

**IEEE
SMART GRID
RESEARCH**

IEEE GLOBAL CONSUMER SOCIALIZATION OF SMART GRID



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Table of Contents

Executive summary	4
The role of a consumer in Smart Grid deployment	6
The consumer as an integral part of the Smart Grid value chain	6
Consumer segmentation	8
Consumer's role in successful implementation of Smart Grid	10
Key consumer issues and expectations identified with respect to Smart Grid adoption	11
Consumer expectations from Smart Grid	12
Smart Grid consumer socialization channels	13
Consumer awareness in USA—case study	15
Consumer survey	16
Smart Grid assessment by country	22
Consumer socialization scenario in USA	22
Consumer socialization scenario in Germany	26
Consumer socialization scenario in India	28
Consumer socialization scenario in China	30
Consumer socialization scenario in South Korea	32
Consumer socialization scenario in Japan	34
Consumer socialization cycle	36
Consumer socialization cycle—an introduction	36
Conclusion & recommendations	45
Addressing key consumer issues	45
Country dashboard	47
Required involvement by key stakeholders of the ecosystem	51
Acknowledgement	62
Abbreviations	54
References	55
Authors	62

Executive summary

One of the primary goals of Smart Grid is to provide its consumers control over their energy consumption, with the help of real-time information, which in turn benefits both consumers and utilities in managing electricity. This report details the challenges faced by utilities, government bodies, and industry bodies in understanding the consumer behavior and educating them on Smart Grid. It also suggests action items that can be undertaken in order to create large-scale awareness and understanding among consumers.

The report highlights the role of a consumer in successful Smart Grid deployment. It segregates consumers into various strata on the basis of attributes such as their requirements and priorities, Smart Grid technologies and services from which they will benefit most, and the methods of engaging with them. It also details the key challenges faced by consumers in adopting Smart Grid services. These challenges have become a formidable roadblock in the smooth implementation of Smart Grids. The report also throws light on various expectations that consumers have from Smart Grids and suggests key socialization channels for mitigating concerns and delivering value to consumers.

The survey undertaken in the report studies consumer perception and behavior on renewable energy resources and Smart Grids across six countries: USA, Germany, India, China, South Korea, and Japan.

Despite a relatively small sample size of respondents, the survey successfully brings to notice the awareness level and perceptions of an average consumer, thereby helping in understanding the key focus points for consumer socialization.

Eighty-seven percent of the respondents in the survey belonged to the age bracket of 25-34 years. Consumers in this age group are open to new ideas and technology alike. They not only display willingness to try new services offered, but also spread this awareness among their peers and younger generation. Since consumers belonging to this age bracket are the most pivotal in influencing other consumers and actively participating in new initiatives or pilots, the survey successfully provides us an understanding of the perception of consumers who are/will be most actively involved in Smart Grid rollout across countries.

Among the several findings, the survey reveals that a large number of respondents are familiar with the concept of smart grids and smart meters and their related benefits. However, the deliberate inclusion of some incorrect options indicates that a fraction of the respondents is misinformed and requires education. The survey also substantiates the need for governments and utilities to work in tandem with media channels in order to spread awareness on smart grids among consumers.

The report discusses in detail Smart Grid adoption level in each of the aforementioned countries and analyses the level of consumer socialization based on consumer awareness level, perceived concerns, initiatives taken to mitigate the same, and the impact of consumer socialization on Smart Grid rollout. In addition, it also throws light on Smart Grid implementation across the six countries with respect to four technologies that are most relevant to consumers: advanced metering infrastructure (AMI), distribution automation, renewable energy, and cyber security for smart grids.

The report also discusses the consumer socialization cycle, a step-by-step procedure which ensures a systematic, focused, and effective increase in consumer socialization. It aims at influencing consumers, spreading awareness among them, creating an in-depth understanding in simplistic terms, and taking the required actions which encourage them to adopt Smart Grid technologies. In addition, it indicates the ideal level of involvement that should exist for relevant stakeholders of the Smart Grid ecosystem at every step of the cycle. Success stories from the six countries under study exemplify the four steps of the consumer socialization cycle further. The report also enlists the actions that stakeholders can take to create an amicable environment that facilitates effective adoption by consumers for a smooth Smart Grid deployment. The report concludes with a step-by-step procedure that stakeholders can undertake in order to reach out to consumers in an impactful and positive way.

Methodology

1. Survey:

- Zinnov conducted an online survey to assess consumer awareness on smart grids and deployment of the same.
- Conducted across six countries, the survey sought responses from the 25-50 age bracket, across income and educational profiles.
- Responses were sought on professional networking websites and user groups specific to the six countries.
- Understanding of the current energy scenario, consumer decisions with respect to Smart Grid systems, key issues from the consumer's perspective, and the level of common knowledge about the respective country's Smart Grid program were sought to be assessed. A few incorrect options were included in the given list, multiple options for some questions, in order to understand the misinformed notions consumers had.

2. Primary Research:

Responses from stakeholders of consumer advocacy forums, Smart Grid promotion groups, and consumer-facing organizations such as utilities were sought to determine the extent of consumer involvement in Smart Grid adoption, initiatives undertaken by these agencies, challenges faced therein, and best practices sought to be replicated. Telephone interviews were conducted to obtain a better understanding in these areas.

3. Secondary Research:

Zinnov leveraged multiple research sources to understand and gain more insights on each aspect of the report.

Zinnov utilized its proprietary knowledge base:

- Zinnov proprietary knowledge repositories
- Zinnov domain expertise from multiple engagements and presence in this space
- Industry reports

The components of the Smart Grid value chain covered in the report (i.e., AMI, renewable energy, distribution systems, cyber security and data privacy, and electric vehicle) are the ones that concern/should concern the consumer.

The role of a consumer in Smart Grid deployment

The consumer as an integral part of the Smart Grid value chain

Smart Grid comprises a diverse value chain starting at the point of generation and moving through transmission and distribution to the consumer (end user). Its services include a variety of solutions that connect utilities to consumers in order to enable energy management or demand response, develop distribution automation, and achieve more comprehensive control systems.

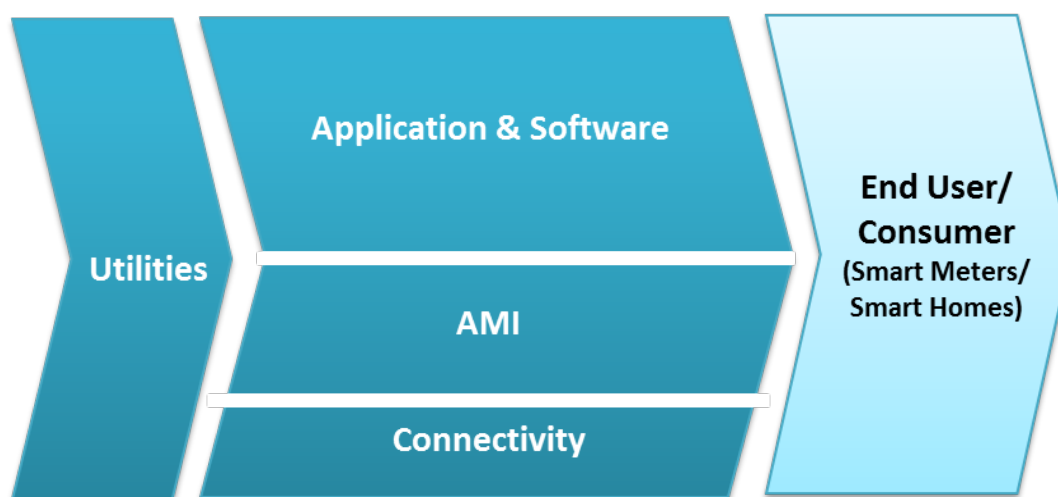


Exhibit 1

A consumer:

- Can be a household, a plant, an office, or similar.
- Can be characterized by distributed generation technologies, energy storing equipment, smart meters, and equipment that monitor, control, and operate.

In a Smart Grid ecosystem, the consumer is an end-user and hence the critical node of the value chain. Only if the consumer is ready to accept the rollout and reap its benefits can the key drivers behind Smart Grid implementation be considered justified.

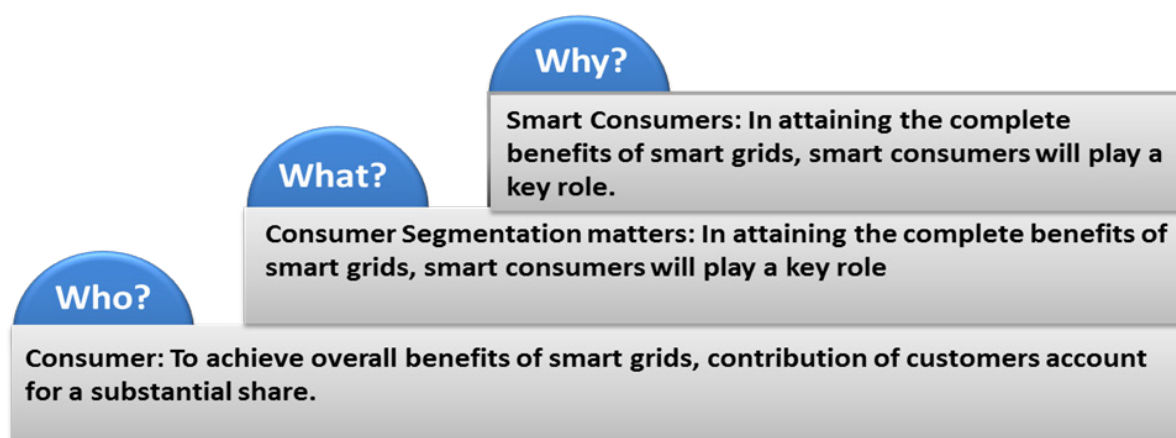


Exhibit 2

As residential consumers form the major part of the consumer group, “consumer” hereon will refer to residential consumer. The study that follows has been done with respect to residential consumers.

Consumer needs

Cost benefit: It is one of the major incentives which can drive consumers to adopt smart grids. Smart Grid not only reduces energy costs but also empowers consumers to have control over their energy usage. Smart Grid provides real-time feedback and detailed energy consumption detail to consumers. This helps consumers assess their energy usage and undertake the required steps to modify the same by opting for a time-based pricing program and/or buying smart appliances, thereby reducing their electricity bill. In addition, it keeps customers informed about peak and off-peak hours and, as a result, helps them schedule energy-intensive tasks during low demand period.

A robust grid infrastructure: As the world continues to expand, so do the needs of the consumer. With this ever-increasing need for electricity, consumers require a robust grid infrastructure that can manage this ever-increasing demand and uses alternate renewable energy sources for energy generation.

Quality of service (frequency control, voltage dip, and voltage control): A sudden brownout or power surge can leave electronic equipment such as TVs, refrigerators, and computers damaged. Smart Grid applications facilitate smooth flow of power, and when aberrations do occur, they are more quickly and easily dealt with.

Self-healing and reliable grid: If a fault occurs in an electricity system, a utility worker is required to drive to the location in order to collect data before devising a solution. However, Smart Grid converts system events into instantly-retrievable digital information, which allows problem solving to begin immediately. Improved efficiency together with reduced power costs are the benefits that customers can enjoy by adopting smart grids.

Efficient energy management without setting up costly power plants to meet demands: Today’s electrical system relies on the building and maintenance of expensive standby plants which remain idle except during critical demand periods. By incorporating a demand response management system, distributed generation, and domestic production of electricity, a Smart Grid helps to reduce electric power consumption during peak periods and diminish the need for costly standby power plants.

Consumer segmentation



Exhibit 3

The above segmentation is not mutually exclusive. For example, a tech-savvy and a social independent might both share love for technology; a social independent can also be socially conscientious and an eco-enthusiast. However, the segmentation does outline unique consumer characteristics based on their needs and priorities, methods of engaging them, and the technology most beneficial for them.

Self-managing: Self-directed consumers prefer to manage electricity consumption on their own. They value transparency and two way communication when it comes to electricity consumption. It is important to acquaint this segment with real-time feedback and variable pricing models provided by a smart grid. Since they face a need to decrease their electricity bills, various benefits of a smart grid and how it can make energy consumption easier needs to be showcased to them. Understanding the needs of this segment, countries like South Korea and India have undertaken some innovative steps. The visitor centers and network operation centers (NOCs) in Jeju (an autonomous island of South Korea which acts as its test bed for the rollout of Smart Grid) not only disseminate information and create awareness among consumers on test bed and Smart Grid technology, but also allows them to experience the new technology, either in the form of demonstrations or an overnight stay at the model smart homes. The Customer Demonstration Center in India also showcases these technologies to the consumers and helps them realize that home energy management can be made hassle-free and less time consuming.

Social independents: Social independents are open to adopting and testing new technologies. They value a program that allows them to connect with a community and share experiences and like the idea that a program is considered “trendy” by family and friends. This segment generally forms a major portion of the population in pilot programs. Pilot programs and utilities should establish forums and social groups for this segment and help them spread awareness among the less aware consumers. This proves to be a very effective means of increasing awareness as it comes from the first-hand experiences of a consumer himself, and fosters more trust among other consumers.

Cost-sensitive: Cost-sensitive consumers prefer, above all, the best financial rewards. This segment accounts for a higher than average share of lower-income consumers. This group becomes another focus segment for increasing awareness. Its need to reduce its electricity bill can be effectively addressed by the variable pricing model provided by a smart grid. In addition, various subsidies and incentives need to be

provided to this segment in order to increase their acceptance of the new technology. Ambiguity over the cost of smart meter acts as one of the deterrents for them, and so do other factors like lack of trust in the utility and fear of higher electricity bills after installing smart meters. Therefore, it has become essential for utilities to win customer confidence by offering various incentives. This can include flexible energy plans or cash-back schemes in the scenario where the electricity bill of a household has increased after smart meter installation. Oklahoma Gas & Electric offers the same to its customers. OG&E's SmartHours allays the consumer concern of high tariff by promising to compensate for the extra cost paid (if any) at the end of every year. The same suit needs to be followed by other utilities to attract this group.

Service-centric: Service-centric consumers prefer, above all, the best quality service for themselves and family members. The group is not averse to change but focuses on quality of life. They are willing to pay more or compromise on monetary aspects but desire better services in terms of electricity and allied services.

Traditionalists: Traditionalists prefer a familiar experience. They are resistant to change in any form and exhibit low willingness and acceptance of Smart Grid services. Utilities can attract this segment either by launching forums where satisfied consumers share their experiences, or through a short experience (stay, visit, demonstration, etc.) at a smart home.

Tech-savvy: Tech-savvy consumers value convenience and efficiency. They account for a higher percentage of men in the age group of 25-34 years with high income level. They are more likely to choose a program that simplifies their lives. This group forms another major component of the pilot program participants. As they are quick adopters of efficient technology, utilities must market their home energy management systems and in-house display units to this segment. Utilities should also involve them in ascertaining the efficiency of various technologies they offer via feedback forms and online surveys.

Eco-friendly consumers: Eco-friendly consumers are eco-conscious and share the belief that smart grids promote eco-sensitive usage of power. They value the technology that can help them reduce greenhouse gas (GHG) emissions and use renewable sources of energy. To target this consumer segment, utilities must reach out to related NGOs. For educating this consumer segment about the green aspects of smart grids and electric vehicles, various workshops should be organized by utilities. As eco-enthusiasts believe in the environmental cause, they can form lobby groups to create awareness.

Consumer's role in successful implementation of Smart Grid

Consumer adoption plays an instrumental role in the successful transition to a smarter, more efficient and digitized electricity grid and realizing its full potential. Consumers facilitate a two-way communication with the utility, thereby helping them analyze power demand patterns, reduce peak-load hours, and supply electricity back to the grid via domestic generation. By using variable tariffs and real time pricing, consumers help reduce the demand, and thereby reduce the frequency and duration of power outages. Electric vehicles and clean sources of energy used by consumers help a country reduce its GHG emission and create an eco-friendly environment. In addition, Smart Grid services such as electricity trading markets and real-time pricing are futile if consumers do not fully utilize them.

The table below showcases various areas where consumers can have a profound impact on the key drivers of the Smart Grid rollout, and on the rollout itself:

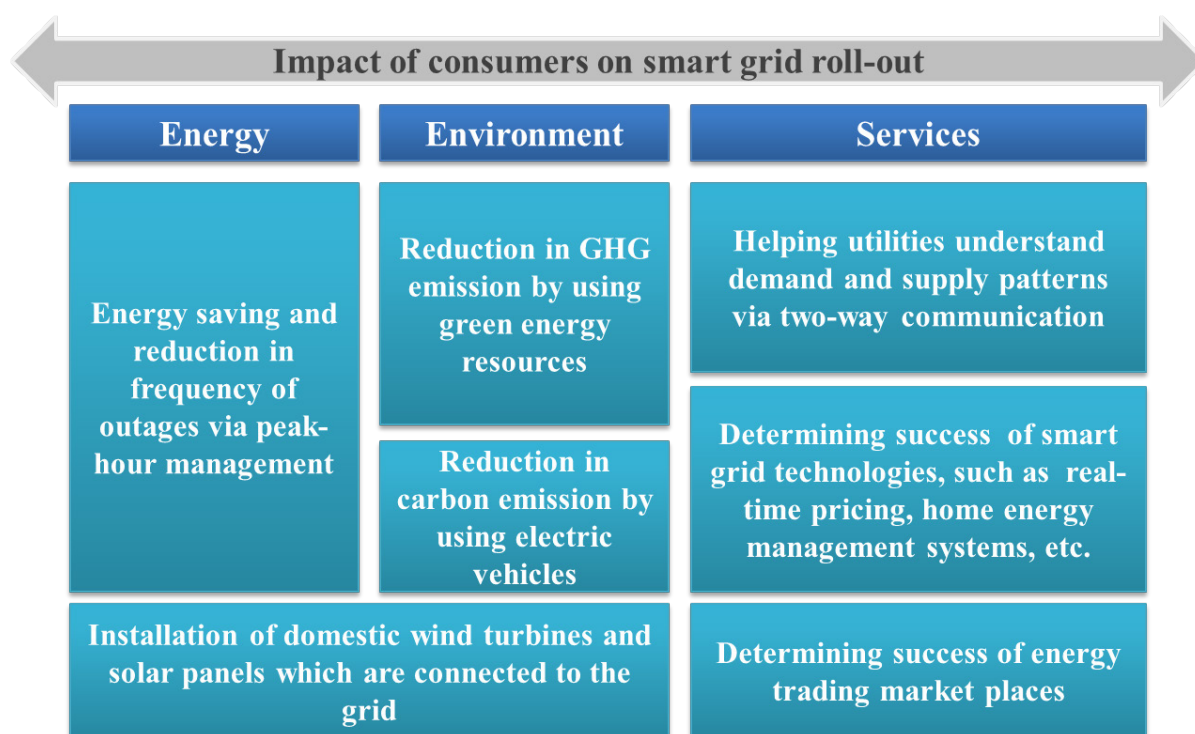


Exhibit 4

Key consumer issues and expectations identified with respect to Smart Grid adoption



Consumer Data Privacy



Supposed increase in electricity bills



Low-Income Consumer strata



Traditional Attitude of consumers



Health Hazards

Exhibit 5

Smart meters are often misinterpreted as a domestic espionage scheme. Consumer apprehension around who is privy to a consumer's electricity consumption data often slows down the large scale rollout of smart grids. In theory, the information collected by smart meters can potentially reveal the number of people staying in the house, their daily routines, changes in those routines, the electronic equipment in the house, etc., which if leaked, can be misused.

An increase in electricity bills resulting from the installation of a smart meter and usage of Smart Grid services is another widespread concern among consumers. Another major concern consumers face is bearing the cost of smart meter installation.

The low-income consumer stratum, which forms a major part of a developing nation's population, has very little awareness on the subject and fails to understand how a smart grid can help them reduce their bills via the variable pricing mechanism and the incentives offered by the government and utilities. Though some might be familiar with the concept, they are skeptical about the promised economic benefits and need effective incentives that encourage them to accept the transition. In addition to this, they may be unable to exploit the benefits of a smart grid to the fullest, owing to financial inadequacy to shift loads or purchase smart appliances.

Many consumers believe that the radio frequency emission from smart meters can be detrimental to their health. This notion is further spread and strengthened via social media channels.

Consumer expectations from Smart Grid

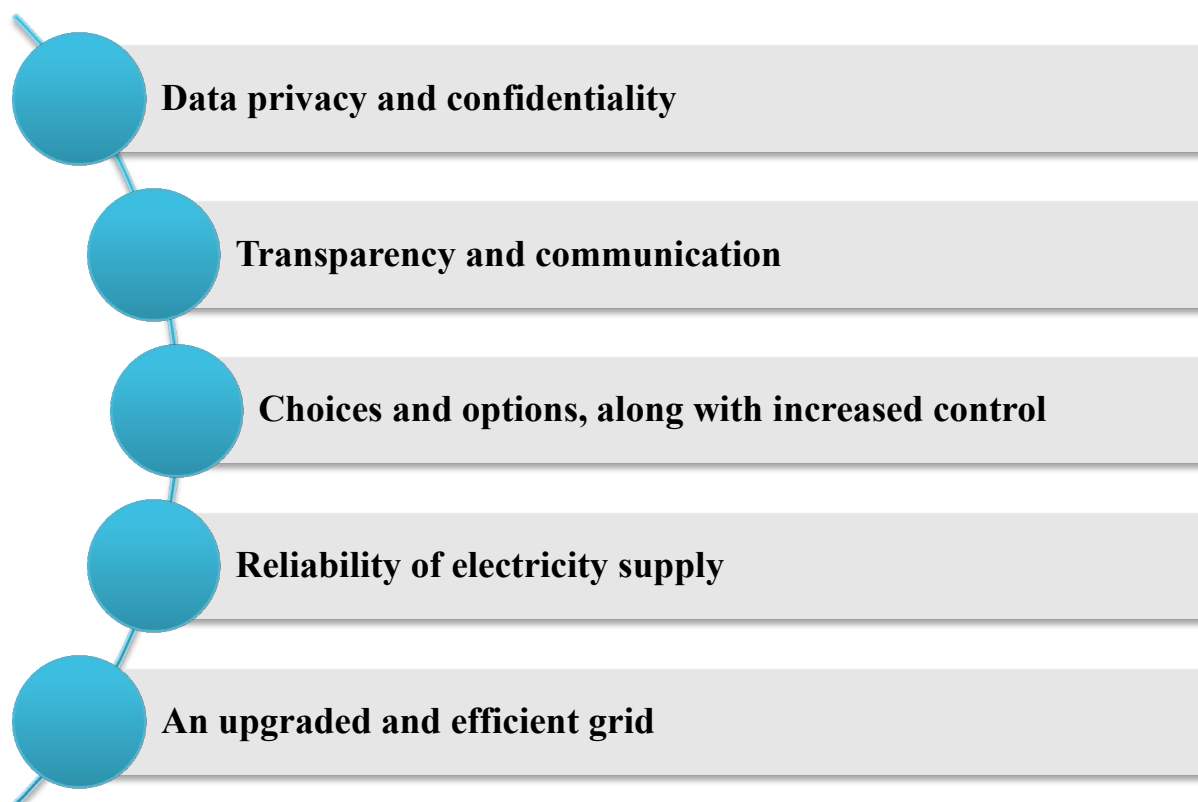


Exhibit 6

Data privacy: Data privacy is one of the key concerns of consumers, which utilities need to address in order to accelerate smart grid adoption. Consumers desire that utilities should maintain the confidentiality of their energy consumption data. In addition, they expect that utilities should seek their permission before sharing their energy consumption data with third party vendors.

Transparency: Consumers expect transparency and prior communication on the change in pricing structure, how the same will affect their energy consumption and the resultant electricity bill.

Choice: When provided with options and increased control, consumers feel more empowered. This helps utilities build trust among consumers. Hence, to promote Smart Grid adoption, utilities need to offer different options to consumers, such as attractive energy plans, to reduce their energy consumption and subsequently their electricity bills. In addition, providing access to online portals to track energy consumption, and a variety of other home control options, can help in attracting consumers.

Reliability: As reliable and quality electricity supply is one of the key requirements of consumers, smart grids can prove to be an apt solution. Utilities need to educate consumers about the advantages that smart technology offers, such as reduced outage time and frequency.

Upgraded grid: Consumers who are aware of the energy crisis scenario of their nation, and the world in general, expect smart grids to address capacity shortage via efficient optimization of energy consumption and usage of renewable sources of energy.

Smart Grid consumer socialization channels

The key issues mentioned above need to be allayed for a timely rollout of Smart Grid. These concerns can be mitigated by reaching out to the consumers through a number of channels. Some of them are listed below with examples:

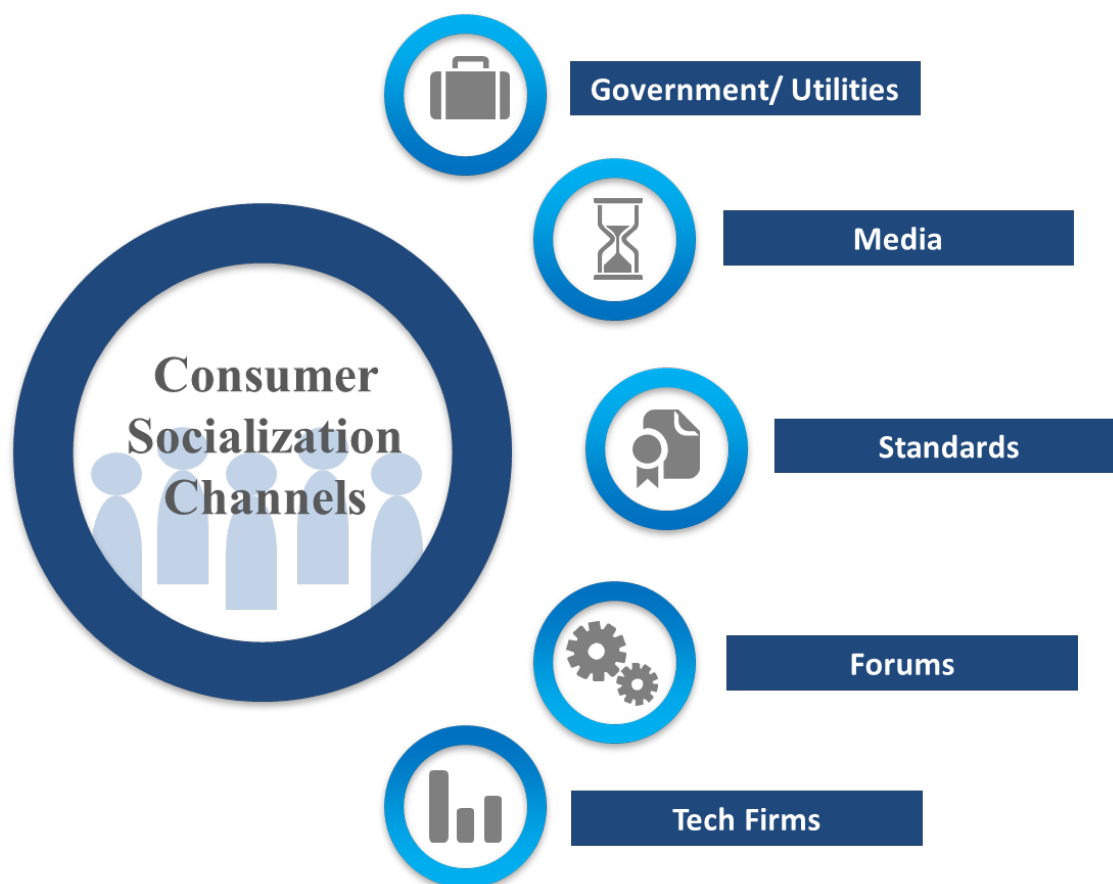


Exhibit 7

Government/Utilities:

- Rochester Public Utilities launched an internet blog “Behind the Meter” to communicate with consumers.
- Florida Power and Light introduced “Energy Dashboard,” which helps consumers check the status of energy consumption.
- Korea Electric Power Corporation (KEPCO) consortium of smart consumer area in Jeju held several briefings and public hearings for residents to provide them better understanding of the Smart Grid project.

Media:

- GE launched Catch Alive where live updates on Smart Grid scenarios are showcased.
- Online community forum Eco-city opened an online community in order to strengthen the contact between the residents and communities which will help to improve the efficiency of Eco-city.
- smartgridnews.com — An online news site that provides news and analysis for modernization and automation of electric power.

Training and student education:

- The Smart Grid Education and Workforce Training Center is led by Illinois Institute of Technology (IIT) — It consists of a team of over 100 participating members including domestic, international universities, community colleges and high schools, city and government entities, etc. The center provides three levels of training on Smart Grid awareness for labor, K-12 students, and veterans: fundamental, applied, and advanced.
- Organized student trips to Smart Grid centers help increase the awareness levels of Smart Grid in the younger generation and teachers. Centers also provide teachers with access to webinars on Smart Grid.

Forums/lobby groups:

- Conducting events and workshops on topics related to Smart Grid and government's role in it to enhance the confidence level of the consumers.
- Conducting teaching programs on helping consumers understand the government policies.

Tech firms:

- In Jeju, the Smart Grid test bed of South Korea, LG provides consumers with overnight stays at fully functional smart homes for a complete experience of Smart Grid technologies.
- Mahindra Satyam, in collaboration with Schneider Electric, set up a Smart Grid customer demonstration center (CDC) at its 120-acre campus in Hyderabad, India. The CDC helps consumers understand the next generation technology in real-time and evaluate various technologies underlying the Smart Grid ecosystem.

Consumer awareness in the USA—case study

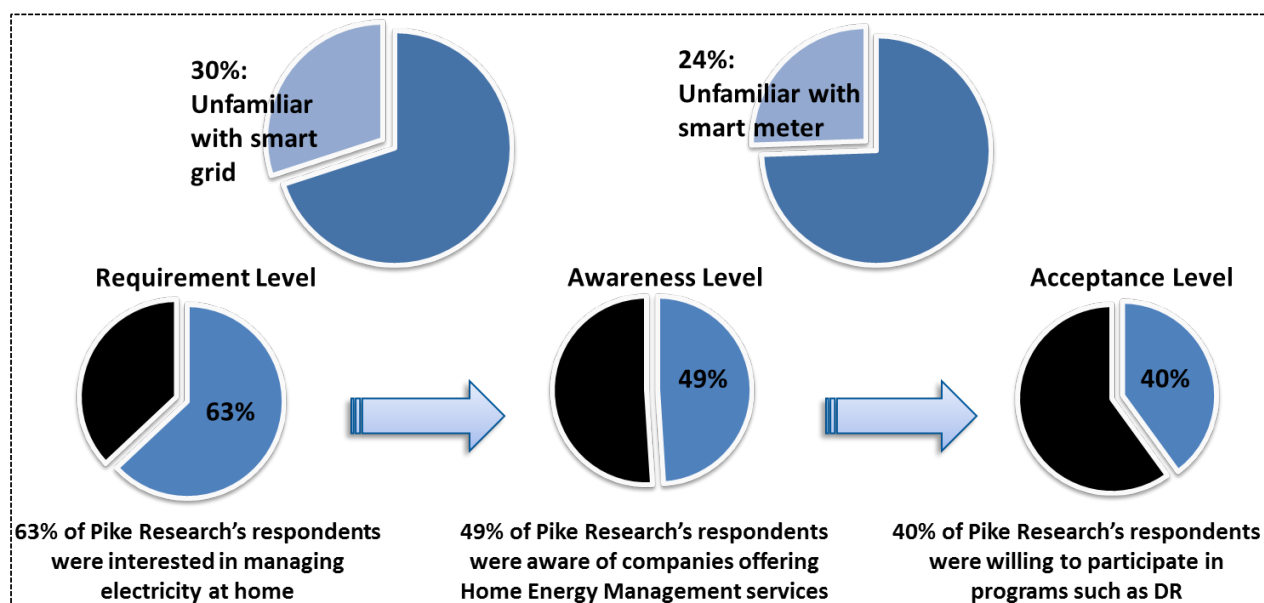


Exhibit 8

According to a survey conducted by Navigant Research [2] as a part of Navigant's Energy Practice to assess consumer awareness on smart grids, nearly 30% of the respondents were unfamiliar with the concept of smart grids, whereas 24% lacked familiarity with smart meters.

Seventy-three percent of the consumers were concerned about the effect their electricity bill has on their monthly budgets, whereas 63% were interested in managing energy at their homes. However, when this segment was asked to take action on materializing this interest, only 49% were aware of companies offering home energy management services (HEM), and only 40% expressed a high level of interest to participate in programs such as demand response.

The survey indicates that consumer awareness in the United States is still in an early phase. Utilities and other Smart Grid players need to find more effective means of engaging consumers with simple, affordable, and helpful energy management products and services.

Consumer survey

Zinnov conducted a survey across the six target countries to assess the level of consumer awareness of Smart Grid technologies

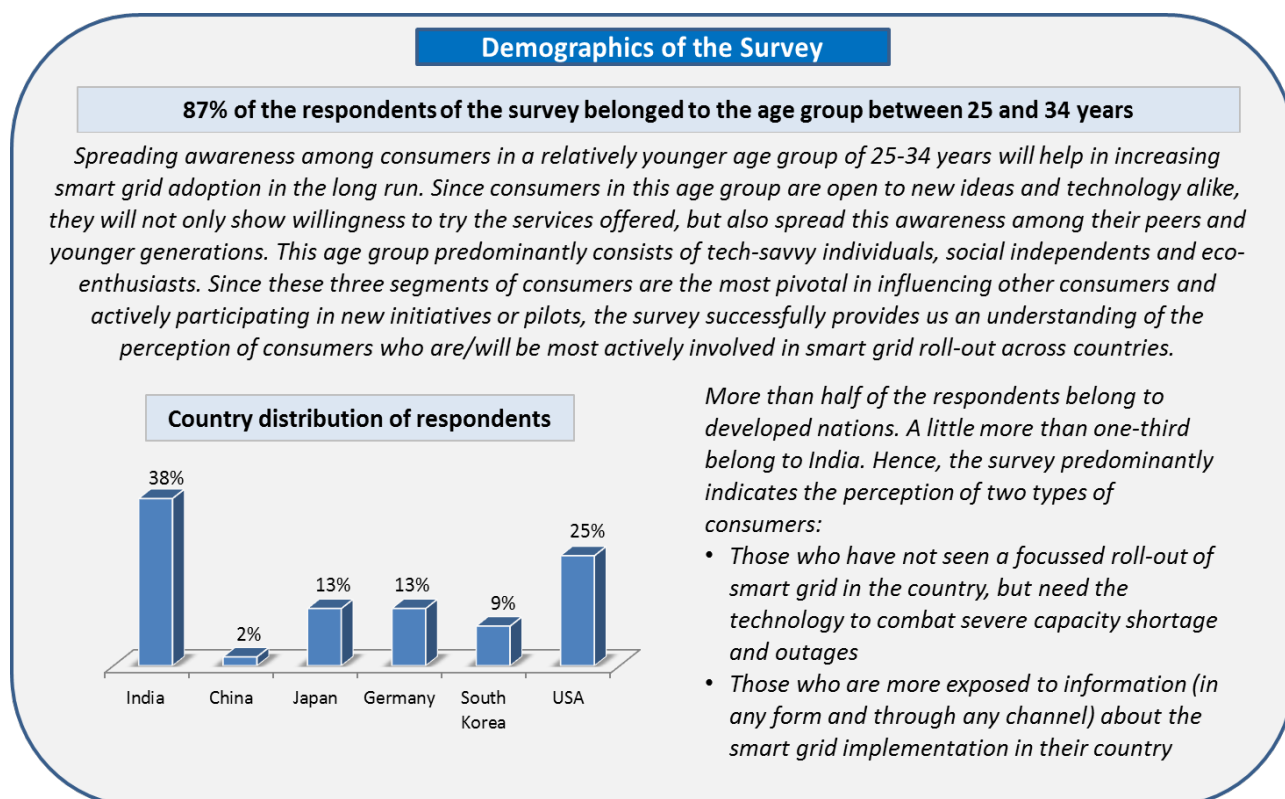


Exhibit 9

The survey assessed consumer awareness of renewable energy sources and consumers' perception of energy scenarios in their respective countries. Despite a relatively small sample size of respondents, the survey successfully brings to notice the awareness level and perceptions of an average consumer, thereby helping illustrate the key focus points for consumer socialization.

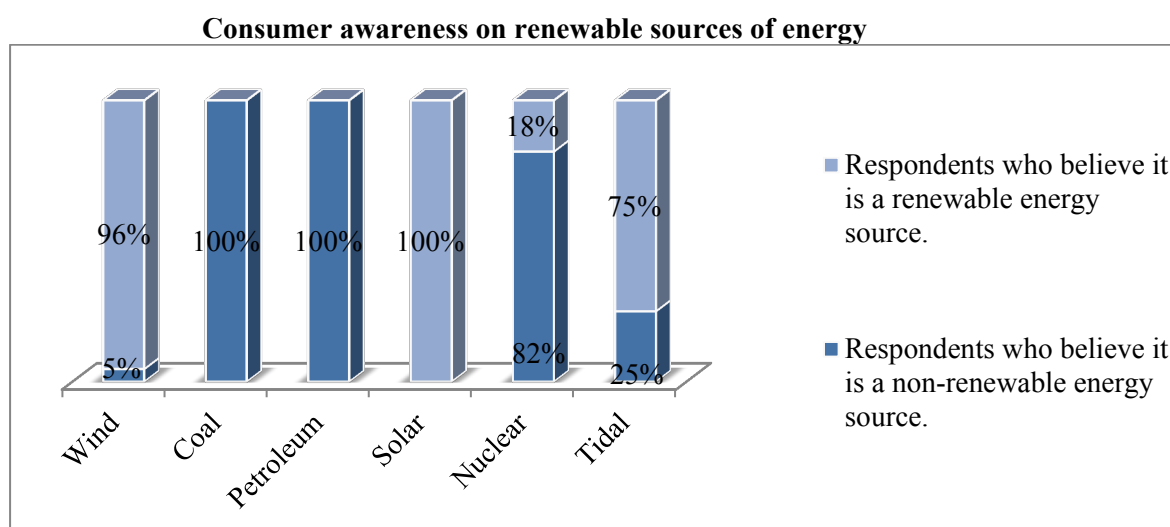


Exhibit 10

Consumer perception about the main source of energy in their country

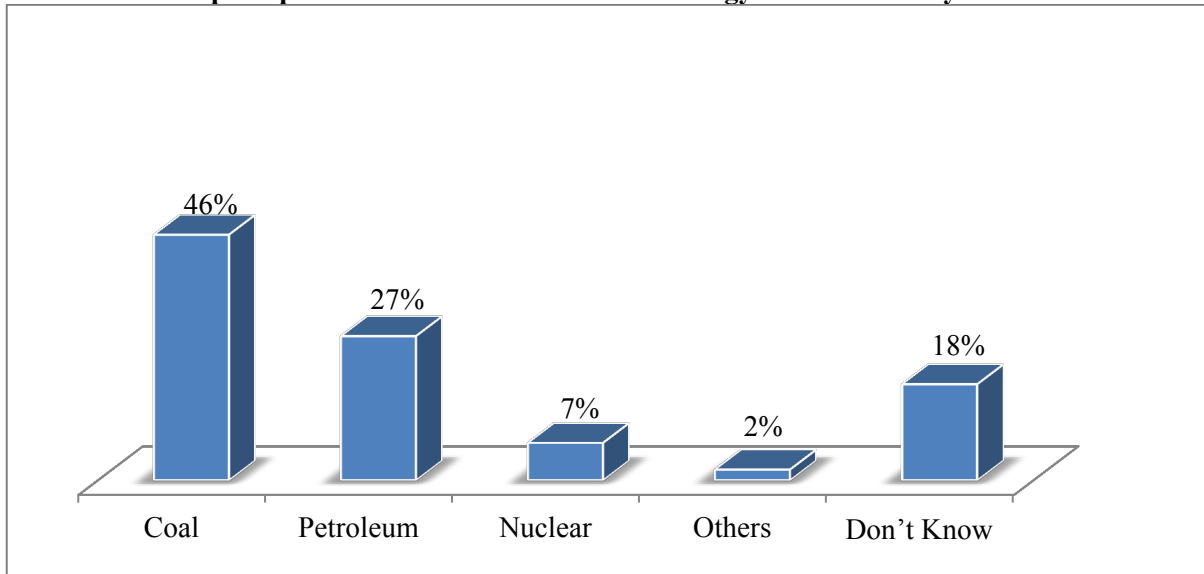


Exhibit 11

Consumer perception of their country's dependency on renewable sources of energy

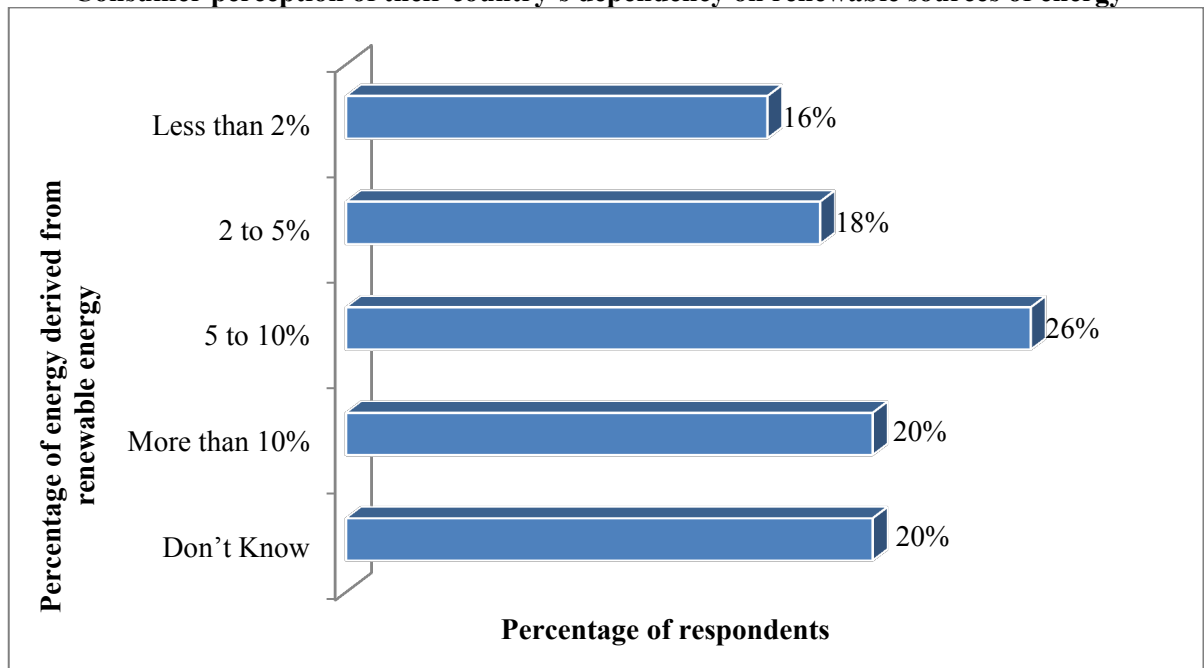


Exhibit 12

The survey revealed that there is a high level of awareness among consumers of renewable energy sources, with wind and solar being the most commonly known. In countries like Germany, where penetration of domestic wind turbines and photovoltaics is high, consumers are provided various incentives to supply the electricity back to the grid, which helps reduce peak load hours. This can be adopted as best practice by other nations. India offers a favorable geographical location for harnessing solar energy. This energy should be harnessed in order to provide rural electrification. In addition, various incentives can be offered to commercial and residential consumers in order to promote adoption of solar panels. Incentivized connectivity of domestic generation to the main grid will not only reduce outages but also win consumer trust by providing them economic benefits.

The survey also assessed the extent of consumer involvement in Smart Grid deployment

Homes/offices equipped with a solar panel or wind turbine

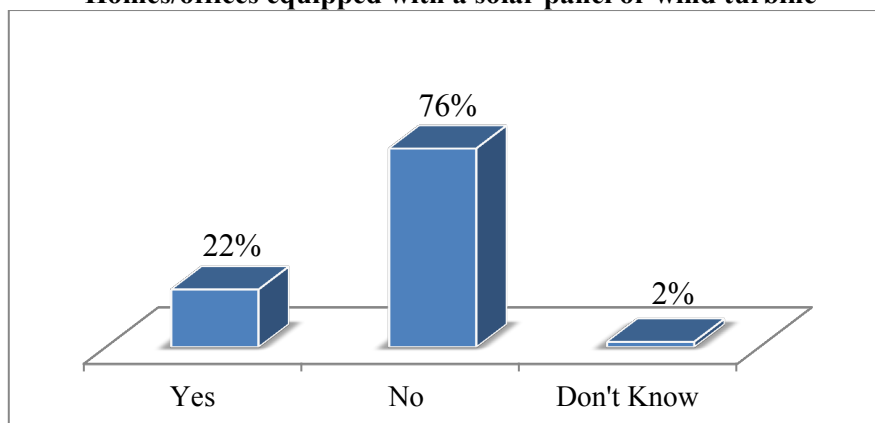


Exhibit 13

If the government provided incentives for supplying power to the grid, would you install solar panels or wind turbines?

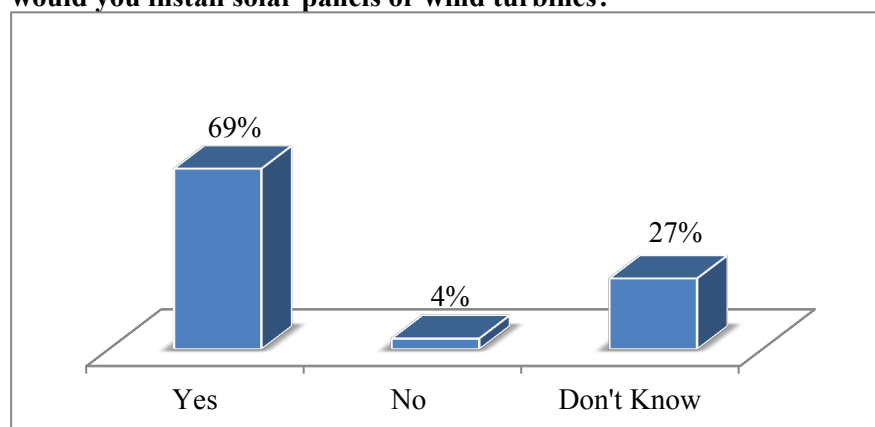


Exhibit 14

Do you have smart meter at home ?

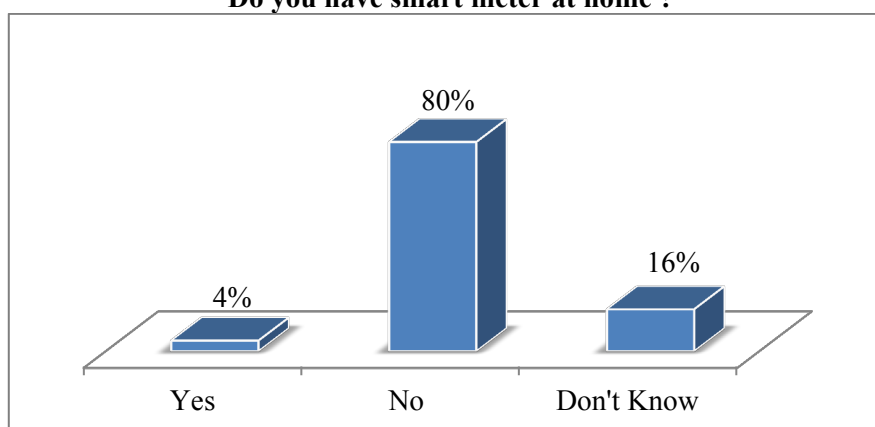


Exhibit 15

Most respondents did not have a smart meter installed at their house, but they displayed an inclination toward installing wind turbines and solar panels if provided with economic benefits. This indicates that