

# **Smarter Together? A Stakeholder Analysis of Perspectives on Home Energy Management**

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## **Abstract**

Within the Home Energy Management (HEM) space, there are a variety of stakeholders who are integral to technology development and end user adoption. While there has been an increased emphasis on integrating customer research and perspectives, less work in this field has incorporated these various stakeholders and their perspectives. In order to understand the emerging HEM market and fully realize its potential for demand side management, a deeper understanding of the various stakeholders and their respective roles is required. This paper leverages three methods of stakeholder analysis (Delphi, online survey, and semi-structured interviews) to synthesize and discuss perspectives on HEM technology. Findings both reveal implications for the HEM space and present an exemplar methodology that can be used in other areas within the energy sector.

## **Introduction**

Home energy management (HEM) technology has been evolving rapidly, from individual products that provide households with energy consumption information to integrated systems that control connected appliances via sensing, communication, and actuation components in household devices. As more and more connected products and systems emerge – combined with continued smart grid infrastructure development – wide-reaching opportunities are increasingly available for leveraging real-time information and control of energy use to deliver benefits to a wide range of consumers.

Emerging industry alliances are supporting the shift toward integrated systems, which has been reflected in the market by the increasing number of hubs and smart home platforms that support information flows between multiple products within the home. However, the HEM market has yet to fully take off despite many high expectations, and significant barriers related to interoperability, data sharing, and customer engagement remain.

Because home energy management systems (HEMS) are emerging within, and inextricably linked to, the larger smart home and IoT ecosystem, a variety of different actors – beyond just the consumer and product manufacturer – have an interest and stake in the development and success of this new technology. To fully realize the potential benefits HEMS may deliver, it is important to understand the larger landscape of stakeholders driving the development and adoption of HEMS. This paper analyzes perspectives and roles among key players across the HEM ecosystem – including regulators, retailers, researchers, manufacturers, and utilities – to better understand the various perspectives on HEMS and which partnerships may support broader adoption and energy savings.

## Methods

This paper synthesizes findings from three methods of stakeholder analysis: a Delphi study, semi-structured interviews, and online survey. All three were designed to discuss and synthesize diverse stakeholders' perspectives on HEMS. Each of these methods is described below.

### Delphi Study

Delphi is a structured communication method in which a panel of experts answer questions in a series of rounds that are summarized and provided back to them by a trained facilitator [1]. Stakeholders engage in a structured, interactive dialogue, revising answers in light of others' replies, ideally leading toward a convergence of opinion reflecting the collective wisdom of the group. We conducted a modified Delphi that combined traditional elements with a newer real-time Delphi method [2] using an idea management platform called GroupMap.

Our study consisted of two online "rounds" of five, mostly open-ended, questions/prompts (see below). Participants were shown the question along with responses of all participants to-date. They were prompted to add responses if their view was not represented and provide feedback by commenting and voting on others' ideas. All ideas and responses were anonymous to other participants.

Table 1. Delphi Questions

	Round 1	Round 2
<b>Products, Players, Platforms</b>	Who and what are the key products, players, and protocols?	--
<b>Features of HEMS</b>	What do you think are some of the important features of Home Energy Management products and systems?	We've listed the top 10 HEMS "features" that you identified in Round 1. Please arrange them below based on their potential cost and savings.
<b>Benefits of HEMS</b>	What do you think are some the main benefits that HEMS can deliver?	--
<b>Trends and Innovations</b>	What do you think are some of the most influential trends and innovations leading to changes and/or growth in Home Energy Management (HEM)?	Looking into the future, what do you think HEMS will, should, or could look like in the near-term (3-5 years) and the long term (10-15 years)?
<b>Barriers</b>	What are the some of the key barriers to growth in this market? These may or may not be directly related to HEM, and could include social, economic, political or environmental factors.	We've listed the top three barriers to HEMS market growth that you identified in Round 1. Please share any ideas that you may have as to how to overcome these barriers?
<b>Role of Utilities</b>	--	What do you think should be the role of utilities in home energy management? What utilities should do MORE of? LESS of? What utilities should KEEP doing?
<b>Defining HEMS</b>	--	Based on your responses from round 1 as well as a review of related literature, we have drafted a definition of HEMS. Please comment whether you agree with this and/or have any suggested edits/additions

A total of 44 HEMS stakeholders participated in the Delphi Study. They had an average of 12.5 years of relevant experience and the majority of participants came from research/academia or tech/industry.

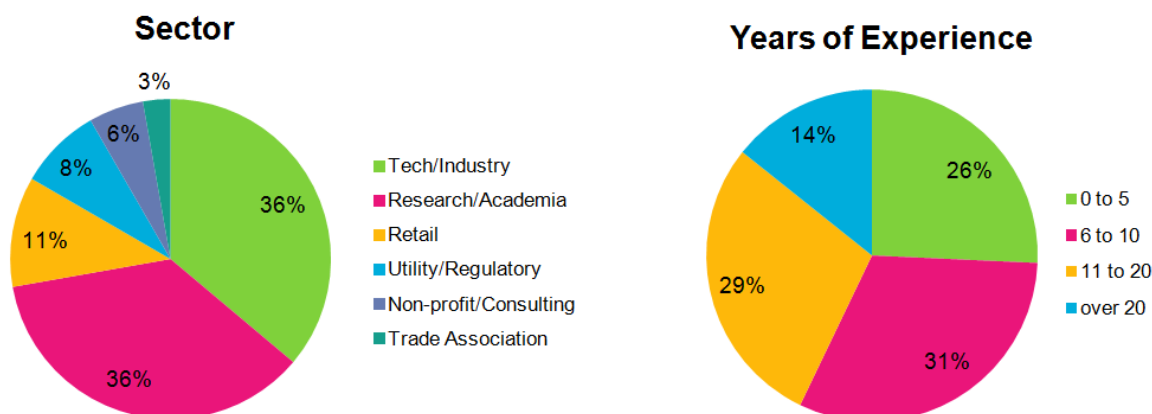


Figure 1. Breakdown of Delphi participants by sector and years of experience

### Semi-Structured Interviews

Following the Delphi Study, two rounds of semi-structured interviews were conducted. In the first round, 14 utility employees were interviewed, with a focus on the role of HEMS in their programs. In the second round, 34 individuals from other stakeholder groups (government, research, non-profits, technology, retail, consultants, and trade associations) were invited, of which 18 individuals agreed to participate in an interview (53% participation rate).

Interviews were conducted virtually via phone or video conference with two researchers present, one to conduct the interview and a second to take notes. They lasted 45-60 minutes and were recorded for transcription purposes with permission from participants. The interview protocol is provided in Table 2; probing questions were added based on responses.

Table 2. Interview Questions

<p>Opportunities: <i>What are your goals in this space? What opportunities do you see?</i></p> <ul style="list-style-type: none"> <li>● <b>Motivations:</b> What is the big problem your organization is looking to solve using HEMS?</li> <li>● <b>Goals:</b> How can your Connected Home initiatives help solve this problem? What does success look like for these initiatives?</li> <li>● <b>Consumer engagement:</b> How engaged are consumers with your (or the industry's) existing initiatives in this space?</li> </ul>
<p>Options: <i>What are your current initiatives? What are your plans for the future?</i></p> <ul style="list-style-type: none"> <li>● <b>Current strategy:</b> What is your current go-to-market strategy? What is/isn't working?</li> <li>● <b>Future plans:</b> What are your plans for advancing your initiatives in the next 3-5 years?</li> <li>● <b>Partnerships:</b> Has your organization engaged with any other external stakeholders? If so, was it successful? What other partnerships would help you achieve your goals?</li> </ul>
<p>Obstacles: <i>What are your main obstacles in the market? How can these obstacles be overcome?</i></p> <ul style="list-style-type: none"> <li>● <b>Identifying obstacles:</b> What are some of your known obstacles, either on an organizational or industry level, for moving forward on your initiatives?</li> <li>● <b>Efforts to overcome obstacles:</b> What efforts are you making to resolve some of those obstacles? Do you see any organizations working to overcome them in a promising way?</li> </ul>

## Online Survey

One hundred additional stakeholders were invited to participate in an online survey. The survey was structured similarly to the interviews; questions were largely open-ended and intended to elicit further qualitative information around the opportunities, options, and obstacles in the HEMS space (Table 3). Of the 100 stakeholders contacted, 15 completed the survey (15% participation rate). Respondents included representatives from research, government, technology companies, utilities, and industry organizations.

Table 3. Survey Questions

### **BENEFITS OF SMART HOME TECHNOLOGY**

1. Please rate the importance of the following for widespread adoption of smart home technology.
  - Remote monitoring and control
  - Scheduling the operation of devices
  - Enabling devices to automatically adjust based on habits and preferences
  - Enabling devices to adjust their operation in response to changes in energy price
  - Allowing third parties to adjust devices in order to save energy or cut peak demand
  - Providing personalized tips and notifications
  - Providing real-time, or near real-time, energy feedback
  - Identifying which devices use the most energy
  - Communicating with other household devices
  - Other (Please Specify): \_\_\_\_\_
2. What do you see as the greatest benefit(s) of smart home technology for consumers?
3. What do you see as the greatest benefit(s) of smart home technology for society at large?

### **BARRIERS TO SMART HOME TECHNOLOGY**

4. Please rate the significance of the following barriers to smart home adoption.  
[Not significant at all; A little significant; Somewhat significant; Very significant]
  - Customer awareness
  - Cost
  - Interoperability
  - Value proposition
  - Security risks
  - Data sharing
  - Complexity
  - Usability
  - Other (please specify): \_\_\_\_\_
5. Please share any ideas you have to overcome these barriers.

### **TRENDS AND INNOVATIONS IN SMART HOME TECHNOLOGY**

6. What do you think the smart home market will look like in the next 3-5 years?
7. Who and what are the key products, players, and protocols in the smart home space?

### **PARTNERSHIPS & ROLE OF UTILITY**

8. Please describe any partnerships your organization has established in the smart home space.
9. What partnerships would your organization be interested in pursuing in the smart home space?
10. What role do you think utilities should play with regards to smart home technology?
11. Is there anything else you would like to share with us at this time?

## Results and Discussion

Interview transcripts and open-ended survey and Delphi questions were analyzed via content analysis, in which large amounts of text are compressed into themes by coding it into categories or themes based on specific definitions [3]. Responses were open coded to identify key themes from the data, then reviewed a second time to both validate initial themes and identify subcategories and relationships between them. The following four primary themes were identified and are discussed in the sections below:

1. Products
2. Systems
3. Customers
4. Collaborations

We also present descriptive statistics to summarize data from closed-ended Delphi and survey questions, where applicable.

### Products

The first theme related to responses about products - both individual products and product categories. There was broad consensus across stakeholders that smart home products have the potential to play an important role in meeting energy management objectives. Most appeared to care deeply about energy efficiency and demand response and saw HEM technology as playing a critical role in the realization of those goals. When asked about the importance of various HEM features (Figure 1), provision of energy feedback was ranked highest, followed by remote monitoring and control, and third-party control. Because of the latter two, many felt the “biggest opportunities [exist] around demand response”.

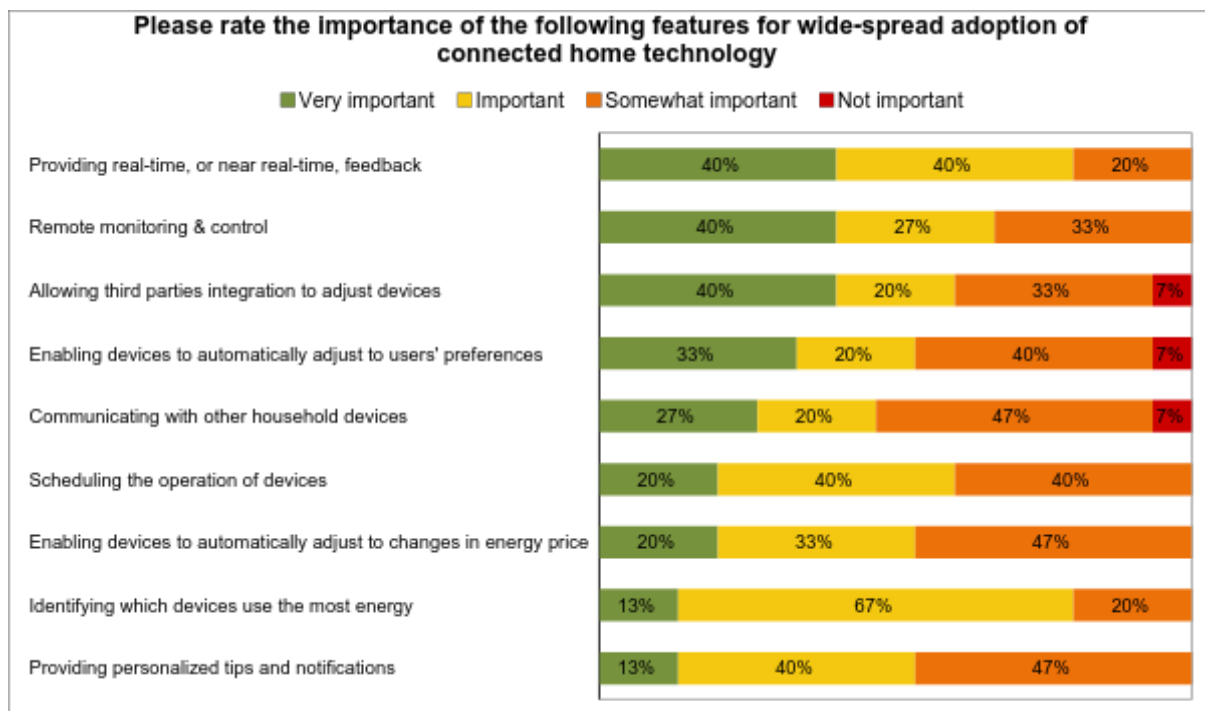


Figure 1: Survey responses on product features

Opinions diverged, however, on whether the opportunities around HEM products were better positioned for automated or behavioral efforts (though of course, these are not mutually exclusive). One industry professional admitted that they saw the most potential in an automated shifting or decreasing of energy usage without the homeowner's involvement because they were "not sure homeowners are ever going to really change." Another interviewee attributed the success of his technology company's HEM product to the fact that it "delivers results as unobtrusively as possible," because "it is folly to consider a program that is going to be dependent on bringing energy to top of mind to people."

Other stakeholders saw great potential in educating households regarding their energy usage to promote behavior change. One technology company stakeholder strongly attributed the success of their pilot programs to "behavioral science techniques" that use feedback and gamification to "save average households that are engaged between 7-10%, [and] save high energy use households who are also highly engaged between 14-15%." Another technology company credited real-time feedback with "driving behavior change" and leading to "10% and in some cases 15-20% savings" as opposed to the "1-2% from typical energy efficiency programs."

Stakeholders across the space were quick to note that while products may be utilized for energy savings, they are often not the prevailing reason underlying purchase. As one utility employee noted: "Customers are happy to be 'green' or help us have a more stable grid if it is a by-product." Benefits of smart home products from the consumer perspective include "to save money, live more comfortably, and save time" and "comfort, convenience, and control". The importance of these non-energy benefits is reflected in product marketing; as the makers of Nest say, "*It's about making your house a more thoughtful and conscious home.*"<sup>TM</sup> [4]

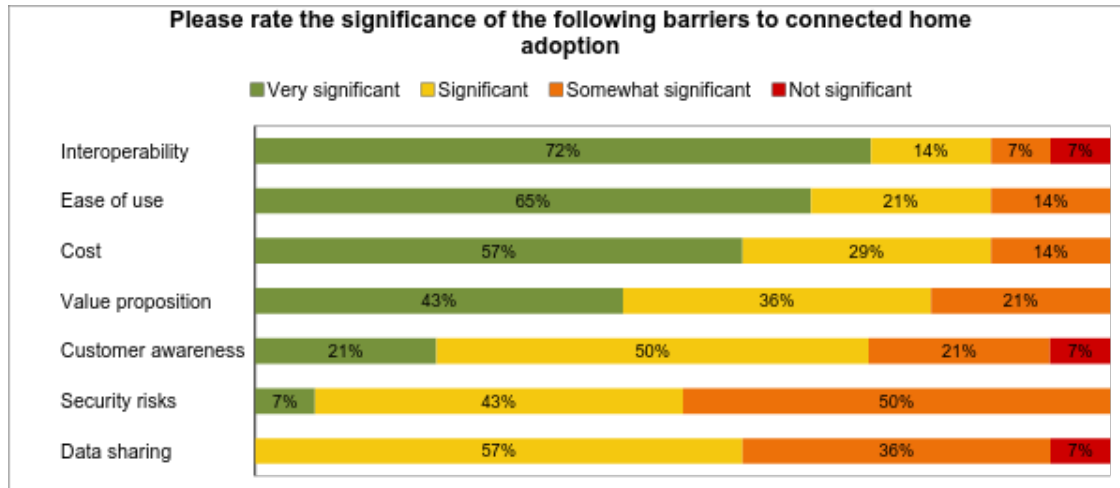
When discussing specific products, the smart thermostat was the most frequently mentioned category. There were several mentions of utility and government pilot programs to measure and verify savings. One government respondent noted how significant the potential energy savings could be just from reducing heating and cooling of unoccupied homes; as an additional benefit, they added, smart thermostats are capable of "making people aware of how their choices regarding their thermostats affect their energy use." In fact, smart thermostats are mentioned frequently as a key first product for consumers. The Consumer Technology Association (CTA) determined that smart thermostats lead the IoT space in terms of household ownership of devices [5]. One respondent said, "Nest made a thermostat sexy and interesting...They buy them because they have great, useful, futuristic features, and they just happen to save energy." One industry researcher attributed the popularity of smart thermostats like the Nest or ecobee to the fact that they are a "cool, shiny device you can show off," while one technology professional declared them now "mainstream."

Another frequently mentioned product was the Amazon Echo, which was widely cited as having potential to galvanize consumer interest in smart homes and encourage energy management in households. "When Amazon introduced that product, initially they thought it'd be used for things like people asking 'Alexa, what's the weather?' or 'What's the largest country in the world?'" one technology company explained; "they found rather quickly that people were using it to manage their devices and applications instead." Now, the Echo is "the #1" product in the space for consumers because it not only provides a clear value proposition but because of "how easy it is to use".

Across products, simplicity and user experience were cited as key. If "Grandma can simply plug in and go" (as one respondent said), adoption will be easier for the average consumer. One expert believes the reason why Apple and Google capture the market isn't simply marketing, but that "it's their simple and customer-centric industrial design and user interfaces that make them appealing." Industry experts seem to agree that the best user interfaces will most likely dominate the smart home market, but we must first know what interfaces consumers prefer in their homes. Respondents stated they would "like to see more studies about how people interact with their energy currently and what is motivating their use." They believe the more we understand consumer behavior around smart home adoption and use, the "better we can provide the simplest possible interface to get the job the household needs done."

## Systems

Despite benefits of smart homes, a number of obstacles to wide scale adoption were identified (Table 2). Several of these related, not to individual products, but to their interconnectivity. These included lack of interoperability, difficulties in setting products up or attending to malfunctions, high costs, and security concerns. This section will address interoperability and issues around data.



**Figure 2: Stakeholder Survey Responses**

### Interoperability

Achieving a sufficient level of interoperability between different smart technologies was the most frequently cited barrier to wide scale penetration of the smart home market. One academic made an analogy relating to the standardization of cars: “Imagine some cars having the gas pedal on the right, and some on the left. Moreover, that is the situation we are often in with some of these products. So it is not surprising that two things happen: the first is that there’s many accidents, and the second is that a lot of people discard these devices or don’t use them the way they’re anticipated...So we have got this sort of house of Babel with several different smart home systems that are incapable of talking to each other and leading to not a smart home but a frustrated home.”

Utilities and program administrators tasked with promoting these products for energy efficiency, in particular, were hesitant about moving forward with initiatives at this stage of market development in the face of such an obstacle. As one utility employee explained, “[F]or us, [interoperability] makes forming partnerships difficult. If we want to form partnerships now, it may force us to pick a narrower set of market participants, thus creating winners and losers. However, if we wait, it may take years for this industry to shake out.”

Not all parties agreed, however, about the significance of interoperability as a barrier. Some technology companies, for example, were much more confident in the ability of the market (and/or their own engineers) to solve the interoperability problem. While one representative from a technology company admitted that they could not “see the world coalescing in the next decade on a single standard,” for dictating how products communicate, this respondent felt that achieving a single standard was not the appropriate goal to consider. Instead, they felt the future of the industry depended on products that can “play very nicely in a multi-mode world.”

Some players in the smart home market are competing for a majority share of consumers without much concern for interoperability outside of their own “suite” of devices. As one expert put it, “the major tech companies are really busy trying to outdo each other and we may not get consensus in the near term if left up to them.” While many discuss a lack of interoperability as a key challenge to the realization of smart homes for energy management, it may be unlikely for companies to address this challenge unless consumers demand it. One expert said, “Interoperability will remain an issue for the

foreseeable future as it will take mass adoption of devices by consumers to weed out tier 2 and tier 3 technologies. Once consumers show a clear preference for the type of technology they want in their homes, the industry (OEM's, utilities, etc.) will follow the consumer." Major players in the market are pushing products out to consumers to see "what will stick," but learning what consumers want and how they use their devices will help shape the future of home energy management.

What was clear from the responses was that systems integrated into the home must work together. One said, "I see a natural evolution of these devices to where nearly every appliance or piece of consumer electronics sold will be Wifi-enabled and contribute to the 'Internet of Things'. Then, manufacturers and vendors will have to start figuring out how they talk to each other." Others discussed an evolution of the smart home where users are almost entirely removed, creating autonomously systems that communicate with one another and manage their own behavior. One respondent listed "predictive and adaptive technology that does not actually require the user to proactively manage or make constant decisions regarding their energy consumption" as a key component, stating that "the best HEMS will require minimal user interaction after initial implementation." According to another, "autonomy is the future of HEMS". However, such a future would require interoperability to go beyond the ability for users to access and control multiple devices from a single platform, enabling them to also share data directly such that information or actions of one product could directly influence the operation of other products in the smart home ecosystem.

## **Data**

The question of sharing data (both smart meter AMI data as well as consumer usage data) was widely cited as a prerequisite to adoption, helping to enhance the offerings provided by these products (e.g., a respondent from one mobile energy app reported that they are working to incorporate smart meter data to enhance their product), as well as being important to the measurement and verification of the impact of smart products.

One academic described data sharing as the "starting point" for many useful analyses to support the proliferation of the smart home market, lamenting that currently data is "held very tightly to the chest of the utility." Even more strongly, one respondent from a non-profit trade association declared the number of meters with electronic third party access is a "primary" metric of success for their goals. The importance of data sharing was reflected by many others; one consultant voiced a similar opinion that utilities and manufacturers "need to change their idea of sharing data to be a little more cooperative" to "get the backing" necessary "to get their products into home[s]."

It is clear, however, that successful and streamlined data sharing for maximum benefit requires equally optimized legal policies. One respondent from a non-profit discussed how laws are necessary to protect utilities as "the holder of...information." This issue is the "lynchpin in so many states" on which the ability to share data is dependent. This same respondent described how in California, the commission "strongly and affirmatively eliminate[d] any kind of liability for the utility," which is the only way that this organization obtained its desired data. Clearly, similar legal protections are necessary nation-wide to fully reap the potential benefits of more openly sharing data.

Data privacy and security were also cited as barriers to engagement in HEM technologies. The list of vulnerabilities mentioned included password security, encryption, and lack of granular user access permissions. As more Internet connected devices enter the smart home, privacy and data security will become a bigger concern for the everyday person, though these issues could in part be mitigated via greater transparency and increased public education. For instance, transparency on what data that companies are collecting and what they are doing with data is key. An expert posed, "Why not just tell people what you're collecting and going to be doing with their data? If they wouldn't like it, you probably shouldn't be doing it." Participants agreed full disclosure could "eliminate data and privacy concerns" and the explanations should be simple, not complex and hidden in fine print. As one participant put it, "the number of people who decide never to create a Facebook account due to privacy is pretty darn small," but if products are "excellent and convenient," consumers will begin to adopt them. The key is knowing what consumers deem as excellent, and simultaneously developing transparent customer data security processes.



## Customers

Although stakeholders agreed that the smart home market has great potential for home energy management, they also acknowledge that significant customer barriers exist. Primary among these was the issue of people likely not caring much about their energy use. One energy advisory stakeholder maintained that energy is a relatively “niche” interest, one that “traditionally [has] not been an important consideration.” Another respondent, an academic, explained that “there are people who will only spend a few minutes a year on topics related to saving energy, so it is difficult to market these products and convince users to do something different if you have their ears for only those few minutes a year.”

Even more challenging is the fact that one of the most immediate and marketable customer benefits – monetary savings – is in some cases at such a small scale that it cannot fully be leveraged to encourage consumer interest in smart technology; consumers “may not care that much about saving \$5/month,” especially if there is an upfront cost to obtaining and installing smart products. Further complicating the monetary motivation is the fact that smart home products today are still expensive and “prohibitive” for a large segment of the population. Coupled with the fact that some of these technologies do not always work as they are intended, due to either hardware, software, or connectivity issues, and you have, as one retail employee explained, “expensive products that don’t always work well.” As one utility employee summed it up, “Customers will second guess why they are paying so much for ‘cool’ if products do not live up to savings.”

Incentives were one strategy discussed by stakeholders to address cost barriers. One of the most common sentiments expressed was the widespread belief in the utilities’ unique potential to help drive the smart home market forward. There were many perspectives as to how a utility could successfully do so. While rebates and incentive programs were the most commonly cited pathway to catalyze awareness and drive down costs, differences emerged in terms of what program specifics were most likely to help achieve this. One emerging pathway to implementation was considered to be through bring-your-own-device programs, where customers can receive rebates for acquiring any number of devices that fit a set of parameters. One respondent from an energy advising firm stated that the model of Bring Your Own Thermostat (BYOT) programs is optimal because it allows utilities to clearly convey and communicate a need and present technology vendors with an opportunity to meet that need, potentially fostering competition. Further, Bring Your Own Device (BYOD) programs establish a greater sense of consumer choice, which could further encourage customer trust of utilities.

While not everyone may care enough about the energy or financial benefits to purchase smart home products for energy savings, as one technology expert put it, “everyone cares about something.” Among the larger ecosystem of smart home technology there are ample value propositions to excite and engage interest despite cost and value barriers. Security, for example, was the most commonly cited value proposition for customers among respondents. However, while one technology expert felt that the “majority of people care” about security, they admitted that worst-case scenarios, like burglaries and robberies, “don’t happen very often.”

Instead, the success of their company’s security offerings were due to expanding the value proposition of these products to include the ability to monitor the everyday health and safety of household members, like “mak[ing] sure that your kid came home from school on time, even though you are at work.” This not only provides customers with a clear benefit to owning and engaging with a smart home product but also enables energy saving benefits to enter the home via a gateway.

As one academic explained, the best path to engaging customers around energy is to “create products that are cool and attractive for reasons other than energy savings, because energy savings is particularly unsexy; the technology or features have to get a free ride on something far more appealing to the consumer.” A utility employee elaborated: “I am dubious of any approach that attempts to make customers care about something they do not care about. So we need to understand that if it is security that customers are really after, we piggyback energy on that.”

Stakeholders can also help drive the market simply by capitalizing on their already wide customer reach. As one technology company employee explained, “the best way to get millions of people to use our technology is to sell it to companies with millions of people as their customers.” The topic of “bundling,” whether in reference to bundling products or services, was also a common theme.

Another respondent from a technology company elaborated on the potential significance of the utility leveraging its customer base through bundling by drawing an analogy to the successful adoption of Wi-Fi. Wi-Fi, they explained, was at first relatively unpopular until cable companies began bundling it with other services. This respondent felt that utilities could serve the same purpose as the cable companies for smart home technologies, taking advantage of their already existing network of customers and services to push for more widespread adoption. In fact, external market research has determined that “83% of Americans expect smart home devices to be packaged with other services such as cable and Internet” [6]

## **Collaborations**

It is clear that interest in this market is far-reaching, not just among entities with a seemingly obvious stake in energy; as one technology expert admitted, “[if utilities] choose to do nothing, Telcos will be selling HEMS.” Another respondent, a retail employee, described “HEMS as one vertical” in the larger IoT ecosystem they aim to “become a major player in” – and expanded their vision for partnerships in the space as follows: “A health or medical insurance company is likely to be interested in wearables. An auto insurance company is likely to be interested in ... smart car technology. All State is already incentivizing and discounting those products, so people put them in their cars, so if we could work with them to create a triangulated ecosystem in some way, that is beneficial to everybody.”

While utilities were central to most respondents’ recommendations for partnerships that could either help drive consumer adoption or mitigate market obstacles, respondents also touted the benefits of many other types of partnerships towards these ends, including those that involve technology manufacturers, regulatory bodies, behavioral economists, usability designers, safety and data privacy stakeholders, and insurance companies. As one respondent nicely summarized, “there’s a lot of stakeholders involved, so the opportunity for partnership and integrating lots of different systems is unique in the energy space.”

Collaborations with utilities are not without certain risks and precautions, however. One respondent from a technology company worried about utilities’ ability to be an effective ambassador between consumers and smart technologies. This respondent stated, “if utilities are educating consumers, we have to be on the same page that there’s a lot more than thermostats,” worrying that an incomplete education initiative could skew the market and prevent consumers from fully taking advantage of the benefits that can come from a more integrated and systematic approach.

Respondents described the importance of involving the private sector, in particular companies that are “developing both the hardware and the software,” as it is these companies who are driving the market. The same respondent, a non-profit industry professional, added the caveat that it is first necessary for the home energy management community to “come together” and elaborate their needs so that manufacturers can meet those needs. Also, one respondent from a government agency highlighted the importance of partnerships and suggested connecting academics studying human behavior with both utilities and the companies designing the technologies to develop processes for iterative design.

Other proposed partnerships included those between technology companies, utilities, and the Environmental Protection Agency (EPA.) One respondent stated that EPA’s ENERGY STAR had enormous potential to “successfully drive measurements of energy efficiency” from anonymized smart thermostat data. Additionally, other stakeholders identified the necessity of partnerships with companies working in data security and privacy; given that many of these smart products collect sensitive and highly private information, partnering with third-party experts in the field of data privacy could go a long way in appeasing customer concerns about potential security breaches or hacks.

However, despite utility uncertainty about their level of engagement with the market, stakeholders suggested that customers not only *expect* their utilities to provide smart home technologies and services, but many *prefer* to engage with this market through their utility. One interviewee from a smart technology vendor cited an internal study that found 82% of people surveyed would prefer to receive Home Energy Management technology from their local utility, whereas only about 19% of customers would prefer this technology to come from third-party companies. Though this sentiment may seem surprising, one respondent summed it up as follows: “People [may] hate their utilities, but they trust their utilities.”

Because consumer awareness of home energy management technologies is low, distribution partners are among the most important players “as a sales channel and possibly as an installer resource”. In fact, several experts commented on the importance of retail partners, such as Lowe’s, Home Depot, Best Buy, Sears, and other home improvement stores with “Wal-Mart and Target...likely right on the heels of bringing [in their own products]”. “The merchandising must be worked out in order to tell the right story to the consumer.”

Many respondents felt that there should be stronger collaborations between utilities and technology companies, particularly because utilities own information that would be useful for technology companies to develop their products appropriately. One respondent from a government agency stated: “I think we all probably want a world in which the utility will work with the technology developers to provide real-time data and real-time electricity utilization; the more utilities engage with tech developers, the more actively tech development can happen.”

## Conclusion

It is clear that most stakeholders see significant potential for smart home technologies to deliver values to both users and the broader energy efficiency landscape. However, in such an early stage market there are significant challenges to prompt actors to be wary. Given the lack of interoperability between HEM technologies, product selection is of particular importance to prevent customers ending up with multiple “smart” products in their homes that are unable to communicate with one another. While there are risks associated with the formation of utility-technology partnerships to promote only specific products (e.g., forcing market winners and losers), there may be opportunities for the utility to support consumer choice through the provision of more guidance around interoperability.

Data emerged as a key issue, particularly around supporting technology development and validation of energy saving measures by making end-user data available to manufacturers. However, legal issues remain regarding data ownership and privacy to ensure both customers and the utility are protected. It was also recognized that home energy management may not have an independent value proposition to customers, but that there is an opportunity to piggyback on either existing and prevalent products (e.g. Amazon Echo) or other strong value propositions (e.g. home security). However, it is important to understand how different HEM technologies interact with other smart home devices.

It is clear that this is an ever-changing market and every prediction is a moving target. A supportive environment that promotes energy efficiency and demand response initiatives can help facilitate the further development and evolution of a strengthening smart home market. Additionally, further research to help better understand consumer uptake, behavior, and interaction with smart home technology for energy efficiency and demand response will assist in piecing together a more accurate market and savings forecast. It seems that many market predictions to-date have overshot the market potential, which may mean that the products are not as attractive to consumers as preliminary researchers and product developers think and further research focused on the user experience could be fruitful. However, if they are able to attract consumers, it seems that HEMS have a great deal of potential for energy efficiency and demand side management within the residential sector.

## References

- [1] Hsu, C. C., & Sandford, B. A. The Delphi technique: making sense of consensus. *Practical Assessment, Research & Evaluation*, 2007. 12(10), 1-8.
- [2] Gordon, T. J. The Real-Time Delphi Method. In J. C. Glenn & T. J. Gordon (Eds.), *Future Research Methodology*, 3rd: The Millennium Project. 2009, pp. 1–19.
- [3] Stemler, S. An overview of content analysis. *Practical Assessment, Research & Evaluation*, 2001. 7 (17): 1-9.
- [4] Tanous, J. Nest adds third party integration with new “works with Nest” program. 2014. <http://www.tekrevue.com/nest-adds-third-party-integration-new-works-nest-program/>.
- [5] Consumer Technology Association. Consumers adopting innovation: Wearables, wireless audio, connected devices experience largest ownership growth in 2016. Retrieved from <https://www.cta.tech/News/Press-Releases/2016/April/Consumers-Adopting-Innovation-Wearables,-Wireless.aspx>. 2016, April 28.
- [6] Intel. New Intel survey finds 71 percent of Americans expect at least one smart home device to be in every home by 2025. 2015. <http://download.intel.com/newsroom/kits/iot/pdfs/IntelSmartHomeSurveyBackgrounder.pdf>