Impact of Smart Grid on the Connected Home

Landmark Research Study

Continental Automated Buildings Association (CABA)

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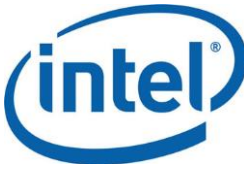

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In addition to the above, Frost & Sullivan's robust in-house research models and processes, along with the repository of Industry Research and Decision-support Databases, have been instrumental in the completion of this report.

The trends identified in this report are based on discussions with industry participants and Frost & Sullivan's ongoing research in connected home, energy, and related markets. Conclusions drawn are anticipated only, and do not imply prediction of events in the future. These conclusions are based on best judgment of exhibited trends, expected direction the industry may follow, and consideration of a host of industry drivers, restraints, and challenges, which represents the possibility for such trends to occur over a timeframe. All supporting analyses and data, as permissible, within contractual time and budget, are provided to the best of ability.

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STUDY BACKGROUND

The Continental Automated Buildings Association (CABA) is an industry association dedicated to the advancement of intelligent homes and intelligent buildings technologies. CABA is an international association, with over 300 major private and public technology companies committed to research and development within the intelligent buildings and connected home sector. Association members are involved in the design, manufacture, installation and retailing of products for home and building automation. CABA is a leader in initiating and developing cross-industry collaborative research, under the CABA Research Program.

In 2012, CABA's Connected Home Council (CHC) and the CABA Smart Grid Working Group, through various collaborative industry discussions, commissioned the "Impact of Smart Grid on Connected Homes" with the objective that it would assist in building the industry's knowledge base and perspectives on the connected home market and its future prospects, in relation to development and deployment of residential Smart Grid. The broad purpose of this study is to identify the current status of connected home solutions and technologies, determine the existing and emerging supplier landscape and ecosystem, identify the status of current residential Smart Grid deployment, identify potential business models for stakeholders and to determine the emerging opportunities for various industry participants.

Organizations that participated in CABA's Impact of Smart Grid on Connected Homes 2012 study included: CableLabs, ClimateTalk Alliance, Comcast Communications, Consolidated Edison of New York, Consumer Electronics Association (CEA), Energent Incorporated, Hydro One Networks Inc., Hydro-Québec, IBM, IEEE, Intel Corporation, Landis+Gyr, Microsoft Corporation, MTS Allstream Inc., Niko Group/fifthplay, Pacific Gas & Electric Company, Pella Corporation, Philips Lighting, Qualcomm Incorporated, Samsung Telecommunications America, Sigma Designs, Southern California Edison, Sykes Assistance Services, TELUS, Tridel Corporation, TRLabs, and Z-Wave Alliance. CABA commissioned Frost & Sullivan (www.frost.com), an independent market research and consulting firm, to conduct this 2012 landmark research study.

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1. Executive Overview

1.1 Project Background

The Continental Automated Buildings Association (CABA) is a not-for-profit industry association dedicated to the advancement of intelligent home and intelligent building technologies. The organization is supported by an international membership of more than 300 organizations involved in the design, manufacture, installation, and retailing of products relating to home automation and building automation. Public organizations, including utilities and government organizations, are also members.

CABA's Connected Home Council (CHC) and the Smart Grid Working Group, through various collaborative industry discussions, commissioned this research project titled, "Impact of Smart Grid on the Connected Home," with the objective that it could assist in building the industry's knowledge base and perspectives on the connected home market and its future prospects. Frost & Sullivan was commissioned by the Project Steering Committee, instituted for the specific purpose of funding and overseeing this collaborative research, to undertake the project on behalf of CABA.

1.1.1 Overview and Focus Areas

The connected home market is a fast evolving segment that is being influenced by a number of emerging industry trends. The recent developments in the implementation of end-to-end smart grid at the utility level, as well as the changes witnessed in the area of managed home devices and systems are expected to further impact the dynamics of this market segment.

The connected home suppliers catering to this fast evolving market are facing the challenges of keeping abreast with technology development in meeting new grid infrastructure requirements as well as innovating solutions that are compatible with changing standards and communication topologies.

Additionally, there are uncertainties with regard to which technologies will remain current and adaptable to emerging changes in digital home requirements, energy dynamics, as well as smart grid infrastructure deployment.

For industry participants, it is critical to be well informed of the distinct challenges, the market gaps, the influence of key channels, and the evolving market environment, to execute a successful market strategy.

Therefore the key focus areas agreed upon by the Project Steering Committee include the following:

- Current status of connected home solutions and technologies
- The existing and emerging supplier landscape and ecosystem
- The status of smart grid deployment
- Business models for stakeholders

- The opportunities for various industry participants

The contents of this report encompass the above focus areas.

1.2 Key Objectives of Project Sponsors

The key objectives of project sponsors for undertaking are as follows:

- Increase awareness and generate demand for connected home solutions
- Understand the changing dynamics of the industry with smart grid deployment and the impact on connected home solutions
- Create the right business models and technology roll-out initiatives to meet changing demand
- Achieve standardization with regard to codes, communication standards, and topologies, that will be critical for market adoption of these solutions
- Understand the technology market curve and isolate hype elements from actual growth trajectory
- Create differentiating platforms for solutions and demonstrate value adds through field trial data and case studies
- Define growth zones and prospects for market participants

1.3 Methodology and Research Design

Frost & Sullivan used a combination of primary and secondary research methodologies to compile the necessary information for this project. Information provided in all segments is based on availability and the willingness of participants in sharing these within the scope, budget, and allocated time-frame of the project. The trends identified in this report are based on discussions with industry participants and Frost & Sullivan's ongoing research in home and building technologies, energy, and related markets. The conclusions drawn are based on our best judgment of exhibited trends, the expected direction the industry may follow, and consideration of a host of industry drivers, restraints and challenges which represent the possibility for such trends to occur over a time-frame. All supporting analyses and data, as permissible within the contractual time and budget, are provided to the best of ability.

Primary Research

Primary research formed the basis of this project. Interviews were conducted with technology providers, utilities, and other organizations, as well as stakeholders in each of the technology segments, standards organizations, privacy commissions, and other influential agencies. To provide balance to these interviews, industry thought leaders who track the implementation of the outlined technologies were also interviewed to get their perspective on the issues of market acceptance and future direction of the industry.

Secondary Research

Secondary research comprised the balance of the research effort and included published sources such as those from government bodies, think tanks, industry associations, Internet sources, and Frost & Sullivan's own repository of research publications, and decision support databases. This information was used to enrich and externalize the primary data. Data sources are cited where applicable.

1.4 Definitions

Frost & Sullivan's interactions with the connected home industry, and building upon previous projects undertaken by CABA in the connected home area, the following definition was adopted to define a 'connected home': "A residential dwelling unit that uses both technology and process to create a plug-and-play environment that is safe, responsive, adaptive and comfortable for its occupants". A connected home provides timely, integrated system information for its owners so that they may make intelligent decisions regarding its operation, energy use, and ongoing maintenance. In its most robust format, a connected home has an implicit logic that effectively evolves with changing user requirements and technology, ensuring continued and improved intelligent operation, management and monitoring, and optimization of functions. In a broader context it is possible to attain connected intelligence, energy optimization and environmental sustainability in a connected home."

What can we expect of such a home?

- Improved interdependency between systems and devices and their users
- A home that can detect the state it is in and make adjustments to itself
- Connected to external third party resources for delivery and control of its functions
- Incorporates renewable energy technologies
- Improves long-term economic performance
- Reduces energy and resource waste trough smart sensing and optimization

Connected homes transcend integration to achieve interaction, in which the previously independent systems, devices, and applications work collectively to optimize the home's performance, and constantly create an environment that is most conducive to the occupants' goals. Connected homes serve as a dynamic environment that responds to occupants' changing needs and lifestyles. As technology advances, and as information and communication expectations become more sophisticated, networking solutions both converge and automate the technologies to improve responsiveness, efficiency, and performance. To achieve this, connected homes bring together home controls, resource use, data, voice, entertainment, health devices, and security on a single network platform that facilitates user management, control and optimization, energy conservation, comfort, and mobility.

1.5 Summary of Key Findings

Frost & Sullivan's research indicates that the concept of a connected home is desirable for consumers due to the perceived benefits of controllability, energy savings and security that

home owners derive from it. However, lack of awareness of the right solutions, confusion regarding which solution is best suited for their needs and why, and most importantly, the real benefit derived for the cost they pay are some of the key issues that have kept this industry from moving forward. The key findings of the research are summarized below under the following headings.

1.5.1 Current State of the Industry

The connected home industry in North America is still in its early adoption stages, though there are distinct signs of it gradually moving upward in the market life cycle. The key characteristics depicted by the industry are:

- Technology innovation has made a wide range of options available for consumers to make their homes more plug-and-play environments, with remotely controllable features and interfaces.
- The myriad of solutions and varying price points have made it difficult for the home owner to choose a particular solution over others.
- The price-performance ratios of products and solutions are still relatively unknown, which in turn makes the perceived value from them lower than expected.
- Energy savings and the need to reduce waste have prompted homeowners to explore energy-saving smart devices that are offered by both vendors and utilities.
- The issue of data sharing with unknown third parties and allowing information access to service providers, who could carry out analytics and diagnostics in remotely hosted platforms, is making the consumer skeptical of deploying robust connected home solutions.
- The connected home's interaction with an end-to-end smart grid is still considered years away, owing to the slow rate of deployment of smart grid infrastructure by utilities, as well as operational constraints of utilities that would delay their initiatives in this area. These initiatives include residential demand response, home area network deployment, and retrieving data from smart meters and translating them into useful information for use by both utilities and the consumer.
- Presently the supplier landscape is marked by proactive actions from telcos, security solution providers and communication service providers, who view the connected home industry as a lucrative revenue opportunity. Selling additional bundled products and services to their growing customer base is seen as a good way to augment revenue streams.
- Industry participants expect a gradual shift toward adopting connected home platforms, as opposed to ad-hoc solutions, over the next 10-year period, which will help define the delivery models and the industry's value chain more distinctly.

1.5.2 Technology and Business Evolution – Time-line for Major Issues

In laying out the time-line with the associated opportunities and challenges for the connected home industry, Frost & Sullivan considered various scenarios from best-case to realistic, and investigated the achievability of these goals, given the present state of the industry.

The major opportunity triggers over the next five years include energy efficiency, device and system integration, and a move toward getting closer to a universal connected home platform within the home. Energy efficiency will continue to dominate the discussions around adopting smart technologies by homeowners. The ability to quantify energy savings and reduce operational expenses will help keep demand upbeat in the immediate period.

Beyond the next five years, opportunities would be triggered by other fundamental changes that could be brought about by strategic partnerships and industry convergence aspects. Changes to the solution delivery models and ecosystem will dominate the connected home landscape. Industry participants will have to prepare to address the issues around a connected home's integration with the smart grid, including information sharing, data security, and consumer privacy, among others. Frost & Sullivan expects more integrated approaches to solution delivery to be adopted by product and service providers, including utilities. The challenges will emanate from issues such as the possibility of achieving a complete convergence of systems and networks, and whether or not that would be realistic and cost effective.

However, as more strategic alliances are formed and stakeholder initiatives brought together, the acceptance and awareness of connected home solutions could increase favorably. The technical challenges around convergence and integration could potentially be overlooked as new apps and technology platforms make their way into the market that are able to deliver connectedness with more open features, and harmonized interfaces allowing for ease of integration.

1.5.3 Key Conclusions – The Way Forward

The key takeaways of this research are the following:

- Limited customer engagement and lack of personalization of solutions, as well as the lack of predictive and self-sensing capability of solutions, will continue to hinder value demonstrations in the connected home industry.
- The industry horizon will continue to be dotted by both pure-play and turnkey players. Competitive advantages will, however, depend upon scalability of solutions to accommodate the emerging demand in technology integration.
- The IP influence will dominate the convergence in domain expertise, but practicalities of full convergence are questionable and not a near-term reality.
- The connected home's relationship with energy is likely to be further stressed with the ability of such a home to integrate with the smart grid; however, optimized solutions in this area are currently only demonstrative in nature, with limited initiatives undertaken by the utility industry.
- Industry participants need to collaborate in a cohesive manner to make smart home solutions work together; however, both conceptual frameworks and technology development initiatives should work simultaneously toward this end.

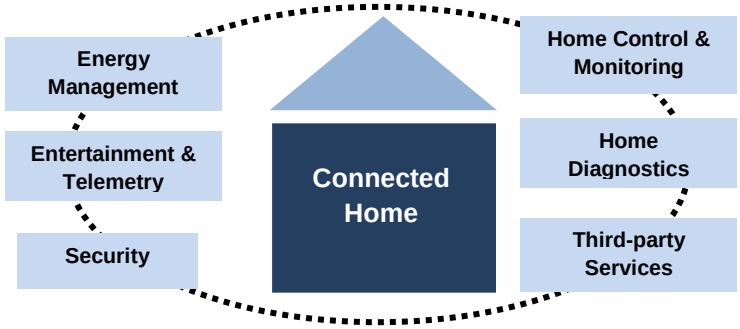
2. The Connected Home Concept

2.1 Snapshot of the Connected Home – Segments and Applications

The “connected home” can be simply defined as a home characterized by the presence of devices, communication services and applications that interconnect and communicate with one another to enable an environment that is responsive and adaptive to a homeowner’s needs and comforts. The degree of “connectedness” varies by the sophistication underlying the ‘connected network’ that is ultimately the backbone of this evolving concept, which has its roots in what used to be defined as the ‘digital home’.

The various examples of connected home ranges widely, starting with instances where one or more personal devices are being connected to a home area network, to a comprehensive home-wide integrated platform that eliminates all silos. No matter how robust the vision of a connected home is today, there are some distinct functionalities and applications that have come to exist within its domain, and others that are potentially going to feature as part of its future evolution. Chart 2.1 shows the key segments of a connected home.

Chart 2.1 Segments of the Connected Home

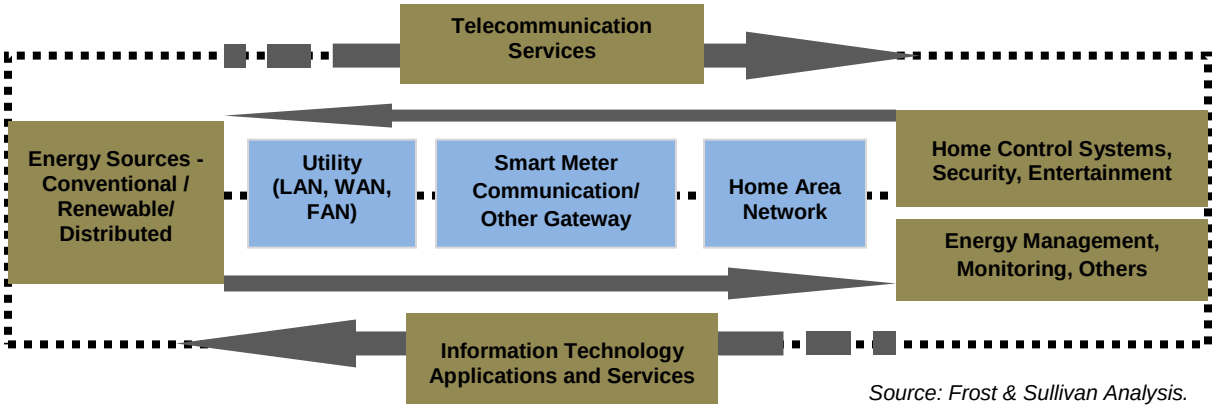


Source: Frost & Sullivan Analysis.

2.1.1 The Connected Home Taxonomy

The taxonomy of the connected home has broadened over the last decade to encompass a variety of functionalities and applications that work inside a home to those that permeate beyond into the external communication environment. Frost & Sullivan's research on this project, and the effort to define the taxonomy of the connected home based on industry interactions, leads to the following explanation. The connected home, and its interconnection with the smart grid, is being conceived as the convergence of four key segments/layers of the industry as shown in Chart 2.2.

Chart 2.2: Key Segments of the Connected Home Environment



Source: Frost & Sullivan Analysis.

By combining the expertise of each segment, the creation of the connected home network is being achieved, which thrives on a few key components. These include energy resources, physical infrastructure components within a home, data communication and control, applications and services, and systems automation and integration interface or platform that supports interconnectivity, information display, and enables a home owner to action upon such information.

The concept of home automation has made progressive inroads in the North American market over the last decade. However, the solutions offered have largely remained confined to the premium home owner segment, owing to their high price. Although solutions in the mid market price range have been introduced by various established and new industry participants, uptake can be considered modest at best. In the high end segment, home owners' interest in such products and solutions has been driven by lifestyle comfort needs and security, whereas, in all other segments, energy management and security have predominantly dictated a homeowner's need to opt for a home automation system.

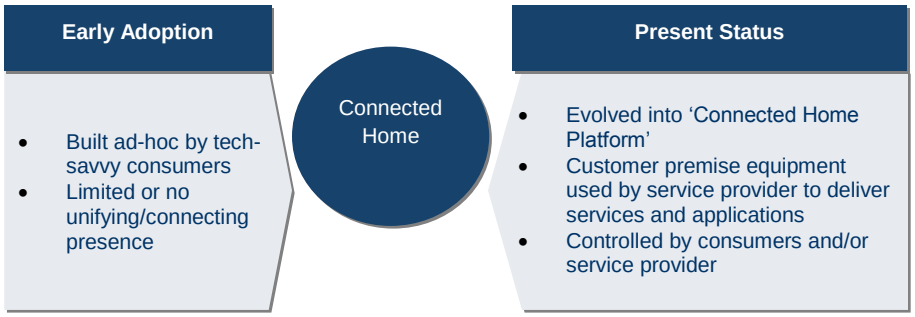
The incorporation of connectivity into these automated or digital components, however, changes the demand dynamics greatly, as this enables the home owners to manage every aspect of the home and their lifestyle from any location, while also having the ability to save energy and money doing so. An automated and smart sensing home environment does provide the basic foreground to a home owner to ultimately scale up toward a comprehensively connected environment. A simple home control or energy management system that a home owner can hook up to his or her in-home communication network qualifies to create the elementary

framework of a connected home environment. Broadly, the connected home is therefore characterized by the following components:

- An environment of systems and devices inside of the home, using various technologies
- A managed residential gateway inside the home
- Broadband connection to the Internet via the Service Provider's managed network
- Remote access and management of devices through the residential gateway
- Operation and business support systems (OSS/BSS) of the service provider
- Value-added services and associated devices inside the home

Chart 2.3 shows the evolution witnessed in the connected home concept.

Chart 2.3: Evolution in the Connected Home Concept



Source: Frost & Sullivan Analysis.

This evolution has led to the formulation of an extended taxonomy for the connected home industry and its various segments. This taxonomy, further validated by this study, is depicted in the next page.

Chart 2.4 depicts the taxonomy of the connected home.

Chart 2.4: Taxonomy of the Connected Home

	Connected Home Systems and Devices	Residential Gateway	Devices Managed via Gateway	Consumer Access & Management	Third Party Service Platforms
Domains	Home Devices and Appliances Home Control & Automation Home Energy Management Security and Access Energy Monitoring and Diagnostics In-home Displays Telemetry and Entertainment Tele-Health	Utility Home Area Network Systems Home PlugAV, IEEE 802.11 (Wi-Fi) IEEE 802.3 (Ethernet) IEEE 1901, IEEE P1905.1 (Convergent Digital Home Network for Heterogeneous Technologies) ITU-T G.9959 (Z-Wave) Bluetooth, ZigBee Z-Wave ITU-T G.hn, MoCA Technology Broadband over Power Line (BoPL)communications Cellular/LTE/3G/4G	Smart Meter, Smart Thermostats, In-Home Displays, Smart Plugs, Load Control, Smart Appliances, Security, Access, Lighting, Connected Health	Home PC, Laptop, Network/Tablet PC, Smart Phone, TVs	Over-the-top (OTT) services, OSS/BSS, Value-added services
Participants	Home Controls, Automation, Security and Monitoring Providers	Telecom, Internet Service Providers, Cable Service Providers, Utilities, Home Owners/End Users	Utilities, Utilities with Third Party Solution providers, Home Energy Management System Providers, Security/Alarm Providers	IT Hardware, Software and Service Providers	Application service providers, billing and diagnostic service providers, installers

Source: Frost & Sullivan Analysis.

2.1.2 Mapping the Taxonomy to Industry Participants

Frost & Sullivan has attempted to position various connected home players in order to gain more clarity as to where these specific companies compete and how they fit into the larger picture. As a note, this taxonomy is derived based on core competencies of participants and is not exhaustive.

Additionally, only those segments are considered that are significant from the perspective of a connected home's interaction with the smart grid. Chart 2.5 depicts the connected home taxonomy as it encompasses the key industry participants.

Chart 2.5: Mapping the Connected Home Taxonomy to Industry Participants

Home Controls, Automation, Security, Appliances	Home Energy Management	Telecom Service	IT – Software, Hardware and Service	Utilities and Energy Services	Retailers and Others
Crestron Electronics, AMX Corporation, Control4, Niko Group/Fifthplay, DSC Security, GE Security, Home Automation, Inc., Honeywell, Tyco/ADT, Alarm.com, Vivint, Ingersoll Rand/Schlage, Samsung, LG, Philips	Schneider Electric, GE, Energent, Energate, Allure Energy, EnergyHub, Opower	Verizon, AT&T, Qualcomm, Comcast, Telus, Rogers, MTS/Allstream, Bell, Sprint	IBM, Intel, Google, Microsoft, CISCO, Amdocs, Sykes,	Pacific Gas & Electric Company (PG&E), Southern California Edison, Ontario Hydro, British Colombia Hydro, Consolidated Edison, Reliance, Duke	Best Buy, Lowes, Home Depot
Note: This is a representative list only and does not constitute the entire universe of participants					

Source: Frost & Sullivan Analysis.

An average homeowner today, either in full/partial combination or in a standalone manner, uses some form of connected/smart solutions such as, smart appliances, home management and control solutions, smart appliances, security systems, information dashboards, etc, which are further combined with entertainment and/or infotainment, voice and data services, monitoring and diagnostic services. These functions and applications are dependent on an internal as well as an external communication environment or network, to carry communications that could enable various lifestyle supporting functions. Given the complexity of interconnection between these various networks for service delivery, increasingly the connected home concept is driving the need for single network solutions, where both internal and external networks run on an Internet protocol (IP) base. The concept of integration (of functionalities, services, and platforms) is essentially abstracting services across these networks. Chart 2.6 shows the various network options used in a connected home.

Chart 2.6: Network Options Used in a Connected Home

	Connecting the In-Home World	Connecting to the Outside World
Communication Networks	Twisted Pair for Voice; Coaxial for Video; Wireless Wi-Fi for Data; Z-Wave; HomePlug; Powerline networking for data, video and voice	Landline for Voice; DSL provided Broadband - Twisted Pair Data; Coaxial or Fiber for Data and Video; Wireless Connection for Mobile Communications

Source: Frost & Sullivan Analysis.

It is not surprising to witness telecom and security solution providers taking the proactive 'first steps' toward enabling a connected home experience for the home owner. Building upon existing relationships with the home owner, these service providers are increasingly positioning themselves to cater to a myriad of connected home needs, ranging from security and alarm monitoring, to home energy management platforms, as well as remote access and on-demand mobility for home owners to operate their connected home systems from wherever they are.

2.2 Current State of the Industry in North America

Frost & Sullivan's research on this project indicates that the Connected Home Industry in North America is at its early evolution stages, and the market acceptance of the connected home concept is governed by mixed consumer reactions and supplier initiatives to make it a commercially viable option for all participants. Chart 2.7 shows the key characteristics of various connected home participants.

Chart 2.7: Key Characteristics of Connected Home Industry Participants

Participant	Key Characteristics	Issues to be Addressed
Consumers	• Increasingly becoming tech-savvy with growing need for connectivity • Slow to accept new technology due to lack of perceived value • Willingness to pay is low-to-moderate • Confused by multiple technologies/solutions • Lack of understanding of connected solutions interfaces, and their various functionalities • Confused by the multitude of service providers and their various responsibilities • Lack of clarity about who provides trouble shooting and support • Privacy concerns regarding data sharing with external parties	• Simplicity of systems and interfaces • Ability to select flexible pricing and bundled service options from service and solution providers • Reliability of communication networks • Availability of cost-effective technology options • Data and personal security vulnerabilities
Home Products and Technology Suppliers	• Already made inroads into the consumer space with a variety of products and solutions to address a consumer's immediate needs within a home • Can influence technology adoption by offering a variety of benefits - energy reduction, multi-functional systems, remote management ability, etc. • Works toward awareness creation, collaboration with adjunct industry partners for innovation • Enjoy consumer mindshare and trust to a certain extent • Taking initiatives to create additional revenue streams by offering additional products and solutions • Products still highly customized and needs professional installations	• Align technology with actual market needs • Create scalable solutions that can be adjusted with changing demand • Introduce cost efficiencies • Seek out potential partnerships with adjunct connected home industry partners to offer affordable solutions to consumers • Actively collaborate on an open-source basis with adjunct industry partners • Standardize technology solutions by adopting unified protocols and software platforms for their solutions
Telcos and Service Providers	• Piecemeal collaboration • Wide coverage; ubiquitous access • Growing participation with standards bodies is helping create a positive niche for them • Technology innovation ahead of actual market adoption needs	• Active participation with product vendors from conceptual stages • Achieving better alignment of technology with user needs • Delivering scalable solutions and interfaces that could work harmoniously • Catalyst in policy change and incentives for technology adoption
Utilities	• Initiatives to move from static to dynamic framework • Technology adoption incentives and rebates • Energy efficiency goals favoring intelligent technology adoption • Challenged with embracing culture changes • Financial constraints in implementing changes	• Overcome financial hurdles in creating dynamic operational framework • High degree of technology adoption and diversification • Collaborative role in policy implementation • Dynamic partnerships with technology vendors and IT partners

Source: Frost & Sullivan Analysis.

From a homeowner's standpoint the ability to operate their home and its various aspects by using their existing technology solutions is desirable. The issue of security and energy makes it

appealing to consider including connected home solutions into their expense budgets. However, the willingness to pay for all things connected is not forthcoming. Part of this is influenced by the fact that the consumer do not always know what this connectivity means, what real value-add are the systems capable of offering, and most importantly how does it impact his or her privacy and security.

From a solution supplier's standpoint, taking advantage of technology innovation and garnering the ability to expand their present revenue streams by selling additional products and services is an attractive proposition to be part of this evolving market. However, making connectedness happen is challenging both from software as well as hardware standpoint at present. While the physical layers of technology is becoming pervasive, the simultaneous developments in software and protocols that can make devices work seamlessly is yet to be achieved.

Apart from the consumer and the product supplier, there are a host of technology enablers, service providers, as well as utilities that play facilitators' roles in the connected home industry. However, their involvement and prospective revenue streams in the market are either undefined, or at best, piecemeal at the moment.

Chart 2.8 shows the key active areas of the connected home industry.

Chart 2.8: Active Areas of the Connected Home Industry

Source: Frost & Sullivan Analysis.

2.2.1 Key Trends in the Connected Home Industry

The key trends in the connected home industry range from those that affect adoption of products and technologies, to others that could potentially help to redefine the value chain and ecosystems within it. These encompass technology, service as well as applications trends that are part of this industry. The prominent ones, based on their present and future impact, are depicted below in Chart 2.9.

Chart 2.9: Key Trends and their Impact on the Connected Home Industry

Trend	Present Status	Mid Term (Next 5 Years)	Long Term
Smart metering	Large-scale deployments currently being undertaken	Expected growing market penetration with further Infrastructure build-out	Region-wide implementation
Residential demand response (DR)	Limited to utility pilot cases only	Business case demonstrations to prove its financial viability for utilities to consider mass deployment	Scattered penetration expected, primarily the concept of DR with enabling technology (smart meters, smart sensors, etc)
Converged connected home platform	Limited penetration, with only a handful of consumers in premium homes exploring the concept	More devices and systems are expected to be layered on the home network for consumers to access, control and operate their homes remotely	Gain mass adoption, with the entry of standardized communication platforms and open systems
Home monitoring and security	Moved beyond early adoption to gradual growth stage	Rapid penetration, with more attractive pricing options from telcos and other service providers	Gaining mass market presence
Utility Home Area Network	Only a few pilots by utilities or voluntarily explored by customers using available residential gateways	Expected to gain importance as integration of distributed energy sources become gradually prominent	Expected to play a crucial role in supporting distributed generation and the success of microgrids
Home energy management systems	Undergoing pilots that exhibit latent consumer interest	Gaining acceptance among consumers as easy-to-use and cost effective solutions	Wide penetration, Web-based, SaaS model used
Telecom and media services	Currently experienced as ad-hoc services from the telecom provider, with some instances of these being networked into the connected home platform	Consumer's need to maximize on interrelated products and services will lead to increased dependency on telcos and service providers	Telcos and service providers will emerge as key solution integrators, working with product vendors, utilities and service providers to make connected home a reality for consumers
Third Party Analytics	Presently used as a value add with a core product or service and not as an integral part of connected home solutions	Service providers in this category will work in conjunction with utilities and telcos to enable connected home experiences	Will emerge as a core part of the connected home ecosystem

Trend	Present Status	Mid Term (Next 5 Years)	Long Term
Communication Standards and Networks	Standard bodies and technology vendors will work towards unification and homogeneity in software standards and protocols	Adoption of open stands will be supported by product and solution manufacturers	Unification challenges and emergence of new smart devices working on varying protocols will lead to multiple standards and protocols coexisting in the connected home landscape

Source: Frost & Sullivan Analysis.

2.2.2 Market Drivers and Challenges

The key drivers and challenges impacting the connected home industry are discussed below. Charts 2.10 and 2.11 shows the key drivers and challenges for the connected home industry, in terms of their order of impact over time.

Chart 2.10: Key Drivers, Connected, Home Industry, North America

Rank	Driver	1-3 Years	4-6 Years	7-10 Years
1	Need to control, monitor and save on energy usage	High	High	High
2	Growing demand for home security	Med-High	Med-High	High
3	Personal wireless networks at home becoming increasing common	High	High	High
4	Increasing consumer awareness and need for on-demand access and control	Medium	Medium	High
5	A growing base of tech savvy consumers looking for plug-and-play and a managed home experience	Medium	Medium	High
6	Availability of multiple options from technology and service vendors within various price points	Med-High	Med-High	Med-High
7	Narrowing gap between traditional Carriers and OTT* service providers	Medium	Medium	High

**OTT – Over-the-top services*

Source: Frost & Sullivan Analysis.

For the average home owner, the need for energy savings and home security are paramount considerations when expressing their demand for a connected home solution, be it, home energy management platform, security and monitoring or a whole home control solution. The positive impact of these drivers will continue to drive the need for connected homes over the next decade.

Technology improvements and the availability of cost-effective and easy-to-use interfaces are expected to make connected home solutions more appealing to home owners. Additionally, carriers and telcos are expected to take on a more turnkey role in provisioning communication services layers with over-the top applications, which in turn will make more homeowners experiment and adopt connected home solutions. However, given the nascence of the industry,

the impact of most drivers, except for energy efficiency and security needs, is moderate at present.

Chart 2.11: Key Challenges, Connected, Home Industry, North America

Rank	Challenge	1-3 Years	4-6 Years	7-10 Years
1	Interoperability and communication standards	High	High	Medium
2	Enabling peer-to-peer connections between devices in the home	High	High	Medium-High
3	Overemphasis on monitoring and managing energy as opposed to 'connected experience'	High	High	Medium-High
4	Inadequate initiatives from utilities and a lack of incentives	High	High	Medium-High
5	Consumers' perception of high cost	High	High	High
6	Pace of consumer adoption of connected home solutions and applications	High	High	High
7	Security and privacy issues	Medium-High	Medium-High	Medium-High

Source: Frost & Sullivan Analysis.

The moderate impact of key drivers on the industry, and the slow rate of adoption of connected home solutions, can be explained by reviewing the high impact of some of the distinct challenges that the industry and its value chain currently face. In order of impact, the issue of interoperability and lack of standardized communication protocols is one of the most significant challenges the connected home industry faces. The vast array of systems and devices are developed on a multitude of software platforms, often working as proprietary components within a home. However, the industry has come to realize the adverse effect this has on technology adoption, and is currently engaged in harmonizing standards where possible, or developing more neutral standards with open frameworks so that systems and devices can interoperate and communicate seamlessly within the home and external network.

As a corollary to the above challenge, multiple communications standards hinder peer-to-peer connections between devices in a home. This adds to a consumer's lack of perceived value from these solutions, which are often higher priced than what an average home owner budgets for the same.

Among other challenges, a lack of initiatives from utilities home area networks, residential demand response and inadequate incentives to the home owner to adopt these concepts add to the delayed market adoption of connected home technologies and solutions. Consumer privacy issues are also not being addressed adequately at present, leaving consumers vulnerable to data theft and misuse, which in turn has resulted in a slow rate of adoption.

Although steps are being taken by relevant stakeholders such as utilities, technology vendors, application providers, etc, these challenges are expected to exert strong influence on the industry over the next decade.

In responding to these challenges, services providers need to take into consideration the perceptions home owners have of them, and the service expectations that conform to those perceptions. For most part, home owners will expect security and privacy issues to be addressed via their local utility initiatives. However, given that they deal with technology vendors independently, such as those offering home security, energy management, entertainment and communication etc, it is clear that home owners will continue to approach these respective service providers to address their technology adoption challenges. Initiatives such as consumer education, simplification of technology, and interoperability will have to be addressed by technology vendors and service providers to address these challenges.

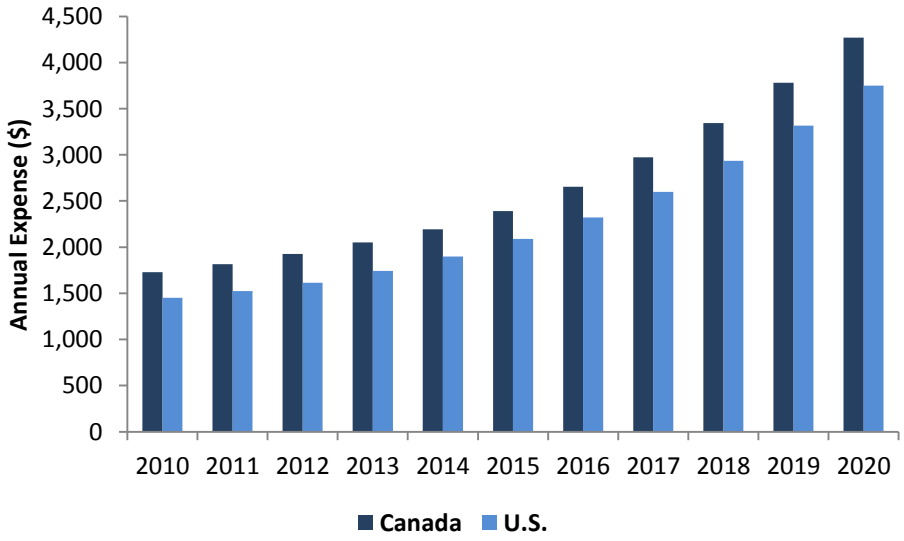
Having said that, there is definitely a very proactive role being assumed by service providers such as ADT, 2GIG, etc, particularly in the mid-end homes segment, where they are not only providing security and monitoring solutions, but also installing and maintaining HAN equipment for home owners. This penetration achieved by such companies has not only brought them to the forefront of the connected home service provider landscape, but has also given them significant mindshare with the consumer. To some degree consumers are gradually becoming receptive to the idea of sharing information with such service providers, which in turn makes it their responsibility to address security and privacy concerns of the consumer. Frost & Sullivan expects that ultimately collaboration among the utility provider and such service providers will be inevitable in addressing such issues of consumer security and privacy. However, in the short to medium term, it would be essential for service providers to assume responsibility of such issues on their part by working closely with their customers.

2.3 Adoption Influencers for the Connected Home Concept

Amongst the key adoption influencers of connected home solutions, homeowners' demand for communication-related services witnessed a significant increase during the last five years. This trend is expected to continue in both the United States and Canada, highlighting the fact that connected homes will proliferate into a mass market concept, beyond the premium home segment where it is more prevalent at present.

The growing spending per household on communication in the United States and Canada is indicative of the fact that the average home owner in North America is pursuing a connected lifestyle and that a significant influence of this dynamic is witnessed within the various functionalities within the home environment. Chart 2.2 shows the annual household expenditure on communication in the United States and Canada, projected until 2020. The compound annual growth rate (CAGR) from 2010 to 2020, for each country, is estimated at 10 percent. Chart 2.12 shows the projected growth in communication expenditure in the United States and Canada.

Chart 2.12: Projected Growth in Communication Expenditure per Household, United States and Canada, 2010-2020



Source: StatsCAN, U.S. Labor Bureau, and Frost & Sullivan Analysis.

In United States, an estimated 2.3 percent of annual income, or approximately $1,500 was spent on communication expenditures in 2010 and 2011, and in Canada this is estimated to be approximately 3 percent or $1,730. These estimates are expected to more than double in the next ten years, thus pointing towards a fast growing market for communication services for the home, and in turn, the potential for increasing the footprint of connected home solutions and services within the home.

In addition to communication, there is a growing need from consumers to connect existing home functions such as security, energy and home controls into one platform that they can operate and manage from any location via their smart devices. The tremendous penetration achieved by smart phones and hand-held devices that enable a consumer to perform multiple functions via downloadable applications, costing little or nothing, is a popular trend that will continue to grow in the future. Considering that security and energy savings from optimized home systems are a key driver for home owners to adopt connected home solutions, it is imperative that faster penetration and the growth of smart applications and devices will have a positive impact on better adoption of connected home concepts by consumers.

2.3.1 Consumer Perception Analysis

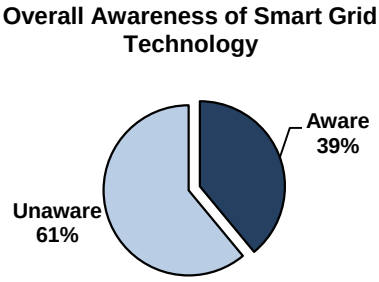
In order to analyze the consumers' understanding of the connected home, and the perceptions towards the smart grid, and adoption of connected home technologies, Frost & Sullivan reviewed in-house customer research, carried out by Frost & Sullivan over the last year.

Analyzing the results of customer perception research, undertaken among a random sample of over 1,500 households across North America, Frost & Sullivan was able to determine some key aspects of consumers' attitudes and outlook towards the connected home and its interaction with the smart grid. These are discussed below.

Awareness of the Smart Grid

Overall, only 39 percent of consumers had some level of understanding of the smart grid. However, only 34 percent of consumers, who have general smart grid awareness, attribute this awareness to their local utility company. Chart 2.13 shows the overall awareness level of the smart grid among respondents. Chart 2.14 shows the breakup of awareness level of consumers about the smart grid due to efforts of local utilities.

Chart 2.13: Awareness Level of Respondents



Source: Frost & Sullivan Analysis.

Chart 2.14: Awareness of Smart Grid Technology from Utility Company Efforts

Utility Company Efforts to Introduce Smart Grid in Community	
Yes	No
34%	66%

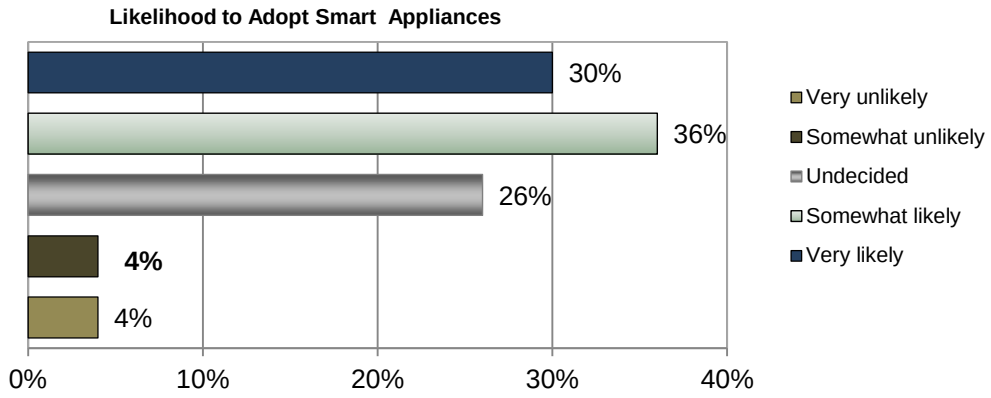
Source: Frost & Sullivan Analysis.

Consumers are relying on a variety of information sources, including internet, media, local home improvement stores, municipal efforts, etc to learn about the smart grid.

Acquiring Connected Home Appliances

Awareness of the benefits of smart appliances was found to be instrumental in helping consumers make the choice to purchase them. However, ultimate decision to purchase was mostly governed by replacement needs and incentives offered, either by the appliance manufacturers, or in some cases federal and state rebates. 66 percent of the respondents stated that they are likely to adopt smart appliances. Of these, 70 percent prefer to delay adoption until appliances need to be replaced. And among those likely to adopt smart appliances, nearly two-thirds expect a short return-on-investment for their smart appliances investment, despite this being an unrealistic expectation according to suppliers. Chart 2.15 shows the likelihood of consumers to adopt smart appliances.

Chart 2.15: Likelihood of Consumers to Adopt Smart Appliances

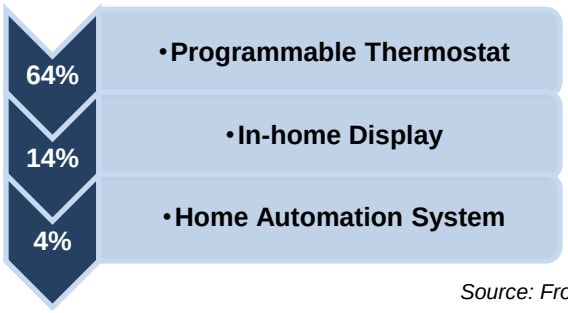


Source: Frost & Sullivan Analysis.

Current Use of Home Energy Management Options

Among home energy management solutions, the ones that consumers are most widely familiar with appear to be programmable thermostats, in-home displays, and home automation and control platforms, as seen from chart 2.16. The largest proportion of consumers report they currently have a programmable thermostat in their homes. The majority of respondents who are interested in leasing an in-home display report their preferred provider to be their utility company. Roughly 18 percent of the respondents did not have any energy management solution.

Chart 2.16: Type of Energy Management System Currently Owned



Source: Frost & Sullivan Analysis.

Furthermore, 59 percent of energy consumers, who are interested in leasing a programmable thermostat, would prefer to have their utility company as their provider. However, nearly 20 percent would consider leasing from a third-party provider as shown on Chart 2.17.

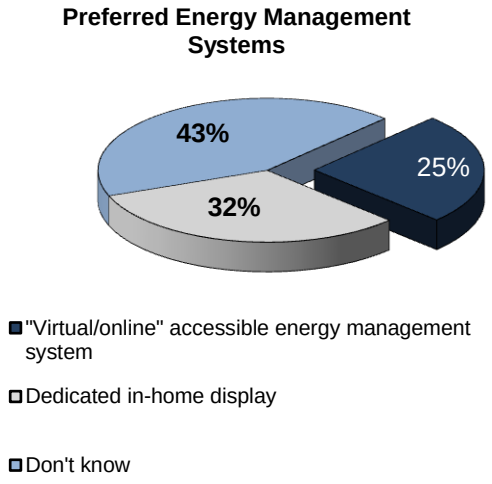
Chart 2.17: Preference for Energy Management Solution Provider

	Preferred Provider			
Potential Energy Management Solution	**Utility Company**	**Third-party Provider**	**No Preference**	**Do not Know**
In-home Display	67%	11%	11%	11%
Programmable Thermostat	59%	18%	12%	11%

Source: Frost & Sullivan Analysis.

Among consumers who responded in favor of preference for in-home displays, 25 percent (which represents a significant 37% of those who responded) were inclined to opt for a "virtual/online" accessible energy management portal due to the ease of accessibility from anywhere at any time, giving the consumer more flexibility, as depicted on Chart 2.18.

Chart 2.18: Consumer Preference - Virtual/Online Display Vs. Dedicated In-home Display



Source: Frost & Sullivan Analysis.

Reasons for Preferring a "Virtual/Online" Accessible Energy Management System

"Because I can check it from my cell phone or home computer and I can view it anytime I want."

"It is easier to use and I like to have it available online."

"I feel like everything is heading towards online management today and like other parts of life, it is easier to be able to manage things via the Internet."

"It is less expensive and easy to update by the utility company."

"I can access it from anywhere and not have to be home to use it."

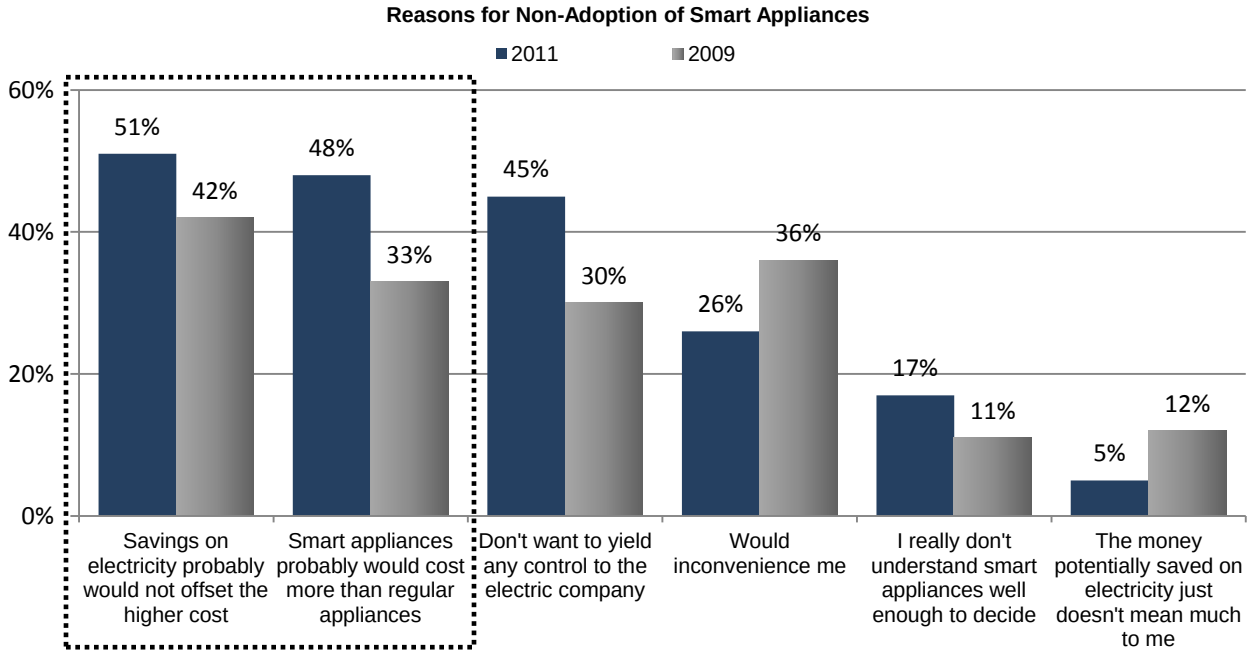
"I can view it from anywhere and possibly make adjustments when away from home."

"That way I would be able to manage my energy away from home and at the computer."

"Would most likely be easier to set up and manage. As well as less costly."

In evaluating the key factors deterring adoption, cost appears to be one of the most important reasons behind non-adoption or delayed adoption. Cost-related factors will continue to impose a potential risk to adoption, although the perception of inconvenience has waned since Frost & Sullivan's previous customer perception research in this area undertaken in 2009. Chart 2.19 shows the reasons for non-adoption of smart appliances compared between 2011 and 2009.

Chart 2.19: Reasons for Non-adoption of Smart Appliances, 2009 and 2011



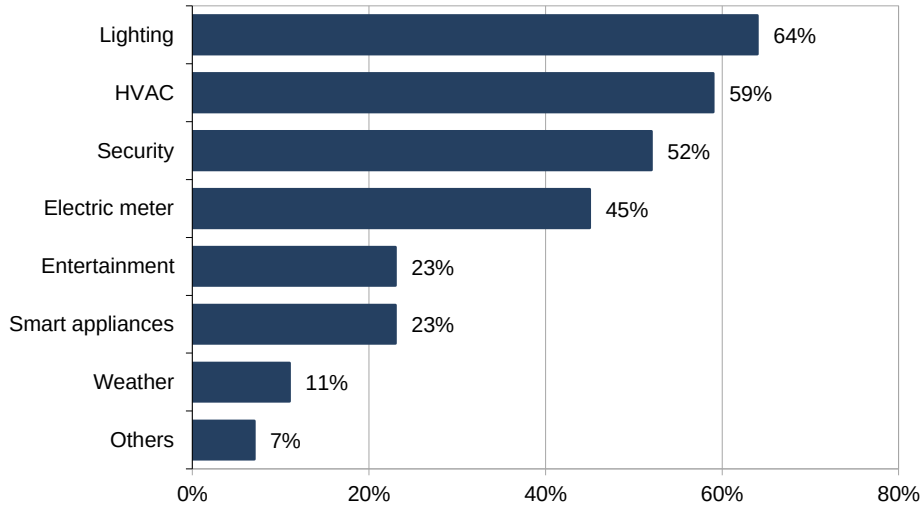
Source: Frost & Sullivan Analysis.

Consumers do not appear to have a good clarity on what kind of energy savings should they expect to derive from smart appliances, and are therefore, not able to justify the cost of acquiring them. Investment is either deferred, until there is a need to replace existing appliances in the home or, an attractive rebate or incentive is offered, either by the manufacturer, or through a state/provincial or federal energy retrofit program.

Home Automation System: Type of Functions and Estimated Energy Savings

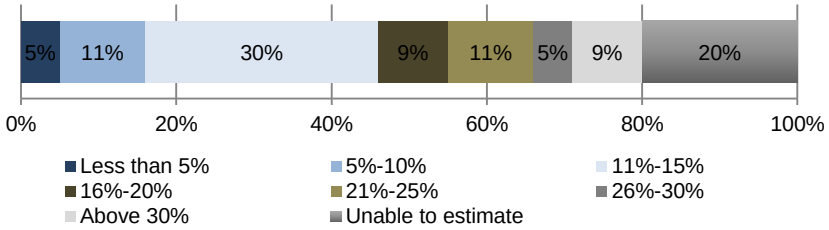
Of the small percentage of homeowners who use home automation and control systems, most report that lighting, HVAC, and security are the top-three functions controlled by these systems as seen from Chart 2.20. The main reasons for installing a home automation and control system are convenience and comfort, closely followed by security. On an average, consumers who were able to estimate their energy savings report to save between 11 and 15 percent, as depicted on Chart 2.21.

Chart 2.20: Functions Controlled by Home Automation and Control System



Source: Frost & Sullivan Analysis.

Chart 2.21: Estimated Energy Savings



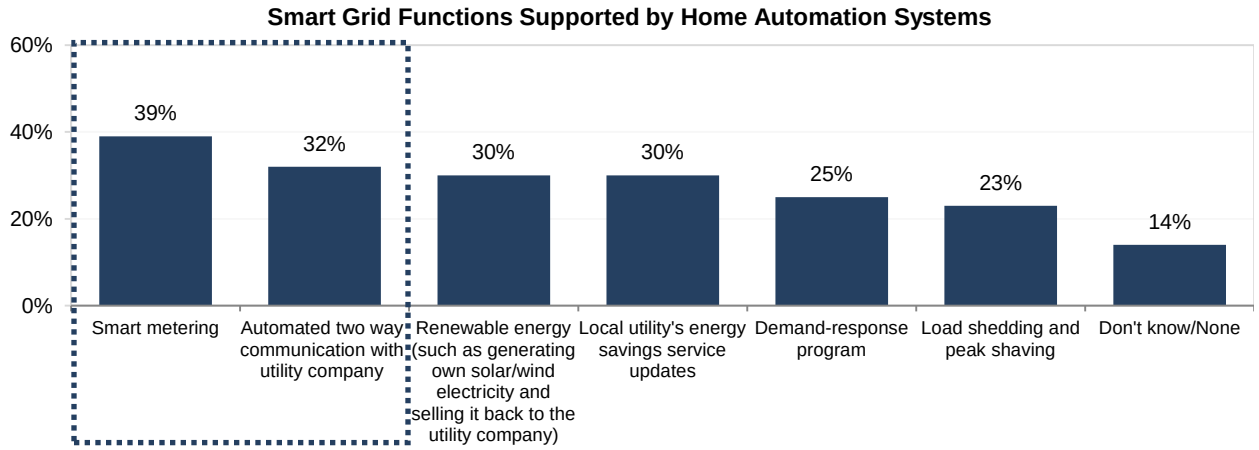
Source: Frost & Sullivan Analysis.

While the expectation of energy savings is top-of-mind for most consumers, the actual outcome of installing these solutions is not aligned with that expectation. This could either be due to the fact that the functions controlled by home automation are not optimized, or, that the equipments/products used do not necessarily lead to low energy use. For instance replacement with smart kitchen appliances and HVAC solutions have infact resulted in higher energy bills for consumers in certain cases.

Smart Grid Functions Supported by Home Automation Systems

The majority of homeowners report that their home automation system supports smart metering and automated two-way communications with the utility company as shown on Chart 2.22. Load shedding and peak shaving are the least supported smart grid functions for home automation systems.

Chart 2.22: Smart Grid Functions Supported by Home Automation



Source: Frost & Sullivan Analysis.

The majority of residential energy consumers report they would prefer to contract a demand response program through their current utility company. Therefore, local electricity companies are the ones who should promote demand response programs more heavily, as most potential smart appliance adopters would prefer to lease or purchase these energy management systems from their local electricity company.

It is therefore imperative that manufactures and technology vendors would need to collaborate with local utilities to alleviate general concerns about smart grid technology and smart appliances, and in awareness creation initiatives for these technologies.

Additionally, there are concerns about privacy with demand side management, and electric poisoning caused by smart meter radiation, which are highlighted in the next chapter.

Connectivity and Technology Use Profile

Technology use profile provides a relevant way of judging the consumers' interest in having a connected home experience. Some of the indicators used to judge this interest encompasses the presence of multiple personal computers in the home, broadband internet penetration and presence of home networks. Frost & Sullivan's research confirms that these indicators are thriving and will continue to grow in the future. The following trends were observed:

- Almost 91 percent of respondents have broadband access, which indicates a 3 percent growth over 2009 levels

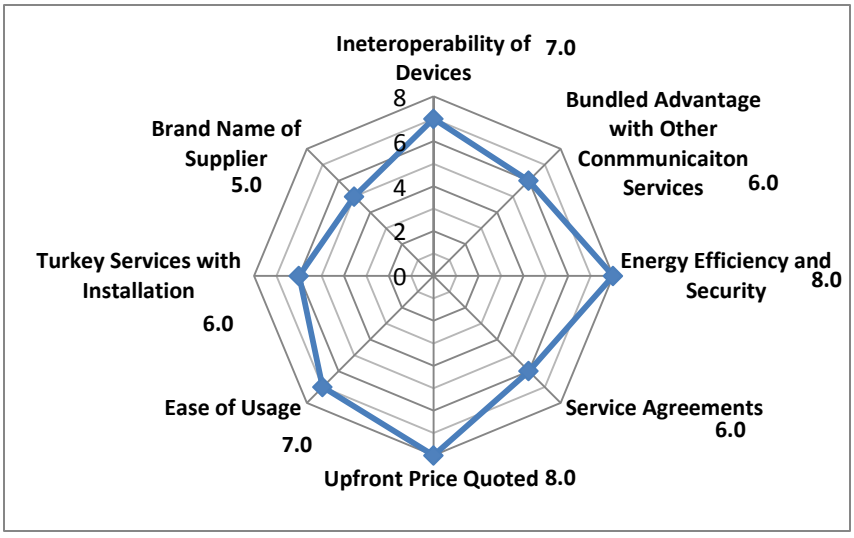
- Approximately 55 percent of the respondents had more than one personal computer in the home
- Approximately 42 percent had a home network deployed, driven by wireless presence such as Wi-Fi

Increasingly, consumers are creating their own connected set-ups within the home by connecting home computer networks with entertainment, home control systems, security systems, to name a few. Another trend is the growth in media entertainment technology, with consumers increasingly looking to use their personal computers and laptops for media and entertainment purposes.

2.4 Demand Analysis – Current Adoption Factors

Combining consumer insights as well as research among industry participants, Frost & Sullivan analyzed a variety of factors that contributed to consumers' demand for connected home related solutions and services, primarily in the area of home automation and home energy management. Among these factors, the following were identified as those that had a key impact on demand and consumers' decision-making criteria. Chart 2.23 shows the rating of these factors based on consumer perception research conducted to support this project.

Chart 2.23: Key Factors Influencing Consumer Demand



Source: Frost & Sullivan Analysis.

Consumers generally agreed that upfront price quoted appears to be a key criterion in deciding which provider to go with. Complexity of solutions and lack of clear demarcation of their capabilities and features made this criterion very important for decision-making.

The ability to deliver greater energy efficiency, either on its own, or combined with security monitoring, was cited as an equally important criterion. However, gradually the need for greater energy efficiency could gain more importance. There was a perception among most homwowners that use of a greater level of tehcnology and connetivity is not necessarily going to bring their energy footprint down. However, to keep operational costs low and run an efficient

home, it would be critical for most homeowners to have solutions that could help them incorporate energy efficiency and sustainability into the mix.

Other aspects that were considered important in customers' decision making included bundled advantages offered, supplier reputation, the ability to offer attractive service aggrements, and finally, easy-to-use interfaces.

2.5 Identification of Opportunity Hot Spots

Frost & Sullivan's research indicates that the Connected Home has all the prerequisites to become an emerging technology platform for mass deployment in the near future. Vendors and service providers have already started to integrate this into their business strategies, and have invested in various technologiess and service programs toward this end. The opportunities it represents for various indsutry participants, and the corresponding value propositions that these participants can adopt, are summarized below on Chart 2.24.

Chart 2.24: Opportuntiies and Value Propositions Emerging in the Connected Home

Participant	Opportuntiies	Value Proposition to Participants
Consumer	• Energy reduction and savings • Secure and managed home environment • Communication and inforamtion rich enviornment • Actionable data on home systems and devices for predictive management and optimization • Multiple value-based solutions to choose from a wide network of product and service providers • Buyer's market advantage – for devices, displays, appliances and service propositions • Competitive service agreements and pricing to choose from	• Variety of services with a rich set of functionalities • Efficient and comfort-driven lifestyle • Simple configurations, easy to install plug-n-play devices • Add-on services to the basic communicaiton packages • Upgradeability to enable new features • Ability to manage multiple services via one framework • Remote support for troubleshooting, leading to rise in customer satisfaction
Connected Home Technology, Product, and Service Provider	• Providing technologically upgraded solutions (controls, appliances) • Providing more managed services and devices • Revenue generation from partnerships • Up-selling basic communication and media packages, triggered by new services addition • Reducing support cost and total cost of ownership • Convergence of telcos and service providers in delivering multi-screen experience	• Innovation and R&D prospects to offer solutions meeting niche demand • Creating parallel revenue streams and additional partner ecosystems • Increasing subscriber/user base and upselling products and services • Expanding engagement terms with existing consumers • Exploring potential new revenue streams – data hosting/data center (telcos); customer service master centers (combining services for multiple partners)

Source: Frost & Sullivan Analysis.

For telcos/communication service providers, home controls and energy solution providers, connected home services are essentially "sticky" and could therefore, help to increase consumer loyalty while decreasing subscriber churn. The residential gateway deployed by the communication service provider will ultimately have new Internet-based services, remote access of devices, home health, monitoring and energy services, pass through it. Therefore, the

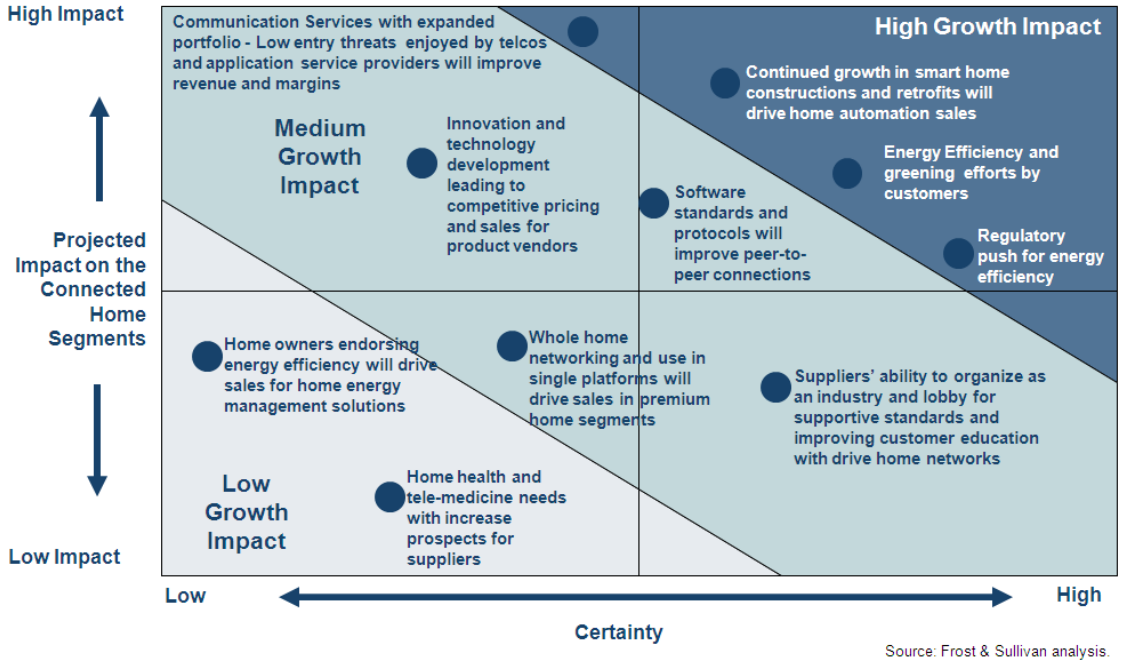
position of the residential gateway provides the service provider a point where services may be deployed, rather than being a termination point. This point could also be used for media servers, home management & support, and will allow the service provider to further take advantage of the new service opportunities.

As the connected home increases in complexity, service provider-supported remote management of the residential gateway and home network devices will enable the seamless integration of connected home services for customers. The service provider will support remote management through to a broadband network via management servers.

For consumers, however, connected home solutions such as home automation and controls, smart appliances, security, media and entertainment, etc, that have been used so far, have not offered a simple and user-friendly experience for most parts. Most installations have been fairly customized, thus creating the need to hire professional installers, which expalins the overall moderate volume of deployed products and services. However, as the concept matures and cost of devices and services go down, Frost & Sullivan expects connected home products and solutions to make more deliberate inroads into the mainstream market segment within the next decade.

Chart 2.25 provides a snapshot of the various opportunity hot spots identified by this research for the different stakeholders involved in the connected home value chain.

Chart 2.25: Opportunity Hot Sports for Connected Home Value Chain



Source: Frost & Sullivan analysis.

In the immediate term the opportunities lie in home owners endorsing energy efficiency mandates and trying to incorporate technology to monitor and manage home energy usage. This clearly indicates opportunities for home energy monitoring vendors who offer dashboards

and hosted portals for consumers to achieve this goal. The opportunities with the highest growth impact are expected to be concentrated in the communication services areas, where telcos currently enjoy a monopoly in terms of consumer access, and are therefore, well-positioned to cater to increased needs for products and services in related media and home monitoring segments.

Standardization of software platforms and protocols is expected to be driven by vendor and association-led initiatives. In this regard, the IEEE P1905.1 draft standard for a convergent digital home network for heterogeneous technologies, including a software abstraction layer that provides a common data and control service access point for wired and wireless networks, is worth pointing out in the area of near-term standard development initiatives. The standard is expected to be finalized in 2013.

However, any significant harmonization of standards could be further prolonged owing to the fact that an increasing number of new smart devices, platforms and applications could potentially enter the connected home space over the next decade. This will warrant the need for further review and neutralization of standards, which are yet to be foreseen by the industry.

Some of the long term opportunities in the connected home space center around regulatory initiatives in energy efficiency and incentives that may lead to prescriptive technology adoption mandates, thus creating opportunities for all vendors and service providers of the value chain.

3. Smart Grid and the Connected Home

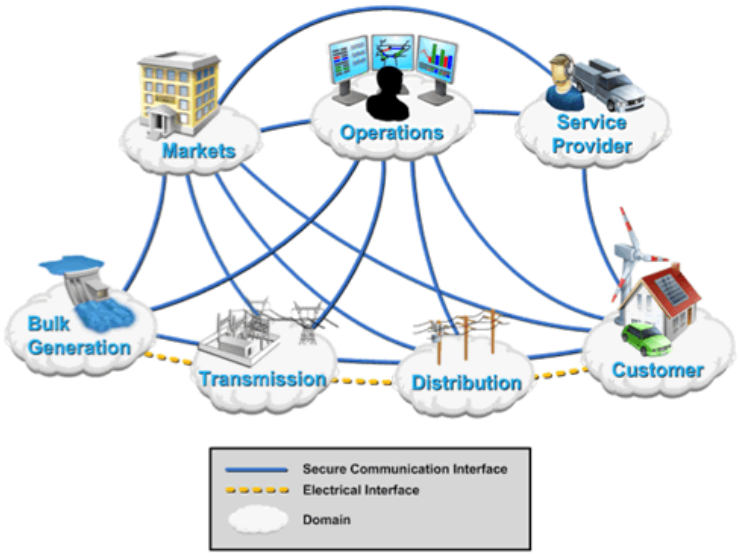
3.1 Overview of Smart Grid's Impact on the Connected Home

While the previous section provides an overview of the connected home, the purpose of this section is to determine the relevance of smart grid for evolving and commercializing the connected home. Can a truly "connected home" be sustained with or without smart grid? What does smart grid really do and what can it do?

Frost & Sullivan views smart grid as a strategy rather than a specific technology that utilities are applying to modernize its existing grid electric infrastructure across power generation, power transmission, and distribution. Many of these strategies have been brought to the front because of long delayed issues of an aging grid as well as in preparedness for future changes that are going to have a direct impact on the health of the electric grid. These include the pressure to accommodate renewable power, prospects of charging electric vehicles, as well as increased demand for electricity. These objectives are common for most utilities, however, the approach to achieve these goals varies significantly and are dictated by the type of technologies that the utility already has installed, the state's energy law, and the approved budgets. This might explain the confusion that sometimes exists on how to define smart grid and what to cover under smart grid. Despite this scenario there are technologies that are actively being discussed and deployed in terms of smart grid. The Smart Grid Conceptual Model, which was developed by the National Institute of Standards and Technology (NIST) categorizes smart grid into seven different domains and several sub-categories under the macro-level domains.

Chart 3.1 shows the conceptual model of the smart grid.

Chart 3.1: Smart Grid Conceptual Model –Top Level Analysis



Source: Report to NIST on Smart Grid Interoperability Standards Roadmap[1]

Frost & Sullivan has simplified this model by categorizing smart grid into four main segments including, advanced meter infrastructure (AMI), demand response, distribution grid management, and high voltage technologies. Though for the purpose of understanding the smart grid's connection to the connected home, this project will only highlight two segments of the smart grid namely, AMI and demand response.

There is a distinct pattern on what is being deployed at the moment and what is going to be deployed in the future. Most of the upgrades started with the modernization of distribution systems, which covers AMI and smart meters as well as substation and distribution automation. Frost & Sullivan' research shows that in terms of sheer sales AMI represented 29.4 percent and distribution grid management represented 45.2 percent overall smart grid revenues in North America during 2010. To understand what has shaped and influenced smart grid, it is important to understand the regulatory backing of smart grid.

Regulatory Backing of Smart Grid and Priority on Distribution Upgrades

Understanding market ties to federal and state level policies are essential as operations of utilities are dictated by state-level energy policies. The first serious U.S. debate on "smart grid" can be traced back to the passing of the Energy Policy Act of 2005[2] (EPAct).

The Mandate of Time-Based Rates Drives Technologies for Smart Meter Reading

The EPAct is a federal bill that was signed into law by President George W. Bush with the intent of addressing the growing usage of energy. Under the EPAct Section 1252 Smart Metering (a)

[1] http://www.sgiclearinghouse.org/ConceptualModel
[2] http://doi.net/iepa/EnergyPolicyActof2005.pdf

(14) each electric utility is required, per customer request, to provide a time-based rate schedule in which the rate charged for electricity varies during different time periods. Approved types of time-based rate schedule include time of use pricing, critical peak pricing, real-time pricing, and credits for consumers. These time-based rate schedules would in return allow customers to better manage their energy usage and cost.

The subparagraph C of this section states that each utility providing time-based rate shall provide a "time-based meter capable of enabling the utility and customer to offer and receive such rate, respectively", which in other words means either a smart meter or advanced meter reader (AMR). Unlike analog revenue meters, smart meters feature digital technology, which can enable two-way data exchange between a household and utility electric operations.

At the time EPAct was passed, the states were only required to conduct an investigation and make decision on whether or not utilities really require smart meters or AMR to provide time-based rates. In fact, at that time, 22 states decided not to adopt EPAct[3]. It was not until December 2007 when The Energy Independence and Security Act of 2007(EISA)[4] was signed into law that Smart Grid became a Federal policy for the United States.

Federal Policy to Improve Energy Efficiency and Accommodate Renewable Power Promotes Smart Grid Technologies

The primary aim of EISA is to increase energy efficiency and availability of renewable power. However, Section 1301 is specifically geared towards modernizing the electric grid. Section 1301 describes Smart Grid to have the following characteristics listed in chart 3.2.

Chart 3.2: EISA Section 1301 Description of Smart Grid

1. Increased use of digital information and controls technology to improve reliability, security, and efficiency of the electric grid.
2. Dynamic optimization of grid operations and resources, with full cyber security.
3. Deployment and integration of distributed resources and generation, including renewable resources.
4. Development and incorporation of demand response, demand-side resources, and energy efficiency resources.
5. Deployment of "smart" technologies (real-time, automated, interactive technologies that optimize the physical operation of appliances and consumer devices) for metering, communications concerning grid operations and status, and distribution automation.
6. Integration of "smart" appliances and consumer devices.
7. Deployment and integration of advanced electricity storage and peak-shaving technologies, including plug-in electric and hybrid electric vehicles, and thermal-storage air conditioning.
8. Provision to consumers of timely information and control options.
9. Development of standards for communication and interoperability of appliances and equipment connected to the electric grid, including the infrastructure serving the grid.
10. Identification and lowering of unreasonable or unnecessary barriers to adoption of smart grid technologies, practices, and services.

Source: EISA TITLE XIII –Smart Grid Section 1301

As seen in this table smart grid is not restricted to cover smart metering infrastructure but also contains steps toward improving overall reliability and efficiency of the electric grid but at the same time is also very customer centric. Other important sections of this policy require the DOE

[3] http://www.kema.com/services/ges/smart-grid/ai/regulatory-ami.aspx
[4] http://www.ferc.gov/industries/electric/indus-act/smart-grid/eisa.pdf

to establish a Smart Grid Advisory Committee and a Smart Grid Task Force to assist with implementation as well as for the National Institute of Standards and Technology (NIST) to establish protocols and standards with the purpose of increasing adaptability of Smart Grid technologies.

The American Investment and Recovery Act

The biggest push for smart grid finally came with the approval of The American Investment and Recovery Act of 2009 (ARRA), which contained two smart grid programs. The Smart Grid Investment Program (SGIG) (1306)[5], which granted awards to 100 different smart grid projects worth $3.4 billion[6] . The vast majority of grants went towards the development of advanced meter infrastructure and smart meters. The second program is referred to as Smart Grid Demonstration Projects (1304), for which the Department of Energy (DOE) selected 32 projects to receive a total of $620 million[7]. The purpose of these demonstration projects is to verify smart grid technology viability, quantify smart grid costs and benefits, and to validate new smart grid business models that can be readily adopted and accepted across the U.S.[8] Both programs are administrated by the U.S. Department of Energy's Office of Electricity Delivery and Energy Reliability (OE).

Green Button Initiative

The latest federal push came in early 2012, when the U.S. government announced the Green Button Initiative. The program is designed to encourage increased customer participation in monitoring energy usage and related data online. Currently nine utilities are committing to use a common technical standard in collaboration with NIST. Utilities include: AEP, Austin Energy, Baltimore Gas & Electric, CenterPoint Energy, NSTAR, PECO, Reliant, and Virginia Dominion Power.

In addition to the Green Button Initiative, PG&E, Southern California Edison, Oncor, Pepco Holdings Inc., Glendale Water and Power, and San Diego Gas & Electric have made similar announcements.

State Level Initiatives

State level initiatives have been even more impactful in promoting smart grid technologies. State level energy policies are typically communicated through the state's public utility commissions (PUC). PUC are also responsible for overseeing and approving rates for water, gas, and electric. The collective interests of PUCs are overseen by the National Association Regulatory Utility Commissions (NARUC). NARUC is also responsible for regulating utility services. Two of the most notable state level and relevant standards include renewable portfolio standards (RPS) and energy efficiency resource standards (EERS).

[5] United States Smart Grid Market, N5FB-14, July 2009:https://www.frost.com/n5fb
[6] http://energy.gov/sites/prod/files/SGIG%20Awards%20by%20Category%202011%2011%2015.pdf
[7] http://greensource.construction.com/news/2009/091210ARRA.asp
[8] United States Smart Grid Market, N5FB-14, July 2009:https://www.frost.com/n5fb

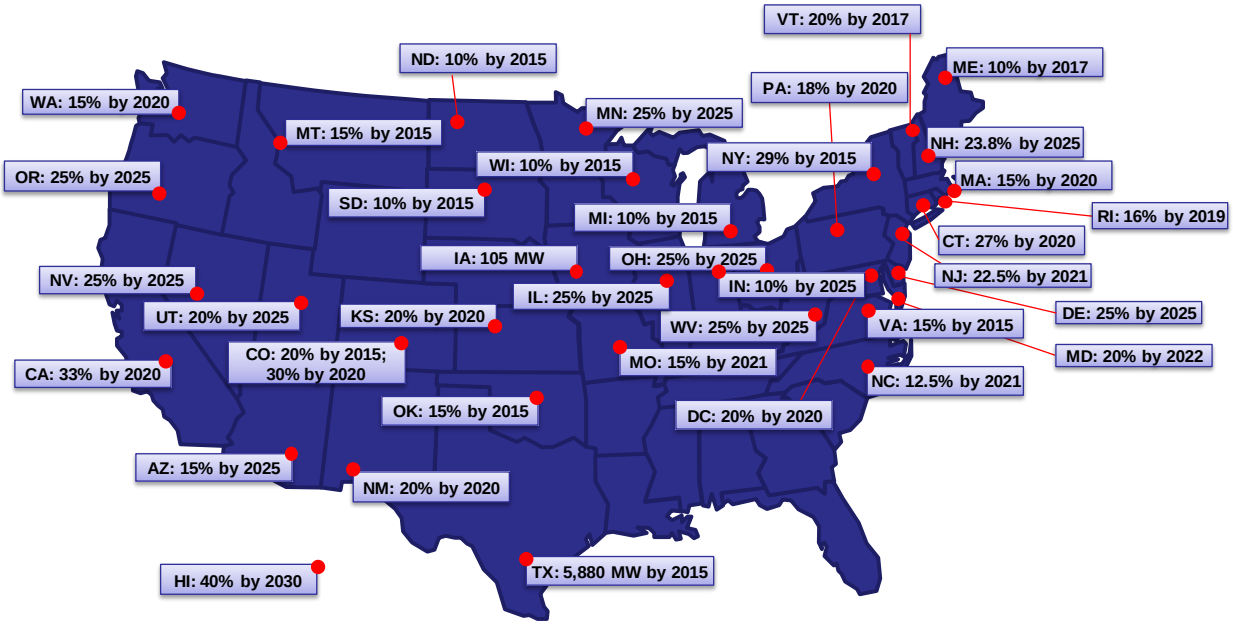
Renewable Portfolio Standards

RPS require electric utilities to have a certain amount of their electricity come from a renewable source, including wind, solar, biomass, and geothermal. Overall, 30 states have a renewable mandate, while an additional six have renewable goals without a financial penalty. Goals vary by state and deadlines range from 2015 up to 2025 for some states.

RPS are expected to trigger investments for smart grid technologies such as monitoring devices, advanced meter infrastructure, distribution management systems, and energy storage technologies in order to prevent potential disruptions caused by intermittent power.

Chart 3.3: Renewable Portfolio Standards Deployed by States.

Renewable Energy Market: Renewable Portfolio Standards, United States, 2010

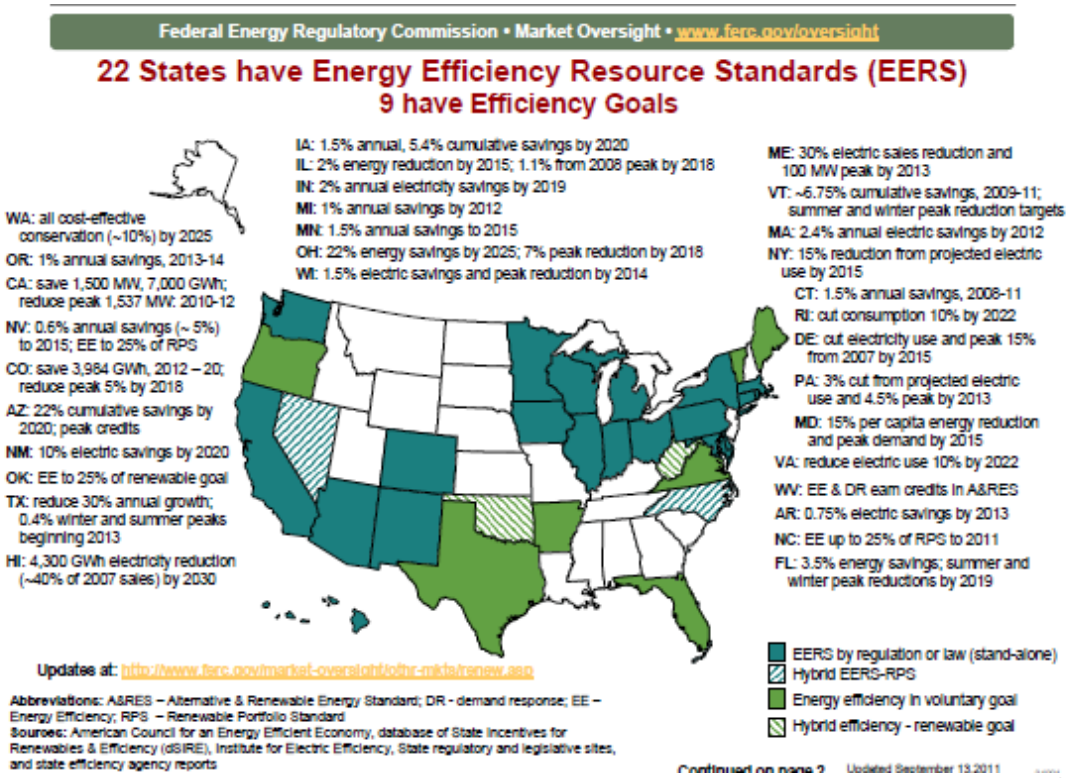


Source: EIA and Frost & Sullivan Analysis.

Energy Efficiency Resource Standards

According the Federal Energy Regulatory Commission, 22 states have adopted EERS standards and nine states have pending energy efficiency goals[9]. Out of the 22 states, 17 states have EERS implemented by state law and regulation. California is looking to save 1500 MW and 7000 GWh as well as reduce 1500 MW in peak power by 2012. These EERS standards require electric utilities to save energy through energy efficiency. EERS sets goals for reducing or flattening electric load growth through energy efficiency measures. In some instances states have expanded its renewable portfolio standard to include energy efficiency. Leading states in terms of goals on reducing energy consumption include Vermont and Massachusetts.

[9] http://www.ferc.gov/market-oversight/othr-mkts/renew/2011/09-2011-othr-rnw-archive.pdf



Source: FERC

These initiatives are pressuring electric utilities to expedite its programs and projects including demand response, which is considered an effective approach to reduce peak power load.

Consequently, the industry has witnessed a rapid deployment of smart meters across the country. According to a report developed by the Edison Foundation (IEE), as of May 2012 one in three homes is now equipped with smart meters[10] . The report also projects that by 2015, 50 percent of U.S. households will have a smart meter. However, FERC reports a lower penetration rate than IEE, stating that a number of smart meters have been deployed but these have not been activated for advanced metering purposes yet.[11]

Across the border, Canada also has a number of government and province-funded initiatives in place to promote smart grid initiatives. In 2009, under the Clean Energy Fund (CEF) the Canadian Budget for Research, Development and Demonstration (RD&D) provided $795 million in funding of clean energy advancements[12]. A number of smart grid demonstration projects are taking place, which are being supported by CEF and the ecoEnergy Innovation Initiative. The country has also established a Smart Grid Task Force and expects to release a Smart Grid Roadmap by the end of 2012[13].

[10] http://www.edisonfoundation.net/iee/Documents/IEE_SmartMeterRollouts_0512.pdf
[11] Assessment of Demand Response and Advanced Metering Staff Report, November 2011
[12] http://www.nacleanenergy.com/articles/14009/canada-s-smart-grid-landscape-picks-up-as-the-us-loses-dominance
[13] http://www.renewgridmag.com/e107_plugins/content.php?content.8610

At the province level, the province of Ontario passed the Green Energy and Economy Act of 2009, to promote renewable energy. Prior to 2009, the province had successfully installed 4.5 million smart meters and now has customers on time of usage rates (TOU), which charges higher rates during peak demand hours and lower rates during off-peak time. Similarly, British Columbia has goals of its own to modernize its metering system. BC Hydro has allocated $660 million to deploy smart meters for approximately 1.8 million residential, commercial, and industrial customers. The utility hopes to complete deployment by 2013. This amount also covers the cost for meter data management system, communication network, system integration, in-home display, and feedback tools. In addition to smart meters, BC Hydro is also rolling out a smart grid program, which is to be completed by 2014.

There is also a joint effort between Canada and U.S. to promote low carbon economy and green energy[14] through the U.S.-Canada Clean Energy Dialogue (CED) Action Plan II. CED was formed in 2009.

As a result, investment for smart grid related technologies such as those supporting an advanced meter infrastructure, demand response, and a modern distribution grid management have been exhibiting consistent growth during the course of the past three and four years. Frost & Sullivan research shows that the North American AMI market is projected to reach $4.23 billion in annual revenues by 2016, indicating a compound annual growth rate of 10.7 percent between 2011 and 2016. Similarly, Frost & Sullivan estimates annual sales for the overall smart grid market to reach $15.79 billion by 2017.

With continued high penetration rate of smart grid technologies, determining the possibilities and benefits of a truly connected home has never more been more relevant, especially since it was determined in the previous section that there is a strong interest among residential homeowners to use a universal communication system for connecting multiple applications.

[14] http://www.renewgridmag.com/e107_plugins/content/content.php?content.8610

3.2 Taxonomy of the Smart Grid

To define the taxonomy of the smart grid, it is important to begin by defining the various smart grid segments and applications that form a core part of this classification. These applications and segments are summarized in chart 3.4 and explained in the detail in the following segment.

Chart 3.4: Taxonomy of Smart Grid

	Smart Meters	Communication Networks	Meter Data Management	Demand Response	Third Party Service Platforms
Domains	Time of usage pricing and programming Outage detection Remote connect and/or disconnect	Home area network Local area networks Wide area networks	Import, validation, estimation and edition Outage management Creation of information of billing, outage management, customer services	Dynamic pricing with enabling technology Dynamic pricing without enabling technology Direct load control	Over-the-top (OTT) services, OSS/BSS, Value-added services
Participants	Meter manufacturers	Meter manufacturers, telecom, Internet Service providers, cable service providers, utilities	Meter manufacturers, IT software and hardware service providers	Electric utilities, curtailment service providers, energy management providers	Application service providers, billing and diagnostic service providers, installers

Source: EIA and Frost & Sullivan Analysis.

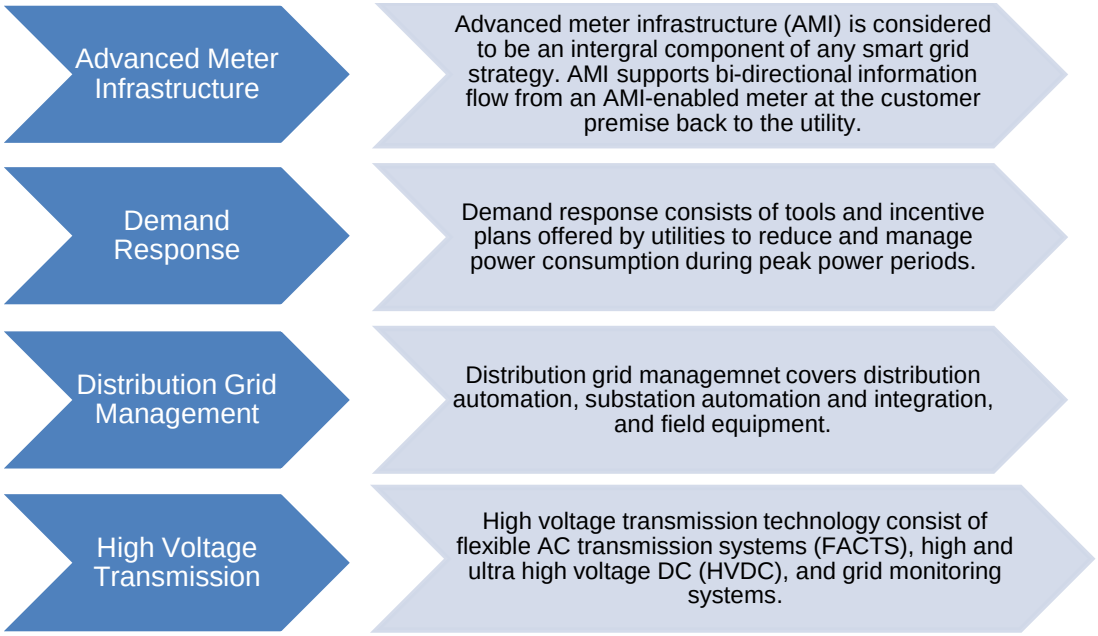
3.2.1 Definition and Highlights of Smart Grid Systems – Segments and Applications

Frost & Sullivan defines smart grid as a strategy that aims at automating, improving efficiency, and increasing the availability of the electric grid, ranging from generation, to transmission systems, to distribution levels[15].

Frost & Sullivan has identified four key categories for smart grid technology including advanced meter infrastructure (AMI), demand response, distribution grid management, and high voltage transmission systems. Not all segments may have a direct impact on the connected home nevertheless the segments are defined as described in chart 3.5.

[15] Global Smart Grid Market, N856-14, August 2011.

Chart 3.5: Key Smart Grid Components



Source: Frost & Sullivan Analysis.

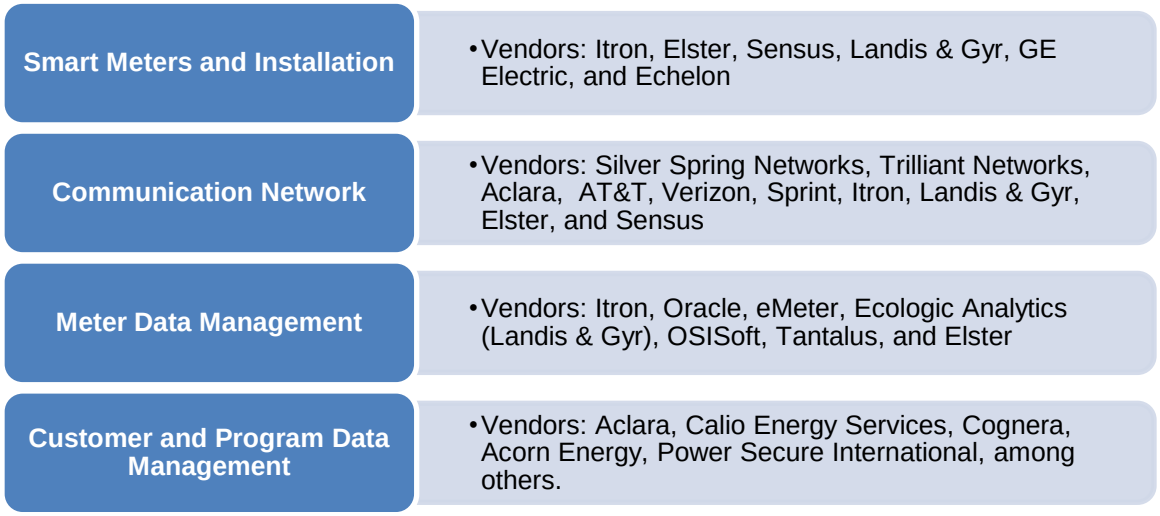
Of these four segments, AMI and demand response are going to have a direct influence on shaping possibilities for the connected home.

Advanced Meter Infrastructure

AMI supports bi-directional information flow from the smart meter at the customer site back to the utility business system. Through AMI, utilities will be able to record electricity usage on a time differentiated basis. AMI enables information exchange between the electricity supplier and the customer. A key component of AMI system is the smart meter. Unlike conventional meters, smart meters are connected to a time switch that can enable TOU pricing and programming. Other important features include remote outage detection and remote connect and disconnect.

AMI consist of four key components as described in the following chart.

Chart 3.6: AMI Components



Source: Frost & Sullivan Analysis.

Smart Meters

Smart meters are the core of an AMI system and consist of meters for electric, gas, and water. Smart meters as defined by the Federal Energy Regulatory Commission (FERC) are "meters that measure and record usage data at hourly intervals or more frequently, and provide usage data to both consumers and energy companies at least once daily. Data are used for billing and other purposes."

Traditionally meters have been primarily used for billing purposes by measuring a household's electric consumption. However, with the advent of AMI, there are also discussions on using smart meters as the primary communication gateway for smart grid equipped electronic home appliances, also referred to as smart appliances. The idea is that these smart appliances are expected to be connected to smart grid allowing it to either shut-off or to go into energy saving mode during peak power period. In addition, customers will be able to go online and look up their hourly energy usage. Specific smart meter features are described in chart 3.7

Chart 3.7: Key Features of Smart Meter

Features	Description
Time of Usage (TOU) Pricing and Programming	This feature allows the utility to differentiate energy prices for different consumption times. Thus, utilities can charge premium price during peak load periods and lower prices during off-peak load periods. TOU type meters are usually connected to a time switch and have multiple registers switching between tariffs. The switching usually occurs via a radio activated switch rather than a time switch to reduce risk of tampering of the meter.
Outage Detection	This involves sensors that are likely to direct a repair crew to the site of a drowned power line. Another example is that a utility can remotely test a customer's connection to determine whether a power outage at a residence is the result of grid problem or wiring in the customer's house.
Remote Connect or Disconnect	This feature is meant to be used to avoid extended outages and overloading of transformers at a critical peak by allowing grid operators to disconnect customers where lines are stressed.

Source: Frost & Sullivan Analysis.

Communication Network

This consists of communication systems that work with metering devices, including meter modules, home area network (HAN), local area network (LAN), and wide area networks (WAN).

Home area networks

HAN allows the interaction between smart appliances and devices to enable home automation. Utilities allow consumers to monitor and control their energy usage as they receive real-time data informing them about their consumption. Key communication protocols relevant for HAN include:

- ZigBee Smart Energy Protocol (SEP) 1.0, 1.1, and 2.0: A low-cost, low-power, high-communication alternative that uses radio frequency (RF) signal for data transmission through a wireless mesh network. Some advantages of this technology include long battery life and low data range requirements. The vast majority of smart meters deployed today are interoperable with ZigBee SEP 1.0. A modified version of ZigBee SEP is SEP 1.1. This protocol is designed to address issues such as dynamic pricing enhancements, prepayment features, and over the air updates[16]. A SEP 2.0 is currently being developed in collaboration with HomePlug Alliance and Wi-Fi Alliance. The goal is to develop IP-based control for AMI. Per ZigBee Alliance website, this new standard feature control of plug-in electric vehicle charging (PEV), prepay service, demand response and common information application profile interfaces for wired and wireless HANs, load control, user information and messaging[17].

[16] http://ZigBee.org/Standards/ZigBeeSmartEnergy/Overview.aspx
[17] http://ZigBee.org/Standards/ZigBeeSmartEnergy/Version20Documents.aspx

- HomePlug Green PHY: is a form of powerline networking technology. This protocol enables electrical wires within the home to distribute broadband Internet as well as able to connect to any devices that is plugged to a power outlet. According to HomePlug Alliance, there are currently 65 million HomePlug certified products that are in use today.
- Z-Wave: A low power radio wireless communication protocol that has been specifically designed for home automation devices. It is considered an ideal protocol for low-latency communication of small data packets. Z-wave devices can be added to an existing home network. As of 2012 there are 700 products that are interoperable with Z-Wave.
- Wi-Fi: is an Internet based protocol, which enables data exchange and internet connection over computer network.

Local area networks

In charge of collecting and transferring data from smart meters to the utility after going through a concentrator or directly to the backhaul system or aggregator. Various choices for local collection include:

Power line carrier (PLC) based: This uses power lines already installed. It is the simplest and most economical option, although data is transferred at lower rates. Typically, PLC will have the fewest number of end points per collector. However, it is considered an ideal solution for rural areas.

RF Star or Mesh—Data is transferred at higher speed than PLC but depends on vendors' established frequency ranges. RF Mesh can have between 500 and 10,000 endpoints per collector and is considered an ideal solution for urban areas. RF technology may be licensed or unlicensed.

- Licensed frequency is private. Data transmission takes place in an unshared environment. Communications are generally of higher power compared to public frequency. The relevant benefits of licensed communications are the guarantee granted by the Federal Communications Commission (FCC) of interference-free communications and greater security.
- Unlicensed or public frequency is shared, and results in increased weakness in data transmission due to interferences, resulting in data loss. Devices in unlicensed frequency networks must meet high-density requirements.

Wide area networks

WAN allows the transfer of data in a longer range. Receives the aggregated data collected by the LAN and transfers it to the data management system which processes the information.

The different technologies available in a WAN include:

- Ethernet and digital subscriber lines (DSL)
- Private RF, including microwave and 900 megahertz (MHz)
- General packer radio service (GPRS)

- Public WAN systems
- Cellular, Wi-Fi, and WiMAX
- Some cellular network companies, including AT&T and Verizon
- Public systems, which are a more economical alternative

Meter Data Management

Meter data management systems (MDM) have the task of storing and analyzing data that is collected from meters.

Meters accumulate vast quantities of interval data that needs to be translated and managed. MDM have been extremely important in AMI deployment projects and in making business cases as they enhance the relationship between the utility and end users.

Some of the various capabilities allowed by MDM include:

- Import, validation, estimation, and edition (VEE) clean-up and processing of usage data
- Creation of information for billing, outage management, customer services, and other utility operations
- Aggregation of data in case of network failure or loss, as well as theft or tampering detection, and outage detection
- Remote connect and disconnect

Demand Response

Demand response consist of tools and incentive plans for reducing and managing power consumption during peak power periods. Demand response programs provide monetary incentives to reduce power. According to NIST's Framework and Roadmap for Smart Grid Interoperability Standards, demand response "is a temporary change in electricity consumption by demand resources in response to market or reliability conditions."

While demand response is a relatively new concept for residential customers, it is an established service for commercial and industrial customers. Monetary incentives and cost-savings options to curtail power during peak power periods have been available for commercial and industrial (C&I) customers for almost a decade. These are programs in which customer are alerted about a possible power emergency and are requested to curtail power based on a predetermined shutdown plan. Notification and consultation is managed by a third-party solution provider referred to as curtailment solution provider (CSP). In return, the grid operator gives a monetary award to the CSP, which is shared with the customer. The rollout of AMI to residential customers should further enhance adoption of demand response programs.

<u>Demand Response Solutions</u>

The U.S. Federal Energy Regulatory Commission (FERC) is required by EPAct to report the annual progress of advanced meters as well as the adoption of demand response. In its latest

report from 2011 FERC reported that based on the number of deployed advanced meters in 2011, the demand response potential has grown 16 percent since it was last reported in 2009.[18]

FERC list five different demand response programs including:

Dynamic pricing without enabling technology: This typically involves dynamic rates, including critical peak pricing, peak-time rebates, and real-time pricing. This is likely to exclude TOU rates in which prices vary by rate period. Instead, dynamic prices are expected to be set on a day ahead or real-time basis and are likely to vary by peak and nonpeak periods. Customers are expected to respond to higher peak prices by manually curtailing various end uses.

Dynamic pricing with enabling technology: This program is similar to dynamic pricing. The difference is that customers are equipped with devices that can be programmed to reduce consumption during the hours when electricity is at its highest price. This includes automated technologies, such as a programmable communicating thermostat (aka smart thermostat), that can adjust air-conditioning energy use.

Direct load control: In this program, customer power use is directly controlled by the utility and is shut down or moved to a lower consumption level during specific events. This could be an air conditioner that is controlled by a smart thermostat or a conventional switch.

Interruptible tariffs: In this program, the customer agrees to reduce consumption to a pre-specified level during periods of reliability issues. In return, the customer receives an incentive payment. This program is only available to medium and large C&I customers.

Other demand response programs: These programs consist of capacity bidding, demand bidding, and other aggregate offerings. These programs are only offered to medium and large C&I customers.

Programs are likely to vary depending on customer type. Customer types consist of residential, commercial, and industrial. The market for residential customers is in the early commercialization stage, whereas demand response is prevailing in the C&I sector.

In the United States, use of an interruptible tariff is considered the most common form of demand response program. Such a program is typically managed and offered by a mix of entities, including:

- Independent system operator (ISO)/regional transmission operator (RTO): PJM Interconnection of Pennsylvania; New York Independent System Operator of New York; New England Power Pool, which serves the New England area; and the Electric Reliability Council of Texas
- Electric utilities
- Curtailment service providers based on a shared savings model
- Energy management providers (technology providers)

[18] Assessment of Demand Response and Advanced Metering Staff Report, Federal Energy Regulatory Commission, November 2011.

The market is fragmented based on the type of demand response program and rollout stage.

3.3 Current State of Smart Grid Deployment –United States and Canada

The market is witnessing a healthy deployment rate for smart grid technologies particularly for smart meters.

Chart 3.8: The number of utilities within the U.S.

Utility Type	Number of Utilities in the U.S.
Investor owned utilities (IOU)	There are approximately 159 IOUs, which includes 60 holding companies and 29 transmission companies
Co-operatives (Co-ops)	There are 893 co-ops, which includes generation, transmission, and distribution.
Municipals (Munis)	There are approximately 2,118 municipals, which includes local and government utilities and federal, state, and district government utilities.

Source: Frost & Sullivan Analysis.

According to a report published by IEE, approximately 22 utilities in 16 different states will have completed smart meter deployment its customer territory by end of 2012. Notable utilities that have either completed or are close to completing smart meter deployment are centered in California, Oregon, Idaho, Arizona, Texas, Oklahoma, Alabama, Georgia, Florida, Virginia, Maryland, Michigan, Vermont, Maine, Ohio, Indiana, New York, and New Jersey area.

Notable utilities include are listed in chart 3.9.

Chart 3.9: Key utilities per region within the U.S.

Region	States	Utilities
West Coast	• California • Oregon • Idaho • Nevada	• PG&E • San Diego Gas & Electric • Southern California Edison • Los Angeles Department of Water and Power • Sacramento Municipal Utility District (SMUD) • Avista Utilities • Idaho Power • Portland General Electric • NV Energy
Southwest	• Texas • Oklahoma • Arizona	• AEP • Austin Energy • Centerpoint • CPS Energy • Oncor • Texas New Mexico Power • Oklahoma Gas & Electric • Arizona Public Service • Salt River Project
Midwest	• Michigan • Indiana • Illinois • Ohio	• Consumers Energy • DTE • Commonwealth Edison • *Ameren Illinois* • Duke Energy • Indianapolis Power & Light

Region	States	Utilities
Atlantic	• Florida • Alabama • Georgia	• JEA • Progress Energy • Southern Company • Tampa Electric
East Coast	• Pennsylvania • Maryland • Virginia • Maine • New York • New Jersey • Vermont	• Central Maine Power Company • Baltimore Gas & Electric (BGE) • Dominion • Consolidated Edison • Bangor Hydro Electric • First Energy • PECO Energy Company • PEPCO Holdings • PPL • PSE&G • Vermont Utilities • National Grid

Source: Frost & Sullivan Analysis.

3.3.1 Review of Deployment Initiatives

The stimulus funding of 2009 has aided 100 smart grid projects and 32 smart grid demonstration projects. According to FERC, SGIG covers the installation of 15.5 million smart meters. State initiatives to conserve energy and adopt renewable power have played an instrumental role in driving smart grid deployment. The industry is far from reaching 100 percent penetration and is often dependent of rate increase approvals from the state PUC, which in itself is a lengthy process. Furthermore, given the recent economic conditions utilities have struggled with the justification of smart grid investments and have as a result delayed projects.

3.3.2 Key Trends and Gaps

There are an estimated 150 million households in North America, with the current rate of smart meter penetration, the industry anticipates 50 percent penetration rate of smart meters by 2015. This heavy deployment of smart meters does not guarantee that the connected home will reach a similar penetration rate, particularly as it relates to utility involvement in which utilities are able to partner with energy management service providers to facilitate demand response.

3.4 Overview Grid-enabled Applications for the Connected Home

3.4.1 Current Status Review - Management of Residential Devices

At the moment management of residential devices with smart grid is happening only in a small scale mainly through pilot tests. Examples of pilot test include:

- **San Diego Gas & Electric** -Currently, has a pilot project going on with Tendril involving 500 in-home displays and 800 programmable controllable smart thermostats.
- **PG&E** –Professionally installing and supporting up to 500 in-home displays with residential PG&E customers. The in-home displays will show customers their real time energy data and can help the customer better understand energy savings opportunities in their home, gain control over their usage, and help to better manage monthly electricity costs.

Notable stimulus supported customer program

- City of Tallahassee received funding to support a demand response program that involves smart thermostats and advanced load control systems
- The Iowa Association of Municipal Utilities consists of 75 consumer owned utilities. This group received funding to implement load control and dynamic pricing program using smart thermostats and web based energy portals

There are also instances where the management of the devices is not going to be dependant of smart meters or smart grid per say but is instead occurring manually through a separate communication gateway.

Some states are in the process of minimizing the role of utilities all together. For instance, in California utilities are working towards enabling commercialization HAN technology but are not necessarily going to take part in controlling devices inside the home in the long run despite their ongoing involvement in pilot tests. The role of utilities in the state of California would be to register HAN devices but not control them.

While demand response is widely available for commercial and industrial customers, very few utilities at this time offer real time or dynamic pricing for its residential customers. The few examples of residential demand response programs, which are elementary and centers mostly on curtailing HVAC usage during hot summer days.

These include:

PEPCO's Energy Wise Rewards™ Program[19] is a voluntary program in which the air conditioner or the heat pump temperature is adjusted for short intervals using either a web-programmable thermostat or an outdoor switch. The adjustment of the temperature aims to reduce the overall energy consumption, particularly during peak power periods. These periods are referred to Energy Wise Rewards conservation periods and are only activated during the

[19] https://energywiserewards.pepco.com/md/index.php

period between June and October. The company is hoping that it would be able to enroll 300,000 residential and small and medium businesses (SMB). This service is being offered in Maryland and in District of Columbia (DC).

Oklahoma Gas & Electric's offers a similar program called PSO Cool Rewards[20]. The program currently has 40,000 customers enrolled on a peak pricing program and expects to have an additional 110,000 customers to join the program in the coming years. The program involves the utility installing a device that can receive signals from the utility to turn the HVAC system on and off for a few minutes during peak power period during the summer.

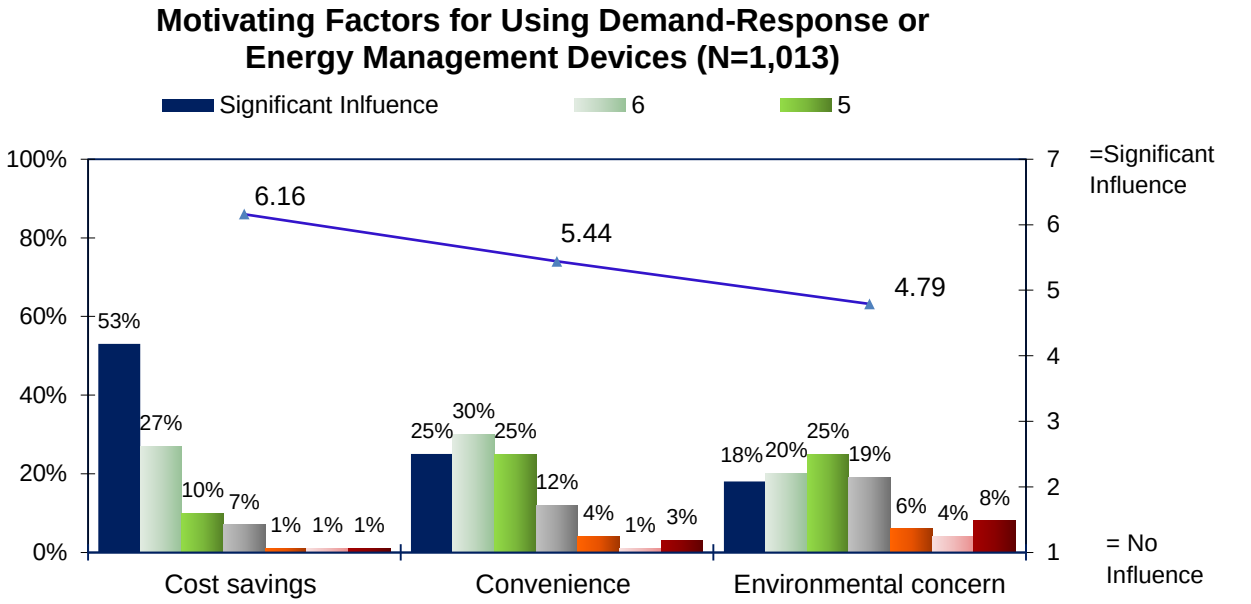
Real time pricing

There are also examples of real time pricing where the electricity consumption is adjusted manually and not through a remote control systems. The state of Illinois is the first state in the U.S. that has launched statewide real-time pricing program[21]. Participating utilities include Ameren Illinois and ComEd -both are offering real time pricing programs[22] to its residential customers. In the case of Ameren, the utility sets hourly prices a day ahead. These prices are then notified to its residential customers so they can adjust the usage of appliances accordingly. ComEd's hourly rates are only notified when the real-time prices are too high or are expected to be too high, particularly if the price exceeds 14 cents per kWh. Customers are alerted via email or text (SMS) message. ComEd's prices are adjusted to real time wholesale market prices for electricity. This voluntary program also allows its customers to monitor is electricity usage and prices on ComEd's website: https://www.thewattspot.com/.

This is not to say that customers are not interested in demand response program presented in the form of dynamic pricing with enabling technology such as using smart thermostat. Frost & Sullivan survey[23] of U.S. households shows that 73 percent of residential energy users are very or somewhat likely to monitor their electricity consumption. The primary motivator for signing on to demand response is to reduce the overall electricity bill[24] as it is illustrated in the chart below.

[20] http://www.ktul.com/story/14396201/pso-cool-rewards-program
[21] http://www.citizensutilityboard.org/ciLiveWire_RI_ComEd_RTP.html
[22] http://www.pluginillinois.org/realtime.aspx
[23] U.S. Smart Grid Market –A Customer Perspective on Demand Response (N72B-14)
[24] 2011 U.S. Smart Grid – Saving Energy / Saving Money-Customers' Perspective on Demand response (N972-14 July 2011)

Chart 3.10: Key Motivating factors for Using Demand response or Energy Management Devices



Source: Frost & Sullivan Analysis.

In Canada, some utilities have implemented time of use pricing for its residential and SMB customers using its smart meters. Hydro One has over 1.2 million meters installed[25] and has over one million meters on automated meter reading. The utility is in the midst of switching its customers to TOU rates and has approximately 1.1 million of the 1.2 million customers already on TOU rates.

Overall, utilities do recognize that they are behind in the development of supporting the connected home in comparison to telecom and IP companies. The biggest reason outside of technical issues as explained by San Diego Gas & Electric is “utilities are required to provide non-discriminatory service to its customers. It cannot provide a ‘premium’ plan/service to selective customers”. In other words, if a utility were to justify HAN, it would have to be offered as premium solution to its residential customers. However, since utilities under the law are required to provide universal service, they are not allowed to segment their products according to household type, income, and demographics. It also would be difficult for utilities to justify the cost for supporting such an initiative.

Instead the market is seeing the emergence of non-traditional companies that are combining elements of security and comfort along with energy management. ADT offers a service called ADT Pulse, which is a home automation service that features climate and lighting control and remote video monitoring. The system uses Z-wave wireless technology to enable the home area networking. The non- Z-wave devices can be made compatible by plugging them into a Z-Wave

[25] http://www.hydroone.com/TOU/Pages/Default.aspx

accessory module[26]. Other examples include Comcast's Xfinity Home, which features automation systems for home security, control, and energy that are all managed through the home's internet system. The service is offered at $39.95 per month for a year service[27].

3.4.2 Utility Home Area Network Deployment Initiatives and Impact on Connected Home Solutions

As mentioned in the previous section the vast majority of home area network deployment initiatives that are being supported by utilities in the North America exist only in the pilot stage and are only to the degree of installing smart meters, enable time of usage pricing, and eventually control the data that generated through its devices and communication network. It is very clear that utilities will not enter the business of actually selling HAN devices due to the pact of having to provide universal service to its customers.

There are also some utilities such as SMUD that have expressed concerns about being able to keep residential customer interested and engaged in demand response functionality. The utility did not think that bandwidth or that inadequate network was an issue. The utility mentioned that it has one of the speediest networks that can respond to 4 second calls.

Another challenge is the selection of hardware devices to make sure they that it does not end up with stranded devices that become obsolete as product standards are still being developed. Although, they consider the current devices as part of the pilot project to be compatible that easily can be upgraded if need be.

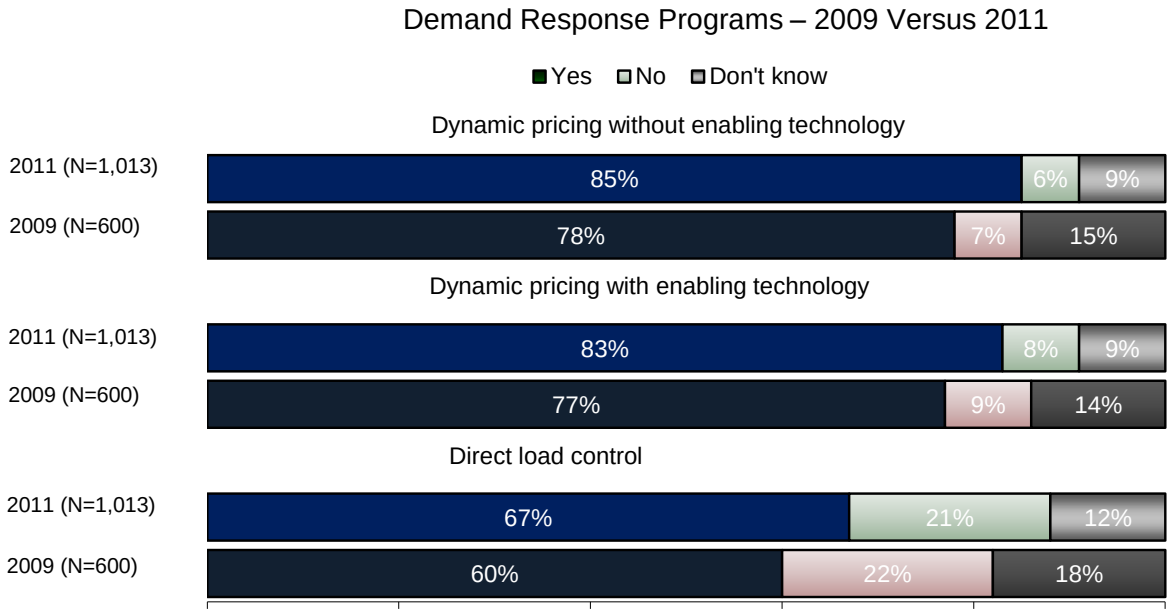
Many utilities have expressed that the smart meter is not going to be main communication gateway. They are looking to promote separate communication gateway that is going to be installed inside the house. They do not want to be in the business of selling devices however, they do want to control it, control the data, as well as maintain and control the security element of the device.

[26] http://www.adtpulse.com/
[27] http://www.comcast.com/homesecurity/index.htm?SCRedirect=true

3.4.3 Residential Demand Response Initiatives – Current Status; Challenges and Unmet Needs

Overall, there appears a strong consumer interest in signing on demand response. Frost & Sullivan customer survey reveals a high probability for consumers to sign-on demand response program. Results indicate 85 percent of respondents are willing to participate in dynamic pricing without enabling technology. Approximately, 83 percent of respondents are willing to participate in dynamic pricing with enabling technology. Only, 67 percent of respondents are willing to participate in direct load control. Chart 3.11 illustrates customers' willingness to sign on to demand response programs.

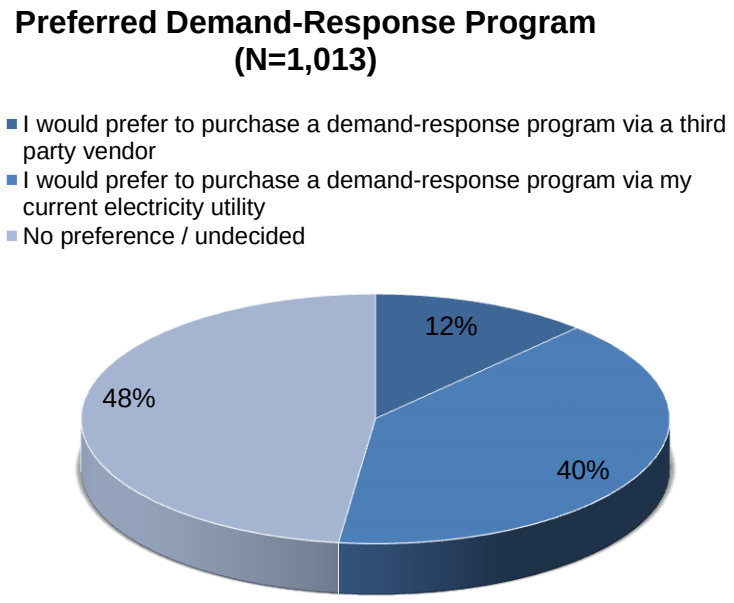
Chart 3.11: Customer Choice per Demand Response Program



Source: Frost & Sullivan Analysis.

The respondents were also asked who they would prefer working when it comes to signing on to demand response programs. Nearly half of all respondents are undecided or do not have a preference when it comes to signing on to a demand response program. However, 40 percent of respondents do report that they prefer signing on to a demand response program via their current electricity utility. Chart 3.12 illustrates customers' responses.

Chart 3.12: Preferred Demand Response Provider

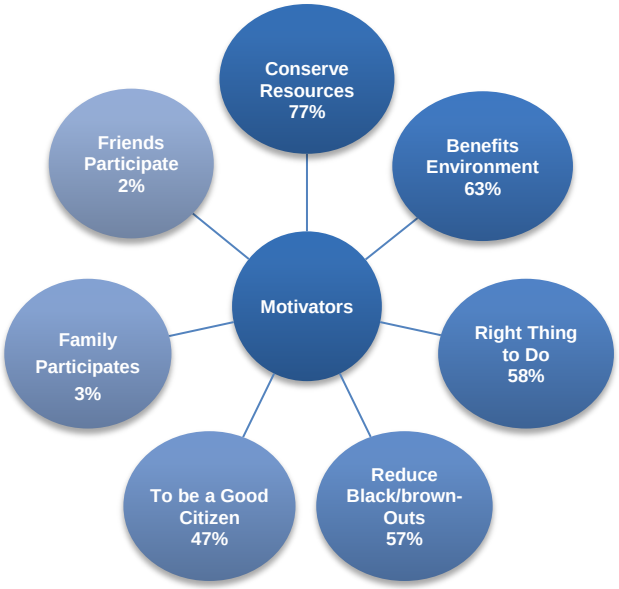


Source: Frost & Sullivan Analysis.

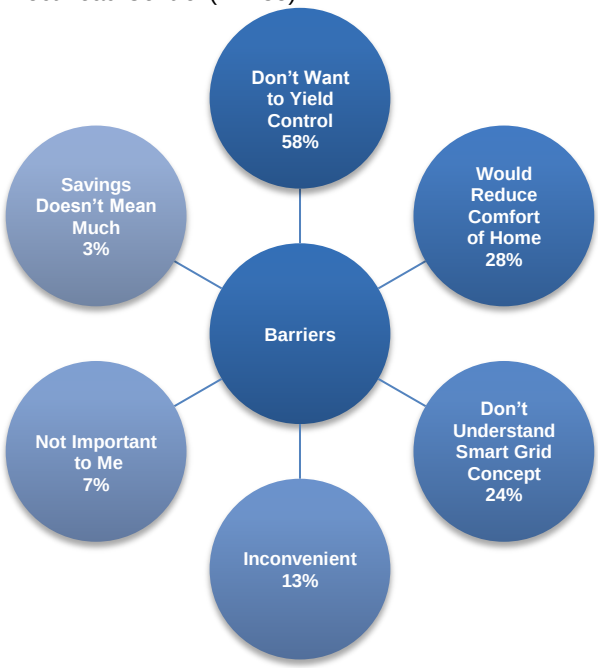
Again the primary motivator for signing on is prospects of being able to reduce monthly electricity bill where as 28 percent of residential households expressed concerns on reducing the comfort of their home as seen in the following chart.

Chart 3.13: Motivation Factors for Demand Response Program Participation and Non- Participation

Reasons Respondents would Participants Even without Financial Incentives (N=211)



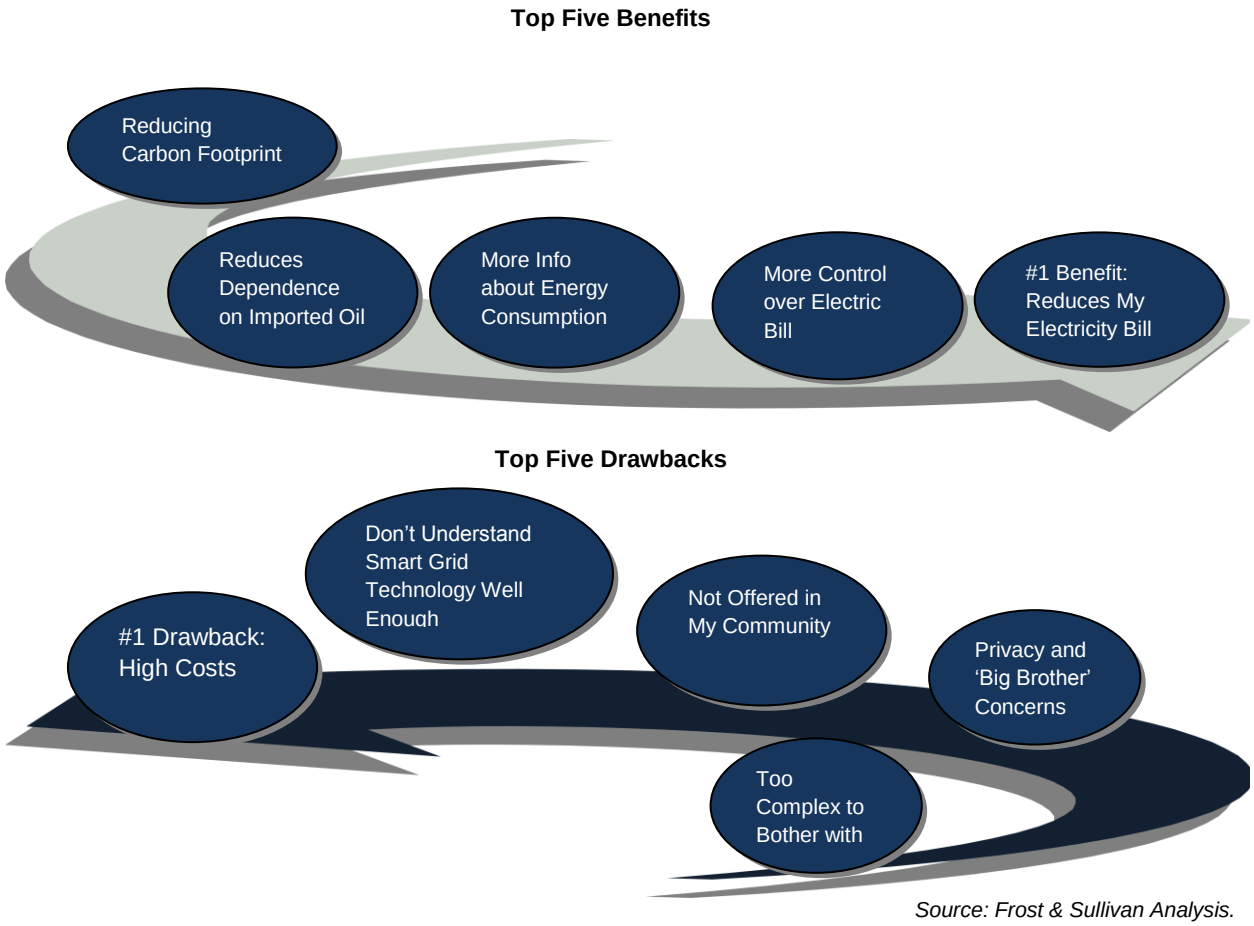
Reasons for Not Participating in Dynamic Pricing or Direct Load Control (N=235)



Source: Frost & Sullivan Analysis.

The following chart summarizes the key benefits and drawbacks of smart grid as perceived by residential households in the U.S.[28]

Chart 3.14: Perceived Benefits versus Drawbacks of Smart Grid Technology



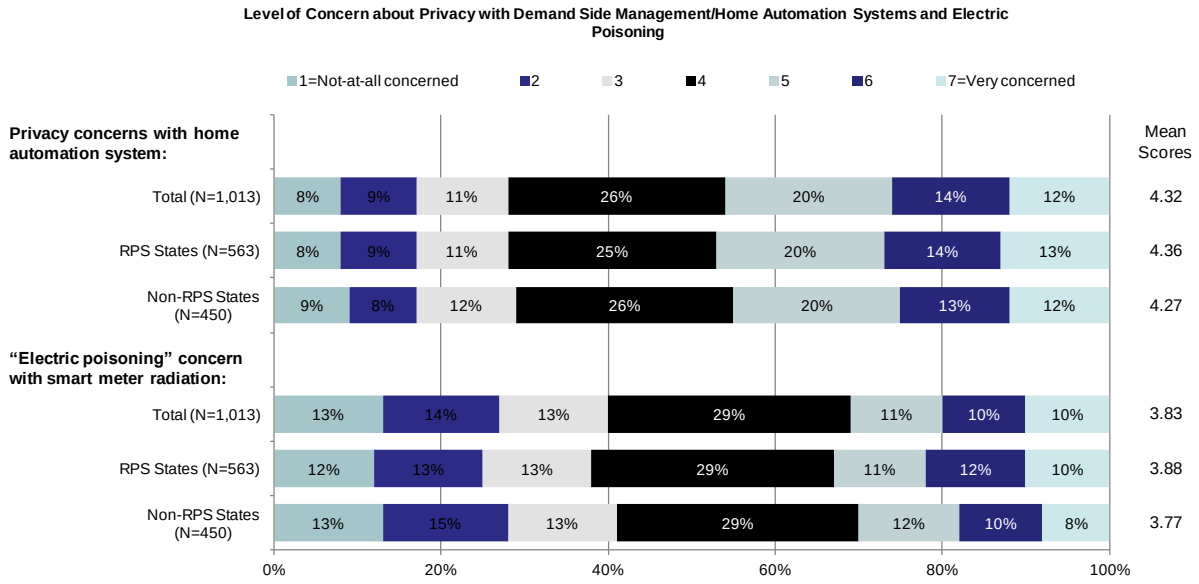
Source: Frost & Sullivan Analysis.

As seen here, although there is a high interest in supporting smart grid, one issue that residential customer have is the fact they still are not quite sure what smart grid technology actually is. The research shows that very few respondents are aware of any efforts by electric utility companies to introduce smart grid technology in their communities (16 percent in 2009 and 2011). Thus, it appears that electric utilities may not be the primary source of smart grid information.

In terms of privacy and smart meter radiation concerns, it appears that consumers have somewhat greater concerns about privacy than radiation and electric poisoning coming from smart meters. Chart 3.15 illustrates customer responses on privacy and smart meter radiation.

[28] 2011 U.S. Smart Grid – Saving Energy / Saving Money-Customers' Perspective on Demand response (N972-14 July 2011)

Chart 3.15: Level of Concerns about Privacy with Demand Side Management/Home Automation Systems and Electric Poisoning with Smart Meters



A25: Are you concerned about your privacy with demand side management and home automation systems?
A27. Please rate your level of concern about electric poisoning caused by smart meter radiation.

Source: Frost & Sullivan Analysis.

3.4.4 Integrating Connected Home Devices to the Grid –Issues and Challenges

While the market is observing a strong deployment of smart meters there are still obstacles to be solved including technology immaturity, security lapse, interoperability gaps, delay of Smart Energy 2.0 protocol, conflict of interest, and market fragmentation.

Constellation mentions that the technology for connected home is available but is being held back by utilities because of smart meters not being used to its fullest. The company states, "At the moment customer data is still being collected on a monthly basis and not on real time basis". The company's opinion was that "regulators need to force utilities to open smart meters to equipment vendors. They are currently discouraged to do so because they want to control the data."

Utilities are on the other hand concerned about the security element of its smart meters. This has been among the reasons why PG&E is not currently using smart meters for connecting with energy management systems. Instead PG&E is currently relying/recommending an IP system that will connect with energy management system. Furthermore, at current time demand response is enabled through energy management system and not the smart meter.

The market also observes a disconnect between featured smart home appliances and the smart meter. Most smart meters feature ZigBee 1.0 and many utilities do not even turn ZigBee on for it

to connect with HAN. The big play for a company such as Constellation companies would be once the data can be viewed in real time in order to enable the energy component of the connected home. In this instance, Constellation would be able to push prices to the devices.

There is also the issue of utilities having AMR systems instead of AMI systems. A large installed base of advanced meter reader systems discourage some utilities to proceed with full AMI deployment. An example includes Bluebonnet that stated, “We didn’t have to change out the meters in order to accommodate this; we have not fully deployed AMI meters. We are using the AMR system in conjunction with a software portal that provides hourly reads to users. We are probably one of the only utilities that you will find doing that”.

Finally, market fragmentation is major issue. The utility market is characterized as a highly heterogeneous sector where no two utilities operate alike. Each utility is under the influence of state regulations and goals. Regulatory decisions have a strong influence on the type of investments it makes and type of projects it prioritizes as well as the technology it selects. A representative from IEEE agrees that market fragmentation is an issue stating, “Extreme fragmentation hinders a mass market there is a lack commonality between utilities…technologies are being deployed before even standards have been introduced.”

3.5 Utilities’ Mandate and Initiatives in End-to-End Infrastructure Deployment

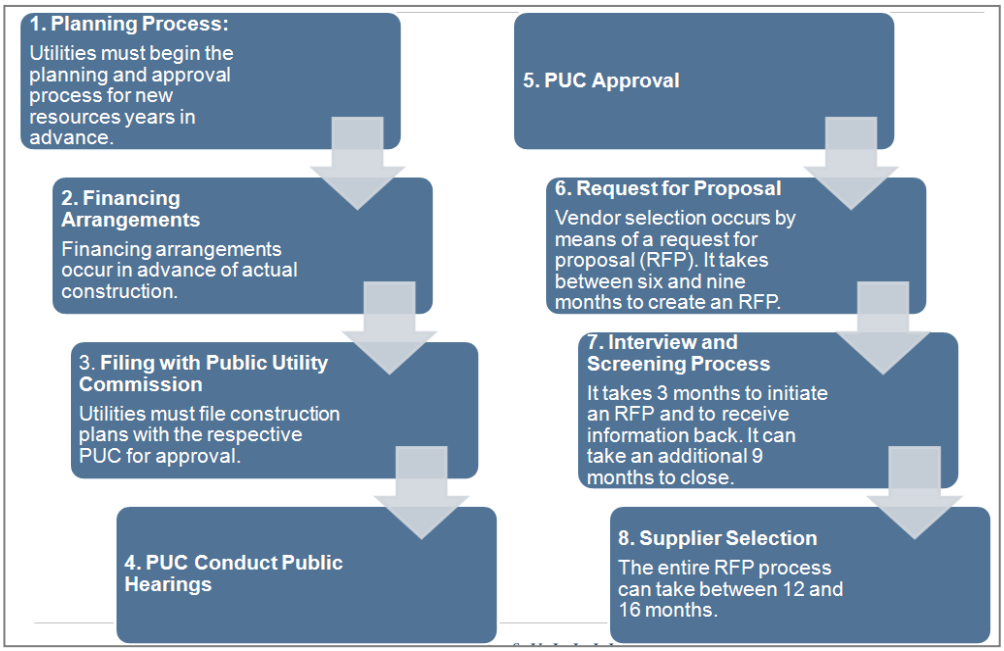
Utilities are not mandated to provide end-to-end infrastructure for the connected home, instead they are by the residing State’s energy bill, RPS or EERS obligated to implement strategies for accommodating renewable power or/and reducing energy load and increase energy efficiency. How utilities choose to act on these mandates is dependant of what is already deployed, what can be afforded, as well as is approved. So far in terms of a concrete technology, the industry has seen investments for smart meters soar where as upgrades for a specific substation automation and distribution automation technology have been sporadic.

3.5.1 Current Decision Making Process – Issues and Changes Required

Clearly decisions to pursue smart grid and select technologies are regulatory driven. Since, vast majority of utility investments are supported by rate pay and rate increases all changes have to be filled as well as approved by the state’s PUC. PUCs are responsible for regulating retail electricity rates based on the state’s energy policy. Filling occurs according to schedule. For instance, PG&E has to file its plans every three years. Currently, it files separately for demand response and its energy efficiency plans. The current plan for demand response is for 2012 through 2014. In 2011, the CPUC required each of its IOUs in California to file implementation plans for HAN. PG&E laid out a three-phased program with the intent to enable home are networking to the mass market.

The chart 3.16 shows the typical stages of procurement for most investor owned utilities (IOU).

Chart 3.16: Purchase Process for IOUs



Source: Frost & Sullivan Analysis.

3.6 Overview and Analysis of Utility Partnerships in Enabling Connected Home Environments

The deployment of smart meters and AMI networks will eventually enable utilities to offer time of usage rates in a more automated and seamless way. The overall investment for smart grid on the other hand is driven by the need to improve power distribution and energy efficiency. Understanding these motivations is important in order to determine the effort that utilities are going to make to enable connected homes and commercialization of related products.

Frost & Sullivan research on AMI shows that utilities in North America have since 2008 spent over $5 billion in AMI deployment, whereas close to $700 million has been spent on upgrading the communication infrastructure (primarily in terms of LAN systems for supporting meter connection to the head-end server and meter data management system) and close to $400 million in upgrading meter data management systems. But as it has been pointed in report from FERC, a number of smart meters have not yet been activated for advanced metering purposes yet.[29]

Hence, possibilities for forming true partnership with utilities seem unlikely to materialize in the near term. Utilities are unlikely going to share customer data and control of the AMI system. There is a privacy legislation that prohibits utilities from sharing customer data without their consent. There is also a cost associated with obtaining and tracking customer consent, which is currently not high on the utility's priority list.

[29] Assessment of Demand Response and Advanced Metering Staff Report, November 2011

Other factors include transition to TOU rates and guaranteeing a secure network that does not compromise customer privacy and utility business operations.

In the immediate term if the industry is looking to create a mass market for connected home services, it might have look outside of working with utilities such as those services that are being offered by companies such as ADT, Comcast, and Verizon.

It is also important to understand what exactly the utility is most likely going to provide to enable the connected home as illustrated in Chart 3.17.

Chart 3.17: Key Participants and Primary Role for Enabling Connected Home

Participant	Primary Role
Utility	Utilities investments for enabling HAN are restricted to the smart meter, website for monitoring energy usage, providing TOU rates, and LAN that tie the meter to the utility's head-end server and other business operations. The communication gateway inside the house that connects to all the appliances for controlling energy consumption, the in-house display, the smart thermostat, are all something that utilities will not be providing or selling, especially regulated utilities.
Energy management service provider	These companies will supply load control devices, gateway, and hosted services.
Power dispatchers	This includes curtailment service providers whom primary role is to monitor electricity usage and alert their customers to reduce their power usage during peak periods to avoid escalation of brownouts or blackouts. In return, grid operators or utilities pay power dispatchers a stream of recurring revenues for managing this demand response capacity, such as on a monthly basis. Power dispatchers make payments to commercial, institutional, and industrial end users of electricity for both contracting to reduce electricity and actually doing so when called upon.
Grid operators	Grid operators such as an ISO or RTO are responsible for maintaining Federal reliability standards designed to avoid power service interruptions. These are also responsible for coordinating the supply of electricity in restructured markets.

Source: Frost & Sullivan Analysis.

Another delay may occur as a result of reprioritization of projects. Since the early AMI deployments utilities have discovered and are discussing possibilities of converging AMI systems with distribution automation in order to facilitate voltage regulations and outage detection, possibly to further justify the expenditure on AMI as well as on other smart grid technologies.

3.6.1 Select Current Initiatives in US and Canada; Models Adopted; Challenges in Delivery

The partnership with utilities to enable the connected home environment is in terms of allowing Retail Electric Providers to gain access to the smart meter in order to provide real time pricing. Companies such as ADT and Comcast are however still able to speak to non-HAN enabled appliances as part of their package but cannot control or produce a utility bill and would therefore not necessarily need to partner with utilities to begin with. In terms of identifying models adopted, Frost & Sullivan directs the attention to two states that are further along with its smart grid plans, namely California and Texas.

In California utilities such as PG&E and San Diego Gas & Electric have filed a three phase plan, which ultimately aims as enabling mass market for smart home devices and energy management. The following describes PG&E HAN implementation 3 stage plan:

1. Initial Deployment of 500 in-home displays to residential customers in 2012. The in-home displays will show customers their real time energy data and can help the customer better understand energy savings opportunities in their home, gain control over their usage, and help to better manage their monthly bill.
2. Early Adopter Phase –Start date in early 2013. PG&E is expanding the number of customers and providing customers with a list of up to five PG&E validated devices that customers can purchase through retail channels. Customers will be able to purchase, install and self register the HAN device of their choice to obtain their real time energy data.
3. Mass Market Phase –Start date is early 2014. If the market develops, PG&E will open up the HAN platform to all third party HAN devices that meet PG&E's certification and registration standards.

In California, the role of utilities would be primarily to enable HAN through securing the network, and enabling AMI to connect to HAN-enabled devices. Demand response on the other hand is currently planned to be connected to a separate IP-enabled device and not AMI.

In Texas the three largest utilities, Oncor, AEP, and CenterPoint, all expect to complete their smart meter installations between 2012 and 2013. All three utilities are part of a consortium called the Smart Meter Texas. Once, a residential customer has its smart meter installed it can register the meter at www.SmartMeterTexas.com. The website provides data down to 15-minutes intervals. The web portal can also be accessed by retail electric providers (REP), who then in return can promote TOU prices and energy analysis tools to its customers. The website will also eventually allow the REPs to register HAN enabled devices as well as connect devices to the smart meter similar to California.

In this regard, it is interesting to note the importance of home energy optimization technologies that utilities are piloting to help customers control and manage energy. In Canada, there is evidently good progress being made by some utilities in deploying their demand-side management programs with the help of third party energy conservation service and solution providers. Pilots undertaken by utilities in Canada such as Hydro One, British Colombia Hydro, and Milton Hydro, with Energent's home energy optimization technology are good examples of how utilities can get proactively involved with connected home energy management aspects. Energent's robust energy management platform collects, analyzes and reports accurate energy data into actionable information for both consumers and utilities. In the short term, programs like these will continue to keep utilities involved in DSM programs via energy optimization, with the help of technology enablers such as Energent. http://www.energent.com/solutions

3.6.2 Review of Partnership Structure

By observing the two most progressive states in the U.S., it is clear that utilities primary role would be to enable HAN services and not necessarily manage it. Chart 3.18 summarizes the previous discussion on partnership structure and responsibilities.

Chart 3.18: Partnership Structure and Shared Responsibilities

Responsibility to →	Utility	Consumer	Telcos and service providers	Home products and technology suppliers
Utilities		RS: • To provide changes to the billing system and educate the customer accordingly • To provide TOU rates • To provide customer programs and incentives reduction of power consumption • To provide access to web portal where the consumer can monitor its activity	RS: • To select the network technology that is best suited for the territories where the utility is looking to deploy AMI system and demand response.	RS: • To grant technology providers access to consumer and meter data in order for smart home appliances to connect with demand response alerts • To open smart meters to AMI network
		FI • To make investments for smart meters • To make investments for securing the network infrastructure for AMI • To make investment of time and effort in standardization	FI • To investment in network upgrades • To decide whether to outsource or use internal resources for project management for tying the network system and back office operating systems	FI • To make investments for smart meters • To support for alternate communication gateway if the smart meter technology is determined to be unsecure for HAN enablement or demand response • To make investments for securing the network and guaranteeing that the consumers' privacy is not compromised
Consumers	RS: • To determine whether to participate in utility programs for demand response for when it becomes available • To register household appliances to receive and send signals from the utility to activate TOU or demand response when it becomes available • To actively monitor power consumption online or using the in-home displays and react to utility alerts accordingly		RS: • To determine the carrier for activating HAN technology best suited for the household such as Comcast, Verizon, or AT&T among others. • The selection could be based on the household's existing service for IP, mobile, or telecom.	RS: • To determine the necessity of switching to smart household appliances • To select smart household appliances that best suited for the household

Responsibility to →	Utility	Consumer	Telcos and service providers	Home products and technology suppliers
	FI • Determine whether to invest smart appliances		FI • Decision to select universal communication gateway or vendor/technology specific gate way for the home and the related cost.	FI • Cost of the smart home appliance • Cost of installation of the smart home appliance
Telcos and service providers	RS: • To provide a relevant, secure and adaptable network that would benefit utilities in terms adjusting to future changes to the grid and consumer needs • Roll out of hosted and cloud services to better manage utility data	RS: • To addresses consumer need for a consolidated signal HAN network for the home, consumer friendly, secure, and relevant network technology		RS: • To determine compatibility of smart home appliances with current and future HAN systems. • To determine product strategies and technology roadmap for networks and software based on the trajectory of future smart home appliances
	FI • Investment in product development and marketing • Investments for complying with standards	FI • Determine marketing and customer outreach strategies for reaching mass market for households for HAN systems.		FI • To determine the effort and investment required for product development
Home products and technology suppliers	RS: • Determine how the activation of TOU rates and access to consumer data is going to benefit utilities in term of reaching its state and federal goal for conserving energy	RS: • Commercialize a viable smart home technology for households	RS: • To develop smart home appliances based on the trajectory of future network systems.	
	FI • Qualify smart home appliances for utility programs	FI • Determine marketing and pricing strategies achieve a mass market for smart home appliances	FI • To determine the effort and investment required for product development	

Note: RS: Responsibility Sharing; FI: Financial Implications. Source: Frost & Sullivan Analysis.

3.7 Adoption of a Dynamic Framework for Utilities - Changes required to their business and delivery model

The current general framework for utilities in terms of connecting with the residential customers is highly passive and is mostly limited to measure electricity usage and to produce a usage bill accordingly. This occurs as most are aware of this either through manually reading of the meter or through an advanced meter reader. Utilities are also responsible for guaranteeing interruption-free and reliable electric service to its customers for which it can face penalty from regulatory bodies such as FERC for non-compliance. As a result, utilities on a periodic basis do have to invest in equipment upgrades. The passing of EPAct, EISA, and SGIG that drove smart grid and AMI investments requires the utility's relationship with its customers to become more dynamic. Chart 3.19 list changes required.

Chart 3.19: Current utility model for the connected home and changes required

	Current Approach	Implications	Changes Required
Utility Model	**Customer Billing** • Most utilities have a monthly billing model, where the electricity usage is measured on a monthly basis. • In places with high deployment of smart meters actual real time reading has not fully been activated and wide adoption of TOU is also low.	• Missed opportunity to conserve energy and educate customers about the benefits of managing energy consumption	• Effective rollout of TOU as well as enable mass adoption of demand response programs for consumers based on dynamic pricing programs. • Activation of AMI systems • Continued investments on data management systems such as meter data management systems • Rollout of effective customer programs
	Customer Interaction • Mostly a passive approach that is restricted to monthly billing, notification of utility rebates, and Energy Star programs. • Ineffective approach and limited resources spent on educating and marketing customer	• Faded customer interest in utility business and service offerings • Misconstrued opinions about the investments that utilities are making	• Increase effort to educate the customer and increase interaction
	Project Approval • Lengthy process that is often dictated rate increase approvals by the state's PUC. • There is not a real consensus and political battle on agreeing on technology standards	• Speed to market for connected home delayed • Missed revenue opportunities for technology providers	• The PUC role is to communicate the State's energy law as well as protect customer's rights • Utilities need to develop a more concise business plan to demonstrate clear benefits of activating AMI system

Source: Frost & Sullivan Analysis.

3.7.1 Identification of Opportunity Areas for Utilities to Capitalize On

Effective monitoring and control of energy consumption within the household through the connected home model offers the following opportunities for utilities to capitalize on in the near, mid, and long term:

Chart 3.20: Opportunity Hot Spot for the Utility through the Connected Home

	Near Term	Mid Term	Long Term
Opportunity/Benefit for the Utility	Possibilities for monitoring of electricity consumption to determine usage patterns can help utilities to develop an effective strategy for conserving energy that will be accepted by consumers	Meet energy efficiency standards	• Continued development of customer programs • Product diversification opportunity • Micro grid • Net metering
Market Certainty	High	High	Medium

Source: Frost & Sullivan Analysis.

3.8 What does Smart Grid mean for the Connected Home?

Federal policies have been introduced to improve energy efficiency and eventually reduce the possible burden of having to accommodate renewable power and electric vehicles in the future. One approach for reaching this goal is to make customers accountable for the amount of energy it consumes through monetary incentives such as TOU rates and demand response. Some utilities are adopting AMI systems to effectively automate and manage TOU rollout and some are not. For instance, as described earlier the two primary utilities in the State of Illinois have implemented a very rudimentary TOU strategy that is in stark contrast to Texas and California.

It is quite possible that the adoption of demand response and TOU will help the market transition to a full adoption of a connected home. However, this would primarily be with the intent of improving energy management for the consumer.

Energy management is just one aspect of the connected home experience and is outside the areas of home monitoring and security, media, and health monitoring, which are all being promoted as components of the connected home experience. Hence, in the short-run smart grid will not be prerequisite for the connected home experience as it has already being witnessed through the launch of remote home automation management services offered by the likes of ADT, Verizon, and Comcast. All three services are operating independently of the smart meter and the AMI infrastructure.

Having said that the fact remains that utilities have already spent close $5 billion since 2008 on AMI infrastructure alone out of which $700 million has been spent on upgrading the communication infrastructure for AMI. Therefore there is the possibility and the strong intention of using the AMI build out for more than just automating meter reading and isolating the management access of TOU rates to utilities alone. In this scenario smart home appliances will be able interface with the AMI network and automatically react to TOU rates and utility signals

for curtailing power without causing any major discomfort or inconvenience to the consumer experience.

Smart home appliance manufacturers sees this as opportunity to accelerate replacement cycle for home appliances and well as to promote new consumer products and are therefore in general willing to collaborate with utilities in developing frameworks for advancing the market for the next “it” thing that has an energy conscious.

For energy management service providers or energy retailers this scenario offers opportunities to promote demand response services that involve aggregating power for the energy wholesale market and pass on the rewards to the consumer.

Frost & Sullivan is in the opinion of that in the in the mid and in the long term smart grid will present opportunities for developing and marketing new products in the realm of the connected home market, particularly in terms of smart home appliances that are able to react to TOU rates. Market realization of this scenario is dependant of:

1. Wide roll out of smart meters that can act as communication gateway and interface with smart home appliances. Justify subsequent investments for smart meters by showing ROI in the form reducing energy consumption.
2. Open communication protocol that is technology agnostic with smart appliances
3. Overcoming privacy and consumer perceptions of adopting demand response programs

4. Technology Innovation and Future Evolution

4.1 Technology Developments at the Smart Grid Level

Relevant smart grid technologies to consider for the connected home include smart meters, network connectivity, customer programs, and cyber security. The following chart highlights some technology developments for these listed technologies.

Chart 4.1: Technology Developments at the Smart Grid Level

Technologies	Market Stage and Issues	Product Developments
Smart Meters	While technology for smart meters has been fully commercialized it still does experience issues during the deployment stage. Utilities need to conduct tests to determine compatibility its existing network infrastructure and determine what sort of additional investments are required.	This has led to the development of open computing network protocols, as well as accommodating higher data and memory rates. Elster's new REX2 smart meter offering features a universal metering platform that allows the meter to change networks without having to physically change out the communication radio in the meter itself. The technology embeds metrology and communication on a single chip. Landis + Gyr's fifth generation Gridstream features a data rate of 300 kpbs and a memory of 24MB. The industry is also looking at convergence between AMI systems and distribution automation for activating voltage conservation and outage detection. As the technology matures the price for smart meters are expected to reduce. Furthermore, the market is seeing new entrants such as Glen Canyon introduce an inexpensive version of smart meters, specifically for the North American Market.
Network Connectivity	Most network technologies have been and are commercialized for AMI systems. In order to justify investments for network upgrades associated with AMI systems utilities are assessing possibilities for deploying multi-purpose networks that can seamlessly transmit data from multiple sources. Examples of multi-usage include the Electric Power Board (EPB), which is a municipal that rolled out city-wide high speed Internet for commercial as well as for utility usage.	Developments focus on machine to machine technology (M2M), Smart Energy 2.0, reducing latency level, providing higher data and memory rate, and increase bandwidth.
Customer Program and Meter Data Management	Most of the utility HAN projects are in the pilot stage with limited rollout. As these pilot projects conclude this category is projected to grow in importance as utilities continue to strategize how to maximize utilization of meter data.	Utilization is projected to be in the form of new customer services, determining voltage conservation strategies, among other things. Other areas of development include Demand Response Management Systems that are used to perform analytics, such as forecasting, base-lining, and settlement.

Source: Frost & Sullivan Analysis.

In addition to these trends, market convergence will continue to shape the industry particularly in terms of meter data management. The industry is seeing an interest in managed and hosted

service and cloud-based offerings which could help accelerate the success of AMI systems particularly for smaller sized utilities that have limited capacity to manage complex pricing data. Examples include Verizon's Home Fusion Broadband and cloud-based meter data management.

4.1.1 Smart Grid Standards Development

The market is in midst of developing interoperability standards between the various technologies. The U.S. Department of Energy (DOE) has identified 16 interoperability standards necessary for smart grid integration.

While solutions will vary by utility there is a debate on improving interoperability of the various devices deployed for smart grid. The choices and implementation of appliances has not been finalized as a result of undecided interoperability standards.

In the past decisions to deploy technologies were decentralized, which led to equipment with proprietary technologies. In June the U.S. Department of Energy (DOE) issued 16 interoperability standards for smart grid technologies needed for the interoperability and security of the smart grid and $10 million in Recovery Act funds to the National Institute of Standards and Technology (NIST) for support of the standards. Of these 16 standards there are 5 that are relevant to the connected home including:

1. Advanced Metering Infrastructure Security (AMI-SEC) System Security Requirements - AMI and smart grid end-to-end security.
2. American National Standards Institute (ANSI) C12.19/MC1219 IEEE 1377- Revenue metering information model.
3. Open Automated Demand Response - Price responsive and direct load control.
4. OpenHAN - Home area network device communication, measurement and control.
5. ZigBee/HomePlug Smart Energy Profile Home Area Network - Device communications and information model.

NIST also has a Smart Grid Advisory Committee, which represents a mix of different entities within the industry including the software sector, household appliance sector, meter industry, and the utility industry. The role of this advisory group is to provide inputs to NIST on standards, identification of issues and needs as well as the current implementation status.

Other institutes involved include Institute of Electrical and Electronics Engineers Inc. (IEEE), which is a non-profit standards organization. The organization has taken on developing a Smart Grid guide called IEEE 2030 Guide for Smart Grid Interoperability of Energy Technology and Information Technology Operation with Electric Power Systems (EPS) and End-Use Applications and Loads (2030). IEEE P2030 is supporting NIST's role to coordinate the development of smart grid interoperability standards.

4.1.2 Interoperability and Compatibility of Standards

The roll out of smart metering, and subsequent deployment of home area networks for metering and control devices, makes it necessary that interoperable communications be used such that there are opportunities for home owners and service providers to leverage this infrastructure for experiencing/provisioning additional services and functions.

In limited cases, smart meter deployments are using utility home area networks (HAN) that have high security enabled. This determines what data transfer can be possible, and what kind of devices can be added to the network, and by whom. However, some of this data is useful to other devices in the home, for example tariff times and rates, and opportunities exist to utilize this information. The utility HAN and the connected home network will usually interface at the in-home display (IHD) or other similar gateway or device. Frost & Sullivan's research indicate that the issue of compatibility is typically cited where the IHD has to communicate with the various controls and devices within the home. Additionally, certain functions within a connected home such as security, tele-health, etc., may need to use a gateway with separate path to reach the external communication environment of the service provider, instead of the utility network. Both utility smart metering and connected home services would need to conform to their respective operating standards. Industry participants in the home energy management and IHD area agree that the deployment of multiple HANs could address this issue.

Current Issues - Protocols Connecting Utility Devices

For smart metering, ZigBee Smart Energy Profile (ZigBee SEP) is used, however, its secure network may not allow non-SEP ZigBee to be part of it. On the home front, a ZigBee Home Automation (ZigBee HA) controls network deployed would work differently from the ZigBee SEP on the metering side. At best, these two separate networks could be patched together using a gateway with two ZigBee HANs and a processor to create a firewall within the product. While this will not allow intercommunication between the connected home and the utility network, it will however, allow for sharing of some information such as tariff and pricing data.

Though ZigBee is widely used as part of the controls network for home devices, there are others such as Z-wave that are achieving significant levels of penetration into the home controls and security segments of the connected home. Interoperability can be achieved, depending upon which home networking technology is endorsed by technology and product vendors in this market. The connected home industry has witnessed vendors become members of multiple alliances such as ZigBee and Z-Wave, and successfully developing products under these programs. However, it may be pointed out, even if two devices are approved to ZigBee SEP 1.0, it does not necessarily make them interoperable at all levels of functionality. There are optional clusters that can be implemented, if they do not exist in both devices, in order to achieve full functionality and interoperability. Towards this end, partnerships between equipment and service providers are needed that acknowledges the use of interoperable products and systems. Furthermore, the systems should allow for scalability, without having to discard the system components deployed at an earlier stage, wherever possible.

4.2 Grid Security and Data Management

Grid security covers issues such as encryption of network monitoring system. The industry is actively discussing the implication of cyber security as a result of AMI. Cyber attacks include deliberate and unintentional attacks, including industry espionage, threats from disgruntled employees, user errors, and natural disasters. This is also being addressed through committees such as the National Institute of Standards (NIST) and UtilityAMI, which have formed security working groups to analyze perceived security threats.

Another area of focus for many AMI technology providers is grid security. There is a physical and digital aspect of securing the electric grid. As the grid transitions from a one-way flow into a two-way flow of information and energy, utilities are proactively taking measures to reduce threats from unwarranted cyber intrusions. The perception is that digitalization of the grid will increase vulnerability to cyber threats and that past proprietary standards have become obsolete. Securing the AMI network involves evaluating various entry points of possible intrusion, which, in the case of AMI, can be the application protocol control and network access control.

In terms of application protocol security, vendors are complying with protocols that guarantee that only commands from an authorized and authenticated control application are recognized and acted upon, such as the American National Standard for Utility Industry Standard Institute (ANSI) C12.22 protocol, which is a protocol for interfacing data communications networks with the meter. Other standards include ANSI C12.19, which defines a table structure for utility application data to be passed between the meter and a computer.

In terms of HAN, utilities have placed Energy Service Interface (ESI) in its AMI HAN systems. ESI is a device that acts as a gateway to provide security as well as coordinating secure interaction between the network, devices, and the utility.

4.2.1 Consumer Privacy Issues and Initiatives Underway

The department of Information and Privacy Commissioner Office of Ontario, a non-governmental agency, has been on the forefront of developing standards and methods for securing customer privacy. This department has developed a program called Privacy with Design principals and has partnered with many utilities including San Diego Gas & Electric to implement privacy best practices. Best practices according to a paper jointly developed by San Diego Gas and Electric and Ontario's Information and Privacy Commissioner Office include[30]:

- Building a strong culture of privacy within the utility itself – this includes educating the employees and contractors about the need to respect and protect customer privacy
- Safeguarding the information customers have entrusted the utility
- Adhering to fundamental privacy principals such as Privacy with Design that puts customer privacy first

[30] Applying Privacy by Design Best Practices to SDG&E's Smart Pricing Program, March 2012, SDGE and Information and Privacy Commissioner, Ontario, Canada

- Complying with all applicable privacy laws and regulations
- Listening to the utility's customers' ideas and concerns about privacy and addressing appropriately

Earlier actions on the privacy front occurred in 2010 when California enacted a legislation to ensure privacy protection for consumers and their energy consumption data. According to California Legislative Counsel Senate Bill 1476 of the 2009 to 2010 Session, the release of customer energy information requires customer consent. Furthermore, in 2011 the CPUC adopted a set of privacy rules related to energy use data[31].

4.2.2 Data Analytics and Information Management – Present Initiatives and Future Requirements

Data analytics related to smart grid and the connected home targets management of TOU rates, demand response, as well as access meter usage data. Meter data management (MDM) systems are among the mature technologies used for data analytics. The typical function of this application is analyzing and calculating energy consumption data, also referred to meter to cash (billing) functionalities. In the future, MDM is projected to become a critical component of an AMI system. Utilities are looking for the application to conduct additional functions. In fact, some utilities that already have full deployment of smart meters such as Austin Energy have expressed interest in upgrading their existing MDM system to embed additional features beyond the traditional meter to cash revenue management that takes into account opportunities to conduct:

- Commodity management, which consist of load forecasting and profiling
- Customer relations management to determine customer segmentations based on load consumption behavior
- Asset management to determine optimal network configuration and loss minimization

Other areas of data analytics will focus on:

- Providing customers information on TOU rates through the smart meter or energy management system
- Enabling a web-based interface to control and analyze data

4.2.3 Collaboration with Third Party Solution Providers

The industry has a number of smart grid working groups. However, teams that appear to have the most influence are those with ties to NIST and ultimately FERC who has the authority to mandate standards and rules. This is not to say that the working groups do not have any significance in rolling out of current and next generation smart grid technologies. Developing standards is a collaborative effort since it needs to take into account interoperability of the different layers and areas of smart grid, which stretches all the way from power generation,

[31] California Public Utility Commission Decision (D.) 11-07-056, attachment D: http//docs.cpuc.ca.gov/PUBLISHED/GRAPHICS/140370.PDF

power transmission, power distribution, and ultimately to the consumer. However, when mass and diverse set entities gather together the difference of opinions does occur and this can and has lead to delayed decisions. One area of concern that while utilities see it practical to have open communication standards technology provider might think otherwise since proprietary technology helps protects revenue stream for the vendor. Strategies to mitigate such delays should be evaluated.

4.3 Technology Developments at the Connected Home Level

The taxonomy segment, discussed earlier, details the various technologies that are part of the connected home environment. To reiterate, the connected home experience is about bringing the internal and external communication environments to seamlessly interface with one another. However, achieving this is a far more complex proposition. In most cases the inability to support competing technology profiles act as a restraining factor. Chart 4.2 shows the various technology development initiatives at the connected home level for a select set of enabling technologies.

Chart 4.2: Select Technology Developments at the Connected Home Level

Enabling Technology	Support Profile	Characteristics
HomePNA	• Supports Telco applications such as IPTV	• High Bandwidth - 320 Mbps • Ethernet over coax or phone line • Interference level is minimal • Considered open and interoperable
HomePlug	• Home area networks • HomePlug AV - Broadband applications - low data rate IPTV, gaming, and Internet content, • Others - applications such as smart meters and in-home communications between electric systems and appliances	• High Bandwidth – 200 Mbps • Ethernet over power line • Moderate interference • Fully interoperable
MoCA	• Supports cable systems- Two-way communication channel for VoD, DVR type applications	• High Bandwidth – 100+ Mbps • Ethernet over coax • No interference • Not an open standard and does not support interoperability
802.11n (Wi-Fi)	• In-home communication, Internet, • Home networks • Home appliances	• High Bandwidth – 150-600 Mbps • Ethernet LAN • Moderate to high interference (walls, devices etc) • Open standard
ZigBee	• Smart meter reading • Home Appliance, HVAC and energy control and management, security, sensors • Entertainment controls	• High Bandwidth - 250Kbps, Frequency -2.4GHz • Wireless mesh • Interference level is moderate • Open standard
Z-Wave	• Home automation and control devices, connected home network • Remote control applications	• Bandwidth – 100Kbps, Frequency - 900MHz • Ratified by ITU-T as G.9959 • Interference level is low • Open and interoperable

Source: Frost & Sullivan Analysis.

Considering the early stage of market development, it is not clear which technologies will make a major impact on the connected home. With regard to the native domains supported by these technologies, their strengths and benefits appear to be well established. However, the complexity lies in the ability of these technologies to support adjunct functions and domains. Even with the options that are considered open and interoperable, there is no consistent hard

data to prove that these would indeed be compatible with a broad spectrum of connected home functionalities. The complexity is further enhanced when the intercommunication with the utility network is taken into consideration. Interference issues, communication, data sharing issues, need for multiple HANs, as well as bandwidth variations may lead to challenges for these technologies to work supportively under all circumstances. As stressed earlier under section 4.1.2, partnerships between equipment and service providers are needed to support technology developments, endorsements, and the use of interoperable products and systems.

The technology evolution process for smart grid implementation and the connected home is expected to follow a sporadic pace over the next decade. While ongoing technology development initiatives can be expected to be active at both, the grid and the home front, the industry's expectations of significant advances are confined to the long term period only.

4.3.1 Integration of Emerging Technology

Beyond the issue of compatibility of existing enabling technologies, the connected home industry will also have to consider the challenges associated with integrating new technology options that are making their way into the connected home environment. The issues and challenges associated with such integration are discussed below.

New Connected Devices – The entry of new devices into the connected home space is considered inevitable. Most product and technology vendors view the connected home market as a fast emerging vertical to introduce a plethora of new technology options, either to support existing technologies, or meet a niche requirement. The active areas of new technology integration are considered to be home energy management and monitoring, media and content delivery solutions, OTT and support solutions, which could potentially witness new technology entry. The industry expects that these new devices and technology vendors will support some form of enabling technology or another, in order to offer ease of integration. However, device-level compatibility, cost of integration, communication and data sharing issues are only some of the preliminary challenges that can be foreseen at this time.

Demand Response (DR) – Although an important component of smart grid deployment, residential demand response does not appear to be a financially viable proposition for utilities at this time. However, certain aspects of DR such as curtailment, load shedding, DR via enabling technology are being carried out as pilots by most North American utilities. Consumers have access to a variety of technologies such as displays, programmable communicating thermostats, home energy management systems, load control device, as well as smart rate and program options to choose from and be part of a utility initiated DR program. The challenge of connecting these various technologies to the utility network will need to be addressed for DR to become an integral part of the connected home. Although smart meters have been deployed in majority of these DR pilots they do not serve as the gateway for utilities to derive consumer's home energy use information due to conflicting standards and protocols.

Renewable Technology Integration – The single most important challenge that can impede the integration of renewable energy technologies into the connected home has little to do with the technology integration issue itself, and more with the economics involved in it. Home owners are

willing to explore integration of solar, geothermal and other renewable resources into their home provided the cost of such technologies come down. Intermittent government and utility rebates have positively influenced adoption marginally. There are several home controls and home energy management solutions that are designed to integrate with renewable energy systems such as solar PV panels and heat pumps, and ultimately all energy consuming devices in the home.

However, the ultimate initiative to bring renewable and distributed energy resources into the context of the 'smart grid and the connected home' would require more concerted efforts from the utility end. Advances in gird automation and optimization are necessary for utilities to incorporate distributed energy resources. Additionally, proper incentives are needed for consumers to transition to 'pro-sumers' (consumer plus producer of energy), such that renewable energy technologies receive due attention within the connected home network.

4.3.3 Evaluation of Standards and Protocols

The organizations and alliances that represent various groups of products and technology solutions, offered to the connected home, have endorsed specific standards that apply to the solutions they represent. The vision of a home full of connected, with interoperable devices that easily exchange information, is only partially realized at present.

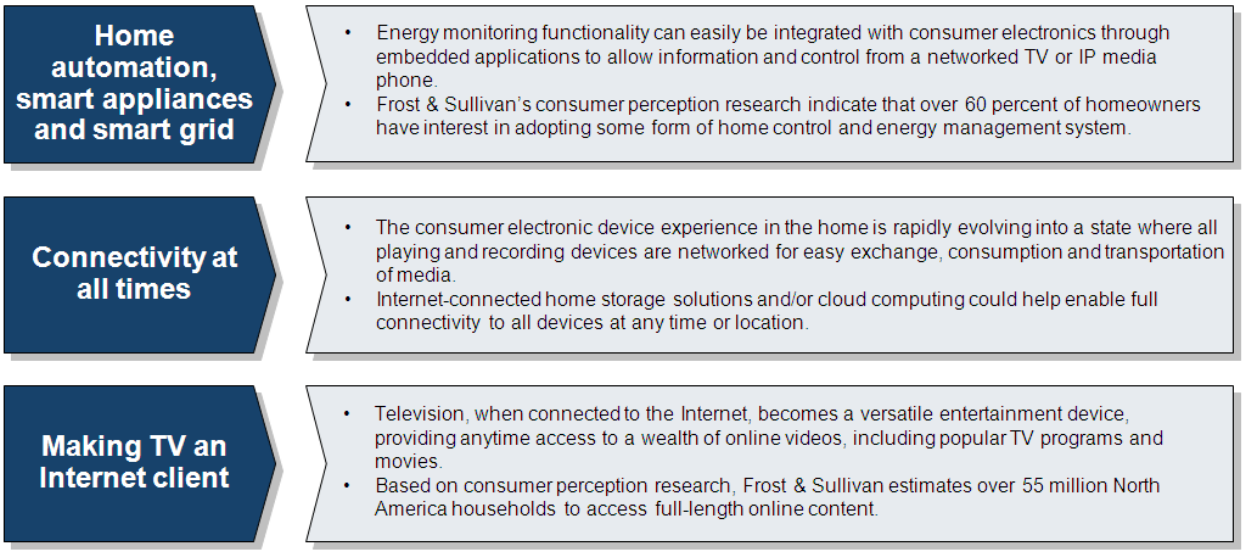
Connectivity and ease of use remain major roadblocks in achieving a connected home. For instance, it can be frustrating and difficult for the consumer to navigate the Internet with a television-style remote control, or to try to add new devices to a home network to exchange content and services. Standard development initiatives should address these shortcomings in technologies in order for the connected home to achieve its full potential.

The positive take on this issue is that most industry participants, representing various facets of the connected home, consider this an effort worth investing in. The goal is to create a full range of industry-supported standards that enable various aspects such as broadband access, data encoding/decoding, device connectivity, networking, and interoperability for home automation, controls, entertainment, and consumer electronics consumer electronic platforms and services.

For example, components such as digital TV broadcast and broadband technologies, combined with advances in-home controls, automation, and home networking, can potentially offer consumers the opportunity for unprecedented control over various home aspects such as home appliances, energy, security, communication and media. This could present significant opportunities for manufacturers, content owners, application developers, and service providers, just to name a few.

Frost & Sullivan's research indicate that most standards development activities are clearly driven by a few compelling trends observed in the connected home industry and with distinct usage models defining these trends. These are shown on Chart 4.4.

Chart 4.4: Connected Home Trends Driving Standards Activities



Source: Frost & Sullivan Analysis.

Standards Development Status

Broadly the various standards adopted, and standard development initiatives undertaken by this industry are shown below on Chart 4.5:

Chart 4.5: Connected Home Standard Development Activities

Industry Segment	Alliance/Development Body	Areas of Focus
Home devices, smart metering, security, remote monitoring	ZigBee, Z-Wave, Wi-Fi (802.11), HomePlug, IEEE 1901 *(Device Connectivity)*	• Focus on home automation, controls, security, lighting, HVAC, etc; • ZigBee and Z-Wave has relatively more endorsement and support for the industry participants • Preferred standards for delivering products and services in the connected health area and home security
Home devices, Entertainment, Consumer Electronics	Digital Living Network Alliance (DLNA) *(Interoperability)*	• Consumer electronic, computing, and mobile device industries; • Focus is on making connected, interoperable devices, including set-top boxes, PCs and handheld devices, work together over wired and wireless networks in the home; • Supports underlying standards, including the Universal Plug and Play (UPnP) initiative of the UPnP Forum
Entertainment, Communication devices	Universal Plug and Play (UPnP) *(Interoperability)*	• Defines how devices in the digital home interconnect and interoperate, including discovery and control of devices • Can run on any network technology including Wi-Fi, coax, phone line, power line, Ethernet

Industry Segment	Alliance/Development Body	Areas of Focus
Laptops and PCs, consumer electronic devices, home control devices	Wi-Fi Alliance *(Network Connectivity)*	• Driving the adoption of high-speed wireless local area networking, including certification of devices • Wi-Fi Direct enables devices in a personal area network (PAN) to make secure, direct connections to one another
Entertainment, consumer electronics, home appliances, home security and controls	HomePlugAV, HomePNA, HomeGrid/G.hn *(Interoperability; Device Connectivity)*	• Goal of these technologies is to help service providers cost-effectively deploy new offerings, including Internet • TV, allow consumer electronics manufacturers to network all types of entertainment, home automation, and security products throughout the house; and simplify consumers purchasing and installation processes; • Network connectivity includes a range of networking standards encompassing IEEE 802.3 and 802.11, HomePNA 3.0,MoCA, HomePlugAV, etc.

Source: Frost & Sullivan Analysis.

In addition to the above, the previous chapter also points out various standards in the smart grid and home-to-grid area that are currently underway to achieve interoperability, communication and enhance management capabilities within the connected home. The key issue is ensuring that ongoing standards development activities eliminate the drawbacks inherent in present standards, and promote the following features and characteristics:

- Create true plug-and-play for devices
- Eliminate or minimize clutter of wires, cables and plugs
- Make the connected experience simple, with interfaces and remote controls that are less complicated and more intuitive
- Create more intelligence in devices
- Incorporate more energy-efficiency and smart grid features

4.3.4 Penetration of Existing Protocols

Among the various protocols that have come to exist within the connected home industry, ZigBee, Z-Wave, an Wi-Fi appear to be most commonly adopted and integrated by technology vendors. Considering the connected home concept is at its early adoption stages and new enabling technologies will continue to emerge in the market, it is not possible to conclusively determine which type of protocols will ultimately dominate the market.

Frost & Sullivan's research indicate that over the next decade, the industry will witness multiple technologies and protocols coexist within this industry. As the delivery ecosystem gets increasingly comprehensive, vendors and technology providers will have to collaborate in ensuring that the consumer's experience of adopting their products and service is less complicated and cost effective. Broadly the observations of this research are as follows:

- ZigBee contains several features that are designed to promote coexistence and robust operation in the face of interference. Even in the presence of interference, ZigBee devices continue to communicate effectively.
- The reason Z-Wave and/or ZigBee is preferred to Wi-Fi is that these technologies are both cheaper and require lower power. The chipsets are cheaper, and they can be set up as mesh networks which can eliminate the need for a base station. The power difference was considered quite significant. For instance, a battery in a Z-Wave or ZigBee thermostat can last many months where Wi-Fi might be only weeks.
- The Wi-Fi Alliance has announced plans for a separate version that will feature both lower power and mesh, however dates and cost are at this point unknown.
- Interestingly, there are products appearing in the market that would allow the last link to the managed device to be ZigBee, even without a ZigBee Smart Meter, through integration of ZigBee into an existing home network. For instance, Belkin has announced that it will be releasing a Wi-Fi router with ZigBee 2.0, and Schneider Electric has a ZigBee module that connects to a home network via Ethernet.
- For remote access, there is wide consensus that communication would be enabled through the Internet, therefore, Wi-Fi is certain to be a requirement so that the manageable device can connect through the wireless router present in most homes.
- At the field device level, it is clear that ZigBee and Z-Wave will continue to be widely endorsed by product manufacturers and technology vendors. More commonly, suppliers will advocate compatibility with both protocols.
- On the utility side, particularly in the area of smart metering and home area networks, ZigBee SEP, Power Line as well as HomePlug are emerging as prominent enabling technologies and will continue to be adopted with varying degrees of effectiveness.
- Owing to issues of incompatibility, inter-communication hindrances, and lack of openness, both in protocols as well as technology solutions, it is unreliable to draw definite conclusions regarding the uptake and penetration expected in these protocols over the next decade.
- Ultimately all protocol harmonization and standard development initiatives will have to be undertaken keeping the consumer in mind, and ensuring that the real value behind plug-and-play, interoperability and ease of interface is experienced by the consumer.

Communication Issues among Various Components

The research evaluated the communication paths, and issues that presently exist among various components of the connected home and the smart grid. It is not clear at this time what kind of requirements have to be met by various technology vendors and service providers to neutralize issues. This is due to the fact that the existing connected home environment will have to continue to accommodate future innovations in products and technologies that will make their way into this industry. Additional smart devices and communication platforms entering the industry may render the present communication paths and processes inadequate.

The main issue that will continue to delay the industry from witnessing real connectedness is that propriety protocols are still widely prevalent, and the issue of sharing IP prevents seamless communication from happening between various domains of functionalities within the connected home. For instance, the home automation industry has only partially adopted open communication protocols. Majority of home automation and controls solutions do not easily interface with other home devices. Thermostats often do not work with IHDs, and there is practically no universal console that can bring together various silos of home controls and devices into one robust platform. While some working groups and industry alliances are actively pursuing open communication standards for home devices to be managed by any external third party, there is resistance from the suppliers of these devices and appliances to comply for concerns of prospective revenue loss.

As an example, it is interesting to note, NIST's Smart Grid Interoperability Panel Domain Expert Working Group called Home-to-Grid, or NIST SGIP H2G DEWG, is currently working on a similar initiative. The idea is to create standards for communication within the home for management by external third parties in an agnostic manner. The specification for such a communication protocol would be open, both for the communication protocol and the application layer, so that market forces can decide which vendor or service provider would claim better presence in terms of providing a pervasive connected home experience. To allow for a variety of communication protocols, the actual interface to the thermostat, or appliance, or hot water heater, would be a replaceable module that might house Wi-Fi, ZigBee, Z-Wave, HomePlug, or any other enabling technology. This spec is expected to be completed and released shortly.

This modular approach endorsed by NIST is also considered well-aligned with the DOE's Energy Star program's push for the appliance industry to accept the requirement of a modular interface to qualify for future Energy Star rating. However, the appliance industry as represented by AHAM, is somewhat resistant to this approach. The appliance industry's value proposition is guided by a desire to completely control the physical interface to the appliance. This could take the form of an internal radio like Wi-Fi on their control board to which the customer would be required to communicate via a gateway or HAN/HEMS supplied by the appliance manufacturer, or communicate via an external socket proprietary to that appliance manufacturer.

Discussions with DOE, NIST, and the appliance industry on this issue make it clear that AHAM's stakeholders are indeed, via this approach, trying to ensure that energy management is an additional revenue opportunity. However, the consumer perceptions reviewed by Frost & Sullivan, clearly indicate that appliances are more likely to be purchased as replacements to

failed units, or in other words, in single purchases (e.g., one refrigerator or dish washer at a time), rather than a whole suite of appliance purchase. This purchasing behavior eliminates the need for consumers to procure additional products, which in turn could make it unmanageable for them.

Overall, it is clear that a more serious effort in moving towards an open environment for standards, protocols and technologies is necessary to take connected homes to an acceptable level of consumer adoption. Otherwise the penetration of various products and solutions will continue to remain modest at best over the next decade.

4.3.5 Scope for OTT Services

Over-the-top (OTT) is a general term for services that ride on top of a basic service that consumers already receive, and do not require any business or technology tie-up with the network operator. In the area of connected home, OTT services and applications will more prominently comprise of Internet TV and in-home entertainment media, which most carriers are already geared to provide. OTT service providers are eyeing the connected home market by way of offering their applications and services to other multiservice operators, and in turn helping them strengthen their end-customer relationship and drive revenue growth.

By leveraging the power of the cloud OTT providers are able to offer the end-user full control over his/her content through local storage and management. Although the range of services vary, generally most OTT providers' cloud-based software platform, and hardware products integrate a wide range of technologies and solutions ranging from digital pay-TV, Internet, home networking, and computing domains, and provide advanced TV solutions for telecom operators, cable operators and pay-TV operators, thus responding to the need for an enriched TV experience of the end-user. Several OTT portals (e.g., Apple, Amazon) have carried out significant global expansion initiatives, driven by the growing adoption of OTT video via connected in-home devices, tablets and smart phones. Additionally, the industry is witnessing applications and service providers collaborate on a variety of areas to offer solutions in this area. For instance, IBM is working with a wide range of customers globally, including service providers and consumer electronics companies, who are pursuing ways to build value through over-the-top services.

Although there are OTT cloud-based platforms providers, who feel it is possible to create a lucrative market for connected home services, with, or without the engagement of network service providers, this could prove to be a significant challenge for them. Given the service-reliability requirements for attending to broadband-delivered home security, energy management and other applications, this may not be a reliable route to the market.

Key market participants such as Verizon do recognize the issues associated with being a full-service provider, and have instead adopted a hybrid model of delivery. Besides offering its own home monitoring and control service, Verizon is also creating the groundwork for other providers to leverage its network to deliver their own branded services. The idea is to capitalize on what Verizon can integrate and offer as a robust service for its consumer, and leave some flexibility for the consumer to incorporate other services by themselves.

In creating a business model, OTT service providers would need to keep in mind that they, ultimately, have to offer the consumers the ability to pick what they want from web-based services, without having to take a bundled arrangement they may not want from the network service provider. Operating as a standalone third-party supplier of such services is a challenge, however, there are providers trying out this option (e.g., Alarm.com). But service providers agree that in the best scenario, carriers would act as enablers to other providers.

4.4 Standards Developments for Home and Grid Communication

The Association of Home Appliance Manufacturers (AHAM) is an accredited organization by the American National Standards Institute (ANSI) and is a fairly active participant in developing standards related to making smart home appliances compatible and capable of interacting with smart grid technologies. The emphasis is on developing technologies that do not cause significant disruption or life style changes to a household's way of living.[32] Technologies promoted to the residential market should be simple as in "set it and forget it".[33] The organization also states that in order to motivate consumers to take advantage of smart home appliances and for smart grid to become successful a dynamic pricing structure is necessary. So the consumer can make adjustments to its electricity consumption usage pattern according to the TOU rates. However, these need to occur without causing any major interruptions to the consumer's daily life. This scenario presents many opportunities for product development especially as utilities transition to TOU rates following the AMI deployments.

In terms of promoting open communication protocol AHAM is mostly focused on HAN technologies in which a single communication network can speak to multiple devices and not just one device. Also, devices are not just limited to household appliances but also extend to electric vehicle charging, renewables, and other future devices. There are some technology providers that are in the midst of promoting such as jETLUN that specialize bridging technology. The company offers a product that is branded JAMES, which ties the meter to the HAN. The technology itself is referred to Advanced Meter Extension Solution. In addition to open communication standards, the communication network must be secure as well as flexible. The technology must be flexible because appliances are typically used for ten plus years and usually moves with the owner the communication network must therefore be able to withstand that. AHAM suggests applying a hub based architecture[34] that is able to coordinate with multiple devices as well as different connectivity and security implementations. The hub will act as a conversion point that can adapt to switch in protocols and physical layers without causing the smart appliance to become obsolete. This hub can be situated in either within AMI, an energy management system (EMS), or any other device[35].

[32] Smart Grid White Paper –The Home Appliance Industry's Principles & Requirements for Achieving a Widely Accepted Smart Grid, Published by the Association of Home Appliance Manufacturers. December 2009
[33] Ibid
[34] Assessment of Communication Standards for Smart Appliances: The Home Appliance Industry's Technical Evaluation of Communication Protocols, October 2010
[35] Ibid

4.5 Anticipated Milestones in Technology Evolution at the Grid

Based on the analysis above, chart 4.6 summarizes the anticipated technology roadmap and milestones. The following initiatives are expected from the utility end, encompassing smart meter deployment, AMI, time-of-use rates, as well as security initiatives.

Chart 4.6: Anticipated Milestones in Technology Evolution - Utility End

Duration	Trends
Near Term (1 to 2 years)	Decision to adopt an open platform for meter technologies to aid further deployment of smart meters and AMI systems Development of multi-functional energy management system Initial roll out of demand response service for residential customers
Mid Term (3 to 4 years)	Partial rollout of TOU rates (many states might have this as elective option unless the states passes a legislation to mandate TOU rates for residential consumers) Adoption of multi-purpose meter data management system that ties asset management, CRM, commodity management, demand response, and distribution grid management. Compliance with Smart Energy 2.0 (though some industry participants question the resilience of this standard and expect this standard to compete with OpenADR and GreenButton).
Long Term (4 to 5 years)	Stronger confidence to tackle cyber security issues Adoption of single communication platform within HAN Registering of smart home appliances with utilities in territories with full AMI deployment Convergence of AMI systems with distribution automation

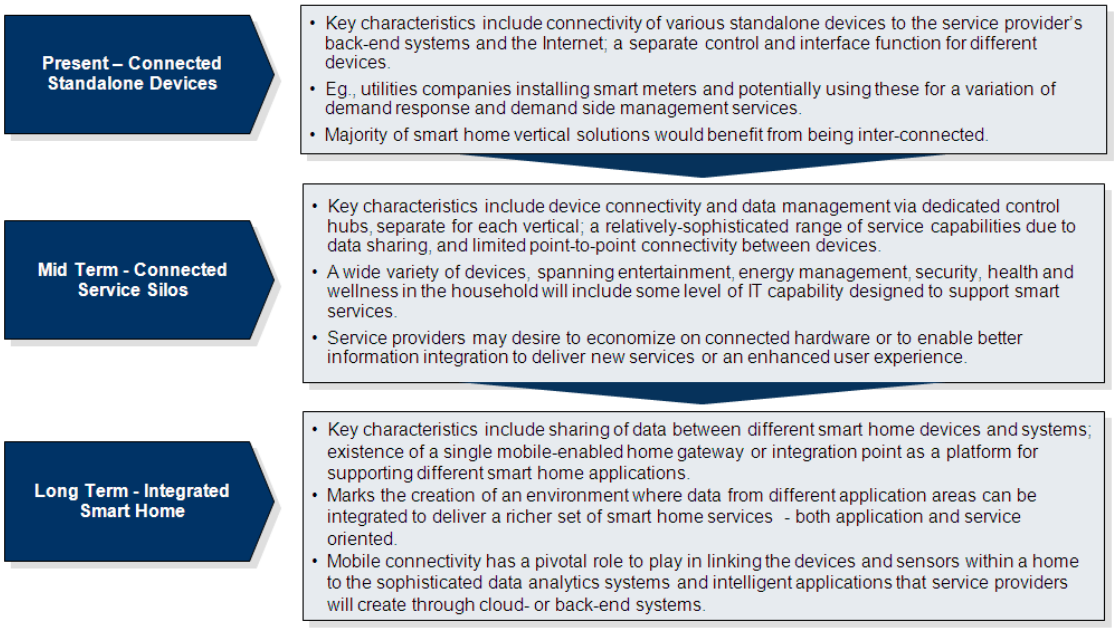
Source: Frost & Sullivan Analysis.

From the perspective of the connected home participants, the key milestones expected over the next decade would include initiatives in the area of standardization, openness in interfaces, technology collaborations, to name a few, which are discussed in the subsequent sections.

4.5.1 Achieving the Connected Environment

Given the stage of adoption and the issues presently witnessed in technologies for the connected home, it is clear that the full vision of the connected home will be realized in progressive stages. At present, embedded connectivity is a novelty in a few high-end home devices. With the exception of connected home devices based on Z-Wave technology, most home control is limited to high-end homes. The Z-Wave Alliance estimates that over 3 million alarm panels are expected to be installed in mid-end homes in 2012, which would be tied to the Internet and monitored 24/7 with Z-Wave radios in them. However, in the future, connectivity is expected to be pervasive, and a feature of virtually all household devices and applications, provided the industry participants addresses the inherent restraining issues cited earlier. Frost & Sullivan's research indicate that the industry can expect to see a few distinct stages of market evolution, which will in turn dictate what technology, product or services would be connected in this environment. These are discussed on Chart 4.8.

Chart 4.8: Achieving the Connected Environment



Source: Frost & Sullivan Analysis.

The immediate and midterm periods will continue to witness varying degrees of connectivity between systems and devices within the home, primarily geared to meet ad-hoc needs of the consumer. As technology improvements gradually embrace better integration of other applications and services in the long term period, a fully integrated smart home could be achieved.

However, the ultimate success of this will be determined by the consumer's perception of value with such integration. The arguments in favor of energy savings and efficiencies in operating the home may not be good enough by themselves to help the consumer justify the need for a

connected home. Monetizing energy saved/generated could be a more compelling value proposition that could change consumer perception in favor of connected homes. Additionally, better managed services from their service providers, single integrated platform with connectivity anywhere, would be other demand influencers.

5. Evaluation of Business Models

5.1 Evaluation of Existing Models and their Relevance

The market approaches adopted by various connected home product, technology and service providers at present ranges from being point product/solution delivery model to a partially full service model, depending upon their ability to meet consumer demand. While participants such as home automation and controls suppliers, appliance manufacturers, and other home device providers generally adopt an upfront pricing model for their consumers, the communication service providers and other third party solution providers would usually adopt the subscription-based pricing model for their consumers.

Recurrent revenue is usually realized from service and maintenance contracts by product and technology providers. For communication and entertainment services, and hardware/solution providers, there is a stronger dependency on duration-linked contracts or bundled services to avoid customer churn and sustain revenue streams.

Given the inter-link between various connected home segments, and the need for players to collaborate to deliver a fully, or partially connected offering, multiple segments of participants could indeed be combining product/service portfolios together to meet a certain consumer requirement. In such cases the elements of the value chain could converge to a certain extent.

Chart 5.1 shows the elements of the present business model adopted by the most active connected home industry participants – home automation and controls, energy management, appliances and the telcos.

Chart 5.1: Elements of Present Business Model

Active Market Participants	Prevalent Model	Expected Changes
Home Automation; Appliances, Other Home Devices; EMS	○ Vendor-centric Model ○ Piecemeal service collaboration ○ Combination of distribution, installer/contractor, and house-rep network to reach the consumer ○ Limited or no-collaboration in technology development with other vendors ○ Upfront product/technology price plus on-going service/maintenance fee; Some subscription based services where EMS is integrated ○ Recurrent revenue from repair and maintenance, and product upgrades	○ Open collaboration for technology development and integration will lead to partnership models for product and service delivery to consumer ○ Revenue share arrangements with partners – factored into customer pricing ○ Partnerships will lead to centralized service delivery model and use of cloud based platforms for ongoing services ○ Potential migration from upfront pricing to subscription based pricing
ISP; Communication Services; Entertainment	○ Subscription based model for various consumer home services ○ Bundled service delivery to achieve longer engagement with the consumer ○ Duration-linked/contractual pricing ○ Aggressively adding security and home monitoring as added revenue streams – fifth play ○ Downward price pressures forcing service providers to resort to bundled services rather than individually pricing each component of the bundle ○ Active collaboration amongst carriers, network services providers and cloud based service providers to bring OTT services to the consumer ○ Convergence services slowly gaining importance as additional ongoing revenue stream	○ Deliver more to retain customer loyalty ○ Efforts to neutralize lower spend ing on certain services by up-selling/adding others ○ Take initiatives to mitigate challenges associated with partnership-based service delivery – resolve consumer's confusion as to who is responsible for downtimes/service issues ○ Delivery models will factor in self-help or self-installation solutions to keep operating costs low – could be a potential new revenue stream ○ Steady revenue generation expected from convergence services

Source: Frost & Sullivan Analysis.

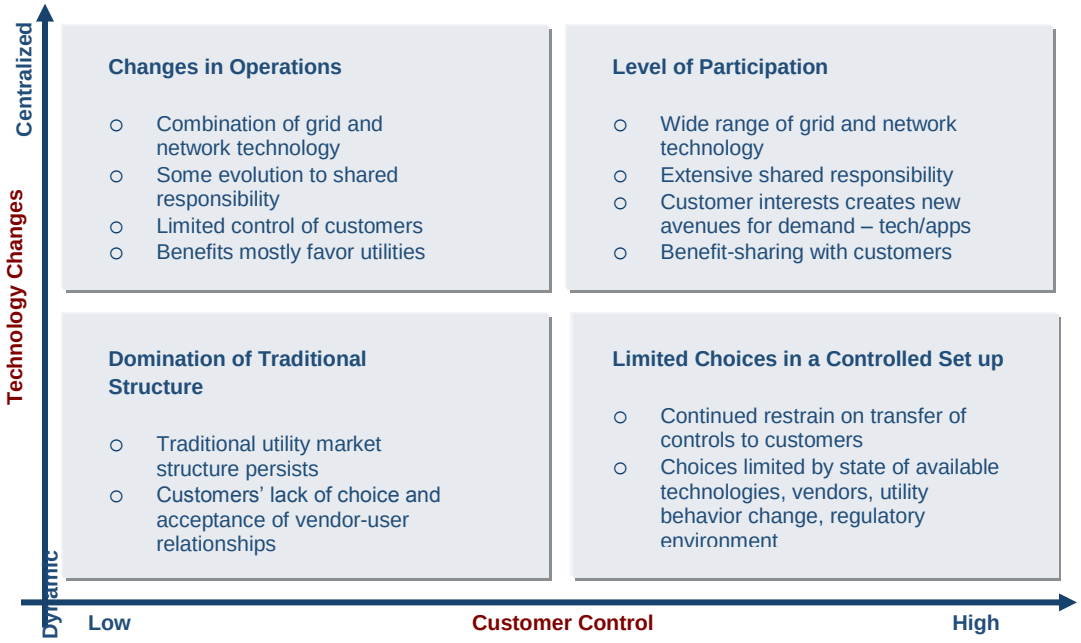
The present model of business prevalent in the utility industry would also need to be reviewed in order for utilities to play a progressive role in making connected home a reality and allowing for seamless integration with the smart grid.

Chart 5.2 shows the expected changes in the utility industry model, in gearing towards a fully deployed smart grid.

From a centralized setup, the utility industry would have to evolve into a more dynamic structure. This new structure would have to advocate a participatory network of grid and network technology to cater to changing consumer behavior, demand situations, and an environment of shared responsibility among a myriad of service and solution providers.

Over the next decade, both utility and connected home service providers will have to strategize to move closer to their individual goals and overcome their challenges in order to meet the emerging needs and take advantage of the opportunities and revenue streams they will create.

Chart 5.2: Changes Anticipated in the Utility Model

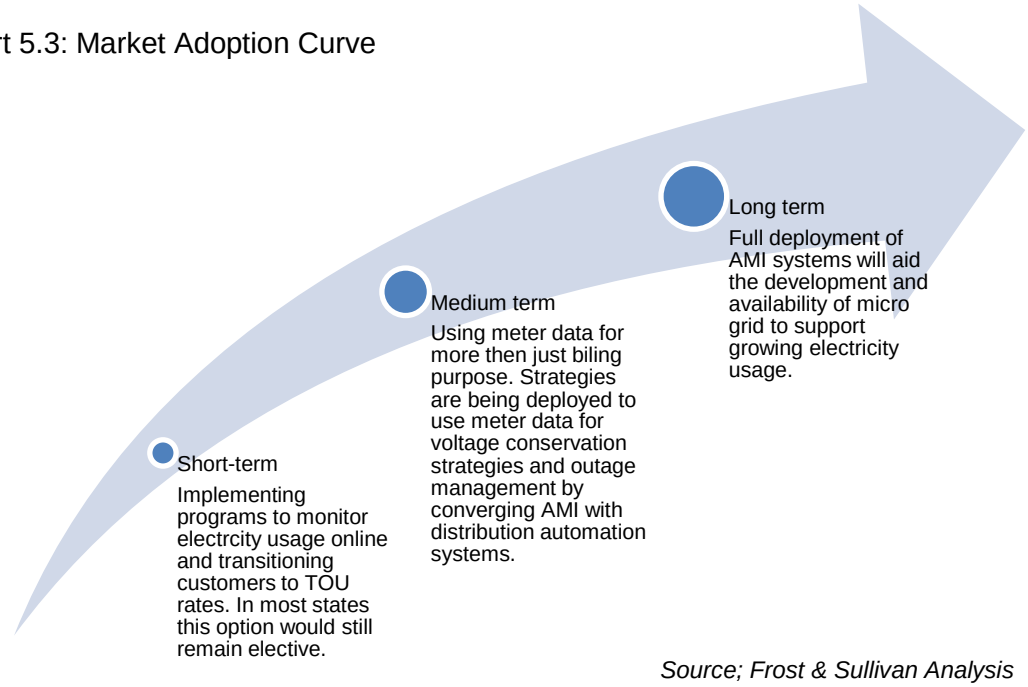


Source: Frost & Sullivan Analysis.

5.1.1 Market Adoption Curve – Short, medium and long term

From a utility angle market adoption curve focuses on smart meter, AMI, meter data management, and demand response. Chart 6.1 depicts the various elements along this curve from the utility side.

Chart 5.3: Market Adoption Curve



Source; Frost & Sullivan Analysis

Short term –Familiarization with accessing meter data online

Market penetration of smart meters is estimated to be around 25 percent in North America, which is a relatively still a low number. In the territories with heavy smart meter deployment, demand response for residential customers have not been fully rolled out. The priority instead is transitioning customers to TOU rates and customers are able to monitor electricity usage online on the utility's website. In areas where smart meters have been deployed most residential customers are still in phase of familiarizing themselves with tools to monitor electricity online. Pilots are currently limited to a small set group of customers and most of these HAN pilot test focuses on smart meter interaction with the smart thermostat, including curtailment of HVAC usage during peak power period.

Medium term –Convergence of AMI with Distribution Automation

Within the next five years market penetration of smart meters is expected to jump to close 50 percent of households in the U.S. Most of the existing HAN pilot test should be completed and by now progressive utilities located in areas such as Texas, California, and Ontario should be further along with having residential customers on some form of demand response program as well as have applications in place to use meter data to conduct voltage regulations and improve outage detection by using meter data.

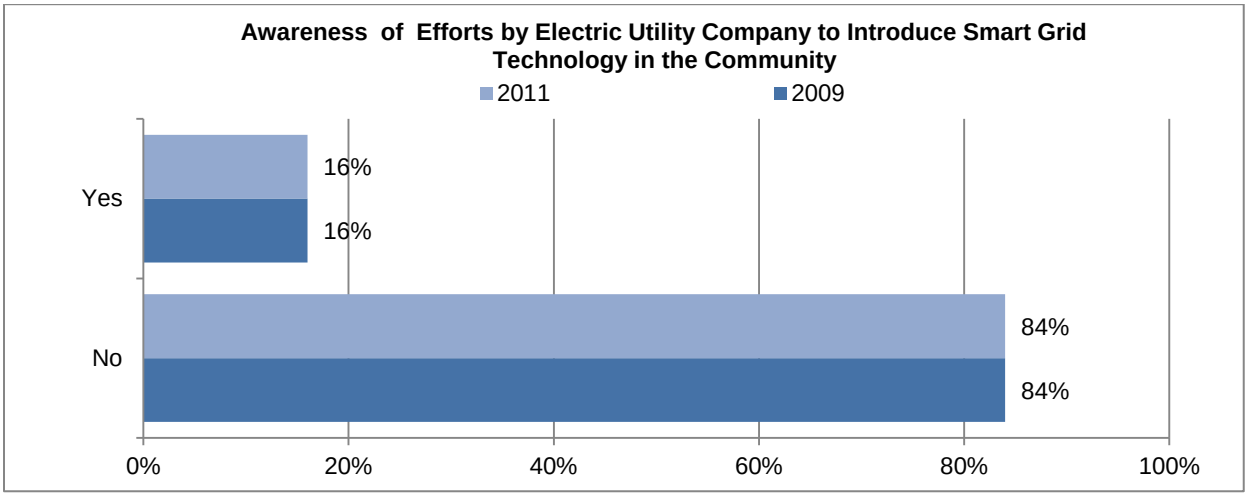
Long term –Formation of Microgrid

Smart meter deployment has reached a hundred percent and at this point meter data can be effectively used to manage the grid including wide spread of micro grids in support existing energy demand.

5.1.2 Customer Perception Analysis – Utility Services

Frost & Sullivan's analysis shows that overall residential customers are receptive to the idea of signing on to demand response program with the notion of possibly saving money in return. A survey that Frost & Sullivan conducted during 2011 illustrated overall, residential energy consumers are likely to manage their energy consumption through demand response and energy management devices to reduce their monthly electric bills. However, this survey also shows that there is still limited awareness about the utilities effort to introduce smart grid technology in the community.

Chart 5.4: Awareness of Efforts by Electric Utility Company to Introduce Smart Grid Technology in the Community

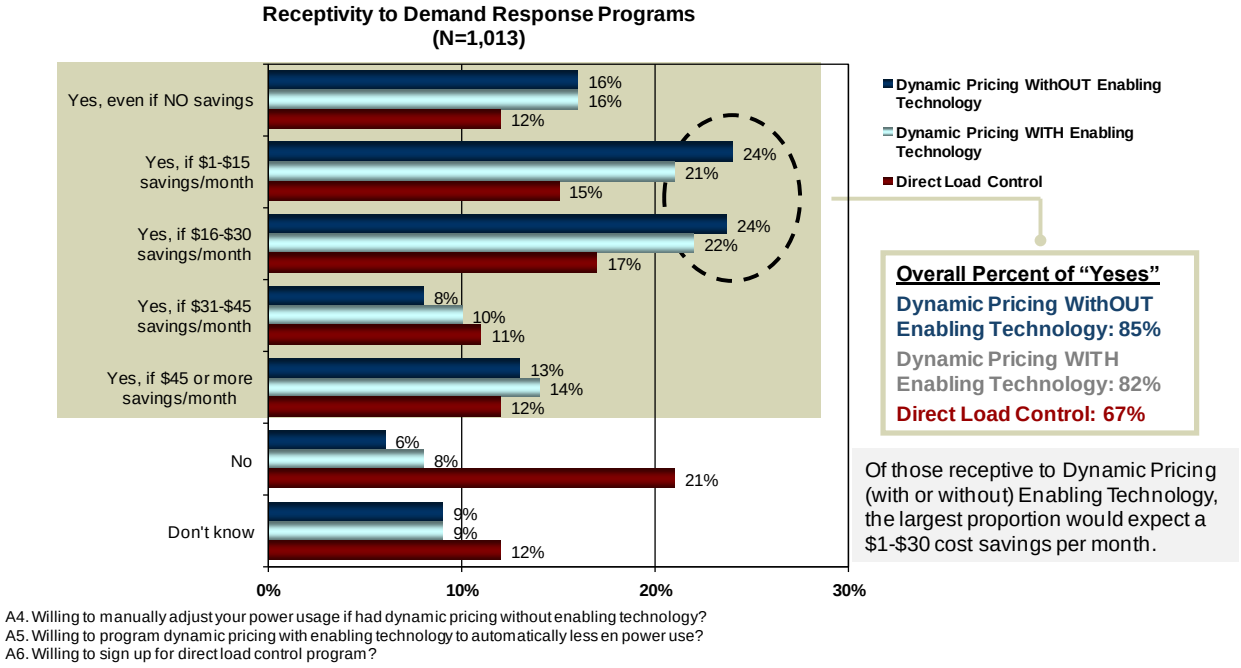


Source: Frost & Sullivan Analysis.

This survey shows that homeowners' behavior toward the use of demand response and energy management devices is not dictated by environmental concerns as much as it is monetarily influenced. In fact, the largest proportion of respondents report that cost savings would have a significant influence on their potential use of demand response and energy management devices. The "sweet spot" of cost saving expectations per month with dynamic pricing with or without enabling technologies is $16 to $30.

Interest in direct load control is lowest of the three demand response programs surveyed, yet still moderately high overall. However, this last place finish is likely reflective of the perception of loss of personal control/privacy related to direct load control. The expected cost savings per month by residential energy consumers is also from $16 to $30.

Chart 5.5: Receptivity to Demand Response



A4. Willing to manually adjust your power usage if had dynamic pricing without enabling technology?
A5. Willing to program dynamic pricing with enabling technology to automatically less en power use?
A6. Willing to sign up for direct load control program?

Source: Frost & Sullivan

Among those who are receptive to dynamic pricing with or without enabling technology and direct load control at any cost savings have similar demographic profiles: located in the Northeast (specifically in Maryland) in urban areas, are 18 to 24 years old, and have higher-income households.

In terms of adopting smart appliances consumers only 30 percent of these respondents stated that they would be willing to switch go smart appliance right away even before the current appliance is due for replacement.

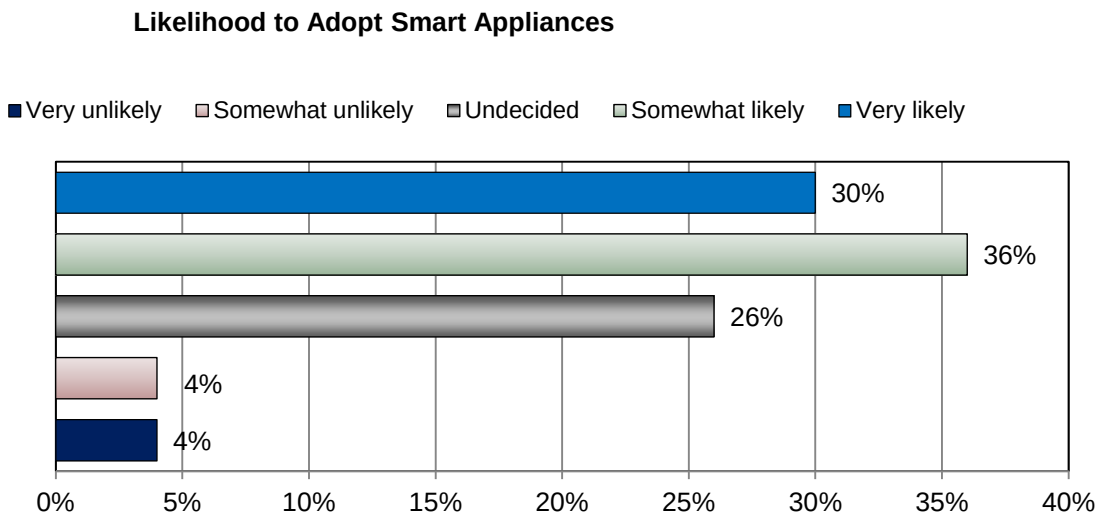
Chart 5.6: Timeframe for adoption of smart appliances

Timeframe for Adoption of Smart Appliances (N=668)	
Right away – even before my appliances come due for replacement	30%
Only as my appliances come due for replacement	70%

Source: Frost & Sullivan

Approximately 66 percent of respondents stated that they were either very likely or somewhat likely to adopt smart appliances.

Chart 5.7: Likelihood to adopt smart appliances



Source: Frost & Sullivan Analysis.

Among those who are likely to adopt smart appliances, 70 percent of these will delay adoption until appliances need to be replaced. And among those likely to adopt smart appliances, nearly two-thirds expect a short return-on-investment for their smart appliances investment - less than one year, as stressed in the earlier chapter.

5.1.3 Utility Ecosystem – Changes Needed

There are currently well functioning ecosystems in place in the industry in the form of smart grid working groups. As mentioned in the earlier section NIST has a smart grid advisory group, which consists of a mix of different entities from the utility, software, home appliance, and meter sector. Incorporating the expertise and specialty of these different entities is essential to improve adoption rate and further commercialization of smart grid technologies. The primary change required is in the form of adopting the recommendations at the federal level. As seen it was only when EPAct and EISA was introduced that the market experienced a movement towards smart grid. A revamped energy bill is required to take into account the current challenges that utility's face with funding, approvals, and customer acceptance.

5.1.4 Scope for Multi-functional Value Propositions from Utilities

Within utilities decisions for construction, retrofits, and upgrades are typically delegated to various departments, presenting challenges such as delayed decision making process, interoperability issues, and lack of synergy between the projects. Many progressive utilities have formed steering committees specifically for smart grid projects. These committees consist of representatives from key decision/relevant departments including asset management, IT, operations, and engineering. In terms of deploying connected home technologies the roles could be defined as following:

- Point solution provider: This would typically be a system integrator that oversees that all analytics to support demand response and TOU operate seamlessly with the installed networks and back-end business operations
- Prime integrator: The prime integrator in terms of installation would be left to either the utility itself or the communication service provider.
- Channel partner and reseller (after market): This could be energy management service providers that can leverage the existing network to promote value add services to the residential home such as an aggregator or other forms of managed energy service.

5.1.5 Issues with Bill Integration

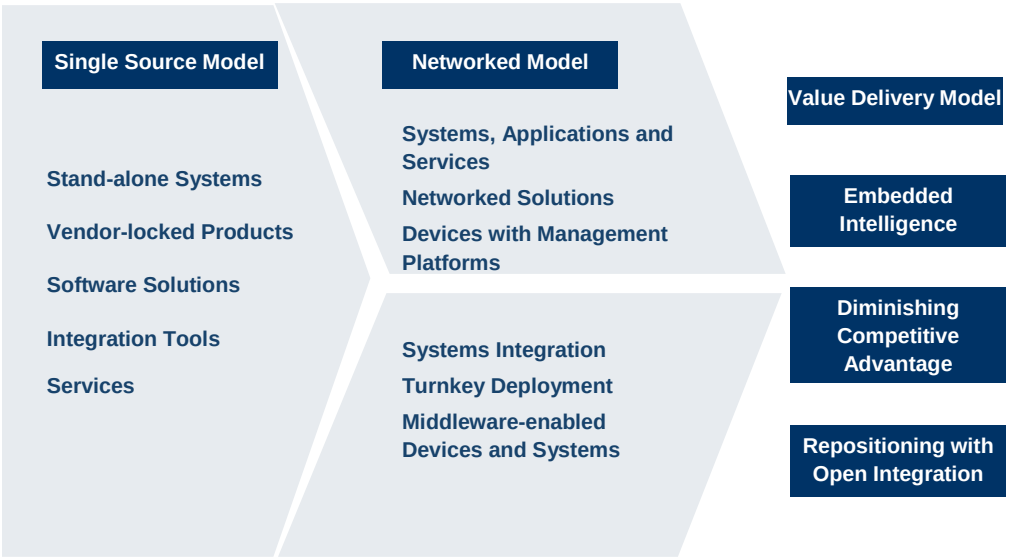
Issues with bill integration as it relates to utilities should be evaluated from a state level since as mentioned earlier the state regulatory PUC has a major role in promoting energy policies as well as approving utility projects. Potential problems with bill integration could be conflict of interest of the utilities involving timelines and investment required for deploying or complying with new technologies as well as the impact on current business.

5.2 Partner Ecosystem of the Connected Home Business Model

It is evident that the advent of new technology, service and solution needs in the emerging relationships between a connected home and the smart grid is likely to result in convergence of domain expertise of various vendors to cater to these new requirements. Although the utilities, home automation providers, and telcos are emerging as the three major groups of players characterizing this convergence, it is expected that this landscape could potentially change over the next decade as new applications and services make their way to facilitate the connected home experience.

Industry partners will eventually comprise a broad spectrum of product, technology, and service segments that will work closely to deliver intelligence, connectivity and managed experiences within the home, as well as redefine the connected home's relationship with the energy grid. Vertically defined, stand-alone products and application markets are expected to increasingly become a part of a larger 'horizontal' set of standards for hardware, software and communications. For connected home solution providers, this represents an opportunity to embrace a 'networked' delivery model that could potentially cut across multiple value-chain partner domains. The positioning of players in this model is going to be influenced by the manner in which product and technology innovation and service solutions will be channeled into the value chain. The value-chain itself is certainly expanding to incorporate a wider net of partners for business sustenance through these changes. To evaluate competitive advantages of players, it is important to take a look at the changing dynamics that product and technology vendors are dealing with. Chart 5.8 shows the changes in the delivery model for products and services.

Chart 5.8: Changes in the Delivery Model for Products and Services



Source: Frost & Sullivan Analysis

While partner rivalry is predictable, most consumer needs would be met by one form of collaboration or another. Alliance partnerships, strategic buyouts as well as open-source innovation will mark the competitive landscape of the connected home industry over the next decade.

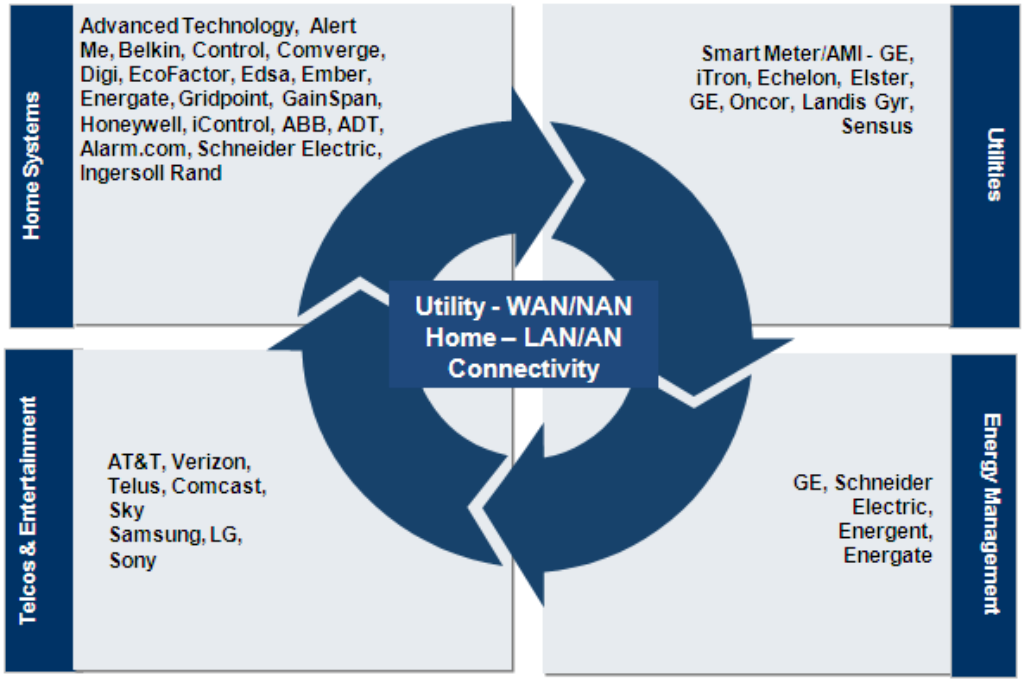
5.3 The Emerging Ecosystem

The success of the connected home, as evident from this research, is dependent on some of its key supplier segments working together. As the present ecosystem of silo-ed operators and service providers start to collaborate, the industry expects a concerted drive from these participants to gain “ownership” of the consumer. The emerging ecosystem will be defined by:

- Diverse set of suppliers and the co-operation/competition dynamics between them
- Technologies and standards that will co-exist in the connected home of the future
- The size and projected revenue growth of important service segments

Over the next five year period the industry will witness delivery of connected home solutions that are basically improvisations and extensions of existing products and service. The four adjacent industry segments that will actively shape this ecosystem include utilities; telcos and entertainment providers, and the home automation, energy management and monitoring providers. This is depicted on Chart 5.9. Participants shown here are representative in nature only.

Chart 5.9: Emerging Ecosystem

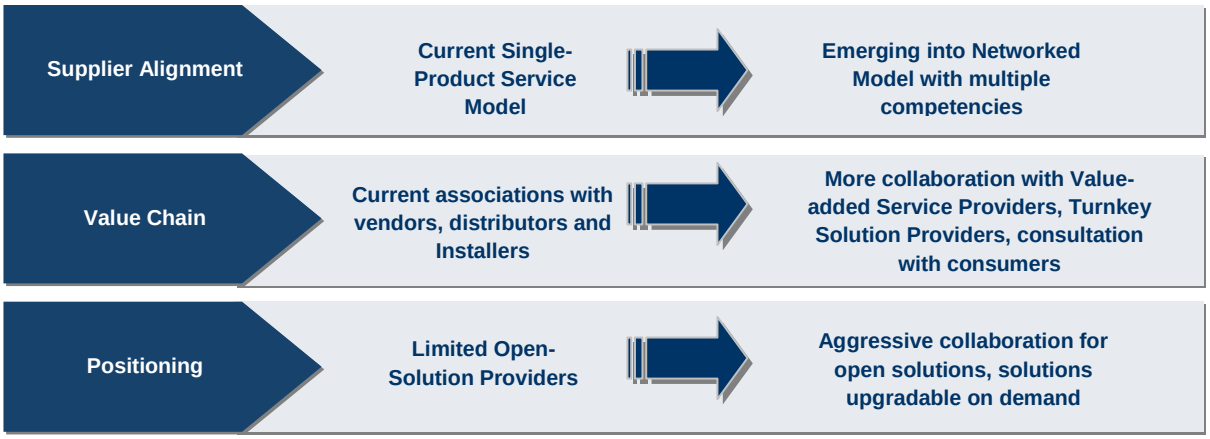


Source: Frost & Sullivan Analysis

5.4 Alignment of Participants – Emerging Dynamics

The connected home solutions, and the emerging industry landscape that these solutions will be part of, is likely to create a new generation of technology- and services-enabling players. These players would be linking users, producers, and intermediary channels in new ways and, in turn, creating many opportunities to offer the consumer new 'managed experiences.' This ultimately would allow the service provider to create and bundle new values. Chart 5.10 shows the expected repositioning of players for competitive advantage.

Chart 5.10: Expected Repositioning of Players



Source: Frost & Sullivan Analysis

In the home automation and controls front, relatively few companies have evolved into successfully designing and delivering fully integrated, networked and open solutions. The evolving combination of players is expected to work in a truly disruptive manner in the marketplace. Among restructuring initiatives that traditional players would have to undertake, there are some that are critically important over others. These are:

- Effecting culture changes within the organization
- Embracing collaborative/open source innovation in delivering business value
- Engaging customers

Organizational changes, particularly influencing corporate behavior and mindset are necessary for vendors to align themselves with emerging opportunities. Traditional approaches to vertical markets, value chains, and product diversification initiatives would need to be replaced by those dictated by new market realities.

Embracing collaborative/open-source innovation is easier said than achieved in most organizations that continue to dwell upon 'vendor lock-in' methods of doing business. While most organizations today express the desire to invite open innovation, in practice, such innovation takes much longer than anticipated from incubation to technology transfer and commercialization. However, as companies would have to rely on quick innovative infusions into their business to cater to dynamic market needs, the negative perceptions surrounding this initiative are expected to lessen.

Perhaps the most important of all initiatives is engaging the consumer. This would include understanding consumers' needs for connected solutions, gauging energy behavior, creating awareness about solutions and services, and understanding their prerogatives and financial appetite. It is evident that not enough is done by most solution providers in this area, and clearly more engagement is needed if vendors are to create better commercial prospects for their products and solutions.

6. Implementation Process

6.1 Defining Roles and Responsibilities for Various Partner

In implementing the connected home business model, the roles and responsibilities, dictated by the changing dynamics in the market, are expected to undergo moderate changes in the immediate term. With slow market adoption rates at present and technology improvements required to speed up the same, the existing alignment and positioning of players is expected to continue, although, collaborative initiatives to gradually move closer to a full-scale connected home environment cannot be ruled out.

Chart 6.1 shows the roles and responsibilities of some of the key players in implementing the connected home business model.

Chart 6.1: Role and Responsibilities of Key Players

Segment	Services	Responsibilities	Value to Consumers
Utilities and Energy Service Providers	Smart metering; home energy management	Implement regulatory initiatives Drive energy efficiency Incorporation of electric vehicles and renewables into the smart grid Endorse energy saving products and services and promote to consumers through incentives New interfaces for energy consumption tracking	Access to historical and current energy and utilities service consumption; Financial incentives Life-style improvement, convenience Ability to remotely manage home devices; Energy efficiency
Home Automation and Security Providers	Home controls, alarm monitoring	Create new functionality Endorse openness and ease of interface Incorporate wireless/ M2M capabilities	Increased safety and security Remote monitoring of the home
Communication, Media and Entertainment Providers	Communication services, Internet TVs, Game consoles media players	Continue with supply-side push and broadband penetration; Offer new IP-based/ OTT media services Package viewing devices (smart phones, tablets)	Content packaging and bundling

Source: Frost & Sullivan Analysis

The ability for various segment players to effectively deploy services and offset costs will depend upon the following:

- Investigating prospects within the value delivery chain, to create enabling products and service offers, before packaging the same for the consumer could potentially help to offset costs in bundling services.
- Besides, offering enabling products and services to the value chain intermediaries will also help in creating secondary revenue streams, as pointed out earlier.
- Offering service contracts to consumers that allow for continued revenue prospects, which in turn could help avoid imposing upfront delivery costs to a price conscious consumer.

6.2 Deploying Utility Two-Way Communication Network

When it comes to deploying smart grid technologies utilities accounts for the bulk of cost sharing. There will some instances, where the utility will decide to use a public communication network for its backhaul operations for which it simply needs to pay a license fee. However, in terms of AMI utilities often have to start for scratch for network deployment. Frost & Sullivan's global smart grid study identified the primary issue to be funding and budgeting. Improper

planning has led to detrimental consequences for some parties. In 2006, the Norwegian company Cinclus signed an agreement with energy companies E.ON and Fortum in Sweden to install 800,000 readers. The investment cost NOK 1.1 billion (approximately $199.8 million), but Cinclus failed to correctly estimate the cost of installing the meters in each home and lost close to $300 million in income. Cinclus's parent company, Telenor, has put the company up for sale and Cinclus has been classified as a "discontinued operation" in Telenor's income statement.

A more recent example is U.S.-based Xcel Energy's SmartGridCity, a smart grid pilot project in Boulder, CO. The utility company originally gave a cost estimate of $15 million, but ended up spending $44.5 million for the project and is facing criticism. This has raised red flags for other projects that are in queue for approval.

For HAN networks the utility would be responsible of deploying smart meters that has HAN capabilities or the ability to operate in conjunction with the communicate gateway or a hub architecture. The utility however, would not be responsible for carrying out the cost for smart appliances, smart thermostats or the energy management system that is located inside the house that would be the residing household's responsibility to bear the cost. The utility could establish mechanism to register smart appliances and qualify it for demand response. It could also provide rebates for purchasing smart enabled devices similar to Energy Star products.

Other avenues for offsetting cost would be achieved through product commercialization and approval of standards that would trigger possibilities for mass market for HAN technology.

6.3 Home Owners' Perceived Needs and Gaps

Frost & Sullivan's consumer perception research reveals that consumers are willing to spend their income on security, TV and media content, video over the internet (OTT), broadband services, as well as to a certain extent on home medical monitoring. However, making full-scale connected home services attractive to the mass-market will require considerable effort on the part of service providers. In order to convince the consumers to pay a monthly premium for connected home services, service providers will need to consider the following:

- Improve the value proposition of smart home services for the mass-market
- Look for potential to bundle these services with others, such as broadband and security

Given the progressive inroads made by the entertainment sector, other segments of the connected home industry participants may need to take a closer look at their model, and restructure their own. For instance, the introduction of double and triple-play service packages by broadband providers, created strong demand for rich media and TV services. It is clear that the determinants of consumer demand dynamics, which were perceived to be paramount by the service providers, are no longer critical just by themselves, unless they are considered in conjunction with other factors. Consumers will need to be provided with much more than just energy savings and connectivity if they are to pay for any services.

This change in demand dynamics will impact how various providers of products and services into the connected home will have to rethink their market approach. For instance,

communications service providers, to capture a greater share of the overall market for connected home services, will first have to enable the companies that deliver services to consumers, or in other words a 'B2B2C' service delivery value chain. This involves first working with the B2B portion of the value chain, which requires dedicated network equipment and enabling services, such as managed connectivity, security and software services. These services are effectively a move forward towards targeting revenues associated with consumer services, i.e., B2C portion of the value chain.

Therefore, meeting consumer needs, and bridging the existing gaps in their connected requirements, could potentially lead to secondary revenue streams for various industry participants. It is critical for product and service providers to consider such impending changes to their structure of business, and target the intermediaries within the value chain, either in an enabling capacity, or as co-service providers, such that they can optimally address both revenue prospects and consumer needs.

6.4 Potential Supplier Ecosystem for the Connected Home

The connected home market has many challenges including regulatory issues, interoperability between various smart home technology components, standardization, and the absence of an established and effective business model. Furthermore, since connected home technologies span different domains such as energy, security, entertainment etc, there is no one single vendor that can provide an all-encompassing connected home solution. A collaborative ecosystem is needed to facilitate implementation.

Given the emphasis on smart grid implementation in North America, most industry participants expect the utility industry to spearhead the implementation initiatives in the connected home front. The utility industry does agree that the 'connected home' is a necessary component for utilities to be part of, in order to derive benefits from smart grid implementation. This study investigated this aspect, proceeding with the initial assumption that utilities might see greater value to consumers in enabling a connected home, and in the process, derive the expected benefits of smart grid from consumers participating in connected home enabled automated demand response programs and home energy management.

However, the findings, discussed in previous chapters, clearly point to distinct challenges that the utility industry faces in implementing such initiatives. Investor-owned utilities that operate particularly in the regulated markets will not be diversifying themselves to provide HAN services. In other words, they will not be selling communication gateway systems, smart thermostats, or any other related devices inside the home. Utilities might influence the type of products/devices that are purchased based on Energy Star rebates and other recommendations, but they are not going to dictate what consumers need to buy.

Given these challenges, the delivery ecosystem will therefore, need to be structured with a greater degree of influence, and proactive initiatives from other participants of the connected home market. This structure has been conceived based on regulatory and market environment, technological capabilities offered by vendors, the perceptions of the customer base, customers'

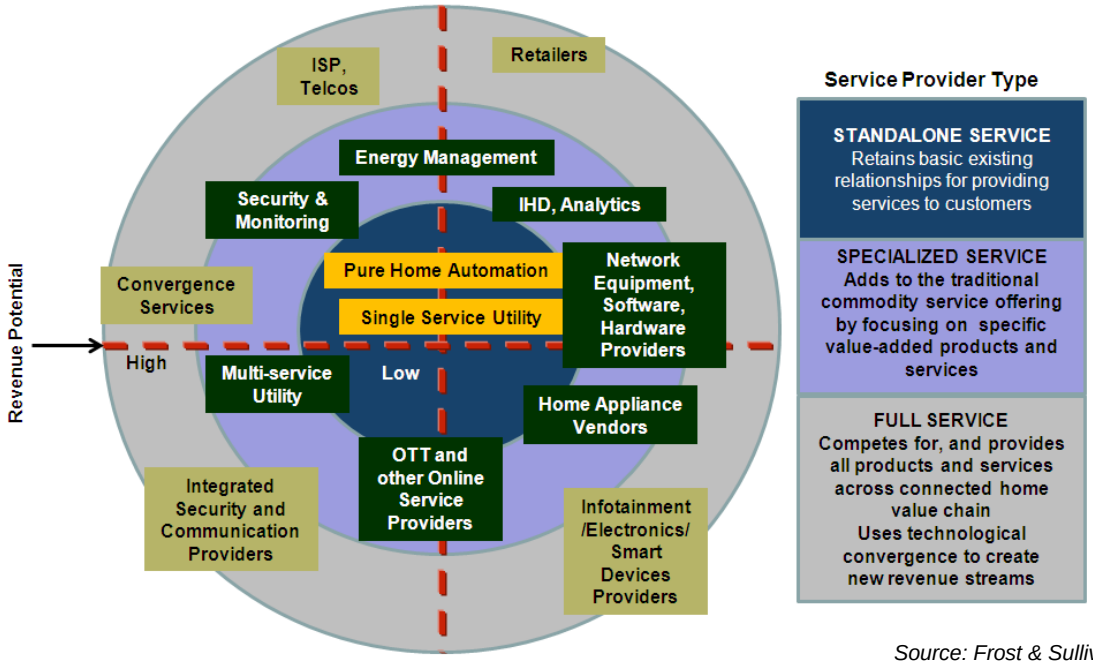
and service providers' appetite for change, and the current business portfolio of various service providers.

Services providers are categorized based on their ability to move away from offering mainly standalone or single point services to encompassing a wider portfolio and access to various connected home services. At the very core of the ecosystem service providers that are presently offering basic single-point standalone service to the consumer will continue to locate. Based on the dynamics exhibited at present, and the ease of mobility characterizing the particular service provider category, Frost & Sullivan expects that pure-play home automation providers, who offer closed systems, and single service utilities will prominently feature in this category. Given their present operating structure, business positioning, and limitation of their technology, any upward mobility for these participants is not expected in the short to medium term.

The next tier in the ecosystem comprises more specialized service providers, who can take due advantage of their existing customer base, technology profile and their ability to combine products and services to offer more 'tailored and combined' services to the connected home market. Typical participants in this tier consists of home appliance and technology vendors, multi-service utilities, HEM and IHD providers, OTT and other online service providers, security and monitoring providers, and software/hardware and network equipment providers. Services from these participants are already gaining good visibility within a connected home, and consumers are increasingly looking to them to offer specialized and multi-pronged services. Compatibility issues with technology, interoperability, and other issues such as ability to integrate B2B components harmoniously in delivering their final solution to the consumer, could potentially keep this category from moving outward to the full service tier. However, there is significant potential for these participants to get more vertically and horizontally integrated, if they effectively respond to the factors challenging such integration.

Chart 6.2 provides a snapshot of the potential ecosystem.

Chart 6.2: Potential Supplier Ecosystem of the Connected Home Market



Source: Frost & Sullivan Analysis.

Finally, the full service tier of the ecosystem will represent participants that are already well-entrenched within the connected home market by way of offering multi-point services at present. Typical participants comprise of telcos, ISPs, smart device combined with media and infotainment providers. Additionally, convergence service providers that bring together various consumer experience within the home – from telemetry, entertainment, health services, to energy and security monitoring are prospective candidates in this tier, who could emerge as the sole integrator of 'all things connected' within the home. Various national level retailers of home improvement, electronics and energy-related services are also trying to position themselves in this category. In terms of mobility and flexibility to scale up and down the tiers of the ecosystem, their tier is definitely better positioned to do so.

However, it would require this category to work closely with the utility industry so that connected home services offered by these players can also rely on, and leverage the presence of the physical infrastructure of the smart grid. This could in turn help both utilities and service providers to collectively derive benefits of the smart grid and the connected home. Consumers on the other hand will benefit from not only having a connected experience, but also one that factors in energy issues. Though energy management and savings is just one element of the connected home that appeals to the consumer, it certainly makes the bundle more attractive when consumers are taking their decisions on adopting connected home products and services.

7. Key Conclusions and Recommendations

7.1 Key Conclusions and Summary of Market Potential

The conclusions in this chapter are based on research conducted by Frost & Sullivan. The recommendations were developed based on how these conclusions are expected to influence the connected home growth trajectory.

The key conclusions of the project are:

- The connected home consumer prefers easy-to-use interfaces and simplified options to control, monitor and remotely manage his or her home.
- The demand potential for connected home solutions is further impacted by the perceived price-performance ratio of these products. Consumers do not have a clear idea of the actual benefits of buying these products and solutions, other than adding to their tech-savvy lifestyles.
- Competitive advantages will depend upon the vendors' ability to offer solutions that have multi-faceted features and can meet scalable needs for the customer.
- The IP-influence will continue to influence how home networks operate and which networks gain popularity, however, the future of the connected home will most likely require the presence of more than one internal and external network to meet customer needs.
- The ability of a connected home to integrate with the smart grid is a beneficial proposition both for home owners and utilities, however, optimized solutions in this area are currently in pilot stages only.
- There is a greater need for vendors and service providers to collaborate and create joint business models to service the connected home market.
- The immediate need for the industry participants is to organize initiatives to unify standards and protocols to enable peer-to-peer connections within the home as well as to better manage external communications and applications from a third-party service provider's network.

7.2 Strategic Messages

The top messages for the project participants are as follows:

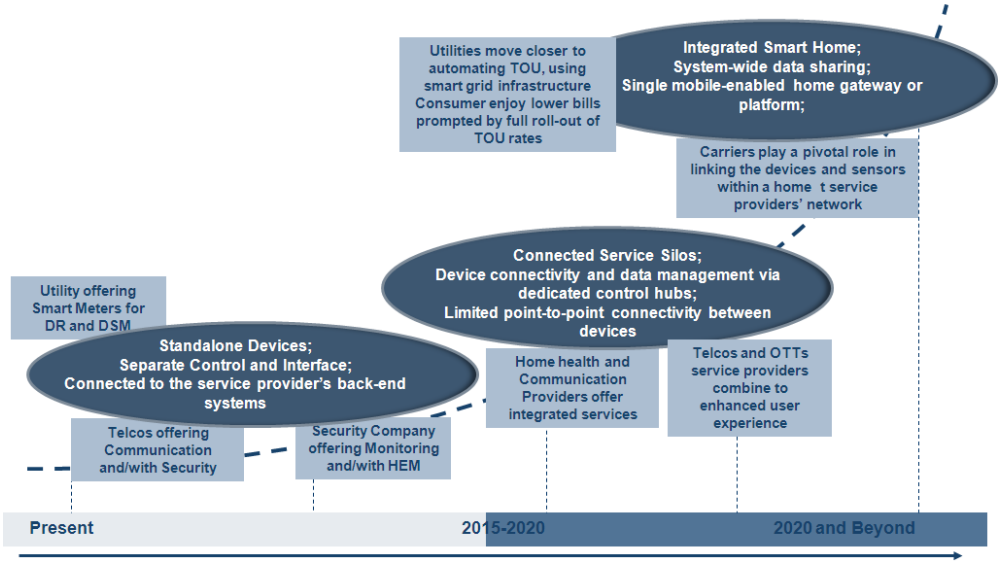
- Connected home industry participants are currently emerging as growing revenue contenders in an active and evolving industry. Emerging customer needs for home connectivity, device control, energy efficiency, security and on-demand mobility will allow vendors and service providers to expand their client base and product portfolio.
- For home controls and automation providers and telcos, an existing presence in their respective segments will provide appropriate visibility and brand recognition among home owners, and in turn the ability to leverage existing customer base for continued business. These initiatives could potentially help the company move higher within the market share pyramid.
- However, in an evolving and less-defined market, all participants will be faced with persistent aggressiveness from new entrants as well as existing players in adjunct

connected home segments that are trying to move up in the value chain with enhanced products and service offerings.

- It will be imperative for all industry participants to consider augmenting service and expanding product capabilities into their current portfolio to remain competitive in the market.
- With strong positions maintained by telcos and home automation providers, industry participants in other segments such as home energy monitoring, analytics and diagnostics, value added services, etc. will have to take into consideration factors, including ease of service deployment and integration with existing solutions in the home, technical sophistication in delivery, and most importantly the security and privacy of consumers to keep ahead of the curve.

Chart 7.1 shows the potential timeline for major issues expected to be witnessed in the Connected Home Market.

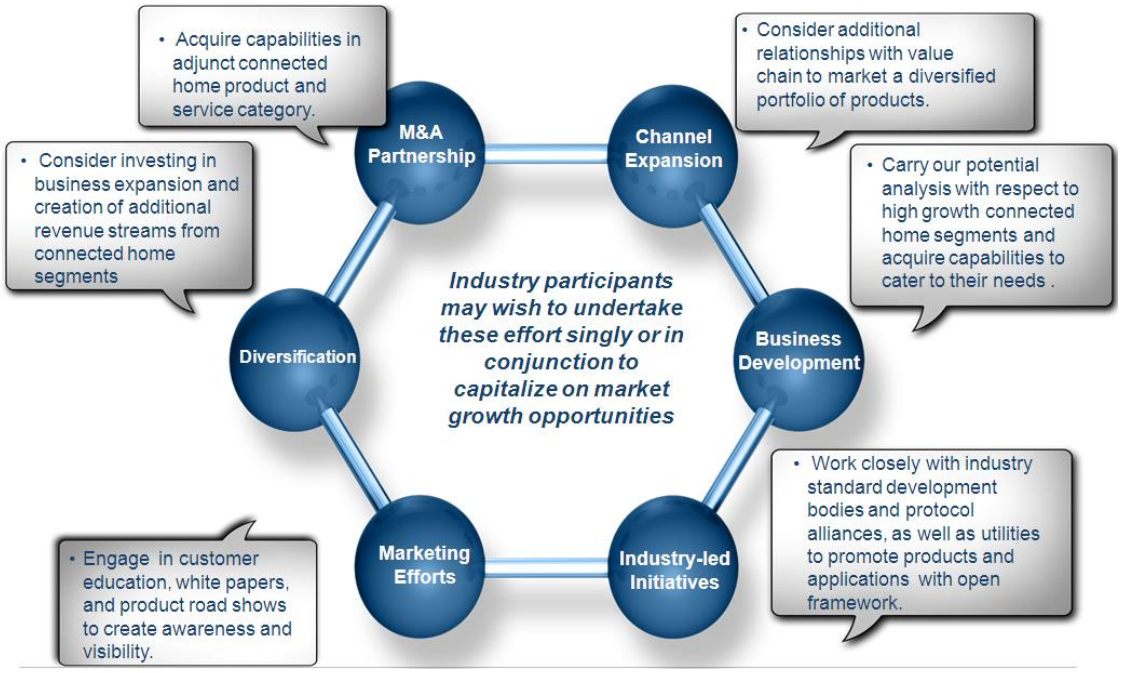
Chart 7.1: Timeline for Major Issues



Source: Frost & Sullivan Analysis.

Chart 7.2 depicts the strategic decision making scenarios for industry participants.

Chart 7.2: Strategic Decision Making Scenarios for Industry Participants

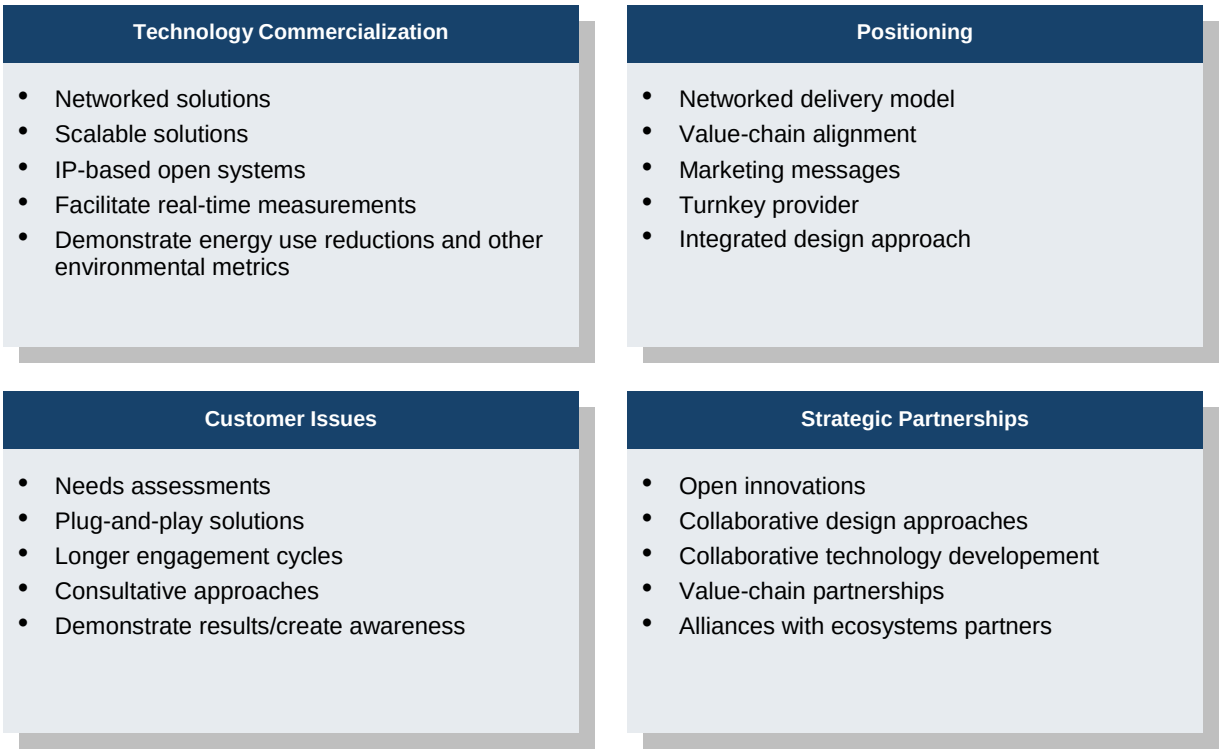


Source: Frost & Sullivan Analysis.

7.3 Recommendations

The recommendations are developed based on the research team's evaluation of the key conclusions of this project. Chart 7.3 outlines the key areas of focus for industry participants, identified as part of this research.

Chart 7.3: Recommendations and Identified Areas of Focus



Source: Frost & Sullivan Analysis.

Among all key issues analyzed, those outlined above appear to be critical in determining the success of industry participants in addressing emerging market opportunities in the connected home space. To respond to opportunities promptly, it is inevitable that most participants will have to use the alliance route to bundle solutions, without investing in building their own competencies from scratch. Customer needs evaluations are expected to be significant in determining the acceptability of various solutions offered and influencing the overall pace of market acceptance for products, services, and solutions. Technology innovation and positioning of participants will exert simultaneous control and establish the manner in which industry participants will gear up to respond to customer requirements and innovation needs.

In the immediate term, energy efficiency and security will continue to be the key drivers for adopting connected home technologies. The ability to quantify energy savings, create ways of reducing energy and operational expenses, and most importantly control all security aspects of the home from any location will be instrumental in keeping market demand sustained for these solutions.

In addition to energy efficiency and security, the adoption will also be determined by consumers' ability to realize financial and bundled services incentives from such installations. Technology vendors, meanwhile, will be prospecting opportunities through IP integration and offering more networked and open solutions.

Over the next decade, the changes in the delivery models and ecosystem alliances are expected to dominate the industry landscape as participants prepare to address the connected home's potential integration with the smart grid through the deployment of utility home area networks, residential demand response, and readying for the next level of end-to-end infrastructure deployment. Integrated approaches to solution delivery are likely to be adopted and participants are expected to work collaboratively in an end-to-end infrastructure environment with more systems integration, networking, and cloud-based models. The industry expects connected home solutions to gain better commercial acceptance in this time-frame, as the key focus areas identified for the success of these solutions gradually get addressed through the strategic initiatives of industry participants.

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Additional Information: CABA Contacts

Additional detailed findings are available via a PowerPoint version of this report. Please contact CABA for further information; see contact information below.

Contact

John Hall
CABA Research Director
1173 Cyrville Road, Suite 210
Ottawa, ON, K1J 7S6
Phone: 613.686.1814 x227
hall@caba.org

George Grimes
CABA Business Development Manager
1173 Cyrville Road, Suite 210
Ottawa, ON, K1J 7S6
Phone: 613.686.1814 x226
grimes@caba.org