National Rural Electric Cooperative Association
A Touchstone Energy® Cooperative

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U.S. Department of Energy
Office of the General Counsel
1000 Independence Avenue, SW.
Room 6A245
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E-mail: broadband@hq.doe.gov

RE: NBP RFI: Communications Requirements

Introduction

The National Rural Electric Cooperative Association (NRECA) is the national service organization representing more than 900 not-for-profit, member-owned rural electric cooperatives ("Cooperatives"). Most of NRECA's members are distribution cooperatives, providing retail electric service to more than 42 million consumers in 47 states. NRECA members also include approximately 66 generation and transmission ("G&T") cooperatives that supply wholesale power to their distribution cooperative member-owners. Cooperatives provide service approximately 75 percent of the nation's land mass, resulting in a consumer density of just seven consumers per mile of line, significantly less density than that of investor or municipally owned utilities.[1] Both distribution and G&T Cooperatives were formed to provide their members with adequate and reliable electric service at the lowest reasonable cost. In total, kilowatt-hour sales by Cooperatives account for approximately 11 percent of all electric energy sold in the United States.

Cooperatives are widely embracing numerous Smart Grid technologies and have been

[1] Investor-owned utilities average 34 consumers per mile of electric distribution line and municipally-owned utilities average 47 consumers per mile.

recognized as leaders in integrating advanced grid technologies.[2] Advanced technologies help Cooperatives to address the fact that they have very low consumer density and vast territories to serve.[3] Richer and faster data from Smart Grid technologies allows utilities to better monitor power quality, identify specific device malfunctions, pinpoint outages and detect overloading conditions and remotely effectuate appropriate re-routing, among other things. Necessary to support this exponentially increased data flow[4] from various points all over the grid are more robust communications networks, with two-way and broadband communications capability in at least some portions of those networks. Cooperatives have adopted various communications platforms, and often operate "hybrid" systems employing different wireline and wireless technologies, including fiber, power line carrier, land mobile radio, microwave, satellite and even unlicensed technologies. Cooperatives will utilize whatever technology is available that can meet their demanding operating requirements and allow them to provide electric service safely, reliably and cost effectively.

NRECA believes the use of spectrum for internal, utility networks should be valued at least as much as the use of spectrum for commercially provided services is valued.[5] While broadband communications is often touted as today's indispensable service, reliable electricity remains a critical necessity. The Federal Communications Commission's ("FCC") National Broadband Plan ("NBP") devoted an entire chapter to discussing the importance of

[2] F.E.R.C. Ann. Rep. on the Assessment of Demand Response and Advanced Metering 8 (Dec. 2008), *available at:* http://www.ferc.gov/legal/staff-reports/12-08-demand-response.pdf.
[3] Cooperatives serve approximately 75 percent of the nation's land mass, with a distribution system network consisting of about 42 million miles of distribution line.
[4] For instance, 12 monthly meter readings becomes 34, 560 readings for one year when meter readings are conducted in 15 minute increments.
[5] President Obama's recent announcement stating the Administration's plan to double the amount of *commercial* spectrum regrettably does not include a specific acknowledgement of the importance of spectrum for private uses, particularly critical infrastructure service providers. Presidential Memorandum: *Unleashing the Wireless Broadband Revolution* (June 28, 2010), *available at:* http://www.whitehouse.gov/the-press-office/presidential-memorandum-unleashing-wireless-broadband-revolution.

communications networks to the Smart Grid. Unfortunately, the NBP did not give due deference to the ability of individual utilities to define, design and deploy such networks for themselves. NRECA is gratified that the Department of Energy ("Department') has taken up the charge in the NBP to more closely examine the current and future communications requirements of electric utilities. Indeed, the Department can provide information and guidance that will help utilities make wise investments in communications networks as well as inform important Smart Grid policy decisions at both the State and Federal level.

NRECA now offers its responses to questions in the Department's RFI, taking some liberties to reframe and combine those questions and raise other points, as invited in the RFI:

What are the current and future communications needs of utilities, including for the deployment of new Smart Grid applications, and how are these needs being met? **(Question 1)**

In many respects, the communications needs of Cooperatives are quite similar to those of investor and municipally-owned utilities, but with much greater challenges due to the vast geographic boundaries of their service territories combined with low customer density. Generally, Cooperatives have three basic applications to satisfy current system needs:

1. Interoffice and Internet-based "high" bandwidth (greater than 500 kbps) links for limited locations;
2. Mobile links for voice and data traffic, at "medium" bandwidth (between 20 to 500 kbps), to, from, and between all fleet vehicles; and
3. Fixed network data traffic with varying bandwidths from high to "low" (20 kbps minimum) depending upon the specific utility application. For traditional operations data such as metering, SCADA, and substation/feeder automation, medium- and low-bandwidth technologies are sufficient.

With regard to "future" needs, the most common Smart Grid applications presently being deployed by Cooperatives are AMI, Direct Load Control ("DLC") over Automated Metering

Infrastructure ("AMI"), AMI-empowered demand response programs (such as critical peak pricing), next-generation SCADA, and Distribution Automation ("DA").[6] Cooperatives' substations are being upgraded to serve as data concentration hubs with the need to transport TCP/IP Ethernet-based, open protocol SCADA and to backhaul data from AMI systems. Also at the substation level, Cooperatives are increasingly looking to add video surveillance and to convert current PBX systems to VOIP, both of which require high bandwidth communications. Cooperatives have significant needs for mobile communications of both mobile voice and data too. Many are now starting to deploy new applications to utility vehicles for service, outage and work orders, and vehicle tracking. Additionally, Cooperatives are making the grid smarter through the integration of multiple utility automation applications and enhanced security. More robust communications networks are necessary to support these enhancements as well.

There are significant challenges to accommodate these new applications. Utilities lack access to available licensed radio frequencies below 700 MHz, which has ideal characteristics for certain key applications. Cellular service can meet some needs, but the availability and overall coverage of cellular service is quite inconsistent across Cooperatives' service territories. For many Cooperatives, they have good cellular coverage in some parts of their service territory (usually in areas closer to cities and towns), but experience large coverage "holes" in other parts. Many Cooperatives have also experienced continued service reliability problems with cellular carriers. As a result, some Cooperatives have explored unlicensed spectrum technologies, but such technologies come with their own sets of the challenges, particularly with regard to the

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[6] The Institute of Electrical and Electronics Engineers defines DA as "a system that enables an electric utility to remotely monitor, coordinate and operate distribution components in a real-time mode from remote locations." DA includes control center-based control and monitoring systems, such as distribution SCADA or distribution management systems, and distribution automation field equipment, ranging from remote terminal units to intelligent electronic devices such as circuit breakers, reclosers, switches, capacitors and transformers that can be remotely monitored, if not also remotely controlled or operated.

interference issues.

What are the basic requirements, such as security, bandwidth, reliability, coverage, latency, and backup, for smart grid communications and electric utility communications systems in general-- today and tomorrow? How do these requirements impact the utilities' communication needs? **(Question 2)**

NRECA refers the Department to the comments filed by the Utilities Telecom Council ("UTC") for specific requirements identified by UTC from data gathered across all the electric industry sectors. In short, the requirements vary a great deal by application. As for security, this means that the network should be resistant to malicious attacks. The more critical the operation of a particular electric utility system feature, the more secure the communications link serving that part of the system must be. The network also should not introduce significant delay or latency in transmitting system control and data signals, because a delay (for certain facilities and equipment, the delay is measured in milliseconds) could render control ineffective. Networks must also be available, with minimal downtime for maintenance and repair and with a resiliency to withstand storms and other disruptive events. Cost is also a basic requirement to be considered. Total costs – purchase price, installation, and maintenance – should be reasonable and in proportion to the benefits the network provides. Further, the application of mandatory reliability standards for owners, operators and users of the bulk electric power system emphasizes the importance of total system reliability for utilities. While these mandatory reliability standards do not specifically address communications network functions and capabilities, a properly functioning and secure communications network is a necessary component to achieving compliance with certain standards.

The following is a brief overview of basic requirements for four important application types being widely deployed by Cooperatives:

AMI: AMI enables a number of applications, including the following.

- *Remote meter reading:* To enable meter reading at 15 minute intervals, readings[7] are transmitted for approximately 30 seconds once every 15 minutes with a latency target of not more than 30 seconds.
- *Outage notification and restoration:* The frequency of use is very infrequent for large scale outages, but significantly more frequent for smaller area outages. The latency target is not more than ten seconds.
- *Load management and demand response (including DLC):* An average forecast of the frequency use would be 30 peak events in the summer for a summer peaking system, with a latency requirement of ten seconds or less.

SCADA & Substation Applications: To support SCADA, the communications media must be able to send about 300 bytes of data every two to four seconds, 24 hours a day, seven days a week. This requires 100 percent availability but low bandwidth with the typical interface being Ethernet and TCP/IP communications protocol. The media must often pass a 99.99% reliability requirement and be made secure, resulting in a bandwidth requirement of about 200 kbps per substation. At the substation, there is also the need for direct connections to devices such as regulators and reclosers, which can function with a higher latency, such as seven seconds. G&Ts have substation relay protection communication requirements of sub-second latency with the need to use circuit switched media to meet this requirement. As an AMI collector point, the bandwidth requirement for AMI at the substation is normally around 500 kbps, but can survive with latency as long as ten seconds.

Mobile Communications: Some applications, such as Automatic Vehicle Location

[7] It bears noting that it is much more common today for meter readings to occur on an hourly basis .

systems ("AVL"), require the capability to have coverage requirements of 95 percent of the roads within a utility's service territory. However, bandwidth requirements are very low, as only 50 bytes of data is typically sent for each AVL message. The typical frequency of AVL messages is one every five minutes. Other mobile data applications require the need to send about 10,000 bytes of mobile data, but can function with small gaps in coverage. The bandwidth requirement for many mobile applications is becoming 20 kbps or greater.

Distribution Automation: The use of downline DA is rapidly growing among Cooperatives. Given the nature of the functions being performed by DA devices, latency generally cannot exceed two seconds. The biggest obstacle to more widespread deployment of DA is the vastness of Cooperatives' service territories and the overall lack of communications alternatives. While unlicensed wireless can provide the needed bandwidth, it often lacks sufficient coverage. Another concern with unlicensed wireless is lack of availability or high costs to acquire from "frequency brokers." Licensed frequencies in the VHF, UHF or 220 MHz spectrum are ideal for DA applications (as well as SCADA).

What are other additional considerations (e.g. terrain, foliage, customer density and size of service territory)? **(Question 3)**

The typical Cooperative faces a significantly large territory with low customer density, which, as noted above, presents challenges to designing a robust and reliable communications network that can meet the Cooperative's needs. Another consideration for many Cooperatives is remoteness. Some Cooperatives serve areas so rural, they can only be reached by boat, snowmobile, or helicopter for at least some of the year.[8] Cooperatives also serve some of the most difficult terrain -- dense forests, mountains, swamps and deserts -- which affects

[8] A perfect example is the Alaska Village Electric Cooperative, http://www.avec.org.

communications network design. Such conditions vary greatly by region, and not uncommonly, even within a single Cooperative. For example, a Smart Grid stimulus-funded project involving New Hampshire Electric Cooperative ("NHEC") is presented with the challenge of heavy foliage and many miles of service territory. As a result, the AMI backhaul communications infrastructure represents more than 30 percent of the total cost of the AMI system. A private communications network has been selected for this project, even at a somewhat greater cost, primarily because of the poor reliability of the area cellular providers and several large holes in cellular coverage.[9] Another consideration that led NHEC to elect to construct a private network is the cooperative's desire to build the infrastructure where it is needed, rather than where the carrier elects to build it.

Coverage gaps and reliability issues like those experienced by NHEC are common issues for Cooperatives. Further, it is not unusual for several (sometimes six or more) different commercial communications providers to operate within the electric service territory of a single Cooperative. Across an entire G&T, the number of commercial carriers multiplies. A decision to use commercial services can thus result in the need to interface disparate commercial systems. Most Cooperatives will still utilize some private, wireless communications network components for purposes such as dispatch, mobile data, or SCADA systems, even if they utilize commercial services for other applications.

Topology, current infrastructure, and weather conditions must also be considered in designing a communications network that can meet future utility needs. Does the utility's distribution system primarily consist of overhead or underground lines? What is the existing communications architecture of the utility and how can it be leveraged? Is the utility's service

[9] In February 2010, cellular service was unavailable for four days to more than 25 percent of NHEC's service territory while the private land mobile radio system maintained by the cooperative remained in service.

territory marked by extreme weather conditions, such as extended periods of severe cold or heat, lightening strikes, ice storms, hurricanes, tornadoes, or fog? The communications network must be able to perform reliably in such conditions and be sufficiently rugged to ensure continued operation through major weather events.

What are the use cases for various smart grid applications and other communications needs and what technology options are available to meet these needs? **(Question 4 & 5)**

For Cooperatives, which are not-for-profit and member-owned, the key drivers behind deploying Smart Grid applications and other communications applicable are the same as any other business investment: Will this investment help to (1) reduce costs, (2) improve customer service, and/or (3) increase productivity or efficiency? If the answer is yes to one or more of these questions, then a Cooperative is likely to pursue the investment.

Applications	***Key Drivers***		
	Reduce Costs	**Improve Cust. Service**	**Improve Productivity**
Capturing individual load contribution during system peak conditions	**X**	**X**	**X**
Evaluate transformer loading	**X**		
Developing load shapes for customer classes		**X**	**X**
Voltage monitoring	**X**	**X**	
Identifying system blinks & power quality	**X**	**X**	
Monitor system conditions during load xfrs	**X**	**X**	
Track phase changes and phase verification	**X**		
Critical Peak Pricing (CPP)		**X**	**X**
Distributed Generation & Net Metering	**X**	**X**	**X**
Reduce theft of service	**X**	**X**	**X**
Distribution Automation (DA)	**X**	**X**	
Time of Use rates (TOU)	**X**	**X**	**X**
Remote disconnect/reconnect	**X**	**X**	**X**
Load Management (LM)	**X**	**X**	**X**

It is difficult in many respects to describe a "typical" Cooperative in terms of a use case and appropriate technology options for each Smart Grid application, given the considerations discussed above. However, some commonalities can be found.

AMI & SCADA: The vast majority (90 percent according to NRECA's estimates), of the new AMI systems being deployed will use Power Line Carrier ("PLC") using substations as nodes. The AMI data is routed from the customer's home or other facility to the substations via PLC. Many Cooperatives have utilized older, narrowband, low-frequency PLC for many years. Broadband over Power Lines offers, as the name suggests, higher bandwidth, but, commercially deployed, long distance BPL is not widely available currently. At the substation, the AMI data (and often SCADA data too) is routed to the Cooperative's data center over communications media that are most likely to be fiber or microwave, Multi Protocol Labeling Service or unlicensed frequencies. NRECA estimates that of these most likely paths, approximately 60 percent is spread spectrum unlicensed at 900 MHz and 2.4 GHz.

Mobile Communications: For mobile voice communications, the most common technology remains licensed frequencies at 150 MHz, 220 MHz, and 450 MHz with both trunking and conventional technology. For mobile data applications, cellular is the most common media being used, with an estimated 80 percent of Cooperatives using cellular service to meet their mobile communications needs.

Distribution Automation: This is a fairly new area for most Cooperatives, with an estimated 5 to 10 percent currently deploying some type of DA program. The most common backhaul communications media being used for DA is cellular with the second most common communications media being spread spectrum unlicensed 900 MHz. Most Cooperatives would prefer to use licensed radio frequencies for DA, spectrum availability in the 150 to 750 MHz range is lacking.

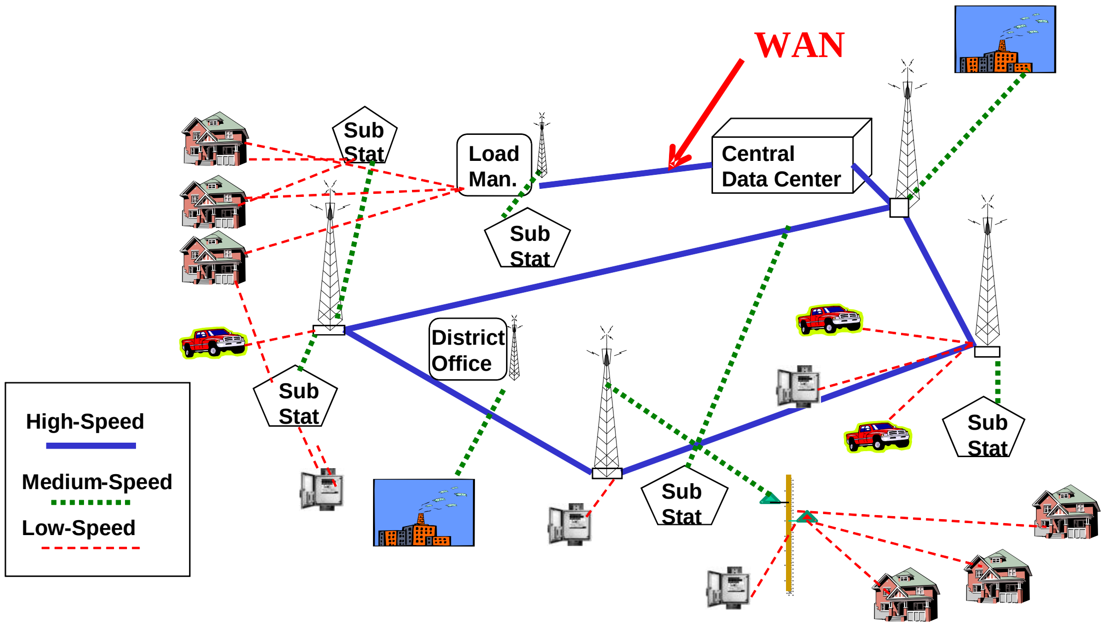
***What are the recommendations for meeting current and future utility requirements, based on each use case, the technology options that are available, and other considerations?* (Question 6)**

A migration to a multi-tiered architectural environment is being made to bridge the vast distances that Cooperatives must traverse in their service territories. This means the use of reliable, private broadband media between tower sites and major nodes. The backbone networks are designed to transport > 20 Mbps of bandwidth. A second tier private communications media is then needed from the tower sites or major node sites to substations, DA points and fixed wireless take-out points. A third tier, extending from the substations to the homes and other customer facilities, may be delivered by AMI vendors on their own proprietary networks as these vendors may provide metering, demand response, direct load control and home automation services.

Below is an illustration[10] of the topology of a three tiered architecture typical among Cooperatives that have been moving quickly to upgrade their communications networks. Tier 1, the high-speed layer, is usually a combination of fiber optics and licensed microwave (6 GHz, 12 GHz or 18 GHz). Tier 2 is the medium-speed layer, utilizing various technologies such as unlicensed 900 MHz, unlicensed or licensed WiMAX, licensed frequencies between 150 and 450 MHz, cellular, software-defined radio, MPLS service or wireless mesh at 2.4 or 5.8 GHz. The third tier, or lower-speed layer (though higher speeds would be required for certain applications such as dynamic pricing), may consist of proprietary AMI technology that is routed between substations or other AMI nodes to the home.

[10] Illustration provided by Power System Engineering, Inc. Used with permission.

Progressive Co-op Communications Architecture



To what extent can existing commercial networks satisfy the utilities' communications needs? What, if any, improvements to the commercial networks can be made to satisfy the utilities' communications needs? **(Questions 7 & 8)**

NRECA has found that commercial carriers are providing adequate mobile data services for Cooperatives' mobile computing applications. The commercial carriers are also providing complimentary mobile voice communications to improve "dispatch to vehicle" and "vehicle to vehicle" communications. However, NRECA does not expect Cooperatives to switch from their private land mobile radio systems to commercial carrier services given the dual challenges of coverage gaps and a poor track record of reliability during major events and storms. When commercial carriers strongly protest the FCC's exploration of survivability requirements, this does not increase the confidence of Cooperatives in the carriers' capabilities.[11] Still, some Cooperatives, particularly those located in suburban areas which tend to have better coverage, may choose to use commercial cellular services for DA. Some Cooperatives may use cellular for portions of their system where coverage exists for the backhaul of AMI. NRECA is aware of a number of Cooperatives that have successfully partnered with commercial providers to design and build communications networks. Certainly, Cooperatives are going to need to explore every available option to meet their expanding communications requirements.

The following improvements, if implemented, would substantially enhance the ability of commercial networks to meet utility requirements:

- Allow utility and public safety users to be placed at the top of the commercial carrier's **priority restoration** list during a major event to better allow the commercial services the required capacity and performance.

- Provide **coverage to 95 percent of the service territory and 100 percent coverage to critical areas**, such as substations, meter points, and other key utility asset areas. The challenge is, for example, if only 75 percent of the sites are served with cellular, the product choices to serve the remaining 25 percent with private often become cost prohibitive because many of the private technologies require a multi-tiered communications structure.

- Require **back-up power at all cell sites maintained for several days** if power is interrupted due to a major event.

- Provide a **Quality of Service (QoS) guarantee** for the level of latency delivered over fixed data links. QoS is defined by agreeing to meet a specific bandwidth and latency 100 percent of the time. For utilities, the level of latency is more critical than bandwidth. While bandwidth and latency are closely connected, there are various

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[11] *See, e.g.*, comments filed in the FCC's Notice of Inquiry, *Effects on Broadband Communications Networks of Damage to or Failure of Network Equipment or Severe Overload,* P.S. Docket No. 10-92, by CTIA, USTelecom, PCIA, and others.

utility applications that require a defined latency time in order for the application to function. Without a defined QoS guarantee, the software applications in some cases cannot function. For example, some applications require a latency requirement of less than three milliseconds, latency greater than three milliseconds will result in a circuit fault and make the smart switching investment useless.

- Provide **modems with both RS232 Serial and Ethernet ports**. Both types of interfaces are required as some Cooperatives are migrating from RS-232 to Ethernet, which migration could take five years or more. Having modems with dual ports allows the same communications product to be used across the system.

- Provide **both static TCP/IP and UDP/IP protocols**. A static IP address is needed to allow the SCADA or DA master to communicate with the remote device and for the network management system software to know the locations of the remote devices. Having both TCP/IP and UDP/IP provides the flexibility to interface with some software applications that require UDP/IP and TCPIP.

- Provide **proactive network monitoring with timely outage notification**, that is, notification within 60 seconds of outage events.

- Provide **reliability targets** of the following: 99.999 percent for backbone and tower site links of 99.999 percent, 99.99 percent for substations, 99.99 percent for AMI take out points, and 99.9 percent for DA.

- Provide for **backward compatibility between 2.5G to 3G to 4G** to allow field-deployed cellular radios to not need replacement for ten years, as many Cooperatives use a ten-year depreciation schedule.

As the Smart Grid grows and expands, how do the electric utilities foresee their communications requirements as growing and adapting along with the expansion of Smart Grid applications? **(Question 9)**

We are already seeing expectations rise. As a utility begins to more deeply benefit from Smart Grid applications, the utility places greater dependency on the Smart Grid software, hardware, and communications infrastructure to operate. Some of the manual processes that have been used are being phased out as the new Smart Grid technologies are deployed. Once the transition from the manual to automated processes occurs, and the new Smart Grid applications become more fully utilized, the overall importance of the utility's communications system becomes mission critical for many applications like SCADA, DA and some applications under the AMI umbrella of services.

Are there Smart Grid technologies that are not being embraced as widely as others yet that if they are eventually deployed in greater numbers would change communications requirements significantly? If so, what are these technologies (or applications) and how do the requirements change?* (Question 10*)

Yes. At this present time many Cooperatives are still using one-way DLC technology. According to NRECA's research, Cooperatives have given higher priority to using AMI to enable automated meter reading, outage diagnostics, power quality monitoring and time of use rates than DLC. NRECA's Smart Grid demonstration project will be conducting about 15 demonstrations using AMI for DLC and AMI for demand response applications such as critical peak pricing and smart thermostats. The NRECA believes the lessons learned from the DOE Smart Grid demonstrations will help answer the questions of what is working and what is not working, and thus identify the means to take full advantage of AMI and new communications infrastructure. As AMI becomes the "workhorse" for various demand response applications, this will stress utilities' communications systems even more and place increased pressure to meet stringent reliability expectations.

Conclusion:

The Department of Energy's efforts to bring together various stakeholders to engage in a consensus-seeking dialog on critical policy issues is commendable. NRECA appreciates this opportunity to provide comments on the subject of Cooperatives' communications requirements. Smart Grid technologies have the potential to provide consumers with significant energy and financial savings with corresponding benefits to the environment. These technologies require more robust communications networks to support them, and in certain portions of their systems, require two-way and broadband connectivity. Determining which communications technologies to deploy where, how and when are critically important questions that each individual utility will need to answer based on its specific circumstances.

The Federal government can aid utilities in answering these important questions as well as provide a policy framework that promotes wise investments, supports innovation and enables continued functioning of a reliable and secure grid. Specifically, the Federal government can:

- Allocate adequate spectrum for licensed, wireless utility communications networks;
- Support the stakeholder processes defining interoperability and security standards;
- Facilitate the sharing of "lessons learned" through stimulus-funded Smart Grid demonstration and investment projects; and
- Ensure that laudable efforts to inventory spectrum use do not inadvertently create unnecessary security risks for the grid.

Further, NRECA believes that there is a role for commercial carriers, but that this role should not be overstated. The choice must be left at the State and individual utility level regarding whether a particular communications network gets built by the utility itself, or by or with the help of a commercial provider. The dialog being created by the Department is very important to help utilities and commercial communications providers better understand one another's needs and capabilities. NRECA believes that the balance necessary to ensure network adequacy, reliability, security, hardiness and cost-effectiveness is one that all utilities must and will answer individually. There is no "one size fits all" set of requirements and no single, perfect communications network design. At the same time, having a national dialog to determine the most effective Federal policy framework to ensure that such networks can be timely built is of vital importance.

Respectfully submitted,

Tracey B. Steiner
Senior Corporate Counsel