In: Energy Policy
Editor: K. J. Sreekanth
ISBN: 978-1-53613-744-6

Chapter 4

BEHAVIOR CHANGE APPROACH: A METRIC TO PROMOTE AND SUSTAIN ENERGY EFFICIENCY

Fotouh Al-Ragom*[*]*, PhD
Energy Efficiency Technologies Program,
Kuwait Institute for Scientific Research, Kuwait

ABSTRACT

The general trend in efficiency programs involves using technological and economical tools. These tools can support decision making specifically for program implementation justification (techno-economic validation). Once the programs are in place, the success of these programs lies in the proper adaptation and retained dedication of project stakeholders or end-users. Hence psychology and behavioral economics tools can be used to capture culture and psychology trends to devise comprehensive energy efficiency programs that can eliminate technologies adoption barriers. Such comprehensive programs will incorporate energy-focused behavior change interventions. This chapter reviews available energy-focused behavior change programs highlights

[*] Corresponding Author Email: fragom@kisr.edu.kw.

behavior biases and gaps and describes a behaviorally informed design scheme that can be utilized as a tool for developing energy efficiency behavior change interventions.

Keywords: behavior informed design, behavior change techniques, energy efficiency, design thinking

INTRODUCTION

"Changing behavior and reducing the per capita energy usage is tantamount to having found a new source of energy. Resource consumption and dependence offset in tandem rather than separately." (Frederiks, Stenner, Hobman, et al., 2015). Harnessing this new source can be of paramount effect to energy consumption and demand. Moreover, to ensure the realization of the maximum efficiency of a system, subsystems efficiencies must be optimized. In energy systems, subsystems will include system/technology adaption by end-users/consumers and their behavior change. Behavior change can propagate faster than infrastructure or technology transfer. It can also ensure the sustained use of systems and technologies. Behavior change is governed by behavioral economics and psychology. Understanding behavior change theory, norms, gaps and failure modes will provide insights into cognitive biases related to energy-related behavior hence explaining why individuals fail to commit to energy efficiency. Energy conservation behavior studies trace back to the 70s after the first Arab Oil Embargo (Shihata, 1974). These empirical studies show that to reform energy consumption behavior several factors need to be considered including rewards (financial) followed by feedback of behavioral performance, exhortation and information. The finical rewards are the most effective while information dissemination was found to be the least effective (Foxx1 & Hake, 1977), (Hayes & Cone, 1977). Kohlenberg et al. concluded that both cash incentives and feedback combined can maximize the reduction in electrical consumption while information dissemination such as the equipment power requirements had a very small

affect on energy consumption patterns. They also noted that the removal of experimental treatments (ex. removal of energy consumption feedback device) reverted the consumption to pre- treatment patterns of consumption (Kohlenberg, Phillips, & Proctor, 1976).

In 1977, Milstein conducted an empirical study to assess the knowledge and behavior of the American consumers regarding energy conservation (Jeffrey S. Milstein, 1977). This study analyzed survey data gathered by the U.S. Federal Energy Administration in efforts to assess the effect of the Arab Oil embargo on energy conservation/consumption. The study spanned over 2 years (from 1974-1976) with 1000-1200 person/month were queried in 48 states through telephone calls (12-20 minutes). He evaluated several factors affecting behavior including the following:

- Awareness: A majority is aware of the U.S. energy problem due to the Oil embargo and that there is a public understanding of its implications yet, they will not take actions to conserve unless they "know how and why they should".
- Attitude: Milstein explained that what people say and what they do is totally different and that virtually everyone is for energy conservation but in the abstract. He elaborated that "there is a great discrepancy between lip service and action" and that people may not accurately report on their own behavior.
- Lack of Knowledge: He addressed the importance of lack of knowledge, as consumers sometimes do not know how to save energy and that there are some misconceptions.
- Other: He evaluated other factors including conveniences and comforts and concluded that Americans (while not a universal trend) highly value indulgence and comfortable life. This, in fact,, can apply to other nations around the world, in materialistic societies. He also evaluated scepticism and cynicism and showed that energy conservation actions are being mitigated because the consumers are a sceptic that their actions/sacrifices will be carried

equitably by others such as the government and the industry. He also highlighted the importance to use motives, the desire to financial benefits and to induce people to save energy (Jeffrey S. Milstein, 1977).

In recent studies such as the one by Frederiks et al. (Frederiks, Karen, & Hobman, 2015) the authors indicated that consumer choices and behavior are governed by cognitive biases and heuristics. They elaborated that people are driven by loss aversion rather than gain, use relative rather than absolute evaluation and prefer lower certainties over higher risks. According to the discussed studies and other several behavior studies, it has been shown that people can think and act differently and cannot maintain behavior change over a long period of time. Often a gap between people knowledge, value, attitude and intention and their observable energy consumption behavior is found. Hence people even when they know about the environmental benefits using a greener technology such as using solar panels, they do not adopt such a technology. Not adopting such a technology while knowing its benefits are not necessarily an indicator of low environmental values. This poses difficulties in predicting consumer behavior. While many think that household energy consumption is driven by financial incentives as indicated by Milstein (Jeffrey S. Milstein, 1977), other behavioral economics studies explain that other factors dictate consumers' behavior. These factors include biases such as the status quo, loss and risk aversion, sunk-cost effects, time and space (temporal and spatial) discounting, and the availability bias (Chatzidakis & Lee, 2013). Thus the behavior assessment is a vast field. Many factors can contribute to either promoting or hindering a targeted behavior. This chapter will shed some light on some factors that can be of influence on behavior in anticipation that it can provide a better understanding of behavior physiological factors. This understanding can aid in designing adaptable energy efficiency interventions that can aid in developing a targeted long-lasting behavior change.

BEHAVIOR GAPS

Despite the individuals' awareness, values, preferences and intention towards energy efficiency, sustainability or any socially desirable behavior, their actions do not coincide with their intentions and their values and attitudes fail to materialize into technologies purchases. Connolly and Prothero's argued that while individuals feel empowered and responsible for environmental issues, their insecurities of not knowing what the 'best' or 'right' choices are can hinder their involvement in pursuing or adopting options that are inline with best environmental practice (Connolly & Prothero, 2008). Often attitudes, intentions and behavior do not correlate well, which can lead to a low adoption rate of energy-saving measures by the consumers (Baker, 2003). This can hamper the desired effect from awareness campaigns, which assume that increasing the consumers' knowledge will alter their behavior and guarantee long-term adoption of efficient practices. Hence the analysis of the behavior gaps can be used to understand the energy consumption behavior and consumer preferences. Various behavior gaps exist, which can aid, once understood in designing successful behavior change campaigns as shown in Figure 1.

Attitude-Action Gap

This gap represents the discrepancy between consumers' expressed preferences for energy efficiency practice or technology adoption and their actual willingness/unwillingness to commit is commonly referred to as the attitude-behavior/action gap (Barnett, 2007; Clarke, Barnett, Cloke, & Malpass, 2007; Claudy, Peterson, & Driscoll, 2013; Moraes, Carrigan, & Szmigin, 2012). The attitude-behavior gap was addressed by several authors and many have demonstrated that attitude-behavior inconsistencies exist as some case studies have shown that positive attitudes towards behaviors will not necessarily lead to the performance of the intended behavior. Marius et al. argued that when focusing only on attitude-behaviour, reasons against adoption will not be evident (Claudy et al.,

2013). By applying behavioral reasoning theory on consumer adoption of solar panels they have concluded that it is important to reduce reasons against adoption in order to increase the adoption of the panels and other renewable energy technologies in the future. Chatzidakis and Lee supported the phenomena of negation and affirmation in reasons theory as they highlighted how the ‘‘reasons against’’ consumption are not always the logical opposite of the ‘‘reasons for’’ consumption (Chatzidakis & Lee, 2013).

They have explained that the reasons against adoption of solar panels included the high cost of renewable energy technologies due to the conventional energy government direct/indirect subsidies, and discussions of stakeholders on the financial payback time of renewable energy investment decisions (Claudy et al., 2013).

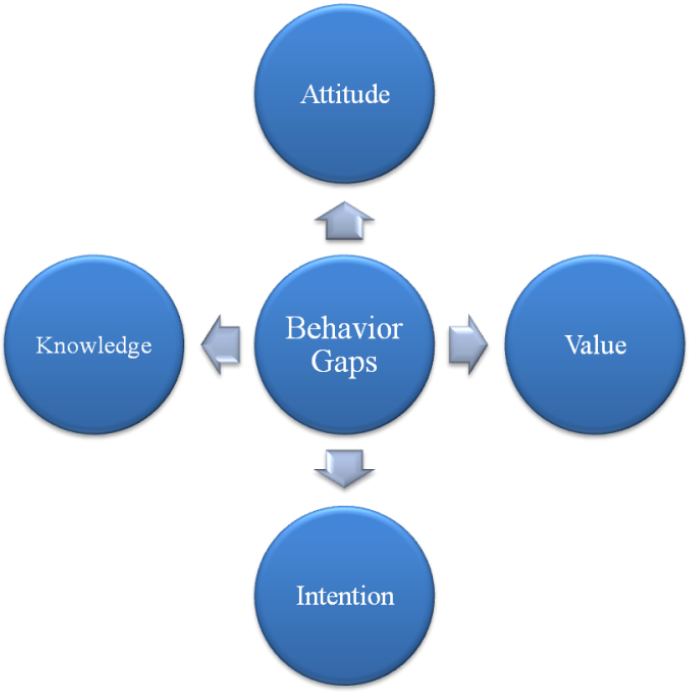

Figure 1. Identified behavior gaps.

Knowledge-Action Gap

Verplanken and Wood argued that in the long run informational interventions will not succeed. They stressed the importance of sustaining habits for behavior change by considering the socio-structural factors. They suggest that repeatability can lead to decision withdrawal and that behavior can be mechanically prompted by contextual and environmental factors (Verplanken & Wood, 2006). Newton and Meyer pointed that "attitudes and behaviors are highly dynamic which prompts changes at any point in time" (Newton & Meyer, 2013). Psychological barriers, not knowing how to change, is amplified in high-cost energy conservation behavior. Lacroix and Gifford (Lacroix & Gifford, 2017) explain that ignorance (as a barrier to behavior change) might not be a barrier for a low-cost behavior (ex. taking shorter showers) but it may apply in a high-cost behavior (ex. installing solar panels).

Intention-Action Gap

Newton and Meyer, 2013, illustrated that, in the conceptual framework for consumption research, urban locality, dwelling, household and individuals all contribute to the actual consumption. While the determinants of consumption include the demand side (individuals, households and the settings related to their dwelling, urban location or social surroundings) and the supply side (a technological innovation of key infrastructures, systems and services), the individuals and households behavior change can hold a faster rate of sustainability transformation. They implied that the change is possible in both determinants, yet the timescale required is considerable for the supply side which explains the amplified government's interest in behavior change policies and programs (Newton & Meyer, 2013; UNEP, 2011). In addition, they highlighted that several research studies on urban resource use are finding a gap between attitudes and actions as individuals' behavior and their intentions (Gilg & Barr, 2005; Lorenzoni, Nicholson-Cole, & Whitmarshb, 2007).

Newton and Meyer used the lifestyle segmentation (LSS) in studying actual consumption behavior. While they have detected three clusters "committed greens", "material greens" and enviro-sceptics" which validated typology, they could not detect any consumption behavior variation across the three clusters. They reasoned that the current gap between intentions and action is due to the range of barriers to sustainable consumption. These barriers include lack of relevant knowledge; availability of information; organizational challenges, i.e., how to get it done; time (temporal) constraints, similar to (Chatzidakis & Lee, 2013); and financial constraints (return on investment).

Value-Action Gap

This gap describes how individuals place a high value on an issue and the low level of action they take to counteract in an attempt to reform the issue in concern. Environmental behavior studies demonstrate that, in view of climate change, even though Americans and Canadians citizens think that climate change is a serious problem and that scientific evidence is proving the link between human activity and the climate change, they are still engaged in activities that lead to GHG emissions (Lacroix & Gifford, 2017; Leiserowitz, 2006; Lorenzoni et al., 2007). Blake theorized that, based on research evaluation, " that people do not have a fixed, rational and ready-made set of values that will be activated by particular calls to action; rather people's values are negotiated, transitory and sometimes contradictory" (Blake, 1999). From baseline research based on questionnaires and face-to-face interviews in Huntingdonshire sustainable community project in which respondents despite their general concern for the environment, were asked to identify the barriers or reasons that prevented them from carrying out particular environmental actions. The responses were summarized and coded. Three different categories of obstacles were identified between concern and action. These categories are as follows:

- Individuality: Personal attitudes or cognitive structure can prevent an individual from taking action because of several reasons including laziness, lack of interest, not having a self-belief in being the right person for action.
- Responsibility: The belief that external (government, groups) control rather than internal control (individual) can create a difference in changing the situation is another barrier to action. The lack of responsibility is also amplified in those individuals who do not own the property they live in. They lack the motivation to take action even if they value environmental concerns related to rational consumption.
- Practicality: Some practical constraints (social or institutional) may prevent people from adopting an action, irrespective of their values or intentions. These include lack of time, money, physical space, information, encouragement and experience (UK Essays 2015).

Thus, according to Blake, the importance of different barriers to action will vary widely in different communities. Different appropriate strategies need to be designed for specific individuals, communities and institutions. As he clearly states that "There can never be a blueprint for encouraging environmental action".

The behavior gaps discussed above can hinder any behavior intervention program. Hence understanding these gaps and mitigating their effects is essential to interventions success. These gaps usually are happening on the subconscious level. Thus if such gaps are pointed out to the targeted individuals, they might be more aware of their actions which might lead to a behavior change that can match their values and attitudes.

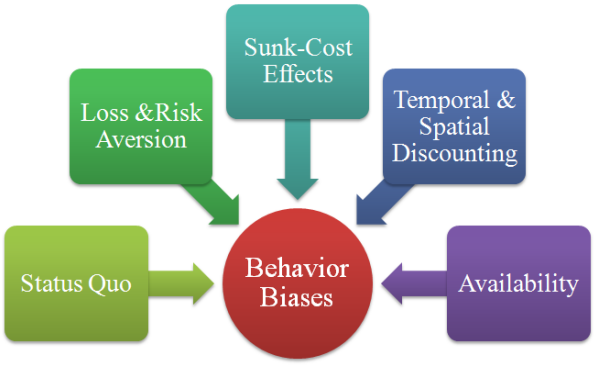

Figure 2. The most pervasive behavior biases.

BIASES

A stimulus can alter an intended behavior of humans by invoking certain biases. Accordingly, understanding these biases can help in adjusting behavior to achieve the desired target such as promoting sustainable energy and energy efficiency. Figure 2 illustrates the most powerful human biases including status Quo, loss and risk aversion, sunk cost effects, temporal and spatial discounting, and availability. While other biases exist the most pervasive one will be discussed. These are important as a large body of research indicates that biases can affect individuals' decisions even when cost-benefit shows advantageous options.

Status Quo

Humans tend to go with the flow and resist change (i.e., Status Quo). Individuals prefer to follow the status quo even when new alternatives might be of financial benefits or materially advantageous (Frederiks, Stenner, Hobman, et al., 2015; Kahneman, Knetsch, Thaler, Johnson, & Professor, 1991; Kahneman & Tversky, 1979; Samuelson & Zeckhauser, 1988). When individuals get overwhelmed with too many options, they

usually prefer the easier option which is, choose nothing rather than face the risk of the new and unknown. “People don’t like change, and they often don’t choose to change a current choice, even if the options available are better than the status quo” (Jewel 2015). Understanding this bias can aid in designing well-suited programs for energy efficiency through behavior change. Opower is an example of a company that utilized behavioral economics in the energy field. Opower, owned by Oracle, is a provider of customer engagement and energy efficiency cloud services to utilities (Oracle, 2016). Opower provides customer engagement platforms for utilities. Opower products are being used by more than 100 utilities in 9 countries. More than 50 million homes are being served by Opower through demand-side management platforms. Opower management platforms which were developed using design thinking methodology informs customers about their energy consumption, and provide personalized ways to save energy and money. Thus their focus is on tailoring solutions to serve the needs of their customers.

Loss and Risk Aversion

The loss/risk aversion in behavior economics arise from prospect theory. Prospect theory is a behavioral model defined by Kahneman and Tversky in 1979 (Kahneman & Tversky, 1979). It explains how people choose between alternatives under risk and uncertainty. They theorized that people value gains and losses differently, and, will base decisions on perceived gains rather than perceived losses. People value certain outcomes rather than taking risks for higher gains involving some uncertainty, this is termed as the certainty effect. The certainty effect contributes to lose/risk aversion. Risk aversion is in selecting choices that involve sure gains and loss aversion (avoid taking risks) in choices that involve sure losses. Thus, if a person is given two equal choices, one expressed in terms of possible gains and the other in possible losses, he/she would choose the former, even when they achieve the same economic end result.

Sunk Cost Effect

Once a valued resource such as effort, time, and money is invested, people tend to become fixated (persistent) in an endeavour and avoid new opportunities even if the valued recourse becomes risky. This is known as the "sunk cost" (Arkes & Blumer, 1985; Garland, 1990; Kahneman et al., 1991; Newport, 1991; Thaler, 1980). Individuals would prefer to recover losses already suffered and discount future costs and benefits. An example of that is when keeping a losing stock and holding it hoping that it will recover. Fredericks et al. (Frederiks, Stenner, Hobman, et al., 2015) argued that this might stem from "Don't waist rule" learned through childhood, where abandoning an option is like waiting (ex. food). Based on research findings it has been suggested that the rate of use of a good or a service increases as the purchase value increases (Arkes & Blumer, 1985). As an example enduring costs for purchasing cars, appliances can increase their use. Hence cars are driven more; appliances are used more often even if not needed (Wolfram 2013). Dixit and Pindyck (1994) proposed a model of investment behavior. This model explains that procrastination of technology adoption when faced with future development uncertainty, can be a rational option. Van Soest and De Groot empirically tested and validated that model (van Soest and de Groot 2011).

Temporal and Spatial Discounting

Discounting can be defined as the "technique for comparing the values of costs and benefits which occur at different points in time" (Baum, Easterling, Baum, & Easterling, 2010). Temporal (time) or Spatial (space, distance), discounting include comparing values of an opportunity when considering timeframe or distance (location, space availability). Temporal and spatial discounting are sometimes linked and both can affect the perception of consequences of actions (Baum, 2012; Peattie, 2010). Analyzing temporal and special discounting can help in understanding how humans discount across space and time. Decisions are affected when

considering the timeframe of any given choice or option. Temporal frame whether it's daily, monthly or yearly contributes to loss aversion. Energy efficiency measures require initial investments, while the benefits are realized later in time. Hence when framing any customer-focused messages, temporal discounting need to be taken into consideration, to minimize the effect of the initial cost incurred and highlight the future savings that will be realized.

Gill found that framing energy savings opportunity on a monthly basis can encourage its adaptation (Gill, 2015) and reduce the temporal discounting. The "pennies-a-day" strategy, in which an aggregate expense is represented on small daily or ongoing expense can provide and explanation of Gill's finding (Gourville, 1998). This concept explains why customers prefer monthly subscription of magazines, internet or mobile plans rather than the yearly subscription. Delayed gratification can also be offset by either providing small immediate rewards (ex. praise, recognition, in-kind gifts) or using a technique known as 'episodic future thinking' (Frederiks, Stenner, & Hobman, 2015). Episodic future thinking involves describing future rewards in a more vivid and tangible way (Hershfield et al., 2011; Kim, Schnall, & White, 2013; Oluyomi Daniel, Stanton, & Epstein, 2013).

Socio-spatial distance is the effect of the resistance on the person willingness to take action. Busse and Menzel examined the impact of social-spatial distance adolescents' willingness to engage in pro-environmental behavior (Busse & Menzel, 2014).

The literature on spatial discounting related to various issues can highlight the link between spatial discounting and risk perception. Baum et al. showed that climate change adaptation is affected by spatial discounting (Baum et al., 2010). People spatially discount the instrumental value of different locations which led some to migrate to these locations. Horst evaluated spatial discounting on wind farm acceptance. He explained that while the concept of some services (i.e., renewable energy) is accepted by the studied population in principle, the residents opposed such service in practice. This phenomenon is known as; not in my back yard (NIMBY) behavior. He elaborated that NIMBY was affected by the living proximity

of the population (Van Der Horst, 2007). Hence those living close to the site of a proposed windfarm are opposed to it because of the level of risk perception. On the other hand, those who lived further away from an existing windfarm are also opposed to it as they lack the local experience which can affect their perception benefits. He added that once the projects were started the opposition rate dropped. Thus, spatial discounting, as well as temporal discounting, is not static but dynamic in nature.

DESIGN THINKING METHODOLOGY

> "We cannot solve problems by using the same kind of thinking we use when we created them".
>
> *Albert Einstein*

Commonly a system, device, technology or intervention is developed to serve a certain need or solve an existing problem then once developed; it has to be marketed to push towards its utilization. On the other hand, People, the end users, are the core of design thinking. People are the users of buildings, equipment and new gadgets. Hence, design thinking is an approach that puts "human needs, capabilities and behavior in the first place, and then applies technical and design tools to accommodate those needs and ways of behaving." (Kuzniatsou 2016). Design thinking invokes innovation and creativity. It is defined by Tim Brown CEO of IDEO, an international design and consulting firm in California USA, as follows:

"Design thinking is a human-centred approach to innovation that draws from the designer's toolkit to integrate the needs of people, the possibilities of technology, and the requirements for business success." (IDEO 2017).

Services, products, devices developed using design thinking, will resonate more deeply with people making them easily adaptive for a longer period. The origin of design thinking can be linked to "The Sciences of the Artificial," Nobel Prize laureate Herbert Simon, published in 1969 (Herbert A. Simon, 1996). He developed the first formal 7 steps framework for design thinking. Currently, there are different alternatives to the

number of steps ranging from 3 to 7. While there is no standardized model for design thinking, each industry develops it's own using a basic framework that is common to all design thinking processes. The practices that were developed at d.school at Stanford University involve a 5 steps model will be discussed here (Stanford, 2017). This framework consists of the following five steps (Rikke and Teo, 2017-a):

- Empathize: In simple terms, empathy means the ability to feel and understand the feelings of others. Thus emphasize mode is what a person can do to understand people needs (physical and emotional). Since usually when a system developer or designer work to solve a problem it is rarely his/her own. Accordingly, the empathy must be built for the users in order to understand how they feel and think. One can develop empathy through observing others behavior, engaging with users through questionnaires and interviews and immersing in the user's experience by actually living in the situation. By doing that, insights can be revealed that can lead to innovative solutions.
- Define: After developing empathy for the user, and based on the gathered information, this step is all about making sense and defining the problem statement and then coming up with an actionable problem statement. This stage will start the process for the following stage "Ideation" by asking the questions "How might we do ….?" (SAP 2017).
- Ideate: This step is all about generating a wide range of ideas. It is not about coming up with the best one, as this comes at a later stage. Thus the focus is ideas generation to create, think outside the box, (innovative) solutions for the users. There are numerous techniques for ideation stage including Brainstorming, bodystorming, stoking, worst possible idea and SCAMPER (Substitute, Combine, Adapt, Modify/Magnify/Minify, Put to another use, eliminate and Reverse) (Rikke and Teo 2017-b). The working team can vote on three ideas to carry them out for the next step that is prototyping.

- Prototype: In this step, ideas are transferred to the physical world. The physical forms can be post-it-notes, role playing, an object, a storyboard or an interface. The prototypes allow the users and the designers to interact with the idea in design to test functionality. This is an experimental stage to help in selecting the best solution. The solutions can be rejected, redesigned or accepted based on the interaction and user experience. Rejected/redesigned solutions can help in reformulating the problem statement to come up with a better solution if none has been achieved. At this stage, the design team will be well informed about the product problems, how the users will feel, think and interact with the end product.
- Test: This mode will allow receiving feedback on the created prototypes from the end users. If the users like the prototype, then you need to know why. The prototype is tested by end-users and the design team can monitor how it is being used or misused, how they interact with it and listen to what they say about it and note the questions they have about it. Testing allows refinement of the solutions to make them better.

An example of an energy saving product that was developed using design thinking is the NEST thermostat. The thermostat main design driver was the frustration of programming old thermostats. This driver guided Tony Fadell, a former Senior Vice President at Apple, who was building an energy efficient house at that time. Tony engaged experts, contractors, conducted research, evaluated other versions of thermostats, and interviewed users to come up with the NEST. NEST through its learning algorithm known as "Autoschedule" develops a customer-tailored schedule. The development of NEST is an example of design thinking approach that is being used in energy efficiency (Nest Labs 2017). D. light is another example of employing design thinking in energy efficiency. D. light is a company with a mission to: "enable households without reliable electricity to attain the same quality of life as those with electricity." The founders of the company developed their idea during a design thinking course at Stanford University. They have arrived at their design while

attending a design thinking class at Stanford University titled Design for Extreme Affordability. They immersed themselves in lives of rural villagers. They have realized the dependence of rural villagers on Kerosene lamps despite their cost, indoor air pollution and contribution to causing a fire. Their solution was to bring clean, safe and bright light to every rural household. Their products which include a range of modular products such as desk lights, portable lanterns and solar home systems were sold in about 60 countries and improving the lives of nearly 30 million people (D.light design. 2018).

From the examples discussed above, it can be noticed that design thinking can play a vital role in the development of programs, products and systems. It can increase the adaptability of products. In the case of NEST thermostat, through surveying their customers they found out that "99% of those devices have schedules that save energy, as opposed to 11% before" (Busari 2012).

THE RIPPLE EFFECT CONCEPT

The "ripple effects" is concept studied by researchers in the health field. This concept addresses the behavioral interventions and its effect on triggering multiple outcomes that are beyond the main target of the behavior interventions (Wilson, 2015). These outcomes, in the behavioral medicine field, include physical, psychological, and social health domains across the lifespan of individuals. Numerous evidenced-based intervention trials supported the existence of ripple effects. Some of these trials involved interventions in obesity for children and adolescence, drug prevention, diabetes and self-regulation of chronic diseases (ex. blood pressure) (Davis et al., 2011; Eather, Morgan, & Lubans, 2013; Epstein et al., 2008; Hillman et al., 2009; van Stralen et al., 2012; Wilson et al., 2009; Zarrett, Skiles, Wilson, & McClintock, 2012). The findings of these studies Showed evidence of ripple effect such as significant improvements in memory, attention, executive functioning (ex. planning and decision-making) arising from more complex cognitive processing by using

measures of neuroelectric changes during cognitive performance tasks and self-regulation processes due to long-term adherence to healthy lifestyle behaviors engagement (Ahn et al., 2013; Botvin, Gilbert J, Griffin, Kenneth W, Paul, Elizabeth, Macaulay, Araxi, 2003; Botvin & Griffin, 2004; Botvin, Griffin, & Nichols, 2006; Gerber, 2006; Gorin et al., 2009; Kerr et al., 2008; Mata et al., 2009; Powers, Olsen, Oddone, & Bosworth, 2009; Werch et al., 2007). In addition, positive decision-making enhanced social and personal competence skills. These cascading effects across physical, mental, and social outcomes of well-being can lead to a higher return on investment (ex. less healthcare expenditure).

In view of energy efficiency can realize multiple benefits (i.e., ripple effects) include increased productivity enhanced product quality, improved system reliability and environmental compliance (Russell, 2015). Enhanced learning is an example of such effects (Howard, 2016). Usually, energy efficiency improvements focus almost exclusively on energy savings. While other benefits are recognized in concept but not highly portrayed. In Norway, a school installed tunable LED lighting. These are considered human-centric lighting (HCL) that are known to promote health and wellbeing (Wright, 2017). Lighting replacement additional benefits can include (if lights with longer life are used CFL vs. LED) fewer replacements and lower maintenance costs (Sullivan, Armel, & Todd, 2012). In the manufacturing process, monitoring energy can lead to conservation of water and raw materials and reduced waste (ACEEE, 2015).

CONCLUSION

Energy consumption behavior change targeting achieving energy efficiency is a field that spans over numerous fields including energy economics, behavior change technology, behavior physiology and theories. To create intervention programs that can be the adapted life style in the future requires tremendous efforts specifically from the scientific community. It has been shown throughout this chapter how this filed can

benefit from other fields such as psychology, marketing, health and education. Efforts are required to reduce the perception of psychological barriers to change individual and societal behavior. Combinations of voluntary, regulatory, and structural approaches must be incorporated in interventions to ensure their adaptation and reap their fruition. More research can be targeted to understand behavior science as in other fields to device guidelines that can be developed to direct energy behavior towards the favoured paths.

Several studies are available that benefit from behavior science and theories in sustainability and environment perspective. Yet more specific ones targeting energy conservation/efficiency are required. The understanding of biases, behavior gaps, ripple effects and design thinking concepts can feed into designing consumer (human) centered approaches to come up with a comprehensive behaviorally informed design schemes for developing energy systems, technologies, awareness campaign and behavior interventions that can be adapted for a longer period of time or even become a lifestyle.

REFERENCES

ACEEE. (2015). *How energy efficiency investment creates a ripple effect of multiple benefits for businesses beyond energy savings* | ACEEE. Retrieved December 24, 2017, from https://aceee.org/blog/2015/01/how-energy-efficiency-investment-crea.

Ahn, S., Basu, R., Smith, M. L., Jiang, L., Lorig, K., Whitelaw, N., & Ory, M. G. (2013). The impact of chronic disease self-management programs: healthcare savings through a community-based intervention. *BMC Public Health*, *13*(1), 1141. http://doi.org/10.1186/1471-2458-13-1141.

Arkes, H. R., & Blumer, C. (1985). The Psychology of Sunk Cost. *Organizational behavior and human decision processes*, *35*, 124–140. Retrieved from http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.452.2318&rep=rep1&type=pdf.

Baker, M. J. (2003). *The Marketing Book* (5th ed.). Linacre House. Retrieved from http://htbiblio.yolasite.com/resources/Marketing Book.pdf.

Barnett, C. (2007). *Governing the Subjects and Spaces of Ethical Consumption*. Swindon, UK. Retrieved from http://cftn.ca/sites/default/files/AcademicLiterature/Governing the Subjects and Spaces of Ethical Consumption.pdf.

Baum, S. D. (2012). *Discounting across space and time in climate change assessment.* A Dissertation in Geography. The Pennsylvania State University. Retrieved from http://sethbaum.com/ac/2012_Dissertation.pdf.

Baum, S. D., Easterling, W. E., Baum, S. D., & Easterling, W. E. (2010). Space-time discounting in climate change adaptation. *Mitig Adapt Strateg Glob Change*, *15*, 591–609. http://doi.org/10.1007/s11027-010-9239-9.

Blake, J. (1999). Local Environment Overcoming the "value-action gap" in environmental policy: Tensions between national policy and local experience Overcoming the "Value-Action Gap" in Environmental Policy: tensions between national policy and local experience. *Local Environment*, *4*(3), 257–278. http://doi.org/10.1080/13549839908725599.

Botvin, Gilbert J, Griffin, Kenneth W, Paul, Elizabeth, Macaulay, Araxi, P. (2003). Preventing Tobacco and Alcohol Use Among Elementary School Students Through Life Skills Training. *SubStance*, *652*(March 2015), 37–41. http://doi.org/10.1300/J029v12n04.

Botvin, G. J., & Griffin, K. W. (2004). Life Skills Training: Empirical Findings and Future Directions. *The Journal of Primary Prevention*, *25*(2). Retrieved from http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.552.5881&rep=rep1&type=pdf.

Botvin, G. J., Griffin, K. W., & Nichols, T. D. (2006). Preventing youth violence and delinquency through a universal school-based prevention approach. *Prevention Science*, *7*(4), 403–408. http://doi.org/10.1007/s11121-006-0057-y.

Busse, M., & Menzel, S. (2014). The role of perceived socio-spatial distance in adolescents' willingness to engage in pro-environmental behavior. *Journal of Environmental Psychology*, *40*, 412–420. http://doi.org/10.1016/j.jenvp.2014.10.002.

Chatzidakis, A., & Lee, M. S. W. (2013). Anti-Consumption as the Study of Reasons against. *Journal of Macromarketing*, *33*(3), 190–203. http://doi.org/10.1177/0276146712462892.

Clarke, N., Barnett, C., Cloke, P., & Malpass, A. (2007). The Political Rationalities of Fair-Trade Consumption in the United Kingdom. *Politics & Society*, *35*(4), 583–607. http://doi.org/10.1177/0032329207308178.

Claudy, M. C., Peterson, M., & Driscoll, A. O. (2013). *Understanding the Attitude-Behavior Gap for Renewable Energy Systems Using Behavioral Reasoning Theory*, *33*(4), 273–287. http://doi.org/10.1177/0276146713481605.

Connolly, J., & Prothero, A. (2008). Green Consumption Life-politics, risk and contradictions. *Journal of Consumer Culture*, *8*(1), 117–145. http://doi.org/10.1177/1469540507086422.

D.light design. 2018. http://www.dlight.com/.

Davis, C. L., Tomporowski, P. D., Mcdowell, J. E., Austin, B. P., Miller, P. H., Allison, J. D., … Naglieri, J. A. (2011). Exercises improves executive function and achievement and alters brain activation in overweight children A randomized controlled trial. *Nih*, *30*(1), 91–98. http://doi.org/10.1037/a0021766.Exercise.

Eather, N., Morgan, P. J., & Lubans, D. R. (2013). Social support from teachers mediates physical activity behavior change in children participating in the Fit-4-Fun intervention. *International Journal of Behavioral Nutrition and Physical Activity*, *10*(1), 68. http://doi.org/10.1186/1479-5868-10-68.

Epstein, L. H., Roemmich, J. N., Robinson, J. L., Paluch, R. A., Winiewicz, D. D., Fuerch, J. H., & Robinson, T. N. (2008). A Randomized Trial of the Effects of Reducing Television Viewing and Computer Use on Body Mass Index in Young Children. *Arch Pediatr*

Adolesc Med, *162*(3), 239–245. Retrieved from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2291289/pdf/nihms43558.pdf.

Foxx1, R. M., & Hake, D. F. (1977). Gasoline conservation: a procedure for measuring and reducing the driving of college students. *Journal of applied behavior analysis*, *10*(1), 61–74. Retrieved from https://www-ncbi-nlm-nih-gov.colorado.idm.oclc.org/pmc/articles/PMC1311150/pdf/jaba00112-0063.pdf.

Frederiks, E. R., Karen, S., & Hobman, E. V. (2015). Household energy use: Applying behavioural economics to understand consumer decision-making and behaviour. *Renewable and Sustainable Energy Reviews*, *41*, 1385–1394. Retrieved from https://ac.els-cdn.com/S1364032114007990/1-s2.0-S1364032114007990-main.pdf?_tid=5c4f815a-e275-11e7-8cfd-00000aab0f01&acdnat=1513438114_9df604de6660dc327c99b5b5a970cc81.

Frederiks, E. R., Stenner, K., Hobman, E., Frederiks, E. R., Stenner, K., & Hobman, E. V. (2015). *Household energy use : Applying behavioural economics to understand consumer decision- making and behaviour consumer decision-making and behaviour*, (January). http://doi.org/10.1016/j.rser.2014.09.026.

Frederiks, E. R., Stenner, K., & Hobman, E. V. (2015). Household energy use: Applying behavioural economics to understand consumer decision-making and behaviour. *Renewable and Sustainable Energy Reviews*, *41*, 1385–1394. http://doi.org/10.1016/j.rser.2014.09.026.

Garland, H. (1990). Throwing Good Money After Bad: The Effect of Sunk Costs on the Decision to Escalate Commitment to an Ongoing Project. *Journal of Applied Psychology*, *75*(6), 728–731. Retrieved from http://www.communicationcache.com/uploads/1/0/8/8/10887248/throwing_good_money_after_bad-_the_effect_of_sunk_costs_on_the_decision_to_esculate_commitment_to_an_ongoing_project.pdf.

Gerber, B. S. (2006). The chronic disease self-management program: extending reach through the internet. *Medical Care*, *44*(11), 961–3. http://doi.org/10.1097/01.mlr.0000244923.80923.1e.

Gilg, A., & Barr, S. (2005). Behavioural attitudes towards water saving? Evidence from a study of environmental actions. *Ecological*

Economics, *57*, 400–414. http://doi.org/10.1016/j.ecolecon. 2005.04. 010.

Gill, C. (2015). Temporal Framing, Endowment, and Energy Choices. Retrieved December 16, 2017, from http://www.sjdm.org/ presentations/2015-Poster-Gill-Carrie-LossAversion-Framing-Energy. pdf.

Gorin, A. A., Wing, R. R., Fava, J. L., Hospital, T. M., Street, R., Jakicic, J. M., … Brelje, K. (2009). *Environment : Evidence of a ripple effect*, *32*(11), 1678–1684. http://doi.org/10.1038/ijo.2008.150.Weight.

Gourville, J. T. (1998). Pennies-a-Day: The Effect of Temporal Reframing on Transaction Evaluation. *Journal of Consumer Research*, *24*(4), 395–403. http://doi.org/10.1086/209517.

Hayes, S. C., & Cone, J. D. (1977). Reducing residential electrical energy use payments, information, and feedback. *Journal of Applied Behavior Analysis*, *10*(3), 425–435. Retrieved from https://www-ncbi-nlm-nih-gov.colorado.idm.oclc.org/pmc/articles/PMC1311206/pdf/jaba00114-0053.pdf.

Herbert A. Simon. (1996). *The Sciences of the Artificial*. MIT Press. Retrieved from https://monoskop.org/images/9/9c/Simon_Herbert_ A_The_Sciences_of_the_Artificial_3rd_ed.pdf.

Hershfield, H. E., Goldstein, D. G., Sharpe, W. F., Fox, J., Yeykelis, L., & Bailenson, J. N. (2011). Increasing saving behavior through age-progressed renderings of the future self. *Journal of Marketing Research*, *48*, S23–S37. http://doi.org/10.1509/jmkr.48.SPL.S23.

Hillman, C. H., Pontifex, M. B., Raine, L. B., Castelli, D. M., Hall, E. E., & Kramer, A. F. (2009). The effect of acute treadmill walking on cognitive control and academic achievement in preadolescent children. *Neuroscience*, *159*, 1044 –1054. http://doi.org/10.1016/j.neuroscience. 2009.01.057.

Howard, J. (2016). *How Just The Right Lighting May Improve Learning In Classrooms* | HuffPost. Retrieved November 1, 2017, from https://www.huffingtonpost.com/entry/lighting-boost-learning-concentration_us_5720cb14e4b0b49df6a9b73e.

Jeffrey S. Milstein. (1977). Attitudes, Knowledge and Behavior of American Consumers Regarding 1977. *Advances in Consumer Research*, *4*, 315–321. Retrieved from http://acrwebsite.org/volumes/9358/volumes/v04/NA-04.

Kahneman, D., Knetsch, J. L., Thaler, R. H., Johnson, H., & Professor, L. (1991). Anomalies: The Endowment Effect, Loss Aversion, and Status Quo Bias Anomalies The Endowment Effect, Loss Aversion, and Status Quo Bias. *The Journal of Economic Perspectives Journal of Economic Perspectives*, *5*(1), 193–206. Retrieved from https://www.princeton.edu/~kahneman/docs/Publications/Anomalies_DK_JLK_RHT_1991.pdf.

Kahneman, D., & Tversky, A. (1979). Prospect theory: An analysis of decision under risk. *Econometrica*, *47*(2), 263–291. Retrieved from https://www.princeton.edu/~kahneman/docs/Publications/prospect_theory.pdf.

Kerr, J., Patrick, K., Norman, G., Stein, M. B., Calfas, K., Zabinski, M., & Robinson, A. (2008). Randomized control trial of a behavioral intervention for overweight women: Impact on depressive symptoms. *Depression and Anxiety*, *25*(7), 555–558. http://doi.org/10.1002/da.20320.

Kim, H., Schnall, S., & White, M. P. (2013). Similar Psychological Distance Reduces Temporal Discounting. *Personality and Social Psychology Bulletin*, *39*(8), 1005–1016. http://doi.org/10.1177/0146167213488214.

Kohlenberg, R., Phillips, T., & Proctor, W. (1976). A behavioral analysis of peaking in residential electrical-energy consumers. *Journal of Applied Behavior Analysis*, *9*(1), 13–18. Retrieved from https://www-ncbi-nlm-nih-gov.colorado.idm.oclc.org/pmc/articles/PMC1311891/pdf/jaba00051-0015.pdf.

Lacroix, K., & Gifford, R. (2017). Psychological Barriers to Energy Conservation Behavior : The Role of Worldviews and Climate Change Risk Perception. *Environment and Behavior*, 1–32. http://doi.org/10.1177/0013916517715296.

Leiserowitz, A. (2006). Climate change risk perception and policy preferences: The role of affect, imagery, and values. *Climatic Change*, *77*(1–2), 45–72. http://doi.org/10.1007/s10584-006-9059-9.

Lorenzoni, I., Nicholson-Cole, S., & Whitmarshb, L. (2007). Barriers perceived to engaging with climate change among the UK public and their policy implications. *Global Environmental Change*, *17*, 445–459. Retrieved from https://ac-els-cdn-com.colorado.idm.oclc.org/S0959378007000209/1-s2.0-S0959378007000209-main.pdf?_tid=d639c4ba-d476-11e7-b0d5-00000aab0f6b&acdnat=1511899432_2d3898b5a4dbba9b766af5d555f895d8.

Mata, J., Silva, M. N., Vieira, P. N., Carraça, E. V., Andrade, A. M., Coutinho, S. R., … Teixeira, P. J. (2009). Motivational "spill-over" during weight control: Increased self-determination and exercise intrinsic motivation predict eating self-regulation. *Health Psychology*, *28*(6), 709–716. http://doi.org/10.1037/a0016764.

Moraes, C., Carrigan, M., & Szmigin, I. (2012). The coherence of inconsistencies: Attitude-behaviour gaps and new consumption communities. *Journal of Marketing Management*, *28*(1–2), 103–128. http://doi.org/10.1080/0267257X.2011.615482.

Newport, S. (1991). Effects of Absolute and Relative Sunk Costs on the Decision to Persist with a Course of Action. *Organizational Behavior and Human Decision Processes*, *48*, 55–69. Retrieved from https://www.gwern.net/docs/sunkcosts/1991-garland.pdf.

Newton, P., & Meyer, D. (2013). Exploring the attitudes-action gap in household resource consumption: Does "Environmental Lifestyle" segmentation align with consumer behaviour? *Sustainability (Switzerland)*, *5*(3), 1211–1233. http://doi.org/10.3390/su5031211.

Oluyomi Daniel, T., Stanton, C. M., & Epstein, L. H. (2013). The Future Is Now: Reducing Impulsivity and Energy Intake Using Episodic Future Thinking. *Psychol Sci.*, *24*(11), 2339–2342. http://doi.org/10.1177/0956797613488780.

Peattie, K. (2010). Green Consumption: Behavior and Norms. *Annual Review of Environment and Resources*, *35*(1), 195–228. http://doi.org/10.1146/annurev-environ-032609-094328.

Powers, B. J., Olsen, M. K., Oddone, E. Z., & Bosworth, H. B. (2009). The Effect of a Hypertension Self-Management Intervention on Diabetes and Cholesterol Control. *American Journal of Medicine*, *122*(7), 639–646. http://doi.org/10.1016/j.amjmed.2008.12.022.

Russell, C. (2015). *Multiple Benefits of Business-Sector Energy Efficiency : A Survey of Existing and Potential Measures*. Washington, DC..

Samuelson, W., & Zeckhauser, R. (1988). Status Quo Bias in Decision Making. *Journal of Risk and Uncertainty*, *1*, 7–59. Retrieved from https://link-springer-com.colorado.idm.oclc.org/content/pdf/10.1007%2FBF00055564.pdf.

Shihata, I. F. I. (1974). Destination embargo of arab oil its legality under international law. *American Journal of International Law*, *68*(4), American Journal of International Law. http://doi.org/10.3366/ajicl.2011.0005.

Stanford (2017). Hasso Plattner Institute of Design at Stanford University. https://dschool.stanford.edu/about/

Sullivan, D., Armel, C., & Todd, A. (2012). *When "Not Losing" is Better Than "Winning:" Using Behavioral Science to Drive Customer Investment in Energy Efficiency Utility Energy Efficiency Programs*. Stanford, CA. Retrieved from http://web.stanford.edu/group/peec/cgi-bin/docs/behavior/research/When Not Losing is Better than Winning-ACEEE Summer Study.pdf.

Thaler, R. (1980). Toward a positive theory of consumer choice. *Journal of Economic Behavior and Organization L*, 39–60. Retrieved from http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.454.6386&rep=rep1&type=pdf.

UNEP. (2011). *Visions for Change: Recommendations for Effective Policies on Sustainable Lifestyles*. Paris, France. Retrieved from http://www.unep.fr/shared/publications/pdf/DTIx1321xPA-VisionsForChange report.pdf.

Van Der Horst, D. (2007). NIMBY or not ? Exploring the relevance of location and the politics of voiced opinions in renewable energy siting controversies. *Enrgy Policy*, *35*, 2705–2714. http://doi.org/10.1016/j.enpol.2006.12.012.

van Stralen, M. M., de Meij, J., te Velde, S. J., van der Wal, M. F., van Mechelen, W., Knol, D. L., & Chinapaw, M. J. (2012). Mediators of the effect of the JUMP-in intervention on physical activity and sedentary behavior in Dutch primary schoolchildren from disadvantaged neighborhoods. *International Journal of Behavioral Nutrition and Physical Activity*, *9*(1), 131. http://doi.org/10.1186/1479-5868-9-131.

Verplanken, B., & Wood, W. (2006). Interventions to Break and Create Consumer Habits. *Source Journal of Public Policy & Marketing*, *25*(1), 90–103. Retrieved from http://www.jstor.org/stable/30000528.

Werch, C. E. C., Bian, H., Moore, M. J., Ames, S., DiClemente, C. C., & Weiler, R. M. (2007). Brief multiple behavior interventions in a college student health care clinic. *The Journal of Adolescent Health : Official Publication of the Society for Adolescent Medicine*, *41*(6), 577–85. http://doi.org/10.1016/j.jadohealth.2007.06.003.

Wilson, D. K. (2015). Behavior Matters: The Relevance, Impact, and Reach of Behavioral Medicine. *Annals of Behavioral Medicine*, *49*(1), 40–48. http://doi.org/10.1007/s12160-014-9672-1.

Wilson, D. K., Griffin, S., Saunders, R. P., Kitzman-Ulrich, H., Meyers, D. C., & Mansard, L. (2009). Using process evaluation for program improvement in dose, fidelity and reach: the ACT trial experience. *International Journal of Behavioral Nutrition and Physical Activity*, *6*(1), 79. http://doi.org/10.1186/1479-5868-6-79.

Wright, M. (2017). Norwegian school installs tunable LED lighting to enhance learning. *LEDs Magazine*, *July/Augus*..

Zarrett, N., Skiles, B., Wilson, D. K., & McClintock, L. (2012). A qualitative study of staff's perspectives on implementing an after school program promoting youth physical activity. *Evaluation and Program Planning*, *35*, 417–426. Retrieved from https://ac-els-cdn-com.colorado.idm.oclc.org/S0149718911001170/1-s2.0-S0149718911001170-main.pdf?_tid=1ed865f4-d5f9-11e7-aa62-00000aab0f6b&acdnat=1512065340_a8695cf47f6cbe64c03d7f4dfcd4e0f3.