Analysis of Consumer Expectations, Preferences and Concerns on Deployment of Demand Response in Turkey

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***Abstract*— Demand-side solutions are one of the most important customer-dependent options among innovative smart grid technologies. Flexible loads can be controlled and coordinated in several ways to operate in favor of the grid. Contrary to conventional participators in grid services, responding to grid requests is not the primary objective of the owners of demand-side resources. Therefore, it is a vital task for demand side service operators to provide maximized and reliable participation. However, motivation factors may vary due to demographic characteristics of the society and there are important diversities due to cultural differences of countries. This study investigates consumer expectations, preferences and concerns on demand response (DR) and deployable gamification techniques in Turkey. A detailed survey is conducted with individuals and results are analyzed to evaluate general trends together with distinctive customer patterns.**

***Index Terms*—Customer awareness, Customer segmentation, Demand response, Gamification, Smart grids.**

I. Introduction

Power systems have longstanding challenges, which increase in number as new concerns and approaches emerge. Integration of intermittent renewables in generation increases the volatility in supply, while moving loads like electric vehicles increase the fluctuations in demand. Together with continuous growth of energy consumption and peak demand particularly in developing countries, these factors make utility operators more dependent on fast responding and balancing resources (diesel generators, small hydro, storage systems). However, since these resources are not quite cost effective and limited in number, operators tend to exploit more economic alternatives and increase the capacity. Demand response (DR), is an economic alternative by which the load is managed at the customer side (either directly through remote control by an entity or indirectly via tariffs and notifications to motivate voluntary participation) according to the needs of the grid.

DR has become an essential part of operation in modern utilities. The annual sectoral statistics of US in 2014 shows that 9.3M customers participated in DR programs, achieving 1.4 million MWh of energy savings and 12.7 GW peak reductions [1]. Enrolled customers received a total of $1.2 billion of incentives in turn. It is also notable that the majority of the participators are residential in number and energy savings, while industrial customers achieved the highest demand reduction and incentives.

Contrary to conventional participators in grid services, responding to grid requests is not the primary objective of the owners of demand-side resources [2]. Moreover, in a considerable portion of demand response programs, participation is done on a voluntary basis. Therefore, it is a vital task for demand side service operators to provide maximized and reliable participation through intrinsic and extrinsic motivators. Gamification can be a useful way of promoting behavioral change.

Gamification can be briefly described as using game elements and game design techniques in non-game contexts. The dominant goals of gamification process are increasing engagement, improving loyalty and solving a problem. Adoptable elements cover positive feedbacks, such as accumulation of points, badges, status, progress, customization, pleasant surprises and many more. However, non-game contexts usually have many constraints (such as gaming time, rewards, actions, borders of rules), reducing the number of adoptable methods from games and serious games. Gamification does not imply creating games; but it should be understood as a design technique that introduces game elements and game thinking. Although gamification has been mostly adopted by digital services and products, it also has many examples in education, banking, healthcare services and engineering.

There are several promising pioneer applications regarding gamification of demand response. Nest company introduced a Wi-Fi based learning thermostat and uses gamification techniques for customer engagement. Users are rewarded with green leafs as they change the settings of their heating-cooling systems to save energy [3]. Additionally, monthly report e-mails show performance of the user, while comparing performance with other participators located at the same area. The company also offers Rush Hour Reward Program for peak reduction, Seasonal Savings for less energy use and recently Time of Savings program (that considers Time of Use tariff rates) to its users [3]. Rush Hour Rewards program participators receive static or dynamic rewards based on the agreements with their distribution system operator. Ohmconnect is another company that mainly focuses on peak reduction through gamified demand management [4]. They use several gamification elements like points, rewards,

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lotteries, gifts, leaderboards, additional tasks and recently user levels. Opower company focuses on digital engagement of customers through web-based interfaces integrated with gifts, comparison of performance, suggestions and advanced statistics [5].

Effective strategies aiming to achieve better demand response and gamification objectives can be developed through deep understanding of customer awareness, expectations and concerns. However, these important factors may vary due to demographic characteristics of the society [6]. Some strategies, which are widely accepted by one customer group, may be the source of demotivation for another one. Furthermore, there are important diversities due to cultural differences of the countries. A comprehensive survey study done by a company in 2010 revealed the national differences in customer segments [3]. It was conducted in 17 countries with 9108 individuals in total (around 500 people from each except US, and approximately 1000 from United States). The researchers identified 6 customer segments using the survey results, namely; proactives, eco-rationals, cost conscious, pragmatics, skepticals and indifferents. According to the results of the study, proactive segment had the majority in Brazil with 33%, while it was 6% of the respondents in Japan. On the other hand, cost conscious segment was 35% in Japan, while it was only 10% of the customers in Brazil. The highest percentage of eco-rationals were in Italy with 26%, but that segment was only 5% of the customers in UK. Pragmatics seemed to present a considerable number of customers in all countries with 21% average. Another important segment of many countries, skepticals were the minority in South Korea. France had the lowest percentage of indifferents with only 6%.

All these efforts show that it is crucial to conduct national (side-specific) surveys covering different demographic groups. In a similar study conducted in Switzerland, defined segments had close correlation with the above mentioned worldwide survey [7]. The main gap in the literature is the lack of details in demand response related questions and exploration of gamification opportunities. This study is one of the first efforts to analyze customer expectations, preferences and concerns on demand response and its gamified deployment approaches in Turkey. At the first stage of the study, a number of motivators for customers are determined. In the next step, a survey that consists of three sections to get possible user insights is conducted with more than 300 individuals. The results are then filtered and analyzed to infer the general trends of the society and customer segmentation.

II. Identification of Gamification Elements Suitable for Demand Response and Survey Design

Demand-side applications have three main actors with different perspectives (Table I). Aggregator acts as an entity between the grid operator and consumers to ensure reliable and fast response to grid requests.

Focusing on economic and social motivators for consumers, a number of adoptable elements can be defined as listed in Figure 1. A survey with a total of 29 questions in three sections is prepared. The first section is mainly designed for getting general information and categorizing the respondents under distinctive demographic groups. The second section is devoted to the awareness analysis. The questions are concentrated on electric power industry and energy efficiency in order to understand consumer awareness and habits. The last section is the core of the survey and comprises the questions about the prospective gamified grid responsive society strategies.

TABLE I. Main Goals and Expectations of the Actors of Demand-Side Applications

Grid operator	Aggregator	Consumer
• To provide an increase or decrease in demand for a specified time range • To respond to (event) requests for a number of times in a day, month, year • To respond event requests in a short period of time	• To maximize the numbers of participators • To minimize the number of overrides during events • To acquire experienced, reliable and long-term participators • To deploy in a fast and automated way • To evaluate the participator performance	• To receive monetary incentives • To have social motivation • Not to sacrifice from available welfare and comfort • To receive personalized suggestions and offers

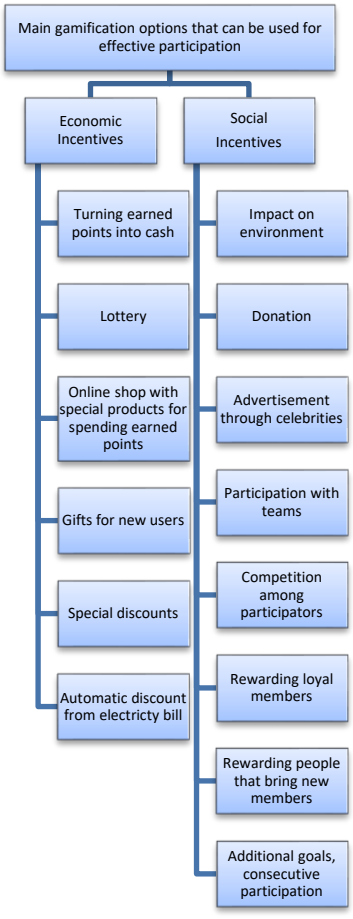

Fig. 1. General economic and social incentives presented to survey participators

Economic incentives consist of transferring the performance points earned during DR events directly into cash, automatic discount from electricity bill, special discounts (such as flight tickets, cinema, book, fuel and etc.), gifts for newcomers, periodic lotteries and an online shopping that has even automation products that will aid better deployment of DR.

Social incentives are reduction of negative impact on the environment, donation to foundations (like in education sector, health sector and many other), advertisement of DR through famous people (singers, actors/actresses, bloggers, social media celebrities), participation with teams to achieve higher goals and close cooperation, competition among participators (friends or similar customers), rewarding of loyalty, rewarding of bringing new members, additional goals (also known as side mission) to earn more points and rewarding of consecutive participation (as streaks).

In addition to the questions regarding gamified grid responsive society strategies, communication channels that would be preferred, organizations that will be trusted, tolerable payback period for investments, frequency of participation to grid events were also directed to the respondents in the last section.

III. Survey Deployment and Analyis of Results

The survey was conducted with 309 individuals covering different demographic characteristics at different cities in Turkey. In order to minimize the misunderstanding of questions and to better detect inattentively filled surveys, all the surveys were conducted face to face, providing respondents a paragraph of brief information about demand response. Surveys with unanswered questions, conflicting answers and surveys filled by respondent that are not responsible of paying monthly electricity bills were excluded. The remaining 184 surveys were used in the analysis.

A. Single Question-based Analysis

Firstly, question-based analysis was done. 50% of the respondents are woman and the rest are man. Except 65+, there are close participation percentages by people from different age groups (Fig. 2). From the perspective of educational background, primary school graduates are minority with 9%, while university graduates are the majority with 44% (Fig. 3). 72% percent stay with their families, while 11% are single and 17% share their houses with students. House owner and renter percentages are 49% to 51% respectively. Monthly income is between 2000 and 5000 Turkish Liras (TL) for 47%, over 5000 TL for 30% and under 2000 TL for 23%. 67% of the respondents are married, while 33% are single. 53% have at least one child.

People are generally sensitive about current fossil fuel dominant today's power systems, covering contribution to global warming (66%), risk of resource distinction in the future (81%), costs (80%) and dependency due to exporting most of the resources from other countries (64%), except environmental impacts (only 22%). A considerable percent (around 4%) has no clear idea. While slightly more people (52%) states that electricity service quality at their home is satisfactory, the vast majority (91%) thinks that the electricity at country level has problems.

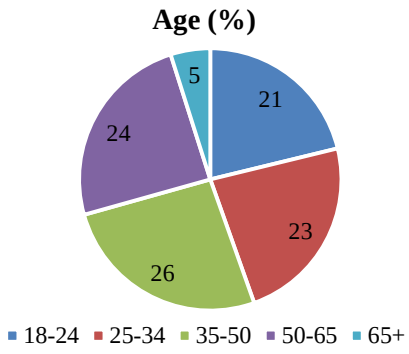

Fig. 2. Age intervals of the participants

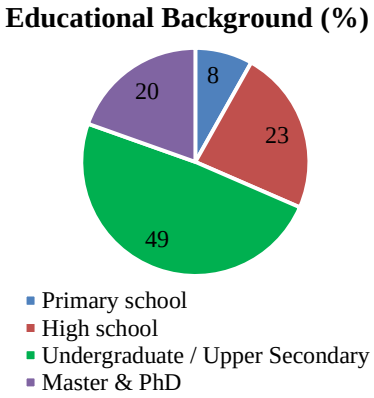

Fig. 3. Educational background

Most of the respondents (88%) feel responsible about recycling waste, saving water, saving electricity, carpooling and public transport. A considerable number of respondents (37%) do not know their current electricity tariff. There is significant percentage of people who are in Time of Use (ToU) tariff; but do not change their habits (72%).

A very high percentage of the respondents (96%) would like to participate in DR programs, 56% of which accept automated control; while the rest prefer manual control. The main concerns about DR programs are details, benefits and time that should be allocated.

When asked expectations other than monetary benefits, reducing negative impact on environment is the most popular intention with 38%, user-friendly interface is the second with 30%, comfort is the third with 28% and social media interaction is the last with only 3%.

Donation is widely accepted (94.5%). The top fields for donation are education (41%), health (27%) and social solidarity (18). Environmental foundations are the last with 0.4%. As being among the most important findings, 80% stated that they can change their daily consumption habits with DR. 45% can spare time weekly, while 40% prefer rare participation monthly. Still, a considerable amount of people 15% can use the system everyday.

For point spending options, 52% wants reduction from energy bills, 14% desires conversion to cash, 16% waits until collecting a certain amount of money and 18% are motivated by special discounts (such as flight tickets, special online store, fuel discounts, cinema tickets and etc.). For communication channels, integrated options to today's widely used ones are acceptable, while an additional device for DR

has the lowest acceptance with 7% (Fig. 4). As entities trusted to introduce DR to society, universities are relied on with 40% and government with 30%; while private sector is the last with 2%. Positive experience of family-relatives and friends are widely considered with 38% and 32% respectively. High numbers of user suggestion are effective for 24%, while advertisement with celebrities is the last with 2%. Only 4% relies on own evaluation. Comfort seekers are the majority with 76%, while the rest can sacrifice from comfort for achieving more savings. Loyalty rewarding is the most popular additional earning option among the proposed 4, while the others are also considerably accepted by individuals (Figure 5).

Majority of the respondents (65%) can make investments with a payback period of 1 year.

The social motivators proposed in section 2 of the paper were asked as the last question of the survey. As can be seen from Figure 6, every option has acceptance above 18% up to 41%. Both the percentages in Fig. 5 and Fig. 6 exceed 100% in total; because respondents were free to select and selected several options.

B. Multiple Question-based Segmentation Analysis

At the second stage of analysis, answers to several questions are analyzed to detect distinctive patterns that may reflect insights about different customer segments. Three specific customer segments identical to the ones in previous studies cited in Introduction section are observed (Table II).

The people that are ready to make investments with a long payback period, seeking for several additional earning options and accepting several gamified DR approaches have electricity service problems at their home and they already care about current tariff rates.

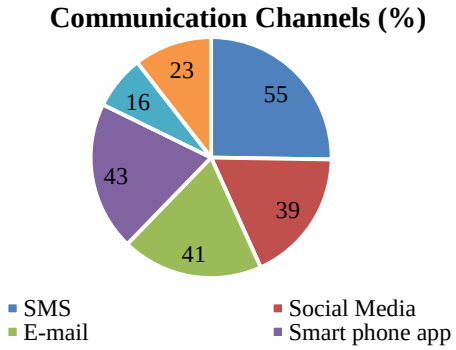

Fig. 4. Communication channels for DR

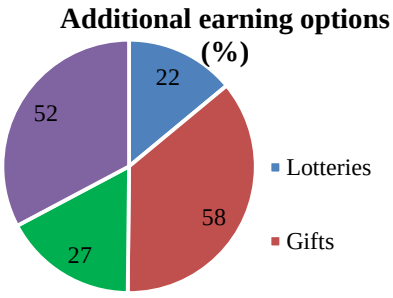

Fig. 5. Acceptance of additional earning options

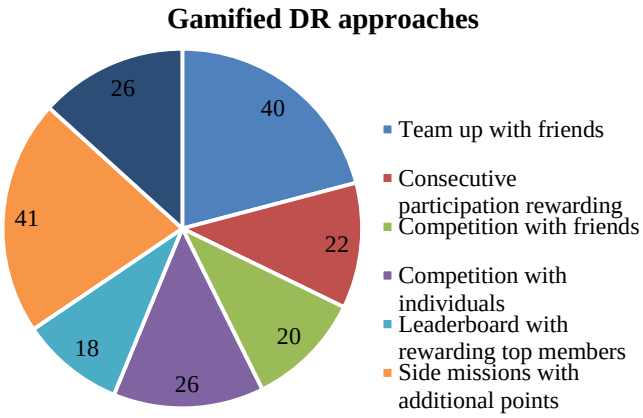

Fig. 6. Acceptance of gamified DR approaches

TABLE II. DETAILS AND PERCENTAGES OF DETECTED GROUPS SIMILAR TO PREVIOUS STUDIES

Customer Type	Percentage (%)	Attitudes
High income, less motivation	9	• Shorter investment time, • Lower trust to the others, • Tend to accept loyalty rewards and additional missions
Young, women, low/middle income	9	• 100% DR acceptance, • Comfort seeker, • Low loyalty, but high acceptance of gamified DR approaches
Motivated, but do not have time	33	• Comfort seeker, • Special interest to special events, low acceptance of additional goals

While people living with family can spare time every day, people less than university degree tends to use it monthly. 18-34 years old people prefer phone application as communication channel, while people over 50 years old wish to be notified through SMS and e-mails. On the other hand social media is the most popular option for people with university degree. People over 50 years old and people less than university degree can sacrifice from their comfort to increase savings, while all the other groups give priority to comfort. People that conducted postgraduate studies consider high number of costumer suggestions, while others listen to their family members.

Gamification approaches have different levels of acceptance in these different groups. For instance, people without university education do not want to participate with teams. Moreover, people between 18 and 34 years old do not like comparison with other people, while it is the favorite option for people over 50 years old. However, they do not prefer to be compared with friends.

TABLE III. INSIGHTS ABOUT DIFFERENT DEMOGRAPHIC GROUPS

Focus Group	Percentage (%)	For more profits	Gamification
18-34 years old	7	Gifts	Team & events
50+ years old	28	Loyalty	Competition with similar people
Primary school & highschool graduates	30	Lottery & bringing new members	Leaderboard & events
University graduates	46	Gifts & loyalty	Team & additional goals
MSc and Phd	18	Gifts & loyalty	Teams & comparison with similar people & additional goals
Living single	9	Gifts & loyalty	Team & events & additional goals
Living with family	65	Gifts & loyalty	Teams & additional goals & comparison with similar people

IV. CONCLUSION

Demand response as a customer oriented solution needs motivated and reliable participators from the perspective of aggregators and grid operators. Effective approaches to enable active participation may differ due to demographic characteristics in a society and cultural differences between the countries. This study aimed to fill a number of gaps in the literature by investigating customer attitudes towards DR and its gamified deployment approaches in Turkey.

There is generally high awareness about challenges in power generation; but impact on environment should be emphasized with more details. Time of Use tariff in use in Turkey seems to be not quite effective at changing behavior of customers, while there is a high potential to stimulate it through the use of DR and gamification.

There is no dominant result for communication channel; but integrated options to today's widely used channels are widely accepted.

As entities to be trusted for DR applications, private sector in Turkey has to set up collaborations with universities and government bodies.

The proposed additional earning and gamification options are accepted with high percentages and found motivating. There are several groups with different preferences, while some groups have common trends. The different motivators proposed in the study are suitable for motivating different groups.

The future work will be on field deployment of gamified DR in a number of residential buildings in Turkey, through a widely used building automation system and a user-friendly gamified interface developed considering survey results.

V. ACKNOWLEDGEMENT

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