Kids in the Grid:

The Role of Family Energy Lifestyles in Changing Residential Energy-Use Behaviors

By

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Abstract

The increasing complexity and connectedness of energy networks has opened pathways for new forms of collaboration with energy consumers. Despite the emergence of the smart grid an array of policy options like demand-side management (DSM), many families continue to disregard daily household energy consumption, particularly during peak-use times of day. While many studies have explored residential energy behavior, few have focused on the role of lifestyle—interlinked, culturally-approved behaviors—and even fewer on the role of children in family energy behaviors.

My study uses social-cognitive and social practice theory to analyze a series of focus groups, interviews and hands-on activities conducted with 89 elementary and middle-school children who were asked about their family energy lifestyles. I uncovered four key findings about these children's energy lifestyles: a tendency toward habit and pattern, familial dependence, tech-saturation, and burgeoning independence. Based on these findings, I make three recommendations for interventions targeting behavior change: underscore social involvement, incorporate a dashboard approach, and emphasize education and co-provision. I also make the theoretical claim that attitude-behavior-choice approaches to understanding energy behavior seem at times highly inapplicable to these children's energy lifestyles. Finally, I offer policy implications and goals for future research, commending and critiquing California's broad supply-side match of consumer conservation mandates, and recommending forward-thinking changes to DSM that more holistically center consumer needs.

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Introduction

Spurred by climate change and urbanization, residential energy consumption is embedded in an increase in "the complexity of energy networks...with higher volumes of information and numbers of controllable components," including smart metering, smart appliances, and the availability and legibility of big data (Thomas, Zhou, Long, Wui, & Jenkins, 2019, p. 140). In particular, the smart grid holds potential to engage end-users and energy service providers in "new forms of collaboration," in which consumers play a stronger role in management of their consumption (Smale, Spaargaren, & van Vliet, 2018, p. 585). Even so, demand for energy in the residential sector is expected to increase 50% by 2040 (Asadinejad, Rahimpour, Tomsovic, Qi, & Chen, 2018).

In California, energy utilities and third parties, with oversight from the Public Utility Commission (CPUC), are employing demand-side management (DSM), an attempt "to manage electricity supply and reliability and costs by influencing consumer demand patterns" (Gyamfi, Krumdieck & Urmee, 2013, p. 72). In demand response (DR) programs, a subset of DSM, utilities and aggregators (i.e. third-party providers) use price- and incentive-based billing to try to shift energy behaviors to generation times that are convenient for the grid (Gyamfi et al., 2013). Time-of-use pricing (TOU), through which utilities charge different rates for electricity depending on the marginal cost of supply (Potter, Stuart, & Cappers, 2018), is currently the norm in California for industrial and agricultural consumers, and will become the opt-out norm for residential utility customers by 2020 (CPUC, 2015). TOU attempts to reduce energy use during peak hours, which Pacific Gas & Electric (PG&E) defines, depending on the rate plan, as 3-9PM, principally on weekdays. The demand for energy during hours of peak use requires 'dirtier' energy to supplement supply from renewables, such as solar, for which generation decreases as the sun goes down, making a shift of energy behavior to off-peak times beneficial for both planet and profit (Powells, Bulkeley, Bell, & Judson, 2014).

Many studies have found that DR policies are not as effective as models predict (Ohnmacht, Schaffner, Weibel, & Schad, 2017), perhaps because they are rooted solely in an individual's cost concerns. Behavior is instead the result of multiple factors that are sociological and psychological as well as environmental and economic (Lutzenhiser, 1993; Bandura, 1986), compounded by factors like the characteristics of a house, its appliances, and its inhabitants (Shove, 2003). Understanding the lifestyles that incorporate these factors is integral to the success or failure of DR and DSM (Asadinejad et al., 2018). Lifestyles can be defined as "the distinctive modes of existence that are accomplished by persons and groups through socially sanctioned and culturally intelligible patterns of action" (Lutzenhiser & Gossard, 2000, p. 215). Children's schedules, particularly in the role that school plays daily and seasonally, can to a large degree determine the behaviors of their families (Nicholls & Strengers, 2015). While there is a rich tradition of literature exploring the psychological and sociological aspects of household energy use (Shove, 2003; Van Dam, 2013), there is a particular dearth of information on the energy lifestyles of families with children (Nicholls & Strengers, 2015; Aguirre-Bielschowsky, Lawson, Stephenson, & Todd, 2018).

Here, I analyze focus groups and artifacts that resulted from hands-on activities with 4th-6th graders in California and Oregon to better understand the energy lifestyles of these children and their families, particularly during TOU pricing windows. Such work can inform interventions and messages designed to influence their lifestyles. I supplement this analysis with a review of CPUC and City of Fremont policy documents related to DSM, DR and TOU.

This study proceeds with a literature review exploring eco-feedback, residential energy use and conservation in the context of DSM and TOU, and theoretical approaches to energy use. I then introduce in-depth the conceptual frameworks of social-cognitive theory and social practice theory. I proceed with research questions and a description of the research sites, relationships, and positionality of the author and other researchers, followed by methods of data collection and analysis and validity concerns. I summarize the findings, then discuss them as they inform potential behavioral interventions, with a particular emphasis on feedback. Before concluding, I offer policy implications and directions for future research.

Literature Review

Feedback

Eco-feedback (which I will refer to as simply ‘feedback’) is "information about resource consumption provided back to consumer(s) with the goal of promoting more sustainable behavior" (Sanguinetti, Dombrovski, & Sikand, 2018, p. 56). One of the first meta-reviews of residential energy feedback programs in the U.S. found that well-implemented feedback could generate 6% of savings relative to total residential electricity consumption, and 100 billion annual kilowatt-hours of electricity savings by 2030 (Ehrhardt-Martinez, Donnelly, & Laitner, 2010). Behavioral feedback studies are important because many researchers and practitioners claim that “realisation of a digitalised energy system is no longer constrained by technological factors...but rather by behavioural and economic challenges” (EEA, 2013, Goulden et al., 2014; and Huovila et al., 2007; in Goldbach, Rotaru, Reichert, Stiff, & Golz, 2018, p. 245).

Research has shown that feedback is less successful when it solely emphasizes financial and environmental benefits (Ohnmacht et al., 2017; Petersen et al., 2014), since energy use and feedback engagement are motivated by a multitude of factors. As such, many studies have created frameworks through which to understand successful feedback design. Petersen et al. (2014) name six features of effective feedback. They are summarized, with supporting information from other studies, in Table 1.

Table 1: Effective Feedback Features; Petersen et al. (2014)

Feature	Description/Examples
Usability	*Information should be easily accessible, actionable, and timely.* Best practices for information display include simplicity, clearly delineated features and eye-catching colors (Karjalainen, 2011), repetition in different formats across time to minimize relapse (Winett, Leckliter, Chinn, Stahl, & Love, 1985; Ohnmacht et al., 2017) and real-time delivery (Geelen, Reinders, & Keyson, 2013; Gronhoj & Thogersen, 2010).
Social Norms and Comparison	*Employ socially or personally comparative information.* Numerical information in particular should be accompanied by normative messages (Geelen et al., 2013). As energy-use behavior varies widely across households, those within a given feedback program should have similar behaviors and occupants (Karjalainen, 2011).
Goals, Rewards, and Commitment	*Encourage public commitment-making, reinforced by rewards.* These methods can be enhanced via competitions (Vine & Jones, 2016), allowing participants to choose their own goals (Geelen et al., 2013; Palm & Ellegard, 2011), and discouraging dependence on rewards (Karjalainen, 2011).
Scale and Group Dynamics	*Honor the reality of social systems with complex cultural dynamics in which individual energy consumption occurs.* Feedback should be relevant to a given community or person (Goldstein, Cialdini, & Griskevicius, 2008; Peschiera & Taylor, 2012), particularly since household energy use can vary up to 300% among households (Palm & Ellegard, 2011).
Targeting Non-Rational Motivation	*Recognize behavior is often the result of "habitual, emotional, and non-rational cognition" (p. 83).* Challenge the notion of the consumer as a downstream energy user by embedding feedback with messages about social and ecological realities. Feedback should not only aim to inform, but to educate and empower, increasing personal and communal efficacy (Ohnmacht et al., 2017).
Combining Approaches	*Tailor feedback to respond to varying needs and motivations, even within a given community.* "Gamification" (Vine & Jones, 2016) and dashboards (Clark et al., 2017) can grant access to different layers and interfaces, such as numerical and metaphorical layers; gamification is widely underapplied in energy apps (Beck, Chitalia, & Rai, 2019). Feedback programs should be combined with educational and technological programs (Faruqui & Sergici, 2010; Abrahamse, Steg, Vlek, & Rothengatter, 2007). TOU schemes are rendered more effective by interventions of "demand-side flexibility instruments" such as home energy management systems (HEMS) or smart meters (Smale et al., 2018).

Feedback in DR and TOU

Energy conservation, rather than shift, has been the focus of the majority of DR and feedback research (Delmas, Fischlein, & Asensio, 2013; Abrahamse, Steg, Vlek, & Rothengatter, 2005). Meanwhile, 80% of commercial, industrial, and big-building peak load reduction has already been achieved, which leaves a considerable gap for studies and programs targeting shift in the residential sector (Asadinejad et al., 2018). The introduction of HEMS and smart meters has in some ways paved the way for a research and policy focus on energy shift instead of energy conservation (Strengers, 2012). In the policy realm, feedback programs are often accompanied by TOU rates. TOU policies have various windows and structures, as elaborated in Table 2.

Table 2: Five Common TOU Tariffs; Nicolson, Fell, & Heubner (2018)

Tariff	Description
Static TOU	As currently employed by PG&E, static TOU establishes fixed and regular prices during given times of day (i.e. 3 to 8PM on weekdays).
Dynamic TOU	Fixed prices apply at varying times from day-to-day, with potential high-, medium-, and low-price periods, and frequently customer notifications before applying a given price.
Real-time Pricing (RTP)	Pricing changes dynamically depending on the moment-to-moment wholesale cost of electricity.
Critical Peak (CPP)	Customers notified about occasional and irregular high-price events.
Critical Peak Rebates (CPR)	Customers notified about opportunities for financial reward to reduce consumption during irregular events.

These tariff structures accomplish various goals. Peak-clipping involves attempting to ‘shave’ energy-use behaviors off the beginning and/or end of the multi-hour peak period, while load-shifting attempts to reposition the aggregate of behaviors to a later or earlier time range (Faruqui & Sergici, 2010). To date there has been no comprehensive study exploring DR models that also distinguishes between types of tariffs (Boßmann & Eser, 2016). A review of some of these tariffs found that static and dynamic TOU induce a peak demand reduction between 3 and 6%, CPP tariffs to a greater reduction of between 13 and 20%, and CPP enabled with enabling technologies, such as communicable thermostats, triggered an even greater reduction of 27-44% (Asadinejad et al., 2018). This finding reinforces the need for diverse, multi-layer DSM programs (Petersen et al., 2014). Another review of price elasticity of demand measurements due to DR measures found greater long-term than short-term elasticity (Asadinejad et al., 2018). There are many limitations to these results, as the number of observations in meta-analyses is frequently low, and "experiments are...heterogeneous in their designs and the variation...limits derivation of a consistent perspective" (Faruqui & Sergici, 2010, p. 195).

Theoretical Models of Energy Behavior

TOU and feedback to a certain extent ascribe to an Attitudes, Behavior, Choice (ABC) model of psychological and economic theories (Shove, 2010) of human behavior. These theories centralize “autonomous and cost-reflective decisions about the scheduling of...consumption” (Strengers, 2012, p. 227). When employed in the energy field, these theories, and the DSM managers who largely ascribe to them, aim to deliver the same services with fewer resources, by promoting energy efficiency, the premise of which is to avoid endangering end-use consumers’ notions of normality or comfort (Shove & Walker, 2014). Two such theories include the theory of planned behavior (Ajzen, 2012) and social-cognitive theory (Bandura, 1986). Bandura’s theory emphasizes the ability for individual actors to learn through observation, and by learning inherit “values, attitudes, and patterns of thought and behavior” (p. 48). These theories, emphasizing individual agency, are “the foundation for...programs intended to achieve social and environmental transformation in an era of climate change and resource uncertainty” (Strengers, 2012, p. 226). The problem with the application of the theories in this fashion is that they “normalize a particular form of energy-intensive comfort” that goes unquestioned, and is ultimately itself shifting and unsustainable (Strengers, 2012, p. 231). Per Table 1,even feedback researchers who actively employ ABC models stress “habitual, emotional, and non-rational cognition” (Petersen et al., 2014, p. 83).

In the early 2000s, social practice theory emerged to challenge ABC models (Schatzki et al., 2001). Social practice perhaps has its root in Giddens (1984), who emphasized that “the day to day activity of social actors draws upon and reproduces structural features of wider social systems” (p. 24). Social practice theory treats practices—an “arrangement of material and social elements,” such as energy consumption—as the center of analysis of social arrangements (Gordon, Waitt, Cooper, & Butler, 2018, p. 2). Practices, and “bundles and constellations” of them, for example in a family residence, converge on what energy is used for, and how those practices evolve over time, rather than on energy as a unique and separate system (Shove & Walker, 2014, p. 47). For example, Shove traces the decades-long progression of the social practices of refrigeration and air-conditioning, which were not always considered normal, and illustrate shifts in “domains of daily life” such as the definitions of convenience and comfort (2003, p. 395).

These “domains” are particularly salient in families with children. Nicholls & Strengers (2015) explore the salience of patterns and the way they limit energy behavior flexibility:

> Interlinked bundles of practices were meaningful beyond their commonly assumed functions. For example, bathing of children (re-)connected siblings and parents, occupied children while dinner was prepared or cleaned up, and calmed children in preparation for sleeping. The analysis also shows how flexibility during the peak period is constrained by the relation to other periods of the weekday. (p. 116)

The authors are underscoring the irrelevance of the ABC model generally, and price signals like TOU rates in particular, in relation to peak energy use in families, during which familial and culturally-sanctioned sets of practices create meaning together. Moreover, energy-use practices are scheduled and interlinked with other institutions, such as school and work, in that flexibility is “constrained by relation to other periods of the weekday, along with its synchronisation with school, work, and childcare arrangements” (p. 116).

In social practice theory targeting behavior change, practices minimize the role of feedback strategies like goals, education, cognition and affect, and emphasize the role of the “repetitive, unconscious, routine” in lifestyles (Gram-hanssen, 2013, p. 449). Scholars in this tradition argue instead that behavior change should be targeted through co-management opportunities that erase the role of consumers as “passive recipients” (Strengers, 2012, p. 230), through, for example, advocacy in the housing sector for passive cooling, or employing advertising strategies to expand notions of cleanliness and hygiene. Table 3, reproduced from Strengers (2012), highlights the differences between ABC and social practice theory.

In line with SPT, some studies have endeavored to suggest that targeting certain family behaviors will be more effective than others. The most energy-intensive behaviors (i.e. heating/cooling, water heating) may be the most obvious starting point (Smale et al., 2018). Moreover, the *who* of the behavior is significant, with one study finding that moms have greater control over energy behaviors and are thus better feedback targets (Nicholls & Strengers, 2015). With regard to children, behaviors shared with siblings, electronics and lights are particularly effective targets, as one qualitative study found that very few children thought about unplugging or minimizing electronics as an option for conserving energy (Aguirre-Bielschowsky et al., 2018). Other scholars, however, generally challenge the notion of targeting specific behaviors or people, given the inflexibility of family energy lifestyles (Nicholls & Strengers, 2015).

Table 3: Assumptions of ABC and Social Practice Theories; Strengers (2012)

ABC theories	Social practice theory
The world is populated by people	The world is populated by practices
People and their barriers, drivers, attitudes, values, opinions, choices and/or norms are the central unit of analysis and change	Practices (and their elements) are the central unit of analysis and change
Emphasis on changing people and their consumption/ demand	Emphasis on the changing elements of practices
Technology, supply systems and people are separate from each other	Technologies and supply systems are elements of practices
People have agency	Practices, people and things have agency
People change through targeted information, education, price signals, social norms, community interaction etc.	Practices circulate and change through changing or mixing elements, and through innovation in practice
Change is orderly, predictable and controllable	Change is emergent, dynamic and often uncontrollable
Efficiency improvements and demand reductions are long-lasting	Practices are constantly changing along trajectories that may negate efficiency and conservation improvements

Research Questions

By describing these children's lifestyles within a policy and technology context, I will seek to address the following questions:

1) What behaviors, patterns, knowledge, attitudes, and motivations form the energy lifestyles of these children?
2) What are best practices for targeting energy shift and conservation within these families?
3) How do these lifestyles present barriers and opportunities for the success of DSM?

Answering these questions will help guide interventions to successfully influence this community's energy-use lifestyles, while contributing to engaged local energy management.

Conceptual Framework

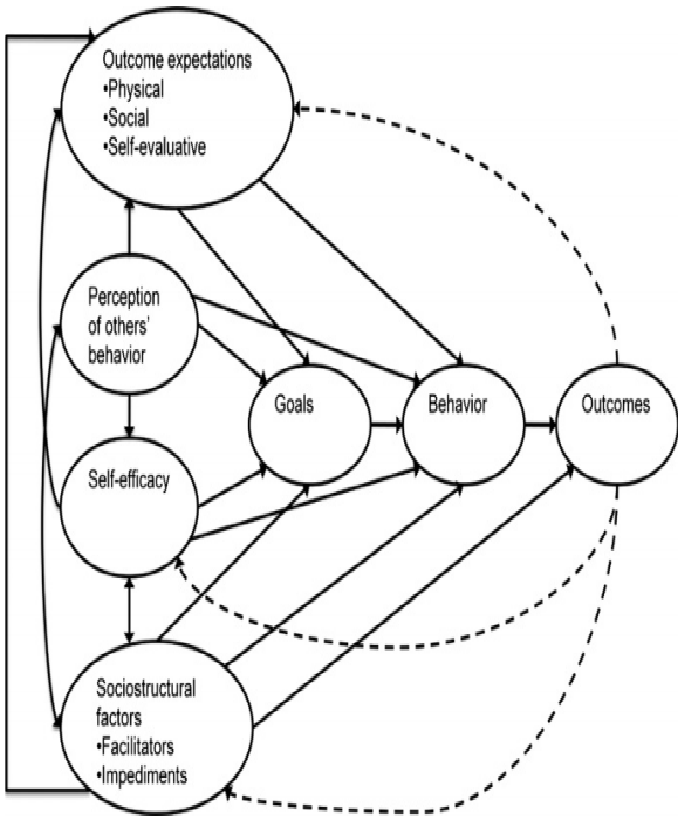

Figure 1: A Social-Cognitive Model of Behavior and Learning
Source: Thogersen & Gronhoj (2010)

Originated by Bandura (1986), social cognitive theory (SCT) has been used to explain, predict and change human behavior, particularly in public health fields (Linke, Robinson & Pekmezi, 2014), but also in energy use (Cornelius et al., 2014; Boudet et al., 2014). SCT models behavior as the interaction of personal, cognitive, behavioral, social and environmental influences on learning. These learning factors interplay with outcome expectations, perception of others' behavior, self-efficacy, and sociostructural elements, which reciprocally inform goals, behavior, and eventual outcomes (Figure 1). Accordingly, interventions designed using SCT target behavior change by building skills and knowledge among participants, both of which increase self-efficacy, while also employing modeling, normative feedback, and goal- and commitment-setting. SCT is particularly relevant to understanding children in social settings, such as family residential energy use, because of its emphasis on control and knowledge (e.g. self-efficacy), its exploration of methods of learning, and its analysis of reciprocal systems, in which outcomes, like energy behaviors, can eventually alter inputs, like sociostructural factors (Bandura, 1986).

While SCT is used primarily to target behavior change, however, I am primarily seeking to describe these children's lifestyles in a policy context; thus my analysis focuses more on behavior, and less on behavior change. To understand lifestyle, I will employ social practice theory (SPT). SPT's focus on practices meshes well with the description of 'patterns' used in the definition of lifestyle used for this study, namely "the distinctive modes of existence that are accomplished by persons and groups through socially sanctioned and culturally intelligible patterns of action" (Lutzenhiser & Gossard, 2000, p. 215). Shove, Pantzar, & Watson (2012) describe practices as the interplay of "material, competence, & meaning" (p. 22).

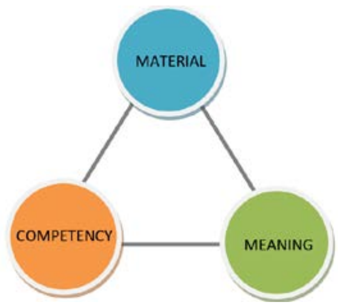

Figure 2: The Elements of Practice in Social Practice Theory
Source: Shove, Pantzar, Watson (2012)

Figure 2 illustrates these elements. Materials involve the physical; in the case of energy use this might include a house, its appliances, even the human body. Competencies encompass knowledge and skill, such as a child's ability to use an appliance. Meaning describes "mental activities, emotion, and motivational knowledge" (p. 23), which would include the feelings or reasoning associated with taking a shower, for instance as a cleanliness or relaxation mechanism. A practice, such as showering or using the thermostat, is formed by the linkages of these three elements. Of particular note is the fact that humans are minimized in this model, excluded in order to emphasize humans as mere carriers of practice, and de-emphasize the human-centric approach of ABC theories (Shove et al., 2012). However, the attitudes, motivation, and self-efficacy described in SCT or other ABC theories are not altogether absent; rather they are embedded within, and thus less significant than, an analysis of practice.

Methods

Research Site, Relationships, and Positionality

Fremont, California was chosen as this study's site as part of a larger research project aimed at encouraging energy conservation through youth engagement, due to the project team's extensive connections to local youth, city employees, and DR providers. The state of California, and the city of Fremont in particular, feature a highly renewable energy mix, relatively advanced DR programs, and smart technology saturation, allowing researchers an ample playground to explore the grid of the future (CPUC, 2018).

The city of 231,000 people is racially, ethnically, and generationally diverse (City of Fremont), and has particularly strong ties to the tech hubs of Silicon Valley and San Francisco. 13.3% of the population identifies as Hispanic and/or Latinx, more than 50% as Asian, within this over 40% as Indian or Chinese (U.S. Census Bureau, 2018a). 23.7% of the population is under 18 (U.S. Census Bureau, 2018a), with 40.7% of households having children under the age of 18 (U.S. Census Bureau, 2018b). In 2010, 70% of the city's 71,000 housing units were single-family owned or occupied (2018b).

The team also conducted five focus groups and one interview in Corvallis, where the principal investigator has close relationships with area schools. Corvallis could be considered demographically the counterpoint of Fremont. A city of approximately 60,000 people, it is surrounded by agricultural land, and centers largely on the industry and culture generated by OSU. 25% of the population is under 19, 83% is white, and 19.6% of households have occupants under the age of 18 (U.S. Census Bureau, 2019).

Data Collection

Table 4 summarizes data collected analyzed for this study, with their location and number of participants. The data come from two hands-on activities with a total of 55 4th-6th grade children, and 11 focus groups and 2 interviews with a total of 34 4th-5th grade children. These hands-on activities, which will be called ‘large-group activities’ in the remainder of this study, and 7 focus groups took place in Fremont, and the other 6 in Corvallis. All activity facilitators were trained by the core project team. All followed IRB protocols while conducting their focus groups and interviews. The participants were enlisted through the research team's relationships with local schools and the Girl Scouts of Northern California. The purposive sampling method was meant to build relationships with the very community members who will be collaborators throughout the project (Creswell & Poth, 2017).

Table 4: Types and Quantities of Data Analyzed

Activity Type	Document/Artifact Type	City	Number of Participants
Focus Group	Transcript	Fremont	7
Focus Group	Memo	Fremont	5
Interview	Transcript	Fremont	1
Focus Group	Transcript	Corvallis	5
Focus Group	Transcript	Corvallis	6
Interview	Transcript	Corvallis	1
Focus Group	Transcript	Fremont	4
Focus Group	Transcript	Fremont	5
Focus Group	Memo	Fremont	4
Focus Group	Transcript	Fremont	4
Focus Group	Transcript	Fremont	4
Large-Group Activities	Graphs	Fremont	55 artifacts (2 separate events)

There are many significant differences between best practices for interviews with adults and children. Many researchers (Eder & Fingerson, 2003; Gibson, 2012) suggest focus groups and group interviews, rather than individualized interviews, are more appropriate for youth. While adults have a fully developed sense of their identity, youth "construct meaning through a shared process," (Eder & Fingerson, 2003, p. 35), and thus feel more comfortable exploring their perspectives when they are with familiar peers. Conducting group interviews also lessens the power differential between participants and the interviewer, which is exaggerated by age differences. Disadvantages to the focus group approach include that "power dynamics…may influence the nature of their responses" (Eder & Fingerson, 2003, p. 45). In particular, I was wary of children's potential to repeat what they've heard from the interviewer and from other participants.

All activities were conducted in school and extracurricular settings familiar to the participants. Adults familiar to the youth were within earshot but did not sit with the group or participate. This setting complies with the best practice of making young people as comfortable as possible in qualitative research by securing a familiar setting with familiar people present (Gibson, 2012; Eder & Fingerson, 2003). The shortest interview was 30 minutes, and the longest focus groups were just over an hour long.

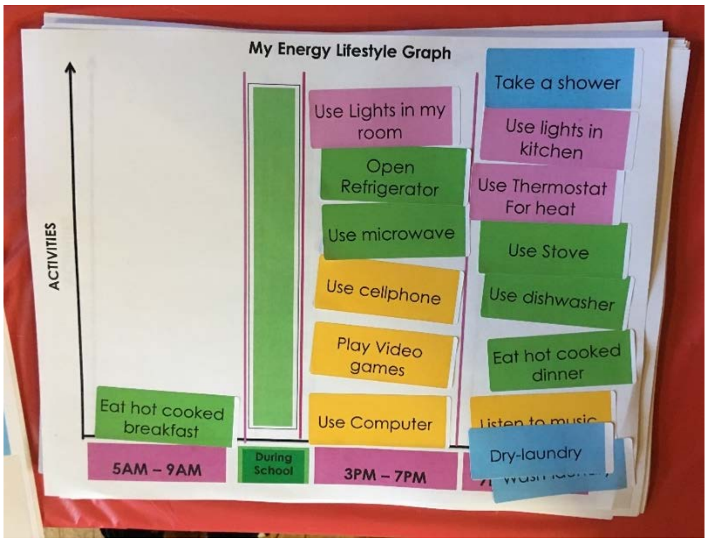

Figure 3: Example Hands-on Artifact from Large-group Activities

The hands-on activities were conducted at Girl Scouts World Thinking Day in Fremont, and as part of an elementary school assembly. Researchers invited passersby to construct a graph of their daily energy behaviors (Figure 3). Participants were given a graph, divided into four distinct times of day: morning, school, after school/peak, and nighttime. They were also given a sheet of stickers containing various energy behaviors, divided into four colors to highlight the role of social practices: purple for comfort, yellow for entertainment, green for hunger, and blue for cleaning.

Participants were invited to describe their use of energy *yesterday* by placing stickers in the bucket of time during which they performed a given activity. Asking the children about a recent and specific day was more likely to trigger accurate memory—one of the learning processes of SCT—than asking about their lives in general. There were some limitations to this approach, as not every participant received the same directions. Moreover, some children in both the large-group activities and in the focus groups reported that their yesterdays were atypical (e.g. they stayed home sick; their parents were late to pick them up so they didn't eat dinner at home). Overall, however, the 55 graphs capture a generalized energy day in the life of a 4th or 5th graders.

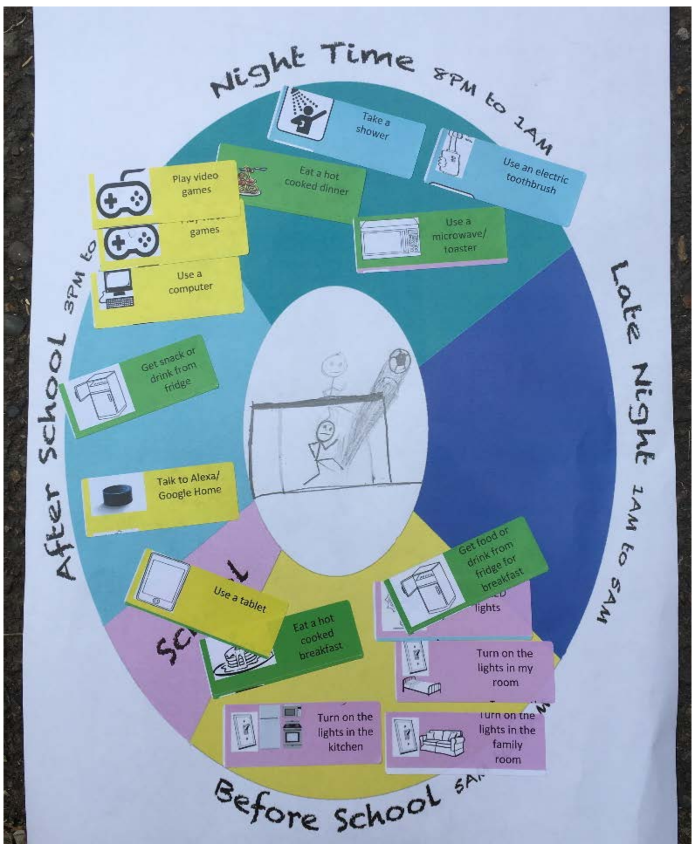

Figure 4: Second Iteration of Energy Day Graph

Like most applied studies, our study followed an iterative process, with initial steps informing changes in future steps. The interviews and focus groups incorporated an updated version of this initial hands-on activity, with more behavior options, pictures of the given appliance on the sticker, and adjusted time slots to more closely align with the local utility's TOU rates. The second iteration also turned the linear graph into a circle, with children's choice of writing their names or images in the center, to better reflect children's centrality in their day (Figure 4).

Hands-on activities not only embody the ‘production’ approach to learning in SCT, they are also a best practice for interviews with young people, since "concrete materials provide a shared focus for the children and interviewer, allow for nonverbal responses, increase verbal productivity, and…opportunities to elaborate" (Gibson, 2012, p. 157). The interview and focus group protocol were semi-structured. Some structure was important not only to answer specific questions that are relevant to intervention design, but also because "children are much more likely than adults to need help telling their story" (p. 156). Given flexibility and interaction have been shown to prioritize young people’s comfort in research situations while minimizing power dynamics (Gibson, 2012; Eder & Fingerson, 2003; Creswell & Poth, 2017), researchers did their best to memorize the main ideas of the protocol (Appendix A), incorporate jokes and their own personal stories when the participants needed prompting or exhibited shyness, and allow youth to guide the conversation. Moreover, preventing conversational tangents, a common practice for adults, can impede the collection of rich data when working with young people (Gibson, 2012).

Data Analysis

Of the 11 focus groups and two interviews conducted, eight were fully transcribed primarily using online transcription programs Temi and Trint, though background noise, and the fact that many focus groups and interviews were conducted in the same room, required significant repetitive listening to fill in gaps. One focus group transcription had too much background noise and too little microphone sharing to transcribe fully, so I only transcribed and coded the first 10 minutes. Four of the transcribed interviews and focus groups were accompanied by timely memos written by the researchers who conducted them. These do not serve not as distinct data and are as such not included in Table 4, but I also coded and analyzed them. In addition to the transcriptions, I analyzed one stand-alone memo, written by researcher in a focus group without a recording. These memos tended to be more thorough than those accompanied by transcriptions; their information was treated as distinct data. Moreover, all of the focus groups and interviews included the graphs created while the recording was taking place; these artifacts were collected and analyzed to back-up claims from the recordings.

Data collection began in September 2017, and data analysis has been ongoing and evolving ever since. Dedoose, a CAQDAS software program, provided the basis for analysis. Each iteration of coding contributed to and informed the search for and structure of themes, ultimately resulting in a final codebook (Appendix B). Literature-based, deductive coding aligns the data according to an intersection of SCT, SPT, and reviews of feedback studies. These categories expanded and were renamed as data saturation was reached, but the synthesis of these approaches is the basis for describing how and why these families use energy, and what might be done to change this energy use. In line with the qualitative nature of this study, and the goal to empower and educate young people, findings will largely center on the words and ideas as the participants express them. I make a concerted effort in this study to use children's expressed words and sentiments in delineating major findings.

Validity

In line with Maxwell (2013), I summarize my validity concerns in three parts. First, as elaborated in the data collection section, I am wary not only of peer influence on youth's answers, but researchers' influence on their responses, which is an inevitable and necessary piece of qualitative research (Maxwell, 2013). For instance, youth may have tailored their answers to fit with what they perceived would be desirable or useful to interviewers. To minimize this reactivity and reflexivity, researchers followed IRB protocols and strove to make environments comfortable for youth by hosting the groups among familiar peers and in familiar spaces.

Second, given the applied and iterative nature of this project, procedures varied slightly between groups, which might have presented challenges in finding parallel claims. Children more than other age groups might also have the tendency to forget the sequence of their days, particularly when engaging in an exciting activity, and when discussing such a subconscious behavior as energy use. Third, there is potential for interviewer and analyst bias. While many researchers participated in writing the protocol and collecting data, I was the sole qualitative data analyst, meaning my bias could have influenced my coding.

I managed these validity concerns with the help of a research team. Background noise, quieter children's voices, and multiple groups in one room compounded these challenges, though careful listening, repeat-transcribing and recoding likely resulted in more accurate transcriptions and codes than automatic transcriptions would have. The richness and diversity of the data superseded these differences and challenges and allowed for compelling findings to emerge. Accompanying memos from different researchers, 55 stand-alone artifacts, and accompanying artifacts, from a total of 89 children, together reinforce a view of these children's energy lifestyles. Finally, the fact that the protocols were planned, the data were collected, and the results were viewed and discussed by a team of multidisciplinary researchers, rather than a single author, allowed for the most comprehensive validity check. As an example, I was able to search through other researchers' memos for evidence that they detected enthusiasm at the same points in these children's stories.

Findings

This section is organized according to four major themes that emerged from children's ideas. These four points focus largely on this study's first research question: What behaviors, patterns, knowledge, attitudes, and motivations form the energy lifestyles of these children? In sum:

1) Their energy lifestyles are largely characterized by patterns and habits.

2) Their home energy use is largely inseparable from their families'.

3) Their lives are tech-saturated.

4) Girls (and boys) don't 'just wanna have fun;' they can also be financially and environmentally aware, and exhibit some enthusiasm for more 'adult' energy behaviors.

Firstly, **(1) some generalized, predictable patterns characterize these children's home energy lifestyles, and these patterns are marked by a lack of cognition and the presence of habit.** This is unsurprising given the overwhelming evidence in literature that residential energy use is dominated by habit and repetition (Gram-hanssen, 2013). To some degree, the contents and sequence of these children's schedules are predictable across the sample. The vast majority of the children interviewed, with graphs they constructed, described the sequence of their days uniformly: wake up, eat breakfast, wash (e.g. brush teeth, maybe shower), go to school, come home, do homework, use electronics, eat dinner, wash, go to bed. Most energy-use activities occurred in peak or at nighttime. Interestingly, peak did not overwhelmingly contain more behaviors than other times of day.

Children said that some appliances were consistently used throughout the day, including lights, the fridge, and electronics. The large-group activities support this finding; Table 5 below shows the percentage of the 55 participants in the large-group activities who chose to place stickers about lights in various rooms in different time slots. For instance, about ¼ of respondents chose the "lights in my room" sticker, *and* said they perform this activity in the morning. While these percentages should not be considered statistically accurate, it is notable that no clear time slot emerges as the most popular for turning on lights. This was also the case for the use of the refrigerator and for technology.

Table 5: Children's Time-Use of Lights, By Room

	My Room	Family Room	Kitchen
Morning	25%	11%	18%
Peak	25%	27%	15%
Night	29%	18%	22%

There was also less consensus on when showering, using the dishwasher, washing clothes, or using HVAC was the most common. None of these conclusively happened during peak. More important to this qualitative study, however, are the *reasons* children gave for their habits and patterns. Nicholls and Strengers (2015) describe that the connections between behaviors in families with children, rather than the behaviors themselves, actually inscribe their meaning. Just as family members' behaviors are linked to other family members, so are children's behaviors linked to their other personal behaviors, and everything was linked with school: waking up and eating breakfast with departing on time, playing video games or watching TV with finishing or needing a break from homework, even fitting in a shower:

> Participant 1: And sometimes you take a long time [in the shower] accidentally.
>
> Participant 2: Yeah. I always go in and stay in for such a long time and my parents get mad at me.
>
> Participant 1: Yeah, like, "You're getting late for school!"

School creates a predictable pattern; summer and weekend schedules are very different from school-week schedules. Policy is aware of this; most TOU rate plans adjust prices during the summer or on weekends (PG&E). These children overwhelmingly highlighted that washer/dryer use often happened on the weekends, that food practices were different on weekends (e.g. going out to eat, or sitting longer at the dinner table), and mentioned longer and more frequent use of electronics on Friday evenings, Saturdays and Sundays:

STAFF: So…like how long do you think you're using [electronics] for, every day?

Participant 1: An hour.

Participant 2: An hour.

Participant 3: Maybe on the weekends a bunch of hours. Seven.

STAFF: A bunch of hours on the weekends? Seven? Wow.

Participant 1: Sometimes on the weekends I get carried away.

These quotes, with participants' use of the phrases "accidentally" and "get carried away," illustrate the degree to which specific behaviors are unconscious and habitual. A habit is "a specific type of automaticity characterized by a rigid contextual cuing of behavior that does not depend on people's goals and intentions" (Wood & Neal, 2009). Children often referred to their days with impressive automaticity:

> So at nighttime I take a shower, well usually just after sports. I turn off the lights in my room. I turn on the lights in my room. And then my mom is like, "Turn off the lights!" And I'm like "But I want to keep them on." And then I do the same in the family room. And then I do the same in the kitchen. And then mom gets mad at me. And then late at night I turn on the light sometimes. And then I roll over and read because I don't want to go to sleep. And then I stay up. And then I sleep. And then in the morning mom makes me wake up because I'm exhausted.
>
> After school, I have to refill my dog's water. I turn on my bedroom light if it's dark, which it kind of was yesterday. I charge my school iPad and I charge my home iPad, and I ate a hot dinner, and then right after school I got a snack from the fridge, and towards the end of the day I used the tablet and listened to music and turned on the family room lights.

Both participants ran through their days seamlessly and breathlessly. The first participant's use of "And then…and then…and then…, " and her discussion of her mother's expected reaction, and the second participant's beginning her afternoon with refilling her dog's water (which had nothing to do with the prompt about energy), signal these children are describing routines. It's particularly telling that these children were asked about what they did *yesterday*, on a given day in particular (which the second participant acknowledges), but they still talk about yesterday in the present, and as if it's the same as any other. Alongside this breathless monologue about the course of the day is a lack of thought about the *why* of their energy behaviors. Most children answered the question "How do you know when it's time to wash clothes?" not with "I notice they're dirty," but "when the basket is full." One researcher tried to get past this mantra:

STAFF: Like how do you know when to put them in the laundry basket?

Participant 1: If they get dirty I might wear them twice. I don't know.

Participant 2: Uh, when I run out of clothes to wear.

Participant 3: I put them in a lot (laugh).

STAFF: But how do you know that something you're wearing is time to go into the laundry basket? Like how do you determine that?

Participant 3: Um, I just throw it in after I shower. (laugh)

STAFF: Oh you just wear it once and then...OK.

Participant 1: You see, there's like a lot of baskets, and we just put our clothes when we're done with it every day...

A participant in another focus group answered similarly, "I know it's time to use the laundry because the baskets are all full and my parents do the laundry." "Contextual cuing of behavior" (Wood & Neal, 2009) is particularly evident here in the way they don't think much about whether clothes need washing in the first place.

Time, and the perception of the lack of it, likely leads to the overrule of goals and intentions, and the creation of habit. Children talked about showering, rather than bathing, as a time-saver, and about convenient quick snacks rather than cooking after school. They talked about using the dryer instead of hang-drying, and the dishwasher instead of hand-washing, with one participant explaining, "I think it's not possible to [handwash] every time…it's hard. It will take really long." They even discussed the lack of time to use electronics as much as they wanted to, with one saying, "We never get time on the weekdays, so usually all of it happens on Saturday and Sunday." Many used about two hours of electronics for non-work purposed every day. It's interesting to juxtapose this entertainment time with the lack of time they say they have to wash dishes by hand, hang dry clothes, or use the tub. It's their *perception* of time, and what they use it for, rather than how much time they actually have, that determines their patterns.

Children did mention some exceptions to routine. For instance, it was 'routine' that participants didn't access the oven, stove, or computer without permission due to safety concerns, but one talked about his dad teaching him to use the computer alone so he wouldn't need to ask for help every time. Many discussed having access to the oven and stove only to help their parents on busy mornings, or with younger siblings' routines. One participant said she's only promoted to clothes-washer "when mom gets sick of it and makes me do it." A few participants even referenced using the thermostat, an appliance about which they had limited efficacy, only in winter when the house was too hot or too cold. The undercurrent of these quotes is the eroding of routine during some sort of extreme circumstance, such as parental stress, or extreme weather.

But routine is the general rule. Another indication of this, one which presented challenges to the study's methodology, is the degree to which children struggled to remember when, how often, or how long they perform various behaviors. The majority of the participants in four focus groups admitted they don't think about turning lights off, nor do they remember whether and when they used them on the day in question. The same was largely true with using the washer and dryer. Even showering, an effortful, time-consuming and sensory-strong energy-use activity that all children participated in, illustrates these children's lack of cognition. When asked how they decide when to shower, many responses were, "I just do it." Showers seemed affect-, rather than cognition-, centric:

STAFF: So do you all like using the showers and bath?

Participant 1: Yeah, it feels good.

STAFF: No but do you like, do you feel dirty before you take a shower?

Participant 2: Yeah.

Participant 1: I feel tired, and like I wanna go in the warm water.

Participant 2: I know same here!

Participant 1: I prefer using the shower; it's so fun! It's like I'm in a waterfall and water is going onto the rocks.

Participants repeatedly highlighted 'feeling good' as a physical outcome expectation (Thogersen & Gronhoj, 2010) of their showering. This contradicts the assumption that showering is primarily for cleanliness; there was a similar phenomenon around electronics. Many children forgot what they watched on the day in question; one interjected "I don't even know what I'm doing" when she watched TV until late. This was the clear consensus in one focus group. After one student mentioned getting "so caught up in the game" when playing video games with his father, one researcher asked if other participants ever catch themselves spending a long time playing electronic games:

Participant 1: Yeah.

Participant 2: Um, I think about it but...

Participant 3: I think about it but I just don't care.

Participant 1: Yeah.

Participant 2: Yeah. Same.

This interaction happened after one participant mentioned This illustrates not only a lack of cognition in screen time, but a deliberate choice to reject it. In two other groups, participants talked about having screen time rules but not following them.

The salience of rules segues into point (2). Unsurprisingly, **(2) these children's home energy use is a family affair**. They do not act, or think about energy, in a silo; their lifestyles are largely determined by their families. For instance, many participants with siblings, when asked "you" questions, didn't hesitate to answer with "we," and then didn't bother to explain who they meant by "we." While the researchers even directly discouraged children from answering about their parents and siblings instead of themselves, they regularly did so:

STAFF: So, tell me how often do you use the shower or the tub?

Participant 1: My parents wash uh…my parents shower every morning.

Participant 2: Well my mom, she separates cleaning her hair from like, everything else.

STAFF: We're just going to talk about you right now. So imagine like…Home Alone 3, you're the only person in your house and you're using energy.

Participant 2: Then I wouldn't shower that often!

Participant 2's comment also illustrates the gap between the norms and habits of children and their parents. Three mechanisms emerged by which families influenced children's lifestyles: rules, interlinked schedules, and modeling.

Given the safety norm referenced as part of habit and routine in Point (1), the salience of rules is not surprising. Children talked about rules in connection to almost all of their energy-use behaviors. Keeping the fridge closed, turning off the lights, when to wake up and go to bed, which chores to complete at what time, when and how much they were allowed to use technology, when and how to use kitchen appliances, even how long and when to shower--all were very commonly referenced, even when the interviewers weren't specifically asking about rules:

Participant: Before school yesterday, I used my iPhone while I was eating.

STAFF: Why did you do that?

Participant: Because my mom lets me.

In this quote, rules overrode this participant's cognition. When asked why she used her iPhone, she determined her mom's permission was more relevant than her own reasoning. In connection to point (1), her mother's rules have become habit.

Even without rules, the influence of one family member on another is inevitable, given finite space and interlinked schedules. Nicholls and Strengers (2015) describe the way interlinked schedules constrain flexibility during peak. Constraint, with limited resources, inevitably creates competition. Children referenced competing for use of showers, electronics, and even lights:

> My mom always shouts at me...that you wasted all of the hot water, at me and my brother. And my father doesn't have any water, so they have to take a bath with cold water.
>
> My dad...he actually [showers] in like...13 minutes...He says it's five minutes but it's actually 13 minutes. And then I'm like, I need to take a long shower, and then one time the water went cold then I was like AHHHH I need to get out!
>
> Well, I don't really have my own computer; I really share it with every one of my family members. So I get very little time. 15 minutes, because my sister also has to do homework. And my Dad also has to do work things on his computer. So my sister and my dad always fight about who gets the most.

These children are highlighting the tension of interlinked schedules that any family member can create, and the routine of that tension. They “always” compete for time in various behaviors. Competing and sharing signify that these children’s behaviors and lifestyles are part of a powerful family unit. There was also some evidence that competition and interlinking is greater in families with multiple children.

Another way energy lifestyles are inevitably familial is through modeling. Aguirre-Bielschowsky et al. (2018) found modeling, with rules and reminders, to be a key method of children’s energy-use and energy-saving socialization, to the point that they recommend “parents...should hence be specifically targeted by government, school and media campaigns...stressing...their importance as role models” (p. 185). Children observed, and referenced mimicking, their parents’ food, cleanliness, and electronics behaviors. While peers, school, and the influence of urban society are no doubt powerful influences on children, the amount that these children referenced their parents may signify they have the most influence on their children' home energy behaviors.

> STAFF: So, do you guys often watch things together with other people in your family, or is it an individual thing?
>
> Participant: Only me and my dad and my brother watch, because my Mom's too busy cooking and working, but she's actually on Facebook all the time.

> STAFF: Do [your parents] use the computers?
>
> Participant: Yes, they use computers a lot.
>
> STAFF: At what time of day?
>
> Participant: Uh, at work, like 8:30 to like 6 o'clock. And then they use, like their phones, so basically like, so basically um, all day they're using something.

Inevitably, and sometimes unintentionally, parents are modeling daily, consistent use of technology for their children. Bandura refers to modeling as "observational learning" and emphasizes its power to transmit values and patterns as well as behaviors themselves (1986, p. 48). In short, children aren't only ingesting patterns from their parents, but the meaning attached to those patterns.

> STAFF: So here's another question, when you are in front of the fridge, how long do you leave the fridge open for?
>
> Participant: Usually my Dad tells me off and says don't leave the fridge open, you're wasting energy and our bills are going to go up.

This is an example of a participant processing not only his father's rule, but his father's reasoning. Parental approval is likely both a social and self-evaluative outcome expectation. To some degree, children have no choice but to follow their parents' rules. But they also likely develop a need for approval, internalize their parents' behaviors via modeling, and perhaps even develop their own personal norms. External influences on behavior become internal.

Undoubtedly, children exhibited the most efficacy, enthusiasm, and ownership of tech behaviors; **(3) these children's lives are tech-saturated.** Children (and their parents) use technology in every segment of the day. In all five focus groups, at least one participant referenced using some kind of device for entertainment even before school. Children discussed how common technology-use is during school, even when the researchers intentionally excluded this period of the day from questioning. Not a single participant mentioned living without a television. Not only does this illustrate tech saturation, it may also hint at the social stigma of being 'techless' in a demographic that is tech-saturated and creates meaning socially. All of them mentioned multiple phones, tablets, and/or computers per family. Many children had their own phones; those that didn't had regular access to one. The data from the large-group activities supports this finding (Table 6).

Table 6: Electronic Use By Time Of Day

Time of Day	Cellphone	Tablet	Charge Device	Printer	TV	Cable Box	Video Games	Computer	Alexa/ Google Home	Music	Avg. Per Time Period
Before School	4%	7%	13%	0%	13%	8%	9%	2%	9%	9%	7.4%
Peak (3 to 8PM)	15%	22%	8%	11%	40%	4%	29%	62%	18%	29%	23.8%
Night (8 to midnight)	7%	13%	54%	13%	33%	4%	7%	7%	13%	13%	16.4%
Total	26%	42%	75%	24%	86%	16%	45%	71%	40%	51%	N/A

Much like Table 4, this table shows the percent of 55 children who used a given tech device at a given time of day in the large-group activities. The final column shows the average use of all electronics within a given time period. For instance, 15% of the 55 participants selected the cellphone sticker *and* placed it in the peak bucket. Meanwhile, an average of 23.8% of respondents used some sort of electronic device during peak, making this the most common period for technology use. Notably, almost all tech devices were used by someone during every bucket of time. In comparison, no one in the sample of 55 chose laundry or dishwashing before school. As illustrated in the bottom row, over 70% of respondents charged devices, watched TV, or used computers on the day in question. Though these percentages should not be considered statistically representative, the large-group data support the interview and focus group finding that technology is omnipresent in these children's lives.

This omnipresence begs a *why*—Why do children use technology, and so much of it? While researchers created an entertainment behavioral cluster (like comfort and cleanliness) to encompass electronics, children most often talked about schoolwork as the first reason they used computers. Many families had rules in place about only being able to use portable electronics for fun once work was finished, and many children indicated these boundaries were important for them personally, regardless of rules. This exchange in one group is particularly telling of motivations for tech use:

> STAFF: And a question for all three of you. What do you watch TV for? What makes you think that you want to watch TV?
>
> Participant 1: For me, it kind of helps us calm down.
>
> Participant 2: Oh really?
>
> STAFF: How about you guys?
>
> Participant 2: Oh, for me, I watch TV when I just feel like flopping down.
>
> STAFF: When you feel like flopping down.

Participant 3: My mom makes us watch TV at night because we fight. My brother and I do wrestling stuff, and that calms us down.

STAFF: The TV calms you down when you're fighting. That's funny.

Participant 2: TV never calms me down. It makes me...it makes me more hyper.

While “flopping” and calming down may be related to being entertained, each of these three participants experiences TV in a different way—one as a calming mechanism, one as a stimulant, and one as a parental prescription. The quotes also indicate the social role that television plays: ‘it helps *us* calm down,’ and ‘Mom makes my brother and I do it.’ In one of those groups, when there seemed to be unaccounted-for time in participants’ schedules, they defaulted to saying that time was likely used on technology. In sum, the social practice of technology use has different meaning to different children, and entertainment is not a complete descriptor.

Not only are children tech-saturated, they are knowledgeable and enthusiastic about this saturation. One group erupted in applause when the researcher pulled out a picture of various electronics, and then:

STAFF: OK...so what are these things? What do you see here?

Participant 1: Awesome stuff.

Most children were able to identify computers’ specific brands (even correcting each other), differentiate between various smart home assistants, and talk about the iterations of their family phones (from flip, which earned eye-rolls, to iPhoneX). One participant said she uses technology “any time, if I can.” There were also some children who spoke about using technology to solve energy problems:

Participant 1: You should connect Google to your lights and then you can be like "Google, turn off the lights."

STAFF: Yeah, Googles are cool that way.

Participant 2: Yeah, but they can steal your identity.

Participant 1: Oh, it's true!

Participant 3: (whispered) That's terrible.

Participant 1: ...I saw this thing that you could pause all devices.

STAFF: Really?

Participant 1: (Very excitedly) Yeah. Like you can get this app on your phone. Like I saw my mom's boss, you can like lock the door...On your phone because you forgot to. It's an Xfinity thing, and you could…you could just pause everyone's devices...And then you can turn it back on.

These quotes convey enthusiasm, but the enthusiasm isn't limitless. Together with their parents, they are wary of the effects of too much technology. Many spoke about the importance of time limits, "*because if you watch too much or play too much of anything you're gonna get addicted to it.*" In response to this assertion by a troopmate, one participant in the same group told this story:

> Like last night I stayed up really late and watched a movie. It affects me, because there's this like tiny clock...it's like the master clock of your whole body, and if that gets disoriented, it can stay like that for a long time, so I woke up at 9 because I stayed up so late.

Likely some of this awareness and language comes from their parents. One participant said of her parents that as a result of using computers too much, their "eyesight [became] so bad, they go to eye appointments every six months." In all but one of the focus groups, the children's parents imposed "screen time" rules, which took many forms, and were very different on Fridays and weekends. Importantly, however, children themselves were wary of the consequences of technology, with some stating schoolwork, rather than rules, as the reason for some of their limitations.

Connectedly, the final finding is that **(4) Girls (and boys) don't 'just wanna have fun;' they are also aware of 'adult' environmental and cost concerns, and exhibit enthusiasm for more 'adult' energy behaviors.** Children spoke about environmental and cost concerns without referencing their parents' oversight. Many gave spot-on examples of how to conserve energy when using various appliances. One participant even suggested creating a rule for her father:

> My dad's usually like...he's watching TV, like, news, and then for some reason he falls asleep, and then he never actually comes to turn off the TV. So actually when I wake up, I have to go turn it off for him. So maybe you could make a rule that you have to always have to turn it off…

Many participants mentioned only running appliances "when they're full" to save money, energy and water. Two participants in separate groups in Fremont referenced drought conditions in California, and many referenced ideas for, and the importance of, saving water. One suggested using buckets to catch water, but when asked if she does it, said, "No (giggle), but we should." Her sentiment highlights disregarded norms, as does this interaction:

> STAFF: Is the light on in all the rooms? Or is it only on in the rooms where you're actually using it?
>
> Participant 1: Well that's what we're supposed to do, but sometimes we don't...we forget (laugh).

Overall, however, the saturation of environmental norms was considerable. This is not surprising, considering the demographics of these children's upbringing, some of them in an urban area of the most environmentally progressive state in the country, the others in a liberal university town. Two participants even seemed to low-key 'battle' each other about the fact that both of them had solar panels, but one of them 'won' since her family's were owned rather than rented, and her parents also drove electric vehicles.

Participants also exhibited a reasonable grasp of parental and adult concerns, like providing for the family, keeping bills low, and an eagerness to master behaviors they didn't yet have control over. One participant spoke about using the stove to help her dad, who "comes home from work very tired," and her mom, who's "sleeping because she's tired…doing the housework." Another said, "My mom taught me how to cook…she trusts me," to which her troopmate eagerly added, "I know how to use [the oven] by myself; I know how to turn it on and put stuff in. And I know how to cook." A few participants mentioned the use of the fridge in order to keep from spoiling food. This awareness connects to an undercurrent of enthusiasm about being independent, regardless of the behavior. Children regularly said "by myself" and "mine" or "I don't need help" with eager inflections, as if they carried their responsibility with pride.

One HVAC conversation shows the interesting nuances of knowledge and attitudes among these children. HVAC behaviors can have one of the largest impacts on the energy use of a home (Smale et al., 2018), but children's knowledge of thermostats was limited. Some didn't know a thermostat when they saw one. Another called it a "temperature thingy," and a few had no idea if their houses even had thermostats. But in a few cases, those who did know about, or had used thermostats, were excited by it:

STAFF: So, do you know what these are?

Participant 1: So basically these are like uhm...these are...I dunno...this is a heater, isn't it?

Participant 2: I know what this is! This is a therm-o-stat! (Emphasizes the 'o')

Participant 3: That um, that...keeps track of the temperature, and I think that's a fan or heater, and I think that's...that's what powers...

Participant 2: (proudly) Water heater. Water heater.

Participant 3: ...Something to do with that stuff.

STAFF: And do you know what you do with these types of things?

Participant 2: This is a…a nest, it's like…contacts all the heaters and coolers in the house, and you can control what temperature you want the house to be with that. This is a heater; it heats up the room. And this kind of heater can't be controlled by nest; you can turn it on if you want to. And this one is a water heater I think, and it heats up the water that you use.

Participant 3: (proudly) Like um, a more simpler way to say what [Participant 2] said is, it controls the temperature.

These quotes capture the pride these children feel when they are able to identify, and use, appliances that are just-out-of-reach. These children may be entering a sweet spot, between having so much responsibility that a behavior becomes boring or dreaded, and having so little that the behavior isn't part of their lifestyle. In general, this hypothesis fits with the dynamics of this age group, eagerly approaching the independence of puberty. Child psychology describes this particular age group's eagerness to 'grow up' (Elkind, 1981).

Connectedly, as the thermostat quotes show, these children have some room to grow in their energy knowledge. For the most part, children were able to name that if an appliance changes temperature, is plugged in, or moves, it likely uses energy. More sophisticated concepts seemed a little out of reach:

STAFF: What about...do you know how we make electricity?

Participant 1: Uh, huh...wires? (giggle)

Participant 2: There's like this...(laughs)...yeah, something about wires.

These knowledge limitations were the case for specific appliances as well. One participant said that too cold on the thermostat was 15°, and too hot was 98°. Two, in separate focus groups, remembered that the smart meters in their houses changed color during various stages of energy use, but otherwise couldn't describe their smart meters. Another summarized her opinion of thermostats succinctly with "It can get really confusing if you don't know what you're looking for."

In sum, and with some exceptions, these findings capture children's habitual, familial, tech-saturated, and burgeoning adult energy lifestyles. The next section will discuss the findings in light of potential behavioral interventions targeting these families.

Discussion and Recommendations

In order to tailor broader implications from my conceptual framework into specifics for behavioral interventions with children and families, I will discuss some of the practical implications of my findings using a design-behavior framework for improving the effectiveness of eco-feedback, as elaborated in Sanguinetti et al. (2018).

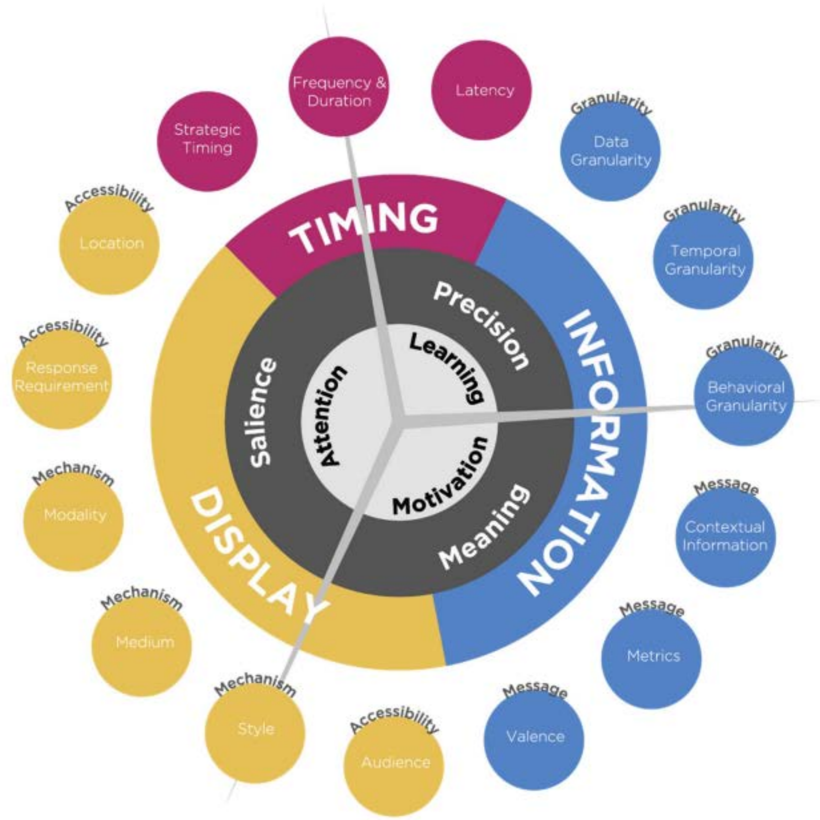

Figure 5: A Design-Behavior Framework for Eco-feedback
Source: Sanguinetti, Dombrovski & Sikand (2018)

The authors conducted a broad literature review across human-computer interaction and environmental and behavioral psychology to identify and create an eco-feedback model (Figure 5). The *behavioral mechanisms* they identify by which eco-feedback operates—attention, learning, motivation—are unsurprisingly similar to SCT's learning mechanisms (attention, retention, production, motivation). *Qualities* of eco-feedback, corresponding to the behavioral mechanisms, are salience, precision, and meaning, the last of which intersects with one of SPT's elements of practices. *Dimensions* of eco-feedback are timing (when is information displayed?), information (what is displayed?) and display (how is information displayed?). More closely aligning this framework with SPT and SCT provides practical suggestions for this applied study.

This discussion focuses on the implications of the findings as they relate to two of this study's research question: How do these lifestyles present barriers and opportunities for the success of DSM? And, what are best practices for targeting energy shift and conservation within these families? I will address these two questions with three practical points, all of which have been studied in detail in literature that will be referenced in this discussion:

(1) Underscore social involvement.

(2) Incorporate a dashboard approach.

(3) Emphasize co-provision.

Moreover, I make one final theoretical point, that (4) in contrast to ABC theories, motivations for behaviors can overlap or be entirely unidentifiable.

Point **(1), underscore social involvement**, takes advantage of these children's intrinsic connection to their parents, families and communities. No behavioral intervention will be successful that targets these children alone. Perhaps more importantly, however, these children have the potential to be the originators of energy-saving activities in their families. Their enthusiasm and burgeoning independence may give them the capacity to tackle flexibility in their family lifestyles. Very few cases have explored the effects of children teaching and reminding their parents about energy conservation or shift, but the few that have were successful (Aguirre-Bielschowsky et al., 2018; Agarwal, Rengarajan, Sing, & Yang, 2017; Boudet et al., 2016; Lawson et al., 2019). The first step may be to undertake more specific family-informed data collection. Children could use phones or tablets to record what activities they and their parents (whom they observe thoroughly) undertake during given hours of a day across one week. They could then present their families with ideas for shift and conservation specific to their lifestyles, and formalize their commitments electronically. Petersen et al. (2014), Vine & Jones (2016), and

Palm & Ellegard (2011) recommend such goal-setting and commitments, particularly if they are self- (or in this case family-) selected.

This point also indicates the potential for competitions to thrive among these children. They exhibit a desire to 'one-up' each other, their parents, and their siblings, a desire that could be gamified into family or community competitions. Competitions are most successful when conducted among communities that know each other, due to the potential for social diffusion (Vine & Jones, 2016). They also tend to be more effective when coupled with engaging and public displays, and when the emphasis is on participation rather than reward (Vine & Jones, 2016). Since these children are enthusiastic, but wary, about technology, competitions could involve counting the number of electronic devices used or plugged in on a given day, successfully navigating a tech-free peak, and sharing these results publicly.

Finally, feedback to these children should embrace social norms. Since children at this age are particularly inclined to create meaning socially (Eder & Fingerson, 2003), messages targeting shift could compare their performance to their parents', their siblings, and even their peers'. Feedback to parents could even incorporate the very things their children slyly captured about their energy-wasting habits.

A dashboard approach to feedback, point (2), accentuates interactivity, attention-grabbing, and personalization. Clark et al. (2017) use an environmental dashboard (Figure 6), with interactive levels, selectable metrics, and relatable characters, to convey feedback to 4th and 5th graders about energy and water use at their elementary school in Oberlin, Ohio. They found that children exposed to the dashboard method of education and feedback "exhibited significantly greater improvements in both content retention and content-specific systems thinking" than students in the control, whose teachers used existing lessons (p. 9).

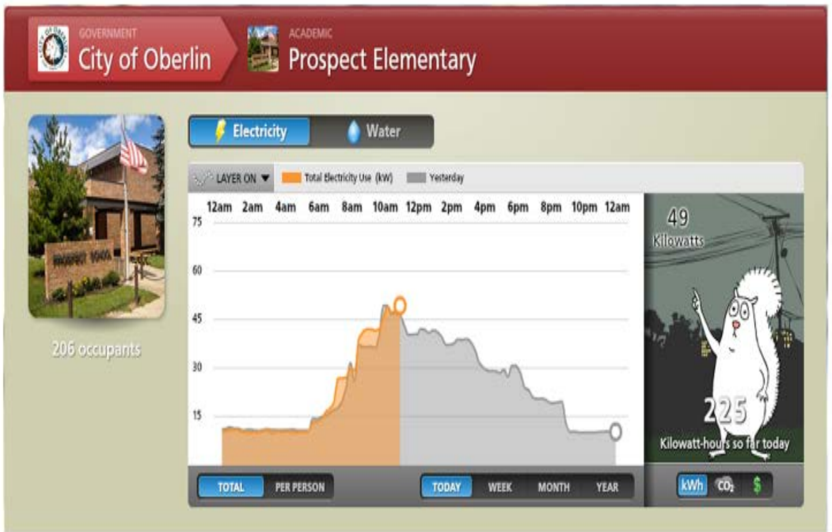

Figure 6: An Electricity- and Water-Use Kid-Friendly Dashboard
Source: Clark et al. (2017)

The relative simplicity of this dashboard, the capacity for viewers to navigate to their chosen page, and the attention-grabbing squirrel, are best practices for feedback (Sanguinetti et al., 2018) that seem even more appropriate given the perspectives of the children in this study. Moreover, participants seemed to be more enthusiastic about computers and video games than TVs, suggesting that interaction, rather than shiny display, might trigger attention, learning or motivation more successfully.

Even these children, however, are wary of their attachment to electronics. Their potential 'addiction' exists on the heels of an overwhelming increase in the amount of time people in the U.S. spend on electronics (Sekar, Williams, & Chen, 2018). Literature on feedback and behavior change is similarly skeptical, even of technological innovation in general. Shove, a social practice theorist, is more interested in the "conditions in which new technologies thrive and die," because "sustainability has less to do with technological innovation than with innovation in the way that…devices are…used together in…maintaining 'normal' ways of life" (p. 203). Interventions should not shy away from challenging 'normalcy,' because while energy-efficient technologies can be designed maximally, "the risk is that these inadvertently sustain what are ultimately unsustainable concepts of comfort" (p. 203).

Accordingly, **point (3) recommends a shift from consumer- to co-provider-centric energy systems thinking.** Not only are energy consumers largely unconscious of their energy behaviors, the grid and energy provision has historically supported consumers' ability to disconnect from dynamics of supply. Smart grids are challenging this assumption, but the grid and its connected technologies have a long way to go in more actively supporting consumers' embrace of a co-provider role.

A first suggestion on how to encourage this transition among these children and their families is to emphasize their own words, ideas, and enthusiasm in designing interventions. Their ideas about energy-saving in their families could be imprinted in feedback platforms, used as reminders, and embedded with praise: "Don't forget your awesome idea to talk to your mom about turning the thermostat down!". Given nascent independence and interest in more mature behaviors, our interventions could potentially target behaviors that are slightly out of reach: HVAC, washing and drying, and dishwashing, for instance. A community leader board could publicize these ideas and family successes.

A connected way to encourage co-provision is to incorporate energy education into feedback. At a minimum, education increases knowledge and skills required to perform certain behaviors (Geelen et al., 2013), and correspondingly increases self-efficacy (Bandura, 1986**).** In our study, reminders to undertake various changes could be paired with actionable education items, like instructions learn the typical settings for a household thermostat over the course of one week. Clark et al. (2017) go a step further in promoting a systems approach to education. They claim "environmental education for children is still dominated by reductionist, information-oriented approaches" that "break down environmental science concepts into small components that can be studied in isolation" (p. 1). Their dashboard approach, covered in point (2), "situates the systems thinker within the systems they are studying," by connecting the feedback element in question to the processes that create it. They claim such education improves analytical thinking and decision-making skills. In these children's case, education-centric interventions could overlay feedback with clickable maps of local or regional energy systems, or a link to www.environmentaldashboard.org, for expanded youth-centric opportunities of community-based energy and climate change learning. Linking to other media is a simple way to minimize a message's cost and complexity (Van Dam, 2013). The key is not to expect feedback to work without an understanding of what is being tracked, and why.

There are important qualifiers here. While engaging, customizable displays, education-embedded feedback, and multi-layer interventions are ideal in principle, more elements can imply discouraging complexity and high costs. These children agree with feedback reviews that complexity is a turnoff, and high costs can make interventions infeasible (Van Dam, 2013). Moreover, mechanisms used to grab attention, such as style, timing, and location, are very different from mechanisms used to target motivation and learning, such as granularity, metrics, and context (Sanguinetti et al., 2018). Emphasizing the design and deployment of one of these mechanisms inevitably detracts from the others. Similarly, interventions designed to be effective in the short-term look different than interventions designed to educate for the long-term. Studies have cautioned about the tendency for HEMS and feedback efficacy to wear off in the long-term as new technologies become backgrounded (Hargreaves, Nye, & Burgess, 2013). Learning, community-building, and education, meanwhile, are lifelong, and particularly pliable among young people (Clark et al., 2017). In sum, our study, though it is targeting tangible results in energy shift and conservation in Fremont, should be wary not to sacrifice community engagement, empowerment and education, for concerns over short-term efficiency.

Connectedly, as many of these efforts depend on understanding and targeting motivation, **point (4) cautions that motivations for behavior can change, overlap, or be entirely absent**. The degree to which habitual and unconscious behaviors dominate energy lifestyles may mean that feedback has the potential to disrupt that pattern with cognitive cues. It may also mean, however, that feedback and behavioral intervention efficacy are limited by the dominance of practice (Shove et al., 2012; Schatzki et al., 2001).

DSM is firmly centered in ABC approaches to energy use that seek out, and attempt to alter, outcome expectations and motivation. But these children repeatedly illustrated the absence and intersection of motives for various behaviors. Showering, for instance, was rarely described as a cleanliness activity; technology was used not only for entertainment, but for parental control, schoolwork, or calming down. The motives shifted on the weekend and in the summer, when there is greater time to be filled, and school is less relevant. Moreover, almost every focus group answered even direct researcher questions about *why* with some variant of *I just do it.* Even if there was a motive for a given behavior, the practices of throwing clothes in the laundry basket, leaving the lights on, and sitting down to play video games, often rendered motivation irrelevant. Shove would thus argue that individual agency and cognition is less relevant than the interlinked practices of energy use itself, which changes over time (2003). Even the most specific and detailed interventions can't universally target multiple, changing, or absent motives, which is why policy has an important role to play in consumer energy-use change.

Policy Implications

Engaging and educating small communities is only one piece of the DSM puzzle. Consumers—even co-providers who are actively engaged in the energy system surrounding them—have limited power to make the enormous changes required by current ecological crisis. Moreover, end-users tend to lose interest in behavioral interventions, if they believe institutions are not also doing their part to change. Hargreaves et al. (2013) conducted a feedback experiment over 12 months in the UK and found that "household practices may become harder to change as householders realise the limits to their energy saving potential and become frustrated by the absence of wider policy and market support" (p. 126). Shifts in the energy system require an all-angles approach, involving both broader policy changes and more specific local initiatives.

The good news is that California, and even the City of Fremont in particular, are doing their part (Grunwald, 2009). The City of Fremont's 2012 Climate Action Plan maintained that the city, on a five-year timeline, would "work with PG&E in a public information and education campaign to encourage every household...to reduce their energy consumption and to utilize more energy efficient lighting and appliances" (Rakley, 2012, p. 3-16). This action likely contributed to the opportunity to conduct this applied research, in addition to leading to multiple partnerships with local and statewide organizations to facilitate energy efficiency and conservation (City of Fremont). Statewide, one of the CPUC's long-term energy efficiency goals is to "develop comprehensive, innovative initiatives to reverse the growth of plug load energy consumption through technological and behavioral solutions" (2011, p. 2-21). Meanwhile, along with opt-out

TOU rates, the state and its large energy utilities offer smart metering, online billing with energy-saving tips, and opportunities for consumers to be rewarded for their behavior changes by partnering with third-party DR providers. In other words, Fremont and the state of California are to some degree providing a strong base of support for DSM, through which behavioral interventions are the most successful.

Perhaps more importantly, however, utilities need to signal their commitment to the changes they market by standing by their word to undertake supply-side changes. California's cap-and-trade bill, for example, has served as a model policy since 2013, and corresponds with a statewide GHG emissions drop since 2001. Early assessments of cap-and-trade, however, have found that emissions from in-state electrical power have actually increased since the bill's implementation, which may be due to leakage and the purchase of offsets (Cushing et al., 2016). Reducing offset allowances could solidify California's commitment to its energy goals. Moreover, while the state has boosted its low- and zero-carbon resources used for electricity generation since 2012, more than half of its electricity mix came from fossil fuels or unspecified imports in 2017 (Cullenward, Inman, & Mastrandrea, 2017). If energy policymakers in California want to inspire end-user action and meet their ambitious 2030 energy goals, they need to ensure bold changes in energy generation to accompany tiered DSM—even if their policies are some of the most progressive in the country.

Even California's innovative DSM policies could benefit from a re-orientation to a co-provision approach. Describing and empowering the consumer as a co-provider not only entails a cultural and lingual shift among both energy providers and end-users, it requires shifts in the policies informing design and deployment of energy goods and services. Geelen et al. (2013) describe the need to "empower the end-user in smart grids" by improving "product and service design that supports end-users in their role as co-providers in the smart grid," as the literature and pilot activities they reviewed related to smart grids are highly technically and financially focused (p. 151). One way the CPUC, utilities and third-party DR providers could accomplish this is by employing sociologists in the design of energy conservation programs, which studies have shown leads to better results (Heberlein, 2012). Another way is to pair TOU rates with in-home displays providing feedback, which Faruqui & Sergici (2010) found made load-shifting more effective. Nicholls & Strengers (2012) recommend critical peak, rather than peak pricing, and pairing TOU with peak alerts, to give highly inflexible family energy lifestyles more warning and control over rates. Given TOU is entirely price-centric, Geelen et al. (2013) recommend energy providers consider contracts with suppliers that offer differentiated rates based on other potential behavioral motivators, such as comfort or environmental norms. Finally, products and services should "facilitate communication among end-users" (p. 160). This approach embraces community norms while building local energy ownership and management, making room for more impactful steps like distributed energy resources, community renewable projects, and community choice aggregation.

An approach regulators and policymakers are taking to maximize the connection of these technologies and services is integrated demand-side management (IDSM). IDSM integrates and coordinates the delivery of three or more of the following individual DSM programs: (1) energy efficiency, (2) DR, (3) distributed generation, (4) storage, (5) electric vehicle technologies, or (6) TOU pricing. IDSM goes a step beyond singular program provision by delivering "customer-centric strategies with the goal of increasing the amount of DSM in the field," but meanwhile "improving performance and penetration" (Potter et al., 2018, p. vii). For IDSM to be truly customer-centric, it must give end-users a choice among options. According to a Berkeley Labs study, two of the greatest barriers to successful IDSM are the separation of program budgets and departments, and the lack of cohesive cost-effectiveness metrics for DSM success (Potter et al., 2018).

Lastly, proponents of SPT in energy use would argue that “the traditional siloes of energy policy and management [were] inadvertently promoted by the supply-demand paradigm [and] leave integral elements of practices overlooked” (Strengers, 2012, p. 231), and that successful policy implications grounded in practice would dismantle these siloes. Strengers discusses the potential for DSM managers to advocate in the housing sector for more passive cooling designs, calling it strange that “peak electricity demand is primarily framed as an ‘energy’ issue rather than a housing one” (p. 231). She also recommends energy service providers entertain marketing strategies to shape the way consumers define comfort and cleanliness. Strengers, Nicholls & Maller (2016) recommend expanding the definition of consumers to include all living dwellers in residences, including even ‘pets’ and ‘pests,’ and considering and targeting each subset of agents differently. The person who pays bills in a household, for instance, likely embraces a level of rationality and choice in energy use that is not applicable to pets, children, or the “unwell” (p. 767). Even houseplants and appliances, in that they consume elements of energy, can be considered “actants” of energy practices, and can thus be used and implicated in energy policy (p. 774).

Limitations and Future Research

This research joins a select few others (Nicholls & Strengers, 2012; Aguirre-Bielschowsky et al., 2018) in qualitatively exploring children’s residential energy behaviors. As such, completing this study, particularly as part of a multi-tiered applied project, has demonstrated many paths for future research. Firstly, more research could delineate potential for children to impact adult behavior, even outside family residences. As a single researcher working to synthesize the work of a team, I was limited in my capacity to delve deeply into children's conversations. Some attempts to triangulate the particulars in schedules detracted from the ability to ask *why*. In particular, future research could better understand families' understandings of Shove's (2003) "domains of daily life," how children's domains could influence parents', and how both reflect or challenge each other, and understandings of sustainability. Some participants had the opportunity to talk about how they felt when they showered, for instance, but some of that richness was lost in the many iterations of our protocol. Greater depth here would further SPT research in energy use, by focusing less on maintaining the levels of calmness, comfort or entertainment these children and families experience, and more on how these domains have shifted over time.

Similarly, I would have liked to spend more time understanding these children's understandings of energy and related environmental norms. In our focus on TOU and appliance knowledge and saturation, we necessarily eliminated the potential to specifically evaluate and understand children's awareness of sustainability and energy systems. Because our interventions will specifically target behavioral shift and community energy management, it would have been interesting to see correlations between environmental and energy awareness and knowledge, and the actual outcomes of behavioral shift.

Conclusion

As part of a multi-stage effort, this study aimed to describe children's energy lifestyles, offer recommendations for behavioral interventions and TOU design to shift and conserve energy among these children and their families, and describe the ways these lifestyles interplay with DSM. I used interviews and focus groups to identify four key characteristics of these children's energy lifestyles: their tendency toward habit and pattern, familial dependence, tech-saturation, and burgeoning independence. Based on these findings, I made three recommendations for interventions: underscore social involvement, incorporate a dashboard approach, and emphasize education and co-provision. I also make the theoretical claim that the ABC model, including SCT, is at times highly inapplicable to these children's energy lifestyles, given SPT. Finally, I offered policy implications and goals for future research, commending and critiquing California's broad supply-side match of end-user conservation efforts, and recommending forward-thinking changes to DSM that more holistically center consumer needs.

In my last year of listening closely, I was struck by these children's enthusiasm, tempered by self- and societal awareness. The gravity and opportunity of current energy trends demand action from everyone, and require an unprecedented understanding of the link between human and natural systems. These children's ideas and eagerness to share them match that need. I look forward to the role they will play in a connected, local and sustainable energy future.

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Appendix A: Sample Focus Group Protocol

Training
Phone with headphone jack and memory space for recording, then you'll upload on Box
Give each leader a number and their kids are lettered (4A)

Supplies
- Assents
- Microphones (5)
- Phones with memory space (5)
- Individual energy graphs
- Dry erase markers in four energy service color categories
- Pencils/crayons
- Energy-use stickers
- These scripts

Agenda
8:00: arrive/set-up
    Write things on board – four color categories
    Set up microphones
    Distribute graphs and stickers to group leaders
    Break into groups
8:20: Group intro (5 min)
8:25: Assent (for those groups with consented children) / Energy-use intro (10 min)
8:35: Construct "my energy day" graphs (10 min)
8:45: Energy-use conversation (20 min)
9:05: Energy rules conversation (10 min)
9:15: Closing/thank you/depart (5 min)

Assent (for those groups with consented participants)
- Before we begin with our activity, we would like to ask you to assent to participate in this research study. Each of your parents has already agreed to allow you to participate, but we want to make sure you are okay with being part of a research study.
- I'm going to pass out a form for each of you. We will read it aloud together and then you can agree to participate by signing the back of the form. We will only be audio recording our conversations today.
- *Read aloud the form with them and then ask them to sign. You will sign as the person obtaining consent later.*

Energy-use intro
- *Make sure to test/start recorder.*
- *Explain microphone use to kids*

- I’m here today to learn about how you use energy in your house. *Ask your group*: What do you think energy is? Energy and electricity help us do many things in our lives. What are some things energy and electricity help you do during the day? *(Leave time for comments. Introduce the idea that energy helps us to stay comfortable, entertained, fed and clean.)*
- The goal today is to use your “my energy day” graph and these energy activity stickers (*do not pass out the stickers yet)* to create a picture of all the things you did yesterday at home that used energy and electricity.
- *(Pass out the “my energy day” paper.)* Look at the “my energy day” paper. It has spaces for each time of day for you to put stickers of things you did. We’re going to focus on activities you did inside your home. Why do you think the school slot is so small? *(Answer: Because we’re focusing on behaviors performed in the home. Throughout the activity, make sure they're focusing on in-home activities, rather than things like driving in a car or using computers at school).*
- Before we pass out the stickers, let’s personalize your “energy day” paper. Take a few minutes to draw yourself in the middle.
- These stickers have the names of activities that you might have done yesterday to use energy. Was yesterday a normal school day for all of you? Like did you do normal things after school? Think back to yesterday, or the last day you did normal things before and after school. Use these stickers to put on the graph what you did on that day, during the right portion of the day. For example, if you opened the fridge before school, pick that sticker from your sticker sheet and put it in the before school slot.
- Please only place stickers on your graph if you actually did those activities. (*This is to help the kids not get sticker happy)*
- Make sure this is just what you did, not your mom or dad did! If your dad cooked something on the stove, don't pick the stove sticker.
- If you have trouble remembering what you did yesterday, you can remember four categories:
    - Green is for what you did when you were hungry…
    - Pink is what you did when you wanted to be comfortable, like if you were hot or cold or needed to go to the bathroom in the middle of the night and needed to turn the lights on.
    - Blue is what you did to get yourself, your clothes, or your house clean…
    - Yellow is what you did to educate or entertain yourself or stay connected with others using technology. Can someone tell me an example of technology that does these things?
- Any questions before we begin?
- OK, now take a few minutes to fill out your graphs! At the end, we will have each of you present your graph the rest of the group. I'll be walking around asking you questions, and you can ask me or your neighbors if you have any questions. Go ahead!
- *While they're filling out their graphs, walk around and watch and ask questions, and answer their questions.*

- *If participant is having trouble thinking of things, remind them again of things energy helps us do (ex: be entertained or educated, get clean, stay nourished, be comfortable, etc.). Or, have them look at the stickers for inspiration.*

Energy-use conversation

- Let's share our "energy day" graphs! *Have each group member go through their day in order (begins with "before school"). If they don't address all 4 behavioral categories in each time period, probe with:*
    - What did you do to be clean or to clean?
    - What did you do to avoid being hungry?
    - What did you do to keep the house at a comfortable temperature?
    - What did you do to do educate or entertain yourself or stay connected to family and friends?
- During what time period did we all together use the most energy? (*should be peak time, 3PM-8PM)*

Energy rules conversation

- Now, we're going to talk a little about any rules your parents or guardians might have about how you use energy or the devices that use energy in your house.
- **Cell Phone and other portable electronic devices:** Who has their own cell phone? When was the last time you used a cell phone? How long were you on it? Do you have any other devices in your family, like iPads or kindles? Do you share it with other family members? What do you use these devices for? Are there any rules about using these devices?
- **Television:** What did you use the TV for? How long did you use the TV? Do you share it with other family members? Are their rules in your family about using your TV?
- **Computer:** Do you use your own computer (or do you share it with other family members)? What rules do your parents give you about using a computer? What do you use the computer for?
- **Video games:** Do you use your own video game player (or share it with others)? What rules do your parents give you about using video games? Why do you play video games?
- **Alexa/Google Home:** For those of you that have an Alexa/Google Home, what do you use it for? How often? Any rules?
- **Lights:** Did you remember to turn your bedroom light off when you left for school this morning? Do your parents talk to you about turning the lights off?
- **Shower/Bath:** How do you know it's time to take a bath/shower? Do you bath/shower every day? Are there any rules in your family about using the shower or bath? How long does your shower/bath last?

- **Oven/Stove/Microwave/Toaster:** Are you allowed to cook on the stove or use the oven? (For those who use oven/stove) How old were you when you started using the oven or stove? Are there any rules in your family about you using the oven or stove?
- **Refrigerator:** Do you know what you want when you open the refrigerator or do you stand, look and think with the door open? Does your refrigerator have an ice maker on the outside? Did you get ice yesterday?
- **Washing Machine/Dryer:** Did you load anything into the washing machine/dryer yesterday? Do you know how to start it? How does your family decide when to wash clothes? Does your family ever hang dry clothes?
- **Dishwasher:** How many of you have a dishwasher? Did you load anything into the dishwasher yesterday? Do you know how to start the dishwasher? How does your family decide when to wash dishes?
- **Air Conditioning/Fan/Heat/Thermostat:** Do you ever use the AC/Fan/heat/thermostat in your house? Are there any rules about using the AC/Fan/heat/thermostat? Why do you turn them on when you do?

Energy-saving intro (time permitting)

- *If you get to this activity, please take a picture of each student's "my energy day" graph before having them shift things around.*
- So now we've completed our energy day, good job everyone! The next step is to think about saving energy. Why is it important to save energy (*help the planet, save our families money)*? Has anyone ever heard of renewable energy? *(Energy created from clean sources like the sun, wind or water, instead of dirty fossil fuels like coal, oil or gas)*
- Remember how most of us did more things that used energy at the same time? Well, when everyone uses a lot of energy at the same time that means that we're more likely to use dirtier energy, instead of renewables.
- The next step in our time together is for you make some changes for your graph to save energy during times when everyone else is using it. Take a few moments to think before you start: what would you like to do during this next week to save energy during this time period? There are lots of things you could do, but we want you to pick a few things you'll actually do.
- You can think about this in two ways.
    - One, you can think about how you'll move some things out of the time slot between 3PM and 8PM. Are there some things you did yesterday during that time that you could do at another time? If so, you can pick a sticker off that part of the graph, and move it to another part of the graph.
    - Two, you can choose to do the same things but in ways that use less energy, for example by taking a shorter shower or taking a shower instead of a bath.
    - Take a few minutes to shift things around or write how you would save energy doing the things you're already doing.

Energy-saving conversation

- Let's go around in a circle and each person share one thing they chose to change. Why did you choose to change that activity?
- *After every student shares, ask*, did anyone else move/choose that sticker?

Appendix B: Codebook

Code ID	Parent Code ID (if applicable)	Title	Description: Used when participant _______.
1		Chores	Mentions chores.
2		Conscious/Unconscious/Habit	Gives some indication that a behavior is performed unconsciously.
3		Everybody's Different	Illustrates entirely different motives, timing, rules etc. from another participant. To illustrate one-size-fits-all feedback approaches don't work.
4		Facilitators/Impediments	References sociostructural factors involved in behaviors (e.g. positioning of appliances).
5	4	Appliance Saturation	How many of various types of appliances are common in households?
6	4	Linked Behavioral Bundles	Individual behaviors are linked to other behaviors.
7	4	Timing	When or how often is a given behavior performed?
8	7	Convenience	References doing something quick, or says they do something because it's quick.
9	7	Duration	How long does a given behavior last?
10	7	Sequence	When does a given behavior happen?
11	7	Weeks/Weekends	References differences between Mon-Thurs and Fri-Sun
12		Good Quotes	Marking quotes that are likely to be used directly in thesis.
13		HAHA Quotes	Marking funny quotes.
14		I am not into/don't understand this focus group	References not understanding what's going on in the focus group, or being tired of/annoyed by participating.
15		Outcome Expectations/Motivation	Mentions reasons motivating a specific behavior.
16	15	Physical	Mentions physical reasons (e.g. 'feels good') for performing a behavior.
17	15	Self-evaluative	Mentions self-evaluative (e.g. 'it's important to me') motivations for behavior.
18	15	Social	Mentions social reasons for behavior.
19	18	Adult Behavior Awareness Pride	Mentions affinity for behaviors over which they don't have yet high levels of efficacy, or pride at independence in a given behavior.
20	18	Environmental Consequences and Behavior	Mentions being aware of enviromental issues.

21	18	Peer Influence	Mentions or indicates the influence of peers.
22	18	Rules and Parental Influence	Mentions or indicates the influence of rules and parents, including modeling.
23	18	Siblings	Mentions a sibling.
24	15	Tech Uses Motivation Excitement-Knowledge	Mentions or indicates enthusiasm about technology, or reasons for using technology.
25		Self-efficacy	Says something related to how individually efficacious they feel about a given behavior (e.g. access to or control over a given appliance).
26	25	Knowledge	Mentions knowledge, or lack of knowledge, about a given appliance or behavior.
27	26	Energy Usage Knowledge	Mentions knowledge, or lack of knowledge, about whether/how much energy an appliance or behavior uses.
28		Specific Appliances and Behaviors	The codes below were all used to mark specific references to individual appliances.
29	28	AC Heat	
30	28	Bathroom	
31	28	Dishwasher	
32	28	Food	
33	32	Fridge	
34	32	Microwave	
35	32	Oven Stove	
36	28	Light	
37	28	Sleeping	
38	28	Technology and Smart Appliances	
39	38	Computer Printer	
40	38	Music	
41	38	Phone	
42	38	Tablet	
43	38	TV	
44	38	TV Links	
45	38	Video Games	
46	28	Washer Dryer	