



# Smart Grid Development in Poland

## Response to Questions

*by Lawrence Markel and Christopher O'Reilley<sup>1</sup>*

### 30 SMART GRID QUESTIONS FROM THE POLISH PARTICIPANTS OF THE EXPERT VIDEOCONFERENCE

- 1. How to empower the customers to manage their energy use based on the available data?**
- 2. How to teach the customers to choose the best offer on the energy market and to change their supplier?**
- 3. The “pro-sumer” – how to encourage such an attitude?**
- 4. How to make the clients see that a smart grid development makes sense instead of making them feel like they are paying for yet another useless gadget? How to make them see the smart grid connection to energy security?**
- 5. How to encourage different companies to employ the intelligent technologies?**
- 6. Is remote meter reading economically justified for both the commercial consumers and the individual consumers?**
- 7. How to encourage the energy producers to actively participate in the e-energy market through offering new deals and promotions?**
- 8. How to define the functions the smart metering system should fulfill?**

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9. What are the systemic solutions, which aim at “the vulnerable customer” protection?
10. How to keep the collected data secure?
11. What conditions need to be met for the smart grids to operate? Who is to create the e- market of energy – a private or a public stakeholder?
12. What types of market incentives would encourage the development of smart grid?
13. How to manage the collected data without violating the privacy laws?
14. Smart metering and demand side management.
15. What kind of regulatory policy is needed for beneficial development of smart grid?
16. What is the American definition of “smartness” for Smart Metering and for Smart Grids? Is Smart Metering considered in the U.S. a first step to further Smart Grid deployment?
17. What kind of cooperation and support framework was established (formally and informally) with the regulator, industry, TSO’s and DSO’s, in order to foster research, development and deployment of Smart Metering and Smart Grids in the U.S.? How to ensure a coordinated and a coherent approach of all energy market actors to the deployment timescales?
18. What are the regulatory tools to promote Smart Metering in American conditions?
19. What are the potential benefits of Smart Metering deployment in America to the regulator, customer industry, TSO and DSO?
20. What new services emerge and what is the American society gain from Smart Metering and Smart Grids?



- 21. Who is the meter owner of the smart meters and who is responsible for managing the Smart Meter (i.e. installation, maintenance, data management, etc.)?**
- 22. What are the typical American smart metering standards (frequency of measurements and meter reading, communication protocols, other)?**
- 23. Do the applied functionalities also include quality regulation of electricity of supply and if yes how does it work?**
- 24. How does smart metering affect the renewables and the distributed electricity generation in the U.S.A.?**
- 25. What is a “smart grid”?**
- 26. How can we relate the American experiences to the European given we operate on two different systems?**
- 27. The benefits of introducing smart grid for the customers and the grid operators?**
- 28. To what degree is the loss of energy limited through the rational grid use?**
- 29. How much investment does it take to introduce smart grid effectively?**
- 30. What legislative changes were necessary in the U.S. in order to introduce and make the smart grid operational?**



## ANSWERS

### *1. How to empower the customers to manage their energy use based on the available data?*

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One of the biggest challenges facing any utility, related to smart grid and advanced metering infrastructure (AMI), is providing information that the customer will use and convincing the customer to use the data available. The benefits of smart grid usually focus on the utility with only broad statements related to customer benefits such as energy costs savings or “customer choice.” Three components are necessary for empowering the customer to manage their energy usage. The first involves education and training of the services and capabilities available through a smart metering program and a concise description of the potential benefits (from the customer perspective) for using available data to make decisions.

The second component to empowering the customer is the use of pricing / rate schedules such as time of use rates to make it economically advantageous for the customer to take some action to use the data available to control energy use in ways that are beneficial for the system as a whole (economics, reliability, environment). Unless the consumer faces higher energy costs for maintaining existing behavior, the customer may not have any incentive for changing usage patterns. A secondary component to this involves demand side management where the utility could reduce / alter end use consumption. This however presents privacy and potential legal issues discussed as part of the answer to Question 10.

This third component is to make available to the consumer (through hardware and/or choices for purchasing appliances and equipment, controls, and building envelope materials) some well-defined and well-understood methods to implement changes in energy use.

### *2. How to teach the customers to choose the best offer on the energy market and to change their supplier?*

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First is the answer as it applies to the U.S.:

The first part of the answer to the question is ensuring that the customers are aware that competitive energy market exists. For example, in New York in 2007 only 42% of consumers were aware of energy deregulation and a smaller percentage was aware of the Energy Service Companies (ESCO) and how they operated (T&D World 2007). The second is to educate the consumer on what deregulation is, what it means, and how a deregulated market can assist in lowering energy bills. The challenge is how to get the message out to the consumer. Distribution companies and producers will play critical roles in providing this education.

- The California Public Utilities Commission’s (CPUC) integrates phased mass media messages, direct mail to each electric customer, multi-ethnic and multi-lingual materials and grass roots, organization-sponsored outreach educational activities.



- The Vermont Department of Public Service published *A Consumer Information and Education Plan*. The goal of this education plan is to "empower Vermonters to make informed choices about their electricity provider
- The Massachusetts Public Utilities Commission has promoted public forums via newspapers, radio and television public service advertisements and has developed brochures and bill enclosures
- Pennsylvania Public Utilities Commission is actively distributing brochures, mailing newsletters, answering questions through an electronic bulletin board and toll-free telephone numbers and surveying citizens on the most effective and trusted sources of educational information for the public.
- New Hampshire's Public Utilities Commission has issued an RFP for an advertising professional to assist the Commission and its working groups in the development of a statewide consumer education plan for electric restructuring. This plan will use multi-media techniques and follow the California and Vermont models in the development of its overall effort

One of the biggest challenges with any education program is having information available to consumers when needed. For residences in an existing area, the timeframe for decisions is more relaxed. However, people moving from one location to another often have little time to determine who their service providers will be. Having information available as to what options are available and where to get information quickly is important and leads to a multi-faceted information availability partnership among the Distribution companies, State Public Utility Commissions. This information should be available to consumers in multiple ways including the distribution company and PUC web sites, via telephone, and for existing customers local programs such as discussion forums lead / held at the distribution company, through radio public service announcements, and direct mail fact sheets and directions for where and how to obtain additional information. One important factor that the utility conducting the education needs to understand the values of the community served (and this may vary) and target the message to those values. For example, if the customer base is focused on the environment, demonstrating how implementation of smart grid reduces the carbon footprint may be more important than the potential cost savings on the energy bill. Knowing the customer base is critical to education and gaining acceptance.

#### Second is to address the situation in Poland:

It is not clear how useful the U.S. situation is for Poland. One fallacy of U.S. regulators and policy makers is to try to have competition for competition's sake. (A draft of a position paper produced by DOE and the national laboratories lamented that while Pennsylvania had established an electricity market, in fact there were no competitive providers "because the rates were too low" to encourage competition.) One should decide what the purpose of competition is. If it is simply to keep rates low, a regulatory agency (in the case of the U.S. it is the State Public Utility Commissions (PUC)) can do this, as well as ensure that independent power producers – especially wind, solar, bio-fuel, and co-generation – have access to the grid. The State of Hawaii



does not have a competitive market, but the PUC guarantees that renewable energy developers can sell energy to the utility at advantageous prices. The Tennessee Valley is served by a large government-owned generation and transmission system (TVA), with local distribution companies. There is not a competitive market here, either, but tariffs are low, and TVA has will buy power from independent power producers and renewable energy sources. Federal legislation has been in place for many years to open the energy selling market to non-utility producers.

Therefore, for Poland, one must first determine what benefits competition may provide. Currently large generators are owned independently, and PSE regulates the transmission system and the energy production market. Therefore, you already have competition among generators to provide electricity at the lowest cost (economic dispatch). Enabling a customer to make a separate energy purchase contract with, for example, Opole, may not improve *system* efficiency, but it could require very complicated accounting and the need for complex, time-varying wheeling tariffs from PSE. Most customers would not chose a more expensive “green” supplier on their own, and requiring PSE to purchase electricity from green sources adequate to meet EU directives may be the best way to ensure a market for these producers. In conclusion, we suggest that URE and the other government agencies first look at what type of competitive market for energy would be best for Poland before relying on a market driven by end-use consumer contracts.

### ***3. Is remote meter reading economically justified for both the commercial consumers and the individual consumers?***

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This will depend upon the particular utility. In Poland, where access to residential electric meters is sometimes a problem, many of the ZE’s have implemented short range radio-based remote reading using trucks to send the “read” signal and retrieve the data. These systems have been cost-effective in reducing meter reading costs, improving billing accuracy, and reducing costs to generate the bills. Large commercial customers often have more complex tariffs, and meters, so remote meter reading is more often justified economically.

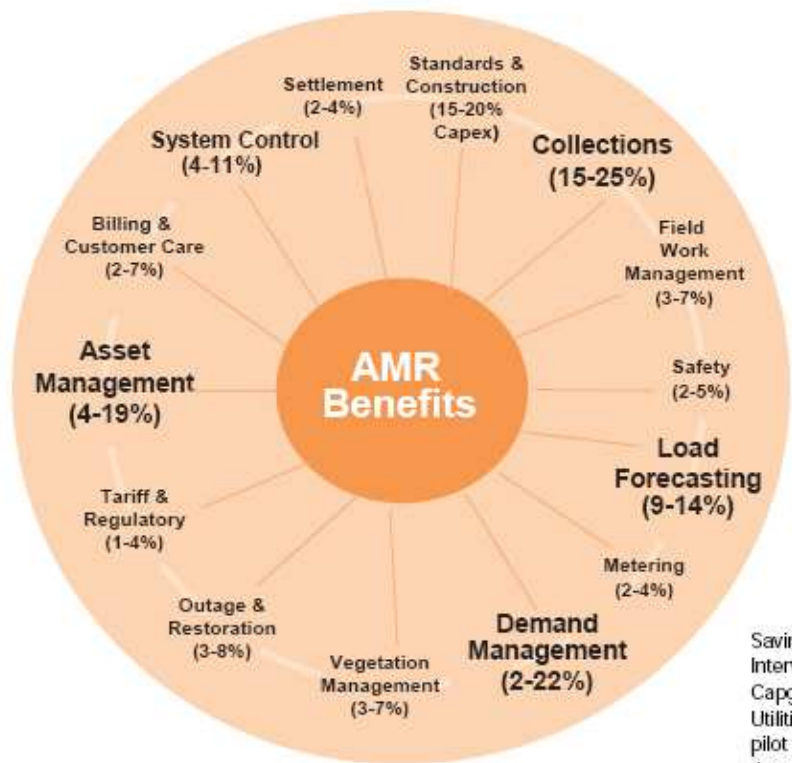
Determining the economical justification of remote meter reading can be challenging and depends on the individual utility. Installing smart meters and the associated communication infrastructure for the sole purpose of remotely reading meters is often not cost justifiable. This is why many utilities, including those in Poland, opt for a less expensive communications infrastructure using short-range radio from vehicles. However, centralized remote meter reading combining with the other functions may justify the cost of installation. These other services may include remote connect and disconnect of power, more rapid outage detection and restoration, reduction in billing costs, etc. The other area to consider is that what is cost justifiable by one utility may not be by another. For example, a municipal utility may view a cost / revenue or (avoided cost) neutral program as cost justifiable, whereas an Investor Owned Utility (IOU) may view only those with relatively short break-even points and cost reduction as cost justifiable. The difference between these two groups is who they are responsible for satisfying. The municipal utility is primarily responsible to the community and city government. While the IOU is primarily responsible for providing reliable and safe delivery of electricity to the consumer; it must also keep the shareholder’s interest in stock growth in mind



There are several factors in determining the cost justification of the AMI capability including:

- Costs
  - Capital cost of meters
  - Installation cost for meters
  - Capital cost for communication infrastructure
  - Monthly communication infrastructure fees
  - Capital cost for CIS data base
- Potential utility savings / avoided costs
  - Monthly meter reading
  - Remote connect and disconnect (reduction of “truck rolls”)
  - Faster outage detection and response
  - Outage restoration notification
  - Reduction in billing errors
  - Employee Salaries
- Customer density or consent to participate

CapGemini conducted a cost- benefit review of piloted smart meter programs throughout the U.S. through interviews of the utilities in 2005. The following chart presents the estimated cost savings when AMR is fully utilized and integrated into utility operations.





#### *4. The “prosumer” – how to encourage such an attitude?*

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Encouraging the “prosumer” attitude relies heavily on the utility’s understanding the values of their specific customer base and presenting the message in relation to the values of the consumer. Whatever advantage(s) are claimed must be perceived advantages for the consumer (must ensure the customer perspective is the focus of the message, not the utility). Ideally, participation from early technology adopters (both residential and commercial) in the community to new technologies as an advocate and part of the education process would aid in the development of a grass roots approach to overall adoption. Local demonstration and education of features/capabilities with talks from local community residence about experience is beneficial. The government can also assist with instilling a “prosumer” attitude by communication the environmental and reliability benefits to the nation of a more responsible approach to energy consumption.

#### *5. How to make the clients see that a smart grid development makes sense instead of making them feel like they are paying for yet another useless gadget? How to make them see the smart grid connection to energy security?*

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This is an issue in the U.S., too. The true answer is for the utility and regulatory agency to first make sure that there *are* real consumer benefits from selected smart grid functions, and that it is not just another useless – and expensive – gadget. One of the most difficult aspects of the Smart Grid in the U.S. is that many, if not most, utilities cannot clearly elucidate a consumer value proposition for smart grid functions. “Giving consumers a choice of energy providers,” “communicating real time-varying prices to the consumer,” and “informing the consumer how much energy is being used” (through metering) are not adequate justifications by themselves. A valid value proposition in terms of costs, reliability, and/or environment must be identified.

If such value propositions do accrue from a smart grid function, then education of the consumers is needed. This was discussed as part of the answer to Question 2. Key to this is showing specific examples of how a specific smart grid function will benefit the consumer and possibly demonstrate the benefits in action. These benefits could be reduced electric bills, shorter outages, etc. The second key is to make the technology transition as transparent as possible. Some will embrace new technologies and gadgets, while others will be reluctant or resistant to change.

Energy security may be a little more challenging to explain the benefits to the consumer. Again specific examples would be important. The recent problems with natural gas imported from Russia will be clear to the Polish citizen. It should be made clear how the smart grid could reduce energy use, with less reliance on imported gas, or provide more flexibility to switch fuels. The smart grid’s capabilities are particularly needed to manage large amounts of as-available renewable energy sources. Utilities need to demonstrate how smart grid functions enable increased use of Polish-based renewable and other energy sources.

### **PRODUCERS/OPERATORS**



## *6. How to encourage different companies to employ the intelligent technologies?*

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From the system operator's point of view, the new technologies must be shown to reduce costs and to improve control and stability of the grid. Some of the meters, sensors and communications functions improve billing and accounting efficiency and enable the operator to reduce technical losses. The enhanced monitoring and control functions, especially applied to large energy consumers and to electricity producers, should enable the operator to improve grid stability and reliability and to reduce the amount of spinning reserve needed. These benefits will be apparent to the operator; but they must be well-demonstrated by pilot or demonstration programs.

For the producers, especially small renewable energy or co-generation producers, the smart grid monitoring and control may help them reduce the cost of an interconnection study and may enable them to sell more energy to PSE. In the U.S., better monitoring and control of as-available or customer-owned generation has enabled the utility to reduce the reserve requirements associated with it; relax ramp rate constraints on production output that limit the amount of electricity purchased; and/or offer a more favorable power purchase agreement. Again, the key here is to first convince the operator to offer these benefits to the producer who adopts the intelligent technologies, and then to communicate these potential benefits clearly to the producer.

## *7. How to encourage the energy producers to actively participate in the e-energy market through offering new deals and promotions?*

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It is difficult to answer this; it depends on the offerings. The way the interconnection studies are priced (i.e., lower cost to use approved interconnection designs and hardware with remote monitoring and control capability) and the way the power purchase agreements are structured should provide the motivation.

## **LEGAL/OPERATIONAL FRAMEWORK**

## *8. How to define the functions the smart metering system should fulfill?*

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Smart meter functions could include some or all of the following:

- ✓ Remote Disconnect/Reconnect
- ✓ Flexible Two-Way Data Retrieval
- ✓ Scheduled & On-Demand Reads
- ✓ Interval Reads (5, 15, 30, 60 minutes)
- ✓ Improved load forecasting – for the system or for a feeder / substation
- ✓ Real-Time Interval Reads
- ✓ Automated Register, Self-Read & TOU
- ✓ Demand Resets
- ✓ Real-Time Meter Event & Alarm Retrieval
- ✓ Real-Time Power Outage & Restoration
- ✓ Service Diagnostics & Tamper Detection
- ✓ Tilt Detection



- ✓ Meter Clock Synchronization
- ✓ SmartMeter Status Display
- ✓ Automated Meter Registration
- ✓ Secure & Encrypted Data Transmissions
- ✓ Bi-Directional Metering
- ✓ Signaling to the consumer
- ✓ Real-time pricing or indications of time-of-use or other tariffs
- ✓ Interface with water, gas meters, and heat meters
- ✓ Interface with building energy management system for demand response
- ✓ Interface with home appliances and / or home controller for demand response or complying with time-of-use tariffs

Not all of these functions will be justified in every case.

### **9. *What are the systemic solutions, which aim at “the vulnerable customer” protection?***

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We are assuming this question relates to protection of consumer information and assurance of quality of service. Information Assurance and security of information is a critical component to the development, deployment and consumer acceptance of Smart Grid technologies and service. This “protection” must occur at multiple levels of the Smart Grid architecture including the smart home/building appliances and home area network, smart meter, wide area network, and at the central office. The following will be divided into several discussions. The answer to this question does not present protection of the utility grid, substation or utility assets from physical attacks. The focus is on protection of data and reducing the threat of a cyber attack or unauthorized access to information.

#### **Customer Premise / Home:**

The meter at the “doorstep” of the home is the demarcation between the Home Area Network (HAN) and the utility AMR/AMI infrastructure. Information must flow from the meter to the home network and from the HAN to the meter. Protecting this interface can take several steps.

- Firewall between the HAN and the meter (external communication)
  - ✓ Especially critical if a non-utility communication provider is used
  - ✓ Firewall acts as a barrier between two networks. This capability monitors traffic and limits access to only packets that satisfy a specific set of rules. Those packets that do not satisfy the rules are blocked.
- The customer has ultimate control over the operation / actions of their internal appliances. Customers have the ability to override any requested action by the utility.

#### **Utility Communication**

- Encryption of data transmitted from the meter to the central office.
- Installation of a firewall between the external communication system and the communication system within the central office.



- On systems using public networks (PSTN, Internet Providers, Cell Providers, etc.) a Virtual Private Network (VPN) capability should be established. VPNs tunnel through open IP-based networks by encrypting the data to provide a secure connection.

#### *10. How to manage the collected data without violating the privacy laws?*

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Advanced metering systems and increased data sharing and communication between the utility and the customer create a data privacy and security risk because of the amount of client information collected. The major risks of a utility not implementing the appropriate protection of information include:

- Resistance to implementation
- Customer liability claims or regulatory fines
- Customer refusal to consent and / or drive political opposition

This issue includes both preventing unauthorized (within the utility) use of the data, and also privacy of the customer's information (the utility's not volunteering or disclosing the data without proper legal basis). The first step in ensuring customer data and information is protected is to establish appropriate privacy policies defining what data can be and cannot be collected, and permissible uses of the data. The policy must be clearly and concisely presented to the consumer and consent obtained by the utility to collect and use the data as defined in the policy.

After permissibility has been established, protection of the information from unauthorized access and use becomes essential. Thus the utility's second step is to establish systems for enforcement of the policies and control of the data through adoption of suitable security practices, training and audits. This second area is similar to those described in the responses to Question 9 and 11.

Privacy and security laws vary widely from place to place. In the United States, privacy and security rules arise out of a large number of federal and state laws regarding the processing of particular types of data or economic sectors, disposition of business records, utility tariffs, etc. Which laws and regulations apply depends upon the system architecture. For example if the utility uses a commercial Internet or telephone provider to access the smart meter, or uses the utility's own communication infrastructure, which also provides Internet and other telecommunication services, the utility is also bound by the privacy laws and regulations governing telecommunication providers. If the utility is sending data cross state lines, federal laws applicable to interstate commerce or the receiving state's privacy laws may apply. If personally identifiable data may have been compromised, breach notification laws may require the utility to send notices to data subjects in certain jurisdictions. Failures to adopt, disclose, or adhere to suitable privacy and security practices may result in U.S. Federal Trade Commission (FTC) enforcement action against "unfair and deceptive trade practices."

The European Union has a slightly different structure concerning privacy of customer data. The *Privacy Directive 95/46 EC* establishes a presumption that personally identifiable information belongs to the data subject. Information may be processed only for specified, legitimate, and limited purposes where there is either valid consent from the data subject or a legitimate need of



the data processor that outweighs the data subject's general privacy interests. A utility that sends personally identifiable information concerning EU residents to an outsourcer on another continent, the EU *Privacy Directive* limits on trans-border data flows will apply.

Below is a list of some general best practices for safeguarding customer information

- Consult with legal counsel to resolve privacy and security issues at the system design stage.
- Adopt privacy and security policies for internal and external access to and use of personally identifiable information that satisfy both legal requirements and fair information privacy principles
- Define the data collection and use rights of customers, vendors, etc. in clear contractual language with strong privacy and security commitments and accountability for breach
- Collect only the data you actually need for specified purposes and retain data only for a reasonable period of time related to the purpose for which they were collected
- Avoid resistance by permitting consumers to turn off or limit detailed data collection, especially during early research phases. Make "Off" the default mode for data transmissions.
- Design security into every collection, access, and transfer point. Create separate pathways for personally identifiable information. Use single hop networks to reduce transmission and storage vulnerabilities.
- Train all utility and third party employees who have access to AMI data or controls.
- Employ internal and external audits.
- Establish incident response and breach notification procedures.

## 11. *How to keep the collected data secure?*

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Keeping selected data secure is necessary to ensure customers are willing to accept and consent to the AMR and Smart grid services. Many of the non-technical measures are outlined in the response to Question 10. Security of the data must occur at different points in the architecture, not just in the various databases located at the central office. Many of these are listed below:

- **Communication System**
  - Encryption of data transmitted from the meter to the central office.
  - Installation of a firewall between the external communication system and the communication system within the central office. The firewall
  - On systems using public networks (PSTN, Internet Providers, Cell Providers, etc.) a Virtual Private Network (VPN) capability should be established. VPNs tunnel through open IP-based networks by encrypting the data to provide a secure connection.
- **Central Office Databases and Local Area Network (LAN)**
  - Establish a firewall between the external network and the central office LAN
  - Access control through Password protection of each database and server. Ideally using a "strong" password. A "strong" password is a password of six



characters or more that do not form a pronounceable word, name, date or acronym, and have at least one special character or digit and one mixed-case character.

- Access control lists should be developed and maintained / updated to ensure that only personnel required to access certain data can access this data. The access list should be updated frequently and immediately after the departure of an employee.
- Defensive tools should also be deployed. Some of these have already been discussed. Others include
  - Encrypted files accessible based on access control lists and passwords
  - Intrusion detection: used to detect unauthorized use of a computer network. Intrusion detection systems should be set-up to address both internal and external abusers of the systems
  - Anti-virus and anti-spam software should be installed and operating on every computer and server on the network. These should be updated frequently (as updates are made available) and pushed from the ant-virus/ anti-spam server to the individual machines on the network(s)
  - Physical Security – This is a broad category and includes items such as:
    - Badged employees and contractors (contractor badges different than employees for easy identification of contractor versus employee)
    - Operational areas located in separate rooms with physical access controls to the rooms, via badge readers, password, biometric, etc.
    - Backup and remote storage of all critical data
    - Facility or critical system UPS and / or backup generators
    - Periodic security evaluation and audits of operational and corporate systems
- **Substation**
  - Redundant communication paths to ensure data is available
  - Firewalls between substation LAN and external communication
  - Physical Security of substation (e.g. fences, access control, cameras, etc.)
  - “Strong” passwords for all substation systems such as EMS, SCADA, etc.
  - Maintained access control lists for all substation systems
  - Periodic security evaluation and audits

It should be noted, however, that many of these issues have already been addressed by Polish utilities in implementing remote electronic meter reading systems and in establishing SCADA systems and communicating among utilities (among ZEs, with PSE, between PSE and other countries’ system operators). Use of the Internet – which is **NOT** a requirement of the Smart Grid (but is an option) certainly increases the risk of insecure data.

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**12. *What conditions need to be met for the smart grids to operate? Who is to create the e- market of energy – a private or a public stakeholder?***

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- Conditions:
  - Standards
  - Capital for investment in smart technologies
  - clear strategy, clear requirements and definitions to support that strategy, clear lines of demarcation concerning roles and responsibilities, and, most of all, well-defined ownership
  - Coordinated effort between Generation, Transmission and Distribution
  - Policy and regulatory consistency across regions / states.
  - Consensus on value among utilities (not just available stimulus money) – both top down and bottoms up buy-in
- E-Market Creation: Generally, a public entity – government – establishes the basic structure of the market. To actually create and operate it, while usually there is a public entity, a private entity may also operate the market. This is the case in the US for regional markets within power pools. Examples of market administration:
  - In the U.S groups like Electric Reliability Council of Texas (ERCOT), PJM created an energy market within their regions.
  - California Energy Commission provides market support
  - Southeastern Europe, created by the individual countries per the Athen's MOA of 2002

### *13. What types of market incentives would encourage the development of smart grid?*

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In addition to legislative requirements (such as federal legislation requiring all states to undertake a feasibility and benefits study of smart meter systems), the long-term incentive is that the utility can include the cost of smart grid functions in its rate base (where the utility's tariffs are set to obtain a regulated profit on its approved investments, or rate base). The utility must show the regulator how the smart grid functions are improving quality or cost of service.

To *develop* the smart grid, one of the major incentives in the U.S. is government funding. The Department of Energy (DOE) has initiated several grant programs to spur the development of smart grids and smart grid technology. These include:

- **\$3.375 billion for Smart Grid Investment Grant Program**
  - DOE's Smart Grid Investment Grant Program will provide grants ranging from \$500,000 to \$20 million for smart grid technology deployments. It will also provide grants of \$100,000 to \$5 million for the deployment of grid monitoring devices.
- **\$615 million for Smart Grid Demonstration Projects**



- Smart Grid Regional Demonstrations will quantify smart grid costs and benefits, verify technology viability, and examine new business models.
- Utility-Scale Energy Storage Demonstrations can include technologies such as advanced battery systems, ultra-capacitors, flywheels, and compressed air energy systems, and applications such as wind and photovoltaic integration and grid congestion relief.
- Grid Monitoring Demonstrations will support the installation and networking of multiple high-resolution, time-synchronized grid monitoring devices, called phasor measurement units, that allow transmission system operators to see, and therefore influence, electric flows in real-time.

### **Market forces driving the development and implementation of smart grids include:**

- Pressure on improved grid reliability and power quality is increasing as more regulators think about attaching penalties and rewards against performance.
- Customer Satisfaction ratings are also viewed with greater scrutiny.
- Grid security has emerged as a serious concern and much attention is being paid to understanding how new investments will improve grid resilience
- To meet the requirements of state Renewable Portfolio Standards (RPS), smart grid functionality is required for increased control of the grid when accepting large amounts of as-available generation. (The EU directives for renewable electricity are similar to RPS in the U.S.) The utilization of distributed generation as distributed generation also requires that the grid is well equipped to manage these types of assets.
- Technology functionality has grown significantly.
- Dramatic reduction in technology costs.

### **Other Incentives:**

- Cost recovery assurance - capital and expenses
- Higher rate of return on desired capital investments or actions
- Rate-base (earn a capital return on) program expenses
- Management pay linked to preferred goals
- Shareholder rewards for performance above targets
- Calculate profits foregone from EE/DR and pay to utility (e.g., Duke or PG&E avoided cost calculation)
- Single-purpose rate proceedings and tariffs

## ***14. Smart metering and demand side management.***

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Demand Side Management (DSM) is the implementation of policies and measures which serve to control, influence and generally reduce electricity demand. DSM is the ability to alter end user electrical consumption in response to system conditions. DSM aims to improve final electricity-using systems, reduce consumption, while preserving the same level of service and comfort.



The smart meter is a means to implement some DSM functions, although smart meters are **NOT** required for DSM. The smart meter may be used to communicate a price or control signal to the customer's appliances or energy management system. It is also a means to verify whether the customer has complied with a "reduce load" request. Since the smart meter will have smart grid functionality beyond DSM (e.g., remote meter reading), using a smart meter for DSM may reduce costs to implement DSM by using the communication link between the utility and meter for DSM also.

### ***15. What kind of regulatory policy is needed for beneficial development of smart grid?***

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The policies needed for beneficial development include legislative action and regulatory action. This is not a question that has been fully answered in the U.S., nor can we answer it for Poland. However, it is one of the areas of discussion for the video conference. Following are some examples of U.S. laws and regulatory policies:

#### **Legislative**

The Energy Independence and Security Act (EISA) passed in 2007 has the objective to "To move the United States toward greater energy independence and security, to increase the production of clean renewable fuels, to protect consumers, to increase the efficiency of products, buildings, and vehicles, to promote research on and deploy greenhouse gas capture and storage options, and to improve the energy performance of the Federal Government, and for other purposes". Title XIII (Section 1301-130) focuses on Smart Grid and includes the following:

#### **Policy Statement (Section 1301)**

It is the policy of the United States to support the modernization of the Nation's electricity transmission and distribution system to maintain a reliable and secure electricity infrastructure that can meet future demand growth and to achieve each of the following, which together characterize a Smart Grid:

- Increased use of digital information and controls technology to improve reliability, security, and efficiency of the electric grid.
- Dynamic optimization of grid operations and resources, with full cyber-security.
- Deployment and integration of distributed resources and generation, including renewable resources.
- Development and incorporation of demand response, demand-side resources, and energy-efficiency resources.
- Deployment of "smart" technologies (real-time, automated, interactive technologies that optimize the physical operation of appliances and consumer devices) for metering, communications concerning grid operations and status, and distribution automation.
- Integration of "smart" appliances and consumer devices.
- Deployment and integration of advanced electricity storage and peak-shaving technologies, including plug-in electric and hybrid electric vehicles, and thermal-storage air conditioning.
- Provision to consumers of timely information and control options.



- Development of standards for communication and interoperability of appliances and equipment connected to the electric grid, including the infrastructure serving the grid.
- Identification and lowering of unreasonable or unnecessary barriers to adoption of smart grid technologies, practices, and services.

#### **Reporting and Accountability (Section 1302)**

- DOE shall after consulting with any interested individual or entity, as appropriate, no later than
  - 1 year after enactment, and every 2 years thereafter, report to Congress concerning the status of smart grid deployments nationwide and any regulatory or government barriers to continued deployment
  - Reporting also through the Smart Grid Task Force

#### **Established the Smart Grid Advisory Committee and Smart Grid Task Force (Section 1303)**

The *Smart Grid Advisory Committee* shall advise the Secretary, the Assistant Secretary, and other relevant Federal officials concerning the development of smart grid technologies, the progress of a national transition to the use of smart-grid technologies and services, the evolution of widely-accepted technical and practical standards and protocols to allow interoperability and inter-communication among smart-grid capable devices, and the optimum means of using Federal incentive authority to encourage such progress.

The *Smart Grid Task Force* shall insure awareness, coordination and integration of the diverse activities of the Office and elsewhere in the Federal Government related to smart-grid technologies and practices, including but not limited to: smart grid research and development; development of widely accepted smart-grid standards and protocols; the relationship of smart-grid technologies and practices to electric utility regulation; the relationship of smart grid technologies and practices to infrastructure development, system reliability and security; and the relationship of smart grid technologies and practices to other facets of electricity supply, demand, transmission, distribution, and policy. The Smart Grid Task Force shall collaborate with the Smart Grid Advisory Committee and other Federal agencies and offices.

#### **SMART GRID TECHNOLOGY RESEARCH, DEVELOPMENT, AND DEMONSTRATION (Section 1304)**

##### **SMART Grid Interoperability Framework (Section 1305)**

- NIST to develop a framework for interoperability for the smart grid, report to Congress in one year
- The interoperability framework shall be flexible, uniform and technology-neutral, including but not limited to information management techs, designed to:
- Incorporate all resources, both generation and demand response and energy efficiency
- Accommodate regional differences and technology innovations



- Consider using voluntary uniform standards that accommodate mass-produced appliances and equipment that are manufactured to respond to grid emergencies and price signals to curtail or shed full or partial load or provide ancillary services
- FERC to adopt standards and protocols as necessary to insure SG functionality and interoperability in interstate transmission and regional, wholesale electric markets

### **FEDERAL MATCHING FUND FOR SMART GRID INVESTMENT COSTS (Section 1306)**

- The Secretary shall establish a Smart Grid Investment Matching Grant Program to provide reimbursement of one-fifth (20 percent) of qualifying Smart Grid investments.

### **STATE CONSIDERATION OF SMART GRID (Section 1307)**

New requirements under the Public Utilities Regulatory Policy Act (PURPA) say that within 2 years, states should consider adopting these requirements:

- PURPA (16) -- Smart Grid Investments
  - Utilities must consider smart grid investments before proceeding with “traditional” investments
  - Utilities are authorized to recover costs of smart grid investments
  - Utilities can recover remaining book value of infrastructure made obsolete by Smart Grid
- PURPA (17) -- Smart Grid Information
  - Purchasers shall get direct access, in writing or electronically, to information including:
    - Time-based wholesale electricity prices and retail rates
    - Usage
    - Electric prices updated no less than daily, with hourly prices and day-ahead projections where possible
  - Sources and emissions of utility electricity
  - Electronic (internet) access to the above, and user privacy

### **Regulatory**

The following are areas that regulators can mandate, enable, fund, or block:

- Time varying Price and grid condition signals
- 2-way communication from the customer’s meter across the T&D system to grid operators, and out to generation assets
- Grid-side ability to use the data -- high-volume analytical and transaction processing for grid, market and device operations and forecasting
- Cost recovery method for the T&D owner
- Standards and protocols to accelerate interoperability and marketability

The following are areas that regulators can assist but markets could get around:

- Customer ability to receive those signals



- Controllability and responsiveness for many devices across T&D, generation and customer end-uses
- Benefits that customers value from participating in these transactions (energy bill, comfort, GHG impact, control)

*16. What is the American definition of “smartness” for Smart Metering and for Smart Grids? Is Smart Metering considered in the U.S. a first step to further Smart Grid deployment?*

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The definition of what makes smart grid “smart” varies depending on what perspective and to whom the question is asked. This is a very pertinent question, and one we will address in the videoconference. In the U.S. often smart grid is defined as whatever the vendor or utility or policy maker wants it to be, to promote a specific function. As to whether smart meters are the first step to the smart grid, opinions in the U.S. vary greatly. It is the moderator’s opinion that while meters *may* be the first step, they do not have to be the first step. Indeed, too much initial focusing on meters may lead to good automated meter reading and billing but result in a grid that does not accomplish nearly the benefits possible with a truly smart grid.

According to the National Association of Regulatory Commissioners (NARUC), the smart grid takes the existing electricity delivery system and makes it “smart” by linking and applying seamless communications systems that can:

- Gather and store data and convert the data to intelligence;
- Communicate intelligence omnidirectionally among components in the “smart” electricity system; and
- Allow automated control that is responsive to that intelligence.

The Department of Energy (DOE) defines smart grid as evolving the utility grid toward:

- information services business model
- single, actionable view of its end-to-end business and technical enterprise performance linked to strategic objectives
- Respond quickly to changing demands

Others equate smart - grid with AMR/AMI. However smart meters are only one of the potential capabilities and technologies that facilitate the offering of services.

Taking these definitions and the development efforts being conducted, smart grid is smart because of the ability to provide:

- Unifying, comprehensive vision for the future of all strategic and tactical technical performance analysis and decision-making activities.
- Implement a robust, data-driven enterprise management framework that will dramatically facilitate the process of optimizing and evolving technical enterprises on a life-cycle and epochal basis



Smart Metering generally involves the installation of an intelligent meter at customers and the regular reading, processing, and feedback of consumption data to the customer. Smart metering has the following general capabilities:

- Real-time or near-real-time registration of electricity use and possibly electricity generated locally, e.g., in case of photovoltaic cells
- read the meter both locally and remotely (on demand)
- Remote limitation of the throughput through the meter (including, in extreme cases, cutting off electricity to the customer)
- Interconnection to premises-based networks and devices (e.g., distributed generation)
- Ability to read other on-premises or nearby commodity meters (e.g., gas, water)

With what makes the smart grid smart, whether smart metering is the first step in the process of developing a smart meter may depend on who is asked the question. President Obama has, as part of the stimulus package, has called for the installation of 40 million smart meters and 3,000 miles of transmission lines. One of the reasons that smart metering is seen as the first step is that this is the primary utility interface with the customer. *However the capabilities provided by the smart meter alone do not constitute a smart grid.*

**17. *What kind of cooperation and support framework was established (formally and informally) with the regulator, industry, TSO's and DSO's, in order to foster research, development and deployment of Smart Metering and Smart Grids in the U.S.? How to ensure a coordinated and a coherent approach of all energy market actors to the deployment timescales?***

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This is still being resolved. It is different in structure – and success – in different regions of the U.S. Our approach is far from “coordinated” or “coherent.” This is a good topic for the videoconference.

**18. *What are the regulatory tools to promote Smart Metering in American conditions?***

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Regulatory tools to promote smart grid and smart metering focus primarily on the ability to manage the utility, not the technology development or program management These include:

- Applying incentives for desired action
  - Cost recovery assurance - capital and expenses
  - Higher rate of return on desired capital investments or actions
  - Rate-base (earn a capital return on) program expenses
  - Management pay linked to preferred goals
  - Shareholder rewards for performance above targets
  - Calculate profits foregone from EE/DR and pay to utility (e.g., Duke or PG&E avoided cost calculation)
  - Single-purpose rate proceedings and tariffs
- Removal of existing barriers to desired action
  - Decoupling (remove incentive to sell more energy) by linking



- profits to number of customers rather than volume sold
- Shift more costs to fixed charges and reduce variable costs
- (rate design, but motivates utility)
- Improve benefits in C-E evaluation of desired actions
- Mandates
  - Specifications for acceptable investments (e.g., smart meter functionality)
  - Order specific actions (e.g., smart meter adoption, DG interconnection, EERS)
  - Create a non-utility administrator for EE/DR
  - Create a system benefit fund to pay for the desired goal
- Penalties
  - Disallowance for imprudent investments
  - Take away earnings from shareholders
- Education, brow-beating, pressure, stalling
  - Customer education (advertising, PR, energy labels, Energy Star)
  - Public and private pressure on utilities
  - Conduct a study
- Other Options
  - Deny full cost recovery for investments in non-smart assets and devices
  - Guarantee recovery for smart grid investments
  - Require minimum %s of EE and DR in resource portfolios
  - Accelerate interoperability standards and protocols and specify basic functionality requirements for grid devices (EISAct 2007 jump-start, fund acceleration of IEEE efforts, and link to NERC reliability standards)
  - Tie DR achievements to wholesale market mitigation (more DR = higher price caps)
  - Change cost-effectiveness rules and tests (and benefits included) for EE, DR and smart grid investments
  - Performance incentives for improved efficiency within utility grid (G to T to D)

**19. *What are the potential benefits of Smart Metering deployment in America to the regulator, customer industry, TSO and DSO?***

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Depending on the functions of the “smart meter” (in the U.S. as in the EU, “smart meter” is not precisely defined), smart meters could reduce meter reading and billing costs and errors, reduce commercial losses, also make it easier for consumers to switch between retailers, give consumers access to value-added services from providers such as time of use tariffs and efficiency packages, help manage charging of electric vehicles, make building energy management systems more effective, provide consumers information on their energy use, and other potential benefits.

They also enable suppliers to offer more tariffs and services, such as ‘time-of-use’ or Critical peak pricing (CPP) tariffs, that can be used to encourage even more efficient and economical energy use or provide support to the grid during emergencies or peak loads.



20. *What new services emerge and what is the American society gain from Smart Metering and Smart Grids?*

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This is yet to be determined. Many potential functions have been identified in answers to other questions.

21. *Who is the meter owner of the smart meters and who is responsible for managing the Smart Meter (i.e. installation, maintenance, data management, etc.)?*

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Traditionally, this is the Local Distribution Company. Some utilities are charging a nominal fee for the use of smart meters (e.g. \$3 to \$5). The charging decision is an individual utility decision, subject to approval by the regulator. Many government agencies are installing smart meters for their own use in better monitoring and managing energy consumption. Non-utility entities such as college campuses or multi-building facilities also may install sub-metering for these purposes. In this case, it is the facility, not the utility, who owns the meter.

22. *What are the typical American smart metering standards (frequency of measurements and meter reading, communication protocols, other)?*

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- Frequency of measurement / meter reading depends on needs of the utility
- Protocols
  - ZigBee
  - X10
  - TCP/IP
  - WiFi
  - Mobile telephone
  - 900 Mhz
  - Tase.2
  - DNP 3
  - Ethernet
- Many of these are industry standards. NIST is in the process of defining the standards for the above and others, however, interoperability with existing / legacy equipment and communication protocols is necessary. It is also not clear that the NIST approach will successfully address the interoperability of **functions** and the sharing of data among applications, rather than trying to standardize specific functions, such as meter reading or transmitting price data to meters.

23. *Do the applied functionalities also include quality regulation of electricity of supply and if yes how does it work?*

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Most PUCs have requirements for voltage excursions (e.g., +/- 0,05 P.U.), similar to voltage service requirements in Poland and the rest of the EU. There are standards for power quality, such as harmonic distortion, that are usually imposed on consumers or equipment manufacturers. Some utilities, such as DTE, have offered performance-based tariffs to large customers (requiring a certain level of reliability or power quality). This is not a common practice.

24. *How does smart metering affect the renewables and the distributed electricity generation in the U.S.A.?*

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Smart meter are often viewed as a means to “net meter,” or give the customer credit for any electricity generated on-site, from renewable sources, and/or sold back to the grid. In practice, most on-site renewable energy-based electric generation will be consumed at the facility; little is fed back to the grid. Smart meters and their supporting communications infrastructure may provide a communications and control link that supports distributed and renewable generation.

25. *What is a “smart grid”?*

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There is no standard definition, Too often, smart grid is used as a term of convenience to promote a specific product or technology. This is a topic to be discussed in the videoconference. The following is offered for discussion:

There is much activity – including Congressional legislation – to implement the “smart grid.” Many of the current projects focus on “smart meters” and give customers price signals and choices to modify their energy use patterns – their loads – in response to grid costs and/or security at a specific time. This theme of choice is ubiquitous in smart grid definitions. But if you asked consumers what they wanted in their energy sector, “choice” and “competition” would likely not be at the top of the list.

DOE’s attributes of the modern grid:

- Reliable
- Secure
- Economic
- Efficient
- Environmentally friendly
- Safe

would be more likely to be cited. Thus, the Smart Grid should be looked at not as an end in itself but as a means to achieve the nation’s basic energy objectives.

In this respect, the “smart grid” could be characterized by two attributes: it should be flexible and integrated. The smart grid concept then becomes a platform for equipment, data and communications to be used to implement advanced functions and applications that enable us to achieve our basic objectives. The grid consists of the following elements:

- Equipment



- Data
- Communications
- Functions
- Applications

Equipment is any hardware. This includes power plants, switches, RTUs, meters, transmission cables, fault detectors, communications receivers, etc.

Data can be digital or analog. A recloser that senses a fault current and opens is utilizing an analog data measurement of the feeder current to perform that function. A “smart” recloser that knows how many times it has operated, analyzes the magnitude of the fault current that tripped it, and waits a prescribed amount of time to again try to close after sectionalizers may have operated, is using digital data. Most of the smart grid functions are utilizing digital data that is measured (sensors), converted into digital information, and then transmitted/communicated and analyzed.

Communications is how data, including control signals, are passed from one grid element to another.

Functions are the very basic control actions that can be taken by the equipment. The disk of a mechanical kWh meter revolves to display cumulative energy use. There are some inherently “smart grid” functions that are more advanced. For metering, this could mean the meter’s receiving a signal and storing energy use data in a specific register to implement the application of “time of use rates.” A PV array generates DC power, and an inverter converts the available DC power to AC power. A “smart” inverter’s functions could also include 1) interrupt the conversion (i.e., disconnect) under certain conditions, such as detection of loss of grid voltage or detection of a control signal; 2) change the power factor (i.e., injection angle) at which the AC power is produced; 3) increase or decrease the amount of DC power that is converted. A power plant generates power, and its function includes increasing or decreasing the power produced. A “smart grid” generator may have the capability (function) of ramping up or down more rapidly for small changes, or riding through disturbances, in response to data from the grid “requesting” such support. Data concentration is a basic function that has become necessary for the smart grid.

Applications are “mega functions” that combine many basic functions to achieve larger objectives. Such applications include AGC, demand response, real time pricing, fault location and service restoration, integrated volt/var control, remote/automated meter reading, etc.

## **Elements of the grid**

To design the smart grid platform, we will have to look at the basic elements or sub-subsystems of the grid. These are not immutable, others may be defined.

- Generators



- Non-utility generators
- Power control/dispatch
- Energy storage
- Transmission
- Distribution substations, feeders and other equipment
- Distribution management system
- Substations
- Metering
- Customer energy management and load control
- Customer information system and billing
- Customer-site generation and storage
- Data bases
- Communications systems

To define an application, we must specify

- What elements (equipment) are involved
- Where is the application “hosted” – e.g., power control, distribution management system, inverter controller. There may be more than one location.
- What data are needed and how are they obtained and transmitted to the locations “hosting” the application (including response time/scan rate)
- What data must be sent to other applications
- Define the application program that directs it

**26. *How can we relate the American experiences to the European given we operate on two different systems?***

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While the frequency, voltage level, construction standards, and feeder configuration may vary, the underlying principles are the same: types of functions; operating problems needing to be addressed such as incorporating more renewable and distributed energy sources; need to define value propositions for the consumer; need for integration of functions, communications and data; open systems architecture; sensor and control technologies, etc.

**27. *The benefits of introducing smart grid for the customers and the grid operators?***

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See questions 6 and 19. The smart grid functions involving system operations should also improve the management of the grid to make it more stable and reliable, benefitting the consumers and the operators.

**28. *To what degree is the loss of energy limited through the rational grid use?***

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There are many CIGRE and IEEE papers addressing this. A definitive answer cannot be given. However, the reduction in technical losses is probably lower than hoped for. On the other hand, initial studies and demonstrations show the ability to better utilize large amounts of as-available renewable sources and distributed generation may depend upon smart grid capability. This also includes reduced use of fossil-fueled generators to provide spinning and regulating reserves to support the renewable and distributed generation.

**29. *How much investment does it take to introduce smart grid effectively?***

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Not known. A good roadmap for implementation of the smart grid is needed, but so far lacking. One key point is that the benefits of many of the automation functions (feeder reconfiguration for service restoration after an outage, load leveling, etc.) cannot be realized by automating a few feeders or substations as a demonstration: a large area or entire utility must be automated. (E.g., you can not switch a section of one feeder to another unless both feeders have automation capability.) The large investment needed to effectively demonstrate and quantify smart grid benefits is a barrier to the implementation of multi-function smart grid systems.

**30. *What legislative changes were necessary in the U.S. in order to introduce and make the smart grid operational?***

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It is not yet operational. See questions 15 and 18.