

**POLICY RECOMMENDATIONS TO REALIZE THE OBJECTIVE
OF THE FUTURE ELECTRIC GRID**

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Presented to
The Academic Faculty

by

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**POLICY RECOMMENDATIONS TO REALIZE THE OBJECTIVE
OF THE FUTURE ELECTRIC GRID**

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LIST OF ABBREVIATIONS

<u>Acronym</u>	<u>Full Name</u>
AARP	AARP, National Consumer Law Center, and Public Citizen
ABB	ABB
AGA	American Gas Association
AHAM	Association of Home Appliance Manufacturers
Alliance	Alliance to Save Energy
Ambient	Ambient Corporation
AMI	Advanced Metering Infrastructure
AMR	Automatic Meter Reading
APGA	American Public Gas Association
APPA	American Public Power Association
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers Inc.
ATSP	Appliance, Technology and Service Provider
AT&T	AT&T
BG&E	Baltimore Gas and Electric Company
Brown	Browning, Stephen
C&I	Commercial and Industrial
CBA	Cost Benefit Analysis
CDT	Center for Democracy and Technology / Electronic Frontier Foundation
CEA	Consumer Electronics Association
Center	CenterPoint Energy

Cisco	Cisco Systems
Current	CURRENT Group
Dairy	Dairyland Power Cooperative
DC	District of Columbia Office of the People’s Counsel
DG	Distributed Generation
Divan	Divan, Deepak, Professor, Georgia Institute of Technology
DOE	Department of Energy
DRSG	Demand Response and Smart Grid Coalition
EEI	Edison Electric Institute
eMeter	eMeter Strategic Consulting
EnerNOC	EnerNOC
EPRI	Electric Power Research Institute
EV	Electric Vehicle
FERC	Federal Energy Regulatory Commission
FIP	Fair Information Practices
FPL	Florida Power & Light Company
Galvin	Galvin Electricity Initiative
Gridwise	GridWise Alliance
Grijalva	Grijalva, Santiago, Associate Professor, Georgia Institute of Technology
Honeywell	Honeywell, Inc
Ingersoll	Ingersoll Rand
ISO	Independent System Operator
kWh	Kilowatt-hour

MBTF	Mean Time Between Failures
Michigan	Michigan Public Service Commission Staff
MW	Megawatts
NAF	New America Foundation
NAP	NAP Coalition
NARUC	National Association of Regulatory Utility Commissioners
NASUCA	National Association of State Utility Consumer Advocates
National	National Grid
NEMA	National Electrical Manufacturers Association
NERC	The North American Electric Reliability Corporation's
NESC	National Electric Safety Code
NESCO	National Electric Security Cyber-Security Organization
NIST	National Institute of Standards and Technology
NRC	US Nuclear Regulatory Commission
NRECA	National Rural Electric Cooperative Association
NY ISO	New York Independent System Operator, Inc.
NYSGC	New York State Smart Grid Consortium
OGD	Okaloosa Gas District
Ohio	Ohio Consumers' Counsel
Opower	OPOWER
Oregon	Oregon Public Utility Commission
OSHA	Occupational Safety and Health Administration
Pen	Energy Services of Pensacola

Pepco	Pepco Holdings, Inc.
Power	Power North America
Progress	Progress Energy
PUC	Public Utility Commission
R&D	Research and Development
RedSeal	RedSeal Systems
RFI	Request for Information
RTO	Regional Transmission Operator
Satcon	Satcon Technology Corporation
SGCC	Smart Grid Consumer Collaborative
SGIC	Smart Grid Information Clearinghouse
SGIP	Smart Grid Interoperability Panel
Southern	Southern Company Services
Spring	City Utilities of Springfield Missouri
Steffes	Steffes Corporation
TDU	Transmission and Distribution Utility
TEEM	Toward Energy Efficient Municipalities, LLC
TekTrakk	TekTrakker Information Systems
er	
Tendril	Tendril Networks, Inc
TIA	Telecommunications Industry Association
Toshiba	Toshiba International
UTC	Utilities Telecom Council

Verizon Verizon/Verizon Wireless

SUMMARY

The Energy Independence and Security Act of 2007 established that the current electric grid was inadequate to serve the United States needs. Congress mandated that the U.S. transition to a more intelligent grid for the future. The Department of Energy was tasked with making this goal a reality.

Six years later in 2013, only marginal progress has been made. Outside of smart meter rollouts and pilots programs funded through the American Recovery and Reinvestment Act of 2009 (ARRA), many issues still need to be addressed in order to realize the U.S. Smart Grid vision. Most of the barriers to progress are not technological; the research and business community are rising to the occasion and meeting the challenge through innovation. However, policy issues present a large barrier to overcome. With issues ranging from vague Smart Grids goals issued by the Department of Energy to a general lack of consumer knowledge about the Smart Grid.

This paper seeks to identify the gaps in the current electric grid and policy schema are inadequate and suggest recommendations to encourage and expedite the growth of the U.S. Smart Grid.

I. INTRODUCTION

This thesis sets forth the findings of the author in studying the Department of Energy's Request for Information in September of 2010 entitled "Addressing Policy and Logistical Challenges to Smart Grid Implementation". The purpose of the RFI and this thesis is to identify policies needed to assist the growth of the Smart Grid in the United States. To form the seven recommendations the author reviewed comments from all stakeholders in the RFI and outside literature. This thesis does not make recommendations on issues related to data access, data privacy, or communications requirements of the Smart Grid because those issues are being addressed by other efforts by the DOE.

Overview of Smart Grid

Why is the Smart Grid necessary? The current electric grid has been in existence since the beginning of the industrial age. It has been effective in servicing the needs of Americans. The electric grid has powered industries, electrified homes and businesses, enabled the electronic revolution, and raised the standard of living; it is a technological marvel and a political miracle. According to the National Academy of Engineering, electrification was named the greatest engineering achievement of the 20th century. If the current electric grid has been so great, then why is there a need for sweeping updates? The answer is simple. The current electric grid has reached its physical and architectural limits. The current industry organization exhibits qualities of public value failure and market failure that must be addressed.

Physical Reality

An invention established over 100 years ago cannot be expected to service the needs of the American people for another 100 years without significant updates. With the growth of the nation, new functionality from the grid is needed. Over the years, some of these new functions have been accommodated by incrementally adding patches to the grid. Small adjustments and modifications have allowed the grid to stretch its usability into the 21st century. However, at some point, it can stretch no further. No more patches can be added. The electric grid has to be re-evaluated and re-invented; thus, the need of the Smart Grid.

The current electric grid operates on a centralized control architecture which was established during the 1960's. This control architecture meets the need for a one way power flow system where utilities deliver power directly to consumers, supporting a generation, transmission, delivery paradigm. However, a centralized one-way architecture won't accommodate two way power that is beginning to be demanded by consumers. With the rise in DG and consumers wanting to "go-green" by adding generation sources to their personal residences a centralized architecture is truly inefficient. The new grid needs to be a distributed consumer friendly architecture [1].

Public Value Failure

“Public [value] failure occurs when core public values are not reflected in social relations, either in the market or in public policy [2].” Bozeman separates public value failure into seven unique categories;

- (1) mechanisms for articulating and aggregating values
- (2) imperfect monopolies
- (3) benefit hoarding
- (4) scarcity of providers
- (5) short time horizon
- (6) substitutability vs. conservation of resources and
- (7) threats to subsistence and human dignity

The current electric grid exhibits two of them; mechanisms for articulating and aggregating values and benefit hoarding. Recently, there has been increasing public concern over the environment and climate change. The importance of environmental stewardship is not widely accounted for in the current electric grid, and this represents a public value failure. The future electric grid needs a way to incorporate environmental stewardship into its market evaluations so that the value of environmentalism is an active electricity cost factor.

The second public value failure present in the current electric grid is benefit hoarding. When the current electric grid was set up, it was established as a natural

monopoly. Electricity providers were regulated by public utility commissions who allowed them to charge certain rates and receive a guaranteed margin of return. Initially, this guaranteed a certain quality of service and gave entrepreneurs incentive to participate in the industry. Now, it is a hindrance. Many utilities prefer the status quo, effectively impeding changes in the current electric grid structure to avoid losing a guaranteed margin of return which could be a potential liability for their business. They want to hoard the benefit of guaranteed returns not necessarily doing what is “best” for the American public according to the emerging energy-related requirements.

The Smart Grid can alleviate some of these problems. An updated architecture and infrastructure can make integrating renewable energy easier. In addition, new market mechanisms can level the playing field and give all forms of generation equal consideration in markets. The increased choices and freedom the Smart Grid will provide also hedges against the constraints of utility monopolies.

Market Failure

A market failure occurs when the free market fails to efficiently allocate goods and services. Generally it is broken down into seven unique categories;

- (1) externalities
- (2) imperfect information
- (3) bounded rationality
- (4) public goods

(5) monopolies

(6) excludability and

(7) transaction costs

Four of these categories; monopolies, externalities, imperfect information and bounded rationality; apply to and plague the current electric grid.

Monopolies represent one of the most poignant market failures in the current electric grid. Although many states or regions have been deregulated, many of the nation's electricity providers still operate under the original monopoly structure. Monopolies lead to imperfect competition. Deregulating the electricity market will let the market drive prices to their optimal values and bring about market efficiency.

As far as externalities are concerned, a lack of environmental stewardship also represents an inefficiency of the current electric grid [3]. In a perfect market, all costs and benefits are considered. In the current electric market, the cost of greenhouse gas emissions and pollution are not accounted for. In order to, know the true cost of electricity that would produce optimal consumption, these elements have to be factored in.

The last two factors of market failure work hand in hand. Electricity consumers are not educated about energy use. Perhaps industrial and large commercial scale consumers are knowledgeable but the average commercial or residential electricity consumer is not educated about energy use. This leads to imperfect information because the electricity provider is very educated on energy use and how much energy each

customer class uses. This lack of education for the consumer leads to bounded rationality. Consumers make decisions based on imperfect information which leads to sub-optimal energy consumption. Also, a lack of knowledge about energy conservation results in repeated inefficient energy decisions. The Smart Grid can alleviate these market inefficiencies by providing the consumer with more information and applications to act upon on that information. For example, daily reports of their energy use or a home energy management system that works to optimize daily energy use based on data from previous days.

It should be noted that the Smart Grid will not be a completely new, from the ground up invention. The current electric grid will serve as its backbone. Existing transmission lines, generators, distribution centers and other aspects will be folded into the new Smart Grid and where the current electricity grid is lacking the Smart Grid has potential to add functionality. The Smart Grid has potential to add functionality through two-way communication, improved operation centers and increased distribution intelligence [4].

Overview of Request for Information

In May of 2010 the DOE issue a Request for Information (RFI) related to the Smart Grid. The first RFI, released on May 11, 2010, sought comment on data access, third party usage of data, and privacy concerns. There were a total of 38 commentators' for the RFI. The second RFI, also released on May 11th, focused on the communication requirements of the Smart Grid and electric utilities. There were a total of 49 responders

to that RFI. In October of 2010, following the end of the commentary period, the DOE published two reports summarizing the public comments related to the first two RFI's. The third RFI was released in September of 2010 and sought comment on policy and logistical challenges to Smart Grid implementation. There were a total of 63 commentators on the third RFI. After the end of the commentary period of the third RFI, the DOE did not issue a report summarizing their findings. The purpose of this paper is to serve as the summary report of the third RFI and make policy recommendations moving forward. The third RFI sought to gain understanding of the following eight unique categories.

1. Definition and Scope

This section was dedicated to determining the best way to define the Smart Grid. The DOE inquired if the definition defined in Title XIII of the Energy Independence and Security Act of 2007 was sufficient to define the Smart Grid.

2. Interactions with and Implications for Consumers

This section was primarily focused on residential and small business consumers. It concentrated on the major issues related to consumers, the best way to motivate consumers to be active participants in the Smart Grid, and how consumers should be educated. There was also a lot of discussion about how consumers will respond to various pricing programs or direct load control.

3. *Interaction with Large Commercial and Industrial Customers*

This section focused on large commercial and industrial customers. They are already highly involved, educated, and proactive about their energy use. The DOE inquired, going forward, what are the benefits from and challenges to implementing the Smart Grid with this class of customers

4. *Assessing and Allocating Costs and Benefits*

This section focused on the financial considerations of the Smart Grid. How should the benefits of the Smart Grid be quantified? When will the costs and benefits of the Smart Grid be realized? There was also discussion on some of the pricing programs that are available to consumers using the Smart Grid.

5. *Utilities, Device Manufacturers, and Energy Management Firms*

This section sought out the opinion of utilities, device manufacturers, and energy management firms on specific issues. For example, how should the federal government and states work together to handle new issues related to the Smart Grid? Are there any policy changes these stakeholders feel are necessary for their stakeholder group?

6. *Long Term Issues: Managing a Grid with a High Penetration of New Technologies*

This section sought potential solutions to determine what is the best way to integrate renewable sources, electric vehicles, and legacy equipment. As the future progresses

and new technologies become available, what is the best way to make the future electric grid flexible?

7. *Reliability and Cyber Security*

This section was concerned with how to ensure the future reliability of the grid and combat cyber security issues. What role should federal, state, and local governments have in assuring that cyber security is maintained? What new technologies will become available to increase reliability and improve cyber security?

8. *Managing Transitions and Overall Questions*

This section focused on the best way to transition from the current electric grid to the Smart Grid? How should legacy equipment be handled and how soon should utilities upgrade?

II. DISCUSSION OF STAKEHOLDERS

Appliance, Technology, and Service Providers (ATSP)

This stakeholder group is comprised of grid hardware providers, telecommunication service providers, home appliance producers, and companies that provide technological services to utilities and customers. In some instances, an entire industry was represented by their trade group instead of individual companies. The ATSP stakeholder group is very optimistic about the Smart Grid because its success could generate an entirely new industry from which their businesses can profit. Their main concerns were access to data, interoperability standards, pricing signals and appropriate cost allocation. The ATSP stakeholder group had a lot to say about allowing access to valuable meter data from consumers so that they can offer new goods and services. They were also concerned with open communication standards so that new goods and services can easily be interchanged and used anywhere in the US. They expressed that independent standards for each individual state could make doing business across state lines difficult and discourage investment. Pricing signals were another major discussion point for the ATSP group. They expressed that proper signals would do a lot to motivate consumers to make wise energy choices. The last major issue for the ATSP group was proper cost allocation. They expressed that Smart Grid technology should be evaluated like all other investments and that whoever takes risk should receive benefits with regards to Smart Grid investments.

Table 1: Appliance, Technology, and Service Provider Commenters

Appliance, Technology, and Service Providers	Abbreviation
ABB	ABB
Ambient Corporation	Ambient
American Society of Heating, Refrigerating and Air-Conditioning Engineers Inc.	ASHRAE
Association of Home Appliance Manufacturers	AHAM
AT&T	ATT
Cisco Systems	Cisco
Consumer Electronics Association	CEA
CURRENT Group	Current
Demand Response and Smart Grid Coalition	DRSG
eMeter Strategic Consulting	eMeter
EnerNOC	EnerNOC
Honeywell, Inc	Honeywell
Ingersoll Rand	Ingersoll
National Electrical Manufacturers Association	NEMA
OPOWER	Opower
RedSeal Systems	RedSeal
Satcon Technology Corporation	Satcon
Steffes Corporation	Steffes
TekTrakker Information Systems	TekTrakker

Appliance, Technology, and Service Providers	Abbreviation
Telecommunications Industry Association	TIA
Tendril Networks, Inc	Tendril
Toshiba International	Toshiba
Toward Energy Efficient Municipalities, LLC	TEEM
Utilities Telecom Council	UTC
Verizon/Verizon Wireless	Verizon

Consumer Protection Groups

This stakeholder group consists of organizations that exist to fight and protect consumer rights. They are predominantly concerned with Smart Grid security issues and costs. The Smart Grid has the potential to allow every watt of power used in a consumer's household to be monitored or recorded which presents security and privacy issues. This group wants to ensure all measures are being taken to guarantee the safekeeping of all private data. They were also concerned with consumer bill rights. They wanted to ensure that remote disconnection and prepay energy service do not cause harm to consumers.

Consumer protection groups were also concerned with the costs of the Smart Grid. If the deployment of Smart Grid technology and pricing schemes create an influx in prices, consumer protection groups want to ensure that low income and fixed income consumers are not adversely affected. In addition, the average consumer is not eager to

pay additional fees for energy. This group has a vested interest in ensuring that the Smart Grid is cost beneficial.

Table 2: Consumer Protection Group Commenters

Consumer Protection Groups	Abbreviation
AARP, National Consumer Law Center, and Public Citizen	AARP
Center for Democracy and Technology / Electronic Frontier Foundation	CDT
District of Columbia Office of the People’s Counsel	DC
National Association of State Utility Consumer Advocates	NASUCA
Ohio Consumers’ Counsel	Ohio

Energy Advocates

This stakeholder group incorporates energy advocates such as green energy advocates, smart grid coalitions, efficiency advocates and energy think tanks. In general, people in this stakeholder group view the Smart Grid as a positive endeavor and advocate policy to encourage its realization. They expressed the importance of federal dollars to support the growth of the Smart Grid through R&D, tax incentives, and continued support for NIST and the SGIC. The energy advocates stakeholder group also felt that price signals were very important to the growth of the Smart Grid. They expressed that price was the best incentive to motivate and inform customers. Their last major recommendation concerned appropriate cost allocation and recovery. They stressed that it was importance for utilities to be able to recover costs and that costs should be allocated to the appropriate parties.

Table 3: Energy Advocate Commenters

Energy Advocates	Abbreviation
Alliance to Save Energy	Alliance
Galvin Electricity Initiative	Galvin
GridWise Alliance	Gridwise
NAP Coalition	NAP
New America Foundation	NAF
New York State Smart Grid Consortium	NYSGC
Power North America	Power

Regulators and ISO's

This stakeholder group is comprised of regulatory utility commissions (UC) and independent system operators (ISO's). UC's have a close relationship with utility providers, but at their core, they are focused on ensuring fairness to consumers and reliable operation of the grid. Not all UC's share the same views on the Smart Grid (some are more progressive than others), but there is a common underlying core set of beliefs. ISO's coordinate, monitor, and control the operation of the electrical grid in a single state or across multiple states. They also have a close relationship with utilities but they are primarily concerned with fairness and competition in electricity markets. The primary issues advocated by this group include consumer education, proper cost benefit analysis practices, and the importance of federal funding. This stakeholder group felt that long term consumer education about energy and the Smart Grid was essential. They also had

strong beliefs about how cost benefit analyses should be conducted for the Smart Grid. They stressed the importance of state jurisdiction, verifying costs, and ensuring deployments happen at a measured pace consistent with benefits fulfilled. The regulators and ISO's also encouraged the importance of federal funds to support R&D for the Smart Grid, the SGIC, and NIST.

Table 4: Regulator and ISO Commenters

Regulators and ISO's	Abbreviation
Michigan Public Service Commission Staff	Michigan
National Association of Regulatory Utility Commissioners	NARUC
New York Independent System Operator, Inc.	NY ISO
Oregon Public Utility Commission	Oregon
The North American Electric Reliability Corporation's	NERC
US Nuclear Regulatory Commission	NRC

Utility Providers

This stakeholder group is composed of utilities and utility associations like the Edison Electric Institute (EEI) and the National Rural Electric Cooperative Association (NRECA). Similar to consumer protection groups, utility providers want to ensure the Smart Grid is cost beneficial but for different reasons. In most Smart Grid implementation scenarios, utility providers take most of the risk and are heavily influenced by policy changes. They feel that if they have to take the majority of the risk, then they should benefit and be compensated monetarily at the same level. This

stakeholder group was opposed to any Smart Grid plan that would put them at risk for financial loss. Outside of proper cost and benefit allocation, this stakeholder group was also concerned with consumer education. Similar to the regulator and ISO stakeholder group they believe consumer education is essential to secure consumer participation in the Smart Grid. The utilities also echoed the regulators comments on two other issues; (1)The necessity of respecting state and regional control and (2) the importance of directing federal funds to R&D, NIST, SGIC and tax credits.

Table 5: Utility Provider Commenters

Utility Providers	Abbreviation
American Gas Association	AGA
American Public Gas Association	APGA
American Public Power Association	APPA
Baltimore Gas and Electric Company	BG&E
CenterPoint Energy	Center
City Utilities of Springfield Missouri	Spring
Dairyland Power Cooperative	Dairy
Edison Electric Institute	EEI
Electric Power Research Institute	EPRI
Energy Services of Pensacola	Pen
Florida Power & Light Company	FPL
National Grid	National

Utility Providers	Abbreviation
National Rural Electric Cooperative Association	NRECA
Okaloosa Gas District	OGD
Pepco Holdings, Inc.	Pepco
Progress Energy	Progress
Southern Company Services	Southern

Other

This stakeholder group is comprised of commenters that do not fit into any of the above categories; mainly professors and people from the industry with intimate knowledge of its interworking's. Their viewpoints were varied based on their background. Though they did not fit into a specific category but they still offered thoughtful comments to the RFI.

Table 6: Other Commenters

Other	Abbreviation
Browning, Stephen	Brown
Divan, Deepak, Professor, Georgia Institute of Technology	Divan
Grijalva, Santiago, Associate Professor, Georgia Institute of Technology	Grijalva

III. KEY FINDINGS

1. The Department of Energy needs to outline specific Smart Grid goals and success metrics.

Many of the commenters from the RFI spoke on the need for the Department of Energy to have **specific** Smart Grid goals. The call for specific written goals was also echoed at the 2012 National Electricity Forum by Lauren Azar, the Senior Advisor to Secretary of Energy Steven Chu who is tasked with coordinating the Department of Energy's overall efforts to strengthen and modernize the electric grid [5] [6]. The goals would have a twofold purpose; bringing clarity to the industry and defining measures of success.

First, specific written goals can bring clarity to the industry. The mission of the Department of Energy is to ensure America's security and prosperity by addressing its energy, environmental and nuclear challenges through transformative science and technology solutions [7]. The nation looks to the DOE for a vision of our current and future energy strategy. Currently, the Department of Energy has identified seven functional characteristics of the Smart Grid but they are not specific enough to bring clarity to the industry. The seven DOE functional characteristics that the Smart Grid should display are as follows [8]:

- Self-healing from power disturbance events
- Enabling active participation by consumers in demand response
- Operating resiliently against physical and cyber attack
- Providing power quality for 21st century needs

- Accommodating all generation and storage options
- Enabling new products, services, and markets
- Optimizing assets and operating efficiently

In order to advance the DOE's objectives, it is necessary to have structure. Therefore, it is vital that the DOE be specific and clear on its goals. Specific goals will inform everyone in the industry where the DOE thinks the United States should be headed and what kind of research they will conduct and fund. It sets a path for the industry to follow. Everyone will not agree with the goals but by knowing them they can conduct themselves accordingly.

Deterring investment is one of the results of an unclear vision; whether those investments are in projects, equipment, or research. Several commentators stressed that the uncertainty surrounding the future of the smart grid can stymie investment. The energy industry is known to be a capital intense industry. No investor wants to commit substantial funds to a project in an industry where things are very uncertain. Risk comes with every investment but with the large capital expenditures that are necessary for the energy industry it gives investors a major pause. Having clear goals and advocating for policy that aligns with those goals will encourage investment. If investors are more certain about the direction of the industry then they will be incentivized to invest. Also, for most electric utilities it takes years to plan the deployment of new growth and how to handle growing demand. Utilities need to know sooner rather than later where the industry is headed. If the vision of the DOE is to encourage the development of the Smart Grid then they need to outline **specific** goals so utilities can begin to plan their five, ten, and thirty year strategies.

Second, specific written goals will help to define quantifiable measures of success. Currently, the DOE reports to Congress on the progress of predefined Smart Grid success metrics but those metrics are very subjective and have limited meaning. The DOE uses eight levels to describe the current success and future trend of a metric. The levels are declining, nascent, low, moderate, flat, improving, mature, and high [9]. It is easy to assign one of those levels to a metric and not fully understand the significance of it; which makes it an ineffective judgment tool. An effective metric should have perspective. It is much easier to understand the successful progress a when the metric is tied to something concrete. Solid parameters help clarify what is the end goal? What is success? What is failure? Industry participants need to know where the finish line is so people can take measurable steps to get there.

For example, the DOE has a metric to track the progress of grid-connected distributed generation (DG). In 2009 it was rated as having low penetration and a high trend. In 2010 it received the exact same rating [9]. What is the significance of these ratings? Was any progress made in 2009? Does high penetration mean that 50% of US Energy is provided by DG or perhaps 50,000 MW? The report and appendices don't provide any further explanation. How will the DOE know that the DG metric is a success and how will they prove it to others? If the DOE set a goal to have a certain percentage or number of kWh meet the US energy demand by DG then it would be very easy to have an easily understood measure to judge progress by. Having concrete measures does make failures more poignant and would draw the criticism of opponents but it also presents opportunity for the public and private sector to come up with new ways and plans to address meeting the concrete goal.

Concrete goals can be studied and broken down. A plan can be developed by people in academia and research institutions as to the best way to reach a goal. A great example of academic and research institutions coming together to strategize on how to reach a concrete goal can be seen in the carbon stabilization wedge strategy [10]. The wedge strategy is a commonly discussed method for maintaining CO₂ levels at the 2000 level over the next 50 years by dividing the 8 billion tons of necessary avoided emissions into eight 1 billion wedges that can be achieved via various strategies. The advantage of this method is that there are many options to fulfill each wedge that many people can contribute to. Trying to think of a strategy to eliminate 8 billion tons of CO₂ is a big undertaking but one million tons is much more realistic and approachable. Since the introduction of the wedge theory, more than eight wedges have been proposed [11]. Various industries were able to chime in and discuss what they could do to reduce their emissions, such as the transportation industry and heavy manufacturing industries.

When metrics are concrete, industries and scholars can find solutions. When metrics are abstract, it is much more difficult to plan, execute and accomplish a task. There have been other instances where the U.S. government set tough specific goals and the public and private sector rose, innovated, and met the challenge. The CAFE (Corporate Average Fuel Economy) and Energy Conservation standards for major household appliances established by the Energy Policy and Conservation Act of 1975 are great examples of this [12] [13]. Concrete metrics for the Smart Grid have the potential to do the same. It is an opportunity the DOE should seriously consider.

2. The transmission planning process needs to be streamlined.

When a survey of literature is done, many researchers [14], [15], [16] [17], [18] see transmission as a fundamental barrier in the current electricity industry. Contrastingly, a survey of the chief stakeholder groups doesn't reflect the same thing. Few commenters spoke on the need to streamline the transmission planning process but that does not mean it is not important. This is due in part to that fact that the Smart Grid primarily focuses on operation rather than planning. With that being said, transmission is still vital to the success of the Smart Grid because of important links to integrating renewable energy. The stakeholder's failure to identify transmission planning as a barrier to the advancement of the Smart Grid only highlights the longstanding problem in interstate transmission planning.

Few traditional territorial utility stakeholders have a vested interest in transmission outside of their service area so the problem goes unsolved. Many traditional for-profit utilities are incentivized to build new generation over transmission lines¹. Public Utility Commission interests fall in line with the traditional utility stakeholders. They are usually focused on reliability and cost. If a utility proposes to build generation over transmission, they're not going to oppose it as long as reliability is maintained and costs are prudent. PUC's are concerned with rates being fair and just. Citing a new transmission line may be a more optimal solution than building new generation but choosing to build generation isn't considered "unfair and unjust", it's just sub-optimal. Appliance and Technology Provider stakeholders are silent on the issue because they can

¹ When a traditional utility builds new generation, if it is prudent, they will recoup costs and a guaranteed return on their investment from their PUC or equivalent. However, when they cite a transmission line, they only recover costs and not a return on investment. This incentivizes building generation over transmission.

benefit either way. They can build technology to advance transmission or encourage generation. Additionally, ATSP's operate at the commercial and residential scale rather than at the bulk transmission scale, where interstate transmission planning matters. Their services and profits are not harmed if interstate transmission is inadequate. Energy advocates were the only stakeholder group to address the need for increased transmission.

As afore breakdown illuminates, few stakeholders are concerned with large scale interstate transmission being built and instead concentrate on things solely affecting their personal objectives. This behavior shows most stakeholders are focused on the trees and few are seeing the forest. It is the responsibility of the DOE and the Federal Energy Regulatory Commission (FERC) to look out for the best interest of the United States. They are tasked with seeing the forest and they need to streamline the transmission citing process so essential transmission can be built.

The issues in system reliability are a perfect parallel to the issues in transmission planning. In 2003 there was a major blackout across the northeast part of the United States and portions of Canada. Prior to the blackout each utility and territory felt that their system was reliable and secure. They were not overly concerned with their neighbors; only looking at the trees. Research after the blackout showed that while individual utilities may have been secure the system wide state was not secure, or there was a lack of "situational awareness" [19]. No one was paying attention to the forest. There was no wide area control or mandatory reliability standards. After the blackout, where billions of dollars were lost [20], it was evident that someone should be tasked with paying attention to the whole picture. Someone needs to be looking out for the best interest of the entire United States and not just each specific utility. NERC was tasked with this effort for

system wide reliability. Transmission planning requires a similar wide area perspective authority. A single authority needs to plan and be responsible for ensuring that transmission lines are built in the most efficient way possible to service the needs of the American people.

FERC Orders 888/889 and 2000 sought to address the issue of a lack of wide area transmission planning by creating ISO's and Regional Transmission Organizations (RTO's). The purpose of these organizations was to promote non-discriminatory access to transmission and encourage interstate transmission planning. These organizations have had success in increasing planning between states but more work needs to be done. In real time operations, each utility control area has data acquisition and models of their own footprint. However, in planning, planners use interconnection-wide planning models. The map in Figure 1 shows how the various ISO's and RTO's are spread across multiple states in the US. The main problems ISO's and RTO's face are state by state regulations. Even if an ISO or RTO thinks a transmission line should be built they may not be able to overcome state restrictions. FERC, the central entity over interstate energy transactions, lacks the authority it needs to cite essential transmission lines. FERC needs the proper authority and a streamlined process to cite transmission lines. Streamlining the transmission planning and siting process will provide two desired benefits. One, a smoother shorter transmission siting process will encourage investors and utilities to invest in transmission lines. Second, it will enable the connection of the renewable energy resource rich central US with population dense coasts.

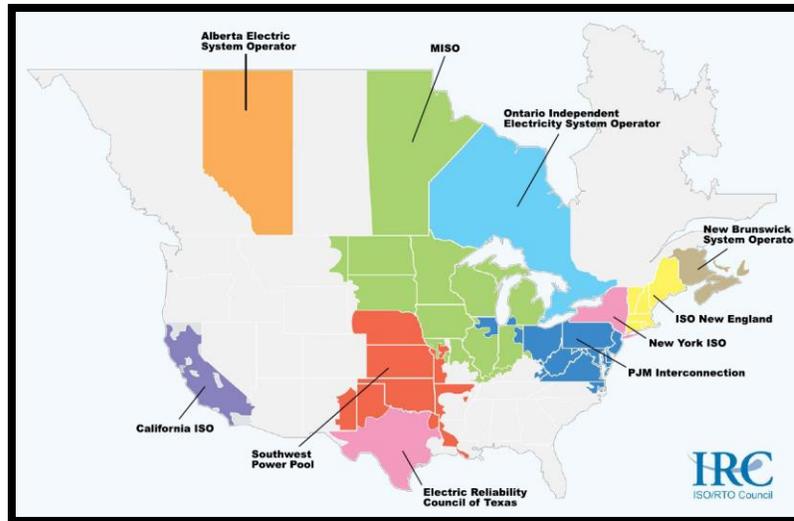


Figure 1: Map of North American ISO's and RTO's [21]

3. A nationwide Smart Grid education campaign needs to be conducted.

The most frequent and clear message heard from stakeholders was the need for a substantial education campaign. It is commonly stated that the success of the Smart Grid hinges on consumer engagement and participation. An education campaign is needed that will reach far and wide. It should address consumers from all across the US at different income and education levels. It needs to convey information about the Smart Grid itself as well as general electricity knowledge. The logic being, consumers should have enough basic electricity knowledge/understanding to be able to make educated decisions for themselves about the Smart Grid.

In order to effectively carry out an education campaign of that magnitude, every stakeholder will have to be engaged. There is too much information to disseminate and too many people to educate for it to be the responsibility of one stakeholder group. On the other hand, having every stakeholder participate creates the possibility of messages becoming too varied and confusing to consumers. To combat both of these issues a

stakeholder wide education campaign panel needs to be formed similar to the Smart Grid Interoperability Panel (SGIP) of the National Institute of Standards and Technology (NIST) that works to address interoperability issues. The purpose of the panel would be to create a unified education campaign, agree upon what information needs to be dispersed, and how best to disperse it. One unified source of information assures consistent verbiage and information. Once a unified education campaign was created then it could be compartmentalized and carried out by the appropriate stakeholder group. The panel would be the central location for consumer information relating to the Smart Grid and general electricity knowledge. The panel website could be the central authority and go to place for consumers to obtain knowledge in one easy convenient location. Consumers would only have to deviate from the panel website to receive information specific to their utility provider.

In terms of what each stakeholder group can provide the Department of Energy, other federal agencies, and state PUC's or their equivalents are best suited to provide broad-spectrum Smart Grid information and general electricity information. They are well suited to deliver this information because many of them already provide this type of information to consumers. Also, in general, they have a good trusting relationship with consumers. Energy advocates can provide advanced Smart Grid information for consumers that are interested in obtaining in-depth information and being aggressively involved. Consumer protection groups are well suited to inform customers of their rights and important information they should be aware of that doesn't fall into general knowledge. They are well suited for that purpose because that is mainly what their efforts currently consist of; advocating for and informing vulnerable populations and average

consumers of potential pitfalls. Utilities are best suited to provide consumers with information regarding Smart Grid upgrades or improvements in their specific territory; when upgrades are coming and what will be available in specific areas. Appliance, technology, and service providers will promote the features and specifications of their appliances and services to customers; providing customers with options. This doesn't represent a significant change in the information any of the stakeholders currently disperses, the most important difference is that the knowledge will be uniform, consistent and easily accessed from one central hub.

Another important task of the education panel will be dispersing information across as many mediums as possible. The Smart Grid Consumer Collaborative (SGCC) has been measuring consumer knowledge of the Smart Grid and Smart Meters and currently only 33% of the U.S. population has basic or complete understanding despite massive efforts on part of many of the stakeholder groups to educate consumers [22]. This demonstrates that future advertising needs to reach across new platforms to try to reach more consumers. Every medium should be considered from billboards, to TV ads, print ads and commercials. Current efforts, like smartgrid.gov, hold good information but they are not receiving enough traffic. By advertising across new mediums you could drive more traffic to the current websites and the new education panel website.

4. The Department of Energy needs to continue to fund research and pilot programs and make that information/data widely available to all stakeholders.

This RFI exposed a fairly common dichotomy found in the electric utility industry. Utilities require that almost any technology or strategy that they implement be thoroughly researched and vetted. However, they do not like to invest money in research and development. Table 1 shows the sales and R&D funds spent for industries performing industrial R&D in the United States in 2005. Excluding the utility industry, the average industry spent 8% of their sales on R&D. The utility industry spent 0.1% of their sales on R&D. The pharmaceutical industry, which has comparative domestic sales as the utility industry, spent 174 times more money on R&D than the utility industry did in 2005 [23]. For an industry that is so stringent about testing and proving that technology works, you would expect them to do more R&D but they do not. A note, the utility industry in Table 1 includes all utilities like water, gas and electricity but the trend is consistent amongst most utilities.

Table 7: Funds and Sales for companies performing industrial R&D in the United States, by industry: 2005 [23]

Industry	Domestic Net Sales (Millions of Dollars)	R&D Expenditures	Percentage of R&D %
Pharmaceuticals & Medicines	\$273,000	\$34,800	12.7
Semiconductor & Other Electronic Components	\$176,000	\$18,700	10.6
Aerospace Products & Parts	\$227,000	\$15,000	6.6
Machinery	\$231,000	\$8,500	3.7
Utilities	\$223,000	\$200	0.1

Throughout the responses there were many calls for more pilots and increased testing. These calls were most often heard from the utility providers and the ATSP stakeholder group. Cumulatively the utility and ATSP stakeholder groups have the most

capital to invest in research but frequently call on someone else to conduct the research and perform tests. This is a great example of the high risk-aversion in the electricity industry. Most stakeholders see the need for increased studies and pilots but they are not willing to pay the costs to perform the tasks. Therefore, if essential research is going to be done then it is going to have to be done by a different party. The best suited stakeholder group for that are the federal entities. Organizations like the Department of Energy and other federal entities like FERC and NERC are already sponsoring research projects and have an effective research staff. They are in a good position to spearhead future research and ensure that the proper research gets conducted in an orderly fashion. That stakeholder group represents the best option for two primary reasons.

First, by having research conducted by the federal government resources can be better allocated. Having one primary entity handle research efforts will prevent unnecessary duplication of tests and pilots. Instead of multiple utilities reproducing the same research or similar pilots the federal government can have overseeing knowledge and make sure duplicate studies aren't carried out; preventing inefficient use of limited funds and resources. Also, if a federal entity conducts the research then they will ensure the results are broad enough to be applicable to all utilities instead of specific to just one; again being most efficient with precious resources which leads to the second point.

Second, if federal entities conduct the research then results will be available to all. Most utilities and companies are very private about the advancements they make and don't go public until they hold a patent. By having major research conducted by federal entities then patent monopolies can be prevented. This way information will be publically available for everyone to use, learn, and benefit from; preventing innovation stifling. The

information gathered would be best shared through an information clearinghouse. The Smart Grid Clearinghouse (smartgridclearinghouse.com) is a great beginning effort, should be continued and used to hold future research. Most stakeholders viewed the clearinghouse in a positive light and felt that it should be continued.

5. Consumer participation programs should be voluntary. System wide upgrades should not be voluntary.

There was much consensus among stakeholders that consumer participation programs, like dynamic pricing and direct load control, **should** be voluntary but system wide Smart Grid upgrades, like smart meter deployments, **should not** be voluntary. The main driver behind consumer participation programs being voluntary is that not everyone has to participate to reap the desired benefits. Most consumer participation programs are built to reduce demand in peak hours when generating power is most expensive. The goal is to keep demand below a threshold point so expensive generators don't have to be turned on or used. Figure 2 demonstrates that as demand exceeds the peak of the day, prices rise sharply. If demand can be constrained to remain below peak then high costs can be avoided.

Consumer participation programs can help avoid these peak costs. The reduced costs from eliminating the top 10% represented by peak demand can be used to create an incentive program. Participants in the program will be rewarded for their participation. This system has threefold benefit: (1) It eliminates the free rider problem. Yes, everyone

in the system benefits but the people that benefit most are the people doing the work and “paying the cost”. (2) It addresses consumer advocate groups concerns about how these programs will affect vulnerable populations. If vulnerable populations are not able to participate then there are no extra costs for them to bear and they still get the benefits of overall demand being less. When overall demand is less, everyone pays lower costs for energy. (3) It also addresses people’s concerns about consumer apathy. Many of the commentators were skeptical that consumers would want to actively participate in the Smart Grid. It is a more reasonable goal to create a program that aims to cut 10% of demand by engaging interested volunteers than creating a program that promises uncertain reductions by requiring 100% engagement of customers. Voluntary participation by interested customers will reduce people’s fears about mass consumer adoption.

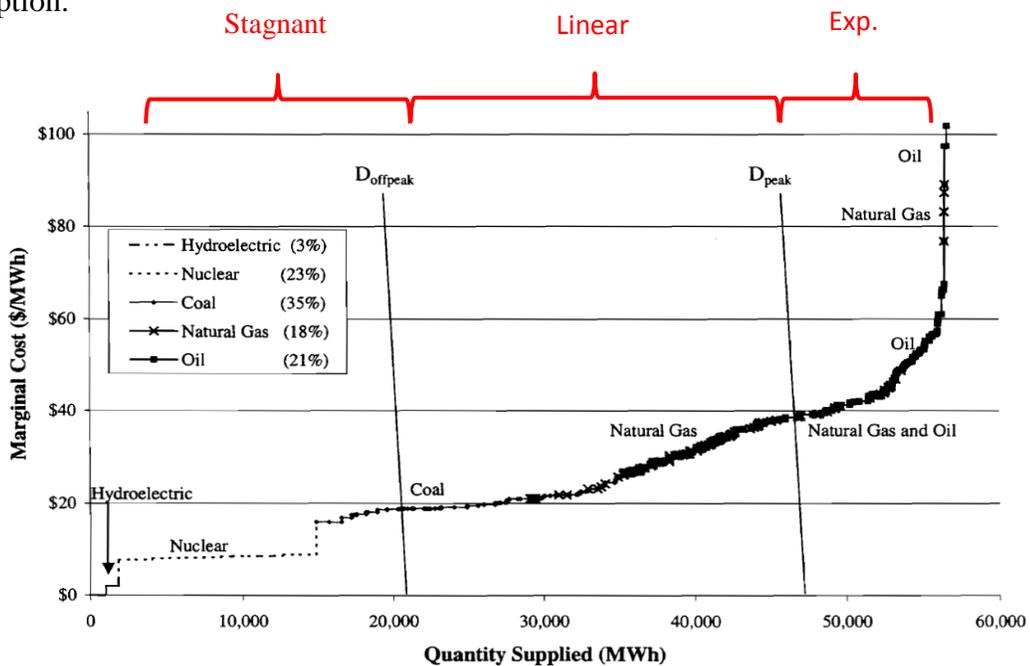


Figure 2: Competitive Supply and Demand in PJM [24]

The driving justification for system wide upgrades not being voluntary is also connected to the free rider problem. When system wide upgrades are implemented everyone benefits regardless of if everyone participates. There are cost savings from a reduction in operations and maintenance such as the rollout of meter reading trucks that won't be fully realized without full consumer adoption. In addition, there are costs that come with the system that have to be built for full-scale use regardless of initial consumer buy-in, such as data centers and software to handle the masses of data generated. These are high price items that have to be built to last long-term and therefore are built to accommodate participation of all customers. If some customers opt-out then they will be reaping the benefits without paying the costs. This is unfair to customers who pay to receive the benefits. This will mirror one of the categories of market failure. For this reason, it is important that system wide upgrades that benefit everyone be paid for by everyone which means no voluntary participation for system wide upgrades.

6. The traditional electric utility industry cost benefits analysis needs to be revised to so that all projects receive equitable consideration.

This finding was echoed by only a few of the commentators but illuminated a possible solution to a big issue in Smart Grid financing. Smart Grid projects should be handled like all other large investment projects and subject to a cost benefit analysis (CBA). However, the CBA used to evaluate all projects needs to be revised to ensure it is equitable to all types of projects. Traditional utility cost benefit analyses were made for the legacy electric grid and do not account for new benefit streams that the Smart Grid will possess. It is known and frequently admitted [25], [26], [27], [28]and [29] that not all

benefits of the Smart Grid are captured in the traditional CBA. If all of the benefits are not accurately accounted for then it is not a fair CBA and the real value of Smart Grid projects can't be reflected. Albert Einstein is attributed with the following quote, "Everybody is a genius. But if you judge a fish by its ability to climb a tree, it will live its whole life believing that it is stupid." This is great explanation of why using the old CBA is not a good way to judge new Smart Grid projects. Many of the proposed Smart Grid projects have merit but if you judge them by a set of criteria that aren't made for them then they will never measure up. New CBA's need to be created or the old CBA's need to be revised to properly account for all of the benefits and costs of the Smart Grid. Then they can be judged by fair criteria and it will be possible to make accurate decisions about whether they are good investments or not.

A great example of the limits of traditional CBA's can be seen with how they handle environmental costs. As discussed above in the public value section, the future electric grid needs a way to incorporate environmental stewardship into its market evaluations so that the value of environmentalism is an active electricity cost factor. The benefit that alternative forms of energy can bring in terms of reducing the United States emission footprint is omitted from most traditional CBA's. Public opinion has expressed that the condition of the environment and air quality is a growing concern. If the public sees increasing value in these two items, then they need to be included in CBA's when evaluating projects but they are not currently included.

7. Open standards are needed to encourage interoperability. The Department of Energy should continue to support the work of the NIST Interoperability Panel.

Many of the commentators stressed the importance of having open standards. Open standards are needed to encourage interoperability. As stated by NIST, “Interoperability—the ability of diverse systems and their components to work together—is vitally important to the performance of the Smart Grid at every level. It enables integration, effective cooperation, and two-way communication among the many interconnected elements of the electric power grid [30].” Interoperability is important because the Smart Grid will be composed of many intricate pieces that will have to work together. If all of the pieces are built and modeled on the same open standards then they should all work together. Currently the interoperability standards are being worked on by the NIST Smart Grid Interoperability Panel which is composed of stakeholders from all sectors of the electricity industry. Most commentators felt that the work that NIST is doing is exceptional and should continue. The DOE should continue to support the NIST Interoperability Panel.

IV. SUMMARY OF PUBLIC COMMENTS AND INFORMATION

1. Definition and Scope

In this section most of the stakeholders agreed with the Smart Grid definition as defined in Title XIII of the Energy Independence and Security Act of 2007 as long as the definition wasn't applied to stringently. Some stakeholders stated that Smart Grid goals were also important outside of the definition.

Utility Providers

In general, the utility provider's stakeholder group found the Smart Grid definition in Title XIII of the Energy Independence and Security Act of 2007 to be sufficient. Some utilities accepted the Title XIII definition under condition that the definition was not applied to stringently and restrictively (Center at 2, NRECA at 6, Southern at 3). They believe utilities should be able to incorporate the elements that make sense for them instead of all of the elements listed. Several utilities also expressed the importance of viewing the Smart Grid as a customizable combination of elements and not necessarily a revolutionary transformation (APPA at 5, EEI at 3, FPL at 6). Other commenters stressed the importance that the Smart Grid is not just for electricity; it needs to incorporate other forms of energy such as natural gas (APGA at 1, Spring at 1, Okaloosa at 1). This goes hand in hand with recent efforts to increase coordination between gas and electricity and should definitely be considered by the DOE for future implementation [31].

Regulators and ISO's

The majority of regulators did not comment on the definition of the Smart Grid. However, NERC did offer its own definition, “[The Smart Grid is] the integration and application of real time monitoring, advanced sensing, communications, analytics and control, enabling the dynamic flow of both energy and information to accommodate existing and new forms of supply, delivery, and use in a secure, reliable, and efficient electric power system, from generation source to end-user (p 3)”.

Consumer Protection Groups

No pertinent commentary provided.

Energy Advocates

There was not broad consensus among the energy advocates stakeholder group because many chose not to comment on the definition and scope of the Smart Grid. Of those that did comment they shared the belief that the Smart Grid should be defined holistically and focus less on technologies and more on the goals the Smart Grid needs to accomplish (Gridwise at 1, Galvin at 1, New America at 3).

Appliance, Technology, and Service Providers

The ATSP stakeholder group had much to say about the proper definition and scope of the Smart Grid. Some commenters echoed what some commentators of the utility group said, they accept the Title XIII definition under condition that the definition

is not applied too stringently or restrictively (DRSG at 2, NEMA at 2). Other commentators agreed with the opinion of the energy advocate group that the Smart Grid definition should be holistic and focus on goals instead of specific technologies (Tendril at 2, TIA at 2). The most consistent comment from the ATSP group focused on the importance of letting market forces drive consensus and interoperability (CEA at 4, DRSG at 5, eMeter at 2, Tendril at 3, TIA at 2). The commenters felt very strongly that the federal government should not hand pick “winning” technologies but let the market chose. They also felt chosen standards and protocols should be from consensus among industry participants. The ATSP group also stressed that it was important to define the Smart Grid as most than just technology. It should be defined for its capabilities and operational characteristics (ABB at 1, AHAM at 2, DRSG at 2).

Other

No pertinent commentary provided.

2. Interactions with and Implications for Consumers

In this section the stakeholders had consensus that consumer education was essential to the success of the Smart Grid. They also felt consumer privacy and consumer rights were an important issue to be resolved.

Utility Providers

A call to educate consumers was the clearest message heard from the utility stakeholder group with regard to customer interaction. The utilities felt strongly that general public awareness needed to rise with respect to the Smart Grid and energy/electricity issues in general (APPA at 9, CenterPoint at 3, EEI at 14, NRECA at 12, Pepco at 5, Progress at 4-5). They felt that increasing general awareness of energy issues would help consumers better understand the need for and benefits of the Smart Grid. When directly educating consumers about the Smart Grid, utilities felt that it was important to continually engage the consumer, not just at the time of installation of hardware (EEI at 12, NRECA at 19, Pepco at 7). Utilities felt they should interact with customers prior to deployment, during deployment and after; outreach should be continuous. Utilities also expressed the importance of using clear billing information, especially comparing consumers use to their neighbors (NRECA at 12, Pepco at 6). Some utilities expressed that it would be helpful to exchange and compile best practice and lessons learned on education campaigns and pilots (APPA at 10, NRECA at 17, Pepco at 4). The information should be made widely available so that utilities can learn from one another and reduce the learning curve of figuring out the best ways to interact with and educate consumers.

There were varying views among the utilities about who should be educating consumers. Some utilities felt that utilities should be the primary education source for consumers (APPA at 9, EEI at 13-14, NRECA at 24). Some utilities felt that there was a place for the utility and other entities to educate the public, such as the DOE, NARUC or FERC (BG&E at 2CenterPoint at 4, EEI at 14, NRECA at 23, Pepco at 3 and 7, Progress at 6). Many of the utilities felt that they should handle implementation specific Smart

Grid education and that the DOE could handle broad general energy education. Utilities already felt the DOE's Smart Grid Information Clearinghouse was a good tool already in practice. Others felt that DOE should focus on dynamic pricing and direct load control education. Overall, the utilities did see the need for collaboration to fully educate the consumer.

Some utilities felt that educating customers would not be enough. Several commentators stressed that customers needed to be motivated with other drivers such as health concerns, comfort, environmental issues, and energy security (APPA at 9, NRECA at 19, Progress at 4-5). Recycling and anti-smoking campaigns were cited as good examples of when multiple motivators can make education campaigns successful. Utilities felt they should consider some of the tactics of those campaigns to form the core of their own Smart Grid education campaigns. Another utility also felt education was not enough. FPL thought consumers could only be motivated with a strong direct price signal (FPL at 11).

Outside of the importance of consumer education, the utilities also commented on the proper speed and way to transition to the Smart Grid. The general attitude was that the transition to the Smart Grid should be slow and measured (EEI at 13, FPL at 8 and 13, NRECA at 14). It was important to the utilities that costs did not outpace benefits. Utilities felt that there still needed to be more long-term pilots to test and ensure that load reductions/shifts would be sustainable as well as customer segmentation studies to determine the best way to implement. Some utilities suggested that Peak or Critical Time Rebates were a good way to transition to a dynamic pricing scheme (BG&E at 2, Pepco

at 4). Many of the utilities expressed support (either explicitly or through participation) for the National Action Plan Coalition for Demand Response (APPA at 11, EEI at 15).

Regulators and ISO's

The Regulator and ISO Stakeholder group echoed the utilities call for consumer education. The regulators felt strongly that consumer education was very important (Michigan at 7, Oregon at 1). They also expressed the need for the education to be going much like some of the member of the utility stakeholder group (Michigan at 8).

This stakeholder group also commented that consumers should get to make their own choices. The Michigan Public Service Commission stated that DR and dynamic pricing programs should be voluntary and that the costs of those programs should be borne by the participating customers instead of rolled into rates (Michigan at 8). The New York ISO also stressed the importance of letting market forces drive development. With market forces leading, what consumers chose to buy and participate in will determine what in the Smart Grid is a success.

Consumer Protection Groups

The strongest message heard from the Consumer Protection stakeholder group was the importance of protecting consumer rights with respect to the deployment and development of the Smart Grid (AARP at 5, DC at 4, NASUCA at 16-19, Ohio 3-4). Consumer protection groups were opposed to remote disconnections that the Smart Grid could enable as well as pre-pay plans (AARP at 5-6, DC at 4, NASUCA at 17-18, Ohio at

3-4). They feel strongly that these services could adversely affect the health of consumers. Many states have laws preventing the disconnection of consumers without a site visit and the CP group felt that these laws needed to remain. Also, if those laws were not already in place in a state then they should be put into effect to protect consumers. CDT was especially concerned with the protection of the privacy of consumer privacy. They advocate for the adoption of Fair Information Practices (FIP) and simpler, more coherent notice-choice-consent policies (CDT at 4-5).

The consumer protection groups were especially concerned with the position of low and fixed income consumers (ARP at 1 and 5, DC at 3). They felt that there needed to be more conclusive evidence that smart meters will benefit all consumers before they are fully deployed. They also felt that if in-home displays are going to be paid for by consumers then utilities should subsidize the cost for low income consumers as well as provide a list of compatible devices.

The Consumer Protection stakeholder group was also in agreement with the Regulator and ISO stakeholder group about the importance of protecting consumer choice. They felt that time-of-use and dynamic pricing should be opt-in options for consumers (NASUCA at 14-15, Ohio at 3). Some commenters went further to say that direct load control programs should be compared to time-of-use pricing (AARP at 4, NASUCA at 15-16). They stated that direct load control programs have been shown to produce greater reductions in overall energy use and might be a better alternative to time-of-use pricing.

Again, there was a call for educating consumers. The Consumer Protection group felt that early comprehensive education would be critical to the success of the Smart Grid

(DC at 5-7, NASUCA at 20, Ohio at 6, 9, and 12). Some previously discussed motifs were repeated by the consumer protection group; the importance of using consistent language, advertising across many mediums, and support for the Smart Grid Clearinghouse (DC at 4 and 8). Ohio also expressed the importance of using more than education to motivate consumers. They felt it was important to engage a sense of civic duty as well as a consumer value system (Ohio at 10 and 13). Ohio said consumers want to feel they are in control so it is important to incorporate consumer values and include consumers in the discussion about the Smart Grid.

Energy Advocates

The energy advocates stakeholder group also commented on the importance of educating consumers about the Smart Grid (Gridwise at 4, New America at 5). They discussed various ways to educate consumers such as leveraging existing state and local programs or using utilities and community based organizations. The National Action Plan Coalition suggested using their experts to help form education programs (NAP at 1). Other energy advocates felt that the Smart Grid Consumer Collaborative could add to everyone's knowledgeable base about consumer needs (Gridwise at 4, Galvin at 9). The SGCC does continuous studies about consumer knowledge and perception of the Smart Grid.

The energy advocate group also that consumer choice was an important issue. They shared previous opinions that consumers should be able to opt-in to dynamic pricing plans (New America at 6). They also commented on the need for consumers to be able to access their own data and have the choice to authorize third parties to access their

data (Alliance at 3-5, New America at 6). The energy advocates felt that the data should be in an easy to understand and accessible format so that consumers could easily understand the information and act upon it as they choose. The same sentiment was expressed about pricing schemes. Galvin commented that pricing markets should be transparent so that consumers could easily understand and make educated decisions (Galvin at 10). Galvin also discussed the importance of incorporating the consumer in the design phase of the Smart Grid instead of proposing to them an already designed system (Galvin at 9). Consumers should get to add their opinion and beliefs beforehand; they should be given a choice what kind of Smart Grid they will have.

Some energy advocates also shared the belief of the consumer protection stakeholder group that remote disconnection and pre-pay billing programs can be harmful programs (New America at 6). They also felt it was important to protect consumer rights as deployment of the Smart Grid continues. Galvin also commented that it was important to encourage regulators to set specific goals (Galvin at 7).

Appliance, Technology, and Service Providers

The ATSP stakeholder group saw much value in educating consumers about electricity usage. They advocated for an ongoing multiyear education program that all stakeholders could participate in (ASHRAE at 4, CEA at 8, DRSB at 8 and 13, eMeter at 10, Ingersoll at 2, Opower at 1, TIA at 9, Toshiba at 1, Verizon at 6-7). Some commentators expressed the importance of providing energy use information in an easy to understand format (DRSB at 12, Opower at 2). Others saw value in the DOE providing best practice recommendations based on past and existing projects (CEA at 10). Also,

the ATSP group shared the beliefs of the utility and consumer protection stakeholders that it is important to motivate consumers with more than education. They felt it was important to motivate consumers with civic participation driver as well as pricing (DRSG at 13-14, Igersoll 1-2, Toshiba at 1, and Verizon at 7). The ATSP group also agreed with the consumer protection group that more studies and research need to be conducted to verify the economic benefits of changing consumer behavior (ASHRAE at 3, TIA at 9).

The ATSP also had much to say about how pricing structure should be implemented in the Smart Grid. Almost all ATSP commenters felt that a pricing signal should be a part of the Smart Grid. Several believed that electricity rates should reflect the true cost and nature of electricity (DRSG at 12, eMeter at 8, Honeywell at 4, Tendril at 3-4, Toshiba at 1 and Verizon at 8). Others expressed their views less strongly but did express that uniform pricing and usage information was important for the development of the Smart Grid (AHAM at 3). The CEA felt that rate structures should be developed that take full advantage if Smart Grid enables technologies; which leaves many possibilities open (CEA at 6). Some commentators spoke of the importance of using price signals to motivate consumers to replace functional equipment with more energy efficient alternatives or utilize energy management tools (ASHRAE at 3 and AHAM at 1).

The ATSP group was also concerned with consumer's rights; especially related to privacy, data, and choice. Like previous stakeholders they agreed that consumer choice and privacy must be respected (AHAM at 5-6, DRSG at 12, eMeter at 8 and Tendril at 3). They felt strongly that consumers should be able to make decisions for themselves as well as maintain data privacy and basic consumer rights. Some commentators specified that direct load control should be a voluntary program (ASHRAE at 3 and eMeter at 9).

As far as data access was concerned there was much consensus among this stakeholder group that consumers should be able to make their data available to third party vendors (AT&T at 1, CEA at 15-16, eMeter at 9, Tendril at 4 and TIA at 8-9). The data should be available to third parties without any caps on type or amount and should be available in real time or near real time (Honeywell at 4, Tendril at 3 and TIA at 8). Some commenters did feel this data should be made available under the Fair Information Practice principles (TIA at 9).

Other

This stakeholder group did not have much to say about consumer interaction but they did feel that consumers were an important element in the Smart Grid. Brown felt that there needed to be increased customer participation in the planning process of the Smart Grid to ensure their opinions were heard. Grijalva felt that consumers were important but that they would want a hands off system (Grijalva at 5). He believes consumers won't be interested in monitoring their energy use every day and will want tools or equipment that can do that for them without having to put in a lot of time and effort.

3. Interaction with Large Commercial and Industrial Customers

There were significantly fewer comments regarding how to interact with large commercial and industrial (C&I) customers. Commenters applauded the DOE for making the distinction between large C&I customers and regular consumers because they felt that they two were very different. The general consensus was that C&I customers are already

very involved with industry participants to manage their energy needs and need less attention than regular consumers. Some stakeholders did comment that there needed to be improvements with regards to data use and access. The rest of the comments dealt with a wide variety of issues.

Utility Providers

The utility stakeholder group had several comments about the proper way to interact with large C&I customers but there was little consensus. Most of the comments are useful but were not echoed by other utility stakeholders.

With respect to demand response, APPA dislikes current federal policies that call for implementation of “potentially uneconomic financial incentives to entities providing wholesale DR in regions with centralized markets operated by RTO’s” (APPA at 14). EEI felt that C&I customers should be able to participate in DR, whether it be through an aggregator or individually (EEI at 16-17). Some have the ability to participate over flexible periods of time which could be very useful as well. EEL also felt that C&I customers should be able to customize their own demand side management programs (EEI at 16). Progress felt that demand response and demand control applications should be made available to C&I customers to help them lower costs (Progress at 8).

Outside of DR, commenters had opinions on a wide range of subjects. Some commenters felt that C&I energy efficiency programs should be continued (APPA at 13 and Springfield at 2). Utilities could help encourage these programs by offering unique billing structures, free energy audits, public recognition and possibly training for key personnel to help customers fine tune their energy efficiency programs. FPL thought that

C&I customers would be motivated by the proper price signal (FPL at 15). Progress thought that enhanced metering and rate services would provide C&I customers with the ability to compare energy bills at multiple locations and improve their energy use across multiple sites (Progress at 8). Progress also warned of the importance of protecting C&I customer's proprietary information and data usage (Progress at 9).

Regulators and ISO's

No pertinent commentary provided.

Consumer Protection Groups

No pertinent commentary provided.

Energy Advocates

The energy advocates stakeholder group also had commentary over a variety of subjects. Galvin expressed the importance of C&I customer having access to real time and downloadable energy use data as well as automated and accurate meter reading (Galvin at 10-11). Gridwise suggested the Department of Commerce Manufacturing Efficiency Program should be leveraged to assist small and medium C&I customers to become more energy efficient (Gridwise at 4).

Appliance, Technology, and Service Providers

The ATSP stakeholder group was primarily concerned with data access and privacy concerns. Some commenters felt that large C&I customer needed to be able to access their data directly from the meter through industry standard communication protocols (DRSG at 18 and eMeter at 11). eMeter felt that C&I customers should be able to provide their data to third parties but that in doing so it was important that C&I customers privacy was respected (eMeter at 11). DRSG felt that standard consumer protection might actually be counterproductive for large C&I customers because they are generally more experience with operating with NDA and commercial agreements to share data (DRSG at 18).

DRSG also felt that there needed to be customization between consumer segments. Residential, medium and large C&I customers all have very different needs and should be treated differently (DRSG at 17). Toshiba was curious, with the advent of the Smart Grid, if C&I customers were going to be able to trade “saved” electricity between various sites or companies over the grid as is done in other countries (Toshiba at 1).

Other

No pertinent commentary provided.

4. Assessing and Allocating Costs and Benefits

The stakeholders had a wide variety of opinions about the proper way to allocate costs and benefits. There was consensus in parts but also many divergent thoughts.

Utility Providers

The utility stakeholder group had much to say about the proper way to allocate costs and benefits in the Smart Grid. Their major comments focused on benefits, costs, AMI deployment, and consumer rights, or lack thereof.

With respect to benefits many stakeholders felt that the installation of Smart Grid hardware should only occur at the rate that they could provide tangible benefits (APPA at 17, EEI at 25-26, NRECA at 35 and Pepco at 1). The logic being that benefits should be verified at each stage to ensure they were actually being achieved. The projects should also face a rigorous engineering level analysis. Other commenters expressed the importance of scrutinizing fringe benefits (APPA at 18 and FPL at 17). They defined fringe benefits as benefits not easily identified in a cost benefit analysis such as environmental factors, the sustainability of customer response, the impact of social norms and others. Some utilities commented on the necessity of utilizing sensitivity analysis to help identify which benefits are contingent upon specific actions or behaviors (EEI at 20 and Progress at 11). EEI also had several other broad comments to make about Smart Grid benefits. They commented that it was important to assess Smart Grid benefits in comparison to the large investments that will have to be made in generation and infrastructure in order to meet projected load increases with a traditional grid (EEI at 19). They also discussed the importance of conducting a prudent cost benefit analysis and ensuring that benefits were not double counted (EEI at 22). Lastly, they suggested that computer model simulation tools can be very useful in assessing various Smart Grid benefits (EEI at 21). The computer tool might help to show that the aggregate of many individual investments might be greater than the sum of their parts.

When it came to cost allocation many utility stakeholders felt that Smart Grid costs should be allocated like all other utility costs (EEI at 22, FPL at 16, NRECA at 38 and Progress at 16). Many utility stakeholders also thought it was imperative to ensure that all costs needed to be included; specifically potential stranded costs and infrastructure upgrades (EEI At 22, FPL at 17 and NRECA at 31). EEI said that costs should be broken down by who bears them; costs borne by ratepayers, costs borne by stakeholders or investors that are not recoverable by rates, costs shared with third party providers and benefits that flow through other channels that are not regulated (EEI at 22 and 27). Utilities also felt that costs incurred by utility-facing upgrades should be socialized among all consumers. In contrast, they felt that all costs incurred by consumer facing upgrades should not be socialized (APPA at 20, EEI at 29, NRECA at 37, Pepco at 12 and 14, Progress at 16). They also felt that pilots were a useful to verify the costs of the Smart Grid (NECA at 37). Progress expressed that utilities need a cost benefit methodology and cost recovery mechanisms approved by regulators to have assurance that all prudently incurred Smart Grid costs could be recouped (Progress at 10). The utilities also had opinions who they thought should reap benefits based on who bore the most risk. If the consumers are to bear the risk then the benefits should significantly outweigh the costs (NRECA at 28). If shareholders are to bear the risk then they will expect a higher rate of return or the ratepayer will be forced to shoulder more costs (Progress at 15).

The utilities were in agreement on the best way to handle the transition from AMR to AMI. The consensus was that utilities should only transition if it made economic sense for them (APPA at 19, EEI at 24-25 and NRECA at 13). The utilities felt that the

decision to upgrade should be made on a case by case basis. Progress felt that the transition from AMR to AMI should happen step by step (Progress at 13). As little as five percent at time by starting with customers who have an interest in controlling their energy use.

The utilities also shared their views on consumer protection rights. Their views were different from views expressed by other stakeholder groups. Progress was in support of prepaid billing services and remote disconnection for customers (Progress at 17). BG&E thought that proactive consent should not be required from consumers to handle data (BG&E at 4). They felt that utilities should be able to broker their own contractual privacy protections.

Regulators and ISO's

The regulator and ISO stakeholder group was primarily focused on the proper way for utilities to conduct a cost benefit analysis, how costs should be handled and the role of the federal government in the Smart Grid.

The regulators shared the opinion of the utilities that Smart Grid projects should be treated the same as all other utility projects (Oregon at 2 and NARUC at 4). In the usual utility cost benefit analysis, costs are balanced against benefits and this practice should be continued for Smart Grid projects. All costs and benefits should be quantified to the extent possible. Oregon also stressed the importance of not letting uncertainty about Smart Grid implementation should not impact benefit calculations (Oregon at 2). They feel that benefits should be subject to the same scrutiny; Smart Grid or otherwise. However they also felt that investments should not be delayed until all benefits and costs

for the Smart Grid can be concretely quantified. Utilities should pay attention to items that are known to incur high costs though (Oregon at 5).

With regard to how costs should be handled, many of the regulators had thoughtful viewpoint but there was little consensus. Michigan stressed the importance of prudently incurring costs related to pilots (Michigan at 3-4). They felt that early project spending should be limited to essential requirements. They suggested using tests in software before going to full hardware deployment. Also, when a utility comes to present costs incurred they should differentiate between pilot expenditures and full deployment expenditures. Michigan also commented that hardware purchased for optional programs should be paid for by participating customers but that the utility should provide a rebate to incentivize customers (Michigan at 8). NARUC was more concerned with how other regulators should handle AMI cost recovery (NARUC at 5). They expressed that regulators should provide for timely cost recovery of prudent AMI expenditures so that the cash flow could be used to help pay for further AMI deployment. Also, they stressed that utilities should be cognizant of the speed of meter obsolescence when calculating the depreciation rate of AMI meters. Oregon stressed the importance of including the cost of enabling devices when performing a regulatory assessment of the Smart Grid (Oregon at 3).

The regulators also expressed the role they thought the federal government should play in the Smart Grid. Michigan commented that the DOE should support the work of the Smart Grid Consumer Collaborative (Michigan at 8). They also proposed that DOE should provide funding to state utility commissions to assist with staff training on complex Smart Grid issues (Michigan at 7). NARUC cautioned against the FERC

authorizing cost recovery for Smart Grid investments that are under the state's jurisdiction (NARUC at 3). This would cost unfair double cost recovery for the same investment.

The NY ISO stressed the importance of real time pricing to create price elasticity (NY ISO at 6). They also commented that markets are the best way to handle Smart Grid costs (NY ISO at 4). The value in a market strategy is that costs will be allocated to investor and interested customers instead of all ratepayers in general. Michigan, like previous stakeholders, commented that system wide upgrades should not be voluntary but DR and dynamic pricing should be (Michigan at 8).

Consumer Protection Groups

The consumer protection stakeholder group was primarily concerned with who should bear the risks and costs of the Smart Grid. The stakeholders held consensus that the utility should bear the risk is benefits they project to materialize actually do not (AARP at 7, NASUCA at 11 and Ohio at 19). The commenters thought that a risk sharing recovery rate should be created to protect consumers from imprudent costs. AARP also stressed that those benefits should be estimated under condition of maximum possible stress (AARP at 7). NASUCA commented that rebates can be an effective way to lower some of the risks associated with time based pricing options (NASUCA at 8-9).

With respect to Smart Grid costs, the consumer advocates stressed that all covered costs must be verifiable and transparent. Also, benefits should be tangible and verified from rigorous engineering analysis (DC at 11, NASUCA at 11-14 and Ohio at 13). AARP remarked that costs for smart metering should be allocated to customer cases based on

usage not a per-customer allocation (AARP at 8). Ohio felt that the most significant Smart Grid costs for consumers would be smart appliances so utilities should factor in the cost of those devices to their cost benefit analysis (Ohio at 14). Other consumer advocates warned against making consumers bear unnecessary costs so that utilities could reap excessive returns (AARP at 8 and NASUCA at 11-14). Specifically, for initiatives that expand the utility's rate base, such as smart meters and smart grid, the utility should not need pre-approval of or payment by consumers of any investments in smart grid, until they are operating and providing the promised benefits. Utilities should not earn excessive returns on this investment over time. The consumer advocates also reiterated that system wide upgrades should not be voluntary because then the costs become uneconomical (DC at 11, NASUCA at 14-15 and Ohio at 15). Ohio suggested that state commission should require utilities to file Smart Grid implementation progress reports to verify benefits and costs incrementally (Ohio at 18).

Energy Advocates

The energy advocate stakeholder group was primarily concerned with cost allocation, how to encourage growth of the Smart Grid, the best pricing strategy for the Smart Grid and the role of the federal government.

NYSGC commented that state utility commissions should provide cost recovery for utilities prudent Smart Grid installations including T&D investments and energy storage (NYSGC at 30). They also felt that smart equipment costs should be covered by money allocated to replace existing dumb equipment (NYSGC at 31). New America echoed the sentiments of consumer protection groups that utilities should bear the costs

for failed or poorly planned projects instead of consumers (New America at 7). Galvin commented that AMR may be a lower cost option for utilities over AMI but there is the possibility that AMI can be provided to customers by a third party as a package solution in response to dynamic pricing or DR (Galvin at 13). This would eliminate the utility from having to bear the costs of meter upgraded all together.

The energy advocates had many ideas on how the growth of the Smart Grid could be encouraged or sustained. New America stressed the importance of comprehensive cost-benefit analyses where benefits are quantified to the maximum extent possible (New America at 7). They also commented that transparency was of the utmost importance to keep people faith in the Smart Grid and verify that all costs were prudently incurred. New America also remarked it was important to provide incentives to landlords to encourage them to upgrade homes and appliances (New America at 7). Galvin suggested that Smart Grids could be paid for by eliminating waste and subsidies for new development (Galvin at 14). They also suggested state commissions could justify investment costs in the Smart Grid distribution system based on commitments to improve reliability indices (Galvin at 14). Gridwise also sees value in the Smart Grid Information Clearinghouse because it helps to communicate the tangible and quantifiable benefits of the Smart Grid which is vital to its success (Gridwise at 5).

In terms of pricing, the energy advocates shared some views. Galvin and NYSGC saw value in exploring market based pricing options (Galvin at 14 and NYSGC at 31). Galvin stated that utility event based pricing does little to encourage conservation so they should consider market based pricing options. NYSGC also recommended the use of locational based marginal pricing in markets (NYSGC at 19).

The energy advocates expressed that the federal government could most help the Smart Grid by offering tax incentives and rebates to pay for consumer facing devices and to help spur development (Alliance at 7 and New America at 9). Alliance also commented that it would be helpful for the federal government to fund research to support others' research activities in the Smart Grid (Alliance at 8).

Appliance, Technology, and Service Providers

The ATSP stakeholder group was concerned with a wide range of issues. Specifically the proper way to evaluate the cost and benefits of the Smart Grid, policies that need to be introduced to help the Smart Grid, proper pricing strategies, Smart Grid communication standards and the needs of consumers.

The general consensus among the ATSP group was that benefits should flow to those who take risk and that those who take risks should receive benefits (DRSG at 25 and eMeter at 12). Many of the commenters thought that the utilities should be able to share in the savings or rewards generated by Smart Grid investments (DRSG at 20 and Current at 4). They felt that this would help incentivize the utility to maximize their operational efficiencies. ABB commented that utilities needed easier cost recovery mechanisms to enable faster deployment of Smart Grid assets (ABB at 2). Others remarked that consumers should pay for costs as they were incurred and that benefits should be realized as consumers respond to price signals (ASHRAE at 5 and Toshiba at 2). With regards to how overall cost benefit analyses should be conducted, ATSP

commentators stated that Smart Grid investments should be treated like any other type of investment (DRSG at 24). They also felt that the probability for cost overruns was no more likely than for any other large scale investment (DRSG at 22-23 and eMeter at 13). DRSG also implored that least cost analyses should be avoided in favor of best cost analyses (DRSG at 20). They stressed the importance of maximizing net present value.

The ATSP had many suggestions for policies that could help move the Smart Grid forward. Some commenters expressed that policies needed to be created that would give utilities incentive to invest in energy efficiency over generation and distribution (ASHRAE at 5 and Current at 5). The commenters felt that current policies encourage utilities to make capital investments over being efficient. AT&T voiced similar concerns with respects to utilities being incentivized to build their own communications network instead of looking for least cost options (AT&T at 2). They felt that network providers, like themselves, could provide communication networks at much lower costs and with more reliability. Satcon commented that a more consistent tariff environment would encourage renewable and energy storage projects (Satcon at 4). Satcon also stressed that policies needed to be put in place to ensure that third parties are paid for providing ancillary services (Satcon at 6). That is currently not the case in many markets and third parties are forced to provide ancillary services without compensation as part of the cost of doing business. TIA commented that the federal government should increase funding for R&D to spur development and fund pilot programs (TIA at 12). Lastly, Tendril expressed the importance of respecting state regulatory authority when it comes to cost allocation and technology deployment (Tendril at 4).

The ATSP had varying views about the best pricing strategies for the Smart Grid. AHAM commented that dynamic pricing was essential to the success of the Smart Grid (AHAM at 3). They felt that uniform pricing and usage information could provide a way to harmonize local rate and timing information. Current felt otherwise. They expressed the time-of-use and dynamic pricing were not necessary (Current at 2). They believe similar effects can be achieved with voltage sensors, capacitor banks and associated controllers. Other stakeholders thought peak rebates were a good alternative or option for interfacing with vulnerable populations (DRSG at 26 and eMeter at 15).

The ATSP did share similar view on the communication standard needs of the Smart Grid. The stakeholders agreed that it was important to have national communication standards to ensure implementation costs were low and make it easier for developers to mass produce products suitable for the entire nation (AHAM at 3, Ambient at 2, Honeywell at 5 and TIA at 11-12). Some provider also commented on the importance of open standards in general because they enable market forces and completion to provide a check on prices (DRSG at 23 and CEA at 14).

The ATSP also shared their views about the needs of consumers in the Smart Grid. There were more calls for system wide upgrades to not be voluntary but customer facing devices should be voluntary (DRSG at 25 and Toshiba at 2). DRSG also remarked that universal participation in DR is not necessary but universal access to it is (DRSG at 21). They believe that consumers should have the option to participate if they so choose to. Ingersoll noted that it was important to give vulnerable populations the option to opt-out of certain upgrades (Ingersoll at 4). They felt that if the upgrade was advantageous enough then consumers would not want to opt-out. Outside of consumer participation,

other commenters expressed the importance of engaging consumers. Opower discussed the importance of bills that engage consumers by providing useful information in an easy to understand format (Opower at 2). CEA thought providing consumers with devices that would help them control their energy use would empower them (CEA at 13). They thought consumer would prefer enabling devices to direct load control programs from utilities.

Other

Grijalva commented that economic valuations of technologies, solutions and practices should be based on how they meet formal Smart Grid functional and performance requirements (Grijalva at 7).

5. Utilities, Device Manufacturers and Energy Management Firms

This section also had many divergent thoughts. The stakeholders were primarily concerned with the appropriate role of third parties, utilities, and the federal government.

Utility Providers

The utility stakeholder group understandably had many thoughts about the role they, device manufacturers, and energy management firms should play in the Smart Grid. They also shared their thoughts on the role of the federal government pertaining to the Smart Grid.

To begin, a discussion of what role the utilities felt they should play as well as their major concerns. The commenters had strong opinions about the best way to handle costs. EEI remarked that utilities would prefer an up-front approval process of costs over an after-the-fact prudence review as well as a pre-defined cost sharing plan for costs in excess of the authorized budget (EEI at 34). Also, utilities commented that there should be cost recovery mechanisms for un-depreciated legacy equipment and accelerated depreciation of AMI/AMR equipment (BG&E at 5 and EEI at 34-35). They felt that the accelerated depreciation of AMI and AMR equipment could help spur investment. BG&E also suggested that AMI costs could be recovered through tracker surcharge mechanisms (BG&E at 5). They also asserted that wholesale markets can provide money to help offset the cost of Smart Grid infrastructure and give customer bill credits (BG&E at 4). Pepco expressed the importance of timely approval of Smart Grid components (Pepco at 19).

Outside of costs, the utilities also discussed what role they and other stakeholders should play. EEI commented that RTO's and ISO's should not offer compensation that preempts or undermines state DR programs or initiatives (EEI at 32). APPA stressed that deployment is a local issues and that the cost of deploying enabling devices should be up to each utility (APPA at 26). APPA also commented that time-of-use pricing holds promise for reducing consumption but thought it should be transitioned to slowly (APPA at 23). They believe policies should start at the local or state level and be supported by the federal government. BG&E commented that utilities needed more support for supply side and demand side DR (BG&E at 4-5). EEI stated that new market rules were needed to ensure non-discriminatory access by third parties to consumers but that utilities should also be given the opportunity to provide services (EEI at 36). They felt that earning from

premium service should not be imputed against the revenue requirements for regulated services. That segues to what other rights and roles the utilities thought third parties should have.

Many of the utilities felt that third parties should have to go through a mandatory certification process and possibly register with state commissions (EEI at 30-31, Pepco at 20 and Progress at 21). They stressed that the certification should be voluntary and not mandated by legislations. Cyber security and adequate protection methods should be an aspect of the certification process. Also, they felt that liability issues should be addressed for failing or poorly performing Smart Grid components. Progress also stressed that if third parties wanted to perform any work on the utility side of the meter then that work should be conducted by the utility and the third parties should have to reimburse them (Progress at 21). Their motivation for this was costs related to fulfilling OSHA and NESC code regulations as well as labor unions. APPA felt the opposite of the above utilities. They commented that additional third party testing and certification was unnecessary (APPA at 29). They felt state laws and regulations should handle privacy issues.

With regard to the role of the federal government and the DOE, the utilities expressed some areas of concern, support for some current initiatives and opportunities for improvement. The biggest area of concern was the federal government overstepping with regard to DR policies. The utilities urged against FERC enacting wholesale pricing or other policies that would have an adverse impact on retail DR programs (APPA at 21-23 and NRECA at 47-48). They viewed some of FERCs recent actions as an attempt to federalize DR because of lack patience with state progress and they thought these actions

would prove harmful down the road. Progress remarked that the federal government should not regulate a singular utility model (Progress at 18). Dairyland was primarily concerned with EPA regulations that could make consumers having their own backup generators difficult as well as regulations that limit the participation of electric thermal storage space and water heaters.

The utilities were in mass support of the Smart Grid Information Clearinghouse and thought it provided very useful information (APPA at 21-22). There was also wide support for the NIST Interoperability Panel (APPA at 25, EEI at 36, NationalGrid at 9, Pepco at 21-22, Progress at 21 and Springfield at 3). They felt interoperability was key to the success of the Smart Grid and could help prevent pre-mature replacement of Smart Grid investments. APPA was also in support of the cooperative action being taken by PUC's, RTO's and FERC to address issues related capacity requirements (APPA at 22). EEI was in support of the collaboration between FER and NARUC on the Smart Grid (EEI at 30).

The utilities also had a few ideas about what the federal government could do to support the growth of the Smart Grid. Several agreed that the DOE funding research and high quality studies was very important (APPA at 22, NationalGrid at 3-4 and Pepco at 18). They again expressed support for the National Action Plan Coalition for Demand Response (APPA at 22, EEI at 20 and NRECA at 45). Other utilities commented that the government should provide grant programs and financing mechanisms to encourage funding of Smart Grid technologies (Progress at 19 and Springfield at 3). CenterPoint thought sponsored workshops that would allow device manufacturers to test their devices against each TDU's system would be valuable (CenterPoint at 7). Pepco felt that the

DOE needed to set specific goals for the Smart Grid (Pepco at 18). They also commented that the federal government should set threshold cost recovery policies and have the authority to set standards for state compliance (Pepco at 18). Pepco also thought the government should encourage ISO's to develop market rules that fully integrate DR into the market (Pepco at 19).

Regulators and ISO's

The regulator and ISO stakeholders did not have a lot comments but they did have a few opinions about the roles of the federal government. Oregon and NYISO were in support of the NIST Interoperability Panel just like the utility stakeholders (NYISO at 19 and Oregon at 4). Oregon was also in support of the Smart Grid Information Clearinghouse. The NRC thought the DOE needed to continue to fund research and high quality studies.

Consumer Protection Groups

AARP and NASUCA commented that dynamic pricing has not been proven to help consumers save energy so it should be further investigated. As a consequence of that, they expressed concern about the ubiquitous installation of smart meters and felt that alternatives should be explored (AARP at 9 and NASUCA at 15-16). AARP again commented that customer facing equipment should be made available without costs to low-income customers (AARP at 10).

Energy Advocates

The energy advocates stakeholder group was only concerned with policies and programs they felt the federal government should be involved with. They encouraged the federal government to continue to support several of their current programs like the Smart Grid Information Clearinghouse, NIST Interoperability Panel, and the National Action Plan for Demand Response (Gridwise at 5, NAF at 8-9 and NYSGC at 25). Galvin also suggested the DOE continue to work with the ISO's and RTO's to create even more transparent prices and performance signals in regional markets (Galvin at 16). Gridwise commented that they were not in favor of national legislation endorsing a particular cost recovery mechanism (Gridwise at 5).

The energy advocates also commented on other programs they thought needed to be put in place for the success of the Smart Grid. Galvin again commented that dynamic pricing would be important to get third parties into the market (Galvin at 16). New America remarked that utilities should be incentivized to encourage energy efficient and empower consumers (NAF at 8). NYSGC suggested that there should be an open source Smart Grid testing program (NYSGC at 36).

Appliance, Technology, and Service Providers

The ATSP stakeholder group commented on a wide variety of issues; communication standards, interoperability issues, the role of the federal government, proper pricing strategies and the needs of third party providers.

The ATSP stakeholders were in agreement that the accounting policies in place now for utilities are providing the wrong incentives. Some commented that regulators should remove the incentives in place today that encourage utilities to build their own Smart Grid communications networks over looking to the lowest cost options provided by commercial providers (AT&T at 12 and Verizon at 7-8). Others thought policies needed to change to incentivize utilities to engage in energy efficiency (Current at 4 and Honeywell at 7-8). DRSG stressed that policies needed to change to ensure that utilities get to benefit and not just bear the risks and costs (DRSG at 28). AHAM stressed that open communication standards are necessary and there should be special attention paid to the interface between utilities and consumers. To the extent possible, communication technologies already in the home should be leveraged (AHAM at 3-4). ASHRAE suggested that the BACnet A Data Communication Protocol for building automation and control networks should be used for the Smart Grid control strategy. They also suggested the ASHRAE/NEMA Standard 201P Facility Smart Grid Information Model could provide a good basis for common information exchange between control systems and consumer devices (ASHRAE at 2).

With respect to interoperability, most stakeholders were in agreement that the work of the NIST Interoperability panel is essential to the success of the Smart Grid and should continue (AT&T at 11, Cisco at 3, Ingersoll at 5, TIA at 11 and Toshiba at 3). Cisco also noted that interoperability standards should be available on a royalty-free or reasonable and non-discriminatory (RAND) terms (Cisco at 10-11).

The ATSP group also had ideas about what role the federal government should serve in the development of the Smart Grid. Ingersoll commented that if federal

purchases specified a specific certification process or authority then the rest of the market would likely follow those guidelines as well. They also commented that those federal purchases could help stimulate demand and reduce costs for the consumers (Ingersoll at 5-6). The TIA felt that it would be helpful if the federal government increased funding for R&D and off the shelf Smart Grid deployments (TIA at 12). DRSG commented federal funds would be well spent by sharing information at workshops, hearing and seminars (DRSG at 27). CEA warned that the federal government should not legislate a particular market structure but let individual states decide (CEA at 15).

The ATSP group had various ideas about the best pricing strategy for the Smart Grid. DRSG again commented that time-of-use pricing is necessary but that peak rebates would be a good transition to that system (DRSG at 29). CEA thought that there should be more flexibility. They commented that the Smart Grid marketplace should be allowed to experiment with various pricing policies to see which ones consumers responded to best (CEA at 16).

As far as the needs of third party providers are concerned, there were varying thoughts. EnerNOC stressed that third party providers needed direct access to smart meter data in order to properly develop consumer facing devices (EnerNOC 4-5). They also stressed that the data should be available in real time. Toshiba commented that third party providers should utilize federal funding to make proofs of concept that can drive industry standards (Toshiba at 2). DRSG remarked that there was no need for additional testing and certification for strictly consumer side devices (DRSG at 30). They suggested that open standards used by WiFi or UL were good examples of how that could work.

However, there were open to additional testing and certification for devices that interface between the utility and consumer.

Other

Grijalva felt that the DOE should be cautious about enforcing energy efficiency standards because these actions could stifle the opportunity to implement market based mechanisms (Grijalva at 8). He also commented on the importance of decoupling architecture, functional and performance requirements from Smart Grid technologies.

6. Long Term Issues: Managing a Grid with a High Penetration of New Technologies

In this section the stakeholders commented on what tools and technology they thought were necessary to help deal with the influx of new Smart Grid technologies. They also commented on policies and federal assistance that would be helpful.

Utility Providers

The utility stakeholder group issued comments covering three primary areas; technology or tools needed, policies desired, and required financial investments. There were also a few general comments given.

With respect to what technology or tools are necessary to manage a grid with a high penetration of new technologies some utility stakeholders commented on the need

for new radio frequency spectrum options to allow the utilities to implement reliable wireless networks (EEI at 42 and Progress at 25). NRECA stressed the need for distributed computing, intelligent sensors and bi-directional communications and controls (NRECA at 62). Progress stated that better models need to be developed for load forecasting (Progress at 24). Pepco commented on the need for utilities to be able to control loads and small distributed renewable generation in real-time or semi-real-time (Pepco at 20). They also commented on the need of models that can analyze the electric grid across multiple levels to help better manage and monitor the grid (Pepco at 21-22). Multiple commenters remarked on the importance of energy storage for the long term success of the Smart Grid (Pepco at 21-22 and Progress at 23). Progress also noted that it would be helpful to have a national regulated clearinghouse that would allow for a single access or payment card system where all utilities could arrange billing solutions (Progress at 27). CenterPoint suggested a central federally sponsored repository for cyber security threats. They think this could help to reduce costs by pooling resources and make it easier to identify threats (CenterPoint at 8).

The utility stakeholder group also commented on several policies they thought should or shouldn't be implemented to help manage the penetration of new technologies. Some commenters again stressed the importance of real time pricing to send the proper price signals (EEI at 38 and Pepco at 20). EEI commented that regulatory prices should promote the use of ancillary service and treat similarly situated bulk power system resources comparably (EEI at 41-42). They also commented on the need of a process to notify utilities when customers purchase EV's in advance of procurement so that the utilities can plan for infrastructure upgrades (EEI at 44). EEI was also very adamant in

their commentary that state and regional authority should be respected with respect to the integration of VER rules, DR, energy storage policies and compensation structures (EEI at 39, 40, and 43).

In regards to investments necessary to manage a grid with a high penetration of new technologies utilities again stressed the importance of investing in research, especially with respect to energy storage (EEI at 39 and NRECA at 67). EEI also remarked on the need for additional investments in Smart Grid infrastructure, better modeling tools and power reservation systems (EEI at 38). Springfield remarked on the investments that will have to be made to cover the upgrade costs of distribution equipment (Springfield at 3). NRECA commented they would not invest in infrastructure for PHEV's until they were certain PHEV's will have high penetration in their market (NRECA at 68).

The remaining utility comments were more general in nature and do not fit into one of the above categories. Progress emphasized the importance of enumerating clear measurable objectives and goals (Progress at 23). Springfield commented that the deployment of Smart Grid technology should happen at a measured pace to ensure reliability (Springfield at 3). Some utilities remarked that customers cannot expect to sell a kW back to the utility at the same price they buy a kW for because the utility has more experience and resources which have driven down costs. They believe that customers simply cannot compete with the cheapness of the utility (NRECA at 66-67 and Progress at 23). Progress also expressed that third parties would have to pay for using the grid. Their rationale being that the grid is funded through base rates paid by customers and that has to be taken into consideration (Progress at 25).

Regulators and ISO's

Oregon commented that to ensure that distributed generation and electric/thermal storage can compete utilities need to be mandated to analyze those technologies on a level playing field. They suggested the use of integrated resource planning (Oregon at 4). They also warned that delaying investments in Smart Grid infrastructure and AMI could result in missed opportunities, diminished benefits or increased costs (Oregon at 5).

Consumer Protection Groups

No pertinent commentary provided.

Energy Advocates

The energy advocates stakeholder group commented that appropriate financial incentives and support were needed to manage the penetration of new technologies in the Smart Grid. Galvin reiterated the importance of price transparency and real-time pricing in ensuring the success of the Smart Grid (Galvin at 18). Gridwise commented that tax incentives should be codified and made permanent so manufacturers can count on consistent long term funding (Gridwise at 6). They also commented on the need for federal funding of R&D to support storage, forecasting, distribution automation, data collection and analysis (Gridwise at 6). Gridwise also stated that the loan guarantee

program should be made whole again and ARPA-E should be fully funded (Gridwise at 6).

Outside of appropriate financial incentives the energy advocate stakeholder group also commented on the importance of having automated software and intelligent agents to help consumers respond to price signals (Galvin at 17). New America also commented that the penetration of new technologies will only occur if there is an interoperable platform with localized control and integration at the microgrid level (NewAmerica at 10-11).

Appliance, Technology, and Service Providers

The ATSP stakeholder group thought the Smart Grid needed a few key policies and standards in place to help manage the high penetration of new technologies. They again called for an open national communication standards to ensure that costs remained low and interoperable across many states (AHAM at 4 and Ambient at 4). Some commenters expressed that price signals and automated controls would be necessary to integrate high levels of electric vehicles in addition to smart charging (DRSG at 32, TIA at 5 and Toshiba at 3). Others stressed the importance of affordable and reliable energy storage for long term grid reliability (Steffes at 3 and Toshiba at 3). DRSG and Honeywell felt that DR would play a big role. DRSG remarked that FERC should adopt wholesale policies to allow DR to compete fairly in wholesale markets for ancillary services (DRSG at 32). Honeywell that fast and automated DR would be essential for grid stabilization and high renewable penetration (Honeywell at 8-9). ABB commented

that virtual power plants should be utilized so utilities could aggregate programs, like DR, by type and location in the distribution topology. They thought this would assist with forecasting and processing data (ABB at 2). TekTrakker focused on the importance of reliability measurements in securing safe operation of the Smart Grid above all other things (TekTrakker at 5).

Other

Grijalva again emphasized the importance of simplicity and having a clear vision for the future electric grid and the electric industry architecture. He stressed it is more important to focus on functionality than technology (Grijalva at 11).

7. Reliability and Cyber Security

In this section the stakeholders agreed that there needed to be new policies put in place for sharing data; with regards to consumers and in between utilities, ISO's, and third parties. The stakeholders also agreed that the work of NIST was good and helpful and should continue to be supported.

Utility Providers

The utility stakeholder group had suggestions to improve reliability and cyber security overall as well as specific commentary related to sharing and protecting data. With respect to overall recommendations APPA commented that utilities need to use

encryption methodologies like the ones proposed by NIST (APPA at 29). They also suggested that utilities consider a defense in depth methodology; meaning incorporating security at all levels (APPA at 30). Others were in agreement and expressed that it was imperative for Smart Grid equipment manufacturers to address cyber security protection in the development and manufacturing process (NRECA at 70 and Progress at 28). APPA also suggested that there needed to be security isolation between the distribution system and the transmission system (APPA at 31). EEI remarked that Smart Grid technology testing centers were needed so that Smart Grid equipment could be tested to ensure compliance with cyber security standards (EEI at 56). They also again stressed the importance of interoperability standards (EEI at 55). The utility group had specific suggestions for the federal government. Pepco commented that the federal government should have the authority to set threshold policy standards for state compliance (Pepco at 24). APPA stated that the work of the National Electric Security Cyber-Security Organization (NESCO) and top cyber security research should be funded (APPA at 31). BG&E stressed that it was important for the federal government to clarify the term “automatic load shedding” to clarify whether this term would apply to large scale AMI systems (BG&E at 7).

In regards to specific recommendations about sharing data some utilities stressed that open sharing of substation and circuit configurations and their operational states should not be allowed beyond what is absolutely necessary. They felt that sharing that information with third party providers would provide an inappropriately broad view of a utilities system (EEI at 51 and Pepco at 23). EEI also commented that there needs to be better protocols for electric utilities, RTO’s and ISO’s to address risk mitigation with

regards to sharing data between these entities (EEI at 53). They went on to suggest that there needed to be a public private partnership data sharing model (EEI at 53).

Springfield commented that individual customer information about usage patterns should be deemed confidential and made exempt from mandatory sharing laws and policies (Springfield at 3).

Regulators and ISO's

The NY ISO commented that there needed to be an on-going risk based assessment of the Smart Grid in addition to impact assessment of new infrastructure and existing infrastructure (NYISO at 19). They also felt it was important to create a structure approach to evaluating vendor to ensure they were in compliance with security standards (NYISO at 20). NERC stated that future government initiatives and regulations for the Smart Grid must consider bulk power system reliability (NERC at 96). NERC also commented that Smart Grid technologies will change the character of the distribution system and must be incorporated into bulk power system planning (NERC at 96).

Consumer Protection Groups

NASUCA stated that it was necessary to have policies that prevent third parties from accessing consumers' personal information for marketing purposes. They also commented that utilities should update security measure at the same time that they update smart meters to best protect customers (NASUCA at 19).

Energy Advocates

The energy advocate stakeholder group had overall suggestion to improve reliability and cyber security in the Smart Grid but they also had specific recommendations for the federal government. Gridwise stressed that a risk management approach that focuses on protecting the functions of the electric grid was very important. However, they also commented that there needed to be a balance between the need to have cyber security and the need to reliably operate the power system (Gridwise at 6). Gridwise echoed the comment of the utility stakeholders that it was important for equipment manufacturers and service providers to incorporate security mechanisms in their equipment and across their environment in the development process to ensure cyber security down the line (Gridwise at 6). New America commented that open source IP based security system could help to improve reliability. They also noted that data from the Smart Grid should be stored locally so that it could be available to consumers (New America at 11).

For federal government recommendations, New America commented that the DOE needed to fund cyber security research (New America at 12). Galvin stressed that the work of NIST needs to continue to be supported (Galvin at 19). They also remarked that the DOE and FERC should establish federal reliability standards similar to Europe which requires reliability reposting from each city or county (Galvin at 18).

Appliance, Technology, and Service Providers

The ATSP stakeholder group had comments covering a wide spectrum. Some commented that Smart Grid equipment needed to be upgraded to use modern protocols that support encryption, authentication, and authorization (ABB at 2 and AHAM at 5-6). ABB also commented that if utilities wanted to secure legacy equipment without replacing them then they should be isolated into a zone to ensure (ABB at 2). Honeywell stated that T&D systems and AMI networks should be maintained as separate communication systems so that it will not be possible to access one system from the other and prevent widespread security incursions (Honeywell at 6). AT&T suggested that commercial communication providers should be considered to provide the Smart Grid communication system since they have so much experience with cyber security (AT&T 3-4). RedSeal expressed, that regardless of who provides what information system, it is important to conduct continuous monitoring and real time risk management. One time yearly audits are not sufficient (Red Seal at 2). TekTrakker suggested that the mean time between failures (MTBF) measurement standard could be used to help locate weak security spots in the electric grid (TekTrakker). Honeywell commented that customer data should be available on their premises so that customers can better optimize their system. They also suggested that firewall, cryptographic security measures and internet gateways were necessary to protect consumer data (Honeywell at 6-7).

The ATSP group also had a few suggestions for the federal government. There was again broad consensus that the work of NIST should continue to be supported (AHAM at 5, AT&T at 11, Honeywell at 9, NEMA at 8-10 and TIA at 11). Others were also in support of the NERC CIP approach to cyber security and thought they provided a

good example to follow (DRSG at 33, Honeywell at 6 and RedSeal at 2). RedSeal also suggested that the federal government should provide financial support for cyber security research (RedSeal at 3). Toshiba thought the federal government should establish administrative key management institutions (Toshiba at 3).

Other

No pertinent commentary provided.

8. Managing Transitions and Overall Questions

In this section, few new issues were discussed. Most of the commenters used this section to reiterate their major points discussed in previous sections.

Utility Providers

The utility stakeholder group had a few new comments to share with the DOE. Some commenters also stressed the importance of not being overly reluctant to deploy Smart Grid technology because it has not fully matured. They commented that doing so would stifle innovation and possibly postpone Smart Grid benefits. Some technology will not fully mature until it's deployed so utilities need to move forward (CenterPoint at 10, EEI at 62 and Pepco at 27). PPA commented that public power systems should conduct pilots because they have more of the consumers trust since they do not operate for profit.

The utility stakeholder group also reiterated some of their major point from previous sections. They implored the importance of thinking of the Smart Grid as evolutionary not revolutionary (APPA at 31-35, EEI at and Progress at 31). They felt progression of the Smart Grid should be measured and proceed at a cautious rate. They again remarked on the importance of education consumers about the Smart Grid (APPA at 31-31, CenterPoint at 9, EEI at 59 and Pepco at 25). The commenters also reiterated the importance of funding research for the Smart Grid. The listed a variety of issues they felt were important including cyber security, consumer behavior patterns, battery storage and home area networks (APPA at 36, CenterPoint at 11, EEI at 65, National at 2-4, Pepco at 27 and Progress at 33). Commenters also remarked on the importance of interoperability and collaboration between utilities, technology companies, consumer advocates and government stakeholders. They believed important programs like the Smart Grid Clearinghouse, NIST and collaborations on cyber security should continue to be supported (APPA at 36, EEI at 59, National at 8, Pepco at 25 and Progress at 33). Some utilities also stressed the importance of encouraging policies to fairly compensate utilities for taking risks. Policies like tax credits, appropriate cost recovery mechanisms, and efficiency standards (CenterPoint at 11, Pepco at 26 and Progress at 31-21).

The utility also re-iterated smaller points from previous sections such as the importance of having flexible software and firmware to take advantage of new technologies as well as better integrate legacy equipment (CenterPoint at 9 and Progress at 31). APPA also restated the importance of constraining mission critical systems from having outside connections to the public to ensure security (APPA at 34).

Regulators and ISO's

The public utility commissions and ISO's iterated some new and old points. Michigan again commented that regulatory policies needed to be put in place to allow utilities to rate-base investments in alternative energy (Michigan at 9). They also stressed, similar to the utility stakeholder group, that the Smart Grid should progress in phases and at a measured pace (Michigan at 9). NYISO stressed the importance of smart charging policy in encouraging the growth and adoption of plug-in electric vehicles (NYISO at 23). They also commented on the importance of net metering rules to encourage the participation of distributed renewable resources in markets (NYISO at 23).

Consumer Protection Groups

No relevant commentary provided.

Energy Advocates

The energy advocates stakeholder group reiterated the importance of defining clear Smart Grid goals. They felt that a clear national vision was importance for the success of the Smart Grid (Gridwise at 7 and New America at 12). They also repeated comments about the importance of the federal government providing policies that promote innovation and spur investment in Smart Grid technology and projects (Gridwise at 7 and New America at 12). Gridwise also commented on the importance of providing information and tools to help stakeholders make deployment and investment decisions (Gridwise at 7). Some commenters also discussed the importance of investing in

transmission and distribution (Gridwise at 7 and NYSGC at 30). NYSGC also repeated that customer engagement is critical and that there needs to be continued collaboration between universities, industrials and utilities (NYSGC at 14 and 34).

Appliance, Technology, and Service Providers

The ATSP stakeholder group brought up some new issues on how to manage transition in the legacy electrical grid to the Smart Grid. Some commenters stressed the importance of focusing Smart Grid deployments on infrastructure capacity, reliability, efficiency and sustainability (ABB at 2-3 and Toshiba at 3). DRSG commented that there needs to be federal incentives and policies to encourage Smart Grid investment (DRSG at 34 and 36). They also warned about the danger of delaying deployment of Smart Grid technology because the alternative would be investing in legacy equipment that could become stranded in the near future (DRSG at 35). Ingersoll also remarked that federal research spending should be directed towards large scale pilots to capture best practices (Ingersoll at 7). DRSG also reiterated the importance of educating consumers and having flexible software that can bridge the gap between legacy equipment and new equipment (DRSG at 34-35). Toshiba also remarked about the importance of energy storage (Toshiba at 4).

Other

No relevant commentary provided.

V. CONCLUSIONS AND ROADMAP MOVING FORWARD

After studying the comments of stakeholders from all across the electricity industry, it is clear there is much consensus on what needs to be done to improve the future U.S. electric grid. There are seven essential findings that were distilled from the comments. The findings outlined can address many of the issues with the current electric grid as well as barriers deterring the growth of the Smart Grid. The connection between the RFI findings to critical Smart Grid issues is demonstrated below in the info graphic in Figure 3. It links each of the discussed shortcomings in the overview to appropriate solutions identified by the author but derived from the responses of various stakeholders.

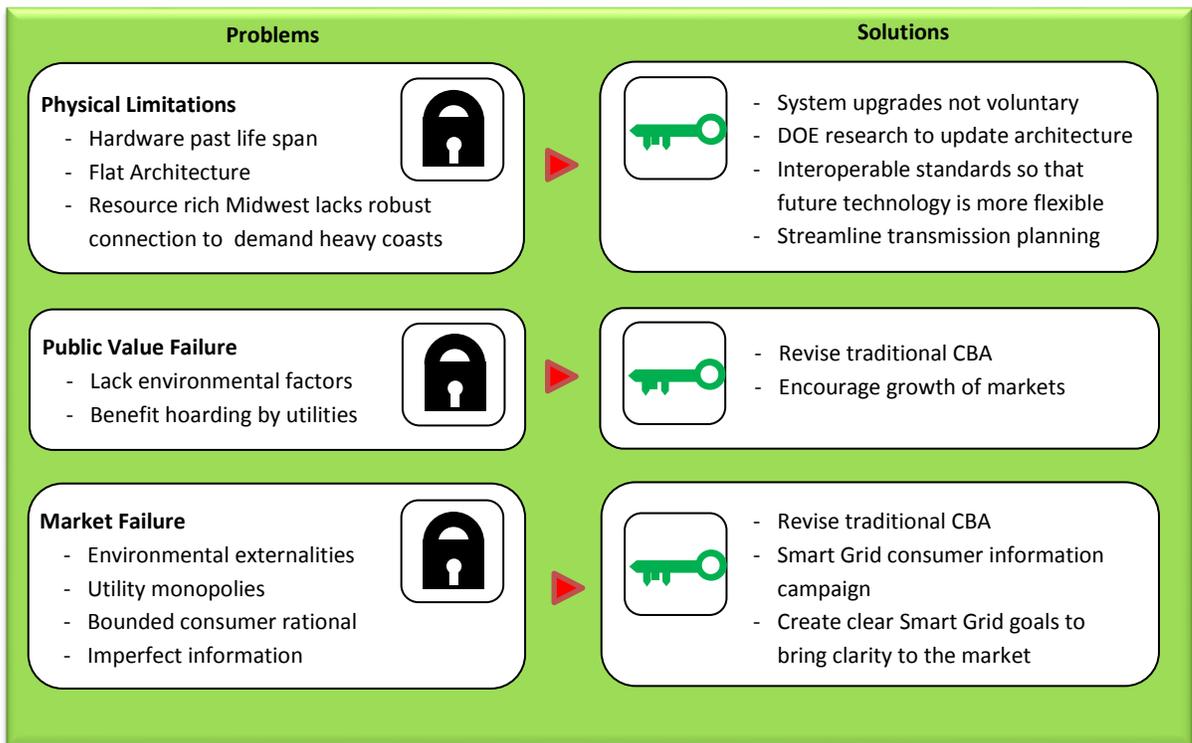


Figure 3: Smart Grid Solutions Info Graphic

It is important when recommending policies to not only identify solutions and link them to current issues but also to give a roadmap on how to implement the policies. Listed below are possible avenues for implementing each of the findings detailed in this thesis. The roadmap specifies who should be taking action and how they could proceed forward.

KEY FINDING 1: The Department of Energy needs to outline specific Smart Grid goals and success metrics.

The primary actor here would obviously be the Department of Energy. The best way to begin work on this recommendation is to review the DOE's current 21 Smart Grid metrics and identify where more specific goals can be outlined. For example, Metric 1 could be more concretely defined by setting a specific number or percentage of customers the DOE would like to see have access to dynamic pricing [32]. After adapting the subjective metrics to more concrete goals the DOE should re-convene electric industry stakeholders and take feedback from them on how to best finalize the specific goals.

KEY FINDING 2: The transmission planning process needs to be streamlined.

The primary actor for this recommendation would be the Department of Energy but it will require interaction with other federal entities, state PUC's, ISO's and RTO's. TO begin implementing this recommendation the DOE could act as an arbitrator between ISO's/RTO's and the affiliated state PUC's. DOE could help to explain the necessity of a

proposed transmission line and negotiate appropriate cost allocation strategies for the line. In addition to smoothing the communication lines between ISO's and RTO's the DOE should continue to be an active member of the Interagency Rapid Response Team for Transmission to shorten transmission line approval time.

KEY FINDING 3: A nationwide Smart Grid education campaign needs to be conducted.

The primary actors for this recommendation would be electricity industry stakeholders. The DOE would have a role as an organizer. A panel of various stakeholders needs to be formed, similar to the NIST panel. The primary difference in the panels would be the information they are seeking. The education panel would determine what information needs to be disseminated to consumers, the best method to deliver this information to consumers and who would be best to deliver the information. The education panel should work with the SGCC because they have already done a significant amount of study on education consumers on the Smart Grid.

KEY FINDING 4: The Department of Energy needs to continue to fund research and pilot programs and make that information/data widely available to all stakeholders.

The primary actor for this recommendation would be the DOE. It is intuitive that to fulfill this recommendation the DOE needs to continue to provide funding to Smart Grid researchers and valuable pilot programs. In addition to funding research the DOE

should continue organizing the SGIC so that stakeholders can continue to get valuable information about Smart Grid research and projects being conducted.

KEY FINDING 5: Consumer participations programs should be voluntary. System wide upgrades should not be voluntary.

The primary actor for this recommendation would be the Department of Energy. The best method to share this recommendation would be promoting the concept to state PUC's and utilities. The DOE could perform a small survey to validate the finding and publish the results and promote them as a best practice in the industry.

KEY FINDING 6: The traditional electric utility cost benefit analysis needs to be revised so that all projects receive equitable consideration.

The primary actor for this recommendation could be the Department of Energy or a major policy researcher. Study needs to be done to determine what would should be added or revised in traditional CBA's that would make create a fair evaluation for all energy projects. Simulations and models should be built to test the results of the study. In the end, the work should be published and the Department of Energy should promote the revised CBA to utilities as a best practice model when evaluating energy projects.

KEY FINDING 7: Open standards are needed to encourage interoperability. The Department of Energy should continue to support the work of the NIST Interoperability Panel.

The primary actor for this recommendation would be the DOE. It is again intuitive that to fulfill this recommendation the DOE needs to continue to provide funding and support for the NIST Interoperability Panel.

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