EnergyRight® Solutions

Benchmarking Study

for TVA Smart Communities

April

2014

This paper describes the results of research conducted by Deloitte on behalf of the Tennessee Valley Authority (TVA). It presents leading practices in the design and implementation of the TVA Smart Communities project, including both Smart Energy Technologies and Extreme Energy Makeovers.

TVA energyright solutions

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March 14, 2014

Frank Rapley
General Manager, EnergyRight® Solutions for Home
Tennessee Valley Authority
26 Century Blvd
Nashville, TN 37214

Dear Mr. Rapley:

This document serves as the national benchmark study report for the Tennessee Valley Authority (TVA) Smart Communities project. This deliverable presents our findings on leading practices related to both Smart Energy Technologies and Extreme Energy Makeovers. Deloitte has provided a market overview and framework for each project, as well as a description of the primary business models being used in each market.

We have very much enjoyed working with TVA on this project. We hope you find Deloitte's passion for this subject matter reflected in the depth of the analysis and in the quality of the recommendations set forth in this report. We look forward to continued discussions with TVA regarding our findings.

Please do not hesitate to contact me by phone at (813) 230-3714, or by e-mail at jamthomson@deloitte.com.

Sincerely,

James Thomson
Principal
Deloitte Consulting LLP

Attachment

Table of Contents:

1.0 Executive Summary

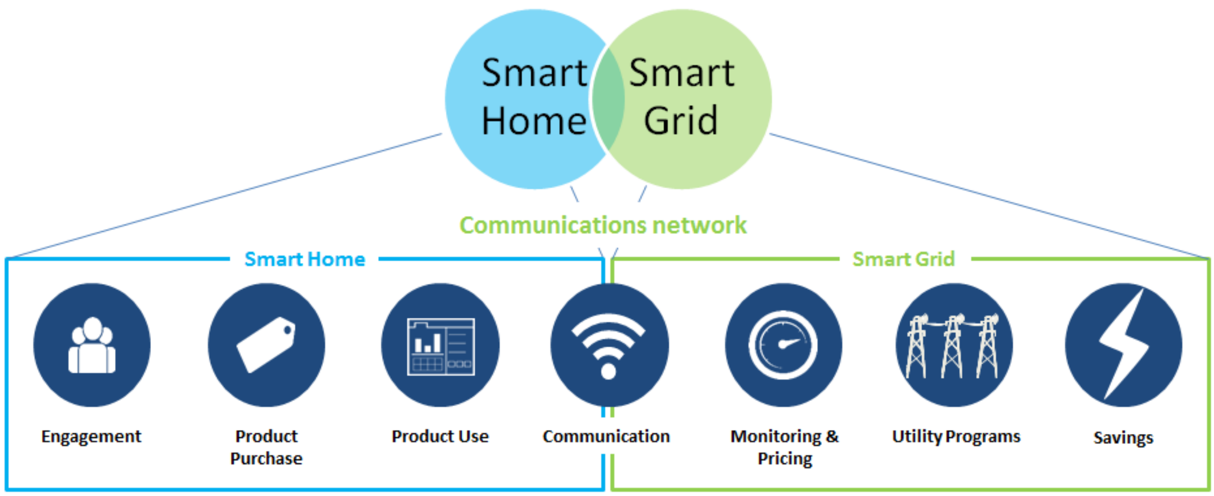
The Tennessee Valley Authority (TVA) Smart Communities project is described in the Federal Facilities Compliance Agreement (FFCA) between the United States Environmental Protection Agency (EPA) and TVA. This Benchmarking Study (the "Study") has been prepared pursuant to an EPA Approved Plan (the "Approved Plan") which outlines the execution of this project.

Section 3.1 of the Approved Plan explains that TVA will conduct a study of "Smart Energy Technologies" (SET) and "Extreme Energy Makeovers" (EEM) projects from across the United States to determine leading practices and lessons learned. The outcomes of the study are to be used in support of a Request for Proposal (RFP) from eligible project implementers, Local Power Companies (LPCs), and/or other partner organizations with respect to the development of SET and EEM projects in the TVA service territory.

Smart Energy Technologies is to showcase the human interaction of smart grid technologies and ultra-efficient homes on a local power distribution system. Extreme Energy Makeovers is to demonstrate cost effective deep energy retrofits, in lower income communities in two different climate regions within the TVA service area.

1.1 Smart Energy Technologies

As part of this Benchmark Study, the following market framework was developed to help contextualize the various segments of the Smart Energy Technologies marketplace.



This study identifies a number of different business models in the smart home market. These are outlined below and discussed in greater detail in section 3.4:

1. **Utility-Centric:** The Utility-Centric model is set up, branded, and controlled by the utility. The utility provides devices to customers in exchange for participation in Demand Response (DR) programs.

2. **Utility "Bring Your Own Device":** The utility sets up a communications infrastructure that enables customers to purchase and connect their own devices (commonly limited to Programmable Communicating Thermostats).
3. **Specialized Device Manufacturer:** A specialized manufacturer offers a single smart device either through a direct-to-consumer model or through retail channels.
4. **Telco:** A telecommunications company ("telco") provides home automation as an additional service that can be bundled with its existing services.
5. **Big Box Retailer:** A big box retailer offers bundles of smart appliances that can be controlled via a single retailer-branded app.
6. **Electric Vehicle:** A car manufacturer sells electric vehicles (EVs) that can be connected to the grid and used for energy storage and load shifting.
7. **Diversified Manufacturer:** A diversified manufacturer enables any of their appliances or devices to be controlled and monitored by a single app.

The key findings in the table below are organized according to the market framework for Smart Energy Technologies. The findings are numbered here and in the full report for ease of reference.

Smart Energy Technologies		
Category	**No.**	**Key Finding**
Engagement	A1	Messaging is most effective when it combines saving money with other simple, customer-focused benefits
	A2	Programs can build on existing relationships to drive participation
Product Purchase	A3	Consumers prefer to choose their own devices, but are not ready to pay for them
	A4	Technologies are immature and vendors can be inexperienced
Product Use	A5	Access to a simple display can improve results
	A6	Smart thermostats can generate more energy savings than other devices
	A7	Though automation generates more energy savings, consumers prefer greater control
Communication	A8	Open communications standards are best for programs, but often resisted by vendors
	A9	Interoperability is difficult to achieve, even with a common protocol
	A10	Cloud-based communications can achieve smart grid benefits; smart meters can enhance those benefits
Monitoring & Pricing	A11	Consumers prefer smarter, but simpler pricing schemes
	A12	Remote monitoring can increase value proposition

Category	No.	Key Finding
Utility Programs	A13	Back office infrastructure may need to be upgraded to realize smart grid benefits
	A14	Opt in programs achieve lower participation rates, but higher energy savings per participant
Savings	A15	Energy savings has not been a focus of many "smart" projects

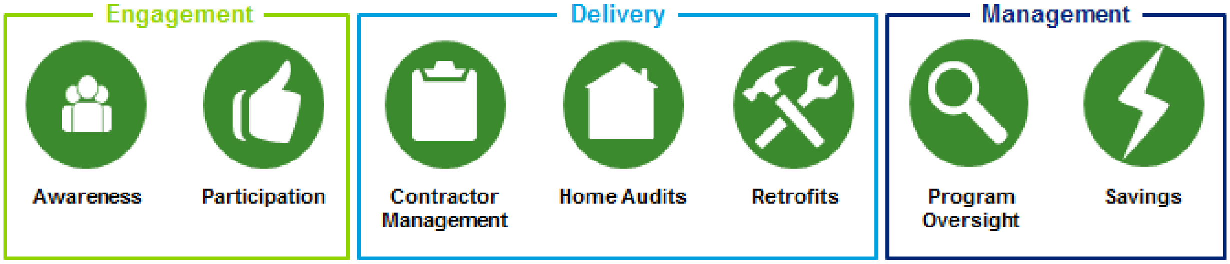
This Study identifies a list of key design elements for Smart Energy Technologies projects. These design elements can assist TVA and LPCs in tailoring national leading practices and business models to the Valley:

Smart Energy Technologies Key Design Elements

- **Behavior Change** – Improves consumer attitudes toward energy efficiency and/or utility control of home devices
- **Benefit to Participants** – Creates positive impact on Consumers, Utilities/Local Power Companies (LPCs), and other Participants
- **Ease of Implementation** – Allows Utility/LPC to more quickly and easily implement smart community project
- **Innovation** – Advances the market by achieving a new element of or approach to a smart community
- **Peak Load Reduction** – Reduces peak load through demand response or load shifting
- **Replicability** – Creates infrastructure or partnerships that facilitate replication of projects at other Utilities/LPCs
- **Savings** – Saves energy and reduces emissions of greenhouse gases and air pollutants
- **Sustainability** – Creates a business model that could enable the project to continue

1.2 *Extreme Energy Makeovers*

Similar to SET, the following market framework was developed to help contextualize the various segments of the Extreme Energy Makeover marketplace. This framework was used to categorize the various players and activities associated with the projects researched in this study.



This study identifies a few different business models in the residential retrofit market. These are outlined below and discussed in greater detail in Section 4.5:

1. **Utility-Led Model:** A utility—or, in this case, an LPC—runs the project, though it may contract with other companies or organizations to provide specific program components.
2. **Third-Party Implementer Model:** A utility/LPC partners with a third party implementer to run a utility-branded project.
3. **Retailer Partnership Model:** A utility/LPC partners with a big box home improvement retailer to implement a co-branded project.

The key findings in the table below are organized according to the market framework for Extreme Energy Makeovers. The findings are numbered here and in the full report for ease of reference.

Extreme Energy Makeovers		
Category	**No.**	**Key Finding**
Awareness	B1	Consumers respond best to messaging centered on their pain points
	B2	Enlisting local spokespeople can help programs gain trust
	B3	Leveraging existing community infrastructure can increase participation
	B4	Marketing is essential even when programs have rich incentives
Participation	B5	Low-income threshold should be defined to streamline verification process
	B6	Targeting homes with higher usage can increase energy savings
Contractor Management	B7	Program design should take into account industry capacity and capabilities
	B8	Contractor requirements should be standardized across programs
	B9	Actively managing contractors yields better results, but can be time intensive
Home Audits	B10	A flexible audit implementation process can help prevent program bottlenecks
	B11	Participant engagement is key to keeping the audit process on track

Category	No.	Key Finding
Retrofits	B12	Leading programs have a method to address safety issues encountered during retrofits
	B13	A whole-home, custom approach generates higher savings per home, but can take longer to implement
	B14	The market may move toward a performance-based approach
Program Oversight	B15	Involving key stakeholders can improve program design and oversight
	B16	More flexible programs achieve better results
Savings	B17	Measuring actual savings is more challenging and costly than other measurement options
	B18	Low-income weatherization must be paired with education to produce energy savings

This Study identifies a list of key design elements for Extreme Energy Makeover projects. These design elements can assist TVA and its LPCs in tailoring national leading practices and business models to the Valley:

In conclusion, this Study describes leading practices and business models in use across the United States. These leading practices should be viewed through the lens of what is important in the Tennessee Valley and what will benefit the Local Power Companies and end use consumers. The combination of national leading practices and key design elements for SET and EEM will produce the best outcomes for the Smart Communities project and the Valley.

2.0 Introduction

2.1 Overview

The Tennessee Valley Authority (TVA) Smart Communities project is described in the Federal Facilities Compliance Agreement (FFCA) between the United States Environmental Protection Agency (EPA) and TVA. This Benchmarking Study (the "Study") has been prepared pursuant to an EPA Approved Plan (the "Approved Plan") which outlines the execution of this project.

Section 3.1 of the Approved Plan explains that TVA will conduct a study of "Smart Energy Technologies" (SET) and "Extreme Energy Makeovers" (EEM) projects from across the United States to determine leading practices and lessons learned. The outcomes of the study are to be used in support of a Request for Proposals (RFP) from eligible project implementers, LPCs, and/or other partner organizations with respect to the development of SET projects and EEM projects in the TVA service territory.

SET projects are to showcase the development of energy efficiency technologies while integrating them with the primary enabling elements of a smart grid on a local power distribution system. EEM projects are to demonstrate cost effective deep energy retrofits, maximizing the use of the energy efficiency measures and focusing on a whole house approach in two different climate regions of the TVA service areas with a focus on homes 20 years or older in lower income communities.

More specifically, SET projects refers to TVA's requirement[1] to establish one or more projects in the TVA service territory that integrate the most energy efficient technologies with the primary enabling elements of a smart grid (intelligent devices, two-way communications, and information management) on a typical power distributor system. Smart Energy Technologies is about exploring the opportunities and testing the human interaction of smart grid devices and ultra-efficient homes.

"Extreme Energy Makeovers" refers to TVA's requirement[2] to develop extreme energy makeovers for at least two communities of homes or residences located in different climate regions in the TVA service territory. EEM projects are to include cost effective deep energy retrofits, maximizing the use of energy efficiency measures and focusing on a whole-house approach. The target audience for EEM is residents of homes 20 years or older, in lower income communities. The goal of the Extreme Energy Makeovers is to achieve a 25% energy reduction in home energy use with an estimated energy savings of 1,000 megawatt-hours (MWh)/year at approximately $10/square foot.

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[1] Pursuant to FFCA, Appendix C, § II.F.2.a
[2] Pursuant to FFCA, Appendix C, § II.F.2.b

Both SET and EEM projects are expected to contribute directly to the reduction of greenhouse gas (GHG), sulfur dioxide (SO_2) and nitrogen oxide (NO_X) emissions, as well as mercury (Hg) levels, in support of TVA's statutory mission and vision that includes TVA being the nation's leader in improved air quality.

2.2 Context

The Study is part of a broader TVA Smart Communities Project Methodology. A Request for Proposals (RFP) will be released following this Study.

2.3 Approach

The following diagram provides an overview of the approach undertaken to perform this Study.

In accordance with TVA's requirements,[3] the Study focused on the following:

- Leading Practices and Lessons Learned: Examples where communities or a local power distribution system deployed programs similar to Smart Energy Technologies or Extreme Energy Makeovers
- Engagement Strategies: Ways other programs have been successful in engaging consumers and communities
- Educational Tools and Technologies Used: Information on what devices, products, and/or tools are being used by similar programs
- Program Results: Methodologies employed to increase efficiency, comfort, actual energy savings and control of the home, as well as homeowner satisfaction and awareness of ways to control energy use

[3] As outlined in TVA's Solicitation for Energy Right Solutions for Home Benchmarking Studies for Smart Communities.

3.0 Smart Energy Technologies

3.1 Objectives

The Approved Plan outlines the goal of the SET projects to "showcase the development of energy efficiency technologies while integrating them with the primary enabling elements of a smart grid on a local power distribution system."

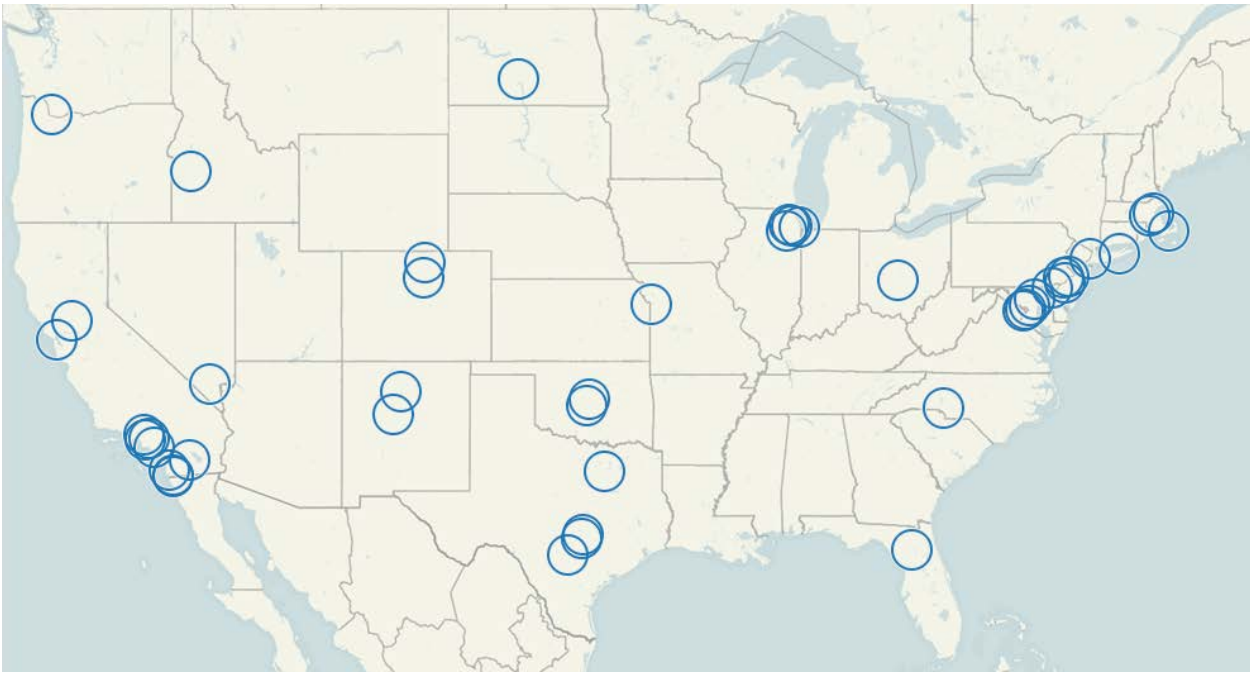
3.2 Research Approach

A national review identified energy efficiency and smart grid programs relevant for Smart Energy Technologies. Published resources were reviewed for all of the programs included in this study. Of the more than forty programs reviewed, a portion were selected for an interview with program managers and/or a deeper review of documents and relevant program materials. A select number of industry experts also were interviewed to provide additional perspective on the market.

Programs were selected for an interview or further research based on whether they had implemented multiple smart grid programs, whether those programs included deployment of smart appliances or energy management devices in consumer homes, and whether the program had been operating long enough to have measurable results. Research focused on smart homes because the Approved Plan states a SET project makes "a house function as a machine" and tests "the human interaction of smart grid devices and ultra-efficient homes." Programs were reviewed based on the technologies employed and whether they had a unique approach to any of the program components in the framework presented in section 3.3.

Figure 1 maps the smart grid programs included in the study, followed by a complete list of programs. A list of program sources and interviews is included in the appendix.

Figure 1: Smart Grid Programs Reviewed in Study



- AEP: gridSMART
- Austin Energy: Bring-Your-Own-Thermostat Pilot
- Baltimore Gas & Electric: Smart Grid Initiative
- Bismarck State College: National Energy Excellence Smart Grid Laboratory (GridLab)
- Burbank Water and Power: Smart Grid Program
- Cape Light Compact: Residential Smart Energy Monitoring Pilot
- City of Naperville: Smart Grid Initiative
- Commonwealth Edison (ComEd), Philadelphia Electric Company (PECO): Customer Application Pilot
- Commonwealth Edison: Consumer Application Program Pilot
- Commonwealth Edison: Smart Home Showcase
- Connecticut Light & Power: Plan-It Wise Energy Pilot Program
- Consolidated Edison Company: Secure Interoperable Open Smart Grid Demonstration Project
- CPS Energy: AMI Program
- Drexel University: Drexel Smart House
- Duke Energy: Virtual Power Plant Project
- Fort Collins Utilities: Renewables and Distributed Systems Integration Project
- FP6 INTEGRAL: PowerMatching City
- Honda: Smart Home US at UC Davis
- Idaho Power: Dynamic Pricing Pilot
- Illinois Institute of Technology: Perfect Power
- Kansas City Power & Light: Green Impact Zone SmartGrid Demonstration
- Konterra: Solar Microgrid
- Long Island Power Authority (LIPA): Smart Energy Corridor
- Los Alamos Department of Public Utilities: US-Japan Demonstration Smart Grid
- Los Angeles Department of Water and Power: Smart Grid Regional Demonstration
- Mesa del Sol: New Mexico Green Grid Initiative
- National Rural Electric Cooperative Association: Enhanced Demand and Distribution Management Regional Demonstration
- NSTAR: Automated Meter Reading-Based Dynamic Pricing
- NSTAR: Urban Grid Monitoring and Renewables Integration
- NV Energy: mPowered
- Oklahoma Gas & Electric: Smart Study Together

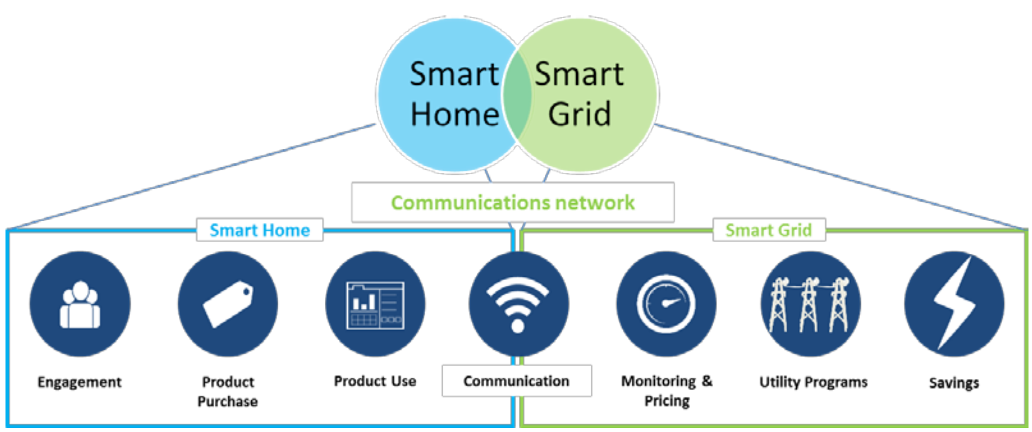
- Oklahoma Gas & Electric: SmartHours
- Pacific Gas & Electric (PG&E): Home Area Network (HAN) pilot
- Pacific Northwest Smart Grid Demonstration Project
- Pecan Street Inc., Austin Energy: Pecan Street Project
- Pepco: PowerCentsDC Program
- Philadelphia Electric Company (PECO): Drexel University
- San Diego Gas & Electric: Beach Cities Microgrid Project
- San Diego Gas & Electric: Borrego Springs Microgrid Demonstration Project
- San Diego Gas & Electric: Smart Energy Solutions
- San Diego Gas & Electric: Streetlight Working Group
- Southern California Edison: Bring-Your-Own-Thermostat Pilot
- Southern California Edison: Irvine Smart Grid Demonstration
- TXU Energy: Brighten iThermostat
- University of Delaware, NRG: Vehicle to Grid
- University of Florida: Gator Tech Smart House
- Xcel Energy: SmartGridCity

3.3 Market Framework

As part of this study, the following market framework was developed to help contextualize the various segments of the Smart Energy Technologies marketplace. This framework was used to categorize the various activities associated with the programs researched, and it forms the basis for organizing the key findings.

Based on the description in the Approved Plan, a smart home is a key building block of a Smart Energy Technologies project. As described in the plan, this project is about "testing the human interaction of smart grid devices and ultra-efficient homes" and making "a house function as a machine that works in conjunction with the power grid/power delivery system." Though projects may include a wide variety of technologies ranging from energy storage to grid integrated renewable energy and voltage optimization, a SET project must include homes. For this reason, smart homes are the focus of the findings and business models in this report.

Figure 2: Smart Energy Technologies Market Framework



The framework is organized into three main market components (the Smart Home, the Smart Grid and the Communications network that connects the home to the grid); and seven subcomponents (Customer Engagement, Smart Device Product Purchase, Product Use, Communications, Monitoring and Pricing, Utility Programs and Savings). A holistic SET project would touch on each component in this framework. A brief description of each of these components is outlined in the following table.

Main Component	Description	Examples (not exhaustive)
Smart Home	A household containing connected devices and sensors linked via a home area network and connected to service providers' back-end systems. Connected devices could range from household appliances and security systems to personal health applications.	• Programmable Communicating Thermostats (PCTs) • High Efficiency Appliances • High Efficiency Air Conditioners and Water Heaters • Lighting Upgrades • Consumer Interfaces/Display Devices • Grid-Integrated Renewable Energy • Energy Storage • Electric Vehicle Charging • Mobile glucose or blood pressure monitors
Smart Grid	A modernized electrical grid that uses information and communications technology to gather and act on information to improve the efficiency, reliability, economics, and sustainability of the generation and distribution of electricity.	• Automated Demand Response Systems • Meter Data Analytics • Voltage Optimization • Utility-scale, Integrated Renewable Energy • Utility-scale, Integrated Energy Storage • Outage Restoration • Grid Resiliency & Microgrids • Electric Vehicle Charging Networks
Communications Network	A collection of terminal nodes and links which are connected so as to enable telecommunication between the terminals.	• Home Area Networks • Wireless Area Networks • Neighborhood Area Networks • Smart Meter/AMI Networks
Sub-Component	**Description**	**Examples (not exhaustive)**
Engagement	Programs and approaches to increasing consumer awareness of the products and services available in the marketplace, including approaches to targeting consumers.	• Direct Mail and Email • Billing Outreach • On-line Advertising • Social Media/Customer Analytics • In-store Advertising • Multi-media Advertising • House Calls • Community Events • Conferences • Ad-hoc Events and Activities

Sub-Component	Description	Examples (not exhaustive)
Product Purchase	Process of getting smart devices into customer homes, whether provided by utility, offered through retail channels, or incentivized via rebate or discount programs. Includes determining product eligibility.	• In-store and Online • Single Product vs. Bundled Products • Rebates, Discounts, and Free Products • Products Validated in a Performance Test
Product Use	Consumer's use of the product according to its function, including how well the product meets consumer preferences, changes behavior, and increases energy efficiency.	• Manual Adjustments vs. Automatic Adjustments • On-Device, In-Home, and Mobile Displays
Communication	Networks, technology and protocols to transmit and exchange information.	• Smart Meters • Wireless vs. Wired Networks • Open Standards • Multi-device Interoperability
Monitoring & Pricing	Ability of service providers to inform smart devices in the home when energy demand is high, as well as track how much electricity is used and when it is used. Also could Include handling bi-directional energy flows.	• Critical Peak Pricing • Time of Use Pricing • Tiered Rates • Remote Monitoring of Appliance or Device Performance • Net Metering
Utility Programs	Programs offered by a utility to manage energy consumption, and the back-end systems necessary to run those programs.	• Demand Response Management • Advanced Billing Systems • Smart Meter Data Management
Savings	Efficiency gained in the amount of energy consumed and/or reductions in air pollution or greenhouse gas emissions associated with the deployment and use of smart home and smart grid technologies	• Measurement utilizing industry-accepted engineering calculation of pre and post factors

The Smart Home

A "smart home" is a home that incorporates advanced automation systems, including a communications network, to provide the inhabitants with monitoring and control over the building's functions. For example, a smart home may control lighting, temperature, multi-media, security, window and door operations, as well as many other functions.

Figure 3: Emerging Smart Home Products

Audio: Sound Systems

Telecommunications: Landlines, Mobile Devices

Home Theatre: TVs, Screens

Medical: Pulse, Blood Pressure, Glucose, Body Fat, ECG monitors, Pill cams

Security: Motion Sensors, Security Cameras

Automation & Control: Mobile Devices, In-Home Displays, Smart TVs

Climate Control: Programmable Communicating Thermostats, In-Home Weather Stations, Adjustable Window Shades & Blinds

Lighting: Automated/Pre-Programmed Controls, Remote Monitoring & Adjustment

Energy: Appliances, Solar, Electric Vehicles, Energy Storage, Power Strips (Water Heaters, Pool Pumps)

The marketplace for smart homes is rapidly evolving and, while it is still in its early stages today, some market analysts[4] expect the market to boom by 2020. Forecasts for the size of the smart home market (also known as the home automation market) range from $15 billion to $35 billion by 2020, propelled in large part by the growth of new technological advances, decreasing technology costs and cloud-managed services.

Though it is expected that the smart home market will grow in coming years, there are still some hurdles slowing its ability to move forward. Obstacles include a lack of industry standards and interoperability among current home automation systems, low customer awareness and acceptance of new products and services, and price points that are too high to drive large scale adoption.

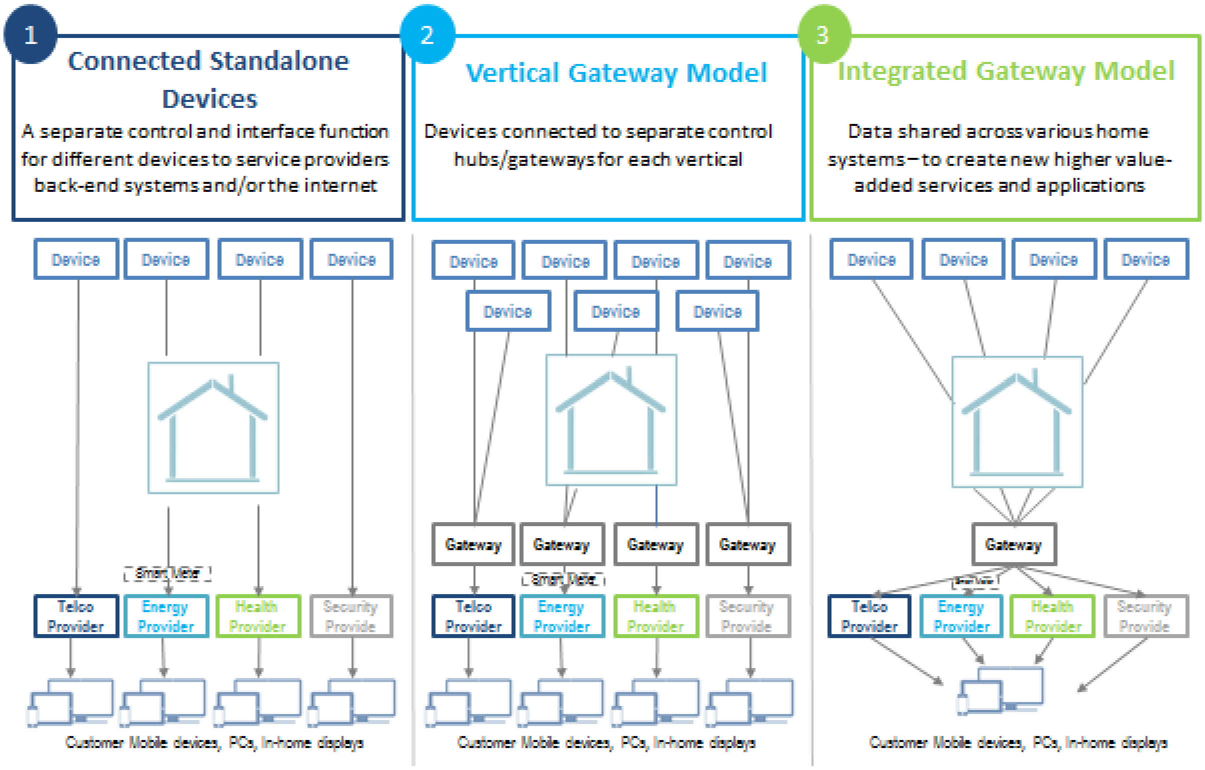
Despite these challenges, the smart home energy market is attractive to a number of different sectors, for a variety of reasons. Each sector is beginning to develop products and services to capitalize on the emerging opportunities in this space. The table below describes some of the emerging vendors in the smart home market. Not all vendors compete in only one sector; for example, though Comcast is primarily in the Telecommunications and Entertainment sector, its Xfinity Home offering includes security.

[4] For example: NextMarket Insights, Allied Market Research, ABI, Berg Insight and Navigant Research.

Sector	Description	Examples
Solar	Residential on-site solar power	SolarCity, SunRun
Security	Increased safety and security; Remote monitoring of the home	ADT, Alarm.com
Telecommunications and Entertainment	Home automation and control; Home theater and entertainment; Security and energy management	AT&T Digital Life, Xfinity Home
Utilities	In-home energy display; Programmable Communicating Thermostats (PCTs)	Southern California Edison, TXU Energy
Operational/ Information Technology	Solution architecture that enables integration and management of services	Cisco
Retailers	Interconnectivity of products purchased in a bundle; Installation assistance	Best Buy, Lowe's
Appliance Manufacturers	Connected devices that allow remote monitoring and control via the cloud	Whirlpool, GE
Energy Storage	Residential on-site energy storage to allow for back-up power or load shifting	Eos, NEC
Electric Vehicle Manufacturers	Electric vehicles and charging stations; apps for managing charging	Nissan, GM, Tesla
Healthcare	Access to remotely monitored physiological statistics. Life-style improvement, safety and security.	Sotera Wireless

As with any new market, the transition to a "smart home" is an evolving one. Outlined below are three operating models that are present in today's marketplace.

Figure 4: Home Connectivity Models



- **Standalone.** Each device is linked directly to each service provider's proprietary back-end systems. Standalone devices operate on separate control and interface functions.
- **Vertical Gateway.** Device connectivity and data management is controlled via dedicated control hubs, but each service provider vertical has a separate hubs. For example, a home could have a smart meter for energy related devices, a broadband box for communications/entertainment related devices, and separate medical hubs for medical devices. If utilities are required to restrict access to the smart metering data, they may choose to limit interconnection between their smart meters and consumer-controlled devices.
- **Integrated Gateway.** Device connectivity and data management is controlled via a dedicated centralized hub that multiple vendors of different industries can access. The key feature of this stage is the creation of an environment where data from different application areas can be integrated to deliver a richer set of smart home services. This approach supports open standards and architectures that are expandable in the future. Its goal is to allow consumers to easily transition from a system that controls one device to a whole home energy management system.

The Smart Grid

The "Smart Grid" is a major component of a Smart Energy Technologies project. A smart grid is a modernized electrical grid that uses information and communications technology to gather and act on information to improve the efficiency, reliability, economics, and sustainability of the generation and distribution of electricity. The smart grid can improve outage restoration, make the grid more resilient, and improve energy efficiency through voltage optimization and automated demand response. It also can facilitate the integration of renewable energy, energy storage, and electric vehicles.

In the context of Smart Energy Technologies, a key feature of the smart grid is the ability to influence the operation of smart devices in the home to affect energy usage. Influence can be achieved by providing information and/or control:

- ***Information-based influence***: The provision of information prompts consumer-driven behavior change.
  Examples include:
  - In-home or smart phone/tablet displays: Consumer energy usage information that is easy to read and to digest, and that is available in an accessible format.
  - Consumption benchmarking: More granular, detailed information on how a consumer's consumption compares to their peers or neighbors.

  Utility Perspective: Smart technology enables utility providers to track usage of electricity, water, and gas at the household level, as well as monitor the amount of energy being generated by solar panels and wind turbines and the charging status of electric vehicles.

  Consumer Perspective: Households can access data on their electricity, water, and gas and track their current and historical consumption patterns. Consumers can monitor this information on the smart devices themselves or remotely using smartphones or tablets. In addition, smart technology gives consumers the ability to monitor the performance of household devices and to save costs by running remote diagnostics and maintenance. In addition, gas, electricity and water sensor readings will be able to provide advanced analytics to enable householders to become more efficient.

- ***Control-based influence:*** The ability to control a device remotely or through programming or automation.
  Examples include:
  - Remote on/off: Manual device controls that can be triggered remotely (e.g., via smart phone or tablet)

- Reactive on/off: Controls such as voice activation, response to heat levels, etc., allow devices to react to conditions within the home. Smart technology can enable devices to react to external conditions, such as a signal from an in-home weather station or a demand response event signal from a utility.
- Programmable on/off: Devices such as thermostats can be preprogrammed with an algorithm based on a consumer's schedule and comfort preferences.
- Variable response: Some devices can vary their functionality beyond being on or off. For example, electric vehicles and electric water heaters can serve as energy storage devices that respond to the variable output of rooftop solar.
- Automated intelligent controls: Advanced connectivity can enable distributed, automated control in which home devices respond to grid congestion and demand peaks in their location.

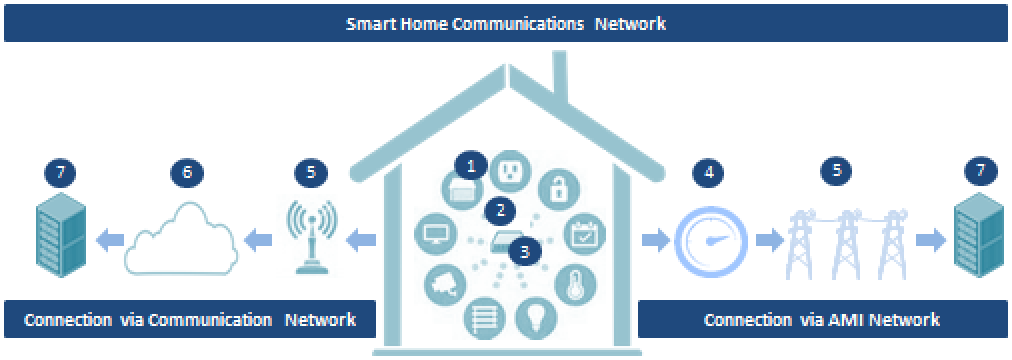
Utility Perspective: Demand response functionality will enable utility companies to improve the operation and efficiency of their networks by changing household appliance usage to manage the overall load on the utility network, subject to agreements with individual households. By accessing information about ancillary power generation or storage, such as solar PVs and electric vehicles, utilities will facilitate the settlements of payment and also anticipate and control any unanticipated power surges that may damage distribution networks or compromise the quality of services.

Consumer Perspective: Smart technology enables consumers to control use of electricity and other utility services by switching on and off various appliances, lighting, and/or heating/cooling systems. Consumers can exercise this control not only from their homes, but also from the office or while traveling. Location-enabled mobile handsets will be able to automatically trigger events, such as turning off the central heating system when a consumer leaves the proximity of their home. The ability to regulate household appliances usage and electric vehicle charging based on the time of the day or dynamic electricity prices can enable the consumer to save energy.

The Communications Network

The third main segment associated with Smart Energy Technologies is the enabling communications network. There is currently no single approach to developing a communications network for the smart home/smart grid marketplace. Both wireless and wired (i.e. over phone lines, cable, power lines) solutions are being used for in-house connectivity and for long haul communications. Smart home solutions are being offered over the internet and Advanced Metering Infrastructure (AMI) networks (both wired and wireless), and there are a range of alternative back-end systems available. The key elements of a smart home communications network are outlined below.

Figure 5: Smart Home Communications Network



1. **Node**: Electronic device that is attached to a network, and is capable of sending, receiving, or forwarding information over a communications channel. In the context of a smart home a node could be thought of as the in-home device or appliance.
2. **Home Area Network**: A network of nodes that is focused on the home. Each device is connected to other devices or network(s) via communication protocols. Example home area communication protocols include: Bluetooth, Wi-Fi, Zigbee, Zwave and HomePlug.
3. **Home Gateway**: A technology that connects a home area network (HAN) to an out of home communications network (such as a wide area network (WAN)). The gateway collects data from the HAN and transfers it to external world in a format needed for the long-haul communication.
4. **Advance Metering Infrastructure:** Architecture for automated, two-way communication between a smart utility meter and a utility company.
5. **Long Haul Communications network**: A data transmission network that handles data transfers over longer physical distances. Examples include broadband over power lines, cellular networks, Wi-Fi Mesh, Wi-Fi Max. It transmits data to where it can be stored and analyzed.
6. **Cloud computing**: The delivery of information management over the Internet.
7. **Back-office systems**: A generic term used to cover both operational technology (OT) such as a Supervisory Control And Data Acquisition (SCADA) system that engineers use to monitor and control mission-critical processes in real time on an electricity grid, and information technology (IT) which is the application of computers and tele-communications equipment to store, retrieve, transmit and manipulate data in order to offer a service or manage an activity. An example of a utility back-office IT system would be a Demand Response Management System or a Meter Data Management system.

In designing a communications network for smart homes, a project developer should think through these key considerations:

- **Interoperability**: Integrating data and information systems for multiple devices from different manufacturers.
- **Security**: Protecting information from destructive forces and the unwanted actions of unauthorized users.
- **Latency**: Minimizing the time interval between the signal and response.

- **Cost/Benefit**: Weighing the relative costs and benefits associated with implementing and running a communications network.
- **Ownership & Control**: Managing control and ownership of the communications network and associated data.
- **Privacy**: Addressing data privacy concerns and regulations that govern third-parties' access to consumer information (e.g. the collection of consumption data of electricity, gas and water).
- **Supervision**: Adhering to requirements to assure a minimum level of services; developing contingency plans to manage scenarios when communications networks fail to respond as expected.

3.4 Business Models

This study identifies seven different business models being used in the smart home market. This list is not intended to be exhaustive or to imply that all categories of providers are using the same business model. Instead, it provides insight into the diversity of players and value propositions in the market today. The business models examined either involve an electricity provider or could involve an electricity provider through a partnership. The electricity provider could play a large role (e.g., buying/installing devices, owning communications infrastructure) or rely primarily on partners and vendors to provide these functions.

The business models discussed in this study include the following:

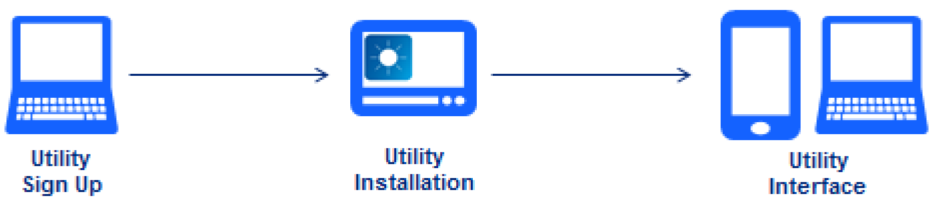
1. Utility-Centric (e.g., TXU Energy, NV Energy)
2. Utility "Bring Your Own Device" (e.g., Austin Energy, Southern California Edison)
3. Specialized Device Manufacturer (e.g., ecobee, Nest)
4. Telco (e.g., AT&T, Comcast)
5. Big Box Retailer (e.g., Home Depot, Lowe's)
6. Electric Vehicle (e.g., Nissan Leaf, Tesla)
7. Diversified Manufacturer (e.g., GE, Samsung)

Utility-Centric Model

The Utility-Centric model is set up, branded, and controlled by the utility. The utility provides devices to customers in exchange for participation in DR programs.

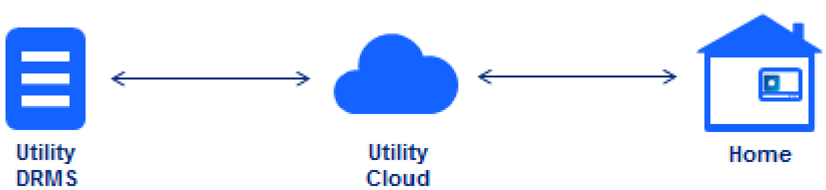
Consumer Perspective

The utility provides a device—most commonly a Programmable Communicating Thermostat (PCT)—to consumers, as well as the communications infrastructure and the installation. The consumer interface and the device both feature the utility brand. The program is free to customers with a commitment to participate in the utility Demand Response (DR) program.



Operational Perspective

The utility connects to the devices via an in-home gateway (i.e., not via an AMI network). The utility manages DR of the devices through its own Demand Response Management System (DRMS). All devices in the program are of a single type and single manufacturer to avoid interoperability complications. This is an example of the Connected Standalone Device Model described in Section 3.3.



Key Elements

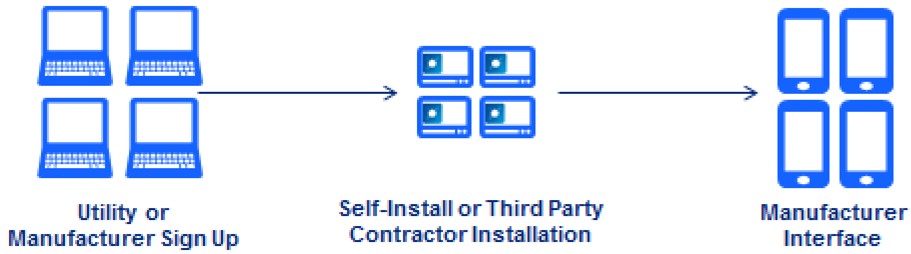
Devices	• PCT is branded with utility logo • PCT is provided by utility if customer joins DR program
Installation	• Utility performs installation
Communications	• Utility provides gateway and modem or utilizes the customer gateway and modem, and maintains home area network
Consumer Interface	• Portal is utility-branded and managed by utility
Back-End Systems	• Utility owns DRMS

Utility "Bring Your Own Device" Model

In the "Bring Your Own Device" model, the utility sets up a communications infrastructure that enables customers to purchase and connect their own devices. To date, this model has been used primarily with PCTs, though it could be expanded to other types of devices.

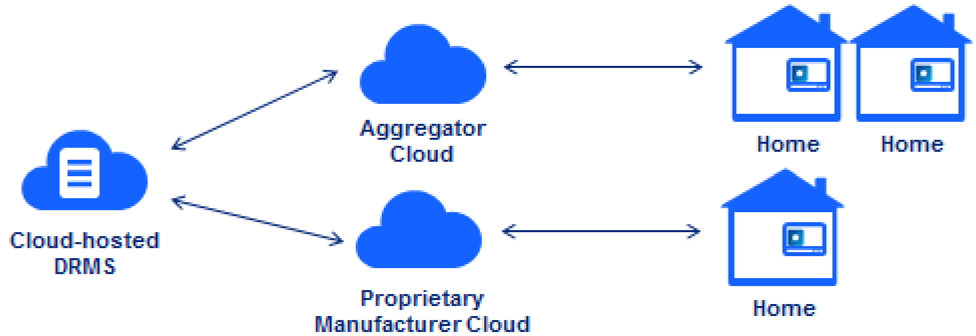
Consumer Perspective

The homeowner buys a device and then registers on the website of their utility or device manufacturer to participate in utility DR program. The consumer controls and monitors the device via the manufacturer's interface and/or app. In the pilot stages of this model, some utilities are providing devices and installation for free. The long term vision for this business model, however, is for customers to purchase and install their own devices.



Operational Perspective

The utility needs to select a set of devices that have been tested to interoperate with its communications network (or its vendor's communications network). The utility can outsource the remote monitoring and control of the devices to third-parties who aggregate devices from different manufacturers. Some device manufacturers use proprietary back end systems that cannot be aggregated by third parties (see Specialized Device Manufacturer model), which requires the utility to contract separately with the aggregator and the manufacturer of any devices with proprietary cloud services. Utilities can also outsource the back end DRMS function to cloud service providers, many of whom use OpenADR—an open standard for automated demand response. This is an example of the Vertical Gateway Model described in Section 3.3



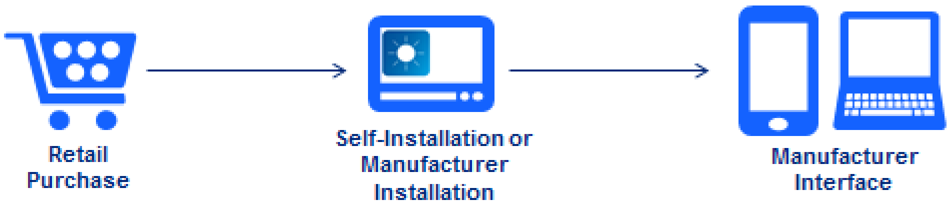
Key Elements	
Devices	• Customer can choose from list of approved devices • Customer purchases device and may receive a rebate
Installation	• Customer self-installs or uses third party (e.g., contractor)
Communications	• Third party acts as cloud-hosted aggregator (and possibly proprietary cloud solutions of certain device manufacturers)
Consumer Interface	• Apps/portals are managed and branded by each individual device manufacturer
Back-End Systems	• Cloud-hosted DRMS

Specialized Manufacturer Model

A specialized manufacturer offers a single smart device (such as an appliance or PCT).

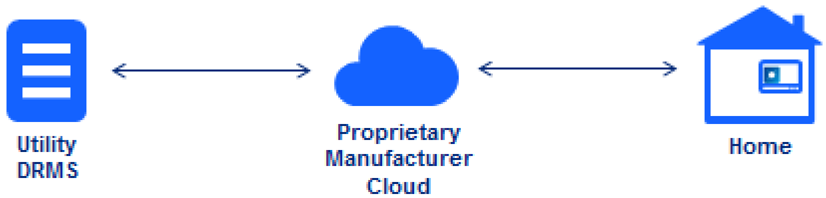
Consumer Perspective

The consumer can purchase a device directly from the manufacturer, through a retailer, or (in some cases) through a contractor. Premium devices can retail for twice that of more generic competitors (such as the white label PCT in the Utility-Centric model). The energy-saving device may qualify for an instant or mail-in rebate from the customer's utility. That rebate may be contingent on the customer's enrollment in a DR program. The consumer uses the manufacturers' portal and/or app to interface with the device.



Operational Perspective

The manufacturer connects directly to the device via a proprietary cloud solution. Other parties that want to communicate with the device (such as a utility DR program) must go through the manufacturer cloud, and pay any associated fees for that service. Similarly, the data gathered from the device is controlled and managed by the manufacturer. This is an example of the Connected Standalone Device Model described in Section 3.3



Key Elements

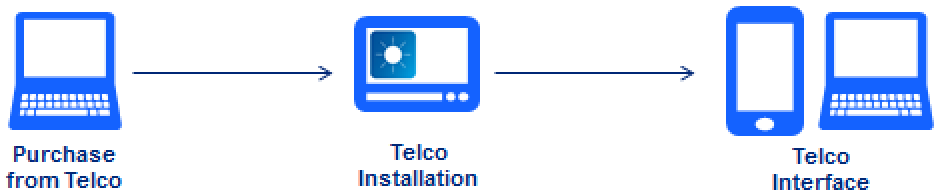
Devices	• Customer purchases device at retail; may receive utility rebate
Installation	• Customer self-installs or uses manufacturer's network of installers
Communications	• Manufacturer offers proprietary cloud solutions
Consumer Interface	• App is managed and branded by device manufacturer
Back-End Systems	• Utility hosts DRMS or uses cloud-hosted third party DRMS

Telco Model

A telecommunications company ("telco") provides home automation as an additional service that can be bundled with its existing services.

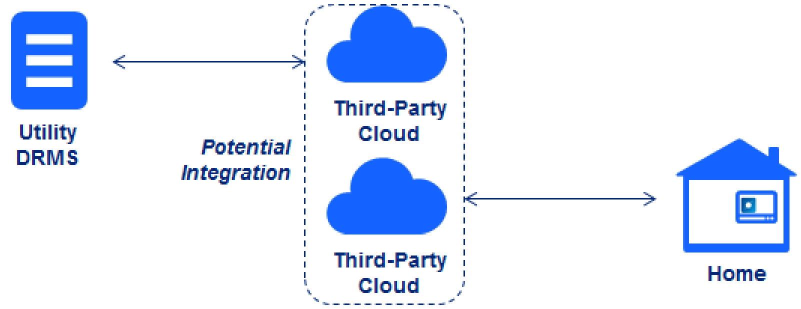
Consumer Perspective

The consumer can purchase home automation services from their cable, internet, and/or phone provider through a multi-year contract. Services may include home security (including motion sensors and cameras), lighting controllers, PCTs, and control of home entertainment systems. The package may be self-installed or installed by the telco for a fee. Some equipment (e.g., PCT) typically is included in the package, and extra equipment (e.g., additional motion sensors) may be purchased separately. The consumer pays a monthly fee for the service, and that fee may be reduced if the service is bundled with other services from the same provider. The consumer uses the telco's in-home display and/or app to interface with all devices included in the package.



Operational Perspective

The telco relies on the customer's high speed internet connection for its home area network. The telco may rely on a third party to provide the in-home gateway or it may modify an existing in-home device (such as a cable box or gaming console) to act as a gateway. A third party provides the remote automation component via the cloud. Though it is possible for that third party to provide DR services in a business models with telcos, DR currently is not a component of the telco model. This is an example of the Integrated Gateway Model described in Section 3.3



Key Elements	
Devices	• Customer purchases package through telco via a service contract
Installation	• Telco installs package or customer self-installs
Communications	• Telco leverages a third-party communications provider
Consumer Interface	• In-home control interface is managed and branded by telco
Back-End Systems	• Third-party cloud provider has ability to connect to a DRMS

Big Box Retailer Model

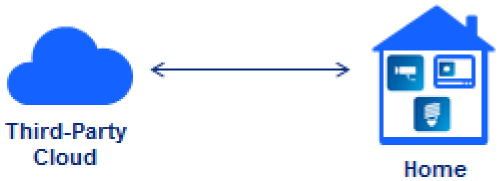
A big box retailer offers bundles of smart appliances that can be controlled via the retailer app.

Consumer Perspective

The consumer can purchase different packages of devices from their retailer, and add on additional eligible devices as desired. Devices may include PCTs, smart plugs, smart locks, cameras, alarm systems, and/or life alert systems. The devices are retailer branded can be controlled via the retailer's branded app or portal. The basic service plan is free, with more advanced control options offered for a monthly fee. The consumer self-installs the package, which includes a retailer-branded gateway, with support from the retailer's online resources and DIY videos.

Operational Perspective

Each device is embedded with a radio that uses a common protocol to communicate with the retailer's gateway. This home area network connects to a third-party cloud via broadband (cable, DSL, or other similar network). The third-party cloud provider in this model has not developed DR capabilities, but it could in the future. This communications model is an example of the Integrated Gateway Model described in Section 3.3



Key Elements

Devices	• Customer purchases package and/or individual devices from retailer
Installation	• Customer self-installs packages/devices
Communications	• Retailer provides a branded gateway for the home area network
Consumer Interface	• App is managed and branded by retailer
Back-End Systems	• Cloud service provider does not have DR capabilities

Electric Vehicle Model

A car manufacturer sells electric vehicles (EVs) that can be connected to the grid and used for energy storage and load shifting. As explained below, installation of rooftop solar photovoltaic (PV) follows a similar model.

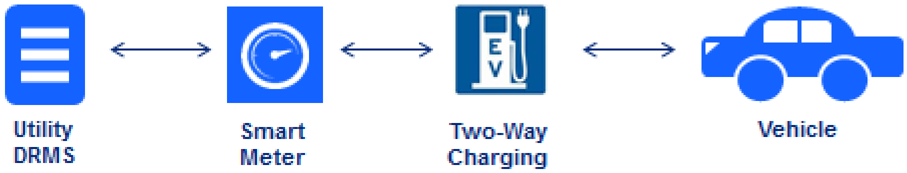
Consumer Perspective

Before purchasing an EV, the consumer must first have a charging station installed in their home. Some manufacturers offer branded charging stations that are installed by their technicians. The cost of installation can be upwards of $2,000; a consumer may qualify for federal tax credits for that amount or may be able to bundle the cost with their car loan. Installation likely involves permitting by local government and/or utilities, a process that may take a month or two. After purchasing the EV, a consumer can use the manufacturer's app to check the vehicle's charge, schedule a charge (e.g., to occur off peak), or turn on the car's heat or air conditioning.

Similar to the EV model, adding solar PV to a home involves additional steps beyond the device purchase. These steps could include assessing the structural soundness of the roof, obtaining local permits, and interconnecting with the grid.

Operational Perspective

In order to support a level 2 EV charger, the utility may need to perform an upgrade of the customer's breaker panel, and the utility would need to ensure that the grid is capable of supporting the additional demand. In order to be able to monitor EV charging, the utility may want to install a smart meter or a submeter on the EV charging station. In order for the utility to involve the vehicle in DR, the vehicle would need a two-way charger or vehicle-to-grid system, but these are nascent technologies that are not widely available. This is an example of the Connected Standalone Device Model described in Section 3.3



Similar to the EV model, solar PV involves an additional utility connection (such as a two-way meter) to fully integrate with the smart grid. This additional connectivity and technical complexity is one thing that differentiates the EV model (and solar PV model) from the Specialized Device Manufacturer model discussed earlier. Project developers should consider these additional connectivity issues when designing project concepts.

Key Elements	
Devices	• Customer purchases EV from car dealer
Installation	• Manufacturer installs EV charging station (prior to EV purchase)
Communications	• Connection to app is managed by vehicle manufacturer • Connection to grid is possible, but not standard
Consumer Interface	• App is managed and branded by vehicle manufacturer
Back-End Systems	• DR capabilities have been piloted, but not widely implemented

Diversified Manufacturer Model

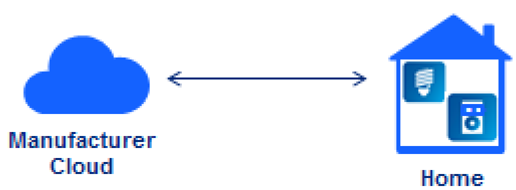
A diversified manufacturer enables any of its devices to be controlled by a single app.

Consumer Perspective

A customer can purchase a variety of devices (including appliances, lighting, air conditioning, and even a robot vacuum) and control them from a single command to a smart watch, smart phone, or Smart TV by the same manufacturer. The service also notifies consumers when it is time to service or replace devices. This is an emerging model, so it is not yet known whether manufacturers will charge for this service or provide it for free as a way to drive sales of their products. Eventually, this model could integrate devices from additional manufacturers in other sectors, such as energy management, security, and healthcare.

Operational Perspective

The devices are connected via a dedicated home area network managed by the manufacturer. The home area network connects to the manufacturer's cloud-based server. This model does not include demand response capabilities, though it may in the future. This is an example of the Integrated Gateway Model described in Section 3.3



Key Elements

Devices	• Customer purchases devices
Installation	• Manufacturer installs or consumer self-installs
Communications	• Home area network and cloud server managed by manufacturer
Consumer Interface	• App is managed and branded by manufacturer
Back-End Systems	• Model does not currently incorporate DR

These business models are not exhaustive. There are additional go-to-market strategies that are being used or could be used to reach this market. A SET project concept may create combinations or variations of these or other business models. For example, a telco and utility could partner to provide a more comprehensive package to their customers. Or, a retailer partnership could facilitate a utility Bring-Your-Own-Device model. When weighing the options, Project Teams should consider the key strengths and drivers of different market players, potential partnership risks, and the ability to adjust to new advances in technology.

3.5 Key Findings

The key findings presented in this study are based on interviews with industry experts and a review of existing research and case studies on the smart grid market. A list of sources is included in the appendix. The key findings are organized according to the market framework explained in Section 3.3.

Engagement

Finding (A1)	Description	Considerations
Messaging Benefits is Most Effective When It Combines Saving Money with Other Simple, Customer-Focused Benefits	Studies indicate that consumers are primarily incentivized by individual benefits. Rather than explaining how a smart grid works, messaging should focus on **consumer benefits**.The benefit that resonates most with consumers is lower energy bills (messaged in terms of **dollars saved**, not kWh saved). However, the majority of consumers are not aware of their energy spend per month, in part due to auto-pay programs, and therefore they may not notice savings. Messaging around **convenience and control** and **improved reliability and outage-related information** are more powerful in some segments and can reinforce the message of saving money. Overall, programs have found that consumers differ in terms of which benefits resonate most with them, creating a need to perform **customer segmentation** to identify the best messages for different consumer groups.	Education on how a smart grid works can drive interest and allay fears concerning **privacy and security**. However, such communication needs to be as simple and non-technical as possible to avoid "sounding like an engineer."

Key Takeaways:

- Undertake customer segmentation analysis
- Focus messaging on consumer benefits for each customer segment
- Design program to address fears concerning privacy security

<table>
<tr><th>Finding (A2)</th><th>Description</th><th>Considerations</th></tr>
<tr><td>Programs Can Build on Existing Relationships to Drive Participation</td><td>Some utilities have been successful by launching technology pilots first in employee homes or with customers who have been active in other utility programs. Also, community-based organizations can be effective due to their existing relationships with customers and their credibility. In particular, scientific, technical, and academic institutions can help engage their employees, who often fit the profile of high-income and tech-savvy early adopters most likely to opt in to smart grid programs.</td><td>Building on existing connection can facilitate a long-term relationship that is useful in future pilots and research trials. This continued engagement can create a “living focus group” of customers.</td></tr>
<tr><td colspan="3">Key Takeaway:
Build on an existing relationship with a customer segment.
Partner with organizations who have relationships with the targeted community.</td></tr>
</table>

Product Purchase

Finding (A3)	Description	Considerations
Consumers Prefer to Choose Their Own Devices, but Are Not Ready to Pay for Them	Most programs have used a single vendor to provide a particular technology for the home. However, customers are more satisfied when they are able to **choose their devices** (e.g., thermostats) and interconnect multiple devices from multiple vendors. Choice also enables technology use in the program to advance with the market. Because of this trend, more recent programs have begun to give consumers choice and offer rebates on a few approved devices. In order to make smart grid projects more cost effective, the industry needs to move toward a model in which customers purchase their own devices. Currently consumer **willingness to pay is well below the retail price point** of most smart home technologies. However, device prices are falling, making a consumer-driven model more viable.	To move toward a consumer purchase model, smart grids should be built to **support different hardware devices** and programs should be structured to allow for collaboration with multiple vendors.
Key Takeaways: • Allow consumers to choose between a short list of interoperable, accredited devices • Offer discounted (e.g., through rebates) or free devices to attract consumers		

Example: Austin Energy Smart Thermostat Program	Austin Energy developed a program in which customers can buy one of three thermostats available through different retailers and local contractors. Customers can purchase an Ecobee, EnergyHub, or Nest thermostat and receive an $85 rebate if they enroll in Austin Energy's Demand Response program. Austin Energy previously administered a free thermostat program where it offered older generation, one-way communication thermostats. With the new thermostats, consumers can control their heating or air conditioning from their smart phones or let the device learn their habits and set the temperature for them.

Finding (A4)	Description	Considerations
Technologies are Immature and Vendors Can Be Inexperienced	Many technologies are **new and relatively untested** (both device and software). Therefore, programs should enter into agreements only after a high level of **due diligence** on technology vendors and with tight **performance clauses** in contracts. Programs also should include a way to test vendor claims and integration compatibility prior to deployment. Some programs have created test labs to certify particular devices as being eligible for inclusion in their programs. In addition, retail and installation channels may not be well established for new devices, so in the short term, program administrators should expect to **play a larger role in device purchase and installation**.	Programs should also **set expectations** with consumers that devices are early stage and performance may vary.
Key Takeaways: • Create a technology due diligence process • Set realistic expectations with participants		

Example: Pecan Street Inc.	Based on its experience with technology demonstrations in residential homes, Pecan Street Inc. created a laboratory in which to test performance claims and now performs third-party performance validation testing for other organizations. Pecan Street also began hiring electricians as full time staff in order to ensure quality in the installation of devices and consistency in the resulting data.

Product Use

Finding (A5)	Description	Considerations
Access to a Simple Display Can Improve Results	Studies on in-home energy display devices have shown that information about **energy use** and **price** or **peak notifications** can change consumer behavior. In trials in which multiple data views were available, most consumers looked only at the home screen and were primarily interested in **what they were currently paying** for electricity. Consumers expressed much more interest in knowing about the **source of their usage** (e.g., by appliance) than in having access to more granular data in terms of time of use.	In-home displays are expensive ($100/device) and can become obsolete quickly. The market is moving away from in-home display devices and toward **smart phone applications**.

Key Takeaway:

- Include smart phone/tablet display as a program component

Finding (A6)	Description	Considerations
Smart Thermostats Can Generate More Energy Savings Than Other Devices	Heating, ventilation, and air conditioning (HVAC) is the **largest single component** of home energy use and accounts for nearly all of the **seasonal variation** in residential customer load. Because of the large impact of heating/cooling, installation of Programmable Communicating Thermostats (PCTs) is the focus of many programs. In addition, studies have shown that PCTs have greater load reduction results than behavior-based measures, such as in-home displays and variable rate pricing. Other large components of load include pool pumps and water heaters. Dishwashers and clothes dryers also present opportunities for load shifting of non-essential use.	PCTs are notoriously **hard to program**, and only a small portion of users program them correctly. The Nest PCT has addressed this problem by learning consumer behavior and effectively programming itself.

Key Takeaways:

- Have a clear view on what devices are going to contribute to overall program goals
- Consider devices with high energy use, such as thermostats, pool pumps, and water heaters

Finding (A7)	Description	Considerations
Though Automation Generates More Energy Savings, Consumers Prefer Greater Control	Automated demand response companies are successfully performing **direct load control** of PCTs, unless a consumer **manually overrides** the control. This is an effective and predictable method of peak load reduction, but the market is moving toward empowering customers with greater control in order to increase their satisfaction. **Convenience and control** are the primary drivers of consumer adoption of smart appliances. Though consumers are interested in energy savings, they are not willing to sacrifice comfort and control for those savings; demand response payments are often not high enough to be worth the loss of control to the consumer. Programs have seen **consumer push back** to utility control of in-home devices and declining participation after curtailment events. Acceptance of utility control can be increased by providing a benefit to consumers, such as free maintenance on a water heater or dryer. Many manufacturers of smart appliances are also opposed to direct utility control.	Automated demand response companies are giving customers more advanced notice and explanation of DR events and creating **more user-friendly** ways for customers to optimize for comfort or efficiency. Some market players are working on **less-intrusive** solutions, such as shifting load from pool pumps and freezer defrost cycles.
Key Takeaways: • Enable consumers to feel in control • Explore load shifting options that are less noticeable to consumers		

Communication

Finding (A8)	Description	Considerations
Open Com-munications Standards Are Best for Programs, but Often Resisted by Vendors	**Open standards** allow for the combination and interoperability of different technologies, and the market is moving towards open standards. However, most home management products and solutions in the market today are on closed systems. Vendors often prefer **proprietary interfaces** and want to sell products that are dependent on their **cloud services**, but this creates a siloed approach that is difficult to scale.	Appliances' long life can be incompatible with the **rapid evolution** of communications. Some industry players are working on **standard ports** for appliances that allow communications modules to be updated without replacing the appliance.
Key Takeaway: • Encourage use of open standards		

Finding (A9)	Description	Considerations
Interoperability Is Difficult to Achieve, Even with a Common Protocol	Many programs name connectivity and interoperability as the **primary challenge** they faced. Though some communications protocols are gaining traction in the market place, the technology is not mature enough to integrate seamlessly, requiring utilities to take a **larger role** in making the connectivity work. Even well-established communications standards like Wi-Fi can experience problems if a customer changes their wireless password or firewall settings.	Device **data caching** is essential in maintaining data quality. Without data caching, information cannot be back filled after a communications outage.
Key Takeaway: • Address technical requirements early on		

Finding (A10)	Description	Considerations
Cloud-Based Com-munications Can Achieve Smart Grid Benefits; Smart Meters Can Enhance Those Benefits	AMI deployment is not a prerequisite for two-way data communications between utilities and consumers. Many emerging solutions can control energy use of in-home devices via the **cloud** without smart meters. Vendors also find that the internet is a less-restrictive avenue for communicating with devices and transmitting data, allowing for more data to be transmitted cost effectively. However, AMI does offer some additional capabilities to a smart grid. The primary benefits of AMI are the ability to offer more granular **time-of-use rates** and to interconnect **electric vehicle charging** and rooftop **solar**. Smart meters also give a unique view of the energy use of the entire home; that information can be used by the utility to add value to consumers or other players. AMI also can provide additional benefits related to **distribution operations** and reliability. Many utilities are testing both approaches, and there is not a clear winner.	In order to achieve the benefits of AMI, utilities may need to upgrade their **billing and IT systems**.
Key Takeaway: • Define smart grid as broader than smart meters to include cloud-based communications solutions • Explore both AMI and non-AMI deployment models		

Monitoring & Pricing

Finding (A11)	Description	Considerations
Consumers Prefer Smarter, but Simpler Pricing Schemes	Variable rate pricing is necessary to realize many of the benefits of the smart grid. Studies show that the main driver of consumer purchases of smart appliances will be utility pricing structures. In general, smarter pricing schemes change consumption behavior and save energy, and higher **price signals** incentivize peak demand reduction better than **rewards**. Studies have found that a **tiered pricing** rate is more effective than a **time-of-use** rate in influencing a reduction in load. Though dynamic pricing gives consumers more information about how to change their behavior, too many price levels can increase **complexity** and hinder consumer acceptance.	Moving to smarter pricing schemes requires significant **consumer education**. Consumers may make inaccurate assumptions about how the pricing works or expect larger savings than they experience.
Key Takeaway: • If smarter pricing schemes are pursued, make them simple and straightforward for consumers		

Finding (A12)	Description	Considerations
Remote Monitoring Can Increase Value Proposition	Connected devices can also enable appliance **performance management.** For example, remote monitoring can identify problems in HVAC performance and notify consumers of the need for maintenance or replacement. Remote monitoring can also help service providers target customers for particular **products and services**.	Collection of data on customer devices can be perceived as an **invasion of privacy**.
Key Takeaway: • Consider remote monitoring as a component of the Evaluation, Measurement, and Verification (EM&V) cycle and as a way to enable additional products and services		

Utility Programs

Finding (A13)	Description	Considerations
Back Office Infrastructure May Need to Be Upgraded to Realize Smart Grid Benefits	Without the IT infrastructure needed to manage data from connected appliances, the grid becomes **more expensive** and **more complex** without becoming smarter. Some programs failed to meet their goals because they did not have adequate back office infrastructure. Programs that do not plan for back office impacts can create **large, unanticipated costs** and increase the **implementation time** of their projects. For example, many utilities have faced issues tying different customer pricing schemes into their **billing systems**. In addition, most utility IT systems were built to do billing calculations once a month. Interval data from smart meters increases that **data load** exponentially and creates the need for new analytical capabilities and organizational structures. In order to run a grid-connected Demand Response program, the utility needs a back office **DR Management System** and associated back office infrastructure.	Programs can build **infrastructure** for a 500 person **pilot** more cheaply than for a full program, but then it cannot be reused. On the other hand, building the infrastructure for a utility-wide program creates a lot of **upfront costs** and limits ability to learn from the pilot.

Key Takeaway:

- Include necessary back office capabilities in program design

Finding (A14)	Description	Considerations
Opt-In Programs Achieve Lower Participation Rates, but Higher Energy Savings per Participant	Pricing studies have found that, whether opt-in or opt-out, only ~5-10% of consumers actively change their behavior. Though overall **participation rates** are lower in an opt-in program, the participants tend to be more engaged and yield significantly higher **energy savings** if they chose to participate. Opt-out programs tend to see better results from a small number of consumers, which could reflect the subset that would have opted in if given a choice. Participants are typically incentivized to opt-in with free devices, rebates, demand response payments, or direct payments (which have ranged from $100 to $400).	An opt-in program may not provide a large enough **data set** to gain valuable learnings about consumer behavior.
Key Takeaway: • If the goal is to achieve higher savings per participant, design programs to be opt-in • If the goal is to collect a large data set, design programs to be opt-out		

Example: Los Alamos US-Japan Demonstration Smart Grid	The Los Alamos US-Japan Demonstration Smart Grid is performing a pricing study as part of the project. Though only one season of four has been completed, the preliminary results indicate that the Opt-In programs drive better results per participant. Though enrollment has been much higher in the Opt-Out group, the energy savings of the Opt-In group have been nearly double that of the Opt-Out group.

Savings

Finding (A15)	Description	Considerations
Energy Savings Has Not Been a Focus of Many "Smart" Projects	The data set for benchmarking energy savings from smart grid projects is not robust. The primary focus of many projects has been **technology demonstration** and **consumer studies**. Energy savings has sometimes been a byproduct rather than a goal. For example, some programs placed greater focus on data collection for consumer display rather than for EM&V, and **energy savings** was not tracked for all programs.	Successful programs focused on one or two primary objectives.

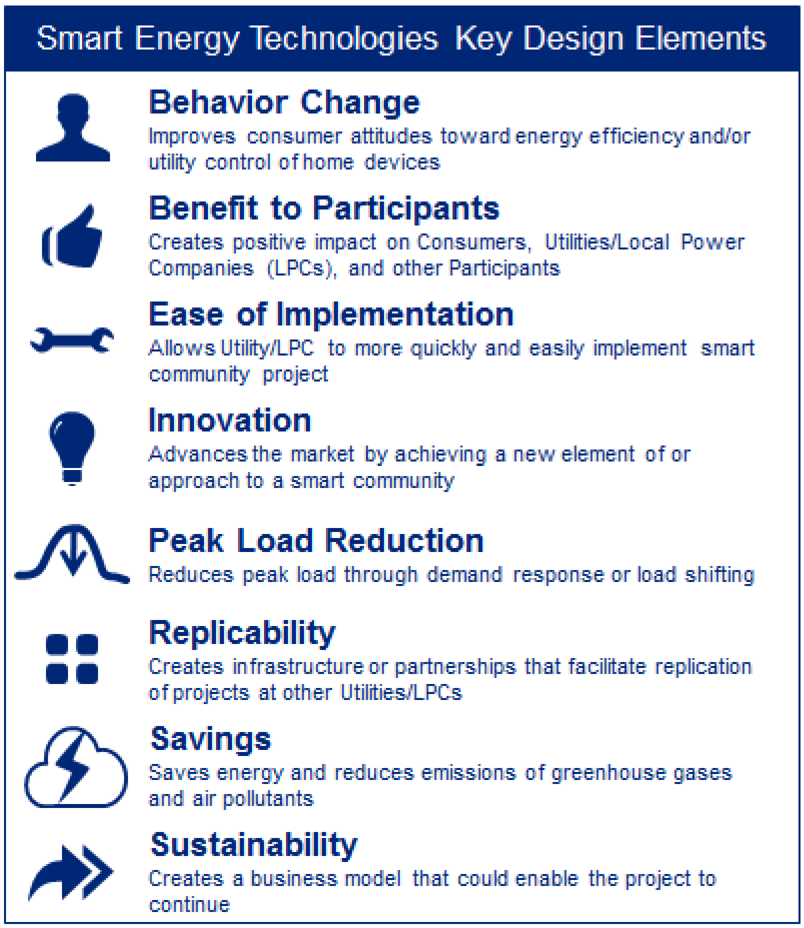
Key Takeaway:

- Create energy savings calculation methodology
- Balance energy/emissions savings with other program objectives

3.6 Key Design Elements

Based on the objectives of this project and the experience of other programs, the following key design elements are desirable for the Smart Energy Technologies project. These elements can assist TVA and LPCs in tailoring national leading practices and business models to the Valley.

Figure 6: Key Design Elements for Smart Energy Technologies



Behavior Change

Behavior change is a component of “human interaction” with the smart grid. A project could involve education, notifications, or incentives designed to improve consumer responsiveness to energy conservation. A project also could improve consumer attitudes toward remote control of home devices by making that control less intrusive, providing offsetting benefits, or improving messaging.

Benefit to Participants
A project should provide benefit to all participants. Consumers may see value from increased home automation and homeowner control, through convenient and non-intrusive conservation incentives, and/or through remote monitoring of devices to sub-optimal performance. LPCs may benefit from engagement with their customers and opportunities to grow their brand awareness and increase customer satisfaction. LPCs may also benefit from power system benefits, such as improved grid resilience, increased situational awareness, and enhanced outage restoration.

Ease of Implementation
Because of the set time frame of the Smart Energy Technologies project, it is important for an LPC to be able to implement a project as quickly and easily as possible. This attribute will need to be balanced with other attributes in an optimal program. For example, a more technically complex project may be more innovative, but it would also be more difficult to implement.

Innovation
An innovative project will advance the market for smart community products and services and will better position the TVA service territory for smarter energy use in the future. A project could pilot a new technology, scale an existing technology, and/or create a new delivery model that has not been achieved in the Valley or in the country.

Peak Load Reduction
A project can contribute to a more efficient and stable power distribution system by reducing peak load through demand response or load shifting. This can be achieved through direct control of smart devices in homes, through customer incentives, and/or through notifications to customers of periods of high demand.

Replicability
TVA serves 155 LPCs that provide power to more than nine million consumers in seven states. By creating a model that can be replicated in other LPC service territories, a Smart Energy Technologies project can create additional value for future projects or programs in the TVA service territory. Projects might create that value through partnerships or infrastructure that could be leveraged across LPCs.

Savings
In addition to reducing peak load, a Smart Energy Technologies project should increase a home or community’s energy efficiency, based on a comparative baseline (e.g., code standard such as ENERGY STAR. By increasing energy efficiency, the project will reduce emissions of carbon dioxide, sulfur dioxide, nitrogen oxides, and mercury.

Sustainability

Sustainability is the ability to extend the life of the project after the term of the Approved Plan. Projects could develop business models, establish infrastructure, and/or create partnerships or community relationships that may enable the project to continue. Innovative funding or financing mechanisms may allow the project—or a portion of the project—to be self-sustaining, although these mechanisms may make the project more difficult to implement.

4.0 Extreme Energy Makeovers

4.1 Objectives

The proposed plan approved by US EPA explains that TVA will perform Extreme Energy Makeovers for at least two communities located in different climate regions in the TVA service territory. The program will focus on homes that are at least twenty years old in lower income communities. The stated goal of the project is to achieve a “25% reduction in home energy use with an estimated energy savings of 1,000 MWh/year at approximately $10/square foot.” In addition to receiving a home retrofit, each participant will be trained on the operation and care of their home needed to achieve its designed energy efficiency.

EEM projects are to “include cost effective deep energy retrofits, maximizing the use of the energy efficiency measures and focusing on a whole house approach.” A deep energy retrofit is a whole building analysis that seeks to achieve much larger energy savings than conventional energy retrofits. Conventional energy retrofits tend to focus on isolated system upgrades (i.e., lighting and HVAC equipment), whereas a deep energy retrofit approaches the building as a complete system. A whole home approach addresses heating, air conditioning, insulation, air sealing, moisture management, lighting, water, and other systems with an emphasis on structural and equipment systems improvements with long service lives and synergistic effects. As a result of their comprehensiveness, whole house retrofits can create uniquely broad and valuable energy and non-energy benefits (such as increased comfort).

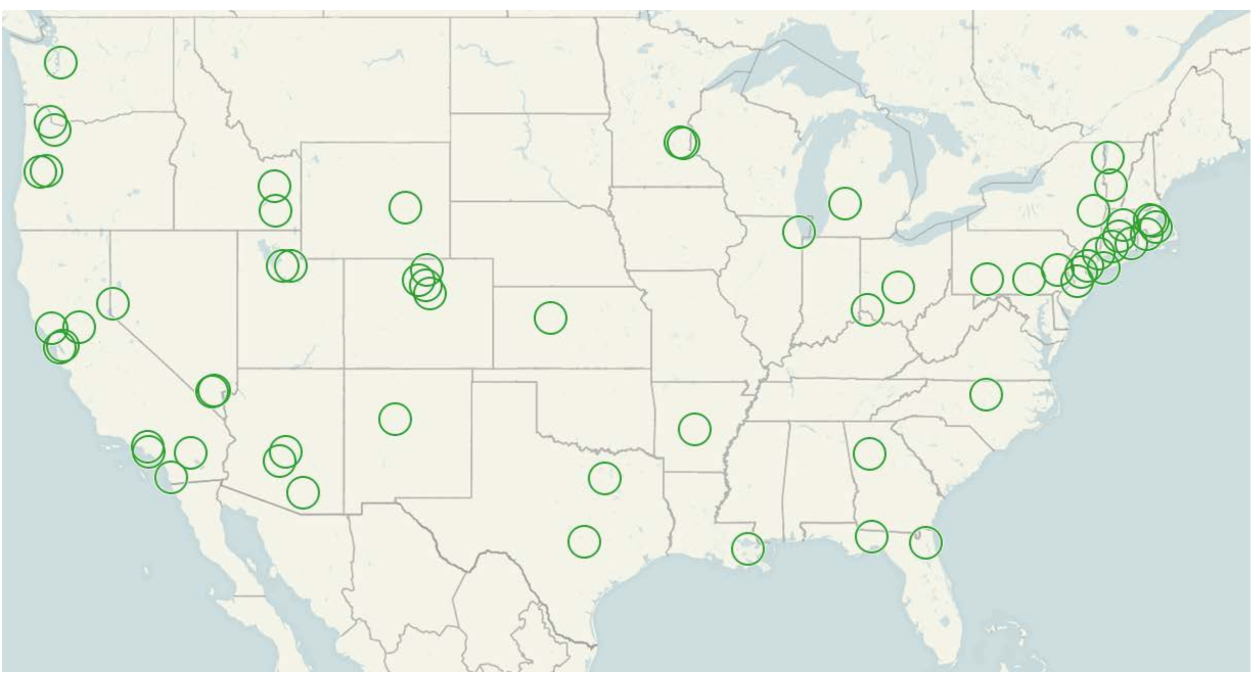
4.2 Research Approach

A national review of home energy retrofit programs identified more than sixty that were included in this study. Programs were reviewed based on whether they were designed for low-income consumers, whether they employed a whole home approach, and whether they had a unique approach to any of the program components in the framework presented in section 4.3.

Certain programs in the study were selected for an interview or further deep dive research. Programs were prioritized based on their size, whether they had implemented more than one retrofit program, whether they included low-income consumers, and whether the program had been operating long enough to have measurable results. In addition to interviews with program managers, the study included a review of published resources and interviews with industry experts who could provide an additional perspective on the market.

Figure 7 maps the home retrofit programs included in the study, followed by a complete list of programs. A list of program sources and interviews is included in the appendix.

Figure 7: Map of Home Energy Retrofit Programs Reviewed in Study

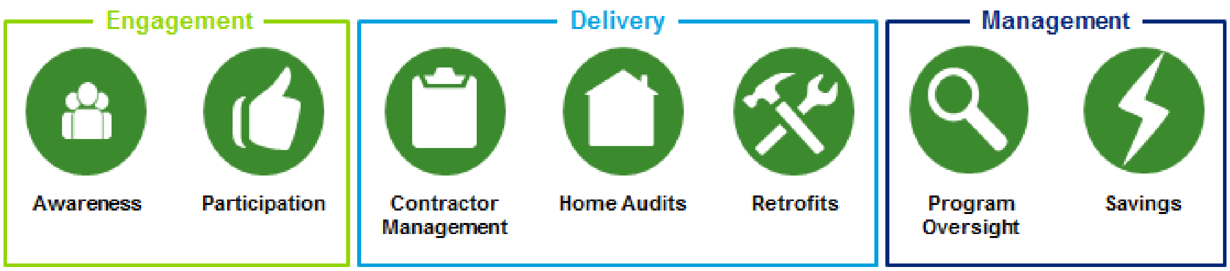


- Arizona Public Service: Home Performance with ENERGY STAR (HPwES)
- Austin Energy: Power Saver
- BetterBuildings for Michigan: Clean Sweeps
- Boulder County: ClimateSmart Loan Program
- Builders of Hope: Extreme Green Rehabilitation
- Chicago Metropolitan Agency for Planning: Energy Impact Illinois
- City of Berkeley: Berkeley FIRST
- City of Boston: Renew Boston
- City of Durham: Neighborhood Energy Retrofit Program
- City of Long Beach Gas and Oil: Residential Energy Efficiency Rebate Program
- Clean Energy Works: Clean Energy Works
- Clinton Climate Initiative of Arkansas: Home Energy Affordability Loan Program
- Connecticut Neighbor to Neighbor Energy Challenge
- Connecticut Light & Power, United Illuminating: Home Energy Solutions (HES)
- Energize New York: Bedford 2020 Energize Community Challenge
- Energy Trust of Oregon: HPwES
- EnergyFit Nevada
- Entergy: MyHome
- FirstEnergy: Whole House Program
- Fort Collins Utilities: Home Efficiency Program
- Georgia Power: Home Energy Improvement Program
- Idaho Falls Power
- JEA (Jacksonville Municipal Utility): ShopSmart
- Lane Electric Cooperative: Weatherization Grant Program
- Los Angeles Department of Water and Power: Home Energy Improvement Program
- Low-Income Energy Affordability Network (LEAN): Low Income Multi Family Energy Retrofits (LIMF)
- Massachusetts Department of Energy Resources: Mass Save
- Massachusetts Municipal Wholesale Electric Company (MMWEC): Home Energy Loss Prevention Services (HELPS)
- Midwest Energy: Kansas How$mart
- National Grid: Deep Energy Retrofit
- NeighborWorks: H.E.A.T. Squad (Home Energy Assistance Team)
- Nevada Power Company: HomeFree Nevada
- New Jersey Board of Public Utilities: Comfort Partners Program
- New Jersey Board of Public Utilities: HPwES
- New York State Energy Research and Development Authority (NYSERDA): Home Performance with ENERGY STAR
- Norwich Public Utilities, Groton Utilities, Bozrah Light & Power: Residential Home Energy Savings Program
- Ohio Office of Energy Efficiency: Ohio Home Weatherization Assistance Program
- Oncor: Home Performance program
- People Working Cooperatively (PWC): Energy Conservation (Weatherization)
- PPL Electric Utilities: Home Assessment Program
- Public Service Company of Colorado (Xcel Energy): Home Performance with ENERGY STAR
- Public Service Electric & Gas (PSE&G): Residential Whole House Efficiency Program
- Questar Gas: ThermWise
- Rocky Mountain Power: Home Energy Savings
- Rocky Mountain Power: Idaho Low-Income Weatherization
- Program
- Sacramento Municipal Utility District: Energy Efficient Remodel Demonstration Program
- Sacramento Municipal Utility District: Home Performance program
- Salt River Project: Home Performance with ENERGY STAR
- San Diego Gas and Electric: Energy Upgrade California
- Seattle City Light: Subsidized Audit Program
- Sierra Pacific Power Company: Home Energy Audit, Residential Retrofit
- Sonoma County: Energy Independence Program
- Southern California Edison and Southern California Gas: Energy Independence Program
- Springfield Utility Board: Joint Loan and Rebate Program
- State of Minnesota: Project Re-energize
- State of Pennsylvania: Keystone HELP Program Whole House Improvement Loans
- The City of Tallahassee Utilities
- Town of Babylon: Long Island Green Homes (LIGH)
- Tuscon Electric Power: Efficient Home Program
- Xcel Energy (Southwestern Public Service Company): Home Energy Services
- Xcel Energy, CenterPoint Energy: Home Energy Squad Enhanced
- Xcel Energy: ClimateSmart Residential Energy Action Program (REAP)

4.3 Market Framework

The following framework was developed to help contextualize the various components of the Extreme Energy Makeovers marketplace. These frameworks were used to categorize the various players and activities used by energy retrofit programs included in this Study. A holistic EEM project would touch on each component in this framework.

Figure 8: Extreme Energy Makeovers Market Framework



Main Component	Description	Examples (not exhaustive)
Engagement	The process of determining homeowner eligibility and performing outreach to make eligible homeowners/residents aware of the program.	• Community outreach and partnerships • Customer segmentation
Delivery	The process of delivering work via contractors who perform home audits and/or retrofits. Contractors involved in delivering EEM programs.	• Contractor certification • Audit to retrofit process • Measure guidelines • Quality assurance (QA)
Management	Management of program by utility, implementer, and/or partner, and the measurement of energy/emissions savings that result from home retrofits.	• Oversight • Documentation • Evaluation • Reporting
Sub-Component	**Description**	**Examples (not exhaustive)**
Awareness	Approach to increasing consumer awareness of the program and interest in participating. Includes messaging, consumer education, marketing channels, and marketing spend.	• Direct mail and email • Billing outreach • House calls • Community events • Ad-hoc events and activities • Contractor co-op marketing • Community organizations • Participant spokespeople • Cross-marketing with other residential programs

Sub-Component	Description	Examples (not exhaustive)
Participation	Eligibility required for participation and incentives offered to drive participation. Encompasses process of income verification. Also includes targeting participants based on household income levels, age of home, climate zone location, neighborhood characteristics and/or participation in other low-income programs.	• Homeowners/Renters • Single family/Multifamily • % of poverty line/% of median income • Homes with high energy usage
Contractor Management	Recruitment, screening, and management of contractors who perform retrofit work, whether a single contractor for the whole home or multiple specialized contractors. Can include rewarding higher performing contractors and mentoring/training lower performing contractors. May address standardization of requirements across programs or geographic areas.	• Contractor involvement in design and ongoing management • Certification and qualifications • Training • Consumer tool for accessing contractor network • Utility/contractor data sharing • QA and feedback process
Home Audits	Process of performing the audit and how it integrates with the rest of the home retrofit process. Includes who conducts audit and what level of audit is performed.	• Blower door tests • Walk-through audits • Virtual audits • Utility, contractor, or third-party audits
Retrofits	Scope of measures to be performed in each home, including guidelines for contractors on which measures to perform and at what cost. Could include measures beyond typical weatherization and/or address health and safety issues.	• Air sealing and insulation • Duct replacement/repair • Windows • High efficiency heat pumps • High efficiency appliances • High efficiency light fixtures • Smart thermostats/smart plugs • Replacement of old wiring
Program Oversight	Management of the program by the lead implementer, whether a utility, community organization, or third party. May include ongoing stakeholder and community engagement and revising program based on lessons learned.	• Program design • Advisory/stakeholder group • Monitoring and evaluations • Revision of processes or requirements
Savings	Measurement of the energy and emissions savings associated with home retrofits.	• Deemed savings • Calculated savings/Modeling software • Actual savings/Utility bills • Impact of customer behavior

4.4 Business Models

This Study describes a few business models being used in the home energy retrofit market. This list is not intended to be exhaustive. Instead, this list provides a sense of the primary delivery models used in this market.

The business models discussed in this study include the following:

1. Utility-Led Model
2. Third Party Implementer Model
3. Retailer Partnership Model

Utility-Led Model

A Utility runs the project, though it may contract with other companies or organizations to provide specific program components. In this project, an LPC would play the role of the "utility."

Implementing the program would involve partnerships with local community organizations, some of which may already have relationships with the utility/LPC. Managing the project may allow a utility/LPC to leverage its existing, related programs to streamline administration. Alignment with other programs could include use of an existing contractor network—or, in the case of this project, TVA's Quality Contractor Network (QCN). In the model, processes are likely localized and specific to a particular utility/LPC.

Key Elements	
Branding	• Utility-branded program
Community Engagement	• Utility partners with local community organizations
Contractor Network	• Utility may leverage existing contractor network
Processes	• Utility employs localized processes

Third-Party Implementer Model

A utility/LPC hires or partners with a third party implementer to run the project. Examples of third-party implementers include, but are not limited to, the following:

- A local community action agency working in the same community that would be served by the project
- A regional company with experience implementing other utility programs in the TVA service territory
- A national company with experience implementing low-income retrofit programs in other parts of the country

The implementer may be able to leverage outreach tools, educational materials, and experience from previous project implementations. If the implementer is already operating locally, it may have its own contractor network or it could use the utility's network—or in this project, TVA's Quality Contractor Network (QCN).

Key Elements	
Branding	• Utility-branded program
Community Engagement	• Implementer partners with local community organizations
Contractor Network	• Implementer may leverage utility's contractor network (TVA QCN) or its own contractor network
Processes	• Implementer could employ centralized, and possibly more automated, processes

Retailer Partnership Model

A utility provider partners with a big box home improvement retailer. The project is co-branded to take advantage of the utility's brand association with energy and the retailer's brand association with home improvement. The retailer may leverage their contactor network and build on existing certification requirements, QA processes, and feedback mechanisms. The retailer may also be able to use programs such as do-it-yourself (DIY) workshops to educate homeowners or residents on energy efficiency and home retrofits. A retailer also may bring additional funding to the program, or could provide an in-kind donation of materials or equipment for retrofits.

A utility/LPC also could choose to create a partnership with a Retailer in which a third-party implementer is hired to manage the program.

Key Elements	
Branding	• Utility and Retailer co-branded program
Community Engagement	• May involve less grassroots engagement, unless utility and Retailer form additional community partnerships
Contractor Network	• Retailer may leverage its own contractor network
Processes	• Retailer could employ centralized, and possibly more automated, processes

4.5 Key Findings

The key findings presented in this Study are based on interviews with industry experts and on a review of existing research and case studies on the residential energy retrofit market. Although leading practices were considered from both low-income and market-based programs, this report presents only those findings that are applicable to low income because that is the focus of EEM in the Approved Plan. For example, consumer financing and energy efficiency loans are not addressed in this report. A list of sources is included in the appendix. The key findings are organized according to the market framework explained in Section 4.3.

Awareness

Finding (B1)	Description	Considerations
Consumers Respond Best to Messaging Centered on Their Pain Points	**Comfort** was the most effective message for a variety of programs. **Health** was also a component of messaging. **Cost savings** from energy efficiency was most often messaged as a secondary benefit. Programs found that, while consumer education is key, it is best to first **inspire action** and provide energy education once a homeowner has decided to participate and is ready to listen. Communications that relied on energy efficiency terminology or technical details on how retrofits work were less effective at driving participation.	No single message will resonate with all consumers. Marketing needs to be multi-faceted and **tailored** to suit the customer base.
Key Takeaway: • Focus on consumer needs, such as comfort, for program messaging		

Finding (B2)	Description	Considerations
Enlisting Local Spokespeople Can Help Programs Gain Trust	**Early adopters** from the neighborhood who have experienced the program can become spokespeople and help build trust in the program. Early adopters can either host open houses at their retrofitted homes, speak at community events, or be featured on printed media. Using program participants can cost less than hiring **spokespeople**, and outreach is most effective via people who already have **established relationships**. Local spokespeople can be particularly effective in low-income communities, which may be more marginalized and suspicious of outsiders.	Relying on early adopters as spokespeople lengthens the **time** needed to ramp up and promote the program. Partnering with local organizations (see Finding B3) can help facilitate this approach.
Key Takeaway: • Market through trusted local community members		

Example: BetterBuildings for Michigan Clean Sweeps	The BetterBuildings for Michigan Clean Sweeps program performed residential energy retrofits in 27 communities throughout the state. Each community was targeted in a 2-3 month "sweep." The program was designed to test different variables on how to generate high participation in a short amount of time. The program learned that every community was different in terms of which outreach tactics worked best and the influence of community organizations. What worked well in many communities was performing a few retrofits in a neighborhood and then having those homeowners work as spokespeople at community events. The most effective marketing campaign used pictures of local people recognizable in the community on postcards and flyers, along with quotes from them about how they benefitted from retrofits.

Finding (B3)	Description	Considerations
Leveraging Existing Community Infrastructure Can Increase Participation	Existing infrastructure can facilitate outreach and implementation and build capacity that enables program sustainability. This existing infrastructure could include **contractors**, whose experience with lead generation and knowledge of the local market can be leveraged through **cooperative marketing**. Some programs have partnered with large **local employers** and used their built-in peer network to establish trust and credibility. Utilities also may have a local infrastructure due to previous residential programs. **Community Action Program (CAP)** agencies, Efficiency First chapters, and other community organizations also have established networks for **grassroots outreach** that can speed up a program's time to market. Community organizations focused on low-income populations also may provide additional funding that can be used in tandem with an energy efficiency program to address other home retrofit needs.	Building relationships with other organizations takes **time and resources**. Partners may require training to acquire sales or marketing skills. Each community is different in terms of which organizations are most influential. A marketing approach should be informed by the characteristics of the targeted community.
Key Takeaway: • Partner with local community organizations, particularly those focused on low-income communities		

Finding (B4)	Description	Considerations
Marketing Is Essential Even When Programs Have Rich Incentives	Even when incentives for participation are very attractive, programs can struggle to meet goals if marketing effort is insufficient. Programs need a **balanced approach** between **marketing expenditure** to raise awareness and **incentives** to drive action. Early in the program cycle, it is particularly important to place greater emphasis on marketing.	Program structures may **limit** the amount of funding that can be spent on administration, which can include program marketing.
Key Takeaway: • Emphasize marketing to optimize results		

Participation

Finding (B5)	Description	Considerations
Low-income Threshold Should Be Defined to Streamline Verification Process	Home retrofit programs typically define the low-income threshold in terms of the **poverty line** (e.g., below 120-200%) or **median household income** (e.g., below 60-80%), and residents must provide **proof of income** in order to participate. Some program administrators feel that too much funding goes toward keeping out a few people at the expense of letting in a wider body of qualified people. In addition, potential participants may not be able to produce income documentation or may view the request as an invasion of their **privacy**. The challenge for low-income programs is to maintain the integrity of the program mission without too much **administrative burden**. To accomplish this, some programs are exploring use of **census block data** to pre-determine eligibility for entire neighborhoods. Others are marketing to people who have already qualified for **fuel assistance** or other government or non-profit **low-income programs** and only verifying income as a last resort.	Each jurisdiction may have a **different definition** of low-income. Marketing should be targeted toward only those who qualify.
Key Takeaway: • Minimize administrative burden by aligning eligibility with existing low-income programs		

Finding (B6)	Description	Considerations
Targeting Homes with Higher Usage Can Increase Energy Savings	Average pre-retrofit energy use typically drives the energy savings. Therefore, targeting homes with higher usage and greater **potential for energy efficiency gains** can generate deeper savings. Some programs have placed a threshold of **minimum usage** required to be eligible and have seen higher per home savings as a result. Some have applied a formula that allows more money to be spent on retrofits in homes with higher usage. Segmentation based on energy usage, size of home, and number of household members can help programs maximize **energy savings per dollar** spent.	Targeting based on highest usage could **limit program participation** and make it difficult to achieve other goals, such as total homes retrofitted or total MWh saved.
Key Takeaway: • Prioritize homes with greater electricity usage to maximize percent savings per home		

Contractor Management

Finding (B7)	Description	Considerations
Program Design Should Take into Account Industry Capacity and Capabilities	The volume of marketing should be appropriate for the available capacity of qualified home energy contractors to perform retrofits. Contractor requirements should be developed with consideration for the **existing capabilities** in the local market. For example, before requiring Building Performance Institute (BPI) **certification**, programs should understand if there is a lack of accredited contractors in their area. Also, programs may not be able to pursue a one-stop approach if most contractors in their area are **specialized** on particular measures, such as HVAC or windows. Industry capacity and adherence to national accreditation standards can be increased over time through contractor **training** and assistance.	Workforce development and training can increase **program costs** and may be beyond the **scope** of an energy efficiency program.
Key Takeaway: • Design program based on local industry circumstances		

Example: Fort Collins Utilities	Fort Collins Utilities initially designed a whole home program that relied on a single contractor as the point of contact for the customer throughout the home improvement process. The utility learned that many of the contractors were not cross-trained in all of the necessary trades, but specialized in insulation/air sealing, HVAC, or windows. The program learned that if it tried to create a new kind of contractor and a market for that contractor at the same time, it couldn't reach a critical mass. Though some contractors broadened their focus to more measures based on training provided by the program, most contractors prefer to continue in their current business model. Fort Collins learned that it needed to meet contractors where they were. In its current program design, Fort Collins uses a traditional contractor network which allows the contractors to focus on their specialty while simultaneously allowing homeowners to include multiple measures. Several contractors have developed over time to provide an integrated whole home approach.

Finding (B8)	Description	Considerations
Contractor Requirements Should be Standardized Across Programs	Program requirements and certifications should align across programs (e.g., between **low-income** and **market-based programs**) and geographies (e.g., **neighboring utility service territories**). This can reduce administrative costs, facilitate contractor participation across multiple programs, and enable new programs to ramp up more quickly.	Requirements or certifications of existing programs may not meet the **needs** of the program being developed.
Key Takeaway: • Leverage contractor networks built for existing programs		

Example: DC Sustainable Energy Utility	The DC Sustainable Energy Utility has both a low-income and a market-based residential retrofit program. The same network of contractors is leveraged across programs, and the audit and retrofit process is the same for both. Although customers enter the program through different channels, contractors do not know whether a customer is in the low-income program or the market program. From the contractor perspective, the product is the same.

Finding (B9)	Description	Considerations
Actively Managing Contractors Yields Better Results, but Can Be Time and Resource Intensive	Both whole home and more specialized contractors should be engaged early in the design process to ensure that the program is structured to align with contractor business models. By performing **QA** and **tracking customer satisfaction**, contractors who are high performing can be given more retrofits. Lower performing contractors can be identified for **additional inspections** or **training**, and QA process can be lessened for contractors with a proven track record of performance. **Active engagement** with contractors can also help anticipate and prevent shortages in contractor capacity as the program grows. The best results come from 100% QA, but most programs perform QA at a level that gives them **reasonable confidence** in the quality of the results (generally 5-15% QA). **Flexibility** is key in defining QA requirements, as not every contractor or type of retrofit requires the same level of scrutiny.	Active management requires additional **resources** for program administration. Some programs with more rigorous contractor management and a higher percentage of QA worry that their processes are not **scalable**.
Key Takeaway: • Place an early emphasis on rigorous QA and contractor management, which can be ramped down over time to lessen administrative burden		

Home Audits

Finding (B10)	Description	Considerations
A Flexible Audit Implemen-tation Process Can Help Prevent Program Bottlenecks	Programs should allow for **multiple pathways** in which different types of companies can perform home audits. Some programs have experienced a shortage of qualified auditors, so allowing contractors to perform audits can increase the pool of **available personnel**. By allowing contractors to perform audits in the same visit as retrofits, retrofits can be performed more quickly with less duplication of effort.	Where audits are performed by contractors, rigorous **third party oversight** is required to ensure quality meets desired levels.

Key Takeaway:

- Allow for multiple pathways in which different type of companies (including contractors) can perform audits
- Create standard audit guidelines and perform third party oversight to ensure consistency

Finding (B11)	Description	Considerations
Participant Engagement is Key to Keeping the Audit Process on Track	A lack of participant engagement can slow down the audit process. Some programs have experienced **significant delays** because the resident is **not home** at the time of their appointment, causing the auditor or contractor to have to **reschedule**. The majority of low-income programs are free for participants. Some low-income programs charge participants a **nominal fee** (e.g., $25) because it makes the homeowner more likely to show up at the scheduled time and be engaged in the process. Fees can be **refunded** after work is completed.	Charging a fee may **lower participation** rates. Collecting and refunding a fee may add **administrative costs**.

Key Takeaway:

- Encourage low-income homeowner engagement to minimize process delays caused by rescheduling

Retrofits

Finding (B12)	Description	Considerations
Leading Programs Have a Method to Address Safety Issues Encountered During Retrofits	Health and safety issues (e.g., gas leaks, combustion safety, mold, asbestos, **lead**, etc.) tend to be more prevalent in older homes and have presented obstacles for a number of programs. For example, one program encountered **asbestos** in 17% of participating homes. **Safety experts** from utilities, regulatory agencies, and building performance contractors should be involved in program planning and execution, and the program should have a plan for addressing safety issues encountered during retrofits. A preferred approach is **partnering** with local organizations that have funding to address home safety concerns in low-income housing.	Retrofitting homes with health and safety issues can be more **expensive** and may be **out of scope** for an energy efficiency program. Some programs have taken a simpler approach of disqualifying homes where such issues were found.

Key Takeaway:

- Create a clear policy and procedure for dealing with health and safety issues
- Consider partnering with local organizations focused on health/safety in low-income homes

Example: New Jersey Comfort Partners	
	The Comfort Partners program frequently finds customers with serious health and safety issues, such as dangerous wiring or heating and water systems in need of serious repair or replacement. They also have found that some homes have issues (e.g., roof damage) that would make the energy conservation work ineffective. To address this problem, Comfort Partners allows contractors, on a case-by-case basis upon utility approval, to spend up to $5,000 to address non-energy repairs needed to effectively install energy conservation measures. If the home requires repairs in excess of this cap, the program performs base-load measures (e.g., refrigerator/freezer testing and possible replacement, installation of CFLs, water heater tank temperature setback, etc.), and then refers the participant to a community organization.

Finding (B13)	Description	Considerations
A Whole-Home, Custom Approach Generates Higher Savings per Home, but Can Take Longer to Implement	Some programs have **lowered implementation costs** by standardizing a set routine (e.g., air sealing, insulation, and duct sealing) to be performed in each home. However, this approach is challenging with a more diverse set of homes and does not achieve **deep energy savings**. Many programs that began with a basic, standard package are trying to build in more **flexibility** in later program phases. Because every home is unique, maximizing **cost-effective savings** requires a **custom approach** for each home, but this is fairly time and resource intensive. A leading practice gives contractors **guidelines** for how deep to go and how much to address on different measures to yield some standardization while adapting to the unique conditions in each home.	The balance between custom and prescriptive is a **current issue** that many programs are tackling, but it is not yet clear how best to achieve it.
Key Takeaway: • Base retrofits on conditions encountered in each home • Establish guidelines for contractors on what cost-effective measures to prioritize		

Finding (B14)	Description	Considerations
The Market May Move Toward a Performance-Based Approach	Some market participants would like to move to a future state where programs and utilities are **procuring energy efficiency** from industry in a **performance contract**. In this model, contractors would be paid based on the actual energy efficiency gains achieved in a home and they would have the flexibility to achieve those savings at the lowest possible cost in order to maximize their profit. However, currently there is too much **uncertainty** in energy calculations to make this possible and contractors are not willing to assume the **risk** associated with this approach.	By improving the **calculation** of energy savings, programs can make this future state more viable (see finding B15).
Key Takeaway: • Create standardized energy savings calculations to enable future development of performance-based approaches		

Program Oversight

Finding (B15)	Description	Considerations
Involving Key Stakeholders Can Improve Program Design and Oversight	Many programs attribute their success to involving a **committee of stakeholders** not only in program **management**, but in program **design** as well. These committees have included different combinations of the following stakeholders: • Electric utilities (including representatives of other residential energy efficiency and renewable energy programs) • Gas utilities • Contractors • Contractor trade organizations • State and local government • Efficiency First chapters • Economic development agencies • Local administrators of fuel assistance and weatherization programs • Non-profits or community organizations serving the targeted population • Evaluators/EM&V providers	**Local circumstances** will inform which stakeholders should be included in the committee.
Key Takeaway: • Create a stakeholder committee in program design and management		

Finding (B16)	Description	Considerations
More Flexible Programs Achieve Better Results	Planning for flexibility can enable programs to **launch more quickly** and to **adapt** based on experience or changing market conditions. Many programs have seen the need to adjust their marketing tactics or retrofit approach after gaining experience in a particular market. Some felt they had "overdesigned" their programs and would have benefitted more from a willingness to be more nimble. Programs can drive the greatest results when they can be **creative** and **agile** and adapt as	Shifts in program requirements can be **confusing** for participants and contractors. Programs should clearly **communicate** changes well in advance and allow industry participants

	the private sector does. Some programs also chose partner organizations based on whether the potential partner's culture reinforced the ability to make mistakes and adjust quickly.	to comment on proposed changes.

Key Takeaway:

- Incorporate flexibility into program design
- Create a best practices committee that reviews performance and adjusts the program at set intervals (see Finding B15)

Savings

Finding (B17)	Description	Considerations
Measuring Actual Savings Is More Challenging and Costly Than Other Measurement Options	There is not a standard practice for the measurement of energy savings from home retrofits. Some programs measure **actual savings** on utility bills, but collecting and analyzing bills is **challenging** and **time intensive**. Without high deployment of smart meters or data loggers, the cost of measuring actual residential savings can be more than the benefit. Some programs perform house-by-house modeling using **software**, but this also adds **expense** to the program. Energy projection software can also be **inaccurate**, particularly when the program does not have a large, localized data set on which to base calculations. Many programs rely on **deemed savings**, often coupled with evaluation to confirm accuracy. Deemed savings work better when averaged over a large **portfolio** of homes (i.e., larger sample sizes can increase confidence level) and paired with a **set protocol** for retrofits (i.e., specific conditions in which you allow contractors to perform measures).	Programs can be designed to build a **statistical analysis** that can be used to improve the accuracy of a software model. This analysis can help improve the program and inform future programs. If improving the accuracy of energy savings calculations is a goal, the program should perform a higher percentage of QA (see Finding B9).

Key Takeaway:

- Consider long-term program goals when determining energy savings methodology

Finding (B18)	Description	Considerations
Low-income Weatherization Must Be Paired with Education to Produce Energy Savings	Changes to **consumer behavior** can offset energy savings that result from weatherization measures. This offsetting behavioral effect, or **"take-back,"** is particularly high among **low-income** residents, who often have been living below the **comfort** level they would like. Some programs have seen energy usage actually increase after a low-income weatherization program was implemented. One low-income program saw increased use in 20-30% of retrofitted homes. When the program performed site visits of those homes, it found that the increase was generally due to factors outside of the program scope, such as a relative now living in a previously unoccupied part of the house.	**Consumer education** can help mitigate take-back. However, often the decision maker in the household is not the person home during the audit and retrofit.
Key Takeaway: • Design program to address take-back—for example, by including installation and programming of smart thermostats as a retrofit measure • Prioritize consumer education • Consider ongoing monitoring to confirm savings and effectiveness of education		

4.6 *Key Design Elements*

The objectives of this project and the experience of other programs were used to identify key design elements that are desirable for the Extreme Energy Makeovers project. These elements can assist TVA and LPCs in tailoring national leading practices and business models to the Valley.

Figure 9: Key Design Elements for Extreme Energy Makeovers

Benefit to Participants

A project should provide benefit to all participants. Retrofits can improve the level of home comfort and quality of life for low-income households, as well as lower their energy costs. LPCs may benefit from engagement with their customers and opportunities to grow their brand awareness and increase customer satisfaction.

Community Engagement
Involving community organizations and leaders throughout the design and implementation process can enable projects to understand the needs and characteristics of low-income communities and to gain the trust of homeowners and residents in these neighborhoods. Community engagement can provide a platform for increasing awareness, educating consumers, improving the processes or requirements, and extending or expanding the project.

Consumer Education
Consumer education is a major component of the proposed plan approved by EPA. Education can increase residents' willingness to participate, improve their knowledge of the work being performed on their home, and empower them to better manage their home energy use in the future. Whether through individual interactions in consumer homes or group classes/community workshops, education can enhance consumer engagement, understanding, and satisfaction.

Cost Effectiveness
The Approved Plan states a goal of approximately $10/square foot for retrofits, which must be balanced with the program's deep energy savings target. A project might use guidelines, rather than a set list of measures, to enable contractors to react to conditions in a home and perform the most cost-effective retrofits.

Ease of Implementation
Because of the set time frame of the EEM project, it is important for an LPC to be able to implement a project as quickly and easily as possible. For example, projects may ease implementation by working with organizations active in the local community and/or leveraging existing contractor networks. A project that is easier to implement can also be more valuable as a model to other LPCs or utilities across the country.

Savings
As stated in the Approved Plan, the goal of the Extreme Energy Makeovers project is to reduce each home's electricity use by at least 25%, with an estimated total project energy savings of 1,000 MWh/year. By increasing energy efficiency, the project may decrease the financial burden on low-income households. The project also will reduce emissions of carbon dioxide, sulfur dioxide, nitrogen oxides, and mercury.

Scalability
TVA serves 155 LPCs who provide power to more than nine million consumers in seven states. By creating a model that can be expanded to other LPC service territories, an EEM project can create additional value for the TVA service territory. Projects might create that value through partnerships or infrastructure that could be leveraged across LPCs.

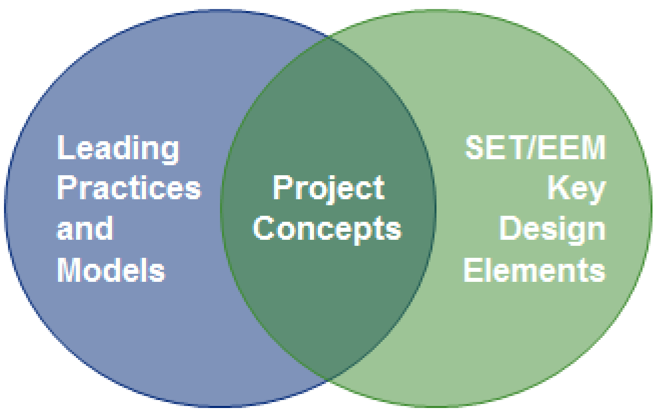
Sustainability

Sustainability is the ability to extend the life of the project after the term of the Approved Plan. Projects could develop business models, establish infrastructure, and/or create partnerships or community relationships that may enable the project to continue. Innovative funding or financing mechanisms may allow the project—or a portion of the project—to be self-sustaining, although these mechanisms may make the project more difficult to implement. A sustainable project can also be more valuable as a model to other LPCs or utilities across the country.

5.0 Conclusion

This benchmarking study describes leading practices and business models in use across the United States. For both Smart Energy Technologies (SET) and Extreme Energy Makeovers (EEM), the findings are broadly focused and address the major components of successful programs. No single project can or should align with every leading practice outlined in this report. Potential project teams will need to create new project concepts that represent the best combination and balance of these leading practices and business models.

The findings focus on experiences shared across regions and utilities, but a common theme of the research was the need to tailor project concepts to the local market and population. Therefore, project concepts should be based on the characteristics of the community to be served and rooted in an understanding of the local area.



The leading practices this Study presents should be viewed through the lens of what is important in the TVA service territory and what will benefit the 155 LPCs and nine million people served by TVA. For that reason, the Study includes both national leading practices and the key design elements for this project. The combination of those two elements will produce the best outcomes for the TVA Smart Communities project and the Valley.

6.0 Appendix

6.1 Programs Reviewed

The following tables list the programs reviewed during the course of this Study. This list is not inclusive of all programs in the U.S., it provides a comprehensive foundation for the Study to address the key issues in program design and implementation.

Smart Energy Technologies	
Program Name	**Source**
AEP: gridSMART	https://www.aepohio.com/save/demoproject/about/Default.aspx
Austin Energy: Bring-Your-Own-Thermostat Pilot	http://www.greentechmedia.com/articles/read/one-demand-response-platform-to-rule-them-all-in-austin
Baltimore Gas & Electric: Smart Grid Initiative	http://www.smartgrid.gov/project/baltimore_gas_and_electric_company_smart_grid_initiative
Bismarck State College: National Energy Excellence Smart Grid Laboratory (GridLab)	https://www.bscnecelabs.net/
Burbank Water and Power: Smart Grid Program	http://www.smartgrid.gov/project/burbank_water_and_power_smart_grid_program
Cape Light Compact: Residential Smart Energy Monitoring Pilot	http://www.nhpci.org/publications/NHPC_White-paper-Making-Sense-of-Smart-Home_20131015.pdf
City of Naperville: Smart Grid Initiative	http://www.smartgrid.gov/project/city_naperville_il_city_naperville_smart_grid_initiative
Commonwealth Edison (ComEd), Philadelphia Electric Company (PECO): Customer Application Pilot	http://www.smartgrid.gov/sites/default/files/doc/files/Exelon_ComEd_PECO_Smart_Grid_Demonstration_Overview_201012.pdf
Commonwealth Edison: Consumer Application Program Pilot	http://www.sgiclearinghouse.org/Technologies?q=node/4816&lb=1\
Commonwealth Edison: Smart Home Showcase	https://www.comed.com/technology/smart-meter-smart-grid/see-for-yourself/smart-home-showcase/Pages/default.aspx
Connecticut Light & Power: Plan-It Wise Energy Pilot Program	http://nuwnotes1.nu.com/apps/clp/clpwebcontent.nsf/AR/PlanItWise/$File/Plan-it%20Wise%20Pilot%20Results.pdf
Consolidated Edison Company: Secure Interoperable Open Smart Grid Demonstration Project	http://www.smartgrid.gov/project/consolidated_edison_company_new_york_inc_secure_interoperable_open_smart_grid_demonstration_
CPS Energy: AMI Program	http://www.cpsenergy.com/services/generate_deliver_energy/energy_delivery/ami/
Drexel University: Drexel Smart House	http://www.drexelsmarthouse.com/
Duke Energy: Virtual Power Plant Project	ftp://public.dhe.ibm.com/software/data/sw-library/information-management/bigdata-partners/integralanalytics/Orchestrating-Dukes-Virtual-Power-Plant.pdf

Program Name	Source
Fort Collins Utilities: Renewables and Distributed Systems Integration Project	http://www.smartgrid.epri.com/doc/Ft%20%20Collins%20RDSI%20Final.pdf
FP6 INTEGRAL: PowerMatching City	http://www.dnvkema.com/Images/factsheet_powermatching.pdf
Honda: Smart Home US at UC Davis	http://www.honda.com/newsandviews/article.aspx?id=7175-en
Idaho Power: Dynamic Pricing Pilot	Chartwell: Demand Response Programs and Rate Programs for Residential Customers 2012
Illinois Institute of Technology: Perfect Power	http://www.iitmicrogrid.net/microgrid.aspx
Kansas City Power & Light: Green Impact Zone SmartGrid Demonstration	http://www.smartgrid.gov/project/kansas_city_power_and_light_green_impact_zone_smartgrid_demonstration
Konterra: Solar Microgrid	http://www.standardsolar.com/About-Us/News/Press-Releases/4748
Long Island Power Authority (LIPA): Smart Energy Corridor	http://www.smartgrid.gov/project/long_island_power_authority_long_island_smart_energy_corridor
Los Alamos Department of Public Utilities: US-Japan Demonstration Smart Grid	http://www.losalamosnm.us/utilities/Pages/LosAlamosSmartGrid.aspx
Los Angeles Department of Water and Power: Smart Grid Regional Demonstration	http://www.smartgrid.gov/project/los_angeles_department_water_and_power_smart_grid_regional_demonstration
Mesa del Sol: New Mexico Green Grid Initiative	http://energy.sandia.gov/wp/wp-content/gallery/uploads/NM_Microgrid_Collaboration_SAND2012-3467P.pdf
National Rural Electric Cooperative Association: Enhanced Demand and Distribution Management Regional Demonstration	http://www.smartgrid.gov/project/national_rural_electric_cooperative_association_enhanced_demand_and_distribution_management_
NSTAR: Automated Meter Reading-Based Dynamic Pricing	http://www.smartgrid.gov/project/nstar_electric_and_gas_corporation_automated_meter_reading_based_dynamic_pricing
NSTAR: Urban Grid Monitoring and Renewables Integration	http://www.smartgrid.gov/project/nstar_electric_and_gas_corporation_urban_grid_monitoring_and_renewables_integration
NV Energy: mPowered	https://www.nvenergy.com/home/saveenergy/rebates/mpowered/mPoweredSouth.cfm
Oklahoma Gas & Electric: Smart Study Together	http://www.occeweb.com/pu/SMARTGRID/GEP%20OGE%20Summer%202011%20Report.pdf
Oklahoma Gas & Electric: SmartHours	http://www.oge.com/residential-customers/products-and-services/pages/smarthours.aspx
Pacific Gas & Electric (PG&E): Home Area Network (HAN) pilot	http://www.pge.com/han/
Pacific Northwest Smart Grid Demonstration Project	http://www.smartgrid.gov/project/battelle_memorial_institute_pacific_northwest_division_smart_grid_demonstration_project
Pecan Street Inc.: Pecan Street Project	http://www.pecanstreet.org/projects/smart-grid-demonstration/

Program Name	Source
Pepco: PowerCentsDC Program	http://www.powercentsdc.org/ESC%2010-09-08%20PCDC%20Final%20Report%20-%20FINAL.pdf
Philadelphia Electric Company (PECO): Drexel University	http://www.smartgrid.gov/sites/default/files/doc/files/Exelon_ComEd_PECO_Smart_Grid_Demonstration_Overview_201012.pdf
San Diego Gas & Electric: Beach Cities Microgrid Project	http://www.smartgrid.gov/sites/default/files/doc/files/California_DR_Integration_Projects_San_Diego_Marin_County_200801.pdf
San Diego Gas & Electric: Borrego Springs Microgrid Demonstration Project	http://energy.gov/sites/prod/files/30_SDGE_Borrego_Springs_Microgrid.pdf www.sdge.com/smartgrid/
San Diego Gas & Electric: Smart Energy Solutions	http://smartgridcc.org/wp-content/uploads/2013/10/SGCC-Peer-Connect-Communicating-Smart-Grid-to-Customers.pdf
San Diego Gas & Electric: Streetlight Working Group	http://www.cleantechsandiego.org/streetlight-working-group.html
Southern California Edison: Bring-Your-Own-Thermostat Pilot	http://www.greentechmedia.com/articles/read/sce-rolls-out-bring-your-own-thermostat
Southern California Edison: Irvine Smart Grid Demonstration	http://www.smartgrid.gov/project/southern_california_edison_company_irvine_smart_grid_demonstration Disintermediation PPT
TXU Energy: Brighten iThermostat	http://www.txu.com/Home/residential/plans-offers/brighten-ithermostat-product-detail.aspx
University of Delaware, NRG: Vehicle to Grid	http://www.udel.edu/udaily/2013/may/vehicles-grid-050213.html
University of Florida: Gator Tech Smart House	http://www.icta.ufl.edu/gt.htm#1
Xcel Energy: SmartGridCity	http://smartgridcity.xcelenergy.com/

Extreme Energy Makeovers	
Program Name	**Source**
Arizona Public Service: Home Performance with ENERGY STAR	http://www.aps.com/en/residential/savemoneyandenergy/rebates/Pages/home.aspx
Austin Energy: Power Saver	http://www.hprcenter.org/sites/default/files/ec_pro/hprcenter/best_practices_case_study_austin.pdf
BetterBuildings for Michigan: Clean Sweeps	http://www1.eere.energy.gov/buildings/betterbuildings/neighborhoods/michigan_profile.html
Boulder County: ClimateSmart Loan Program	http://www.hprcenter.org/sites/default/files/ec_pro/hprcenter/best_practices_case_study_boulder.pdf
Builders of Hope: Extreme Green Rehabilitation	http://www.buildersofhope.org/about/what-we-do/extreme-green/
Chicago Metropolitan Agency for Planning: Energy Impact Illinois	http://www.cicchicago.com/loan-programs/energy-savers-can-save-you-money/
City of Berkeley: Berkeley FIRST	http://www.hprcenter.org/sites/default/files/ec_pro/hprcenter/best_practices_case_study_berkeley.pdf
City of Boston: Renew Boston	http://www.renewboston.org/
City of Durham: Neighborhood Energy Retrofit Program	http://www1.eere.energy.gov/buildings/betterbuildings/neighborhoods/pdfs/conf_whatsworking_8_durham_retrofits.pdf
City of Long Beach Gas and Oil: Residential Energy Efficiency Rebate Program	http://www.lbds.info/civica/filebank/blobdload.asp?BlobID=3347
Clean Energy Works: Clean Energy Works	http://www.cleanenergyworksoregon.org/
Clinton Climate Initiative of Arkansas: Home Energy Affordability Loan Program	http://www.epa.gov/statelocalclimate/local/showcase/littlerock.html
Connecticut Neighbor to Neighbor Energy Challenge	http://www1.eere.energy.gov/buildings/betterbuildings/neighborhoods/connecticut_profile.html
Connecticut Light & Power, United Illuminating: Home Energy Solutions (HES)	http://www.nhpci.org/images/NHPC_ResEfficiencyProgramOverview_2011.pdf
Energize New York: Bedford 2020 Energize Community Challenge	http://www1.eere.energy.gov/buildings/betterbuildings/neighborhoods/bedford_profile.html
Energy Trust of Oregon: Home Performance with ENERGY STAR	http://energytrust.org/residential/evaluate-your-home/home-performance-energy-star/
EnergyFit Nevada	http://www1.eere.energy.gov/buildings/betterbuildings/neighborhoods/nevada_sep_profile.html
Entergy: MyHome	http://www.intelligentutility.com/magazine/article/322067/entergy-takes-customers-virtually-home
FirstEnergy: Whole House Program	http://www.nhpci.org/images/NHPC_ResEfficiencyProgramOverview_2011.pdf
Fort Collins Utilities: Home Efficiency Program	http://www.swenergy.org/publications/documents/Review_of_Residential_Retrofit_Programs_in_SW.pdf
Georgia Power: Home Energy Improvement Program	http://www.georgiapower.com/earthcents/residential/home-improvement-program/home.cshtml
Idaho Falls Power	http://www.idahofallsidaho.gov/city/city-departments/idaho-falls-power/services-for-your-home/loan-qualification-terms.html

Program Name	Source
JEA (Jacksonville Municipal Utility): ShopSmart	http://www1.eere.energy.gov/buildings/betterbuildings/neighborhoods/jacksonville_profile.html
Lane Electric Cooperative: Weatherization Grant Program	http://www.nhpci.org/images/NHPC_ResEfficiencyProgramOverview_2011.pdf
Los Angeles Department of Water and Power: Home Energy Improvement Program	https://www.ladwp.com/ladwp/faces/ladwp/residential/r-savemoney/r-sm-rebatesandprograms?_afrWindowId=r2ycr9ccp_1&_afrLoop=223583872228000&_afrWindowMode=0&_adf.ctrl-state=r2ycr9ccp_4
Low-Income Energy Affordability Network (LEAN): Low Income Multi Family Energy Retrofits (LIMF)	http://leanmultifamily.org/
Massachusetts Department of Energy Resources: Mass Save	http://www.masssave.com/
Massachusetts Municipal Wholesale Electric Company (MMWEC): Home Energy Loss Prevention Services (HELPS)	http://www.nhpci.org/images/NHPC_ResEfficiencyProgramOverview_2011.pdf
Midwest Energy: Kansas How$mart	http://www.aceee.org/sites/default/files/publications/researchreports/e118.pdf
National Grid: Deep Energy Retrofit	https://www1.nationalgridus.com/DeepEnergyRetrofit-MA-RES?ng=us
NeighborWorks: H.E.A.T. Squad (Home Energy Assistance Team)	http://www1.eere.energy.gov/buildings/betterbuildings/neighborhoods/rutland_profile.html
Nevada Power Company: HomeFree Nevada	http://www.swenergy.org/publications/documents/Review_of_Residential_Retrofit_Programs_in_SW.pdf
New Jersey Board of Public Utilities: Comfort Partners Program	http://www.njcleanenergy.com/residential/programs/comfort-partners/comfort-partners
New Jersey Board of Public Utilities: Home Performance with ENERGY STAR	http://www.hprcenter.org/sites/default/files/ec_pro/hprcenter/best_practices_case_study_new_jersey.pdf
New York State Energy Research and Development Authority (NYSERDA): Home Performance with ENERGY STAR	http://www.hprcenter.org/sites/default/files/ec_pro/hprcenter/best_practices_case_study_new_york.pdf
Norwich Public Utilities, Groton Utilities, Bozrah Light & Power: Residential Home Energy Savings Program	http://www.nhpci.org/images/NHPC_ResEfficiencyProgramOverview_2011.pdf
Ohio Office of Energy Efficiency: Ohio Home Weatherization Assistance Program	http://development.ohio.gov/files/is/HWAPImpactEvaluation.pdf
Oncor: Home Performance program	http://www.nhpci.org/images/NHPC_ResEfficiencyProgramOverview_2011.pdf
People Working Cooperatively (PWC): Energy Conservation (Weatherization)	http://www.pwchomerepairs.org/ohio.aspx
PPL Electric Utilities: Home Assessment Program	http://www.nhpci.org/images/NHPC_ResEfficiencyProgramOverview_2011.pdf
Public Service Company of Colorado (Xcel Energy): Home Performance with ENERGY STAR	http://www.xcelenergy.com/Save_Money_&_Energy/Find_a_Rebate
Public Service Electric & Gas (PSE&G): Residential Whole House Efficiency Program	http://www.nhpci.org/images/NHPC_ResEfficiencyProgramOverview_2011.pdf
Questar Gas: ThermWise	http://www.thermwise.com/utindex.html

Program Name	Source
Rocky Mountain Power: Home Energy Savings	http://www.swenergy.org/publications/documents/Review_of_Residential_Retrofit_Programs_in_SW.pdf
Rocky Mountain Power: Idaho Low-Income Weatherization Program	http://www.pacificorp.com/content/dam/pacificorp/doc/Energy_Sources/Demand_Side_Management/ID_LowIncome_2007-2009.pdf
Sacramento Municipal Utility District: Energy Efficient Remodel Demonstration Program	http://apps1.eere.energy.gov/buildings/publications/pdfs/building_america/ns/eemtg032011_a1_smud_eeremodel.pdf
Sacramento Municipal Utility District: Home Performance program	https://www.smud.org/en/residential/save-energy/rebates-incentives-financing/
Salt River Project: Home Performance with ENERGY STAR	http://www.swenergy.org/publications/documents/Review_of_Residential_Retrofit_Programs_in_SW.pdf
San Diego Gas and Electric: Energy Upgrade California	www.EnergyUpgradeCA.org
Seattle City Light: Subsidized Audit Program	http://www.nhpci.org/images/NHPC_ResEfficiencyProgramOverview_2011.pdf
Sierra Pacific Power Company: Home Energy Audit, Residential Retrofit	http://www.swenergy.org/publications/documents/Review_of_Residential_Retrofit_Programs_in_SW.pdf
Sonoma County: Energy Independence Program	http://www.hprcenter.org/sites/default/files/ec_pro/hprcenter/best_practices_case_study_sonoma.pdf
Southern California Edison and Southern California Gas: Energy Independence Program	http://www.hprcenter.org/sites/default/files/ec_pro/hprcenter/best_practices_case_study_palm_desert.pdf
Springfield Utility Board: Joint Loan and Rebate Program	http://www.nhpci.org/images/NHPC_ResEfficiencyProgramOverview_2011.pdf
State of Minnesota: Project Re-energize	https://mn.gov/commerce/energy/topics/resources/Success-Stories/Efficiency/project_reenergize.jsp
State of Pennsylvania: Keystone HELP Program Whole House Improvement Loans	http://www.nhpci.org/images/NHPC_ResEfficiencyProgramOverview_2011.pdf
The City of Tallahassee Utilities	http://www.talgov.com/you/you-products-home-retrofit.aspx
Town of Babylon: Long Island Green Homes (LIGH)	http://www.hprcenter.org/sites/default/files/ec_pro/hprcenter/best_practices_case_study_long_island.pdf
Tuscon Electric Power: Efficient Home Program	https://www.tep.com/efficiency/home/efficienthome/
Xcel Energy (Southwestern Public Service Company): Home Energy Services	http://www.swenergy.org/publications/documents/Review_of_Residential_Retrofit_Programs_in_SW.pdf
Xcel Energy, CenterPoint Energy: Home Energy Squad Enhanced	http://www.mncee.org/hes-mpls/How-It-Works/
Xcel Energy: ClimateSmart Residential Energy Action Program (REAP)	http://www.hprcenter.org/sites/default/files/ec_pro/hprcenter/best_practices_case_study_boulder.pdf

6.2 Interviews Conducted

Smart Energy Technologies	
Organization	**Role**
Arrayent	Smart Home Connectivity Provider
Austin Energy*	Smart Grid Program Manager
Auto-Grid	Demand Response Provider
EcoFactor	Demand Response Provider
Electric Power Research Institute (EPRI) Smart Grid Demonstration Initiative	Research and Delivery of Smart Grid Technology
EPRI End-Use Energy Efficiency & Demand Response	Research and Delivery of Smart Grid Technology
Hitachi	Smart Home Device and Connectivity Provider
Lennox	Smart Home Device Provider
Los Alamos Department of Public Utilities	Smart Grid Program Manager
National Rural Electric Cooperative Association	Smart Grid Program Manager
Pacific Gas & Electric (PG&E)	Smart Grid Program Manager
Pacific Northwest National Laboratory	Research and Delivery of Smart Grid Technology
Pacific Northwest Smart Grid Demonstration Project	Smart Grid Program Manager
Pecan Street Inc.	Smart Grid Program Manager
San Diego Gas & Electric	Smart Grid Program Manager
Schneider Electric	Smart City Services Provider
Southern California Edison	Smart Grid Program Manager
University of Texas at Austin	Smart Grid Research

*Though the interview focused on the interviewee's experience designing and managing a program at the listed organization, the interviewee is no longer an employee of that organization.

Extreme Energy Makeovers	
Organization	**Role**
BetterBuildings for Michigan	Home Retrofit Program Manager
Efficiency.org	Home Performance Advocacy Organization
Fort Collins Utilities	Home Retrofit Program Manager
Honeywell Utility Solutions	Program Management Provider
Low-Income Energy Affordability Network	Home Retrofit Program Manager
Mass Save	Home Retrofit Program Manager
Pacific Gas & Electric (PG&E)*	Home Retrofit Program Manager
Public Service Electric and Gas, South Jersey Gas, FirstEnergy	Home Retrofit Program Manager
Vermont Energy Investment Corporation	Program Management Provider

*Though the interview focused on the interviewee's experience designing and managing a program at the listed organization, the interviewee is no longer an employee of that organization.

6.3 *Additional Reference Materials*

Published resources were reviewed as part of the Study to supplement the program research and interviews. Resources were reviewed if they focused on leading practices and/or if they provided additional insight into a topic raised during the interviews or program research.

Smart Energy Technologies	
Title	**Publication Date**
DNV KEMA Global Inventory and Analysis of Smart Grid Demonstration Projects	October 2012
Electric Power Research Institute Consumer Engagement: Facts, Myths, and Motivations	October 2011
Gartner Competitive Landscape: Smart Appliances, Worldwide	March 2012
Home Appliance Industry White Paper on Communications Standards for Smart Appliances	October 2010
Home Appliance Industry White Paper on Smart Grid Acceptance	December 2009
Navigant Smart Utilities: 10 Trends to Watch in 2014 and Beyond	3rd Quarter 2013
Pike Research Effective Customer Engagement	1st Quarter 2013
Smart Grid Consumer Collaborative 2012 State of the Consumer Report	January 2012

Extreme Energy Makeovers	
Title	**Publication Date**
A Review of Residential Retrofit Programs Offered by Utilities in the Southwest	August 2011
Home Performance Resource Center Best Practices White Paper	March 2010
Model Energy Efficiency Program Impact Evaluation Guide	November 2007

6.4 *Sample Vendors*

The following vendors were identified during the Study and are provided to give additional detail on market players. This list is not intended to be an exhaustive list of vendors, nor is it a comprehensive list of each vendor's products and services. Inclusion on this list does not indicate any form of endorsement by Deloitte or TVA.

Smart Energy Technologies		
Company	**Type of Offering(s)**	**Website**
4Home (Motorola)	Home Automation and Energy Monitoring	http://www.motorola.com/us/home
Aclara	Energy Management Software	http://www.aclaratech.com
AlertMe	Smart Home Cloud Solutions	https://www.alertme.com/
Arrayent	Home Device Connectivity, Cloud Services	http://www.arrayent.com/
AT&T Digital Life	Home Automation Services	http://www.att.com/shop/digital-life.html#fbid=flf2Y7oqUm8
AutoGrid	Cloud-Based Demand Response	http://www.auto-grid.com/
Best Buy	Retailer	http://www.bestbuy.com
BITS Limited	Smart Plug Strips	http://www.bitsltd.net/
C3	Smart Grid Analytics Software	http://www.c3energy.com/
Calico Energy Services	Smart Grid Data Management	http://www.calicoenergy.com/
Carina Technology, Inc.	Automated Demand Response	http://www.carinatek.com/
Cisco	Smart Home Connectivity	http://www.cisco.com/web/strategy/smart_connected_communities/scc_home.html
Comcast Xfinity Home	Home Automation Services	http://www.comcast.com/home-security.html
Compass Management Group	Utility Technology Consulting	http://www.512cmg.com/
Consert	Energy Management Software for Energy Providers	http://www.consert.com
Control4	Energy Management Software	http://www.control4.com/
ecobee	Smart Thermostat	http://www.ecobee.com/
EcoFactor	Cloud-Based Thermostat Control Platform	http://www.ecofactor.com/
Electric Power Research Institute (EPRI)	Research & Development, Program Management	http://www.epri.com
Electrolux	Smart Appliances	http://group.electrolux.com/en/topic/smart-appliances/
Energate	Smart Thermostat	http://www.energateinc.com/
EnergyHub	Energy Management Solutions	http://www.energyhub.com/
Freelux	Smart Plug Strips	http://www.freelux.eu/
GE	Smart Appliances, EV Charging, Home Area Network, Cyber Security, Energy Management, Data Analytics	www.ge.com
GridPoint	Energy Management Software	http://www.gridpoint.com/
Hitachi	Connected Devices, Energy Management	http://www.hitachi.us/

Company	Type of Offering(s)	Website
Home Automation, Inc. (HAI)	Energy Management Software for Energy Providers	www.homeauto.com
Honeywell	Home Energy Management, HVAC Controls, Cyber Security	http://honeywell.com/Pages/Home.aspx
iControl	Home Area Network, Energy Management	http://www.icontrol.com
iGo Green	Smart Plug Strips	http://www.igo.com/green/icat/green
Itron	Meter Data Management	https://www.itron.com
Lawrence Berkeley National Laboratory	Consumption Benchmarking	http://www.lbl.gov/
Lennox	Smart Thermostat	http://www.lennox.com/
LG	Smart Appliances	http://www.lg.com/us
Lowe's	Retailer, Home Automation Services	http://www.lowes.com/
Nest Labs (Google)	Smart Thermostat	http://www.nest.com/
OATI	Meter Data Management	http://www.oati.com/
Pacific Northwest National Laboratory	Demand Response Technology	https://www.pnl.gov/
Pecan Street, Inc.	Program Management, Research Trials, Performance Testing	http://www.pecanstreet.org/
Radio Thermostat Company of America	Smart Thermostat	http://www.radiothermostat.com/
Samsung	Smart Appliances, Home Automation Services	http://www.samsung.com/us/
Sandia National Laboratories	Consumer Energy Storage	http://www.sandia.gov/
Schneider Electric	Smart Cities Solution	http://www2.schneider-electric.com/sites/corporate/en/solutions/solutions-by-business.page
Sigma Designs	Energy Management Software for Consumers	http://www.sigmadesigns.com/
Silver Spring Networks	Home Area Network	http://www.silverspringnet.com/
Sprint Nextel	Machine-to-Machine Communication Services	http://www.sprint.com/
Tendril	Customer Gateways, Home Area Network, Energy Management	http://www.tendrilinc.com/
Texas Instruments	Home Area Network Connectivity	http://www.ti.com/
Toshiba	Smart Grid Solutions	http://www.toshiba-smartcommunity.com/EN/
uControl	Energy Management Software for Consumers	www.ucontrol.com
Watts Clever	Smart Plug Strips	http://www.wattsclever.com/home
Whirlpool	Smart Appliances	http://www.whirlpool.com/smart-appliances/

Extreme Energy Makeovers		
Company	**Type of Offering(s)**	**Website**
Aclara	Home Performance Software	http://www.aclaratech.com
Apogee Interactive	Home Energy Calculator	http://apogee.net
Applied Proactive Technologies	Program Management	http://www.appliedproactive.com/
CLEAResult Consulting, Inc.	Program Management	http://www.clearesult.com/
Conservation Services Group (CSG)	Program Management	http://www.csgrp.com/
Cypress, Ltd.	Program Management	http://cyp-res.com/
EarthAdvantage	Audit Services	http://www.earthadvantage.org/
Ecova	Customer Engagement	http://www.ecova.com/
Enalasys	Measurement and Data Verification	http://www.enalasys.com/
Enercom, Inc.	Audit Software	http://www.enercomusa.com/
Energy Solutions	Program Management	http://www.energy-solution.com/
EnergySavvy	Demand-Side Management Software	https://www.energysavvy.com/
Franklin Energy	Program Management	https://www.franklinenergy.com/
GoodCents Solutions	Program Management	http://www.goodcents.com/
Honeywell Utility Solutions	Program Management	http://honeywell.com/
ICF International	Program Management	http://www.icfi.com/
Intelligent Energy Solutions	Audit and Home Performance Provider	http://www.iesgreen.com/
Johnson Controls	HVAC Controls and Service	http://www.johnsoncontrols.com/
Lime Energy	Program Management	http://www.lime-energy.com/
Mad Dash Field Services	Installation, QA, and Audit Services	http://www.maddash.com/
Nexant, Inc.	Program Management	http://www.nexant.com/
Niagara Conservation Services	Program Management	http://www.niagaraconservation.com/
NRG SimplySmart Solutions	Program Management	http://nrgsimplysmart.com/
Parago	Rebate Processing	http://www.parago.com/
PECI	Program Management	http://www.peci.org/
Public Sector Consultants (PSC)	Program Management	http://www.publicsectorconsultants.com/
The Home Depot	Retailer, Installation Services	http://www.homedepot.com/
TRC Solutions	Program Management	http://www.trcsolutions.com/
Vermont Energy Investment Corporation	Program Management	http://www.veic.org/