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US Department of Energy
Office of Electricity Delivery and Energy Reliability
1000 Independence Avenue, SW
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RE: Smart Grid RFI: Addressing Policy and Logistical Challenges

Pepco Holdings, Inc. (PHI) is pleased to respond to the US Department of Energy (DOE) request for information regarding addressing policy and logistical challenges to smart grid implementation. This follows on the heels of PHI's responses to two other DOE RFIs on data access and communications requirements.

PHI is one of the largest energy delivery companies in the Mid-Atlantic region. PHI's three electric distribution companies - Potomac Electric Power Company (Pepco), Delmarva Power (DPL) and Atlantic City Electric (ACE) - provide regulated electricity service to about 1.9 million customers in Delaware (DE), the District of Columbia (DC), Maryland (MD) and New Jersey (NJ).

DOE is focused on ensuring that smart grid deployments benefit consumers, the economy and the environment and PHI has laid out a series of responses to this RFI that it believes will address the critical issues associated with this challenge. PHI believes that:

- Customer education is a critical component of smart grid implementations;
- Utilities will evolve from providing energy to becoming trusted energy advisors;
- The speed at which smart grid technology is evolving will change the face of the utility industry more dramatically in the next 10 years compared with the previous century;
- Federal policy plays a large role in articulating the broad vision of smart grid but at the same time, states are closer to customers and therefore have an important role in customer acceptance, cost recovery and ensuring the nuances of each market are handled accordingly;
- In the regulated utility environment, smart grid related costs must be proven to be prudently incurred. The speed of deployments will move according to value and cost effectiveness.

There is a monumental task in understanding the policy and logistical challenges that confront smart grid implementation, and PHI would like to express its appreciation to the DOE for undertaking this effort.

PHI recognizes the criticality of staying at the forefront of not just smart grid technology developments in the marketplace, but the progression of smart grid-related regulatory, policy and standards as well. PHI welcomes DOE's interest in smart grid and appreciates this opportunity to respond to the attached questions. Thank you for the consideration of these comments.

Sincerely,

William M. Gausman

Department of Energy (Office of Electricity Delivery and Energy Reliability)
Smart Grid RFI: Addressing Policy and Logistical Challenges to Smart Grid Implementation
Pepco Holdings, Inc Response

Interactions With and Implications for Consumers
Typical consumers currently get energy consumption patterns and associated costs. They also have limited understanding of variations in the cost of providing power over the course of the day and from day to day. Many smart grid technologies aim to narrow the typical consumers' knowledge gap by empowering consumers with greater knowledge of and ability to control their consumption and expenditures. This vision transforms many consumers' relationship with the grid, which prompts us to ask the following questions.

1. For consumers, what are the most important applications of the smart grid? What are the implications, costs and benefits of these applications? What new services enabled by the smart grid would customers see as beneficial? What approaches have helped pave the way for smart grid deployments that deliver these benefits or have the promise to do so in the future?

As a company whose primary focus is the transmission and distribution of electricity, PHI envisions the smart grid as encompassing three domains: substation automation, feeder automation and home intelligence. Investments in the smart grid in each of these domains will provide benefits to customers, but it will be in the area of home intelligence where the benefits will be most visible to customers.

In order to provide significant benefits to customers, many utilities must undergo a step-function of technological advancement, which starts with the installation of an advanced metering infrastructure (AMI) across their entire customer base. These smart meters will serve as sensors that will monitor transactions at the point of service with the customer and provide situational awareness out to the very end of the smart grid and beyond. Through additional communications from the smart meter into the customer premise, the smart grid will be able to extend its reach even further, enabling a host of commercially developed devices and solutions that will directly benefit the consumer in a variety of ways.

One very significant benefit consumers are expected to receive is the increased ability to monitor and manage their energy use. Consumers will have a view into their energy use that they have never had before. Smart meters, in-home displays, smart programmable thermostats, and other devices and technologies will allow consumers to monitor and manage energy use as never before. These devices and technologies will also enable the deployment of dynamic pricing, advance energy management and load control and innovative rate mechanisms that will benefit consumers. In addition, consumers will have better information related to outages and estimated restoration times. These accomplishments will also lead to further developments to improve and enhance customer convenience. Some of these improvements include: flexible billing options, improved energy assistance capabilities and new rate options.

To prove the cost effectiveness of its smart grid strategy, PHI developed AMI business cases for each jurisdiction that it serves. These business cases included the costs, operational benefits and the benefits that customers could expect to see from AMI-enabled demand response. PHI enlisted the assistance of the Brattle Group to model the benefits of demand response in each jurisdiction. Each case showed that the combination of operational benefits and demand response benefits equaled or exceeded the costs.

But it will take more than just the promise of benefits in order for consumers to experience real value from the smart grid. PHI believes that the consumer is the ultimate 'intelligent end device' and must understand how to interface and gain value from the smart grid. Otherwise, utilities will have failed in their mission. Therefore, customer education is a key success factor in ensuring that customers can realize the promised benefits in a timely fashion. This includes educating the customer on dynamic pricing in a way that allows for them to understand it without penalty. For this reason, PHI is proposing critical peak rebate (CPR) programs as its first dynamic pricing offering, an option that carries little risk for the customer. In addition to dynamic pricing, our customers are also faced with understanding the benefits of smart meters, energy efficiency programs, renewable energy devices and markets and direct load control activities. Each of these programs has direct customer benefits. However, for customers to understand each program, and achieve the maximum benefits, they must understand how these programs work together and the behavior changes required to realize a reduction in energy usage. This will require the utility to have skilled representatives to assist customers and to help educate them on the use of energy. This includes the ability to perform home energy audits, details to help them understand the renewable energy markets and be aware of the benefits of energy efficiency activities.

2. How well do customers understand and respond to pricing options, direct load control or other opportunities to save by changing when they use power? What evidence is available about their response? To what extent have specific consumer education programs been effective? What tools (e.g. education, incentives, and automation) increase impacts on power consumption behavior? What are reasonable expectations about how these programs could reshape consumer power usage?

In 2007, the Smart Meter Pilot Program, Inc. (SMPPI) initiated PowerCentsDC. SMPPI is a non-profit organization comprised of the Consumer Utility Board, the District of Columbia Office of the People's Counsel, the District of Columbia Public Service Commission, the International Brotherhood of Electrical Workers and Pepco. PowerCentsDC was initiated to test the response of consumers to smart prices, smart meters, and smart thermostats in the District of Columbia. In July 2008, nearly 900 residential customers across the District began receiving electricity with one of three pricing plans for supply service: critical peak pricing (CPP), critical peak rebate (CPR), or hourly pricing (HP). Each customer received a smart meter that recorded power usage every hour, and those with a central air conditioner were offered a smart thermostat that automatically reduced air conditioning usage when power prices were high.

PowerCentsDC was one of many programs that have tested whether customers respond to time-based pricing by reducing energy use when prices are higher. It also tested the impact of smart thermostats on their response. The results of PowerCentsDC[1] showed that customers do indeed respond to time-based pricing. Participants in PowerCentsDC reduced their usage during events in both the winter and summer and across all pricing plans. The largest response was seen for CPP participants in the summer at 34% and the lowest was for HP customers during the winter at 2%.

An important finding was that customers with limited incomes responded in a similar fashion to customers with higher incomes. This was true even though customers with limited incomes generally use less energy than customers with higher incomes. Another important result was that when utilities really needed customers to reduce energy use due to very hot weather and high demand, most customers increased their response. CPP and CPR customers dramatically reduced energy on hot days compared to days with mild summer weather.

It was also found that smart thermostats do increase customer response in most cases. Response increased from 29% to 49% for CPP customers and from 22% to 51% for all electric CPP customers. Similar response increases were seen for CPR customers.

Almost all customers saved money on PowerCentsDC. Hourly customers saved on average 39% even though they reduced their usage during events by a small amount (4% in summer and 2% in winter). CPP and CPR customers enjoyed modest savings on average and over 91% of CPP and CPR customers paid less on PowerCentsDC than on standard pricing.

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[1] See PowerCentsDC™ Program Final Report, September 2010 at http://www.powercentsdc.org

Customers considering enrolling in PowerCentsDC hourly and CPP pricing plans made their decision based on relative pricing. They knew prices would be higher during events and lower otherwise and that if they were careful about their energy use when prices were higher, they could potentially save money on their electricity bill. Very few customers (less than 5 out of the nearly 900 volunteers) asked what the prices would actually be or how they would be calculated.

Another finding was that participants had a good experience with PowerCentsDC. They preferred PowerCentsDC pricing to their standard pricing by 93% to 7%, and 89% would recommend it to their friends. Only 6% were dissatisfied with PowerCentsDC. In general, if customers saved money on the program, they were happy with it. If they paid more, they were not as happy. This suggests that customers will on average accept dynamic pricing and reduce energy use during events if they enjoy even modest savings.

3. To what extent might existing consumer incentives, knowledge and decision-making patterns create barriers to the adoption or effective use of smart grid technologies?

a. ***For instance, are there behavioral barriers to the adoption and effective use of information feedback systems, demand response, energy management and home automation technologies?***

Electric retail customers, especially residential and small commercial, are not accustomed to thinking about when they use electricity. Customers in general have not yet integrated thinking about electricity into their daily personal or business activities outside of some interest in energy efficiency. PowerCentsDC demonstrated that offering relatively small rewards for using less energy during events is effective and that automation (via smart thermostats) increases their response.

PowerCentsDC also demonstrated that customers do not require detailed information to decide whether to participate. Providing information on relative pricing is sufficient for almost all customers.

As utilities and other entities introduce new pricing, energy efficiency and demand response options, adoption will depend on the perceived benefit and cost to customers in terms of dollars, time, convenience, entertainment, and contribution to social/community goals supported by individual customers. However, the utility industry will need to provide education for customers to understand what a smart grid means for them, how to use energy efficiently, how to reduce electricity use during demand response events, how to reduce their carbon footprint, what tools and services are available to assist them, and what their energy service provider would like them to do.

Customers have been receptive to using smart thermostats or switches that respond to signals provided by their energy service provider to reduce energy use during demand response events. Demand response program sponsors have developed techniques to reduce energy use without causing significant customer discomfort during events. This has contributed to customer interest in continuing with programs such as PowerCentsDC.

The technology to move beyond controlling central air conditioning and/or heating systems is still immature at this time. This presents a barrier for customers with window air conditioners to take advantage of automation to respond to demand response events. Often customers with window air conditioners have more than one window air conditioner - one Pepco DC customer reported in a focus group for PowerCentsDC that their household had nine window units. In addition, some window units will not resume operations if turned off and on using an external switch, which means that plugging the window unit into a device that communicates with an in-home network would not allow the window unit to respond to demand response signals.

The market for home energy management is emerging but customer awareness of home energy management and benefits is still limited. The industry will need to market to customers to build interest in and awareness of home energy management. The market will need to mature to provide products that are easy to install, maintain and use and that provide benefits to customers. Benefits may include non-monetary benefits such as convenience. For example, the customer with nine window units noted above expressed interest in being able to control them from one device rather than needing to turn each unit on and off manually. Marketing home energy management will need to focus on potential benefits from a customer perspective, which may be very different than from an industry perspective.

Absent the smart grid, limited opportunities today for home energy management present barriers for customers to respond to demand response events because automated response is only available via smart thermostats and switches. Customers can use timers on other electrical devices to avoid times when it is likely a demand response event would occur, such as running pool pumps at times when air conditioning or heating loads are less. For other end uses, customers do not have a lot of options. It may be possible in the future to avoid a defrosting cycle during a demand response event but customers generally do not have that as an option today. The inability to automate responses not only reduces response today but also deters customers from participation, especially for hourly pricing programs. During the enrollment process for PowerCentsDC, customers were wary of tracking prices for each hour of the day – this was seen as a much greater burden than responding to a limited number of events associated with critical peak rebate or critical peak pricing plans.

b. What are the best ways to address these barriers?

The utility industry will need to market the concept of energy management in terms of energy efficiency, reducing energy use during events, managing carbon footprints, incentive-based rates and managing energy bills. Marketing to all customers in a region for energy efficiency and demand response is just emerging. State regulators and utilities are aware that marketing and customer education are key components to the success of smart grid implementations and demand response programs and in many cases, are working collaboratively to develop marketing and education plans.

PowerCentsDC is an example of the value of working collaboratively to develop marketing and education plans for customers. The SMPPI Board had representatives from the regulatory agency, consumer advocate, the distribution utility, and a union. The SMPPI Board reviewed decisions about marketing, recruitment, enrollment, and operation prior to implementation.

Education plans for customers are emerging and over time, the industry will be able to evaluate the effectiveness of the various education strategies. It will be important to share information on education strategies and measure the effectiveness of these strategies, recognizing that there will be regional differences that need to be accounted for. It will also be important that regulators recognize the cost for utilities to implement these programs and conduct the customer education programs. In recognizing these costs, Commissions must also allow full and timely recovery of these costs.

c. Are steps necessary to make participation easier and more convenient, increase benefits to consumers, reduce risks, or otherwise better serve customers?

To promote energy efficiency, customers will need to be offered energy efficiency education.

Customers understand the concepts of time and money very well, but have little outside verification for kWh. The industry will need to transform data into useful information for customers, showing customized information to customers at a high level with the ability to drill down to more detailed information for those who are interested. Information of most interest will likely be related to energy spending.

Hourly pricing is unlikely to appeal to some percentage of residential and small commercial customers until home automation is available to set up the automatic response of electrical devices within a home to price signals. Pricing plans such as critical peak rebate and critical peak pricing offer an opportunity for customers to see savings from reducing energy use during critical peak periods while facing minimal risk since the number of events is limited in most cases.

d. Moreover, what role do factors like the trust, consumer control, and civic participation play in shaping consumer participation in demand response, time varying pricing, and energy efficiency programs?

Customers need a trusted advisor to help manage their energy bill and carbon footprint, and advise on how to use energy efficiently. Electric utilities are well situated to fill this role and are already viewed as a trusted source for energy information. The industry will need to continue to develop a trusted relationship with customers. This will come from continuing to work hard to develop this relationship – answering customers' questions, providing information on how to use less energy for a particular end use, and assisting customers with purchases of new appliances. In other words, the industry will need to proactively reach out to customers and initiate conversations with them about energy issues, rather than simply reacting to customer calls to start or end service, or to complain about an estimated or high bill.

Building trust requires following through on promises and commitments to customers. Trust is earned and does not necessarily come automatically. Customer calls regarding new smart grid topics – dynamic pricing, carbon footprint, renewable energy, net metering, energy efficiency, demand response, et al - are likely to take longer and require customer service representatives with more training and expertise. Billing on dynamic pricing is more complex and making changes to dynamic rate structures will take more time since more systems are involved. In order to effect a rate structure change, utilities will need to change a number of systems: billing, meter data management, web portal, bill print, email billing, and perhaps others. It is not unusual today for a billing change to be ordered and implemented within days. In the future however, the industry will need to allow sufficient time to effect changes, including time for adequate design and testing of new requirements. New functions within the customer information systems will be required and in many cases existing systems will not be able to provide these services. New customer information and billing systems will require years to implement and will cost each utility tens of millions of dollars.

Another aspect of trust is building a relationship that is based on respect and fairness. Customers should not be required to participate in demand response events or energy efficiency programs. Rather, customers should be invited to participate and be provided benefits from participation. Customers should be provided with assistance that is customized as much as possible. However, once a customer does participate there will be situations where the customer must participate in a called event and cannot have the option to not participate. This is needed during times when overall load must be reduced to maintain the reliability of the electric system.

Providing general information is useful, but information becomes more powerful when it relates more directly to individual households. As an example, providing information on energy spending for the current bill cycle can help customers avoid an unexpected high bill. CenterPoint is already providing a weekly bill update via email that customers can sign up to receive. PG&E provides customers with their household energy use-to-date and customers can then enter the kWh value on the utility web portal to determine their bill-to-date. In the PowerCentsDC program, Pepco provided a bill-to-date for customers with smart thermostats but the display area may have been too small to be as effective as possible, a key learning resulting from the study.

e. How do these factors relate to other factors like consumer education, marketing and monthly savings opportunities?

Education and marketing programs are necessary because customers will be participating on a voluntary basis. These will provide useful information to customers and create an awareness of the benefits for individual households and society as a whole. The marketing programs should be diverse to appeal to customers of different interests and backgrounds. For example, TVs are marketed to motivate customers to buy a new TV – upcoming sports events appeal to some customers while others may respond to watching old movies without advertisements. It will be important to understand the different motivations of customers to take effective steps to change their view of using energy.

For many customers, saving money on energy bills may provide enough motivation to join programs offered by the industry. Additional motivations to make further adjustments may come from an interest in the environment, convenience of home automation, being part of a team, being the first in the neighborhood to achieve a particular goal, official recognition of success and a number of other motivations. PowerCentsDC found that 73% of participants reported that their motivation for participation was saving money.

4. How should combinations of education, technology, incentives, feedback and decision structure be used to help residential and small commercial customers make smarter, better informed choices? What steps are underway to identify the best combinations for different segments of the residential and commercial market?

We should approach this issue in a similar manner to introducing a new product into our markets. First, we need to build demand for our products by educating our customers as to the full range of benefits available to them. We need to provide access to products, provide training on how to use our products, and make sure customers get benefits from our products. As part of this, we also need to educate customers on why their participation is necessary to achieve national goals for energy reduction. Along the way, customers can enjoy benefits on a household level and total societal benefits exceed the sum of individual household benefits. Feedback then should not be limited to individual efforts but include a summation of efforts of other customers as well and a comparison of their energy usage to their neighbors so that a degree of competition can be developed within the program.

General education about energy efficiency and demand response is useful, but customers are likely to respond more strongly to educational materials customized for their own household or business. This can be in the form of a chart on the monthly bill showing their usage for the month, a detailed analysis of their usage on a web portal that allows each customer access to their energy usage and history of usage, or a direct mailing that periodically shows their energy history and recommendations on how they can reduce their usage in the future. PowerCentsDC participants had a strong interest in the electric usage report because it showed charts of their own daily kWh use and spending. They had a similar response to the PowerCentsDC web portal that showed hourly use and broke it down into different pricing levels. Information that is customized for each household or business is actionable because the effort to apply it to each household has already been done.

In addition, providing a comparison to others is useful because customers do not know how they compare to similar customers. This information has simply not been provided to customers in the past. Typically, today customers may see a comparison to the average customer in the class. However, this average includes households that are of different sizes, apartments and condos are included with single-family homes, and old and new construction is averaged together. The information is so general that it often does not provide a useful comparison. Comparing to similar premises gives a more useful reference for customers. This is achieved by selecting households with a similar number of members, comparing single family homes with other single family homes, using similar size homes and showing what percentage of kWh is used during events or during peak hours. Customers can learn if they are larger consumers of energy when electricity is expensive, or if they are doing better than similar customers.

This information can then be used by the utility to provide advice to customers as to the best pricing plan. For example, customers who have the ability to reduce their energy usage more than average during peak events could be advised to take service under critical peak pricing in order to obtain ever greater savings. Customers who have less ability to reduce energy usage or have the need at times to use more energy than average should be advised to take service under a critical peak rebate plan and be assisted with a goal to reduce their energy use during events. These are the types of situations that are identified only by evaluating each individual customer's energy usage history and working with the customer to access their individual circumstances.

The goal would be to provide a consistent and cohesive experience for customers, from marketing and enrollment to education, feedback and advice. Feedback should be tailored to specific customer interest. For example, if a customer is interested in energy efficiency, feedback should be focused on energy efficiency. If a customer is interested mainly in demand response, then feedback should be focused on their reduction during demand response events.

The focus should not be solely on technology, but rather on the best method for customers to achieve their goals. Feedback should be directly related to customer and community goals and be provided in those terms most useful for customers. For example, some customers may prefer a fast feedback mechanism while others may prefer weekly or monthly feedback. At the same time, some customers may want to use a home energy management system while others may not. Also, some customers may want to set up every aspect of their energy management while others may prefer to let another entity set it up and manage it for them. Our industry should support customers in learning to participate in demand response and use energy more efficiently while allowing for various levels of involvement among these customers.

5. Are education or communications campaigns necessary to inform customers prior to deploying smart grid applications? If so, what would these campaigns look like and who should deploy them? Which related education or public relations campaigns might be attractive models?

Education campaigns will be a critical component of smart grid and should occur early in the implementation process. They should inform customers prior to when the customer will be able to realize the benefit, but it is also important that the systems and technology are in place to support the customer benefit, once the customer education begins. These education campaigns should set expectations appropriately for all involved. It is important to communicate that smart grid implementations happen over a period of years. In order to build trust, we need to educate customers on the significant time frame involved and when each smart grid application relevant to them will be available.

As noted earlier, campaigns should be designed and framed as the introduction of a new product into our markets. We need to build demand because customers will not automatically know what it means for a smart grid to be implemented in their area. Customers will need to be educated on potential benefits and what their participation will mean for their households or businesses, as well as for their community, state, and country.

Campaigns may be deployed by a variety of entities, including but not limited to: state regulatory agencies, federal agencies, distribution utilities, energy providers, chambers of commerce, and other community organizations. An important step is to coordinate campaigns as much as possible to provide a consistent message and avoid customer confusion. However, once household products become available to support energy efficiency and demand response, it may become difficult to coordinate across all parties since vendors will be competing with others for market share. Therefore, it will be important to coordinate as much as possible in the early days when the number of entities involved will be relatively small compared to the more mature future market.

6. What should federal and state energy policymakers know about social norms (e.g. the use of feedback that compares a customers' use to his neighbors) and habit formation? What are the important lessons from efforts to persuade people to recycle or engage in other environmentally friendly activity? What are the implications of these insights for determining which tasks are best automated and which should be subject to consumer control? When is it appropriate to use social norm based tools?

Customers appreciate comparisons when they are praised for good results and not chastised for poor ones. For example, when customers were provided with reports showing a symbol illustrating a frown "☹" when they used more energy than their neighbors, customers were upset rather than inspired to use less energy. Therefore, it is important to use positive reinforcement rather than negative feedback.

The lessons learned from recycling are also useful. Customers learned how to recycle by incorporating it into their daily lives. We need to do the same for energy use so that customers will incorporate energy efficiency and demand response into their daily activities. Customers were able to more easily incorporate recycling after a new industry requirement. This requirement was that manufacturers had to stamp a code on plastic bottles that conveyed the relative ease of recycling. Customers eventually learned the behavior of looking at the code before throwing a bottle into the recycling bin. We need to incorporate a similar model into our plans for energy. This model will involve using simple feedback methods to allow customers to decide if they can improve their use of energy. Using the example of appliances, this could involve providing a ranking of how well the new appliance will allow them to participate in demand response programs:

1. Very capable of support;
2. Capable of support;
3. Won't hinder or help;
4. Will make response difficult;
5. Will make response very difficult.

Customers may wish to control or program some tasks directly – such as when their home is warm or cool - because it directly affects their comfort, convenience or entertainment. Sample tasks that may fall into this category include when they do laundry, when they use their computers or watch TV. Other tasks such as defrosting the refrigerator or when dishwashers, sprinklers or pool pumps run may be ones not as readily noticeable to consumers. For these 'background' tasks, customers may be willing to set wider parameters, such as "my dishes need to be washed when I get up or return from work."

Laundry may be included as a 'background' task if washing and drying is eventually done primarily in one appliance rather than two. Currently, most people must take laundry from the washer and move it to the dryer. This means that laundry involves a manual component that is not as easily rescheduled without some significant changes to appliances. It is not practical to leave clothes sitting in a washing machine for a long period of time after washing and before moving them to the dryer. In the same vein, it is not practical to leave clothes sitting in a dryer for long periods of time before and after drying them.

7. How should insights about consumer decision-making be incorporated into federal-state collaborative efforts such as the Federal Energy Regulatory Commission's (FERC) National Action Plan on Demand Response?

Consumers vary widely across geographies, across demographic groups and across time. For federal-state collaborative efforts to be effective in supporting consumer migration to, and acceptance of, a more modern energy infrastructure and approach to energy management, these variances must be acknowledged and addressed. In particular, the shift to smart grid is a multi-phased process in which consumers will be exposed to wave after wave of new technologies, new functionalities and new market opportunities and dynamics. As a result, federal-state collaborative efforts must remain fluid and adaptive to insights gained regarding consumer decision-making during these various waves of smart grid migration.

Similarly, given the variable nature of consumers and the dynamic learning occurring, it is likely the deepest insights regarding consumer decision-making in the smart grid arena will be at the points closest to consumer contact. Distribution utilities, as direct providers of services, are closer to consumers than the government at any level. As a result, insights regarding consumer decision-making gained by utilities and state or local regulators should have a significant impact on any on-going federal-state collaborative efforts in the smart grid arena.

In summary, whereas federal policy makers and regulators may have the high level view needed to develop the most comprehensive and consistent goals for grid modernization, distribution utilities and their regulators at the state and local levels have the level of consumer contact needed for the most effective coordination of implementation and customer acceptance. Therefore federal policy must be integrated with state policy and a consistent message must be delivered across all customers and regions. Policy alone will not change customer behavior, but policy can support customer changes if it becomes part of the education plan and is understood and accepted by the customer.

Interaction With Large Commercial and Industrial Customers

8. Large commercial and industrial customers behave differently than residential consumers and small businesses. They regularly use sophisticated strategies to maximize their energy efficiency, to save money and to assure reliable business operations. Indeed, some already are or others are seeking to participate directly in wholesale energy and ancillary services markets. Please identify benefits from, and challenges to, smart grid deployment that might be unique to this part of the market and lessons that can be carried over to the residential and small business market. Please identify unmet smart grid infrastructure or policy needs for large customers.

Large commercial and industrial customers will receive the following benefits from the deployment of smart grid technologies: 1) reduced overall electric utility distribution operational costs, 2) downward pressure on regional wholesale electric energy and capacity prices as a result of smart grid-enabled demand response products for both residential and commercial customers, 3) distribution service quality improvements, that include the remote utility detection of service quality problems and avoidance of monthly unread meters, 4) improved distribution utility ability to integrate small scale customer-owned generation resources into the grid, 5) improved distribution utility ability to accommodate significant new electric loads, such as those related to adoption of electric vehicles, without the need to construct new distribution infrastructure and 6) additional utility flexible pricing plans that could be provided by the utility and/or a competitive load serving entity.

One challenging area for larger customers relates to master-metered commercial buildings with multiple tenants or residences. The issue with these facilities is determining a method of encouraging the occupants of these facilities to take full advantage of new demand response program offerings and/or detailed energy usage data. PHI has proposed the establishment of a pilot program in the District of Columbia to explore this issue more fully.

Assessing and Allocating Costs and Benefits

Regulators pay a great deal of attention to the costs and benefits of new investments, appropriate allocation of risk and protection of vulnerable customer segments. The many unknowns associated with smart grid programs make these ubiquitous questions particularly challenging, which suggests a great need to share perspectives and lessons.

9. How should the benefits of smart grid investments be quantified? What criteria and processes should regulators use when considering the value of smart grid applications?

The smart grid will yield significant benefits on many fronts and will revolutionize the way utilities work. The benefits will be achieved in phases and may evolve over several years as the smart grid matures and allows utilities to consolidate and optimize the various smart grid systems. Some of the benefits are quantitative and can be measured and audited in a relatively straightforward manner. Other benefits such as the integration of renewable and distributed generation and plug-in electric vehicles will be largely qualitative benefits and may be difficult to measure in concrete monetary terms.

Once a program is approved by the Commission then appropriate cost recovery should be allowed in a fair and timely manner.

Over a 3-5 year time period following the deployment of smart grid, utilities will begin achieving O&M savings associated with AMI and distribution automation. Utilities have developed a process for benefit evaluation and measurement for this phase of the work. Sample key benefits will be lower truck rolls due to accurate customer outage information (through AMI) and reduced trouble shooting time for field operators and control room operators (through distribution automation). These benefits can be measured and reported to regulators on a quarterly or annual basis.

Over a 5-8 year time period following the deployment of smart grid, utilities will be able achieve capital savings in terms of right sizing of the equipment (cable, transformers, etc) and possibly by deferring capital expenditure. PHI is still in the early development stage of formulating auditable estimates of the capital savings at this time. As the smart grid systems are installed and the industry matures, we will be able to more fully develop the capital savings estimates and report to regulators.

Savings realized by the company will be passed back to the customer in lower rates and deferral of rate cases, thereby saving the customer these expenses. The regulatory structure will allow for monitoring of these benefits and tracking of cost savings to ensure that the customer will realize the savings.

10. When will the benefits and costs of smart grid investments be typically realized for consumers? How should uncertainty about whether smart grid implementations will deliver on their potential to avoid other generation, transmission and distribution investments affect the calculation of benefits and decisions about risk sharing? How should the costs and benefits of enabling devices (e.g. programmable communicating thermostats, in home displays, home area networks (HAN), or smart appliances) factor into regulatory assessments of smart grid projects? If these applications are described as benefits to sell the projects, should the costs also be factored into the cost benefit analysis?

Consumers will begin to see benefits immediately. PHI believes that the smart grid will increase in capability and maturity as it evolves through five definable steps. The first step is the deployment of intelligent end devices. While this step includes intelligent devices in substations and on distribution feeders, the AMI meter is the foundational element of the smart grid because it functions as a sensor at the point of interface with the customer. Not only will it provide interval metering of the use of electricity, it will also provide a unique situational awareness regarding the quality of service at the customer premise.

The second step will be the deployment of a robust enterprise communication network that will capture the data from the intelligent devices and back-haul it reliably back to PHI for analysis. This network will have to be completely deployed before intelligent end device data can be received across the enterprise.

The third step is the integration of key IT systems in order to process the data more quickly and efficiently. This includes the utilization of a common information model and architecture that supports high volume data transfers between key systems of record.

The fourth step is the network analytics stage. If the wide deployment of intelligent end devices leads to more data, then more data leads to better information and better information leads to better decisions. It is this step where we start to truly listen to the system. By performing advanced analytics and metrics on this new data, a whole new vision emerges related to how to properly manage assets connected to the grid.

The fifth and last step is the optimization stage. In this stage, real-time optimization can be enabled to provide a higher level of precision and efficiency than ever before related to the distribution of energy, from the substation to the customer. This will include monitoring and control capabilities for distribution equipment, such as variable transformers, capacitor bank controls, voltage regulation controls, sectionalizing switches, as well as customer-owned load controls such as air conditioning and plug-in vehicle charging.

From a smart grid perspective, the first three steps are the steps necessary to get the technology in place. The next two steps are the ones that maximize the value of the technology.

PHI believes that the capabilities included in the first 3-4 steps will be enabled across the majority of its service territories over the next five years. These capabilities will enable the majority of initial customer benefits, which include better understanding and control of energy usage. Included in the benefits are AMI-enabled direct load control and variable pricing options, including critical peak rebate and critical peak pricing. Many of these benefits were outlined in the AMI business cases that were filed in each jurisdiction. Business cases must be based on all available information at the time they are made. Future business cases – including those for various IT systems – must be evaluated based on their own merit. Future information underlying business cases will likely differ from information used in past business cases. Based on the results achieved during the PowerCentsDC trial, PHI is confident that customers will achieve the benefits related to variable pricing.

11. How does the notion that only some customers might opt in to consumer-facing smart grid programs affect the costs and benefits of AMI deployments?

A typical AMI deployment is comprised of meters, a communications network and integrated IT systems. In most cases, AMI is deployed to the vast majority, if not all, consumers. The exception could be larger commercial and industrial customers that already have a form of sophisticated remote metering and therefore do not require AMI. Since almost all customers typically receive AMI meters and associated components, deployment costs are not impacted whether or not customers opt in to consumer-facing programs.

However, there are examples where the number of consumers in a program may impact ongoing variable incremental operating costs of AMI-enabled programs. For example, a voluntary critical peak dynamic pricing program may only attract 20% of residential consumers. If the program requires notification (e.g., by e-mail and/or text message) to each consumer prior to each critical peak event, then the operating costs will vary based on the number of critical peak events and the number of consumers enrolled.

Benefits derived from reduced utility operating costs accrue to all consumers and can help reduce the costs associated with AMI. For example, replacing manual meter reading with AMI's automated meter reading or being able to identify a customer outage without the need for the customer to call are benefits that all consumers will receive. Therefore Commissions should approve the installation of AMI meters for all customers and develop a rate structure that applies to all customers that utilize the capabilities of these meters. Other programs enabled by smart meters can be voluntary, yet market impacts will flow to all customers within a region.

Demand response has benefits that accrue to both those enrolled in the program, as well as all consumers. For example, reductions in peak demand in response to AMI-enabled dynamic pricing programs can directly benefit those consumers enrolled in the programs. At the same time, the lower peak that demand response realized from the enrolled consumers can benefit all consumers. This is due to the downward pressure exerted by the lower peak on energy and capacity prices in the electricity market. The lower peak demand also benefits society as a whole by reducing the need to operate more costly and more polluting peak load generating units such as diesel generators. Finally, AMI is the foundational platform for the smart grid that utilities and other parties can build on to deliver additional operational and consumer facing benefits in the future.

12. How do the costs and benefits of upgrading existing AMR technology compare with installing new AMI technology?

PHI has not deployed AMR technology.

13. How does the magnitude and certainty of the cost effectiveness of other approaches like direct load management that pay consumers to give the utility the right to temporarily turn off air conditioners or other equipment during peak demand periods compare to that of AMI or other smart grid programs?

PHI believes that these programs are complimentary. PHI believes that direct load management is an effective approach for curbing energy usage during peak periods. Indeed, PHI has implemented direct load management in some of its service territories. However, direct load control programs by themselves do little to change customers' behavior with respect to reducing their overall energy consumption.

Several studies have shown that when customers are presented with information regarding their energy consumption, many will voluntarily chose to conserve energy. AMI, demand response and other smart grid programs represent an opportunity to build on the successes of direct load management to reach larger numbers of customers and therefore have a larger impact on both peak reduction as well as energy usage.

PHI views this as a shift in control from the utility to the customer. As stated in the question above, direct load management gives the control to the utility. However, other demand response programs enabled by AMI and other smart grid technologies will shift the control and decision-making to customers. When customers are empowered to make their own decisions and monitor and control their own energy usage, the potential is huge. The PowerCentsDC pilot, discussed earlier, proved the potential of such programs.

14. How likely are significant cost overruns? What can regulators do to reduce the probability of significant cost overruns? How should cost overruns be addressed?

AMI is comprised of three major components: meters, a communication network and integrated IT systems. The largest percentage (75% to 80%) of the total cost is for the meters and their installation. The costs for the meters and associated installation costs are well established in the marketplace and through contracts. Therefore, the likelihood of a cost overrun for this component is low.

The cost of the second component, the communication network, varies depending on the type of AMI technology deployed. Of the three components, the communication network is typically the smallest percentage (5% to 10%) of the total cost. This cost is a function of the number of meters and the environment of the network. For example, costs may vary between dense urban areas and sparse rural areas. Given that the communication network is the smallest cost percentage, the likelihood of cost overruns in this component causing a significant overrun in the overall deployment is also low. In addition, these costs are controlled by the contracts that are established with the communication vendor that require a certain level of performance and detailed testing to assure compliance with these requirements.

The third component, the integrated IT systems, can comprise 10% to 20% of the total AMI costs. The cost here is a function of several complex variables. These include: the required capabilities needed to deliver the expected benefits, the types and numbers of new IT systems acquired, the nature of the IT architecture the systems must integrate with, and the degree to which internal utility labor along with external software vendor and consulting services are needed to design, build, test and implement the systems. Therefore, the third component has the most variability – and therefore potential for cost overruns - due to the relatively new and developing software applications associated with AMI. Again these costs can be managed with an appropriate contract that outlines the work to be performed and metrics for performance.

Another ongoing cost that could be subject to overrun is the cost associated with customer education. This cost typically has several interested stakeholders such as the utilities, regulatory Commissions, other governmental agencies and various interveners. These stakeholders will often have differing opinions on the content, delivery and timing of customer education. This increases the likelihood of variability in cost and therefore potential cost overruns.

The risk of cost overruns can be mitigated by utilities in a number of different ways. For example, utilities should clearly define the expected benefits and therefore the scope of their AMI program right from the start. Utilities should also establish and use a well-executed governance body along with a program management office to control and monitor progress and use proven project management techniques such as contingency funds and others.

At the same time, regulators can help decrease the probability of cost overruns by working with utilities and other parties to establish expected benefits and not attempt to revise or add new technologies once a plan has been established by the utility. Regulators can also help by addressing utilities' and other parties' filings in a timely manner.

15. With numerous energy efficiency and renewable energy programs across the country competing for ratepayer funding, how should State Commissions assess proposals to invest in smart grid projects where the benefits are more difficult to quantify and the costs are more uncertain?

To the extent that smart grid investments are not part of the normal technological improvement of the transmission and distribution infrastructure, proposed smart grid investments should be evaluated on a benefit/cost basis. Commissions should only approve proposals that can be quantified and benefits identified. Like many programs, it may not be possible to identify all benefits prior to the implementation of a program. However, these additional unidentified benefits would be in addition to the benefit/cost analysis performed at the time that the program was approved. Benefits include those that are directly quantifiable (typically utility operational savings) and those that are more difficult to quantify (service quality improvements, demand side related benefits, environmental benefits, etc.). Forecast energy efficiency and peak demand savings should be valued on the basis of regional wholesale markets, where there is a competitive market, or based upon the marginal cost of generation and the marginal cost of transmission and distribution system build out. Short-run supply-side market price mitigation estimates should be incorporated. Grid integration of distributed renewable generation should be valued, but it is difficult to directly quantify this grid benefit. In the absence of an estimable renewable generator integrations benefit, a national study should be developed to support appropriate quantification of this estimate.

16. What are appropriate ways to track the progress of smart grid implementation efforts? What additional information about, for example, customer interactions should be collected from future pilots and program implementations? How are State Commissions studying smart grid and smart meter applications in pilots? In conducting pilots, what best practical approaches are emerging to better ascertain the benefits and costs of realistic options while protecting participants?

PHI believes that here have been adequate pilots performed across the county to verify that the AMI systems being installed will provide significant benefits to customers. There is no need to perform any additional pilots.

17. How should the costs of smart grid technologies be allocated? To what degree should State Commissions try to ensure that the beneficiaries of smart grid capital expenditures carry the cost burdens? Which stakeholder(s) should bear the risks if expected benefits do not materialize? How should smart grid investments be aligned so customers' expectations are met?

Initially, smart grid related investment costs should be allocated on the basis of the traditional utility cost of service methodology in each jurisdiction. Commissions should examine the manner in which benefits are expected to flow to consumers and if they determine it appropriate to do so, realign smart grid cost allocation to reflect the projected benefit stream. Utility smart grid vendor contractual provisions will help to ensure that consumers receive the expected smart grid improvements. All entities should carefully work to shape consumer expectations in a reasonable manner. Consumer communication efforts should seek to "under promise," but "over deliver" smart grid capabilities to ensure that consumer expectations are met or exceeded. Once smart grid programs are approved, Commissions should allow full recovery of all prudentially incurred costs.

18. When should ratepayers have the right to opt out of receiving and paying for smart grid technologies or programs like meters, in home displays, or critical peak rebates? When do system-wide benefits justify uniform adoption of technological upgrades? How does the answer depend on the nature of the offering? How should regulators address customer segments that might not use smart grid technologies?

Consumers who remain connected to the electric distribution and/or transmission system should only be permitted to "opt out" of smart grid related components that are not necessary to provide smart grid operational benefits. For example, AMI meters should not be optional, but in-home displays should be optional. Generally, smart grid supported programs such as critical peak pricing should be optional, but other programs such as critical peak rebate dynamic rates could be offered on a default basis to consumers, based on consumers' understanding of the program and approval by regulators. Smart grid programs should be developed to be attractive to most customer market segments, but it is unlikely that every customer will choose to take advantage of all program offerings. All customers will benefit from additional demand response/energy reductions within each market, although only a portion of customers will choose to actively participate.

19. How might consumer-side smart grid technologies, such as HANs, whether controlled by a central server or managed by consumers, programmable thermostats, or metering technology (whether AMR or AMI), or applications (such as dynamic pricing, peak time rebates, and remote disconnect) benefit, harm, or otherwise affect vulnerable populations? What steps could ensure acceptable outcomes for vulnerable populations?

Some have argued that the smart grid will supply little benefit for vulnerable populations. In fact, evidence is emerging that supports the fact that vulnerable populations can and do save money when they participate in variable pricing and direct load control programs. As noted above, the PowerCentsDC pilot that was recently completed in Washington, DC, concluded that vulnerable populations, such as low-income populations, did save money over the course of the program. For example, CPR customer results, when broken out by income level, show that customers with limited income responded in a similar fashion to customers with higher incomes. This is true even though customers with limited income generally use less energy than customers with higher incomes. Customers with regular incomes showed peak reductions of 13% while those with limited income showed peak reductions of 11%.

In addition to variable pricing programs, vulnerable populations can also benefit from the use of in-home display technology and web portal information in order to better understand their daily energy use. This information is not only useful for reducing overall energy use, but also for understanding where overall consumption is with respect to a monthly budget. With this information, customers are better equipped to take steps to conserve in order to stay on budget.

Moving forward, utilities, along with regulators, will continue to consider and take steps to protect vulnerable populations as new rate and service innovations are introduced.

Utilities, Device Manufacturers and Energy Management Firms

Electricity policy involves the interaction of local distribution utilities, bulk power markets and competitive markets for electrical appliances and equipment. Retail electricity service is under state and local jurisdiction. Generally, bulk power markets are under FERC jurisdiction. Appliances comply with federal safety and efficiency rules. Smart grid technologies will change the interactions among these actors and should create new opportunities for federal-state collaboration to better serve citizens. Greater collaboration seems essential. Some state regulatory agencies already oversee energy efficiency programs that help ratepayers acquire equipment like energy efficient appliances. Those appliances also are subject to federal regulatory oversight. As the smart grid evolves, these types of ties are likely to deepen. Moreover, EISA foresees a federal role in developing potentially mandatory standards for some smart grid equipment and voluntary standards for smart grid enabled mass-produced electric appliances and equipment for homes and businesses. Many commentators suggest that utilities may lack appropriate incentives to invest in the most cost effective smart grid infrastructure and allow that infrastructure to be used to conserve energy, because most service providers generate revenue based on the number of kilowatt hours sold and pass through the capital costs of things *like smart grid infrastructure. If this is accurate, then those disincentives are an impediment to achieving national and state goals and, therefore, merit state and federal policy makers' attention. In issuing this RFI, DOE is mindful that the states oversee retail electric service and that state regulation differs state by state. Within states different types of service providers may be subject to different regulatory schemes depending, for example, on whether the service provider is investor owned, publicly owned or a cooperative. Recognizing the primary role of states in this area, we ask the following questions:*

20. How can state regulators and the federal government best work together to achieve the benefits of a smart grid? For example, what are the most appropriate roles with respect to development, adoption and application of interoperability standards; supporting technology demonstrations and consumer behavior studies; and transferring lessons from one project to other smart grid projects?

Whereas federal policymakers and regulators may have the high level view needed to develop the most comprehensive and consistent goals for grid modernization, distribution utilities and their regulators at the state and local levels have the level of consumer contact needed for the most effective coordination of implementation and consumer acceptance. PHI believes it is appropriate for the federal government to set over-arching goals for smart grid, including implementation goals such as national rollout timelines and perhaps energy conservation and peak demand reduction targets. However, state and local governments must have the capacity to make implementation decisions sensitive to their particular consumer populations and energy market dynamics.

There are particular areas of policy with regard to the smart grid where scalability and security necessitate a national approach. In these areas, the federal government must have the authority to set threshold policy standards for state compliance and authorize cost recovery for utilities that comply with federal policy. Policy areas where this seems necessary include:

- Interoperability;
- Cyber security;
- Data privacy;
- Communication resources and implications.

In these crucial areas of policy, allowing the formation of a patchwork of state-by-state standards would diminish efficiencies and increase developmental and operational costs without offering any clear benefit.

Similarly, the federal government should also lead on a number of smart grid initiatives because of its high level view and its existing technology research funding and execution mechanisms. These initiatives include smart grid research, technology development, technology demonstration, and information dissemination both in the technology arena and with regard to lessons learned from implementations across the nation.

21. How can federal and state regulators work together to better coordinate wholesale and retail power markets and remove barriers to an effective smart grid (e.g. regional transmission organization require that all loads buy ''capacity'' to ensure the availability of power for them during peak demand periods, which makes sense for price insensitive loads but requires price sensitive loads to pay to ensure the availability of power they would never buy)?

As DOE observes, the Federal Power Act generally provides for federal regulatory authority over bulk, wholesale power transactions and state and local authority over retail electricity service. Whenever issues arise from jurisdictional "seams," it is sensible for the regulatory bodies, the entities they regulate, and other stakeholders to discuss the issues. Such dialogue can bring about greater understanding and coordination.

In this instance, FERC-regulated RTOs have some ability to encourage or impede demand reduction and energy efficiency programs that may be enabled by the smart grid. RTOs that provide appropriate market signals for such programs will provide inducement for the technologies that enable the programs. RTO communication to the states that it serves can go a long way to minimizing or correcting any potential misunderstandings about the RTO's actions that may occur.

22. How will programs that use pricing, rebates, or load control to reduce consumption during scarcity periods affect the operations, efficiency, and competiveness of wholesale power markets? Will other smart grid programs have important impacts on wholesale markets? Can policies improve these interactions?

The absence of adequate quantities of demand response from electricity consumers significantly increases the cost of providing electricity within the United States. The US electricity supply system is designed to meet consumers' highest level of electricity demand whenever it occurs. Generally consumer electricity prices fail to track wholesale electricity market conditions. In the absence of adequate price signals, consumers tend to over-consume electricity during periods of scarcity and under-consume electricity during other times. Clearly, increased demand response capability will improve utility operations by reducing demand during periods of scarcity. Demand response will also improve market efficiency by providing more accurate price signals and automated load reduction capability to consumers. Increased demand response capability can also reduce generator wholesale market power. Additional demand response will place downward price pressure on wholesale electricity markets during periods of market scarcity.

The availability of detailed information about grid conditions will assist both utilities and independent system operators to manage generation and transmission resources.

National policies that encourage additional smart grid supported demand response programs will help to ensure that programs are established in the United States and will encourage state regulatory Commissions to approve and financially support these initiatives. Policies that encourage independent system operators to develop market rules permitting demand response resources to be fully integrated into the market – along with the monetization of market benefits - will greatly assist utility efforts to establish smart grid enabled demand response programs.

23. Do electric service providers have the right incentives to use smart grid technologies to help customers save energy or change load shapes given current regulatory structures?

In states where electric distribution revenue decoupling from energy use has occurred, a utility's disincentive from investing in energy efficiency and/or demand response initiatives is reduced. In addition, the Commissions should not disadvantage the company by reducing the allowable rate of return below acceptable levels just because a decoupled rate structure has been established. The challenge with obtaining timely regulatory approval of smart grid components, such as advanced metering infrastructure, represent substantial barriers to the near-term deployment of these smart grid components. It is important that investors be assured that smart grid investments are likely to be recovered and will earn a reasonable rate of return.

24. What is the potential for third-party firms to provide smart grid enabled products and services for use on either or both the consumer and utility side of the meter? In particular, are changes needed to the current standards or standard-setting process, level of access to the market, and deployment of networks that allow add-on products to access

information about grid conditions? How should the interaction between third-party firms and regulated utilities be structured to maximize benefits to consumers and society?

It should be remembered that smart meters are installed by the utility for the purposes of interval metering, power quality sensing and to provide customers with electrical usage information to facilitate reducing their overall energy consumption. Using the Smart Energy Profile (SEP), customer energy consumption data will be sent directly from the AMI meter to an in-home display or to the customer's home energy management system through a one-way communication medium such as Zigbee. It is at this point where there is the potential to introduce third parties into the mix within the customer premise.

PHI takes a firm position that only registered and reputable third parties should be permitted access to this information, assuming the customer consents to sharing such information. The state registration process should require that such third parties have in place appropriate firewalls, encryption methods, etc., as may be established in accordance with the NIST Smart Grid Cyber Security Strategy and Requirements (NISTIR 7628) and accepted by PHI.

Only those third parties that are registered by the state or local jurisdictions, such as third party energy providers, and who have permission from the customer, should have access to a specific customer's energy consumption data. These third parties must be legally, morally and ethically bound to maintain the confidentiality of the customer's personally identifiable information (PII) in order to be registered and must agree not to correlate data obtained from PHI with other sources of data for the individual, without consent of the individual. Methods such as pseudonymization or anonymyzation of identity should be used to ensure that customer personal identifiable information can be separated from customer energy consumption data where possible.

With the rollout of AMI meters and other smart grid components, a number of new third parties are likely to enter the market, or have already entered the market. These new third parties cover a wide expanse of different industries such as telecom providers, software providers and device manufacturers. Such names as Microsoft, Google, Control 4, Tendril and a host of others have indicated their desire to provide services to customers. These third parties will all be vying for different pieces of the market. The impacts on utilities will be multifold and include: new competition, innovation and the development of new and currently unknown products and services, issues surrounding customer data and privacy and how this is shared securely, to name just a few of the new issues utilities will face in the future from these new third parties.

In addition to the evolution of new third party opportunities, existing utility equipment providers will find themselves in a rapidly evolving compliance maturity model as they adapt their products to include many of the new standards for encryption and intrusion detection that are being recommended. Continued development of smart grid interoperability standards, which will include cyber security controls will be the key to maintaining smart grid reliability and compatibility moving forward. Vendors, in turn, must be willing to quickly adapt these new standards into existing products in order to achieve success.

25. How should customer-facing equipment such as programmable communicating thermostats, feedback systems, energy management systems and home area networks be made available and financed? Are there consumers behavior or incentive barriers to the market achieving efficient technology adoption levels without policy intervention?

PHI envisions a home area network environment that includes the capability to communicate through its AMI network to at least a programmable communicating thermostat (PCT) and an in-home display (IHD) device. PHI believes that the development of home energy management devices and the implementation of smart appliances should be left to those who are expert in these fields and can provide a better customer experience at a lower cost, provided that they can meet the cyber security and customer data privacy recommendations as outlined by the NISTIR 7628.

It is PHI's position that not all customers will desire an in-home display device, but the majority of them will receive their energy usage data from the PHI web portal or from the display of a PCT. Free standing IHDs will be considered for customers who are not able to receive information for either of these two sources. In addition, PHI believes that smart phone applications will rapidly evolve to fill the role of the IHD with consumers, thus replacing the notion of a stand-alone IHD.

It is critical that cost recovery be timely and complete. Cost recovery for any utility incurred costs should be through traditional distribution rates. Prior to inclusion in base rates, a deferred regulatory asset, which could be in the form of a demand side management surcharge or as part of an overall AMI cost recovery, should be used. It is possible that the utility could offer a rebate to customers to cover a portion of the cost of devices, similar to the manner that existing energy efficiency and conservation rebates are covered.

26. Given the current marketplace and NIST Smart Grid Interoperability Panel efforts, is there a need for additional third-party testing and certification initiatives to assure that smart grid technologies comply with applicable standards? If there is a need for additional certification, what would need to be certified, and what are the trade-offs between having public and private entities do the certification? Is there a need for certifying bodies to oversee compliance with other smart grid policies, such as privacy standards? Commenters should feel free to describe current and planned deployments of advanced distribution automation equipment, architectures, and consumer-facing programs in order to illustrate marketplace trends, successes, and challenges. And they should feel free to identify any major policy changes they feel would encourage appropriate deployment of these technologies.

The purpose of a standard is to create a common and uniform understanding of a technology. Electronic and power technology interoperability is an aspiration of the community developing smart grid standards. This highlights the need for a dedicated user's community tasked with identifying interoperability challenges (requirements), writing tests to validate products, and certifying results.

With emerging smart grid technologies there is significant benefit in testing and certifying these technologies and devices. Rigorous testing and certification by the manufacturers will ensure components are compatible with other technologies and meet industry standards. This process will enable quicker smart grid deployments, while at the same time ensuring devices are secure. Failure to follow this process could lead to undesirable consequences. For example, if standards are not readily adopted by the industry and components are not tested and verified for interoperability, then incompatible systems being deployed in the field may result in the necessity for costly premature replacement. Furthermore, if systems and components are not built to standards then security weakness may be introduced into these systems.

The actual testing and certification phase of the NIST/SGIP efforts has not yet started. However, work has begun on requirements and certification criteria for the testing and certification laboratories. The requirements for testing and certification laboratories need to be determined and addressed as soon as possible. Cyber security must be included as a key component of this testing and certification.

Data privacy standards should be considered for smart grid development, deployment and implementation. These privacy standards may be similar to those set for federal government agencies in FIPS-199 (Federal Information Privacy Standard), the Privacy by Design concept developed by the Information and Privacy Commissioner of Ontario, Canada, and those set for the financial services industry under the Gramm-Leach-Bliley Act. In addition, NIST is evaluating new privacy exposures that may be created in smart grid environments, and identifying best practices for meeting these exposures. As with all smart grid equipment standards, if these standards or other standards become part of the solution, then testing and certification of these standards must be part of the scope.

PHI believes strongly that customer information should not be made available to third-party service providers without the full knowledge and consent of the customer. In addition, PHI believes that third-party service providers should be required to obtain state approval before they are deemed to be eligible to receive this information. Such third-parties should be subject to the same data privacy and security standards as the utility gathering the information. An overall testing and certification governance body would help ensure that parties share appropriate information safely and securely.

Testing and certification must be a coordinated effort between groups. PHI believes there should be a certifying body to oversee compliance of the testing and certification process.

Long Term Issues: Managing a Grid With High Penetration of New Technologies

Significant change in the technologies used to generate power and to keep supply and demand balanced is likely to occur over the foreseeable future. We invite comments on the steps that should be taken now to give the grid the flexibility it will need to deal with transitions that are likely in the next few decades. Commenters might address the following questions, some of which have more immediate implications.

27. What are the most promising ways to integrate large amounts of electric vehicles, photovoltaic cells, wind turbines, or inflexible nuclear plants? What approaches make sense to address the possibility that large numbers of other consumer devices that might simultaneously increase power consumption as soon as power prices drop? For instance, what is known about the viability of and tradeoffs between frequently updated prices and direct load control as approaches to help keep the system balanced? How do factors like the speed of optimization algorithms, demand for reliability and the availability of grid friendly appliances affect those trade-offs?

The ability to control loads and small distributed renewable generation in a real-time or semi-real-time approach will be needed to facilitate increased accommodation of new resources while continuing to support the operation of legacy electrical base load generating equipment. Real-time pricing that allows a combination of delivery and commodity pricing would be ideal to enable customer choice. However, much more work is required to understand the relationship between customer usage and the demand increases when price signals drop. The Pacific Northwest National Lab (PNNL) study of real-time pricing signals sent out at 5-minute intervals is a good place to start, but more studies are needed. The ability for the distribution system to respond to these sudden swings in energy usage will create unique challenges for the distribution utility. New controls will have to be developed and energy storage devices will be needed to maintain the reliability of the system and not create high or low voltage situations that customers will view as reductions in the reliability of the electric system. Customers will also have to accept that the utility will be managing their energy usage and that there will be times of the day when operation of appliances or charging of the vehicle will not be allowed.

Real-time pricing will help support a number of capabilities. These include active feeder control for distribution feeders, bulk transmission, transmission and substation level constraint resolution, better asset utilization at many levels and a number of other capabilities. Real-time prices will automatically adapt as customers change load profiles and generation profiles. Home energy management (HEM) devices will be required to make real-time pricing work for the end user while providing benefit to the grid. These HEMs must be easy for end users to program to automatically control their electrical usage. For example, as the HEMs receive higher price tiered signals from the utility, they will automatically curtail use such as HVAC set back, dryer elements, electric vehicle charging, hot water heating, refrigerator cooling levels and defrost cycles and pool pumps. In addition, HEMs may control photovoltaic (PV) panels. This would require appropriate functionality in the end appliance so that as the end user takes advantage of moving their electric use to less costly periods, they are also providing the change the grid needs to operate robustly. All of these activities will require close coordination between the utility and the customer as the demands for a higher reliability of the distribution system is being expected by all customers.

In the near future, tiered pricing signals will be sent out that will allow HEMs to automatically adjust customers' electrical usage to a predefined demand level. These price signals will help reduce system load, local area load, or possibly just the distribution transformer load (i.e., in the case where multiple EVs are charging). This will help prevent overloads during emergency conditions. For customers that cannot afford, or chose not to obtain HEMs, traditional utility direct load control (DLC) programs will continue to be deployed to reduce energy consumption.

On the utility side, there will be a need for programs that can analyze many levels of the grid and utilize pricing signals to monitor and manage grid operations. On the customer side, there will need to be automated ways of responding to pricing signals along with new appliances that can actually respond "on the fly." The program that the grid operator uses may need to have various levels or spans of control at different voltage levels operating and interacting in the background to create customized real-time pricing signals for different parts of the system. Some programs already exist for controlling DLC and for load curtailment, but ultimately more sophisticated programs will be required. These more sophisticated programs must reach down into the distribution level to optimize and keep the distribution system operating robustly. In order to ensure the most benefits possible are realized with real-time pricing, there are a few key requirements. These key requirements include a significant number of customers with HEMs, relevant smart appliances and that the utility's analysis capabilities go down to the distribution levels.

It is sometimes argued that the speed of computing and communication can establish constraints to the frequency of pricing signals. However, with broadband communication and cloud computing, capabilities have increased dramatically and have more flexibility than ever. Therefore, it is likely that those areas will not be the constraint. The constraint may lie in the creation of the structure of the whole interconnected and interoperable system, the devices that will monitor and control that system, along with the education of the customer.

28. What are these strategies' implications for competition among demand response, storage and fast reacting generation? What research is needed to identify and develop effective strategies to manage a grid that is evolving to, for example, have an increasing number of devices that can respond to grid conditions and to be increasingly reliant on variable renewable resources?

If proper real-time pricing can be implemented, it should provide a level playing field for customers to add various resources and functionality, such as home energy management (HEM) systems, so they can respond to the price signals and receive the most benefit. There will still be limits as to what the grid can accommodate and if enough customers don't respond in the expected way to real-time prices, some safeguards may be required. But these safeguards will only be implemented when needed to prevent grid violations. Sample safeguards may entail load or generation curtailment, but hopefully would be rare events. At some point, battery storage will be needed at different levels of the grid, as well as high speed reactive control to manage the voltage on the system to within acceptable limits. If rules for deployment of batteries and payment structures for those installing them are put in place, it may be possible to have end users adding them. Signals used in supporting the grid should control the battery storage and reactive devices and must be integrated into distribution energy management systems that will be similar to the systems used today at the transmission level.

Going forward, large inverters for photovoltaic (PV) or wind on the distribution system must have SCADA communications and the capability of grid supporting functions. Smart devices that consume or create electrical power should have communication capability to interact with pricing and centralized grid control signals as well as local overriding logic to control them based on sensed grid conditions at the point of the interconnection. For larger PV systems, IEEE and utilities are developing standards with these requirements. For small devices, the HEM device that they interface with could be the point of communication with the grid.

It will take time to adopt HEM devices and smart appliances and therefore this is an area where some government-sponsored incentives may be needed. These incentives may be similar to those for energy efficiency, solar or wind. For solar, wind and energy efficiency incentives, the new communication and control capability should be a requirement to receive rebates and SRECs.

29. What policies, if any, are necessary to ensure that technologies that can increase the efficiency of ancillary services provision can enter the market and compete on a level playing field?

Please see our response to Question #28. There may need to be a curtailment order based on the order that generators are added if we arrive at very high penetration levels. However, if generator curtailment becomes the norm, it will discourage the installation of more distributed generation (DG).

30. What policies, if any, are necessary to ensure that distributed generation and storage of thermal and electrical energy can compete with other supply and demand resources on a level playing field?

Both real-time prices and the associated utility tariffs to incent energy conservation will support the adoption of distributed generation and energy storage. Thermal (heat and cool) storage is an area that is currently under-utilized and more education and possible incentives would be worthwhile. For larger buildings, eventually there may be construction guidelines as to how much storage - hence ability to shift demand - may be required. With this type of technology, the ability to vary demand of either electrical or other energy sources based on signals should be quite effective. At the commercial level, federal standards can be developed that would require the installation of these energy storage devices by mandating energy efficiency standards for new buildings. Wholesale markets can be structured so that building owners can take advantage of these devices by selling into the market the energy or demand reduction that these systems will provide.

31. What barriers exist to the deployment of grid infrastructure to enable electric vehicles? What policies are needed to address them?

PHI believes there are no significant barriers that cannot be overcome. Fundamentally, electric vehicle (EV) chargers are simply additions of new load for the utility. Utilities have existing service connection policies to deal with the installation of these devices. However, there are system upgrades needed to accommodate the increased load due to EVs. There are two choices for approaching system upgrade. The first approach could be labeled as "brute force type capacity upgrades" that will allow higher demand levels. The second approach is the move to a "smarter grid approach" that helps regulate use and output to accomplish a much higher utilization while meeting the customer’s expectations until such time as the asset can no longer meet the load.

This reduces the need to prematurely replace assets. Undoubtedly, some typical conductor and transformer upgrades will be needed, but they can be minimized by using smart grid approaches. Some of these smart grid approaches may involve using a HEM device or direct pricing signals to the charger to help shift charging to off-peak periods while still meeting customer expectations or by using variable rate chargers. Another possibility is to turn on the charger when other load devices turn off so as to not exceed a certain tiered demand level. All of these options will require customers to understand the need to limit their energy usage and a willingness to vary their energy requirements during different periods of the day.

In the interim, until appropriate EV tariffs can be implemented, a time of use (TOU) rate could be established for those homes with EVs. This TOU rate would incentivize customers to charge vehicles during off-peak hours (e.g., 9 pm to 6 am). The TOU rate would apply to all electric usage – both for the EV and other electricity usage - and be tracked with a single TOU meter. In the absence of such a rate, prior to the deployment of AMI meters, the only way to isolate EV charging energy consumption is by installing a second meter. This is costly to the utility and the customer and could dissuade the customer from either purchasing an EV or charging off-peak. With an interim TOU rate, consumers would not only be incentivized to charge their EVs off-peak, but to also defer use of other large electrical appliances to off-peak times.

Once AMI technology arrives, there would be no need to install a second meter, and EV charging could be separately metered through a single AMI meter via a Zigbee or Home Plug interface. Ultimately, real-time pricing represents the best approach. This is preferable to a special rate that could concentrate charging and create undesirable new high demand periods. At the same time, it is recognized that not all customers will have appropriate meters for real-time pricing and other tariffs may still be needed. The bottom line is that an incentive structure that moves charging to lower load level periods is the best solution. The alternative of not providing such an incentive structure may create the need for infrastructure upgrades and rate increases much sooner. One utility, San Diego Gas & Electric, is experimenting with some different rates for EV charging and that will provide some feedback as to how that will help mitigate infrastructure upgrades.

Reliability and Cyber-Security

We invite comment on the reliability opportunities and challenges that smart grid technologies create, including: What smart grid technologies are or will become available to help reduce the electric system's susceptibility to service disruptions?

32. What policies are needed to facilitate the data sharing that will allow sensors (e.g., phasor measurement units) and grid automation to achieve their potential to make reliability and performance improvements in the grid? Is there a need to revisit the legal and institutional approaches to generation and transmission system data collection and interchange?

Anytime we speak of data sharing, we must also speak of security: both security of the information and security of the system. Current industry efforts to facilitate Phasor Measurement Unit (PMU) data sharing include the NERC Synchrophasor Data Sharing Agreement posted February 22, 2010. These agreements contemplate sharing data from "PMUs" with electric industry participants and researchers in conjunction with the North American Synchrophasor Initiative ("NASPI"). As is done with NERC Standards, consensus must be derived from impacted parties through open discussion and consideration of related confidentiality and security issues, prior to finalizing these agreements.

Traditional approaches are becoming modernized with enhanced security standards and measures. While these measures may in some cases be seen to impede data sharing, they are necessary and appropriate for robust security. The criticality of the data should determine the level of protection, as is done with Critical Cyber Assets. NERC appears to be an appropriate sponsor of these policies, as has been done with the Critical Infrastructure Protection standards.

It is also important to raise a point about the purpose behind data sharing. A major reason to share data is for learning purposes and for the improvement of reliability. A common non-disclosure agreement (NDA) can facilitate the process of sharing data. A NDA should focus on the sharing of data for learning and reliability purposes as opposed to ownership and commercial interests, as is currently embedded within existing NDAs. The DOE should have a policy that facilitates the open exchange of data to further enhance grid operations and reliability and identify areas for improvement. Policies should support the notion that information shared is for the purpose of supporting and sustaining reliability. Overall, a common approach should facilitate the sharing of data while keeping security at the forefront.

33. What is the role of federal, state, and local governments in assuring smart grid technologies are optimized, implemented, and maintained in a manner that ensures cyber security? How should the Federal and State entities coordinate with one another as well as with the private and nonprofit sector to fulfill this objective?

Cyber security is an area of policy in which the federal government must have the authority to set threshold policy standards for state compliance. Allowing the formation of a patchwork of state-by-state cyber security standards would hamper efficacy, diminish efficiency and increase developmental and operational costs without offering any clear benefit.

Within this federal cyber security framework, however, there must be recognition that transmission and distribution utilities have decades of experience developing and implementing reliability and security policies and programs to protect their systems and, hence, their customers. As federal standards for grid security – both cyber and physical – are developed, this private sector expertise should be exploited through public-private cooperation in standard setting.

For instance, as the energy provider to the nation's capital, PHI has developed and implemented stringent security protocols and practices designed to guard against cyber and physical attacks. As smart grid is implemented, applicable prudent security practices, policies and standards are being incorporated into these systems.

PHI believes the planned smart grid systems should incorporate a layered security approach and include security measures such as authentication, authorization, encryption, detailed logging and auditing for the entire system, including the back-office systems and components, wide area network (WAN) and RF Local Area Network (RF-LAN) communication facilities, as well as at the level of the individual components.

Smart grid solutions should apply guiding principles and policies for the protection of these systems. These principles and policies should address both physical and cyber threats. Corporate policies should include the requirement to activate and implement all security features included within systems and components as recommended by the manufacturer, as well as implementation of industry best practices. The first line of defense is encryption. Although encryption does not prevent intrusion, it does make it nearly impossible for the intruder to use the data once it has been intercepted or otherwise obtained. Application layer encryption offers the highest level of protection and should be used whenever possible.

The use of firewalls, VLANs, encryption, and other methods as defined in technology standards to defend, deter, detect and minimize security threats should be employed in the smart grid systems. In order to assist with monitoring the many components of the smart grid, a centralized system should be established in order to control and isolate identified or suspected threats. All data should be isolated via VLANs or other methods. As data migrates through the different layers it should pass through a firewall. Firewalls provide a perimeter security control ensuring challenges between secured facilities and networks. Firewalls should be configured to pass only predefined services based upon application specific requirements. Any remote access to systems should require authentication before allowing any access to the system.

The use of third-party assessments on regular intervals will help identify vulnerabilities within the network. All identified vulnerabilities should be tracked and mitigation strategies developed to address the vulnerabilities.

Managing Transitions and Overall Questions

The following questions focus on managing incremental change during the gradual evolution of the grid that may transform the power sector over the next few decades.

34. What are the best present-day strategies for transitioning from the status quo to an environment in which consumer-facing smart grid programs (e.g., alternative pricing structures and feedback) are common? What has been learned from different implementations? What lessons fall into the ''it would have been good to know that when we started'' category? What additional mechanisms, if any, would help share such lessons among key stakeholders quickly?

The best strategies for transitioning to "consumer-facing" smart grid supported programs involve well-designed and attractive consumer education and customer engagement programs. The simpler the program design, the easier it will be for consumers to understand the program, utility staff to implement the program and consumers to take advantage of savings opportunities. Utility experience with dynamic pricing pilots helps to provide useful information about customer communications, back office operations, and customer responsiveness. An ongoing national dialog of smart grid program experiences will help to improve program implementation and operations throughout the US.

35. Recognizing that most equipment on the electric grid, including meters, can last a decade or more, what cyber security, compatibility and integration issues affect legacy equipment and merit attention? What are some strategies for integrating legacy equipment into a robust, modernized grid? What strategies are appropriate for investing in equipment today that will be more valuable if it can delay obsolescence by integrating gracefully with future generations of technology?

First, it should be noted that the majority of existing legacy equipment does not support the security features that are built into newer state-of-the-art equipment. It is common standards that will help drive the future development of smart grid equipment. Cyber security should be one of the key elements that is part of the standards.

Interoperability standards and cyber security guidelines must be flexible and capable of being applied within the context of multiple layers of alternative solutions and mitigating controls. These include policy and procedural controls, physical security controls, and cyber security controls. Unfortunately, there is no "silver bullet" cyber security solution that is appropriate and effective in every deployment.

In order for equipment to address the long-term requirements of the electric grid, the following items should be taken into consideration:

- Upgradability of equipment;
- Compliance with current standards and open architecture;

- Collaboration with industry standards-making organizations such as IEEE, NIST, EPRI, together with other utilities' technical developments and issues;
- Engagement of technology vendors to address technical risks and needs;
- Implementation of a controlled deployment, to identify communication solutions needed and resolve issues early in the process;
- Undergoing field acceptance testing before full deployment;
- Involvement of industry experts in systems integration;
- Creation of a robust system to allow remote upgrades and deployment of new standards to prevent obsolescence.

Another important item is that rate-making principles associated with smart grid investments should recognize that accelerated depreciation is appropriate for new components which may have a shorter usable life compared with legacy electromechanical devices.

Lastly, standards should recognize the significant diversity of technologies that are currently present within the electric sector. Standards should not drive towards 'force-fitting' or 'one size fits all' solutions that may unnecessarily increase costs associated with deployment, while at the same time reducing reliability.

36. How will smart grid technologies change the business model for electric service providers, if at all? What are the implications of these changes?

As part of its Blueprint for the Future filings in 2007, PHI made a conscious decision to begin transitioning its existing business model to become a "trusted energy advisor" to our customers. PHI believes that investing in the smart grid will provide the necessary technical capability to enable this goal.

Additionally, through smart grid investments, utilities will ultimately become more reliant on technology changes. No longer will utilities have the luxury of designing 25-year assets using the best possible technology solution. Rather, iterative solutions that maximize the latest technology will become more commonplace. Likewise, cyber security and data network operations must become just as much a part of a utility's future DNA as electric system operations is today. It is for these reasons that the national goal for interoperability and cyber security standards must continue to maturity.

Smart grid technologies have the capacity to change a large portion of the traditional customer segment into an energy information and application driven customer base, whose expectations and desire to better manage their energy use will drive innovation and the evolution of new products and markets.

In the longer-term, smart grid investments will likely increase the presence of zero net energy customers, microgrids and small scale distributed generation. This could cause a shift in the reliance of conventional central station generation, transmission and distribution to that of back-up power, making the utilities the supplier of last resort. However, customers must also understand that as long as they rely on the distribution system for this back-up power requirement, then they must also continue to pay for the ongoing development and maintenance of the distribution system.

37. What are the costs and benefits of delaying investment in metering and other smart grid infrastructure while the technology and our understanding of it is rapidly evolving? How does that affect the choice of an appropriate time to invest?

Each utility considering an investment in AMI must assess its own environment to determine if, when and how to make the investment. Certain areas of the country face generating capacity constraints, transmission congestion, and governmental mandates for load reductions and generation from renewable sources. Costs may increase in the future due to inflation and other factors. PHI and other utilities have already clearly identified quantifiable operating and energy savings along with societal benefits. Delays due to waiting for the technology to be “perfect” just postpone the realization of these identified and achievable benefits. Delays also serve to stifle future innovation in the use of the technologies that can and will release additional benefits over and above those already identified.

38. What policy changes would ensure that the US maintains global competiveness in smart grid technology and related businesses?

PHI believes smart grid has the potential to promote US competitiveness on two levels. First, modernizing the grid across the nation is a fundamental component to ensuring the long-term competitiveness of every sector of the US economy. Grid modernization is a critical step that will help the US achieve energy independence without raising the relative cost of energy to uncompetitive levels. To this end, existing federal funding mechanisms should be continued to further incentivize smart grid deployment. In addition, federal policies targeted at reducing state and local resistance to grid modernization should be advanced, as should joint public-private efforts to educate consumers to increase public understanding and acceptance of the costs and benefits associated with grid modernization. Also, for utilities, an informed tax policy with reasonable depreciation provisions for smart grid investments is vital for rapid deployment.

On the second level, there is significant potential for the future US economy in staking a global leadership position in sourcing smart grid technologies and pioneering previously undeveloped applications and related businesses. Leadership in this arena requires robust R&D funding, tax policy that favors investment, the creation of threshold standards that ensure security while still permitting experimentation, and a willingness to accept the degree of failure associated with innovation.

39. What should be the priority areas for federally funded research that can support smart grid deployment?

In order for the smart grid to reach its promised maturity and capability, energy storage will have to be integrated into the national grid on a broad level. For this reason, battery storage technologies should be a high priority as a focus for future research. This will not only stabilize the future grid from a growing penetration of renewable resources, but also benefit consumers in the form of electric vehicles with greater range and reliability. Similar to the need for more advanced storage capabilities, the smart grid will also need more practical and advanced power electronics and inverter solutions to better manage the load diversity that will result from a higher penetration of renewable resources and plug-in vehicles.

As we become more reliant on the benefits of a smarter grid, it will become even more important that we develop ways to protect it against future threats. These threats would include man-made threats of a physical or cyber nature, as well as threats that might result from the laws of unintended consequences. Therefore, monitoring and modeling capabilities should be more thoroughly developed in order to give utilities the ability to predict real-time power flows and perturbations with enough granularity to quickly identify the source of any future problems and mitigate their effects.

Because the smart grid will run on data, practical and cost effective broadband communications capabilities will also need to be further developed. This will be essential to ensure that rural consumers can obtain the same promise of benefits as their urban counterparts.

40. Finally, as noted at the outset, we invite commenters to address any other significant issues that they believe implicate the success or failure of the transition to smart grid technology.

PHI does not have any further comments for this RFI.