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EFFICIENT USE OF BEHAVIORAL TOOLS TO REDUCE ELECTRICITY DEMAND OF DOMESTIC CONSUMERS

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Abstract

Purpose: The present study investigated the main literature on the subject of methods and policies for reducing the electricity demand of domestic consumers, in order to identify the place of behavioral tools. Methodology: We used secondary sources, performing a literature review, together with analysis and synthesis. Findings: Policy makers prefer to use tools offered by neoclassical economics, such as various forms of taxation, fines and financial incentives in order to make domestic electricity consumers save electricity, on the assumption that consumers will make rational decisions while maximizing their personal benefit. However, studies conducted in recent years in the field of behavioral economics, which are based on the assumption that consumers' decisions are not rational and are affected by cognitive biases, showed that the use of behavioral tools, such as detailed online information (feedback),social comparison information, information on varying rates (dynamic pricing) and general information (advertising campaign), are tools that are not less appropriate than the ones the neoclassical economics offers, mainly because electricity is an invisible product and consumers are unable to assess it by normal cognitive measures. Using an interdisciplinary combination of behavioral tools that come from a variety of approaches taken from a wide variety of different academic fields, it is possible to receive efficient results in the endeavor of reducing electricity demand. Implications: Although the neoclassical economics still remains the fundamental theory used by policymakers, it is recommended to consider behavioral economics as a complementary approach to the neoclassical economics, and combine behavioral tools in the policymakers' toolbox, especially when those tools do not require a significant financial investment, thus efficiently maximizing the reduction of electricity demand among domestic consumers. These theoretical results will be used for designing future empirical researches on the efficiency of behavioral tools in changing the pattern of electricity consumers' behavior.

Keywords: electricity demand, energy efficiency, behavioral economics, neoclassical economics, consumer behavior

JEL classification: Q40, M21, M38, H41

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1. INTRODUCTION

Studies conducted in recent years in the field of behavioral economics point to a series of behavioral tools that can bring about behavioral change, a change in perception, and public support for reducing the electricity demand of domestic consumers (e.g. Abrahamse *et al.*, 2005; Allcott, 2011; Chatterton and Department of Energy and Climate Change, 2011; Darby, 2010), all these without a significant financial investment effort from the state. As such, these tools could help countries deal with environmental problems, including air pollution from polluting power plants, and greenhouse gas emissions which cause climate change (Sverdlov and Dolev, 2009). Choosing the available behavioral tools out of the research areas dealing with behavioral economics is based on the assumption that the decisions and economic choices consumers make are not rational, meaning they are not consistent and cannot be fully explained and represented by a mathematical economic model (Geva, 1994) and accepting the idea that consumers are influenced by a large number of cognitive biases. These biases are not compatible with traditional models of decision making based on the rational assumptions of the neoclassical economic theory.

The tools offered by behavioral economics seem to be just as suitable as the tools offered by classical economics for reducing the demand for electricity, especially because electricity is an "invisible" product, which consumers are unable to assess by standard cognitive measures (Darby, 2006; Watson *et al.*, 2002). In addition, electricity is perceived as a basic product, and this is why its consumption cannot be significantly reduced, especially considering that it has no alternative solutions (Tabori, 2012). In fact, electricity consumption is based on behavior which comes from habits which became almost "mechanic" (such as turning on the light switch or operating the air conditioner) and are often not optimal in terms of economic saving, electricity saving or damage to the environment. Therefore, in order to reduce the use of electricity by domestic consumers, it is required to change the situation in which consumers act out of a habit to one where they make an actively conscious decision. In order to do so, it is necessary to take specific actions which will lead to better economic and environmental interests (Fischer, 2008).

Public policy was found as having a big impact on the economic behavior of consumers (Soman, 2007) and the state is ultimately a system whose purpose is to influence the behavior of society and the behavior of individuals in it, and despite the growing importance of the use of behavioral tools to influence the pattern for electricity demand, the most common and most acceptable way to do so is still by using various tools that influence people's decisions on an economic level (Lusardi *et al.*, 2009). The state prefers to use tools offered by classical economics, including various forms of taxation, subsidies, quotas and fines which constantly affect the citizens' decisions. However, behavioral tools are a significant alternative. Behavioral economics allows for the use of a variety of behavioral tools which come from a variety of approaches and disciplines, taken from various academic fields and with diverse contents. The combination of these different approaches, in an interdisciplinary manner, allows influencing the economic decisions of consumers. This is why we will shortly analyze the main categories of behavioral approaches.

2. BEHAVIORAL ECONOMICS

This section is meant to describe a number of key factors in making un-rational decisions, in order to understand the underlying, the basic influence behavioral tools have on electricity demand.

The classic economic model assumes that people look for their personal benefit and make decisions while optimizing, rationalizing and having perfect and prompt knowledge of the market, and their preferences remain constant over time. Alongside the classical economics, in recent decades a stream that challenges the assumption of rationality in classical economics has evolved, and in fact argues that when it comes to economic decisions, the individual is affected by a long list of factors that do not fit the traditional models of decision-making.

The stream of behavioral economics points to limitations and problems related to actual decision making in conditions of ignorance and uncertainty (Ariely, 2008). Recent studies show that there are other psychological factors that are based on mental processes, automatic and sub-conscious, which direct us into certain behavioral patterns that are less rational, even not rational or irrational. This application of the psychological research of these deviations from economic rationalization has earned the nickname "behavioral economics" (Chatterton and Department of Energy and Climate Change, 2011) where it is customary to think of a model of the "economic man" who is influenced by a large number of factors, and not of a "rational actor" (Lee *et al.*, 2009).

A large number of heuristics - rules of thumb based on common sense or intuition in order to receive a simple way to problem solving and quick decision-making (Tversky and Kahneman, 1974), cognitive biases and external influences on decision-making processes were found by researchers (Ratner *et al.*, 2008). Many of them are characterized by the effect of the i*nformation level* available to the individual when he needs to make an economic decision. The use of heuristics causes mental shortcuts in situations of uncertainty (P. King, 2009) but may lead to systematic biases. Kahneman (2013) explains that the heuristics and biases come from the gap between the two different systems of thought, one being an intuitive, automatic system and the other one reflective and rational.

There are many findings showing that even when people are motivated to make decisions they desire personally and socially, external constraints of decision making or characteristics of decision tasks lead them to make an irrational choice in cases where there is no opportunity to profit (Thaler, 2005).

There are several key biases of the classical economic model which influence decision making that can be attributed to electricity consumers, and we will present them in the next section.

2.1 Biases resulting from presentation of information

It is known that the way a situation is presented to people has an obvious impact on their considerations. So, those people will make different decisions when the framing of the problem is different. Cognition researchers call this phenomenon the "framing effect", and some believe that its origin is in unconscious emotional responses (De Martino *et al.*, 2006). In the study of Newell and Siikamaki (2013), which examined the appropriate framing of information presented on the energetic marking of electric products in order to encourage electricity consumers to purchase home appliances with energy efficiency, it was found that

short, simple information that shows the expected savings had the most impact on the decision of consumers to purchase an energy efficient product. The study also found that information on the amount of energy consumed by the product and the amount of C02 emissions had a positive impact on the consumer's purchasing decision, but less than the information about financial savings (Newell and Siikamaki, 2013). The framing effect becomes a source of biases.

Another bias comes from loss aversion. Studies show that under conditions of uncertainty, people strongly tend to prefer avoiding losses than gaining profit. It was found that the way the framed information is presented affects people differently depending on the risk tendency they show, as risk lovers or risk haters (Kahneman and Tversky, 1979). This happens, for example, when presenting the electricity consumer with the information that he'll lose X dollars in case of not saving energy during peak hours, and if he does save, he'll earn Y dollars.

2.2 Biases resulting from consumer preferences

Human beings' preferences are not consistent over time since they suffer from present bias and they underestimate the future, so that the consumer may prefer a small profit in the present over a larger profit in the future. This means that electricity consumers find it easier to understand the savings in the purchase of an energy efficient product in the short term rather than the financial savings over a longer period. Another bias is people's preference to keep the status quo. The status quo bias is a behavioral bias that causes people to stay in the current situation and stems mainly from the fear of changes. We prefer to make easy and familiar decisions that do not require us to change, even if they are not right or the most rational ones. This bias is expressed in the difficulty to replace something known and familiar, even if it is clear to everyone that it is time for a change. For example, a consumer that knows the fact that using ordinary bulbs consumes a lot of power, and speaks about wanting to replace them with energy-saving bulbs, when in fact he does nothing in this respect.

2.3 Biases resulting from carrying out complex calculations

There are cognitive biases in decision making caused by people's difficulty to perform complex calculations, especially with regards to calculating risks and probabilities (Carlsson and Johansson-Stenman, 2012), as well as the ability to absorb and process complex information. In order to deal with complex information people partially process information while using mental shortcuts ("heuristics") in the decision-making process in order to get an effective result and a considerable saving of cognitive effort and valuable time. For example, by an 'in home display' the consumer receives continuous and detailed information about the household electricity consumption, which will enable him to deal with the complexity of information and thereby reduce the electricity consumption.

2.4 Biases resulting from feelings and social considerations

Kahneman (2005) argues that significant decisions are also made in a social and emotional context, and are affected by beliefs and feelings. Studies conducted about the influence of emotions in decision-making moments have shown that often times these emotions drive people's behavior in directions that do not match ones that might be

expected by careful consideration of long-term costs and benefits. There are also studies examining the effects of environmental factors on decision-making, factors such as weather (Hirshleifer and Shumway, 2003), natural biological cycles of the body (decisions made an hour after getting out of bed may be different from those made moments before sleep) and the effect of emotions when making a capital investment in conditions of uncertainty (Lucey and Dowling, 2005).

When making their own decisions, people are influenced by norms and by other people's decisions, as it was found in an experiment where the electricity bill of consumers was compared to that of their neighbors' and that led to savings in electricity consumption (Schultz *et al.*, 2007).

2.5 Biases associated with false beliefs

There is a considerable amount of literature pointing to biases related to false beliefs, or such biases associated with over-confidence. DellaVigna (2009) points out that people usually attribute success to their personal abilities, while failures are attributed to factors out of their control. In addition, there is a tendency to overestimate the impact of future events on their mental state, and underestimate the level of emotional adjustment to changes in their lives (Gilbert *et al.*, 1998). Mistakes are not limited to the way they will feel in the future, but also to the way they will behave in the future. It is customary to believe that in the future we'll be able to behave and act differently, when the best- known example is the belief that one could in the future quit an addiction that is being created in the present. Such beliefs, however, usually reflect over-confidence and not an accurate assessment of abilities.

The information obtained from the studies presented suggests that consumers' behavior can be understood and somewhat statistically predicted, that is, even if not all consumers will behave according to the patterns revealed, it is still possible to design policies that can influence the behavior of most consumers, most of the time. The universality of the findings also ensures that it is possible to apply the insights received on all segments of the population and have a very broad impact.

3. BEHAVIORAL TOOLS TO REDUCE ELECTRICITY DEMAND

As we already mentioned, consumer behavior in general, and in particular in the case of demand for electricity, is explained using various theories which come from a wide range of approaches and fields, among them being psychology, economics, sociology and education (Abrahamse *et al.*, 2005; Chatterton and Department of Energy and Climate Change, 2011; Darby, 2010), used in order to make a change in the behavioral patterns of electricity demand at the domestic level. For example, avoiding the use of appliances during peak hours or raising / lowering the temperature on the regulator, which are particularly important in managing the electricity demand. The combination of the various approaches allows influencing the economic decisions of consumers. We will see, in the next section, the main approaches that can be used for reducing the demand of electricity for domestic consumers.

3.1 Feedback as a psychological approach

The psychological approach argues that consumer's electricity demand can be affected by changing the emotional aspects and their perceptions - such as values, motivations, motives and norms of the individual consumer (Poortinga *et al.*, 2004; Steg, 2008). Most psychological studies of the subject focused primarily on the effect of the individual's experiences and his perceptions through emotional manipulation rather than the information the individual has about his consumption patterns (Steg, 2008).

Geller (2002) distinguishes between two ways in which information on the individual's level can affect consumer behavior: preceding intervention that focuses on changing the information factor before the occurrence of the consumer's behavior, and consequential intervention, which is based on the assumption that receiving information after the consumer's behavior will later lead to change in the consumer's behavior. Feedback is an example of consequential intervention. Several researchers (e.g.Darby, 2006; Fischer, 2008) emphasized the importance of feedback as a tool for turning electricity from an abstract concept, for which awareness exists only when the product or service is lacking, or when the bill needs to be paid, to a product that is visible and whose use of can be expected and planned, for example by reducing unnecessary consumption and shifting heavy uses of electricity outside of peak demand hours. It seems that providing more information about power consumption can lead to behavioral change resulting from wanting to save consumption costs. The understanding that a specific action is a very significant part of electricity consumption may cause the user to reconsider its use at times when rates are high or even avoid using it altogether (for example hanging laundry out to dry instead of using the dryer if the weather allows it, or avoiding laundering clothes if there is not enough clothes to fully fill a machine).

Effective feedback that will significantly influence consumer behavior has to be accessible and understandable to the consumer. Furthermore, the feedback presented to the consumer may include fields such as data on average kilowatt consumption per hour, or an average of uses by the hour, power consumption in specific areas of the house (important information for roommates, for example) and it is possible to improve its efficiency by improving its visual arrangement and increasing the frequency of the feedback (Fischer, 2008). The increased frequency of the feedback can be done with simple and common tools, such as automatically sending an e-mail or a mobile phone text message at regular intervals, so that the information is "nudge" to the consumer, and there is no need for him to check the smart meter for the data produced. The essential difference between this approach compared to the previous one, is the frequently of the reports and their level of detail. In this way, the customer can specifically match the consumption and the output results. In this manner, the consumer can focus on economically thinking of the relation between certain daily routines and their specific impact that shows up in the report. The feedback content can include not just the immediate energy information and its economic implications, but also additional information, such as environmental impact, like emissions of carbon dioxide. The combination of the direct financial cost and environmental cost may increase awareness of consumption and reduce it (Jensen, 2003; Mack and Hallmann, 2004) and thus increase the economic benefit of the consumer. The environmental impact may seem unrelated to the economic behaviors of consumers, but it should be taken into account that the proposed solutions to the carbon emissions problem are already based on making countries pay a fine for increased carbon dioxide emissions, and it is not unreasonable to think that in the end

such costs will be passed on directly to the end consumers, so it may be worth it to prepare the monitoring systems that provide such data.

The smart grid, by using smart meters, provides domestic consumers with improved feedback (by obtaining accurate information of their electricity consumption), allowing them to make economic decisions and change their behavior in the long and short term (Logenthiran *et al.*, 2012; Mohsenian-Rad *et al.*, 2010; Moshari *et al.*, 2010). Studies also show that when there is a strong relationship between levels and patterns of electricity use and the cost of using it, and the smart meters clearly present this connection, consumers tend to react and save electricity usage. Similarly (and according to the findings of behavioral economics researchers), more information about the economic consequences, presented in a manner that is understandable to consumers affects their consumption patterns, so a deeper cognitive connection between consumption and its economic aspects generally leads to reduction of consumption and a more intelligent use of electricity .

Domestic consumers get real time feedback on their electricity demand ("Online") by an in home display or other applications that allow users to monitor the use of electricity while it is occurring and make immediate changes. Such feedback can be provided at an entire house level or per device, and allow consumers to control consumption using "smart devices" or by an automatic profile where it is "set and forget" (Ehrhardt-Martinez *et al.*, 2010). In order to test the effectiveness of the direct feedback on domestic consumers' electricity demand, several studies were done over the last decade. In a study conducted by Mountain (2006) for the Hydro One company (Ontario, Canada) 30,000 consumers who received feedback through a monitoring device and were provided with energy consumption data in the home at any given time examined. This study found that direct feedback is effective and encourages conservation and energy efficiency. The direct feedback helped consumers reduce the average electricity demand by 6.5%, as well as increased the satisfaction of over 60% of consumers, who found great significance in monitoring their "real time" electricity consumption and manage its costs. This study emphasized that the results obtained in reducing the demand for electricity are a consequence of the direct feedback alone, and did not include other interference factors such as: price, incentives or information on energy conservation. If these factors will be included along with the direct feedback it will be possible to have an even bigger impact on reducing domestic consumers' electricity demand. In another study MacLellan (2008) examined the effect of the direct feedback via a display device on 3,500 consumers of the Electricity and Gas Company in Massachusetts (NSTAR), and found that a savings rate of 2.9% can be reached among those who used the monitoring device. In addition, 63% of participants reported a behavioral change and 60% of the trial participants noticed a change in their electricity bill as a result of using the monitor. Along with the savings rates observed in the two studies above, there are a number of problems in implementing the monitors, the main one being the low motivation to save electricity, which led to a high dropout rate among participants in experiments that used a home monitor. For example, MacLellan (2008) found that 33% of participants who started the trial stopped using the monitor during the study period. In another study that examined the impact of the home monitor in the Netherlands, Van Dam *et al.* (2010) found that domestic consumers were able to reduce the electricity demand by an average of 7.8%, but these savings dissipated after 4 months (study noted there is nothing statistically significant after 4 months), suggesting a difficulty to maintain the medium-term electricity savings using the home monitor. In addition, the Israeli Association of Smart Energy ruled, based on cost-benefit analysis, that the size of

savings as a result from the feedback provided by the home monitor is of just 3% (Israeli Smart Energy Association - ISEA, 2013).

3.2 Social comparison as a tool of the sociological approach

The sociological approach claims that it is possible to influence the behavior by changing the social context in which the consumer activity occurs. Based on this approach, consumers' electricity demand is determined by a list of complex factors which include, among other things, physical and infrastructure systems, social norms, comfort preferences, daily routines and practices (Darby, 2010). The purpose of interventions according to this approach is to shape or change the social context in which electricity consuming activities take place, in order to encourage saving. Among the most significant tools of the sociological approach are interventions at a group level, the use of normative influences on consumer behavior, as well as comparisons with relevant social groups. Triandis (1977) defined social norms of behavior as 'A system of behaviors which are considered appropriate within a particular social group'. The theory of social comparison, proposed by Festinger (1954), claimed that people tend to learn about themselves, their abilities and their opinions through comparison to others. In addition, Cialdini (1991; 1990) argued that social norms affect human behavior systematically and significantly. In this manner, a consumer who believed his neighbors have taken frequent steps to save energy, will more likely save himself. Indeed, whether consumers are aware of it or not, their neighbors' electricity demand had a significant impact on their habits, suggesting that normative beliefs do have an effect on the behavior of saving power (Schultz *et al.*, 2007).

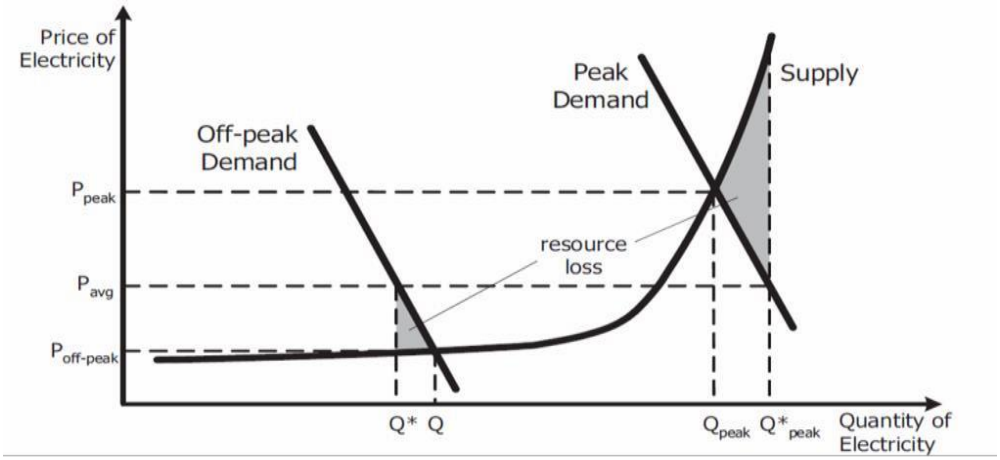
In the Allcott and Mullainathan (2010) study, consumers were presented a report by the energy company OPOWER. The report included two major sections, the first was a module for action items, and provided information on steps consumers can take to save electricity. This section included recommendations to improve home efficiency, such as attic insulation, sealing of the door, installing energy efficient lighting and replacing appliances, and the second section of the energy report included a social comparison module that compared their electricity consumption level with other households who had similar characteristics. The information was presented by visual graphics describing the consumer's electricity consumption in relation to 100 geographically close household consumers. The comparison module, combined with action items, greatly facilitated consumers in understanding what they needed to do in order to match their neighbors. A consumer who reduced energy consumption by more than 20% relative to the average consumption received two "smileys", if the client consumed between the average and less than 20% he received one "smiley", and if the consumer raised his consumption he received a sad, "below average" comment. The study found that the information in these reports resulted in the reduction of the average household electricity demand by more than 2% (the study indicated a reduction of about 6.3% of household electricity consumption in the top decile, while at the lowest decile a reduction of 0.3% in consumption electricity was observed). However, it was also observed that when consumers noticed their consumption was lower than the average of their neighbors, they increased their electricity consumption, a phenomenon known in psychology as the "boomerang effect" (Allcott, 2011). In the Allcott and Mullainathan (2010) it is not possible to attribute the reduction of electricity demand to the social comparison module only, since consumers also received regular information

which included action items needed to be taken in order to reduce the electricity demand in their homes (Allcott and Mullainathan, 2010).

3.3 Dynamic pricing as a behavioral economic approach

There are two main ways to influence domestic consumers' electricity demand by economic means: The first is to use tools available from neoclassical economics, which include various forms of incentives, rewards, awards or fines, while the second way is through the economic behavior approach, which includes supplying consumers with financial information, which affects their decisions and their power consumption. The awareness level of consumers when it comes to a decision they have to make has a significant effect on their behavior (Ratner *et al.*, 2008), when both lack of awareness as well as information overload can lead to sub-optimal financially decision. When asking to examine the impact of the economic aspect on the management of electricity demand of consumers, it is necessary to examine how aware are consumers in general of the economic aspect involved in electricity consumption. If a person is not aware of the economic consequences of his actions, it is difficult to argue that the economic aspect affects his behavior.

One of the characteristics of a smart grid network which uses advanced digital and other technologies to monitor and manage all sources of electricity production for the changing demand of consumers (International Energy Agency, 2011) is the ability to price dynamically (or "smart pricing"). This ability is made possible through the use of smart meters equipped with displays that provide real-time information on energy consumption. The combination of the displays screens and remote shedding creates a system that allows impacting the customer's electricity consumption by creating economic incentives (usually negative ones) to the consumer, causing him to change his consumption behavior immediately, depending on electricity costs at the moment. Remotely shedding can increase the overall efficiency of the system by creating the possibility of making maximum use of the existing electricity infrastructure (Logenthiran *et al.*, 2012). A key way by which consumer behavior can be influenced by economic means is to price dynamically, which is achieved by electricity demand management agreement, which is based on the rate of time of use and load. In this arrangement, there is a higher rate during peak hours and a discounted rate at times when consumption of electricity is low (off-peak hours), in addition to the price that varies according to seasons and the demand hours grouping. Differential pricing is a critical component for the economy of managing demand. For example, in systems with limited capacity the prices during peak demand should be significantly higher than the prices during off-peak demand, in order to motivate a consumer demand shift (Strbac, 2008). Most electricity consumers in the world do not pay the full cost of electricity production, since it is based on the average cost of electricity production and not the marginal cost of electricity prices (see Figure no. 1), therefore it does not necessarily allow an efficient allocation of resources, and causes harm to social welfare of the economy as a whole, and consumers in particular. The fact that consumers do not feel the marginal cost of producing the product causes them to consume the product in a manner that is non-optimal to the system and creates dead- weight losses (or resource losses) (Tabori, 2012), which means a reduction in social welfare (in the graph – the shaded triangles). The excess burden is created due to the change in behavior of market factors as a result of state intervention. Without such intervention, social welfare is at its maximum because the free market and all the market factors behave as they see fit.



Source: U.S. Department of Energy [DOE] (2006)

Figure no. 1 – The relationship between amount of electricity demand and price of electricity during "peak" and "off-peak" hours

The use of various tools for dynamic pricing causes household consumers to manage electricity consumption in a way that is more economically beneficial and they respond to it in a way that makes them reduce peak demand for electricity (Fan and Hyndman, 2011; C. S. King and Chatterjee, 2003), although sometimes by sacrificing some of the comforts of the use (e.g. avoiding the use of the washer and dryers during peak hours). However, in a study that examined consumers' willingness to join the agreement, the case of the California energy crisis of 2001 showed that the rate of consumers who join an agreement that is based on a rate that varies (time of use) was low, and resulted, among other things, due to consumers' fears that a changing price will lead to an increase in their electric bill (Lutzenhiser *et al.*, 2002). Many studies have shown flexibility in domestic consumers' short-term electricity demand, in values that range between -0.2 and -0.3 (e.g. Boyce and Riddle, 2007; Labandeira *et al.*, 2012), i.e. a 10% increase in the price of electricity led to a reduction of between 2% to 3 %, contrary to the popular belief that the electricity demand is inelastic, meaning that a change in price will not significantly change the amount of electricity desired. Even in 24 research pilot studies where more than 100 different experiments of dynamic pricing were used, covering locations and different periods of time, it was found that the pricing was able to reduce peak consumption compared to fixed rates by about 12% on average. In addition, nearly 30 of the experiments led to a reduction of electricity demand between 10% and 15% compared to regular rates (Faruqui and Palmer, 2011).

These findings lead to the conclusion that there is some flexibility in electricity demand despite electricity being a basic and essential product that is considered to have an 'inelastic demand'. A possible explanation for the general decrease in electricity demand when the pricing is dynamic is that people choose not only to postpone their use of an electrical device to a different time, but also give up on using it during peak demand hours without using it in another time. Perhaps the very awareness that usage rates change causes domestic consumers to reduce their electricity demand during peak hours, since the information provided to them creates the feeling that they can influence the economic consequences of the use of electricity to cost reduction, so the additional information does affect their decisions.

3.4 A marketing campaign as a tool in an educational approach

The educational approach claims that consumer behavior can be influenced by supplying information and learning, generally to a large group of consumers, for example, families and households collectively. The uniqueness of this approach compared to the others is in the meaning of different consumption patterns, beyond the specific report on the level of consumption. Public bodies (e.g., government agencies) have a great impact on consumers' economic behavior (Soman, 2007) therefore they employ various tools in order to influence their economic decisions (Lusardi *et al.*, 2009). One of these tools is the use of organized information programs (campaigns) which are suited to households and are aimed at transmitting information that raises the level of awareness of domestic consumers, which affects the behavior and encourages saving electricity, especially when the additional information allows a clear perception of electricity and its cost (Darby, 2006; Fan and Hyndman, 2011; Fischer, 2008; C. S. King and Chatterjee, 2003). It seems that integrating relevant information to the public causes consumers to examine the costs of electricity and improve the level of awareness about the potential for electricity savings and its importance, when, according to the Ministry of national infrastructures, energy and water resources, it is possible to reach savings of 10% in the demand for electricity (Ministry of national infrastructures. energy and water resources, 2010). In addition, knowledge reduces domestic consumers' fear of new technologies, especially when only a small percentage of them know the manner in which the power system operates, the smart grid the smart meter and their implications on household electricity consumption (Smart Grid Consumer Collaborative - SGCC, 2011).

In the "you saved – you earned" campaign that took place in Israel in 2012 by the Government Publications Office in order to get domestic consumers help reduce electricity demand during peak demand hours, particularly in light of the severe natural gas shortage and the fear of electricity supply shortage that year, domestic consumers were offered a discount in their electric bill for reducing demand for electricity during summer months in comparison to the same period in the previous year. A consumer who reduced electricity consumption by 10% -20% compared to that same period the year before, was entitled to receive a discount of 10% in the electricity cost. If the reduced electricity consumption was between 20% and 30% compared to the previous year, he received a 20% discount in the electricity cost. The campaign was a widely presented one in the media (TV, radio, Internet and sectoral newspapers), and addressed the entire population of Israel, in order to reach the largest possible audience. The campaign was accompanied by the slogan: "Why in the afternoon?! Stopping the electricity drought," and it addressed domestic consumers asking to avoid using unnecessary energy-hogging appliances during peak hours, such as washers, dryers, dishwashers, electric heaters, stove, etc. According to the Ministry of national infrastructures, energy and water resources, the campaign resulted in a 42% increase in the level of awareness of domestic consumers about what peak hours of demand are in the summer. The awareness also led to a drastic change in behavior and an increase of 21% in domestic consumers' willingness to reduce the use of high-consuming appliances during peak hours (Ministry of national infrastructures. energy and water resources, 2012). This Israeli campaign is based on a successful campaign carried out in California which was done following the crisis in the electricity sector and the concern that California will not be able to supply electricity in 2001, therefore it was decided to take emergency measures that included a marketing plan to reduce domestic consumers' demand, among then the '20/20

Plan' (a reduction of 20% in electricity demand during the summer in comparison the same period last year, rewarded the saver with a 20% discount in the electricity bill) and the "flex your power" campaign, requesting the public to reduce the demand for electricity. These programs helped reduce the demand for electricity by 6.7% and peak hours' demand by 10.4% (Goldman *et al.*, 2002). A similar figure of reduced demand as part of information campaigns was presented in the Dulleck and Kaufmann (2004) research, that showed that brochures attached to consumers' bills and included general information on saving electricity, led to a reducing of the demand for electricity by 7% over time, leading to a conclusion that information campaigns are successful in reducing the demand, at least in the short term.

It seems that relatively standard marketing techniques of promotions and discounts, such as discounts on the use of electricity during low demand hours or discounts on a significant reduction in consumption on a monthly level, which directly address the economic aspect of electricity consumption, can influence consumer behavior with regard to the use of electricity, even though the purpose of the marketing programs mentioned is actually the opposite of the normal underlying purpose of marketing, which is increasing consumption as much as possible – it is rather an anti-marketing campaign. Along with that, the potential of reducing electricity demand resulting from a change in consumer habits is small, since most subtle changes have already been made and because the attentiveness of consumers in the area decreases (Ministry of national infrastructures. energy and water resources, 2010), therefore there is importance in planning a long-term national plan, which will provide the population with organized information regarding the possible tasks and efficient measures that can lead to saving electricity demand. However, information campaigns often tend to overload general information on consumers, information which is not always applicable and relevant to the situation of the household and therefore does not bring a reduction in electricity use (Abrahamse *et al.*, 2005). Thus, another possible solution to change consumer behavior is to use information specifically designed for the consumer's household. For example, through an energy survey, the domestic consumer gets personalized advice (specific information) verbally, and the interaction between the consumer and the consultant allows the consumer to get the information needed to manage electricity demand (Darby, 2010). Several studies that have investigated the impact of domestic energy surveys pointed to a reduction in the demand for electricity (e.g. Winett *et al.*, 1982), showing that households that had their energy use reviewed (with an emphasis on the energy required for heating and cooling the house) reduced domestic energy consumption by 21% compared to a control group. Another way to receive information personalized specifically to the household is using the tools offered by the smart grid and the use of smart meters (and other technological means) which provide households with much more information about their electricity consumption and costs (Andrey and Morelli, 2010). When consumers deeply understand the economic significance of their consumption habits (whether in terms of general consumption or in terms of consumption during certain hours or of certain devices), they are more likely to respond to costs and reduce electricity consumption in their home.

In conclusion, the educational approach claims that the information and awareness the individual has, have a great influence on the rate and patterns of consumption. However, economic information and awareness, meaning, the information that specifically evaluates the ways in which individuals can save money, have greater contribution to consumption patterns.

4. THE ELECTRICITY DEMAND OF DOMESTIC CONSUMERS

4.1 Characteristics of domestic consumers' electricity demand

The domestic household sector in Israel and in the EU is approximately 30% of all annual demand for electricity (European Environment Agency, 2012) hence the high potential for electricity savings among domestic consumers. One of the unique features of electricity is that the product is "invisible" and the consumer is unable to assess it using normal cognitive measures, as opposed to physical products, which can actually be seen when they run out or are consumed in some way. Electricity is just something that reaches the house and makes things work (Darby, 2006; Watson *et al.*, 2002). This also makes it different from other energy products such as cars' gasoline, which even if the consumer does not see it, he can grasp it and its price by simple terms such as the price per liter and a number of kilometers per liter. In general, the demand for electricity is, for most consumers, an area where they have low involvement (Watson *et al.*, 2002).

Consumption is often spontaneous and uncalculated, or one that is not actively controlled by a specific person or entity. It is noteworthy to mention at this point, that in situations where there is no competition (e.g. in Israel) it is likely that the engagement will be even lower, because the consumer perceives electricity as a basic product for which consumption cannot be significantly reduced and for which he has no other alternative (Tabori, 2012). In fact, the common perception is that the demand for electricity among household consumers is inelastic, meaning that a change in price will not significantly change the amount of electricity requested, so the consumer cannot impact the electricity bill and price in any way. In general, it is obvious that many consumers are unaware of their electricity usage level and the change they can make in their consumption if they change their electricity demand behavior (Darby, 2006). Consumers tend to consume electricity without forethought, out of habit, and the expectation to receive electrical service in routine functions, such as lighting of light, turning on the air conditioner or the heater, things done in an obvious manner.

4.2 Types of domestic consumers electricity demand behavior

Generally speaking, the electricity demand behavior can be divided into two categories: "Curtailment" behaviors in electricity consumption and behaviors based on adopting Energy Efficiency technologies (Gardner and Stern, 2002). The first type, "Curtailment" behaviors, refers to accepting actions to reduce the demand for electricity, requiring domestic consumers to change their patterns of electricity demand and adopt new habits, such as avoiding consumption of electricity with or without the sacrifice of some comfort, for example, turning off a light when exiting the room does not involve discomfort, while giving up one or two temperature degrees on the AC could be interpreted as loss of comfort.

The second type, labeled 'efficiency' behaviors, refers to the use technical means to reach energy efficiency and savings by replacement of electrical equipment or the methods they used, in order to achieve the same level of comfort by other means. The action is mostly a 'one shot' type, in the sense of replacing products or creating an adjustment to their use. During the rest of the time, the behavior and outcome will remain almost unchanged. These are actions that do not require changing the habits of domestic consumers' electricity demand, such as various forms of insulation or the use of energy-saving lighting. Studies

(e.g.: Abrahamse *et al.*, 2005; Gardner and Stern, 2002) show that the electricity savings potential in 'efficient' behavior is considered to be larger than the potential for "Curtailment" behavior, therefore its use is more common. That is why Israel's energy policy is based primarily on energy efficiency, being that through technological changes alone it is possible to fulfill the greatest potential for electricity consumption savings of households in Israel, estimated at about 47% by the year 2020 (Ministry of national infrastructures. energy and water resources, 2010). This statistic is even higher than the estimated 35% by 2020 – estimated as the electricity saving consumption of households in the US (Creyts *et al.*, 2009).

5. CONCLUSIONS

The literature review indicates the effectiveness of behavioral tools to change the domestic consumer's behavior which is expressed in savings and reducing the electricity demand during peak demand hours. In fact, the use of behavioral tools provides information that causes domestic consumers to acquire more knowledge, that in turn affects their behavior. These approaches stemming from diverse academic backgrounds enable us to get different perspectives on the energy conduct of the domestic consumer, and together they provide a complete picture of many dimensions on the different ways to influence electricity demand by households, therefore also enable us to identify opportunities to influence domestic consumers' behavior by studying their patterns of action (Geva, 1994). In addition, Chatterton and Department of Energy and Climate Change (2011) divide the four approaches into two groups: the economic approach and the psychological approach which consider a single consumer or a household unit as an individual unit who makes rational or semi-rational decisions. In contrast, the sociological approach and the educational approach focus on energy behavior of consumers at a group level, for example, families, households, companies and organizations. It is also possible to divide the four different approaches based on the type of information into two main categories: the economic and psychological approaches focus on presenting detailed information in "real time" to domestic consumers, therefore requiring the use of technological tools that the smart grid offers. In contrast, the sociological and the educational approach focus on presenting general information and a low level of detail to the domestic consumers, therefore do not require the use of technological tools that the smart grid offers, such information based on social comparison, presented to consumers through a report that arrived at the household (Allcott and Mullainathan, 2010) and general information as part of a campaign shown in the media (television, radio and the Internet) or the electric bill that the consumer receives.

Based on the literature review, a schematic principle model is presented (see Figure no. 2), showing the way in which the domestic consumers' electricity demand can be affected, using the information provided by the use of behavioral tools from the four different approaches mentioned above.

Studies (e.g. Abrahamse *et al.*, 2005; Benders *et al.*, 2006) indicate that combining several approaches is a more effective way to change the electricity demand by domestic consumers. Indeed, it is difficult to assess the impact each approach has separately on the change of electricity demand by consumers, because studies usually combine several approaches together. For example, a field research conducted in Japan by Mizobuchi and Takeuchi (2012) focused on examining the factors that reduced demand for electricity, while focusing on isolating the economic incentive from the rest of the other factors, it was found

that when providing only an economic incentive as a 20% discount, resulted in a reduction of electricity demand by 5.9%, while the combination of an economic incentive (classical economic approach) with providing feedback information (a behavioral tool from the psychological approach) which included comparative data (a behavioral tool from the sociological approach), led to a drop in electricity demand at the rate of 8.2%. With that the study reinforces the existing effectiveness (expressed in an increased reduction of electricity demand) by combining various approaches and tools. Despite the positive results of using behavioral tools, their influence on public policy is still limited since regulators prefer to use the tools classical economics offers, such as laws regulations, economic incentives or through energy efficiency (technical means). It can be assumed that until a few years ago, regulators feared using behavioral tools since they understand it is not a simple challenge to change electricity consumption habits and convince an entire population of households to reduce electricity demand. In addition, it appears that there was not enough information to use behavioral tools which operate on a large scale and over longer periods of time (Pollitt and Shaorshadze, 2011). Along with this, it seems that in recent years governments realize the potential of changing electricity consumption habits of domestic consumers using behavioral tools which have a big advantage – they do not require a significant financial investment - advertising campaigns asking to reduce peak hours demand during summer months, applying dynamic pricing for the domestic sector and providing electricity bills which include, among other things, comparative information to the neighbors. Governments should therefore view the research approach in behavioral economics as a complimentary approach which provides behavioral insights into the research questions the neoclassical economic presents. Chetty (2015) also notes that research questions in the field of behavioral economics should examine how to cause humans to make decisions that will improve their lives rather than engage in testing the validity of the basic assumptions of neoclassical economics.

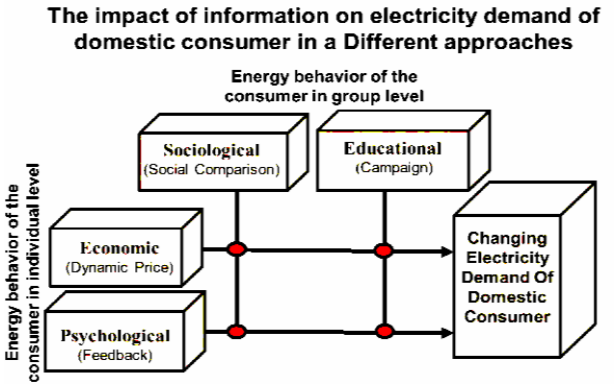


Figure no. 2 – A schematic principle model for changing domestic consumers' electricity demand

In light of the effectiveness of behavioral tools, as seen in analyzed studies, it is recommended to extend the use of these behavioral tools and integrate them in public policies to reduce the electricity demand, together with the classical tools, including economic incentives and energy efficiency, especially when studies show that the combination of tools provided by classical economics with the tools offered by behavioral economics brings significant positive results in reducing electricity consumption by domestic consumers.

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