THE NEW ENERGY CONSUMER

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May 2011

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Dear Executives,

In contrast to overall U.S. consumer prices growing a modest amount in April, food and more specifically gasoline experienced significant spikes northward – forcing Americans to become more cognizant of their energy consumption. During this same time smartphones and new technologies such as the iPad have become the 'always-connected' backbone for the mainstream. Conversely, electric vehicles have become less of a conversation piece and more of a reality as $5 at the pump predictions loom.

With mobile technology becoming synonymous with all-things-tech, energy/automotive industries forging strategic partnerships, and utilities getting closer to understanding their customers, the smart grid will play the ultimate role in how the New Energy Consumer will be born.

So who is this New Energy Consumer and how can both utilities and companies across the Smart Grid value chain gel with this next generation? According to *The New Energy Consumer* study by Zpryme on the surface the typical New Energy Consumer has a college degree or higher, is between 27 – 35 years old, owns their home and has an average household income between 70,000 - $100,000. Probe this cohort further and accurate information will be the fuel that empowers this group to make energy usage decisions. That said, deprived of information by utilities and their allies consumers are left to gamble on how they can better manage household energy consumption – making connectivity and the smart grid essential.

All of us at Zpryme and Itron know this study will provide thought-provoking commentary and actionable insight for utilities and companies within the smart grid ecosystem to make strategic decisions. I personally welcome your thoughts on the varied subject-matter addressed in this study as well as suggestions for future studies. Please feel free to contact Zpryme about this study via email at smart.grid@zpryme.com.

Kind Regards,

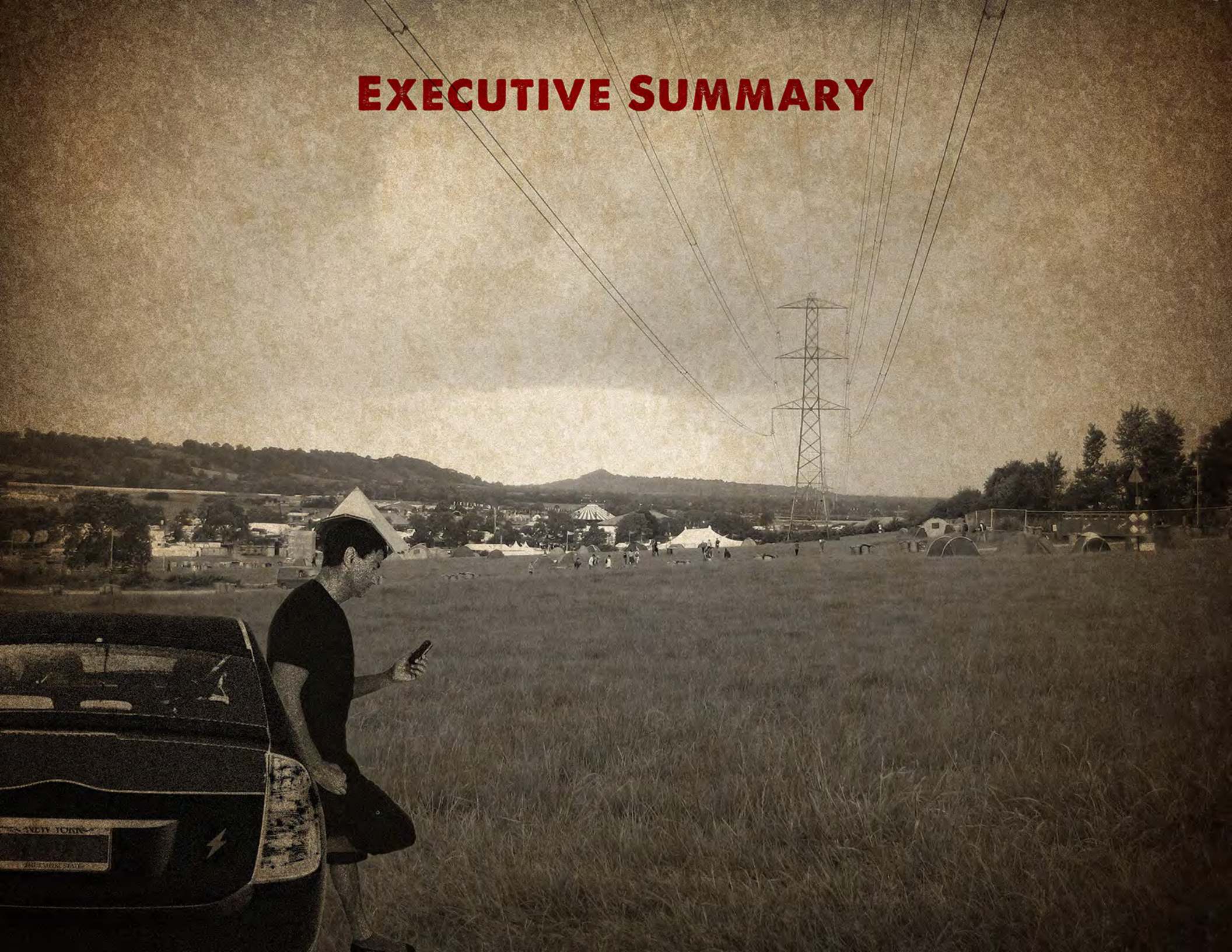
Jason S. Rodriguez
CEO & Director of Research
Zpryme Research & Consulting, LLC

With [mobile technology] becoming synonymous with all-things-tech… and utilities getting closer to understanding their customers, the [smart grid] will play the ultimate role in how the [New Energy Consumer] will be born.

TABLE OF CONTENTS

EXECUTIVE SUMMARY....1
INFOgraphic: The New Energy Consumer....5
BACKGROUND & SCOPE....12
METHODOLOGY....14
CHAPTER 1: NEW ENERGY CONSUMER SURVEY....16
Methodology....16
Summary of Survey Insights....16
Demographics....17
Average Monthly Electric Bill....17
Sensitivity to Rise in Gas Prices....18
Time Spent Online....18
Energy Star Certified Residence....18
Energy Efficiency Actions....19
Appliance Energy Consumption Rankings....19
Home Energy Monitoring....20
Energy Management Devices....20
Frequency of Electricity Usage Monitoring....21
Time Spent Reviewing Electricity Bill....21
Electricity Bill Increases to Prompt Conservation....22
Utility Satisfaction....22
Demand Response Program Offering....22
Willingness to Participate in Renewable Energy Program....23
Willingness to Participate in Time-of-Use Pricing Program....23
Communication Preferences about Time-of-Use Pricing....23
Smart Meter Presence....24
Smart Meter Concerns....24
Communication Preference During an Electrical Outage....24
Exposure to Electrical Outage....25
Importance of Communications Technology for Utilities....25
Utilities and Wireless Carrier Sentiment....26
Smart Grid Definition....26
Smart Grid Awareness....26
Smart Grid Knowledge Level....27
Utility Information about smart grid....27
Energy Management Device Presence....27
Energy Management Device Preferences Rank....28
Electric Vehicle Purchasing Conditions....28
Smart Grid Benefits....29
Negative Smart Grid Factors....29
Willingness to Pay for Smart Grid Technology....30
Overall Survey Key Findings....31
CHAPTER 2: MARKET ANALYSIS....33
Smart Grid Architecture....33
Utility Enterprise and Purpose Built Systems....33
Benefits of Private Networks....35
Benefits of Public Networks....36
The Future of Smart Grid Networks....36
Evolving Smart Grid Architecture....37
U.S. Enterprise and Purpose-Built System/Network Market Value....38
U.S. Smart Grid Communication Network Market Value....39
CHAPTER 3: ITRON Q&A....42

Executive Summary



EXECUTIVE SUMMARY

As utilities, governments, universities, vendors, standards organizations and consumers across the globe debate the pros and cons about Smart Grid technology, the one issue that can't be disputed is that an increase in information will deliver significant benefits to stakeholders across the Smart Grid ecosystem. According to the Electric Power Research Institute (EPRI), the increase in information gained from $338 billion to $476 billion investments in U.S. grid modernization will yield $1.3 trillion to $2.0 trillion in benefits from 2010 to 2030. However, utilities have plenty of work to do in educating consumers about the Smart Grid, as only 18.5% of respondents in Zpryme's Home Energy and Smart Grid Survey said their utility has provided them with information about the Smart Grid. The survey also found that only 4.1% of respondents considered themselves to be very knowledgeable about the Smart Grid.

Access to Energy Information is the Fuel That Empowers Consumers

Real Time Energy Information/Data Flow (Two Ways)

This drive to increase information across the utility value chain will not only transform the utility industry as we know it today, but it will also transform the way consumers perceive electricity, communicate with their utility, and radically incentivize consumers to become pro-active rather than passive energy consumers. The increase in gas prices will further drive consumers to more closely monitor their electricity consumption as 76.5% consumers in Zpryme's Home Energy and Smart Grid Survey indicated that the recent increase in gas prices has made them pay more attention to their electric bill.

Information is the fuel that empowers consumers. Without information, consumers and businesses are left to make random choices about the products and technologies they should purchase to help them better manage their business or household. However, before any of these benefits or transformations can materialize utilities must 'link' information with their consumers. This is a bold task that entails significant investments in enterprise systems, information technology, communications access networks and smart meters before a single consumer can begin to even monitor their energy consumption on a daily basis. Further, only 23.0% in Zpryme's Home Energy and Smart Grid Survey said that increasing utility communications and networks was important enough to them to warrant a short-term increase in their electricity bills.

Progressive U.S. utilities such as Southern California Edison, Austin Energy, PG&E, SDG&E, Florida Power & Light, AEP, Xcel Energy and Duke Energy are currently setting the precedent for deploying Smart Grid networks and technology. On the vendor side, major players such as Itron, Oracle, SAP, IBM, AT&T, Sprint, Verizon, SmartSynch, Alcatel-Lucent, Cisco and Juniper Networks are aggressively seeking market leadership in the utility enterprise system and Smart Grid communications market. By 2015, Zpryme projects the U.S. market for enterprise and purpose-built systems and networks will reach $6.5 billion and the Smart Grid networks market to reach $1.6 billion. Last, as utilities continue to debate the use of private or public networks to link utilities and customers with real-time energy information, the rise of the New Energy Consumer will ultimately become the driving force behind the Smart Grid and the Green Economy of the Future.

Consumer Energy Usage Survey Highlights

Impact of High Gas Prices: The recent gasoline price surge has made 76.5% of all respondents and 92.2% of High Tech Users (HTUs) more sensitive to electricity prices.

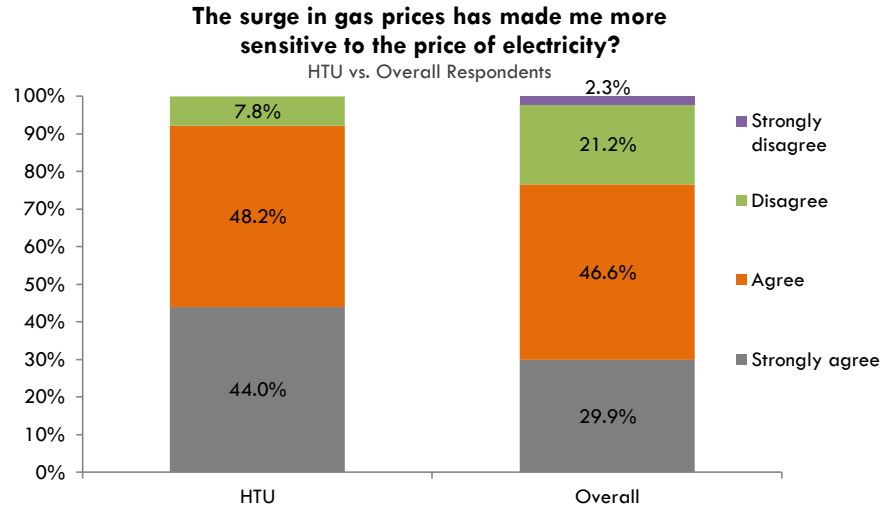


Figure a, Source: Zpryme

Energy Usage and Cost Trends: Just over a quarter of the respondents have an average electric bill of $101 - $150 a month. Age had a u-shaped distribution with 56.9% of those aged 18 – 25 paying $100 or less per month for electricity, as well as 67.7% of those aged 46 – 55 paying $100 or less per month. Nearly half (45.4%) said a 10% to 19% increase in their electricity bill would prompt energy use reductions. Many of the residents had already taken energy efficiency actions in their households. Further, more people monitor/manage their electricity usage on a monthly basis than any other time period. HTUs were more likely to spend more time reviewing their electric bill compared to the overall group. Respondents ranked the air conditioner as the appliance they feel consumes the most energy in their household.

Utility Ratings: Seventy percent of homeowners and 66.8% of renters rated their utility as good or outstanding. Twelve percent of respondents said their utility offered a distributed generation program while only 18.5% said their utility has provided them information about the Smart Grid with their bill, over the internet or through other methods. During the last power outage experienced by respondents, 29.6% said their utility did an excellent job in addressing the situation and getting the power turned back on. During an outage, the top three preferred methods of communication reported by consumers are a phone call, email and text message.

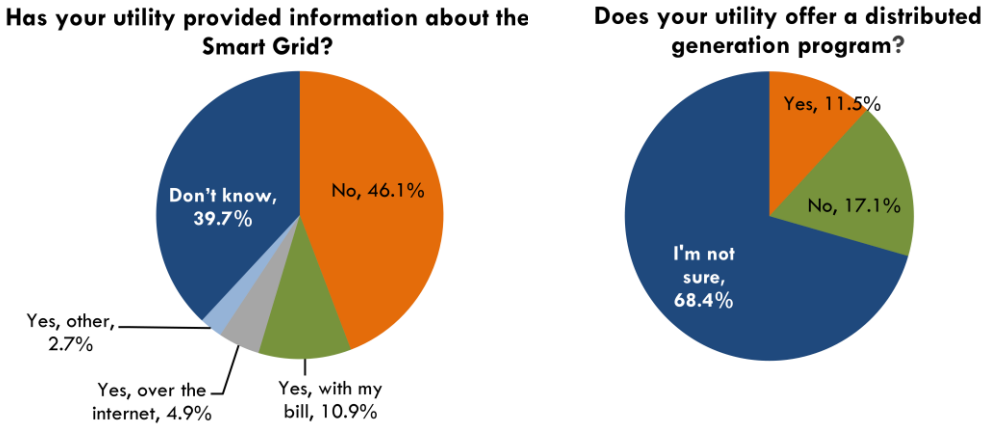


Figure b, Source: Zpryme

Utility Communications Network Perceptions: Ninety percent of all respondents said it was important for utilities to have the most advanced communications technology to increase energy efficiency and prevent power outages, however only, 23.0% said they wouldn't mind paying slightly higher rates over a short time period to fund such technology for utilities. Among HTUs, 44.2% said they wouldn't mind paying a higher rate to fund such technology for utilities. When asked whether they would have any reservations about their utility working with a wireless carrier to expand communications capabilities, 53.1% had no reservations, 22.2% did have some reservations, and 23.7% had no opinion about this question. Among HTUs, 61.6% had no reservations.

Conditions to Purchase an EV: If utilities sponsored a cheaper rate for electric vehicle charging, 25.0% of respondents said they would consider purchasing an EV. However, only 6.8% of respondents said they were already considering purchasing an EV.

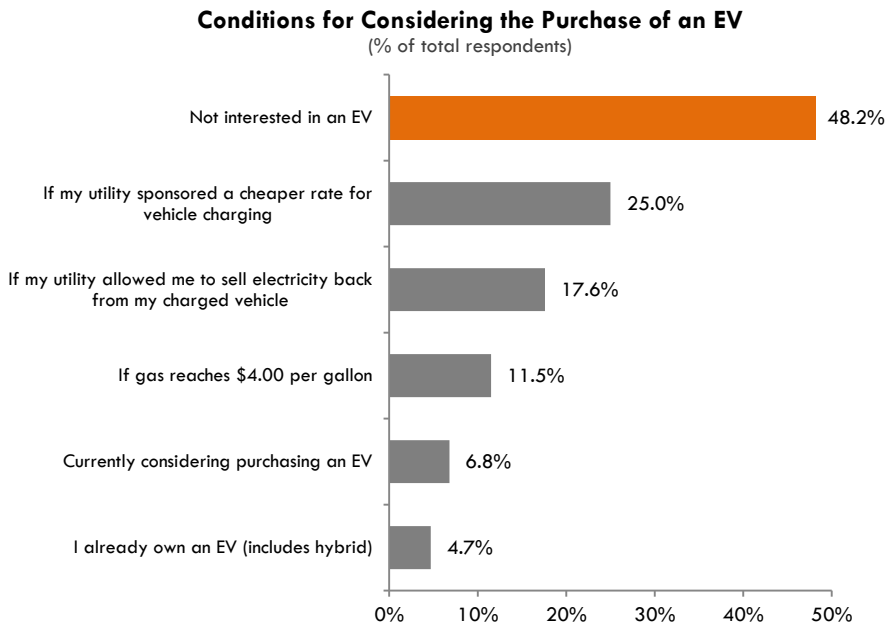


Figure c, Source: Zpryme

Preference for Smart Devices/Technology: Respondents indicated they are most likely to first enable or use a Home Energy Management System as 34.1% ranked it number one.

Renewable Energy and Time-of-Use Pricing Programs Interest: Twenty one percent of all respondents and 44% of HTUs indicated

they would be interested in a program where they could use electricity from renewable energy sources and that they would not mind paying higher rates for the renewable electricity. Residents who said they wouldn't mind paying higher rates for electricity from renewable sources tended to be male, renters, young, and with higher incomes. Seventy three percent of all respondents and 83% percent of HTUs indicated they would willing to participate in a demand response or time-of-use pricing program that gave them option to pay a lower rate for electricity during non-peak usage times of the day. Respondents chose email (44.3%) as their top communication method to receive information on electricity rate prices in a time-of-use pricing program.

Smart Meter Presence and Smart Meter Concerns: Seventeen percent of respondents said their residence has a smart meter, but 45.2% indicated they did know the type of electric meter they have. The highest level of concern about smart meters was their cost. Concern about the cost of smart meters was noted for more females (50.5% highly concerned) than males (37.2% highly concerned).

Smart Grid Awareness, Perceived Benefits and Concerns: Awareness of the Smart Grid was associated with income levels, as higher income people were more aware of the Smart Grid. Further, HTUs (62%) were more aware when compared to the overall respondents (41%). The highest rated potential benefit of the Smart Grid was saving money; the biggest concern was the cost to build it, which likely shows the current state of the U.S. economy currently has a great effect on Smart Grid perceptions. According to all respondents, when asked about how much of a premium they would be willing to pay for Smart Grid technology, 16.9% said a 10% premium (31.2% for HTUs), and 6.1% (25.4% for HTUs), said a 20% premium over current rates. Only 41.0% of the overall sample said they were aware of the Smart Grid, with just 3.9% very knowledgeable. However, 62.3% of HTUs said they were aware of the Smart Grid, with 41.3% very knowledgeable.

Smart Grid Education: Forty five percent of respondents said they preferred to be educated about the Smart Grid through visual presentations video, online or on T.V.

Preferred Method to be Educated about the Smart Grid

Education Method	% of total respondents
Mailed materials or brochures from my utility	51.5%
Visual presentations (video, online or on T.V.)	**45.0%**
Emails from my utility	36.3%
Articles on the internet	32.3%
Commercials from my utility	27.8%
Visual presentations - Online diagrams or pictures	24.9%
Educational materials from the govt. or other non-profit orgs.	23.9%
From friends	16.5%
White papers	15.5%
Utility customer service reps at their office or over the phone	12.8%
Facebook	11.8%
Text messages	6.2%
Applications on my smartphone	4.3%
Twitter	2.9%

Figure d, Source: Zpryme

Utility Enterprise System Market Highlights

As utilities seek to fully leverage the benefits of the Smart Grid they will increasingly replace legacy systems with enterprise wide systems that bring independent networks under the control of a single system. Over the next five years, the market will continue to be dominated by Oracle, SAP, IBM, and Microsoft, but companies such as SolarWinds and Infor will make a strong push to seize their share of the U.S. market. Zpryme projects the U.S. market value for utility enterprise and purpose built systems and networks for mission critical operations will grow from $4.2 billion in 2010 to $6.5 billion in 2015.

U.S. Enterprise and Purpose Build System/Network Market Value
(Mission Critical Operations) 2010 to 2015 (in U.S. billions)

Segment	2010	2011	2012	2013	2014	2015	CAGR
Enterprise	$3.2	$3.6	$4.0	$4.4	$4.8	$5.1	10.0%
Purpose Built	$1.01	$1.06	$1.14	$1.23	$1.31	$1.37	6.4%
Total Market Value	**$4.2**	**$4.7**	**$5.2**	**$5.6**	**$6.1**	**$6.5**	**9.2%**

Figure e, Source: Zpryme

The compound annual growth rate (CAGR) from 2010 to 2015 is projected to be 9.2 percent. By 2015, the utility enterprise systems market and the purpose built network market are projected to reach $5.1 billion and $1.4 billion, respectively. During this time period, the

enterprise system market will grow at 10.4 percent annually while the market for purpose built networks will grow at 6.4 percent annually.

Smart Grid Access and Communication System Market Highlights

Although the debate over public versus private smart grid networks is being heavily debated at this time, one thing is clear, utilities across the U.S. will continue to make significant investments in their communication and access networks as these networks form the information backbone of the Smart Grid. Further, without two-way communications and access to real-time information, the benefits of the Smart Grid simply disappear. Such functionality can only be achieved through the implementation of private or public access Smart Grid networks that link the key stakeholders across the utility value chain.

Currently, the private Smart Grid network market is led by companies such as Itron, Alvarion, and Trilliant. On the other hand, the market for public networks in the U.S. will continue to be led by SmartSynch and the three major cellular providers in the U.S., Verizon, AT&T and Sprint. Further, major communications and networking technology companies such as Alcatel-Lucent, Cisco, Nokia Siemens, GE MDS, Juniper Networks, Ericsson and Huawei will all be seeking to establish themselves as market leader when it comes to providing the switches, routers, access points, radios and relay equipment to fully serve the networking needs for utilities.

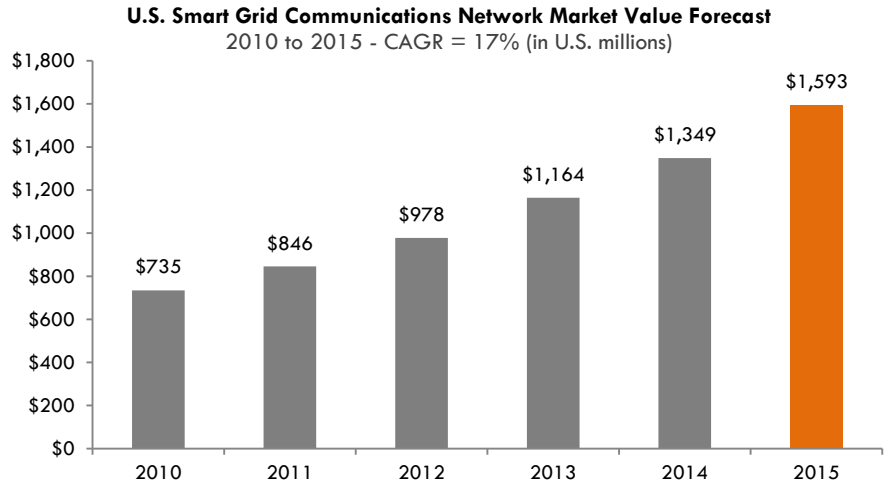


Figure f, Source: Zpryme

The market value for Smart Grid communication access networks in the U.S. is projected to grow from $734.6 million in 2010 to $1.6 billion in 2015. The compound annual growth rate (CAGR) from 2010 to 2015 is projected to be 16.7 percent. In 2010, wired networks accounted for 65.0 percent of the total communication network value, while wireless networks accounted for 35.0 percent of the market. In 2015, wired networks are projected to account for 48.0 percent of the total communication network value while wireless networks are projected to account for 52.0 percent of the market. Within the wireless network segment, the market value for public networks reached is projected to achieve revenues of $333.4 million by 2015 and grow by 38.8 percent annually over the next five years.

INFOgraphic: The New Energy Consumer

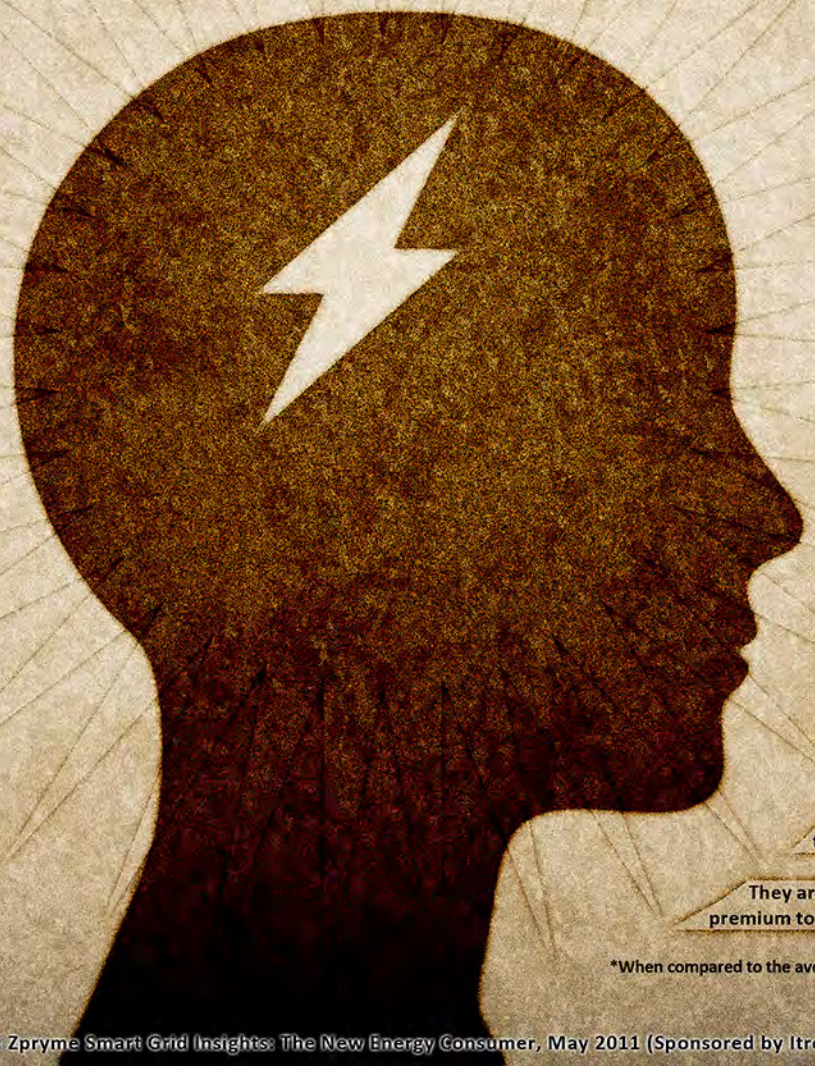
On the next several pages an INFOgraphic illustrating key findings from the consumer survey are represented to zero-in on:

- The New Energy Consumer
- Consumer Survey Findings (Closer Look)
- How Do Consumers Rank Energy Usage by Appliance?
- How will Gas Prices Affect Electricity Consumption?
- Consumer Survey Findings (By State/By Region)

The New Energy Consumer: U.S. Consumer Energy Usage Survey

U.S. Consumer Energy Usage Survey: A survey conducted in mid-March 2011 of 1,082 home owners or renters age 18 – 75 across the U.S. was developed to assess energy usage behaviors, smart grid awareness, energy bill costs, energy consumption trends, utility satisfaction and their preferences to use emerging energy monitoring devices and equipment.

The typical New Energy Consumer has a college degree or higher, is between 27 – 35 years old, owns their home and has an average household income between 70,000 - $100,000. This technology immersed group is keenly aware of the fact that energy is a scarce resource just like food or water and they are inclined to leverage the most advanced technology and mobile devices available to reduce their consumption of energy and electricity bill. The 'Buzz' generated by the success stories of these New Energy Consumers both online and offline will drive mainstream adoption of EVs, smart devices, and distributed solar and wind systems. Utilities seeking to advance Smart Grid programs and vendors seeking to penetrate the market for devices and technology behind the meter should make this group a focal point of their marketing efforts.



In 2011, they represent 11% to 13% of the U.S. adult population. By 2015, this figure will reach about 17%.

They are 2X more likely to pay a premium for electricity from renewable sources.*

They are pro-active energy consumers and recognize electricity is a scarce resource.

They have a good understanding of the Smart Grid and its potential to save them money and reduce overall electricity demand.

They crave connectivity and embrace technology for entertainment, business and financial gain.

They will drive mainstream adoption of EVs, smart devices, and residential solar and wind systems.

They are 3X more likely to monitor their electricity usage on a daily basis.*

They are 2.5X more likely to be considering the purchase of an electric vehicle.*

They are 4X more likely to pay a 20% electricity rate premium to get Smart Grid technology.*

*When compared to the average/typical U.S. energy consumer.

Source: Zpryme Smart Grid Insights: The New Energy Consumer, May 2011 (Sponsored by Itron, Inc.)

Consumer Energy Usage Survey Findings (Closer Look)

Gasoline/ Electricity Pricing Sensitivity

THE RECENT GASOLINE PRICE SURGE HAS MADE **76.5%** OF RESPONDENTS MORE SENSITIVE TO ELECTRICITY PRICES. MANY OF THE RESIDENTS HAD ALREADY TAKEN ENERGY EFFICIENCY ACTIONS IN THEIR HOUSEHOLDS.

Usage Monitoring

MORE PEOPLE MONITOR/MANAGE THEIR ELECTRICITY USAGE ON A MONTHLY BASIS THAN ANY OTHER TIME PERIOD.

Price/ Usage Sensitivity

NEARLY HALF (**45.4%**) SAID A **10%** TO **19%** INCREASE IN THEIR ELECTRICITY BILL WOULD PROMPT ENERGY USE REDUCTIONS.

Cost/Benefit Perception

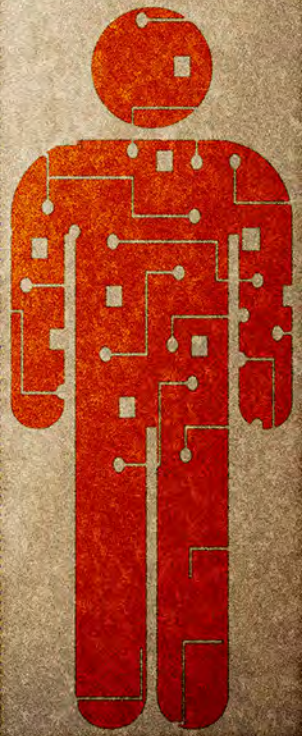
THE HIGHEST RATED POTENTIAL **BENEFIT** OF THE SMART GRID WAS **SAVING** MONEY; THE BIGGEST **CONCERN** WAS THE **COST** TO BUILD IT. (THE U.S. ECONOMY CURRENTLY HAS A GREAT EFFECT ON SMART GRID RATINGS.)

Age Distribution

AGE HAD A 'U' SHAPED DISTRIBUTION WITH **56.9%** OF THOSE AGED **18 - 25** PAYING **$100** OR LESS PER MONTH FOR ELECTRICITY, AS WELL AS **67.7%** OF THOSE AGED **46 - 55** PAYING $100 OR LESS PER MONTH.

User Profile: High Tech User

A TECH SAVVY, HIGH TECH USER (HTU) GROUP OF RESPONDENTS TENDED TO BE **YOUNG**, **MALE**, WITH **HIGHER INCOME** LEVELS THAT USED THE INTERNET/EMAIL FOR THREE TO FIVE HOURS PER DAY. THIS HTU GROUP OF **141** PEOPLE (**13%** OF SAMPLE) USED THE SMARTPHONE, TABLET, OR MOBILE INTERNET DEVICE FOR ELECTRICITY MONITORING/ MANAGEMENT.



Source: Zpryme Smart Grid Insights: The New Energy Consumer, May 2011 (Sponsored by Itron, Inc.)

UTILITY SERVICE PERCEPTION

70% PERCENT OF HOME OWNERS AND **66.8%** OF RENTERS RATED THEIR UTILITY AS GOOD OR OUTSTANDING.

WILLINGNESS TO INCUR ADOPTION COSTS

90% SAID IT WAS IMPORTANT FOR UTILITIES TO HAVE THE MOST ADVANCED COMMUNICATIONS TECHNOLOGY TO INCREASE ENERGY EFFICIENCY AND PREVENT POWER OUTAGES, HOWEVER ONLY, **22.0%** SAID THEY WOULDN'T MIND PAYING SLIGHTLY HIGHER RATES OVER A SHORT TIME PERIOD TO FUND SUCH TECHNOLOGY FOR UTILITIES.

GRID AWARENESS

ONLY **39.3%** OF THE SAMPLE SAID THEY WERE AWARE OF THE SMART GRID, WITH JUST **3.9%** VERY KNOWLEDGEABLE. AWARENESS OF THE SMART GRID WAS ASSOCIATED WITH INCOME LEVELS (HIGHER INCOME PEOPLE WERE MORE AWARE) AND BELONGING TO THE HTU GROUP (HTUS WERE MORE AWARE).

USER PROFILE: RENEWABLE SOURCES

RESIDENTS WHO SAID THEY WOULDN'T MIND PAYING HIGHER RATES FOR ELECTRICITY FROM RENEWABLE SOURCES TENDED TO BE **MALE**, **RENTERS**, **YOUNG**, AND WITH **HIGHER INCOMES**.

SMART METERS

CONCERN ABOUT THE COST OF SMART METERS WAS NOTED FOR MORE FEMALES (**50.5%** HIGHLY CONCERNED) THAN MALES (**37.2%** HIGHLY CONCERNED). THE HIGHEST LEVEL OF CONCERN ABOUT SMART METERS WAS THEIR COST.

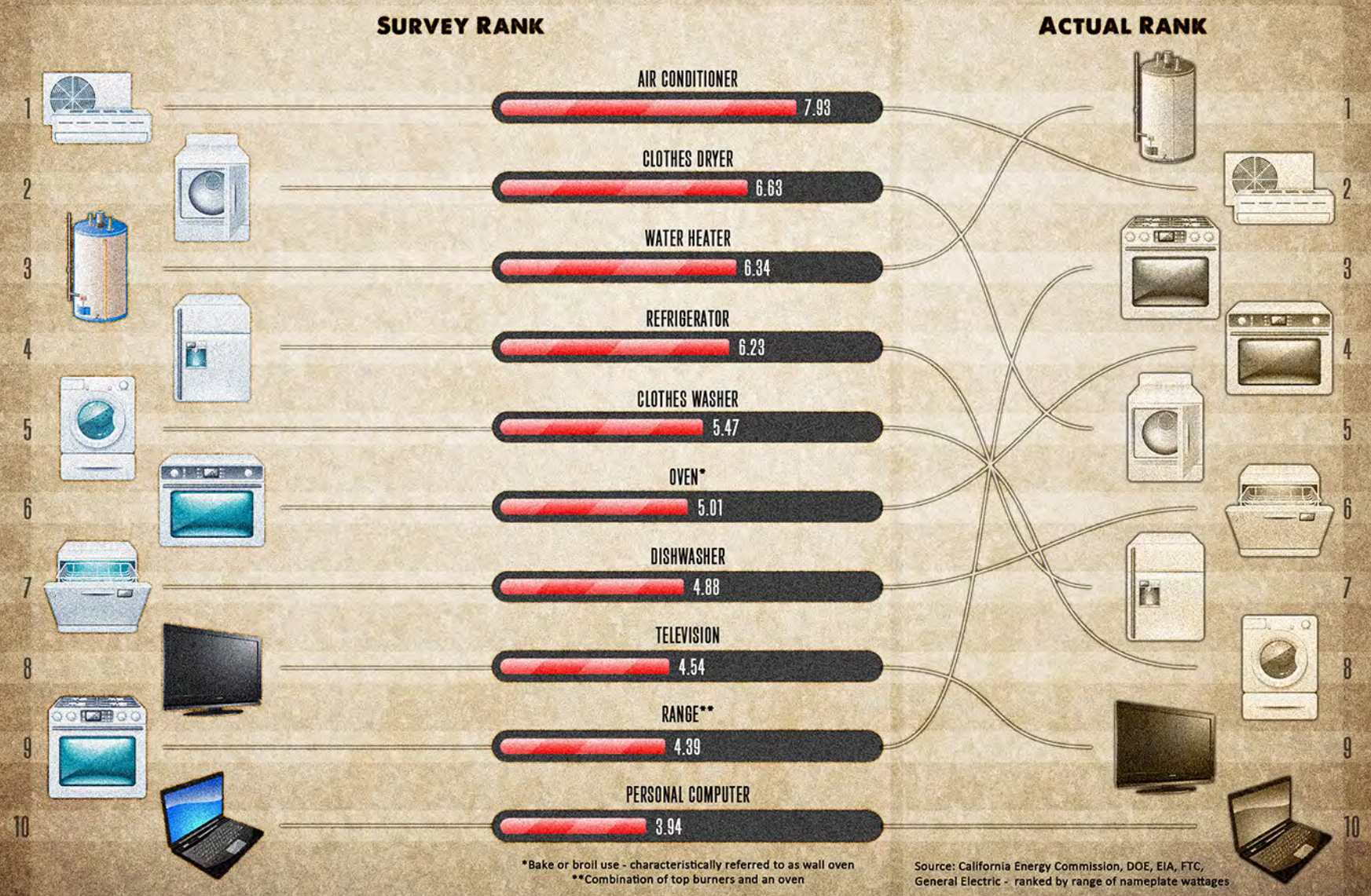
UTILITY/ WIRELESS CARRIER JOINT VENTURE APPROVAL

WHEN ASKED WHETHER THEY WOULD HAVE ANY RESERVATIONS ABOUT THEIR UTILITY WORKING WITH A WIRELESS CARRIER TO EXPAND COMMUNICATIONS CAPABILITIES, **50.8%** HAD NO RESERVATIONS, **21.3%** DID HAVE SOME RESERVATIONS, AND **23.7%** HAD NO OPINION ABOUT THIS QUESTION.

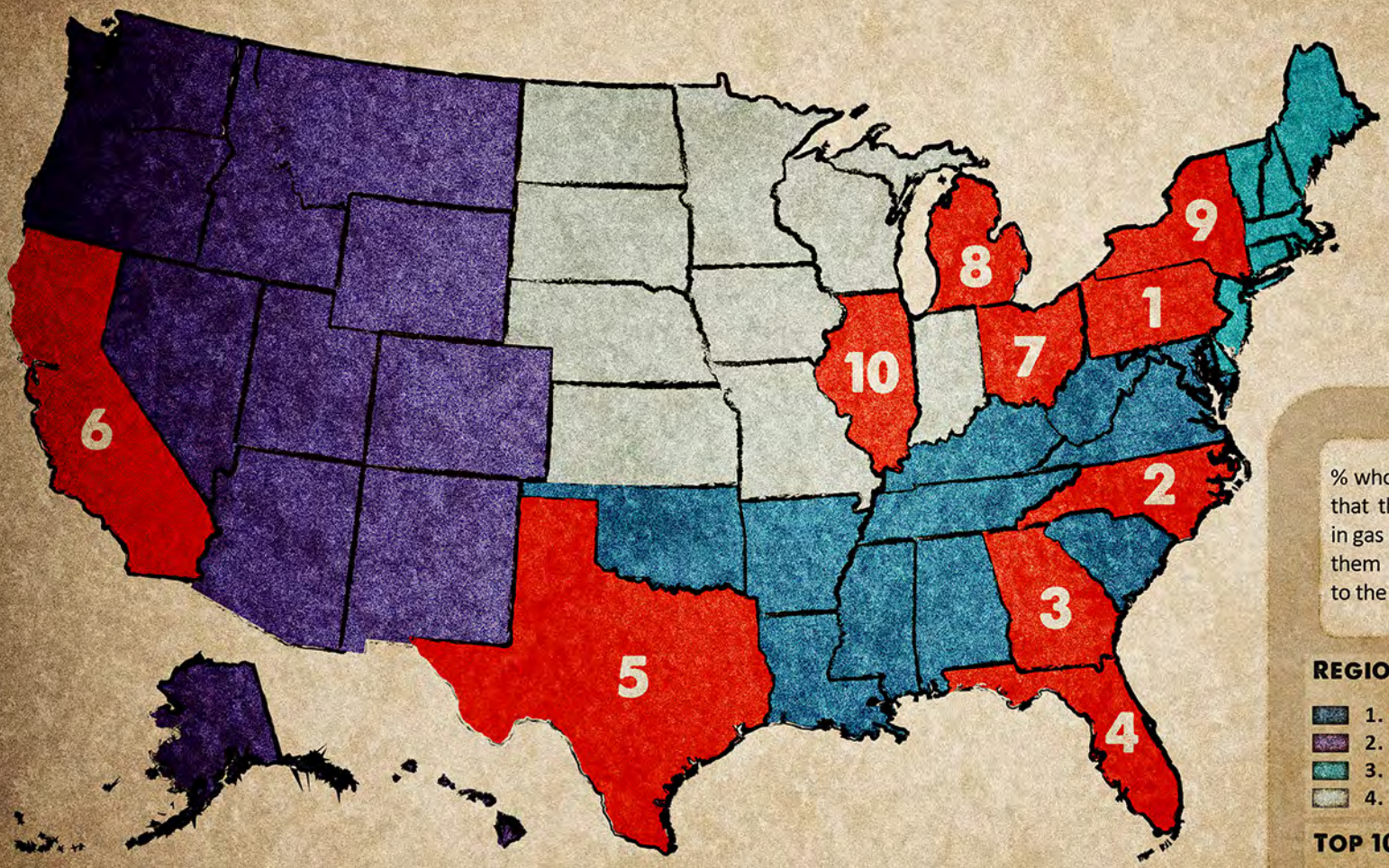
Source: Zpryme Smart Grid Insights: The New Energy Consumer, May 2011 (Sponsored by Itron, Inc.)

How Do Consumers Rank Energy Usage By Appliance?

Respondents were asked to rate several items found in most homes that consumed the most energy by using a ten point scale (where 1 is low and 10 is high). Their ratings (averaged) are shown in descending order.



How will gas prices affect electricity consumption?



% who Strongly Agree that the recent surge in gas prices has made them more sensitive to the price electricity

Regional Rank

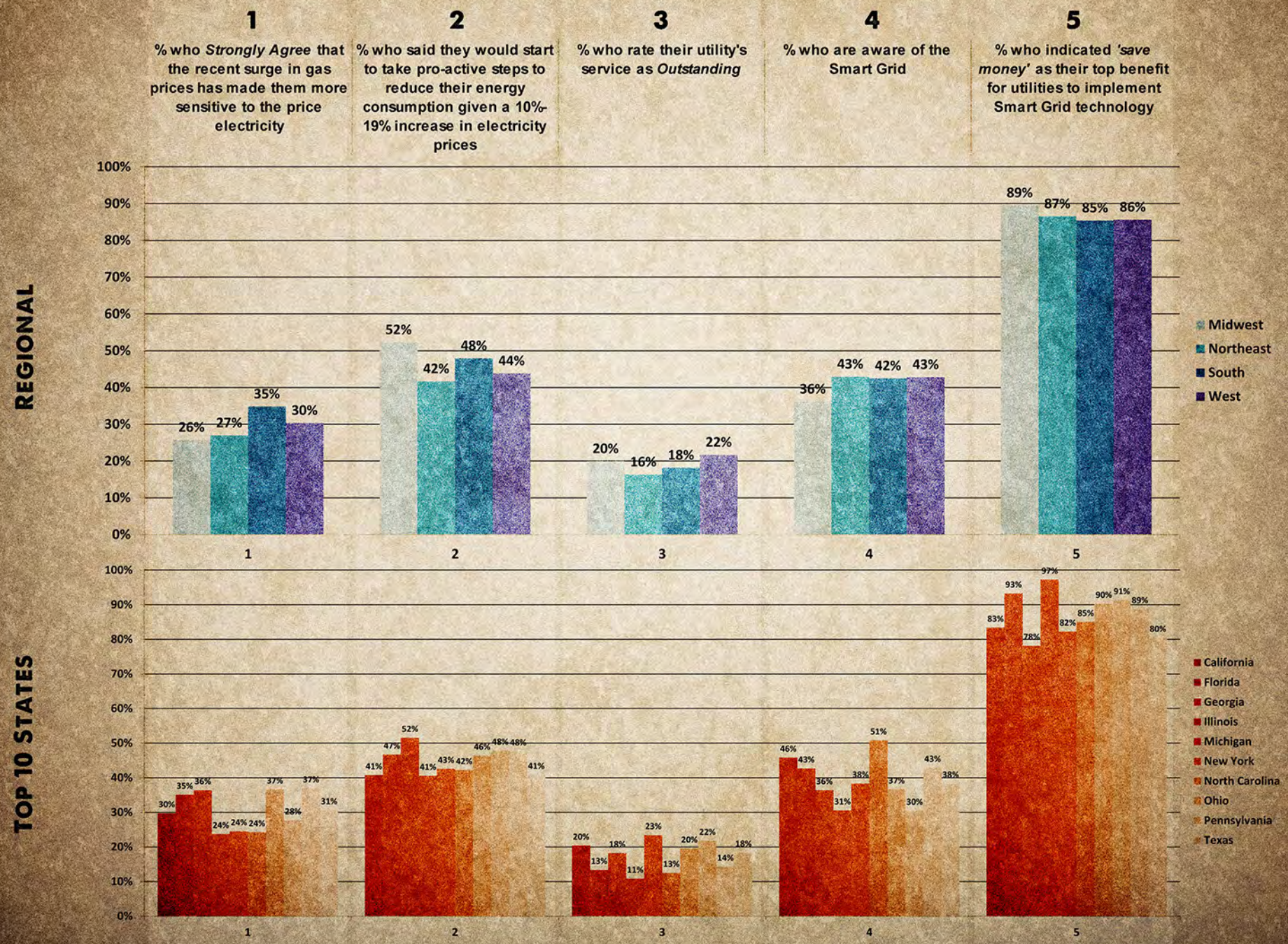
1. South [35%]
2. West [30%]
3. Northeast [27%]
4. Midwest [26%]

Top 10 State Rank

1. Pennsylvania [37%]
2. North Carolina [37%]
3. Georgia [36%]
4. Florida [35%]
5. Texas [31%]
6. California [30%]
7. Ohio [28%]
8. Michigan [24%]
9. New York [24%]
10. Illinois [24%]

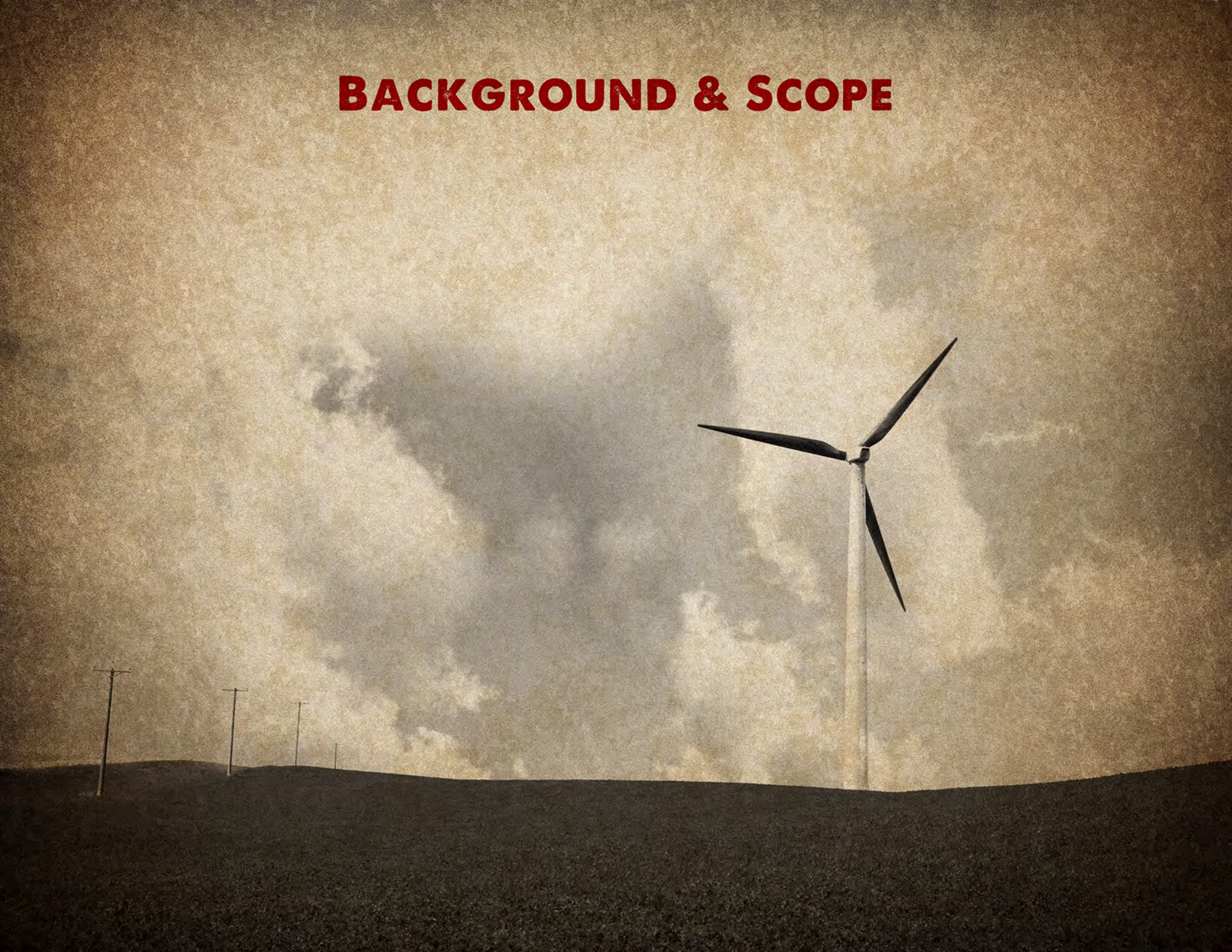
Source: Zpryme Smart Grid Insights: The New Energy Consumer, May 2011 (Sponsored by Itron, Inc.)

Consumer Energy Usage Survey Findings (by State / by Region)



Source: Zpryme Smart Grid Insights: The New Energy Consumer, May 2011 (Sponsored by Itron, Inc.)

Background & Scope



BACKGROUND & SCOPE

The purpose of this report is to present a comprehensive look at energy consumption attitudes and perceptions by consumers, the smart grid communication access network market and the enterprise system and purpose-built system market for utilities in the U.S. Further the report explores the market for private and public smart grid wireless access networks. Zpryme has employed a two-stage research approach to accomplish this objective.

The results of each of the research tasks below are presented in this report:

- U.S. Consumer Energy Usage Survey: A survey conducted in mid-March 2011 of 1,082 homeowners or renters age 18 – 75 across the U.S. was developed to assess energy usage behaviors, smart grid awareness, energy bill costs, energy consumption trends, utility satisfaction and their preferences to use emerging energy monitoring devices and equipment.

- Forecasts: Market value projections for smart grid wired and wireless communication access networks, and for enterprise and purpose-built systems and networks for mission-critical utility functions.

Market Definitions

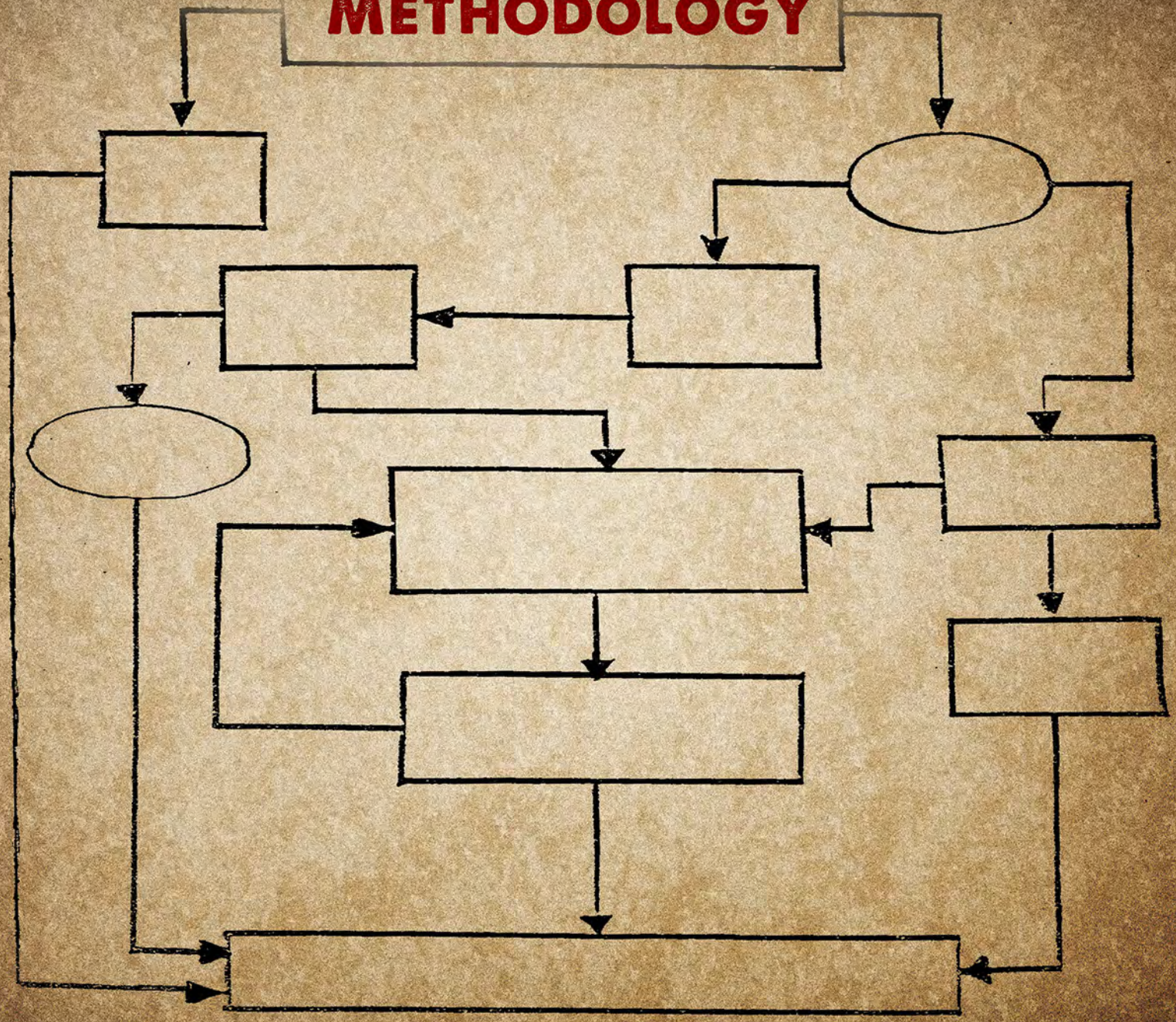
For each of the projections, the expected manufacturer selling prices have been used to calculate the market value. All figures are stated in U.S. nominal dollars. Also, some percentages may not add up exactly to 100% due to rounding.

Communication Access Networks: These are wired and wireless communication networks for utilities that form the main communication gateway across the utility landscape and are a critical component of advanced metering infrastructure (AMI). In this report, access networks are segmented by backhaul, wide area networks (WAN), neighborhood area networks (NAN) and home area networks (HAN). Further, wireless networks are broken out by private and public application or deployment.

Enterprise Systems and Networks: These are utility-wide systems put in place to integrate mission-critical operations and functions into one unified or consolidated system.

Purpose-built networks: These are proprietary systems put in place at utilities to serve a specific function and/or meet a specific mission-critical operation that cannot be delivered through a utility's enterprise wide system or network.

Methodology



METHODOLOGY

Zpryme forecasts in this report were derived using data on U.S. AMI deployments, utility information technology investments, and government funding for smart grid technology. These key inputs were used to derive the forecasts for U.S. smart grid communication networks and utility enterprise and purpose-built systems in this report. The baseline data were then synthesized with inputs from publicly available information on the smart grid and the communications and enterprise system market.

The forecast period for this report is 2010 to 2015.

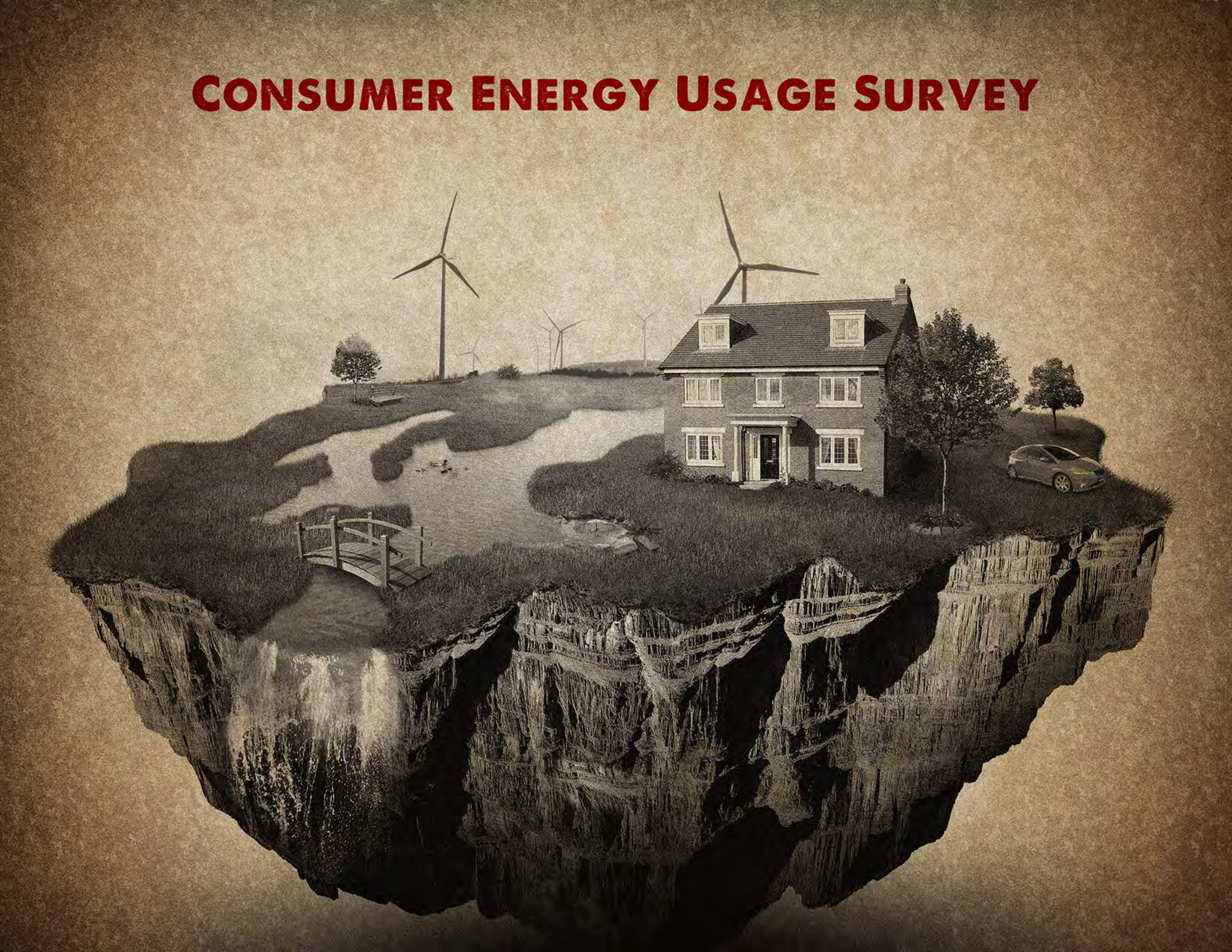
Key Forecast Inputs

- Historical Data and Projected Smart Meter Deployments: Zpryme utilized historical AMI and smart meter deployment data from publicly available information to develop a forecast for smart meter deployments from 2011 to 2015. This forecast was used as a baseline metric to develop the demand for networks to support the projected AMI deployment in the U.S.

- Deployment Costs Per Meter: The average costs to deploy networks were also used to develop growth in the revenues for the overall market during the forecast period.

- Forecast Model: Time series forecasting was used to derive the projections in this report. Once key demand inputs were accounted for, econometric modeling was employed to develop the forecasts in this report.

Consumer Energy Usage Survey



CHAPTER 1: NEW ENERGY CONSUMER SURVEY

Survey on Consumer Energy Usage & Electricity Spending

Zpryme conducted a survey in mid-March 2011 of 1,082 homeowners or renters age 18 – 75 to examine consumer energy usage and electricity spending across the U.S., below are the findings.

Methodology

A survey was conducted in mid-March 2011 to assess consumer energy usage and electricity spending behaviors. The representative sample was composed of 1,082 respondents from across the United States. This report will present descriptive frequencies of each of the 40 items and then focus on specific delineations about how consumers are using energy and how they assess that usage. These specific insights will utilize crosstabs among several items. A final section of the report will offer some key findings that surfaced in the survey.[1] For some of the survey findings, results are segmented between the Overall Respondents and those identified as High Tech Users (HTUs).

High Tech User Definition: Those who reported using a smartphone, tablet, or mobile internet device for electricity management were grouped together to form a high-tech user (HTU) group. A total of 141 respondents were identified as HTUs. This HTU group was then investigated for characteristics and revealed they: were more likely to be male (17.3%) than female (10.4%); were more likely to be young (58.7% were age 35 or younger); have higher education levels (48.4% were college graduates or higher); spanned all household income levels; and had proportionately more representation (14.8%) in the group that used the internet/email for three to five hours per day than for any other internet/email usage time period.

Summary of Survey Insights

There are several insights that emerge when investigating the types of respondents who are associated with various energy consumption behaviors:

- Changes in the average monthly electric bill tend to be associated with age, household size, and household income. Age has a u-shaped distribution with 56.9% of those aged 18 – 25 paying $100 or less per month, as well as 67.7% of those aged 46 – 55 paying $100 or less per month. All other age groups had fewer paying this low amount. Not surprisingly, those households with fewer occupants paid lower electric bills. The largest group (64.5% of those with only one occupant) paid $100 or less per month. Education level did not show an association with amount paid for electric bills. Lastly, household income did trend with monthly electric bills. For example, 67.1% of those earning less than $20,000 paid $100 or less per month for electricity, while only 33.3% of those earning $200,000 and over paid $100 or less for electricity per month. It appears that renters have lower monthly electric bills. However, nearly the same proportion of owners (74.7%) and renters (79.0%) agreed that the recent surge in gasoline prices had made them more sensitive to electricity prices.

- When focusing upon those who would curtail household energy usage if their electricity bill increased by just 10% to 19%, several demographic variables were investigated. There were slightly more females (47.8%) than males (41.5%). Those in middle age had higher representation, with people 46 to 55 years old having the highest proportion (51.9%). There was no discernable association with education level; but more of those earning less than $20,000 per year (54.6%) would curtail energy usage than any other income group.

- Overall, the large majority (93.6%) of respondents felt it was important for utilities to have the most advanced communications technology to increase energy efficiency and prevent power outages; however, only 23.0% said they wouldn't mind paying slightly higher rates over a short time period to fund such technology for utilities.

- Just over half of respondents (53.1%) indicated that they would be comfortable with their utility working with a cellular provider such as AT&T, Sprint or Verizon to expand a utility's communications capabilities.

[1] Please note that for some of the items, percentages may not add to 100% because only valid responses were used.

- Respondents were asked to rate their utility as outstanding, good, average, or poor. Some comparisons between these ratings and other items were made. Seventy percent of homeowners and 66.8% of renters rated their utility as good or outstanding. No relationship was found between those rating their utility as good or outstanding and age of the respondent. When looking at the top 10 states for the sample, the good or outstanding ratings varied from 57.6% (Georgia) to 76.6% (Ohio); all other eight states fell in between those two percentages. One could conclude that over half of the respondents in the top 10 states rated their utility favorably.

- Another set of comparisons was conducted between those residents who said they wouldn't mind paying higher rates for electricity from renewable sources, and some demographic variables. More males (25.2%) than females (18.3%) said they would pay higher rates; and those who were renting (24.3%) would pay higher rates than those owning (19.3%) their residences. Younger residents (those 18 to 25 at 35.0%; those 26 to 35 at 26.1%) were more likely to agree to higher rates than any of the other age groups. Education level did not seem to be associated with willingness to pay higher rates; but household income level exhibited a modest trend that showed those earning higher incomes more willing to pay higher rates for renewable energy.

Demographics

Gender and Age: There were more female respondents (61.5%) than males (38.5%) with nearly two-thirds of the sample (65.7%) reporting that they owned their home or place of residence. The rest of the sample (34.3%) said they rented their residence. More of the respondents said they were from 56 to 65 (27.5%) years old than any other age group, although the reported age span was from 18 to 75 years. The average age for the entire adult sample was 43.12 years.

Household Size and Education: The most popular category to indicate the number of people in their household was three to five people (38.8%). Other household sizes were: two people (37.3%), one person (20.8%), six to ten people (3.1%), and over ten people (0.1%). Education level was relatively high with most (79.6%) saying they had at least some college. Only 1.5% had less than a high school diploma, while the other 18.9% reported having a high school diploma or a GED.

Household Income: Reported annual household incomes were from less than $20,000 to those with over $200,000. The largest category included those reporting from $30,001 to $50,000 per year (24.6%). Over half of the sample (52.1%) had incomes of $50,000 or less.

State of Residence: Geographically, the top 10 states with the most respondents were: California (10.3%), Florida (7.2%), New York (6.1%), Pennsylvania (6.0%), Michigan (4.6%), Texas (4.6%), Ohio (4.4%), North Carolina (3.8%), Illinois (3.5%), and Georgia (3.1%). These ten states represented over half (53.6%) of the 1,082 respondents.

Average Monthly Electric Bill

When asked about their average monthly electric bill, people reported amounts from less than $50 to over $500. The largest single group (27.3%) said their average bill was $101 to $150 per month, while the rest of the group revealed (in descending order): $76 - $100 (19.5%), $51 - $75 (15.6%), $151 - $200 (14.7%), $201 - $300 (10.2%), less than $50 (9.0%), $301 - $400 (2.2%), over $500 (0.9%), and $401 - $500 (0.6%). Four out of ten (44.1%) spent $100 or less per month on average.

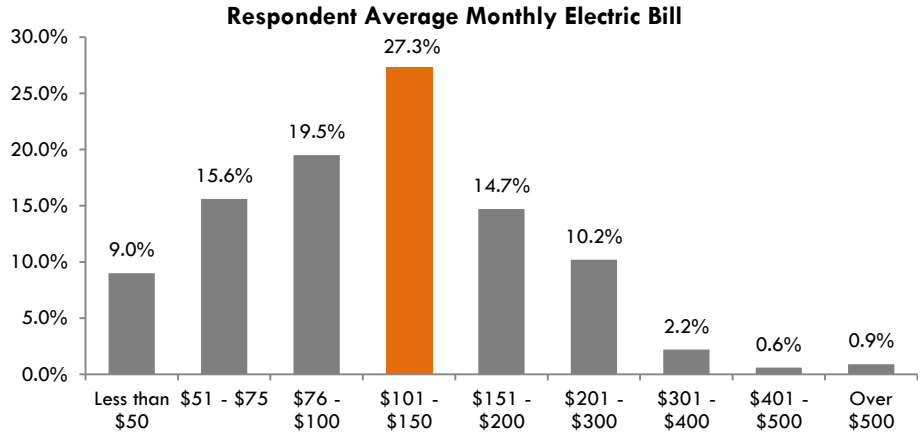


Figure 1, Source: Zpryme

Sensitivity to Rise in Gas Prices

The respondents were asked whether the recent surge in gasoline prices had made them more sensitive to electricity prices. Over three fourths (76.5%) said they were sensitive as a result. Compared to the overall group, high tech users (HTUs) were more likely to be impacted by the recent increase in gas prices as 44.0% strongly agree (vs. 29.9% overall) that they are more sensitive to electricity prices as a result of the increase in gas prices.

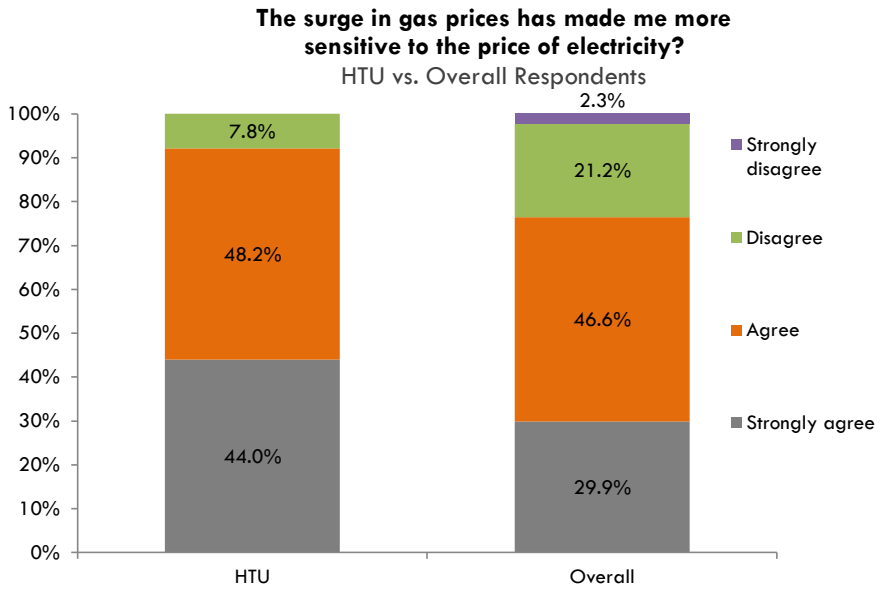


Figure 2, Source: Zpryme

Time Spent Online

People were queried about how much time per day they spent on the internet/email. Their responses were: less than one hour (4.7%), one to two hours (26.1%), three to five hours (42.1%), six to eight hours (15.3%), and over eight hours (11.8%). Nearly 70% (69.2%) spent over three hours per day on the internet/email. This high percentage of time could be partially explained because this survey was internet-based itself.

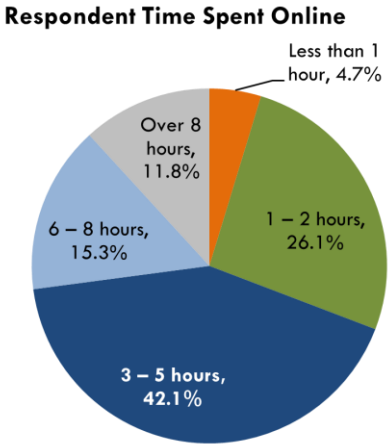


Figure 3, Source: Zpryme

Energy Star Certified Residence

The respondents were asked whether their residence is Energy Star certified. Just over one fifth of the overall group (21.5%) said yes their residence is Energy Star certified. Compared to the overall group 50.4% high tech users (HTUs) have an Energy Star certified residence. Also close to a third for each group (31.2% overall and 36.2% HTU) did not know whether their home is Energy Star certified.

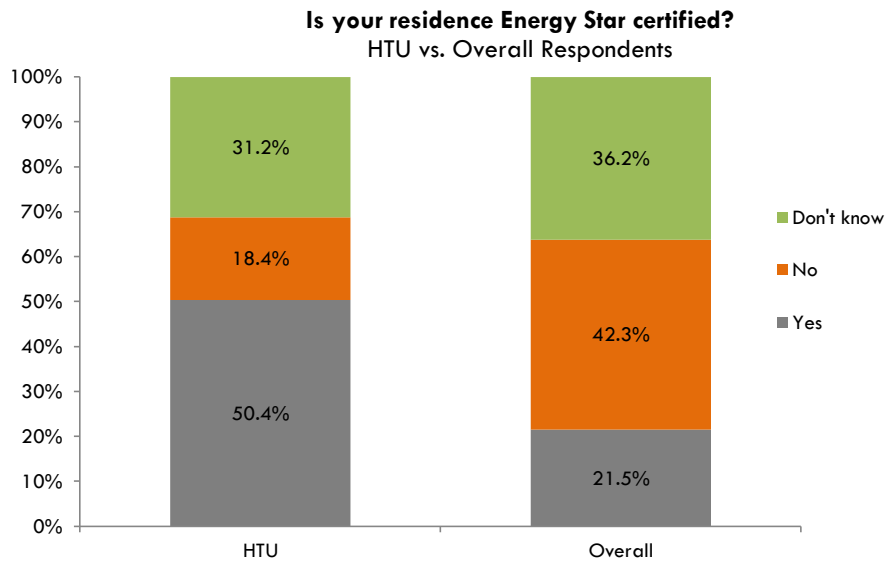


Figure 4, Source: Zpryme

Energy Efficiency Actions

Many of the respondents revealed that they had performed energy efficiency actions in their residences: use energy efficient appliances (64.5%), had caulked around doors and windows (46.0%), installed programmable thermostats (42.7%), installed energy efficient windows (37.9%), installed extra insulation (27.7%), installed blanket around water heater (18.7%), had an energy audit (10.2%), and installed a radiant barrier in the attic (6.3%). Another specified action most often listed was using energy efficient light bulbs.

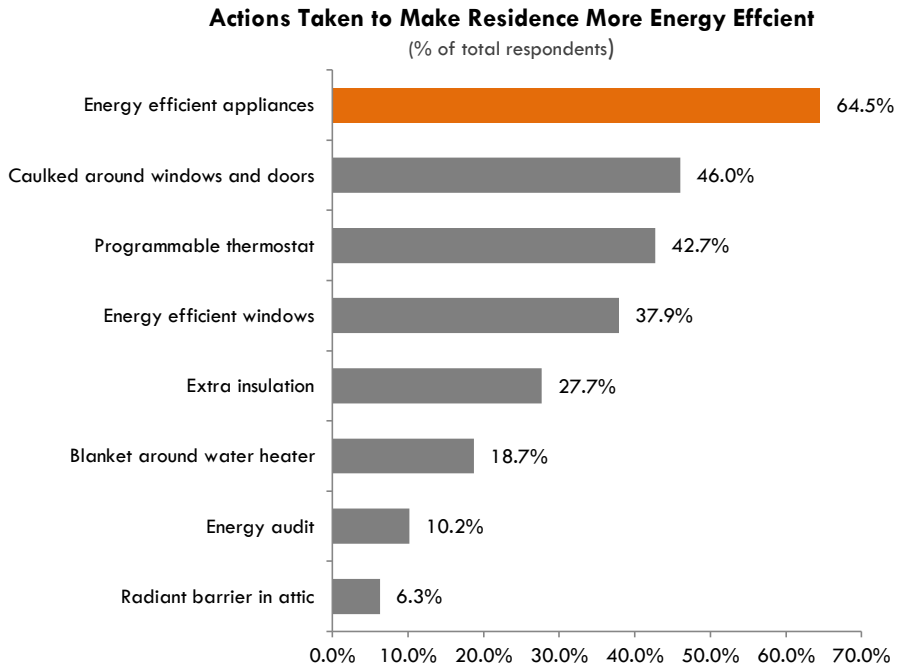


Figure 5, Source: Zpryme

Appliance Energy Consumption Rankings

Respondents were asked to rate several items found in most homes that consumed the most energy by using a ten point scale (where 1 is low and 10 is high). Their average ratings in descending order were: air conditioner (7.9), clothes dryer (6.6), water heater (6.3), refrigerator (6.2), clothes washer (5.5), oven (5.0), dish washer (4.9), television (4.5), range (4.4), and personal computer (3.9) – see INFOgraphic beginning on page 5 for more details.

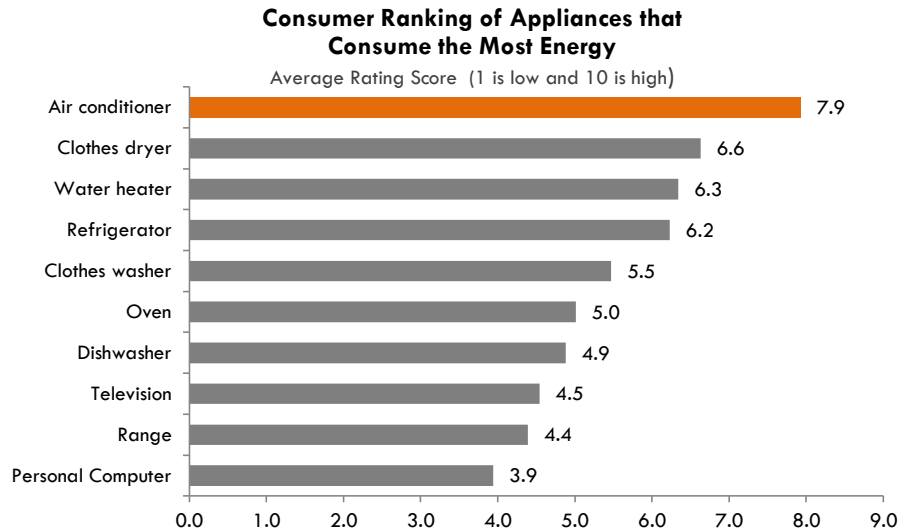


Figure 6, Source: Zpryme

Home Energy Monitoring

Several choices were listed to monitor and/or manage electricity usage. The frequency of respondents who utilized them were: paper bill (74.3%), traditional internet (27.3%), email (21.9%), telephone (13.0%), smartphone app (9.2%), mobile internet (8.8%), vehicle app (4.0%), and tablet (e.g., iPad) (2.9%).

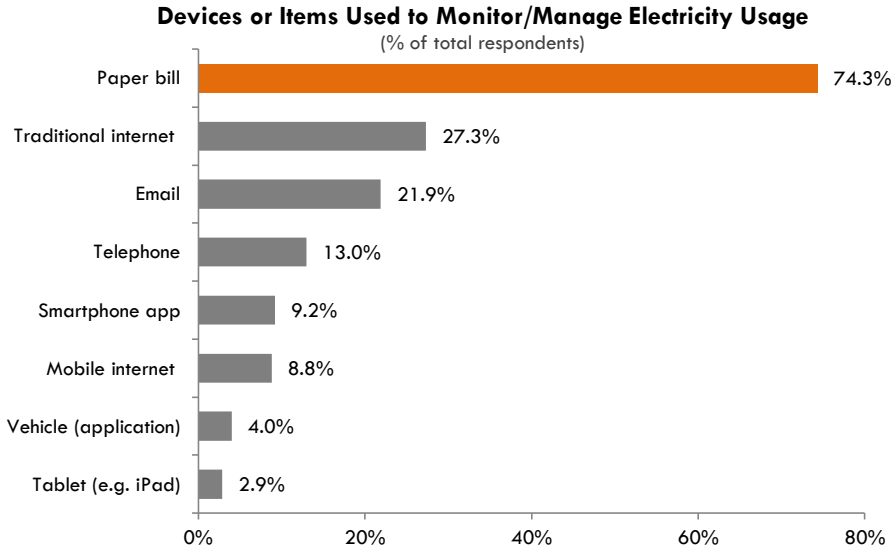


Figure 6, Source: Zpryme

Energy Management Devices

Respondents also rated the importance of being able to monitor/manage their electricity usage from the same locations/devices. Respondents considered it very important to monitor energy usage using the following devices in order of importance: mail (47.7%), traditional internet (34.4%), in-home display (30.7%), email (26.8%), telephone (19.7%), mobile internet (13.0%), smartphone app (11.2%), and tablet (7.9%).

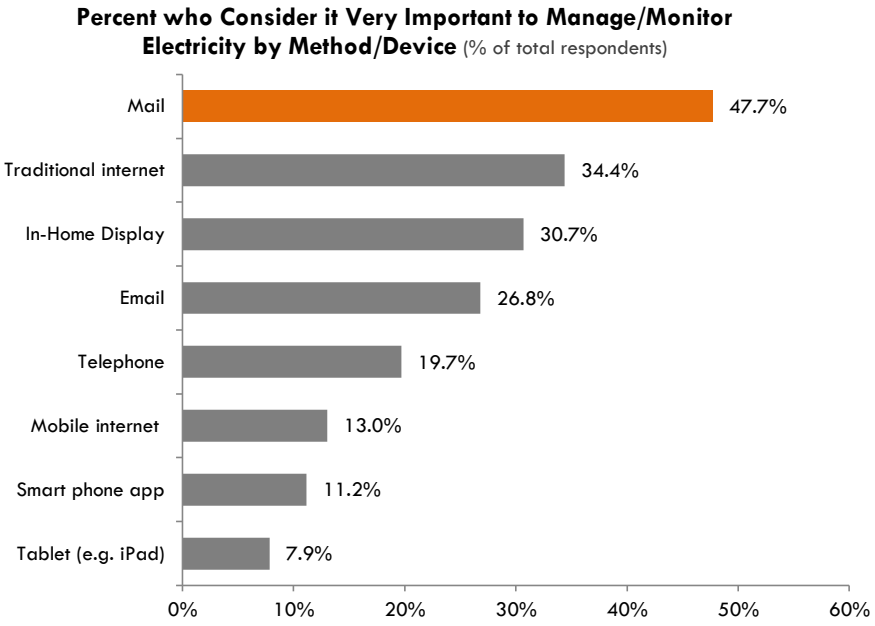


Figure 7, Source: Zpryme

Frequency of Electricity Usage Monitoring

The frequency of monitoring/managing electricity usage for the overall sample was: monthly (62.0%), not at all (12.1%), weekly (10.6%), daily (6.0%), in real time (2.8%), hourly (1. 9%), and yearly (1.5%). HTUs were more likely to monitor their usage in real-time (12.1%), hourly (9.9%), daily (18.4%) and weekly (27.0%) when compared to the overall group.

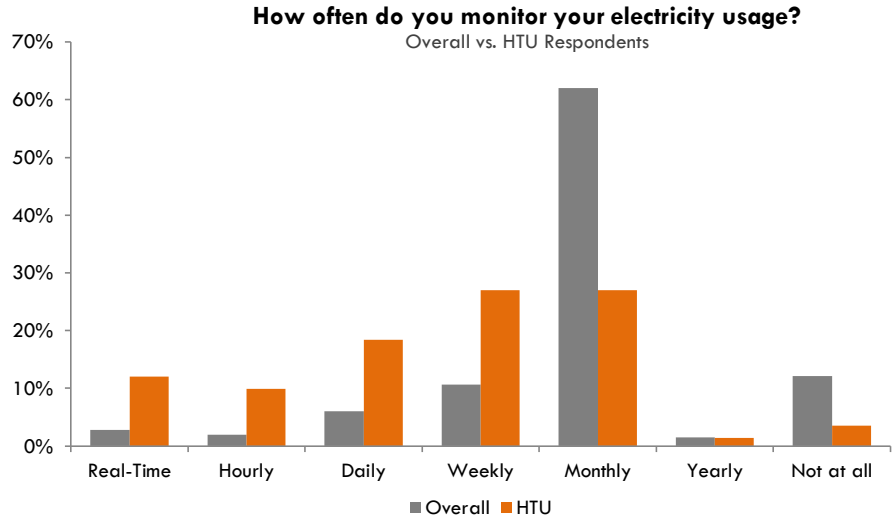


Figure 8, Source: Zpryme

Time Spent Reviewing Electricity Bill

How long people spend in reviewing their electricity bill every month was: not at all (4.0%), less than 30 seconds (5.0%), 30 seconds to one minute (12.0%), one to three minutes (27.0%), four to six minutes (24.1%), seven to nine minutes (9.9%), and 10 minutes or more (15.0%). Close to half (48.0%) spent three minutes or less to review their bill. Compared to the overall group, HTUs were more likely to spend more time reviewing their electric bill for more than 10 minutes or more (29.1%).

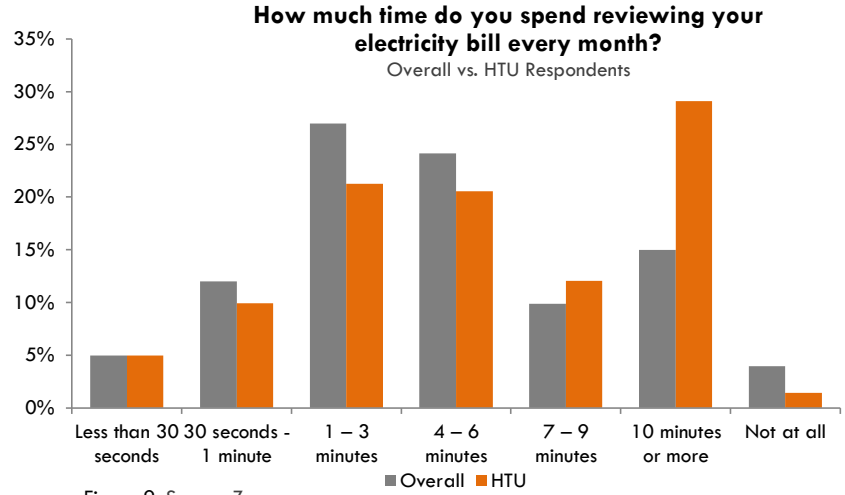


Figure 9, Source: Zpryme

Electricity Bill Increases to Prompt Conservation

What percentage increase in their electricity bill would prompt them to reduce energy usage was asked. Nearly half (45.4%) said a 10% to 19% increase would prompt conservation. Other responses were: an increase of 20% to 29% (33.5%), an increase of 30% to 39% (10.3%), an increase of 40% to 49% (3.0%), or an increase of 50% or greater (4.7%). Apparently, most people (78.9%) would take conservation actions with 29% or lower electricity cost increases.

Increase in Electricity Bill Needed to Prompt Pro-active Steps to Curtail Household Electricity Usage
(% who would change behavior)

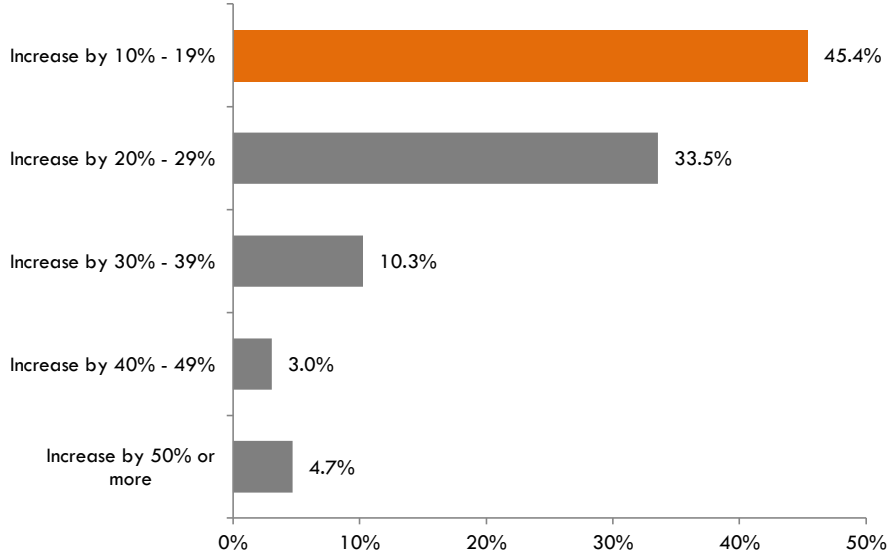


Figure 10, Source: Zpryme

Utility Satisfaction

When rating their electric utilities, more respondents seemed satisfied than not. Ratings were: outstanding (18.4%), good (50.6%), average (24.6%), and poor (3.4%).

How would you rate the service of your electric utility?

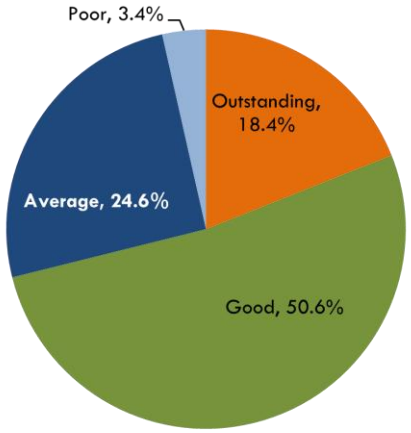


Figure 11, Source: Zpryme

Demand Response Program Offering

Eleven point five percent reported that their utilities offered a distributed generation program, while 17.1% said no, and the remainder (68.4%) said they weren't sure.

Does your utility offer a distributed generation program?

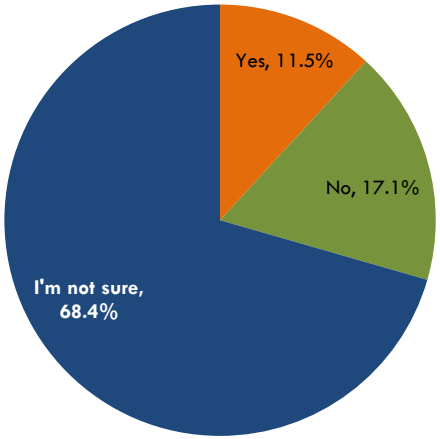


Figure 12, Source: Zpryme

Willingness to Participate in Renewable Energy Program

People were asked whether they would be interested in a program to use renewable energy sources. Sixty-one point six percent said yes, but they would want to have the same electricity rate; 21.0% said yes and they wouldn't mind a higher rate; and 14.3% said they were not interested in such a program. Compared to the overall group, HTUs were about 2 times more likely to be willing to pay a higher electric rate for electricity from renewable sources.

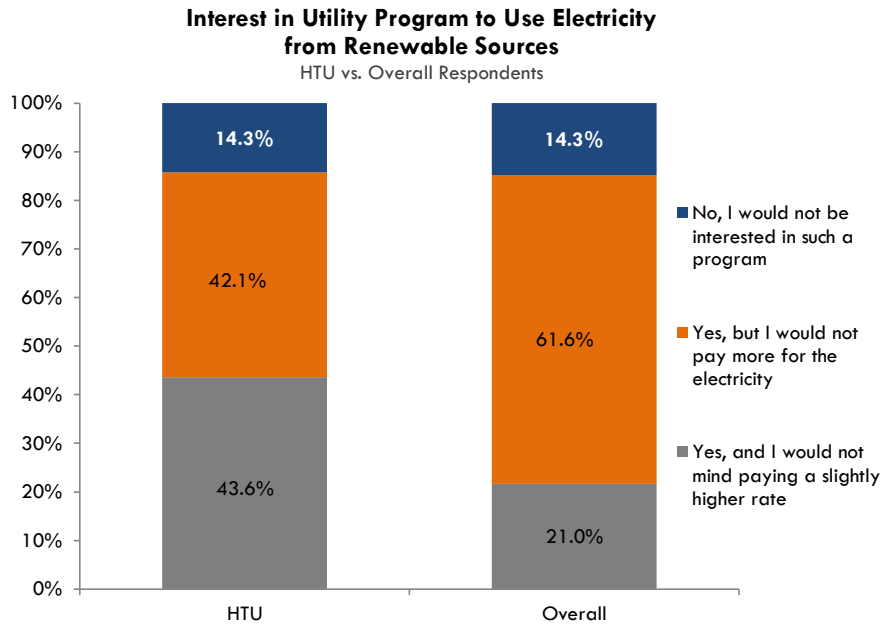


Figure 13, Source: Zpryme

Willingness to Participate in Time-of-Use Pricing Program

Their willingness to participate in a time-of-use pricing program to be able to use lower rates during off-peak times was also asked: 73.4% said they were willing, and 23.5% said they were not. Among HTUs, 82.9% indicated they would be interested in participating in a time-of-use program that offered lower rates during off-peak times of the day.

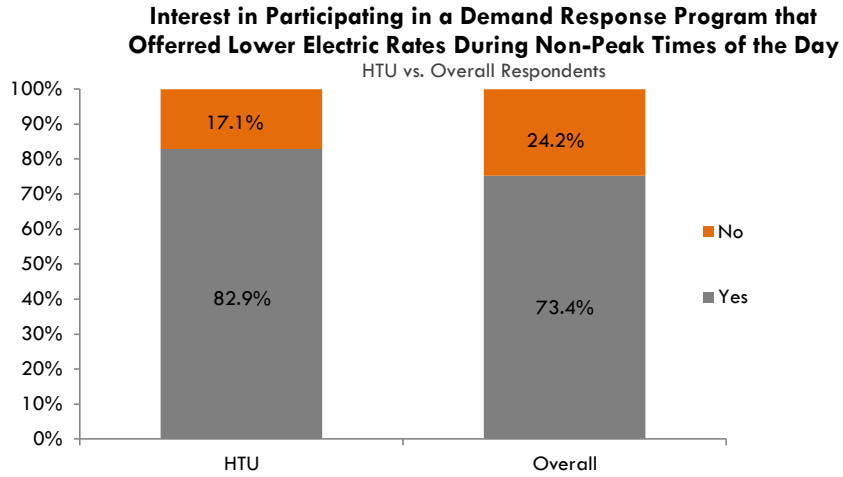


Figure 14, Source: Zpryme

Communication Preferences about Time-of-Use Pricing

A series of communication methods for receiving information about time-of-use pricing programs was presented to respondents to identify which they deem the most important to receive pricing information upon. Respondents considered the following very important (in descending) order): email (44.3%), traditional internet (40.2%), utility website (33.7%), phone (29.6%), in-home display (26.5%), text message (22.3%), Facebook (15.2%), mobile internet (13.9%), tablet (7.5%), and Twitter (6.4%).

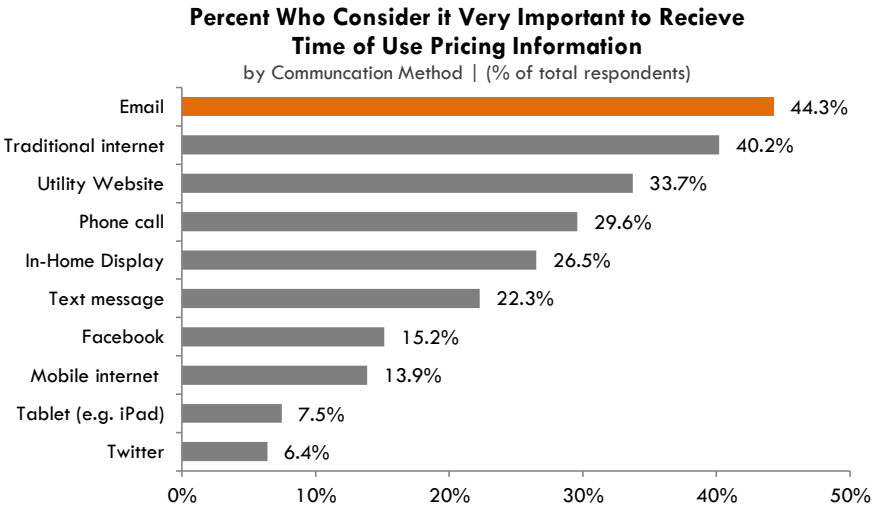


Figure 15, Source: Zpryme

Smart Meter Presence

Residents were asked whether they had a smart meter and 17.3% said yes, 33.8% said no, with the rest (45.2%) were not sure what type of electric meter they had.

Does your residence have a smart meter?

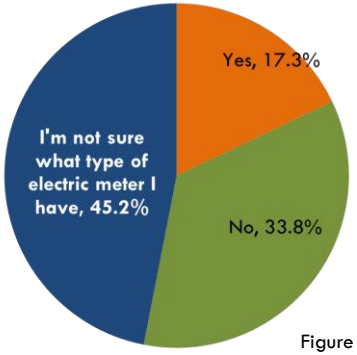


Figure 16, Source: Zpryme

Smart Meter Concerns

In general, the respondents were asked what level of concern they had about smart meters. Respondents were highly concerned with cost (48%), benefits they receive (36%), data and billing accuracy (36%), and data privacy (31%). They were least concerned with radio and frequency emissions (24%).

Smart Meter Level of Conern by Potential Issue Area
(% of total respondents by area)

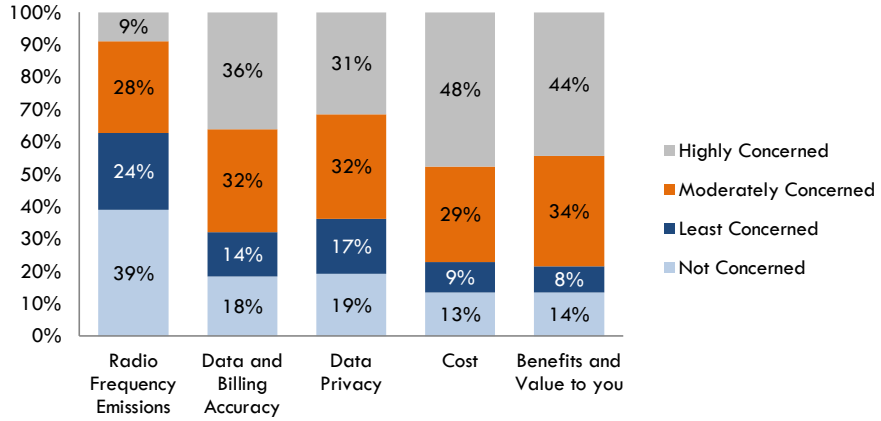


Figure 17, Source: Zpryme

Communication Preference During an Electrical Outage

Another item asked them to indicate the importance of several communication methods in receiving information about electrical outages by using an importance scale. Respondents considered the following very important (in descending order): phone call (47.1%), email (33.5%), text message (30.8%), internet (29.9%), utility website (26.0%), in-home display (25.8%), mobile internet (18.6%), Facebook (13.4%), Twitter (7.2%) and by Tablet (6.5%).

Percent Who Consider it Very Important to Recieve Electricity Disturbance or Outage Information
by Communcation Method (% of total respondents)

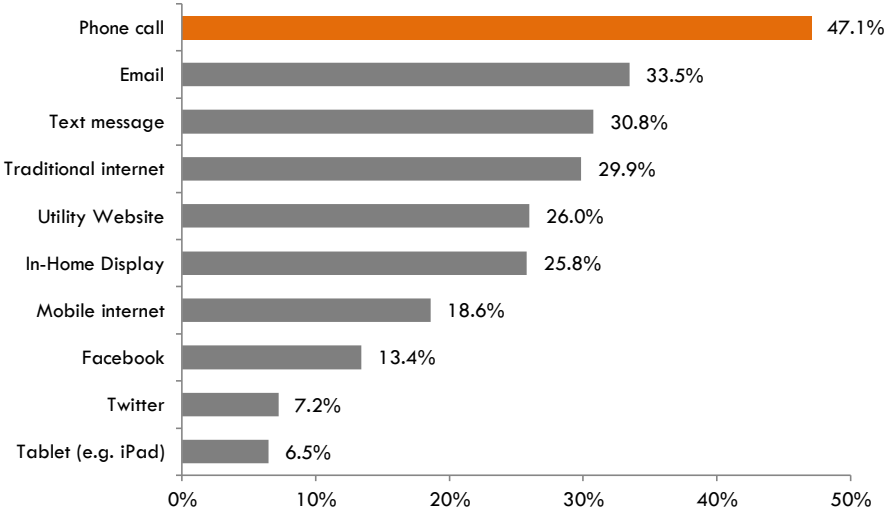


Figure 18, Source: Zpryme

Exposure to Electrical Outage

Over the past 12 months, residents rated how their utility had responded to an electrical outage that was caused by severe weather. Forty-four point five percent said the utility got power back on in a timely manner but could have communicated the status better; 29.6% said their utility did an excellent job and kept them fully informed; 20.1% said no outages had occurred; and 5.9% said their utility had done a poor job.

Over the past 12 months, how do you feel your utility reacted when severe weather caused an electrical outage?

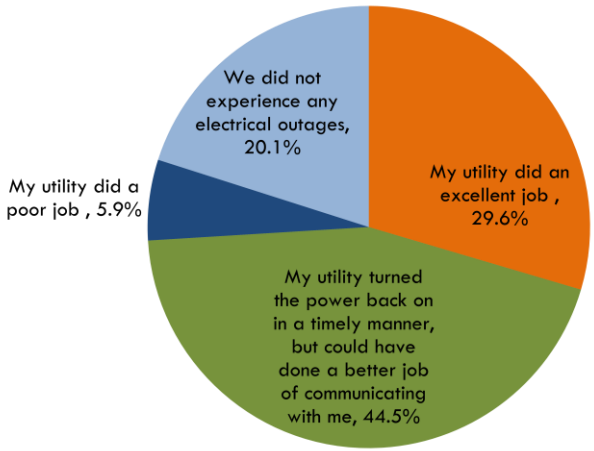


Figure 19, Source: Zpryme

Importance of Communications Technology for Utilities

Residents were further probed about whether it was important for utilities to have the most advanced technology for electricity delivery and to prevent outages. Seventy-one point six percent said yes but they didn't want rates raised to fund advanced technology; 23.0% said yes and they wouldn't mind paying slightly higher rates over a short time period; and 5.5% said no, this was not important for utilities. Among HTUs, 44.2% indicated they would be willing to pay a slightly higher electric rate in the short term to fund advanced communication technology.

Is it important for your utility to have the most advanced and secure technology, network and communication systems available?

HTU vs. Overall Respondents

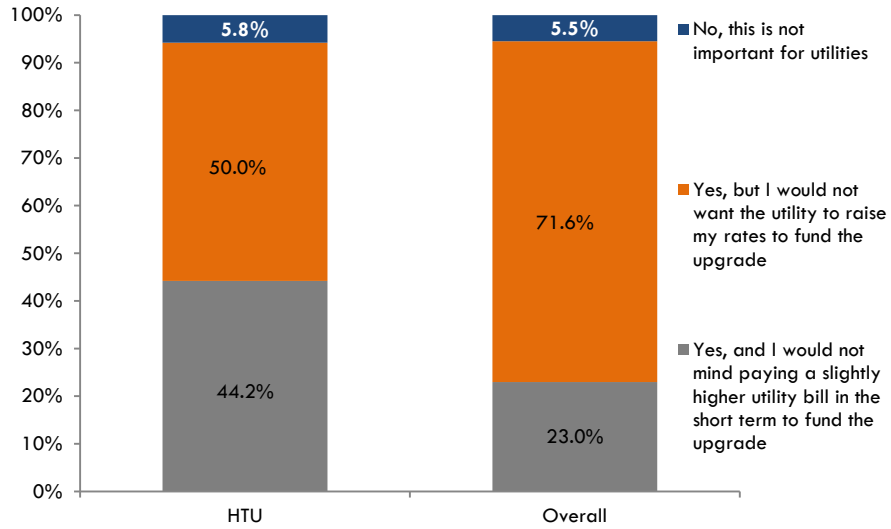


Figure 20, Source: Zpryme

Utilities and Wireless Carrier Sentiment

When asked whether they would have any reservations about their utility working with a wireless carrier to expand communications capabilities, 53.1% had no reservations, 22,2% did have some reservations, and 24.7% had no opinion about this question. Among HTUs, 66.6% indicated they did have any reservations about their utility working with a major wireless carrier to expand communication capabilities and better serve their customers.

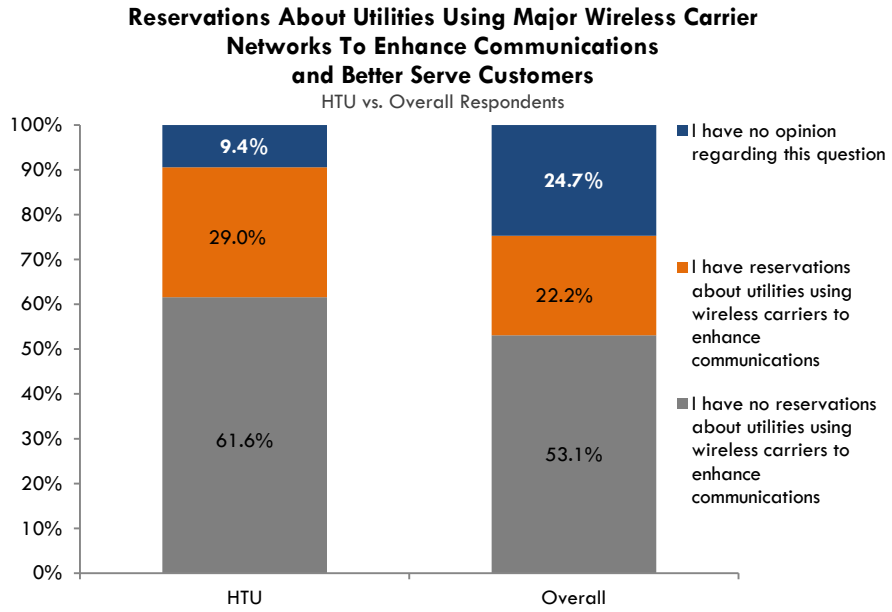


Figure 21, Source: Zpryme

Smart Grid Definition

Respondents were asked to choose the best definition of a smart grid. The correct response (a linkage among customers, utilities, and electricity generators) was chosen by 41.0%. Other choices were: none of the definitions (16.4%), new efficient appliances (14.0%), smart meters (13.9%), solar panels (7.5%), and programmable thermostats (7.1%), below:

Answer Options	Response Percent
New appliances have programming that uses the lowest amount of electricity	14.0%
Electric meters tell homeowners when electricity costs are lowest	13.9%
A linkage among customers, utilities and generators of electricity to enable a systematic, real-time, two way communication and intelligent usage of the power grid	41.0%
New thermostats set temperatures to minimize electricity usage	7.1%
Solar panels provide energy to homes when electricity is not available from the normal provider	7.5%
None of the above	16.4%
Total	**100.0%**

Figure 22, Source: Zpryme

Smart Grid Awareness

People were next asked about their smart grid awareness and 41.0% said they were aware, while 59.0% said they were not. Compared to the overall group, HTUs were more likely to be aware of the Smart Grid (62.3%).

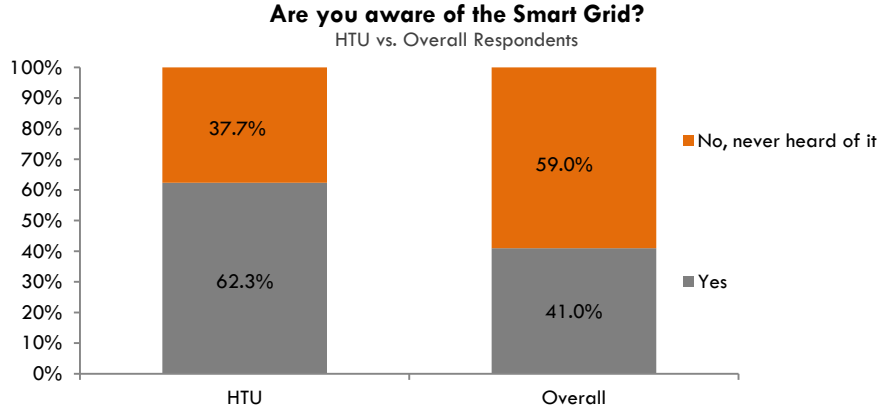


Figure 23, Source: Zpryme

Smart Grid Knowledge Level

When probed about their knowledge level about the smart grid, 69.9% said they had no knowledge, 26.1% said they were somewhat knowledgeable, and 4.1% said they were very knowledgeable. Compared to the overall group, HTUs were about 10 times more likely to consider themselves to be very knowledgeable about the Smart Grid (41.3%).

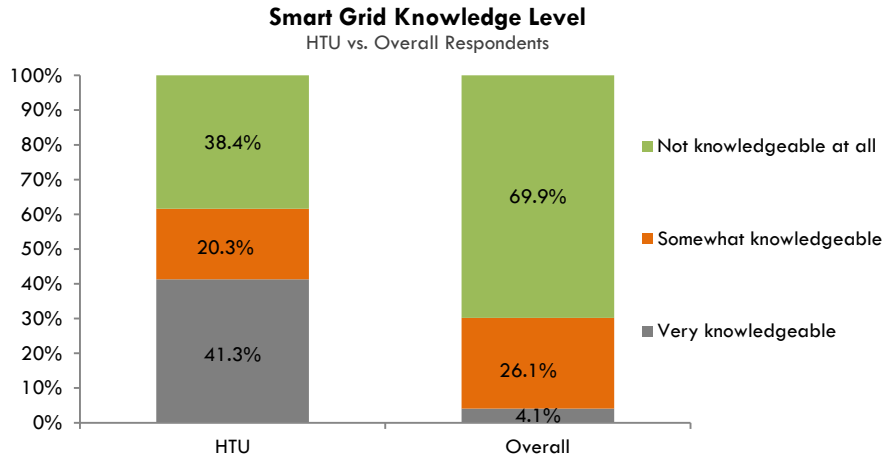


Figure 24, Source: Zpryme

Utility Information about smart grid

A follow-up question was whether their utility had provided information about the smart grid and the frequency of responses (from highest to lowest) was: no (46.1%); don't know (39.7%), yes, with my bill (10.9%); yes, over the internet (4.9%); yes, another method (2.7%).

Has your utility provided information about the Smart Grid?

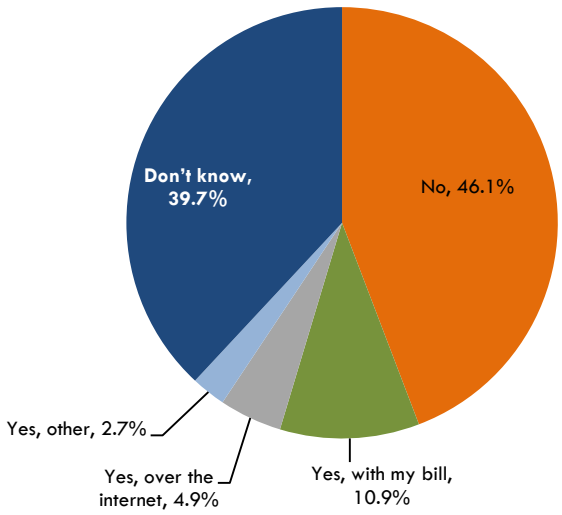


Figure 25, Source: Zpryme

Energy Management Device Presence

The sample was asked to state how many of the following devices they had. Response options were yes, no, no but interested in obtaining, the frequencies were:

Device	Yes	No	No, but I'm interested in obtaining
Smart appliances[2]	34.4%	46.5%	13.4%
Smart thermostats	28.4%	50.4%	15.0%
Battery storage for household usage	12.7%	66.1%	14.9%
In-Home Display	12.0%	64.8%	16.5%
Home Energy Management System	10.7%	67.0%	16.2%
Electric Vehicle[3]	6.1%	72.9%	14.2%
Solar panels	5.9%	67.4%	20.1%
Wind generator	4.3%	73.3%	15.8%

Figure 26, Source: Zpryme

[2] This may include energy efficient appliances (e.g. Energy Star)
[3] This may include hybrid vehicles (e.g. Toyota Prius)

Energy Management Device Preferences Rank

The next item asked residents to rank order their preferences for enabling a set of electrical devices. The highest ranking was for a home energy management system where 34. 1% ranked it number one. Other number one rankings, in descending order were: smart appliances (21.6%), smart thermostats (16.3%), solar panels (11.0%), battery storage for household use (6.8%), and wind generator (3.7%).

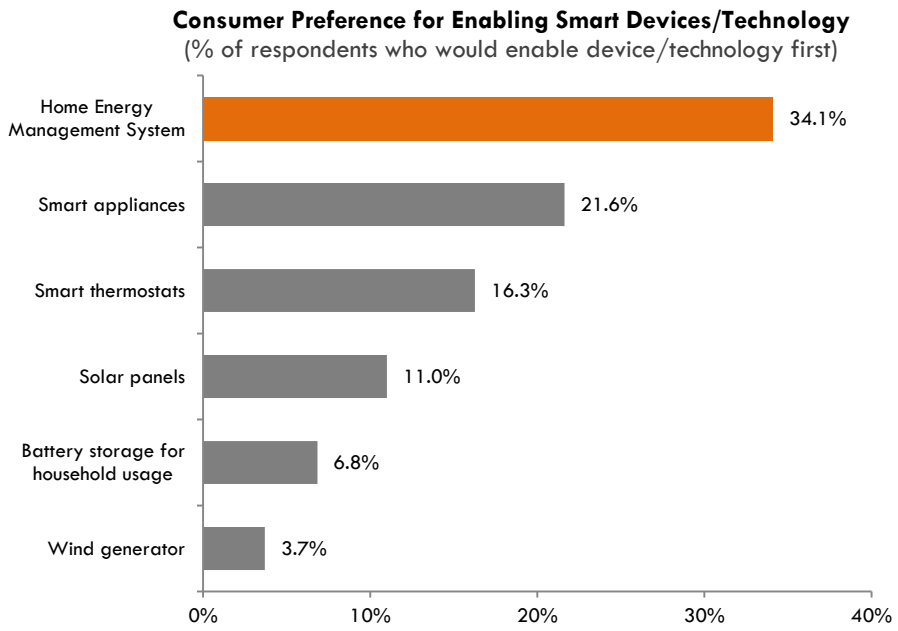


Figure 27, Source: Zpryme

Electric Vehicle Purchasing Conditions

Respondents were asked to tell under what conditions they would consider purchasing an electric vehicle (EV). Among respondents, (4.7%) said they already owned an EV, they were already considering an EV purchase (6.8%), they would consider an EV if gas reached $4.00 per gallon (11.5%), they would consider an EV if their utility offered cheaper rates for recharging (25.0%), they would consider an EV if their utility allowed selling electricity back from a recharge (17.6%), and, finally, 48.2% said they were not interested in purchasing an EV.

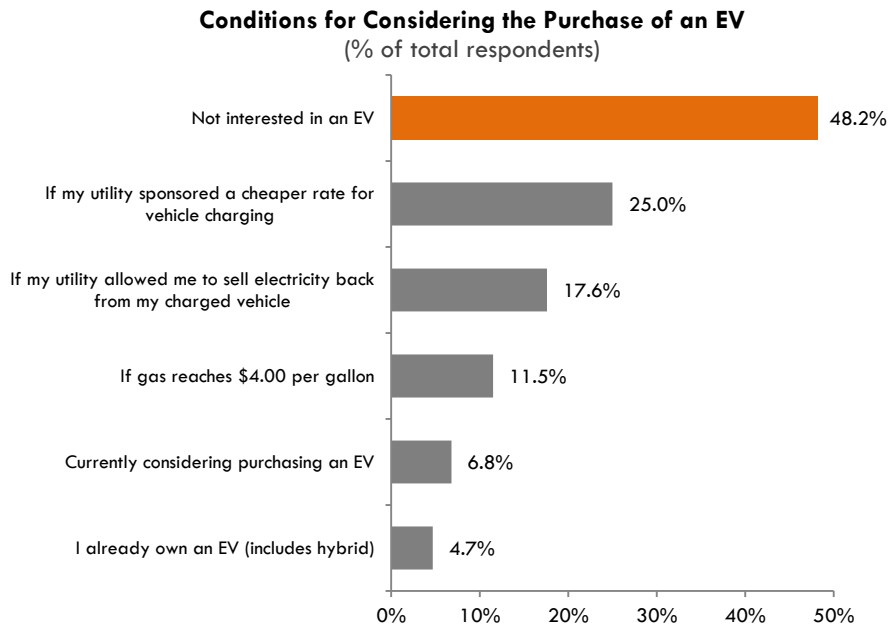


Figure 28, Source: Zpryme

Smart Grid Benefits

The sample was next asked to rate potential benefits of a Smart Grid. Respondents considered the following very important (in descending) order): save money (81.3%), more efficient electricity use (78.2%), reduce my own electricity use (73.2%), create new jobs (67.4%), better preserve the environment (63.9%), increase security of U.S. (62.6%), increase the use of domestic energy (58.3%), reduce the number of power outages (61.7%), and enhance communication with utility when outages occur (52.0%). However, all of these ratings are high.

Smart Grid Benefits Considered Very Important for Adoption

Potential Smart Grid Benefit	% of total respondents
Save money	81.3%
More efficient use of electricity	78.2%
Reduce my own energy use	73.2%
Create new jobs	67.4%
Better preserve the environment	63.9%
Increase security of U.S.	62.6%
Increase use of domestic (U.S.) energy	61.7%
Reduce the number of power outages	58.3%
Communication with my utility when a power outage occurs	52.0%

Figure 29, Source: Zpryme

Negative Smart Grid Factors

On the other side of the coin, respondents were asked whether they agreed or disagreed with some potentially negative consequences of a smart grid. Eighty-three percent (agree or strongly agree) said the cost to build a smart grid was of great concern, 79.0% (agree or strongly agree) said the cost of smart meters is of great concern, and 65% (agree or strongly agree) said the loss of privacy about electricity usage to a smart grid is of great concern.

Smart Grid Concerns by Potential Issue Area
(% of total respondents by area)

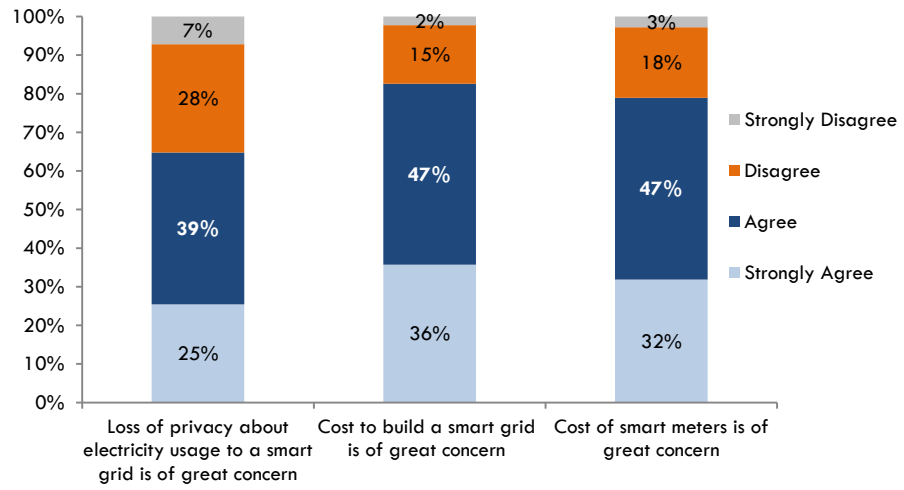


Figure 30, Source: Zpryme

Willingness to Pay for Smart Grid Technology

When queried about how much they would be willing to pay to get Smart Grid technology, 51% reported they wouldn't be willing to pay any premium about current rates, 26% said 5% premium above current rates, 17% said a 10% premium, and 6% said a 20% premium over current rates for smart grid technology. Compared to the overall group, a higher percentage of HTUs were more likely pay a 10% and 20% premium to get Smart Grid technology, 31% and 25% of HTUs, respectively.

Increase In Electricity Rates Willing to Pay for Smart Grid Technology
HTU vs. Overall Respondents

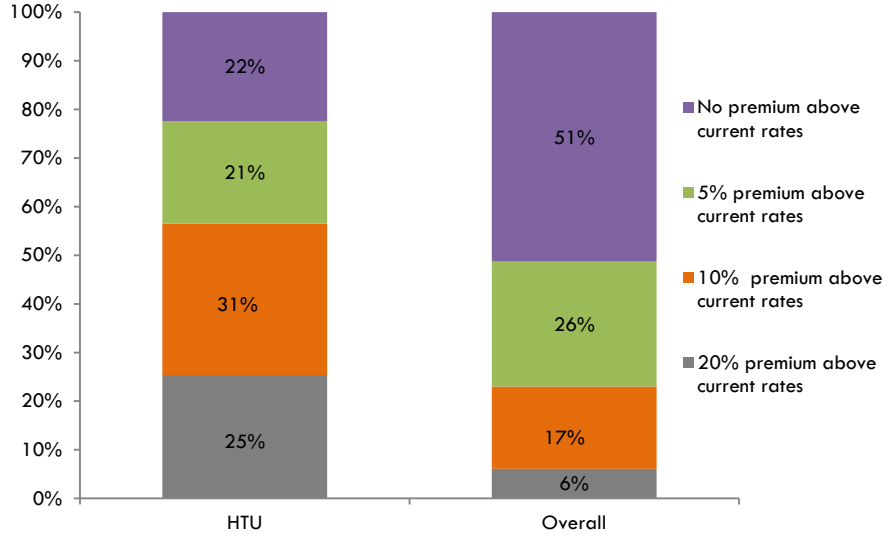


Figure 31, Source: Zpryme

Smart Grid Education Preferences

A final item asked residents how they would prefer to be educated about the smart grid. The majority of respondents indicated they preferred to be educated from mail brochures (51.5%), visual presentations online or TV (45.0%), emails from their utility (36.3%), articles on the internet (32.3%) and from utility commercials (27.8%).

Preferred Method to be Educated about the Smart Grid

Education Method	% of total respondents
Mailed materials or brochures from my utility	51.5%
Visual presentations - Video online or on T.V.	45.0%
Emails from my utility	36.3%
Articles on the internet	32.3%
Commercials from my utility	27.8%
Visual presentations - Online diagrams or pictures	24.9%
Educational materials from the govt. or other non-profit orgs.	23.9%
From friends	16.5%
White papers	15.5%
Utility customer service reps at their office or over the phone	12.8%
Facebook	11.8%
Text messages	6.2%
Applications on my smartphone	4.3%
Twitter	2.9%

Figure 32, Source: Zpryme

Overall Survey Key Findings

- Recent gasoline price surge has made 76.5% of all respondents more sensitive to electricity prices. However, 92.2% of HTUs were more sensitive to electricity prices to the surge in gas prices when compared to the overall group.

- Many of the residents had already taken energy efficiency actions in their households.

- More people monitor/manage their electricity usage on a monthly basis than any other time period. Compared to the overall group, HTUs were more likely to monitor their energy usage on a daily and weekly basis.

- Nearly half (45.4%) said a 10% to 19% increase in their electricity bill would prompt energy use reductions.

- The highest level of concern about smart meters was their cost.

- Only 39.3% of the overall sample said they were aware of the smart grid, with just 3.9% very knowledgeable. Among HTUs, 62.3% said they were aware of the Smart Grid and 41.3% considered themselves very knowledgeable.

- The highest rated potential benefit of the smart grid was saving money; the biggest concern was the cost to build it. (The U.S. economy currently has a great effect on smart grid ratings.)

- Age had a u-shaped distribution with 56.9% of those aged 18 – 25 paying $100 or less per month for electricity, as well as 67.7% of those aged 46 – 55 paying $100 or less per month.

- A tech savvy, high-tech user (HTU) group of respondents tended to be young, male, with higher income levels that used the internet/email for three to five hours per day. This HTU group of 141 people (13% of sample) used the smartphone, tablet, or mobile internet device for electricity monitoring/management.

- Seventy percent of homeowners and 66.8% of renters rated their utility as good or outstanding.

- Ninety-four percent of all respondents said it was important for utilities to have the most advanced communications technology to increase energy efficiency and prevent power outages; however, only 22.0% said they wouldn't mind paying slightly higher rates over a short time period to fund such technology for utilities. Among HTUs, 44.2% indicated they would not mind paying higher rates in the short term to fund such technology.

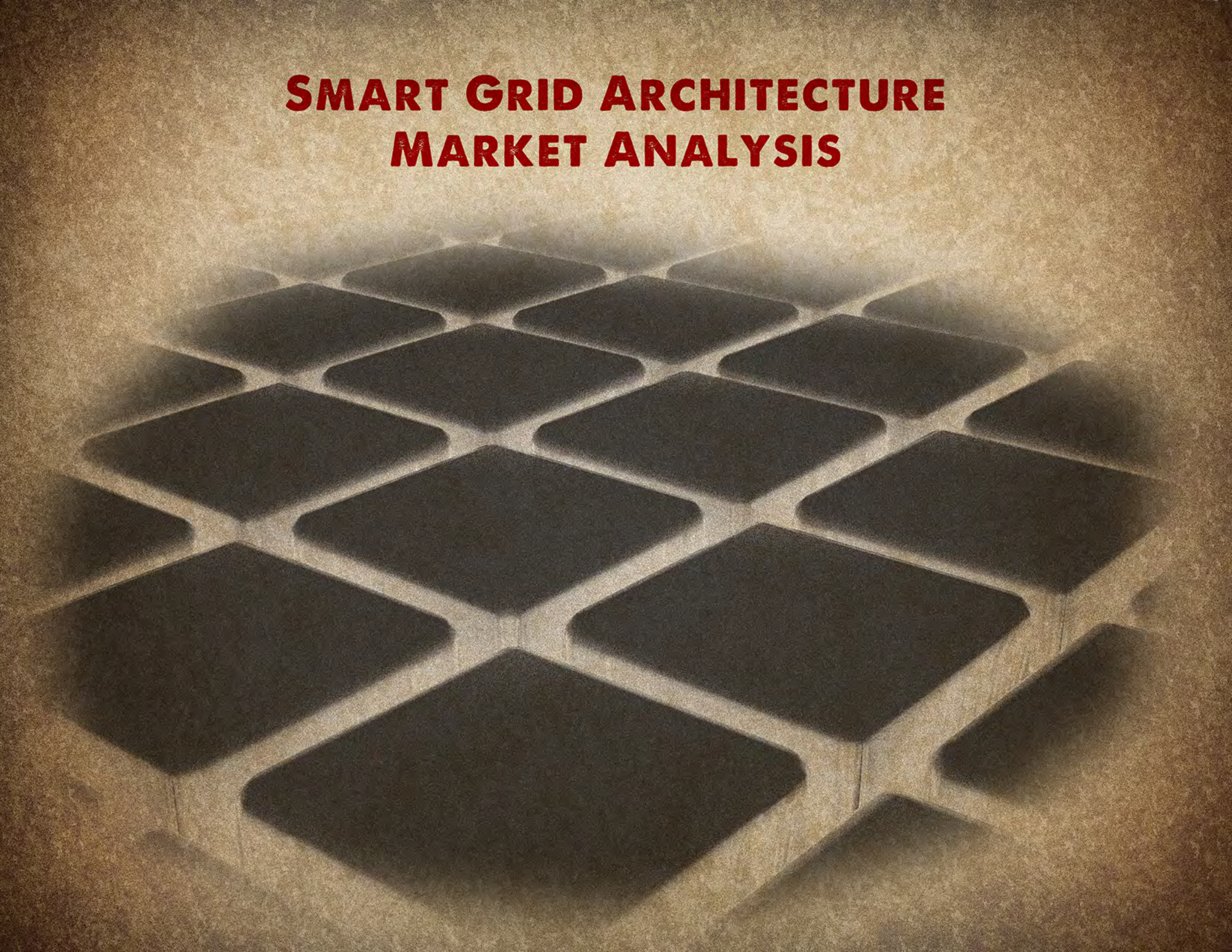
- When asked whether they would have any reservations about their utility working with a wireless carrier to expand communications capabilities, 53.1% had no reservations, 22.2% did have some reservations, and 24.7% had no opinion about this question. Among HTUs, 61.6% had no reservations about their utility working with major wireless carriers.

- Residents who said they wouldn't mind paying higher rates for electricity from renewable sources tended to be male, renters, young, and with higher incomes.

- Concern about the cost of smart meters was noted for more females (50.5% highly concerned) than males (37.2% highly concerned).

- Awareness of the Smart Grid was associated with income levels (higher income people were more aware) and belonging to the HTU group (HTUs were more aware).

Smart Grid Architecture Market Analysis



CHAPTER 2: MARKET ANALYSIS

The transition to an energy economy driven by consumers rather than power generators, petroleum producers, oil producing nations or utilities will be an incremental evolution fueled by information, devices and platforms that empower consumers to rapidly yield benefits from energy management. However, before any of these benefits can materialize, utilities must make significant investments in enterprise systems, information technology, communications access networks and smart meters before a single consumer can begin to even monitor their energy consumption on a daily basis. The nerve center of the Smart Grid is communication and access network architecture that enable real-time bi-directional information to flow across the utility value chain, but most importantly between utilities and consumers. Once this 'link' between utilities and customers is established consumers can then start to bring intelligent appliances, devices, applications and electric vehicles onto the Smart Grid platform.

If communication networks are the nerve center of the Smart Grid, then the intelligent utility of the future will need an evolutionary brain or Smart Grid Enterprise Wide Framework that can control, learn, expand and integrate all utility functions and mission critical operations, from generation to consumers. This is a formidable challenge for utilities as they have historically deployed independent proprietary systems and networks to achieve mission critical operations that did not need to communicate and integrate with one another. At the end of the day, utilities with a strong Smart Grid vision will ensure that their utility system is capable of meeting present and future demands of an evolving system, and thus establish the highest levels of satisfaction for their customers.

Smart Grid Architecture

Over the past several years, smart grid companies, networking solutions providers, and public cellular carriers have been engaged in a fierce debate over the optimal design of smart grid architecture. Stakeholders across the spectrum of the smart grid industry have placed enormous bets on the future design of smart grids, the outcome of which will have a tremendous effect not only on the profits of companies, but also on the way society consumes and pays for energy.

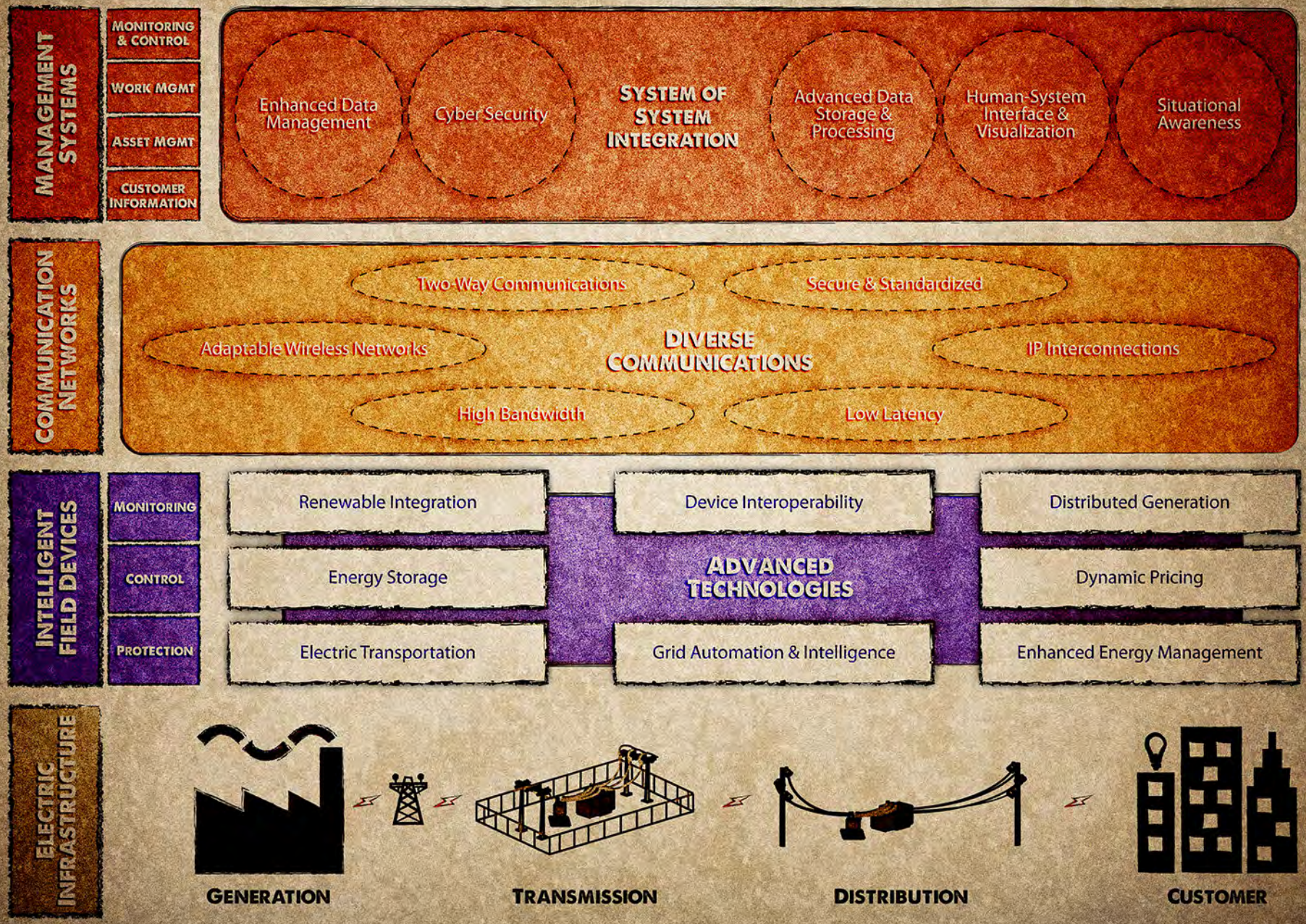
In particular, whether utilities should build private communication networks or should use public ones provided by cellular companies is one of the primary questions arising with the coming wave of smart grids. Proponents of both have cited each side's merits since the early stages of the smart grid, albeit this is just a small component of the evolving smart grid architecture universe.

Utility Enterprise and Purpose Built Systems

Integration, communication and interoperability across the entire Smart Grid ecosystem is a core tenant of the Smart Grid. However, system wide integration among the multiple business units and networks takes a back seat to more buzz worthy Smart Grid technologies such as AMI, communication networks, sensors, advanced SCADA and grid scale energy storage. This is not a surprise as utilities have historically deployed independent proprietary systems and networks to achieve mission critical operations such as GIS, SCADA, meter data management and customer service that did not have an incentive to or business need to communicate and integrate with one another. The SILO approach to utility IT architecture worked well in the past when each system only had to fulfill one specific operation or business task in a satisfactory manner. That said, utilities are promptly discovering that the move towards a modern day Smart Grid will require a unified and evolutionary IT architecture framework to fulfill the present day and future demands and tasks of the Smart Grid.

Such demands are creating strong interest among utilities for Smart Grid Enterprise Systems that have the ability to integrate and communicate with all the stakeholders in the utility value chain, among mission critical operations, ISOs, market operations, and present day and future consumer facing devices and technologies. As with many other areas of the Smart Grid, a push for well-defined standards among utilities and enterprise system and network vendors is essential to developing these types of Smart Grid enterprise systems. Further, consumer empowerment via the Smart Grid is creating new challenges for utilities as they must now account for smart appliances, distributed generation and energy storage, electric vehicles, along with more advanced applications, such as vehicle to grid (V2G) and the ability for consumers to sell their power back to the grid. These challenges are currently being taken head on by blue chip players such as SAP, Oracle, IBM, Itron, Tendril, Infosys, Accenture and Cisco who have

Overview of Utility Network Systems



Source: Visual Design by Zpryme, Visual Concept by Southern California Edison

proven solutions for utilities seeking to maximize the benefits of their Smart Grid deployment.

One Smart Grid Enterprise approach that has received strong acclaim among utilities is the System-of-Systems (SOS) Architecture advocated by K. Mani Cahndy of the California Institute of Technology and Jeff Gooding and Jeremy McDonald of Southern California Edison. Their SOS approach is described below.

> *An SOS is defined as a collaborative set of systems in which its components: 1) Fulfill valid purposes in their own right, and continue to operate to fulfill those purposes if disassembled from the overall system and 2) are managed, in part, for their own purposes rather than the purposes of the whole. The component systems are separately acquired and integrated to form a single system, yet maintain a continuous operational existence independent of the collaborative system. A consequence is that properties, which do not belong to any of the constituent parts, will emerge from the combined system-of-systems. Moreover, the system-of-systems evolves as constituent systems are replaced.*[4]

The move to Smart Grid Enterprise Systems will take 10 to 20 years to be fully deployed across the U.S., which means a business case will still remain for utility purpose built networks in the short term. Of course, purpose built networks will be more tightly integrated within the Smart Grid enterprise model, but their value will reveal itself in ad-hoc circumstances that require a proprietary approach to achieve a business function that cannot be delivered within the Smart Grid enterprise system. Of course, this is expected as the standards are yet to be defined, as consumers bring thousands of energy devices and technologies online. Last, hesitant utilities that are not fully confident that an enterprise system can meet the strict level of operational functionally and security of proprietary systems and networks will make up the bulk of the market for purpose built networks over the next five years.

[4] Smart Grid System-of-Systems Architectures, Systems Evolution to Guide Strategic Investments in Modernizing the Electric Grid, 2010 (http://www.gridwiseac.org/pdfs/forum_papers10/gooding_gi10.pdf).

Benefits of Private Networks

Utilities have cited several reasons for the superiority of private networks in smart grids. Many believe that private networks will perform more reliably and consistently over an extended period of time. While public networks have a high degree of network availability, their service degrades dramatically in times of high traffic, such as emergencies and natural disasters, when utilities need reliable communications the most. Private networks, provided by companies like Itron, Sensus, and Trilliant can be built with mesh networks that have multiple communication pathways that could prove more reliable in times of heavy traffic. Furthermore, it is critical that the physical infrastructure of a grid's communication network can withstand hurricanes, earthquakes, tornadoes, and other accidents. Utilities believe that their private infrastructure can be designed with a higher level of robustness, including having access to an emergency source of power to remain operational during outages.

Sharing a network with other forms of data raises concerns among utilities as well. Renting space on public networks will lead to bandwidth competition with calls and data, an area that will remain a priority for cellular companies. This could lead to delays and inconsistent service for the transfer of smart grid data. In addition, public networks collectively provide coverage to only about 95 percent of the United States. Utilities would have to extend coverage to the remaining five percent should they decide to use public networks. Furthermore, compared to public networks, which have latencies between 100 and 1000 milliseconds, private networks can have latencies between 10 and 100 milliseconds - a level required to meet all critical smart grid demands.

Building a private network could prove more economical for utilities over the long term as well. With control of building the infrastructure, utilities can design a network that fulfills the level of reliability and security required for smart grid applications while avoiding investments into unnecessary capabilities and technology. Over a long period of time, renting space on public networks could become more expensive than the upfront capital and maintenance costs of building a private network. Because public networks are constantly upgrading their infrastructure to meet demands for bandwidth, utilities could also face the prospect of unnecessarily upgrading their smart grid communication

infrastructure to match a public network's requirements. Even further, the regulatory framework provides incentives for building private communication networks because it provides regulated utilities opportunities to recover capital expenditures but not operating costs through rate increases.

Benefits of Public Networks

The benefits of public networks stem from avoiding the redundancy in building private networks to perform tasks for which infrastructure already exists. Already faced with the need to install smart meters, develop software, and upgrade distribution equipment, many utilities can turn to public networks to save on the capital investments required to build a private network from scratch. In addition to reducing costs, public networks could prove more economical over the long term when considering the maintenance and operational costs of private networks. The price of using public networks has fallen dramatically over the last several years and the possibility of even further price reductions exists. In 2005, utilities were paying up to five dollars per meter a month; now they can pay as little as pennies.

Proponents of public networks, such as networking solutions provider SmartSynch and cellular giants Verizon, AT&T, and Sprint, assert that concerns over bandwidth competition are overstated as well. According to a study conducted by AT&T, if every utility meter in the United States transmitted data in 15-minute intervals through its network, less than 1/500th of 1% of AT&T's network would be utilized. While communication technology in public networks may evolve more quickly than utilities can update smart grid equipment, public network providers have already pledged to accommodate older technologies in upgrades. Public networks also provide more robust security than private ones, as cellular companies annually spend billions of dollars maintaining secure networks that protect sensitive data such as financial transactions and government emails. Perhaps most importantly, using public networks will allow utilities to benefit from improvements in the speed, reliability, and availability of networking technology without making additional investments into their own infrastructure.[5]

The Future of Smart Grid Networks

As more utilities install smart meters, update grid management systems, and implement networking capabilities, the future of Smart Grid architecture is becoming clearer. While early developments indicate that one type of solution will not be optimal for or dominant among all utilities, clear winners are emerging as smart grids near actualization.

Building private networks appears to be the early choice of the majority of utilities that have begun implementing smart grid technology. Pacific Gas & Electric (PG&E) and Southern California Edison (SCE) have decided to build and rely on private networks that are designed to their meet their requirements. The importance of these utilities choosing to build private networks cannot be understated. Despite continued debate about which is more cost effective, the early use of private networks has the likelihood of spreading. Utilities are conservative organizations that avoid risk; the newness of smart grid technologies will drive most to adopt solutions that are proven in other smart grid applications. As utilities like PG&E and SCE develop private networks, their practices and chosen technologies will become increasingly attractive among the second wave of utilities implementing smart grids.

With this early lead, private network solutions providers, such as Itron, Sensus, and Trilliant will be able to lower costs and sharpen their technological offerings. Private networking solutions providers have the additional benefit of emerging global smart grid markets that do not have widely available, reliable public networks. The scale of demand for their services abroad will allow them to compete on costs with public network providers. Perhaps most importantly, without regulatory changes, it makes more economic sense for utilities to build private networks even if it may not make economic sense for the entirety of the power sector. While it is true that public network providers could lobby regulators to allow utilities to categorize the use of public networks as capital expenditures, any possible changes are far into the future. Even if public network providers succeed in doing this, the slow capital expenditure cycles of utilities will prevent rapid changes that take advantage of new regulatory structures. Low interest rates over the foreseeable future further encourage capital expenditures by utilities.

[5] Chartwell, Inc.

Despite these advantages, public networks are nowhere near being eliminated from smart grid applications. Many utilities, like Duke Energy, have decided to implement a hybrid solution that relies on public networks to backstop private ones or uses them where coverage is serviceable while building out private networks where necessary. More importantly, public networks will prove to be a better choice for utilities in the long term. While uncertainty about their dependability and robustness currently exists, public network providers will have the opportunity to demonstrate their reliability and improve their offerings over the coming years. Seeing public networks perform in their engagements will alleviate concerns about control that many utilities currently express. The performance of public networks will prove to be superior to that of private networks over the long term as well. As people increasingly rely on mobile communication networks, public network providers will aggressively compete with each other and invest in expanding coverage, improving reliability, and addressing concerns about survivability. As smart grid technology becomes more commonplace, public network providers can focus on improving the functionality of their networks to meet the requirements of utilities. As communication technologies improve, a series of functionalities should be made available that will be more easily incorporated by public networks than private. These improvements will greatly outpace any upgrades that utilities could possibly implement in private networks.

The next round of expenditures by utilities to upgrade smart grid technology could be less encouraging for building or enhancing private networks. Regulatory changes governing capital expenditures aside, interest rate levels are currently at a historical low, and government actions have encouraged utilities to invest in smart grid technology. With the next round of smart grid investments, the level of sophistication that public network will offer will be difficult for utilities to match. The costs of transitioning from the primary use of private networks to public ones will not be prohibitively high. Smart meters already have the functionality to accommodate both private and public networks. Undeniably, one of the primary benefits of public networks is the low level of investments they require to implement. Without high barriers to implementing public networks, once public networks become economical and robust enough to meet technical requirements, utilities will eventually see their use as the rational choice for smart grid networking solutions.

The risks associated with ceding control to public networks are often cited as the main reason for utilities to build private networks. But private networks are not without risks. Public networks provide a networking platform that offers flexibility and adaptability without sacrificing significant resources to maintain and operate them. Over the long run, as smart grid architecture evolves and improves, public networks have a fighting chance to emerge as the more sustainable option.

Evolving Smart Grid Architecture

The debate over private and public networks is one topic in a wide range of questions that have emerged regarding the future of smart grid architecture. Many of these questions can be traced to the issue of standardization, particularly whether the interoperability of different smart grid technologies and systems will be governed through proprietary solutions or open source platforms. As smart grid companies and networking solutions providers settle into disparate standardization camps, utilities have an array of options for their smart grid applications. Over the next several years, the race to implement standards across the smart grid ecosystem will be the primary determinant of the smart grid's architecture.

Jockeying for an advantage, smart grid stakeholders have formed multiple alliances that span the entire ecosystem of the smart grid, attempting to preempt the wide application of smart grid technology by asserting standards that favor their own offerings. For example, The SAP Lighthouse Council works to develop industry-wide standards and processes to address AMI integration from the meter through the back office. The council is composed of a number of leading utility companies such as Southern California Edison. In September 2010, Cisco and Itron formed an alliance to develop a standard for smart grid communications based on IPv6. In this partnership, Itron embedded Cisco's technology in its smart meters and also included Cisco's networking equipment and software as part of its effective smart meter package. Just this past April, BC Hydro selected Itron as the supplier of approximately two million new electric meters over the next two years as part of its Smart Metering Program. The Smart Metering Program will keep rates lower than they would have otherwise been in British Columbia through savings of about $70 million in the first three years of implementation and a net benefit to customers of over $500 million

in the long term. It's the first, multi-million meter commitment to the Itron-Cisco architecture by a major utility who is pursuing a very broad and progressive smart grid vision.

The ZigBee Alliance has attempted to take an early lead in the standardization of communication within future Home Area Networks by enlisting companies that range from smart meter manufacturers like Landis+Gyr and smart appliance manufacturers like LG. These are just a couple of examples of a large number of alliances that are attempting to standardize smart grid technology. Simultaneously, The National Institute of Standards and Technology (NIST) drafted a series of broad industry standards that have coincided with this explosion of smart grid offerings. As these standards solidify, the architecture of the Smart Grid will become more defined.

While the outcome of the standards race is uncertain, proprietary technology has emerged as the preferred choice by utilities. Utilities like PG&E and Florida Power and Light (FPL) have enlisted several companies which uses radio frequency (RF) mesh to provide a proprietary networking solution. However, this early success will not necessarily lead to their long-term domination. Utilities will not want to invest in infrastructure that is incompatible with future smart grid technologies or need to be constantly replaced and updated. As open source standards emerge, utilities will eventually move to implement them in their smart grid technology, particularly when the interoperability of intra-utility grids becomes an imperative. Proprietary networks will not necessarily be unable to operate between power grids, but the use of open source networking will prove simpler and more cost-effective. In addition, open source platforms will spark competition and innovation, leading to more economical solutions and higher performance.

In many ways, the debate over smart grid standards mirrors that of private and public networks. Both have tremendous consequences for the future prospects of smart grid companies and networking solutions providers. Both have uncertain outcomes where utilities appear to be initially choosing control over accessibility. Both will ultimately favor solutions that leverage developments in technology and interoperability. While the exact design of smart grid architecture is still unknown, both debates will have enormous consequences for the future of energy within the United States.

As previously discussed, there are significant challenges for utilities and vendors that must be overcome in developing the Smart Grid of the future. These challenges are creating strong opportunities for major industry players that offer winning enterprise system and communication products, services and solutions. Market leadership in the U.S. is a prized possession as vendors will then be able to take their products and services to the global utility market in a much more dominating fashion. The fierce competition in the industry is healthy overall as it will lead to innovation, decreasing costs for utilities and consumers.

The short term outlook, from 2011 to 2015 for Smart Grid enterprise systems and communication networks will be strong overall, but the communications market will grow more rapidly as utilities have been making strides on their enterprise system investments over the last 10 years.

U.S. Enterprise and Purpose-Built System/Network Market Value

The U.S. market value for utility enterprise and purpose-built systems and networks for mission-critical operations is projected to grow from $4.2 billion in 2010 to $6.5 billion in 2015. The compound annual growth rate (CAGR) from 2010 to 2015 is projected to be 9.2 percent.[6]

U.S. Enterprise and Purpose Build System/Network Market Value
(Mission Critical Operations) 2010 to 2015 (in U.S. billions)

Segment	2010	2011	2012	2013	2014	2015	CAGR
Enterprise	$3.2	$3.6	$4.0	$4.4	$4.8	$5.1	10.0%
Purpose Built	$1.01	$1.06	$1.14	$1.23	$1.31	$1.37	6.4%
Total Market Value	**$4.2**	**$4.7**	**$5.2**	**$5.6**	**$6.1**	**$6.5**	**9.2%**

- In 2010, enterprise systems and networks for mission-critical operations accounted for 76.0 percent ($3.2 billion) of the

[6] Purpose-Built Systems: Systems and networks that are designed to serve or execute a particular business function or operation. Typically, these systems are based on custom software or hardware that requires separate or proprietary computing models or architecture to add services. The use of such systems are often added and operated independently of the overall enterprise system in an organization. In most cases, businesses or organizations will implement such proprietary purpose-built systems when their enterprise system does not support the functionality or business performance desired from the purpose-built system.

market while purpose-built systems and networks accounted for 24.0 percent ($1.0 billion) of the market. In 2015, enterprise systems and networks for mission-critical operations are projected to account for 78.9 percent ($5.1 billion) of the market value while purpose-built systems and networks are projected to account for 21.1 percent ($1.4 billion) of the market.

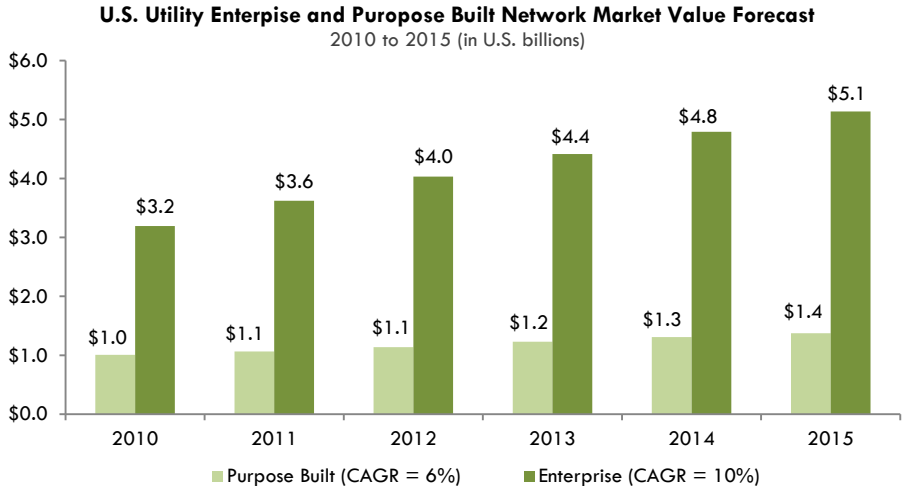


Figure 34, Source: Zpryme

- The enterprise market is projected to grow by 10.0 percent annually while the purpose-built market is projected to grow by only 6.4 annually percent during this time period.

U.S. Smart Grid Communication Network Market Value

The market value for smart grid communication access networks in the U.S. are projected to grow from $734.6 million in 2010 to $1.6 billion in 2015. The compound annual growth rate (CAGR) from 2010 to 2015 is projected to be 16.7 percent.

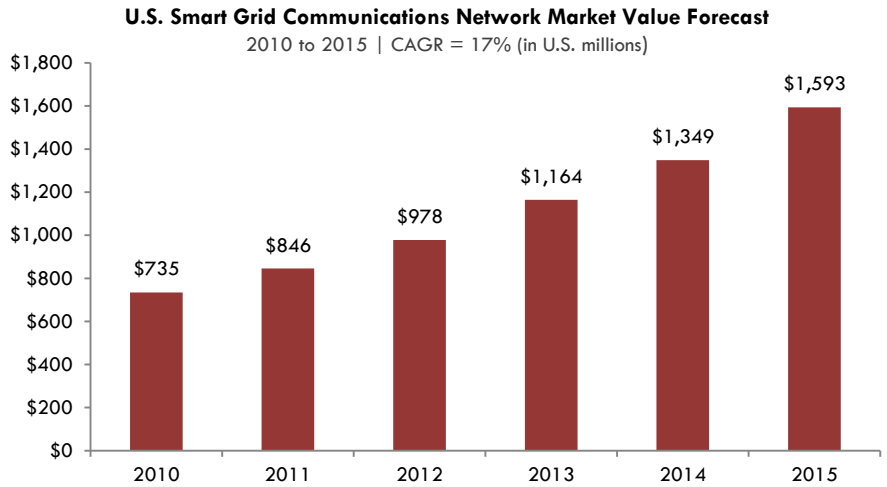


Figure 35, Source: Zpryme

- In 2010, wired networks accounted for 65.0 percent ($477.5 million) of the total communication network value, while wireless networks accounted for 35.0 percent ($257.1 million) of the market. In 2015, wired networks are projected to account for 48.0 percent ($764.8 million) of the total communication network value while wireless networks are projected to account for 52.0 percent ($828.5 million) of the market.

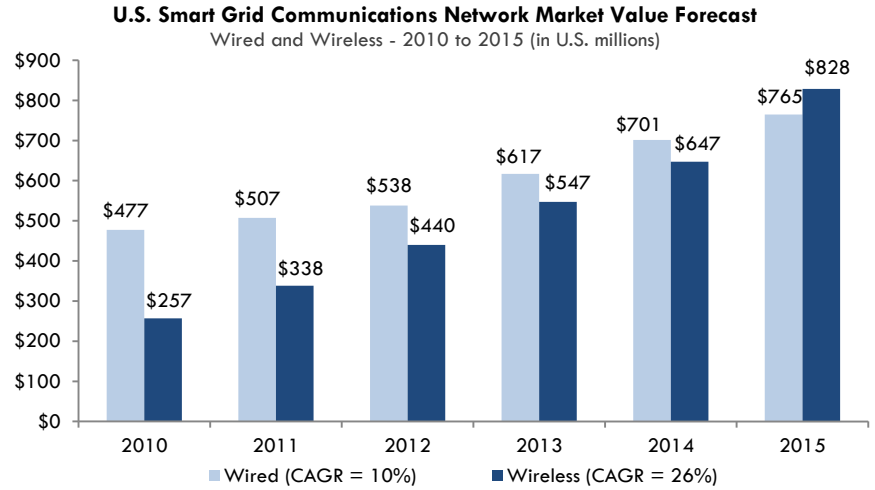


Figure 36, Source: Zpryme

- Within the wireless network segment, the market value for public networks reached $64.3 million in 2010. However, the wireless public network market is projected to achieve revenues of $333.4 million by 2015. This represents an impressive CAGR of 38.8 percent during this time period.

U.S. Smart Grid Wireless Communications Network Market Value Forecast
Public and Private - 2010 to 2015 (in U.S. millions)

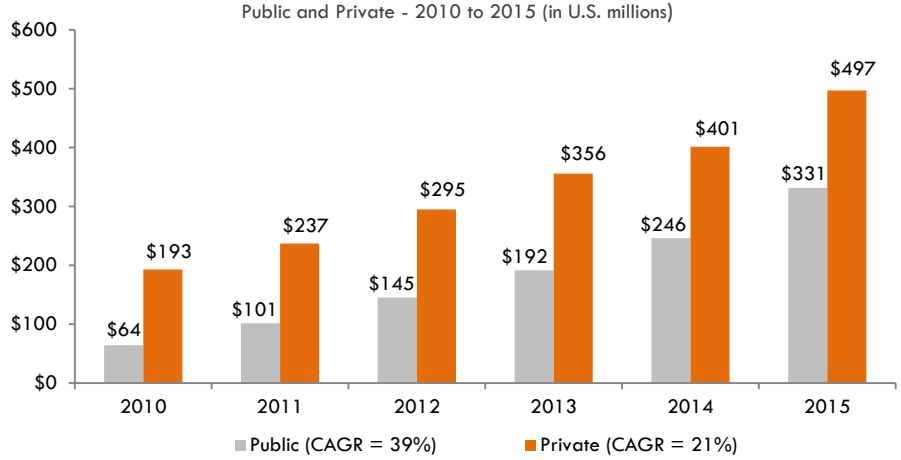


Figure 37, Source: Zpryme

- In 2010, spending on wired and wireless Backhaul, WAN, NAN and HAN parts of the network were expected to reach $124.9 million, $198.3 million, $242.4 million and $169.0 million, respectively. In 2015, these figures are projected to reach $215.1 million, $366.4 million, $390.3 million and $621.4 million, respectively. Among these four network segments, growth will be the highest among home area networks, growing by 29.8 percent a year during this time period.

U.S. Smart Grid Communication Network Market Value
2010 to 2015 (in U.S. millions)

Segment	2010	2011	2012	2013	2014	2015	CAGR
Wired	$477	$507	$538	$617	$701	$765	10%
Wireless							
Public	$64	$101	$145	$192	$246	$331	39%
Private	$193	$237	$295	$356	$401	$497	21%
Total Market Value	**$735**	**$846**	**$978**	**$1,164**	**$1,349**	**$1,593**	**17%**
Network Segmentation							
Backhaul	$125	$135	$147	$163	$189	$215	11%
WAN	$198	$228	$254	$291	$337	$366	13%
NAN	$242	$254	$284	$338	$337	$390	10%
HAN	$169	$228	$293	$373	$485	$621	30%
Total Market Value	**$735**	**$846**	**$978**	**$1,164**	**$1,349**	**$1,593**	**17%**

Figure 38, Source: Zpryme

U.S. Smart Grid Utility Network Segmentation by Type
2011 and 2015 (% of total market value)

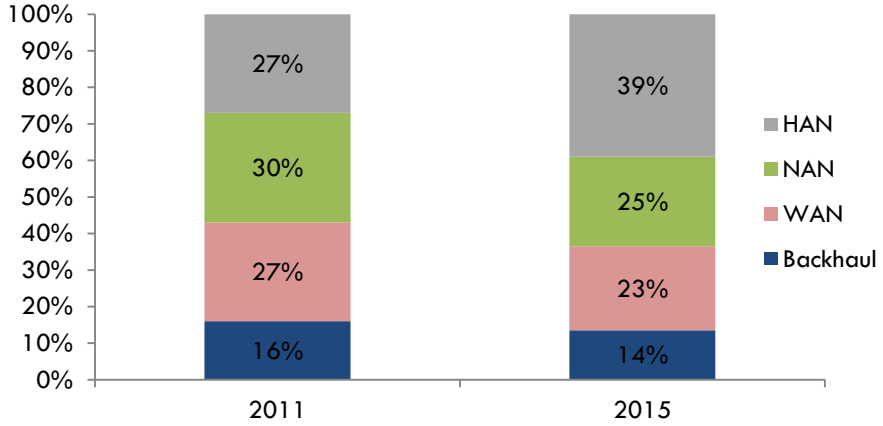


Figure 39, Source: Zpryme

ITRON Q&A

CHAPTER 3: ITRON Q&A

Itron Respondent: Tom Wilson, Senior Product Manager (Smart Grid Solutions)

1. Why are advanced utility networks essential in the development of the smart grid?

As the utility industry moves toward its most significant transformation in 100 years, it is imperative utilities have an open, standards-based infrastructure to support emerging technologies today and into the future, while maintaining a reliable, affordable supply of power in the face of growing energy demand, higher costs and environmental challenges. Evolving the aging power grid into an intelligent and efficient system will not occur overnight; rather it will progress over time. Having a flexible, multi-application network infrastructure that can grow and expand to support and integrate new applications and devices over a number of years is essential to the long-term success of the smart grid. To support the broad range of requirements envisioned for the smart grid, these networks must be secure, scalable, affordable, and provide the same level of interoperability that enables a new desktop computer or printer to be easily added to an enterprise IT network.

Through its alliance with Cisco, Itron is delivering an end-to-end solution to provide the pathway from advanced metering to the smart grid of the future. OpenWay®, powered by Cisco, is a standards-based architecture that enables true interoperability among devices and applications. It provides an Internet Protocol (IP)-based platform that will reduce utilities' total cost of ownership and enable real-time, pervasive monitoring and control for grid operators and consumers.

2. How will consumers benefit from utility investments in next generation grid architecture?

The smart grid provides the platform to bring unprecedented awareness and control to consumers, enabling them to monitor their usage and shift behaviors to save money on their monthly bills, as well as contribute to conserving precious resources. Smart meters and the two-way communication network are at the heart of the smart grid, forming the foundation for more informed and empowered consumers. These new, engaged consumers can opt to participate in special utility programs or even "automate" their choices based on their preferences through in-home tools like smart thermostats and web portals to lower their costs. A utility's investment in smart grid architecture not only helps the utility provide more reliable service and improve operational efficiencies, it provides a platform for future consumer-benefitting applications, including electric vehicle charging, integration of renewable and distributed energy resources, as well as community-based generation.

3. How is Itron facilitating the development of utility networks?

Itron, working closely with Cisco, is bringing the first truly interoperable, multi-purpose IPv6 network architecture to market. In recent years, IP has proven capable of supporting new applications as they are developed, as well as evolving to meet changing networking needs without altering the core design of IP. As a utility grows, an open, standards-based network must be able to support an expanding array of network devices and applications while also providing standardized network operations, quality of service and security. This means building a network architecture with full IPv6 services throughout the entire network stack, not just a partial or proprietary "IP addressing" scheme. Plus, as utilities incorporate smart technology, they must be able to do so in incremental steps, without a fear of stranding assets along the way. The Itron/Cisco IP architecture, which both companies plan to make available to third parties in the form of a reference architecture, provides the flexibility to adopt new applications or increase the number of networked devices without impacting the reliability of the data transport.

4. How has partnering with companies such as Cisco shaped the way Itron delivers smart grid solutions to utilities?

When looking at ways to creatively address the increasingly complex challenges facing the utility industry—from growing demand and the cost of generation to revenue assurance and theft detection—it is clear that collaboration will be key. The smart grid is bigger than any one company or any one technology. In order to support wide-spread cooperation with some of the world's leading technology partners, Itron has always been a proponent of open

standards and interoperability. To turn this vision into a reality, Itron is teaming up with Cisco to deliver a unified, enterprise-class network architecture that is secure, simple to deploy and manage, and is extensible to multiple utility applications. This strategic alliance brings the world's leading smart metering and networking communications suppliers together to deliver the definitive 21st century IP-based communications and control platform for the smart grid market.

5. What are one or two of the core challenges in developing or building (public or private) network infrastructure for utilities?

Today, a critical challenge facing the utility industry is the ability to merge a robust data communications platform with the power grid. The challenge is two-part: making the grid more "network-aware"; and making the network more "grid-aware." Such a union will afford utilities the opportunity to make informed, real-time or near real-time decisions, collect and analyze data about assets on the grid, and engage consumers to create a culture of conservation. The typical metering-centric, purpose-built network will not support achieving this broader smart grid vision. What is needed is a communications architecture that will support multiple applications and ultimately connect millions of devices and nodes that go far beyond just smart meters. These include distribution automation devices and sensors, distributed resources, electric vehicles, smart appliances and other technologies that proliferate into the market.

In response to the multi-purpose smart grid challenge, Itron has taken the lead in understanding how to build a viable architecture that takes advantage of open standards as well as both public and private network architectures to lower the total cost of ownership for utilities, while meeting current business case requirements and positioning utilities for the future. Our goal is to deliver an integrated platform with embedded intelligence that supports dynamic grid operations in order to help utilities manage energy delivery more efficiently and empower consumers.

Open the Grid

Itron is dedicated to delivering end-to-end smart grid and smart distribution solutions to electric, gas and water utilities around the globe. Our company is the world's leading provider of smart metering, data collection and utility software systems, with nearly 8,000 utilities worldwide relying on our technology to optimize the delivery and use of energy and water. Our offerings include electricity, gas, water and heat meters; network communication technology; collection systems and related software applications; and professional services.

Our industry is in the midst of unprecedented change, with utilities beginning to migrate from advanced metering infrastructures to the broader applications of a smart grid. With this comes the need to understand how the underlying network and solution architecture must change to support not only advanced metering requirements but comprehensive smart grid applications and objectives.

Forward-thinking utilities are seeking a smart grid communications architecture that will utilize standardized network management tools, support multiple applications and ultimately connect millions of devices that go far beyond just smart meters. Equally important, utilities are asking for an architecture that will enable them to run multiple applications atop a common, secure, enterprise-class network infrastructure instead of through a meter-centric AMI head-end. Just as Ethernet enables interoperability of devices and applications in an IT network, smart grid architecture must do the same.

To make this advanced network a reality, Itron is collaborating with Cisco to design a unified, enterprise-class network architecture that is secure, simple to deploy and manage, and is extensible to multiple utility applications. This strategic alliance brings the world's leading smart metering and networking communications suppliers together to deliver the definitive 21st century Internet Protocol (IP)-based communications and control platform for the smart grid market.

Our goal is to "open the grid" by employing industry standards and seamlessly connecting any smart device or application within the network to transform the electric grid from proprietary and closed to open and flexible. This openness will ultimately improve the overall economics and business case for far-reaching smart grid implementations by reducing utilities' total cost of ownership and providing a highly adaptable and secure platform that enables real-time and pervasive monitoring and control for grid operators and consumers.

It is time for AMI architecture to become smart grid architecture. Itron and our partners are well on our way to making this vision a reality for the entire industry in 2011.

RETHINK RESEARCH

Intelligent Research for an Intelligent Market

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