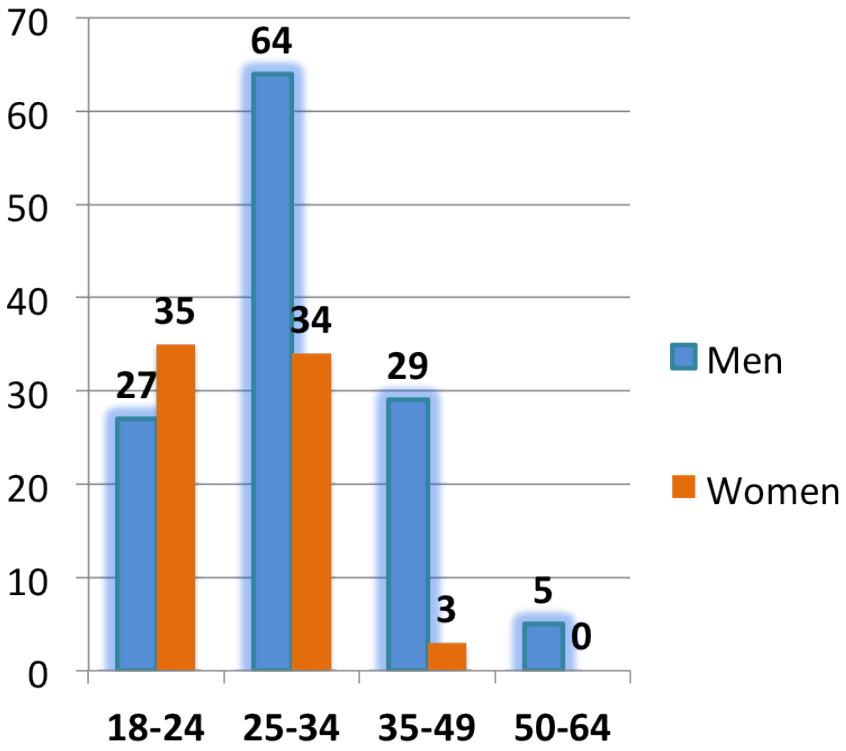

Figure 2.1: Age distribution of participants.

Chapter 3

Analysis of Online Questionnaires

The findings derived from the online questionnaires are discussed in the following sections, categorized according to the main research questions as listed in the previous chapter. The statistical significant results obtained after an analysis of the responses, are listed at the end of the chapter in Section 3.5, Table 3.2.

3.1 Usefulness and Effectiveness

From our 198 subjects, 82% found Social Electricity useful as a green ICT application (M=4.22, SD=0.83 on a 5-point scale, 5 being "Very Useful"), as presented in Figure 3.1. A statistical analysis proved that male found it significantly more useful in relation to female (Mann-Whitney Test, U=5.658, Z=3.12, p=0.02). More than half of the users (57%) claimed they were positively affected to become more energy-aware (M=3.59, SD=1.10).

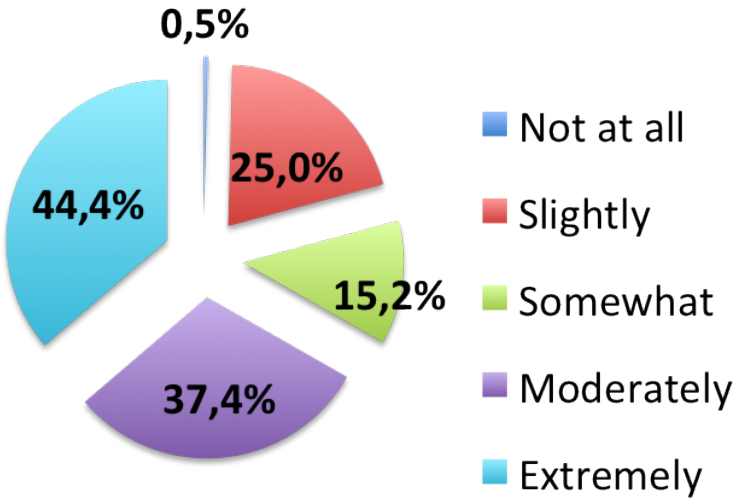

Figure 3.1: Distribution of the answers of the participants in the question whether they found Social Electricity useful as an application.

Moreover, 79% of the users declared they perceived their energy behavior and understood whether they consume low, medium or high amounts of electrical energy (M=4.0, SD=0.90 on a

5-point scale, 5 being "Understood Very Well"), as shown in Figure 3.2. A significant percentage of 63% claimed their consumption was reduced in regard to the same period last year. This is another positive fact indicating a possible initial success of Social Electricity, however, we need to take into account that there is an overall decrease in electrical consumption around the country, due to different weather conditions, the financial crisis and the increasing cost of electricity.

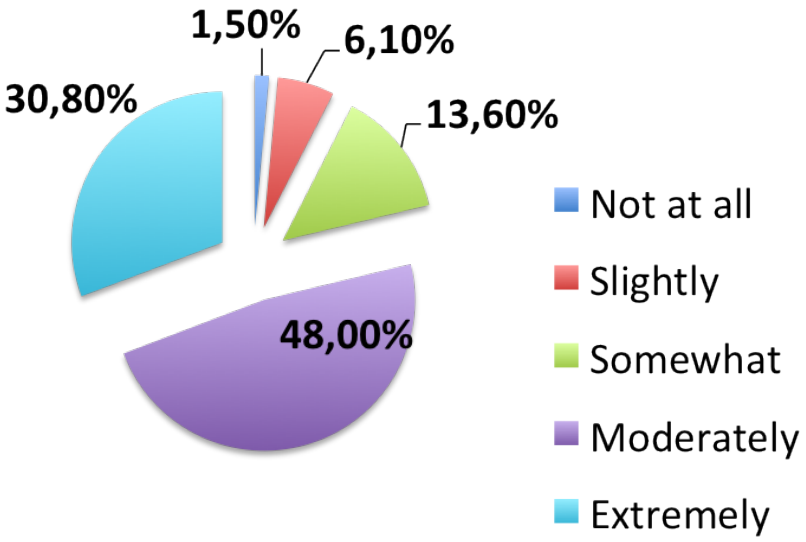

Figure 3.2: Distribution of the answers of the participants in the question whether they understood their energy behaviour after comparing with others.

A percentage of 18% believed their energy consumption is high, in comparison to their neighbors and friends. This is apparently the main target group that needs to become more aware about energy consumption. The remaining, 59% believed they had an average consumption while 23% a low consumption. The percentage of users with low consumption was larger than those with high (23%), possibly because users of such applications are more environmentally-aware, as this finding was observed as well in [6].

We also asked the participants whether the energy consumption of their street, as observed through the historical comparison feature of the application, was improved since the start of the application. A rather small percentage of 30% found the figures of their area to improve, and this is rational, if we consider that the contribution of each user to the consumption of his neighborhood is only small. The detailed answers of the users can be observed in Figure 3.3.

Table 3.1 shows the usefulness and influence of each of the features of Social Electricity to the users (average ratings and standard deviations on a 5-point scale, 5 being "Very Useful" or "Very Influential"). The findings indicate that users prefer simple and easy to understand measures such as tips for saving energy and comparisons with their neighbors. Interestingly, social comparisons come last in their preferences. Moreover, different age groups are affected by different features. As our analysis showed, the age group 18-24 was significantly affected by the energy-saving tips ($r(60)=403$, $p=0.001$), while the age group 35-49 by temporal comparative feedback ($r(30)=-386$, $p=0.029$).

More than half of the users (57%) are aware of their green and red friends. Around 37% claimed they discussed with three or more of these friends about topics related to energy and/or electricity. This is a sign that a fruitful discussion for energy conservation has been triggered.

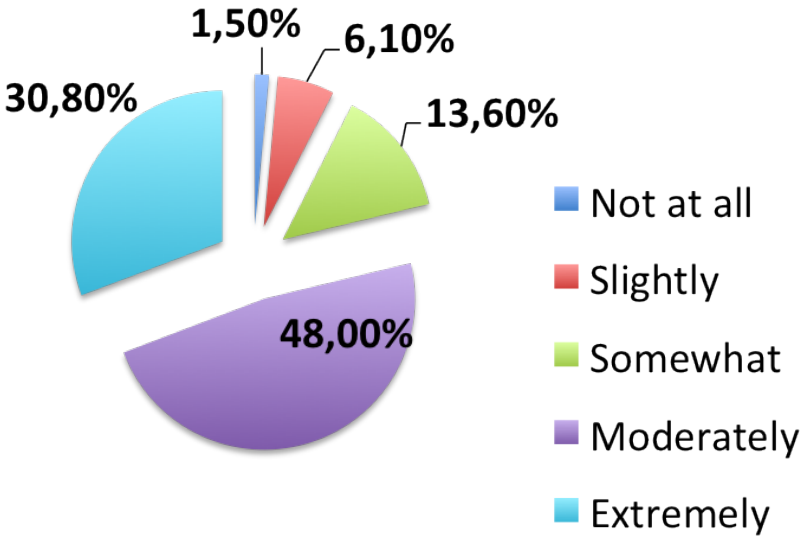

Figure 3.3: Distribution of the answers of the participants in the question whether the energy figures of their street have been improved since the launch of Social Electricity.

Feature	Usefulness	Influence
Energy-saving tips	4.17 (0.91)	3.94 (1.01)
Local comparative feedback	3.85 (0.99)	3.75 (1.01)
Temporal comparative feedback	3.74 (1.06)	3.44 (1.12)
Social comparative feedback	3.62 (1.08)	3.36 (1.11)

Table 3.1: Average ratings of Social Electricity features, in terms of usefulness and influence.

Finally, considering frequency of use, a large percentage of the participants (41%) consider themselves using occasionally the application, i.e. once every month (M=2.85, SD=0.93 on a 5-point scale, 5 being "Very Frequently"). It is remarkable that a significant group (34.%) use the application less than once a month. This may be explained by the fact that energy consumption figures are updated only once every two months, and users do not have any motives to visit Social Electricity more often. The answers of the users are depicted in Figure 3.4.

3.2 Motivations

The general incentives of using Social Electricity are (the subjects could select multiple options): 73% for financial reasons, 50% from curiosity, 45% for preserving the environment, 28% from being influenced by their friends, 25% to improve their social profile and only 15% for their responsibility as citizens.

We also asked the participants about their opinion regarding the most effective incentives for energy reduction. The most popular answer was a discount on their electricity bills (80%), offered by their electric utility. Other suggestions included small gifts to energy-aware citizens (56%), competitions betweens friends and neighbors (35%) and prizes/awards to green streets or villages/towns (34%).

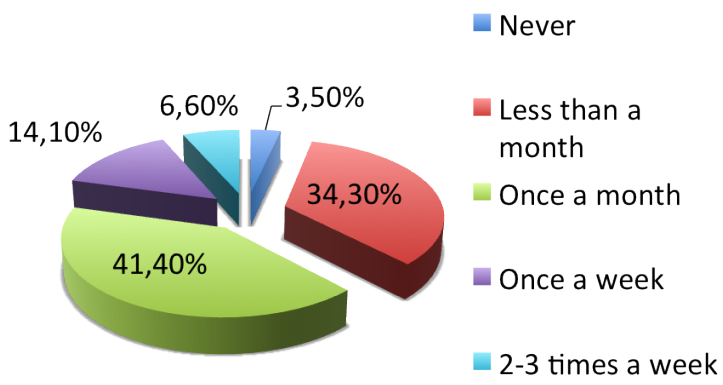

Figure 3.4: Distribution of the answers of the participants in the question how often they use Social Electricity.

Our analysis revealed that financial incentives motivate male (81%) more significantly than female (58.3%) ($x^2(1)=11.81$, $p=0.001$). In addition, people with yearly incomes €17,000-€23,000 have mostly financial incentives (93.8%) in comparison to students without income (62.1%), who do not pay any electricity bills ($x^2(1)=6.17$, $p=0.013$). Obviously, users who pay the bill themselves have stronger financial motivations (84.4%) that those whose parents pay the bill (61.5%) ($x^2(1)=12.333$, $p=0.001$). This latter group is significantly influenced by friends (69.2%), in comparison to users who pay their bills themselves (30.8%) ($x^2(1)=8.971$, $p=0.003$).

Different age groups have different motivations in using Social Electricity. Teenagers (18-24 years old) are highly motivated by the influence from their friends (43.9%) in regard to the age group 25-34 (23.9%) ($x^2(1)=7.123$, $p=0.008$). On the contrary, the age group 25-34 is influenced mostly from financial reasons (79.3%) comparing to teenagers (54.9%) ($x^2(1)=11.114$, $p=0.001$). Moreover, the age group 25-34 is more significantly motivated by curiosity (51.1%) than the age group 50+ (9.1%) ($x^2(1)=6.964$, $p=0.008$).

Finally, low frequency of usage (less than once a month) correlates significantly with the motives of improving the social profile ($x^2(4)=15.913$, $p=0.003$) and being responsible as citizens ($x^2(4)=12.654$, $p=0.013$). Obviously, these motives are not strong enough to encourage users to use Social Electricity more often.

3.3 Privacy

A large part of the questionnaire was devoted to privacy aspects, as they constitute crucial issues in Social Electricity because of the sharing of personal information among Facebook friends. 85% of our users are willing to share their *personal* consumption with their friends towards more meaningful comparisons, and 77% believe that the application respects their privacy. However, the rest 23% have some concerns about the overall privacy, e.g. with the possibility that their energy consumption could be revealed to third parties or with some features of the application. Figure 3.5 presents in detail the general answers of the participants.

For example, 17% believe their privacy is affected by showing the location where they live on the map to their online friends (M=2.42, SD=1.22), 15% are concerned about sharing the

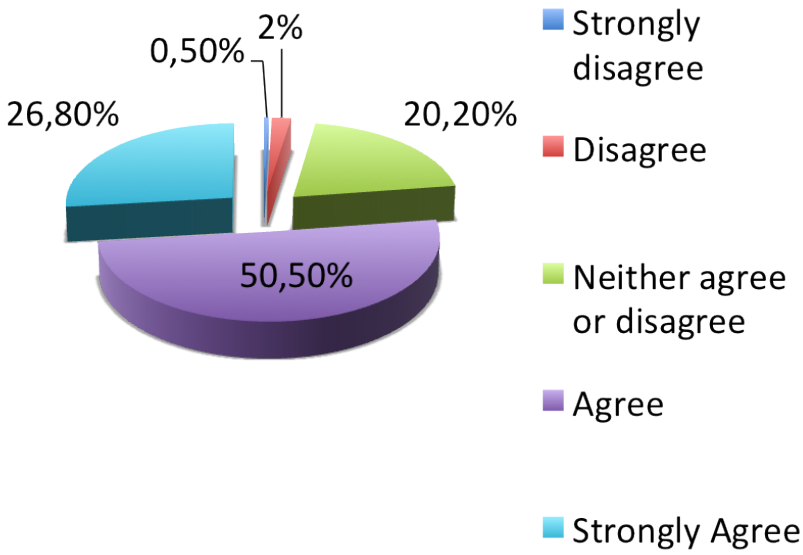

Figure 3.5: Distribution of the answers of the participants in the question whether Social Electricity respects their privacy.

consumption of their neighborhood (M=2.33, SD=1.19) and 11% about sharing historical data of their neighborhood's consumption (M=2.12, SD=1.09).

Obviously, a considerable group of users classify privacy issues as important in terms of sharing their electrical consumption among their friends. To identify the "tolerance levels" of our users in regard to sharing electricity data, we asked them whether they would be willing to share their consumption figures with people they trusted, and with whom they would be willing to share the consumption of their neighborhood, that of their house as well as the detailed consumption of their household electrical appliances. The different user categories for sharing this data were: only me; family members; relatives; close friends; all friends; and everyone. An important percentage of 60% declared their willingness to share their consumption with people they trusted. Their answers are depicted in Figure 3.6. The graphs are interpreted as follows: starting from "only me" and ending to "everyone", each category is a superset of the previous one. For example, sharing personal consumption with relatives, this means that the user agrees to share also with his family members and himself.

As the results show, users have different sharing preferences, depending on the sensitivity level of their energy data. While 19% are willing to share the consumption of their neighborhood with everyone, they are reluctant to share with everyone their home's consumption, or the consumption of their electrical appliances. In this case, they prefer to share their personal energy figures only with family members, relatives and/or close friends (aggregated 88% in home level and 77% in appliance level).

A large percentage of users (30%) trust only the other members of their family for sharing their detailed consumption. A smaller percentage of 14% wish to share their consumption at appliance level with close friends, and this percentage is increased in house (36%) or neighborhood level (41%). Apparently, some users do not trust their close friends, in order to share with them their personal footprint.

It is remarkable that from the general to the more specific consumption data, an increasing percentage of users trust only themselves for viewing these values. This percentage starts from

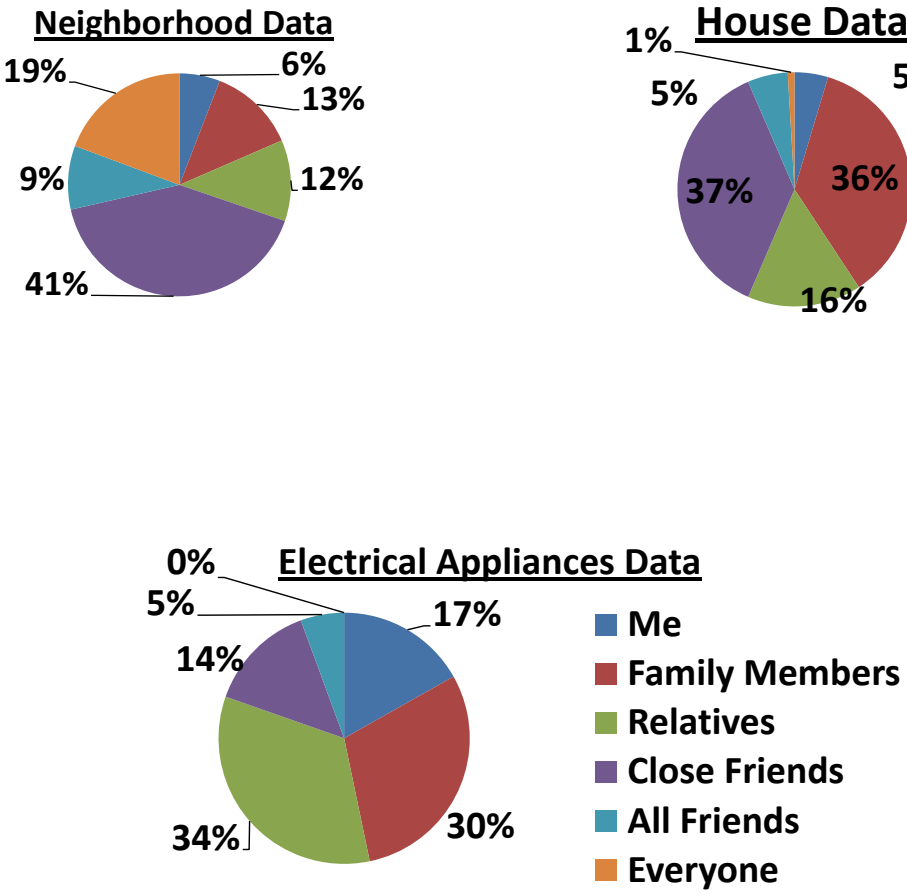

Figure 3.6: Privacy concerns of users in regard to with whom to share their consumption data in neighborhood level (left-top), house level (right-top) and detailed consumption of their appliances (bottom).

5% in neighborhood level and increases up to 17% in appliance level. Finally, the idea of sharing only some consumption indicators (e.g. peak consumption during the day or only the latest average energy savings achieved) sounded promising to the majority of people (59%).

3.4 Potential

It is worth-mentioning that 75% believe that the concept of normative social influence has the potential of influencing people to reduce their consumption. 61% are confident that the application will help them to reduce their electrical consumption by more than 10%, around 10% believe in 1-5% reductions and 27% in 6-10% decrease of consumption. Concerning the relation between the usefulness of the application and time, 63% believe it is mostly useful today, while 27% believe it will be more useful in 1-2 years and 10% in more than two years. It is notable that 37% envision the potential of the application in the coming years, probably having in the back of their minds the introduction of smart meters.

Impressively, 98% of users believe that Social Electricity can contribute in energy conservation in the country. It is highly encouraging that our users are convinced that the app will

contribute to their strategies for conserving electricity in the future.

Interestingly, 69% agree that Social Electricity could be extended for comparisons in inter-country level, between citizens of different countries. Related to this, 63% are interested to compare their footprint with their Facebook friends who reside in another country. Such comparisons could reveal behavioral patterns and attitudes of people from different cultures.

Finally, 92% of the participants agree on the statement that is a duty of the electric utilities to offer comparative feedback services to their customers. Figure 3.7 displays the findings of this question. The same percentage argues that electric utilities and energy agencies should offer standardized and open interfaces, to encourage and promote such ICT applications. Actually, an initiative towards this direction, named "The Green Button", was recently started by three utilities in California [7].

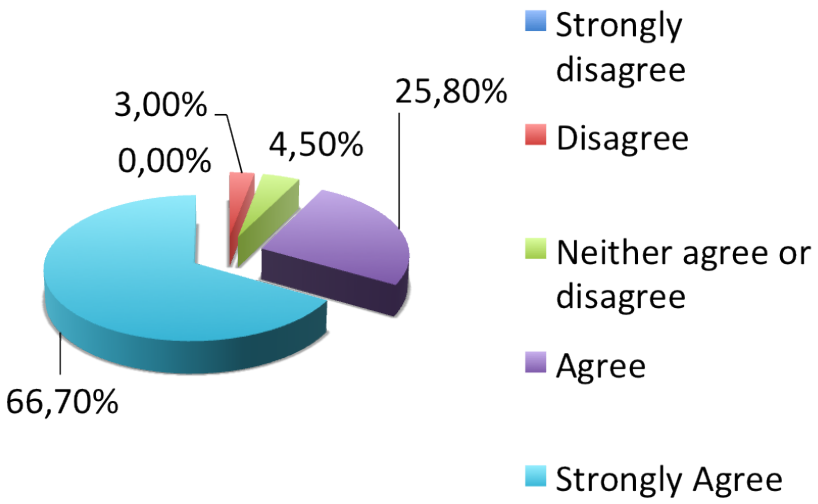

Figure 3.7: Distribution of the answers of the participants in the statement whether utilities have a duty to offer comparative feedback services to their customers.

3.5 Summary of Findings

Table 3.2 summarizes all the statistical significant results, extracted after a detailed analysis of the responses. These results have been discussed in the previous sections of the chapter, and are listed here as a summary.

Question	Min. Value	Max. Value	Group A	Group B	Test Used
How useful is Social Electricity to you?	1-Not at all	5- Extremely	Men	Women	Mann Whitney U test, U=5.658, Z=3.12, p=0.02
Has Social Electricity influenced your electricity consumption?	1-Not at all	5- Extremely	Men	Women	Mann Whitney U test, U=5.493, Z=2.56, p=0.010
How often do you use Social Electricity?	1-Never	5 - 2-3 times a week	Men	Women	Mann Whitney U test, U=5.552, Z=2,784, p=0.05
Do you use Social Electricity for financial reasons?	0- No	1- Yes	Men	Women	Chi Square, x2(1)=11.81, p=0.01
Do you use Social Electricity for potential awards?	0- No	1- Yes	Men	Women	Chi Square, x2(1)=5.304, p=0.021
Do you use Social Electricity for financial reasons?	0- No	1- Yes	People with annual income over 32,000	People with no annual income	Chi Square, x2(1)=6.171, p=0.013
Do you use Social Electricity for financial reasons?	0- No	1- Yes	People who pay their electricity bills by themselves	People who dont pay the electricity bills by themselves	Chi Square, x2(1)=11.421, p=0.001
Do you use Social Electricity due to motivation from friends?	0- No	1- Yes	People who pay their electricity bills by themselves	People who dont pay the electricity bills by themselves	Chi Square, x2(1)=8.977, p=0.003
Do you use Social Electricity for financial reasons?	0- No	1- Yes	People of ages 18-24	People of ages of 25-34	Man Whitney U test, U=3.986, Z=4.057, p=0.00
Are you willing to participate in research programs that target decreasing your consumption?	0- No	1- Yes	People of ages 18-24	People of ages of 25-34	Man Whitney U test, U=3.89, Z=3.24, p=0.01

Table 3.2: Summary of statistical significant results extracted from the answers of questionnaire participants.

Chapter 4

Analysis of Focus Groups

The focus groups were divided in two categories, each consisting of seven people (4 male - 3 female):

- Students (18-24 years old) who live in the country with their parents and do not pay any electricity bills and
- Citizens who live and work in the country (26-32 years old).

From now on, we refer to the former group as *students* and to the latter as *citizens*. These categories represent the majority of our users (75%). Each session lasted 50 minutes and was audio-recorded. To better structure the groups, we initially performed a pilot focus group, consisting of university students.

4.1 Phase A: Current Status of Social Electricity

Concerning usefulness, all agreed that the application is very useful. It helped them to perceive their category of electrical consumption. Two people from each group admitted they had high consumption, and this motivated them to take measures to reduce it. In particular, a student "*started turning off the lights*", "*switching off the laptop during night*" while a citizen "*stopped turning on the heater for heating the water*" in days of sunshine.

From all participants, only two did not decrease their consumption in relation to the previous year. From the various features, students preferred temporal comparative feedback, while citizens found comparative feedback with their neighbors more useful. A student mentioned that "*the adoption of the application has been promoted by being available on Facebook. This made it more reachable, easy to use and interesting*". Citizens had similar opinions and believed that the application became popular because of its social character.

Both students and citizens agreed that they used the application only once every month, mainly when they received their electricity bill and they did not have incentives to use it more frequently. Half of them remember their green/red friends, although this feature impressed them initially. However, only two students and two citizens initiated a discussion with their friends about energy conservation. In particular, a citizen asked one of his red friends about his increased consumption, and this was "*due to having a swimming pool*".

In regard to motivations for using Social Electricity, students were mainly affected by the social influence of their friends and because of curiosity. As they did not pay electricity bills themselves, the financial motive was not strong to them. On the other hand, citizens claimed they had environmental and financial reasons for using the application. While we expected that students would be more aware about the environment, as they are generally more educated, this was not the case. Citizens seem to be more mature in environmental aspects.

About the potential of Social Electricity, three students believed it is more useful today, due to the financial crisis. Citizens did not have a clear opinion, though one mentioned that "*it would be more useful in a future scenario when multiple electric utilities would operate in the country, offering different tariffs/services*". All students and citizens agreed that the application can contribute in reducing the total energy demands. The citizens were more optimistic, discussing about 20-30% reductions (!), while the students predicted 5-10% savings. Students were interested in the opportunity of comparing their consumption with people from other countries, while only a 50% of citizens found this useful. One student and two citizens were skeptical, since different conditions hold at each country.

An interesting aspect is that both students and citizens consider their electric utility responsible for raising the awareness of consumers about the environment. Citizens strongly believed that the electric utilities should have a social responsibility and that electricity is a basic need for people. In particular, a citizen mentioned that "*the management of electricity reflects our civilization*".

In both groups, privacy issues created much discussion. Students discussed that the application respects their privacy, but they asked for more control over the sharing of their consumption and location. They were positive in sharing their personal consumption with their online friends, since this would happen for a good purpose. Citizens were less reluctant about privacy issues, since "*the government and many companies know already a lot about us*". They agreed on sharing their personal consumption, and one even declared that "*it is our duty to share our consumption, because our energy-related habits affect the physical environment and the society*". This is definitely an interesting point of view.

Students are partly afraid that exposing their personal consumption could encourage thieves "*to attempt to steal while the owner is absent*". Citizens were not afraid that their consumption patterns could reveal their lifestyles and one claimed that "*common benefits overcome the risks*". Another citizen noted that "*banks constitute more serious privacy risks as they know much about our personal lives*".

4.2 Phase B: Requirements Elicitation for Future Releases

In the second part of the focus group sessions, we explained to the participants that one of our serious concerns is that people use the application occasionally. Then, we encouraged them to discuss ways to engage the users to Social Electricity more frequently. Citizens were more actively involved in this discussion, probably because electricity for them has more direct financial implications.

Some of the ideas discussed are:

- Use of mobile applications (students and citizens)[1],
- More frequent feedback (students and citizens),
- Adding statistics to the electricity bills of consumers (students and citizens),
- Access to people without a Facebook account (students),
- Engagement with the electric utility e.g. to provide useful information about latest tariffs or important announcements (students) and
- Offering personalized tips for energy savings (citizens).

Finally, we asked them about extra features they would like to see in future updates of the application. Their answers are as follows:

- Notifications/alerts for increased consumption (students and citizens),
- Detailed cost per electrical appliance (students),

[1]The category in parentheses indicates who offered the idea.

- Allowing to define a threshold of maximum consumption, triggering an alarm when this threshold is approaching (citizens),
- Translating consumption figures into more meaningful information such as direct impact on the environment (citizens) and
- Predictions on future consumption based on previous consumptions and weather forecasts (citizens).

Chapter 5

Conclusion

The purpose of this technical report is to present results derived from user studies aiming to exploit the phenomenon of normative social influence towards energy awareness and conservation. Such an effort is important for designing more effective persuasive applications that affect user behavior with regards to energy consumption and sustainability, through credible comparisons with the energy figures of friends, relatives and neighbors.

A subjective evaluation by means of online questionnaires and focus groups, showed that the presented approach is perceived as useful and effective to the users, since it helped them to be more sensitive about energy management and reduce their consumption. Both the participants at the questionnaires and the focus groups had a general consensus about the value of the application. This consensus between the different user groups is also reflected by the fact that the inferential analysis of the questionnaire did not reveal many statistical significant results.

However, the analysis revealed the need for more personalized feedback strategies, taking into account different user profiles and motivations. It is important to study whether normative social influence can contribute in averting the effect of losing interest after some time. Moreover, the social responsibility of electric utilities in offering online services of comparative feedback was stressed by the participants.

Finally, an important finding is related to the privacy concerns of users in such large-scale persuasive environments. The participants stated the requirement of sharing personal consumption data through a privacy policy that satisfies the ability of revealing energy consumption on a street and home level to different user categories inside social networking applications. Therefore, privacy is a crucial parameter when designing green ICT social applications.

Overall, this report provides useful insights for the perceptions of users in using green ICT social applications. The feedback received from Cypriot citizens is valuable for electric utilities, organizations and companies, which aim to design and develop in the future more usable and effective persuasive applications in the scope of sustainability.

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