UNITED STATES DEPARTMENT OF ENERGY

In the Matter of Implementing the National Broadband Plan by Studying the Communications Requirements of Electric Utilities to Inform Federal Smart Grid Policy	)	DOE-HQ-2009-0003-0819 (Noticed May 11, 2010)

Comments of San Diego Gas & Electric Company

San Diego Gas & Electric Company ("SDG&E") files these comments in response to the above-enumerated Request for Information noticed by the Department on May 11, 2010. SDG&E is a regulated public electric and gas utility operating pursuant to authorities granted to it by the Federal Energy Regulatory Commission and the State of California. SDG&E serves 3.4 million consumers in the San Diego and southern Orange County areas of California via 1.4 million electric meters and 830,000 gas meters. SDG&E's sister company, the Southern California Gas Company, is the nation's largest gas-distribution utility, serving another 20.3 million consumers in a 20,000 square-mile area via 5.7 million gas meters.[1]

I. Introduction

SDG&E is among those companies leading the electricity industry in the development of operational and customer-service strategies enabled by the deployment of smart grid technologies and has launched ambitious and wide-ranging plans to deploy those technologies. SDG&E and the Southern California Gas Company are actively engaged in the systemwide deployment of

[1] SDG&E and Southern California Gas Company are wholly owned subsidiaries Sempra Energy, a Fortune 500 holding company headquartered in San Diego, California. Together, these two companies comprise the Sempra Energy Utilities, a division of Sempra Energy. The Sempra Energy Utilities have been participating in the various proceedings and information-gathering processes of the Federal Energy Regulatory Commission, the Federal Communications Commission and the Department related to the definition, development and deployment of the national smart grid. SDG&E, rather than the Sempra Energy Utilities, files these comments due to the Department's focus here on smart grid issues as they relate to the domestic electricity industry.

smart grid technologies and advanced metering infrastructure.[2] The related actions that have been taken by the Department under the aegis of the American Recovery and Reinvestment Act of 2009 have had and will continue to have direct impacts on our business strategies and plans to implement smart grid technologies and upgrade the vital infrastructure through which we serve our customers. We agree with the Federal Communications Commission that the Department is ideally positioned to speed and enhance the deployment of smart grid technologies and thereby increase the efficiency, reliability, and security of America's energy infrastructure. These comments are aimed at providing the real-world context within which the Department should evaluate potential policies, regulations and incentives so as to assist the Nation's energy utilities in achieving these important goals. SDG&E urges the Department to provide this assistance by reporting to the Federal Communications Commission the industry's communications requirements so that these requirements can be reflected in and accommodated as part of the implementation of the National Broadband Plan.

As the Department and Federal Communications Commission are well aware, the advent of the smart grid concept greatly increases the complexity of the communications architecture upon which electric utilities rely to deliver their services. The explosion in smart grid technologies and applications has a huge impact on the need for electric utilities to create and manage a flexible communications architecture characterized by multiplexing, seamless integration and the capacity to serve both our current and future requirements. That communications architecture must reliably, securely and cost-efficiently support a variety of energy-related functionalities at three distinct levels: between our system and the regional bulk transmission system;[3] within our system and among our workers; and between our system and our customers. That architecture must also be flexible enough to address the communications needs we currently have and will be adding. Broadband will, over time, be an increasingly attractive option for the functionalities that SDG&E will be incorporating into our smart grid design because of the capacity and quality broadband communications offers. SDG&E urges the Department to impress upon the Federal

[2] The Sempra Energy Utilities are deploying smart grid equipment and functionalities throughout both the natural gas and electricity systems we operate in California. This is, in part, due to the fact that the California electricity system is heavily dependent on gas-fired electric generation. This creates interdependencies between the power system and the natural gas transmission and distribution system. Smart grid applications on the natural gas system will allow for multi-level and intersystem coordination between the two separate, but linked, utility systems. Therefore, SDG&E encourages the Department to proceed with the understanding that the concept of "smart grid" extends beyond the electricity system.

[3] Pursuant to various agreements and the regulations of the Federal Energy Regulatory Commission, operation of the SDG&E bulk transmission system is the responsibility of the California Independent System Operator.

Communications Commission that the commission should recognize and accommodate energy-related uses within the National Broadband Plan so that the promise and national interests in the deployment and operation of a national smart grid can be realized. This will permit electric utilities such as SDG&E to seize opportunities to make use of broadband where appropriate and cost-effective, whether via licensed or unlicensed spectrum and/or using private networks or public-carrier services.

Before addressing the specific questions posed in the Department's Notice, SDG&E believes it is important to provide some context to its positions and interests. SDG&E operates in the state that has long led the nation in the design and implementation of innovative and comprehensive energy-efficiency and demand-response standards and programs. Collectively, California's regulated energy utilities will spend over $3 billion on customer-level energy-efficiency and demand-response programs over the next three years. The California electric utilities lead the nation in the procurement and integration of renewable-energy resources and the construction and development of new and upgraded electric-transmission facilities whose principal purpose is to connect these resources to the grid and deliver their energy to retail consumers. In this regard, California's policymakers and utilities are committed to achieving a goal of delivering not less than thirty-three percent (33%) of annual electrical energy requirements from renewable resources by the Year 2020.[4]

Additionally, the California utilities are striving to be on the forefront of the deployment and integration of electric and alternative-fuel vehicles in an effort to contribute significant reductions in carbon-dioxide emissions under the State's groundbreaking Climate Change Solutions Program. Recently reinvigorated national policies and attention promoting electric vehicle technologies, including plug-in, hybrid, and battery-powered vehicles, have accelerated the plans of automobile manufacturers to offer these vehicles. Consumer interest in these vehicles is high in California, and we are well-positioned to speed market entry and acceptance of these products.

To support these ambitious energy-efficiency, demand-response, renewable-energy, and transportation goals, California's utilities have been investing billions of dollars a year to expand and modernize the state's gas and electric transmission and distribution systems and are developing a vision of a multi-level, end-to-end Smart Grid enabled through the deployment of new

[4] In assessing the daunting nature of the California goals and the State's aspirations here, the Commission should keep in mind that energy from large-scale hydroelectric facilities and facilities burning waste-coal or –petroleum products cannot be used to meet the California requirements as would be the case in several other states.

and innovative technologies and equipment. Thus, the transformations occurring in the national electricity markets and national broadband policies are well understood in California. Considerable experience has already been accumulated in the state with respect to the integration of new resources and the deployment of technologies that will enable the modernization of the electrical grid. By coordinating the two distinct but interdependent technology paths represented by broadband communications and smart grid technologies, the Department can assure that potential synergies can be captured by leveraging the two paths. This can result in maximizing the public and national benefits and advantages each can provide, a goal wholly consistent with the requests made of the Department by the Federal Communications Commission in the National Broadband Plan. The questions posed by the Department in the instant Notice demonstrate an apt appreciation of the complexity of smart grid policies and programs and, importantly, their dependence on the availability of communications technologies that will facilitate the connectivity of the critical infrastructure linking the integrated end-to-end systems comprising the smart grid. We strongly believe that the experience gained in California can be of great assistance to the Department as the Department contributes its energy-industry expertise to the Federal Communications Commission and thereby guides the development of the energy-sector provisions of the National Broadband Plan.

II. Responses to the Questions Posed

SDG&E previously submitted extensive comments to the Federal Communications Commission as that agency considered the terms and parameters of its National Broadband Plan and their effect on the development of smart grid technologies, applications and strategies. In several respects, these comments repeat the information provided to the Commission, as augmented by the additional and specific information requested in the Department's Notice. Our comments are organized according to the questions enumerated in the Department's Notice.

In the instant Notice, the Department acknowledges that other federal agencies will have expertise and jurisdiction with respect to many of the matters and issues described in the Department's Notice. Similarly, the Department should keep in mind that many state agencies and regulators also have jurisdiction over and considerable expertise in these same matters and issues. As the Department well knows, there is an extensive, well-established, state-based regulatory scheme governing the domestic electricity industry, and many states, California among them, have been actively considering issues related to the development of the smart grid and the deployment of the technologies and applications that make up its moving parts. Evident throughout these comments is that SDG&E's smart grid programs are subject to the laws, regulations and oversight of the State of California and its various agencies. Thus, in many respects, California and its regulated electric utilities, including SDG&E, have participated in public proceedings where there was a thorough vetting of the smart grid functionalities that could be implemented as part of a smart grid strategy. Specifically, in 2008, the California Public Utilities Commission ("the California Commission") and its sister agency, the California Energy Commission, initiated a rulemaking[5] to address the need and criteria for standards recognized by Congress in Title XIII of the Energy Independence and Security Act of 2007, and later to evaluate smart grid opportunities available under Title IV of Subdivision A of the American Recovery and Reinvestment Act of 2009. Recently, the California Commission issued its order setting forth the requirements for smart grid deployment plans that are to be filed by the state's electric utilities. Under the order, each electric utility is to file its plan and address the following eight essential elements within the plan: vision; strategy; baseline; roadmap; grid security and cybersecurity; costs; benefits; and performance metrics.[6]

In light of these circumstances and developments, SDG&E respectfully requests that the Department take into careful consideration the emerging state regulatory schemes under which the electric-power industry is proceeding in the development, deployment and operation of smart grid strategies. To do otherwise could create jurisdictional conflict and confusion that might disrupt innovation and progress needlessly and possibly thwart the delivery of the benefits the smart grid has to offer to the nation.

(1) 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?

SDG&E is among the electric-distribution companies leading the nation in the deployment of smart grid technologies. From its experiences as an early adopter, SDG&E has found that the operation of these technologies demand flexible, reliable, secure, pervasive, scalable, and high-

[5] See *Rulemaking to Consider Smart Grid Technologies Pursuant to Federal Legislation and on the Commission's Own Motion to Actively Guide Policy in California's Development of a Smart Grid System,* Docket R.08-12-009. Order and filings in this docket are available on the Commission's website at http://docs.cpuc.ca.gov/published/proceedings/R0812009.htm.

[6] *Id.,* Decision 10-06-047, at pp. 2-5, 138-139.

performance communications solutions. In particular, these communication solutions, both alone and in combination with others, must provide maximum flexibility so that additional technologies can be integrated as innovative new products and programs become available to the market. The communications solutions of today must be able to adapt during the evolution and growth of smart grid technologies.

SDG&E's current communications requirements vary among business units and applications, but nevertheless share some common attributes. SDG&E's facilities and infrastructure are distributed across a territory encompassing more than 4,100 square miles of highly varied topography (*e.g.*, desert to sea, mountains to valleys) and population density (*e.g.*, major metropolitan and suburban areas to rural, remote areas). Thus, SDG&E not only requires reliable, secure communications to and between our fixed assets, but our large mobile workforce must be equipped with wireless communications capable of operating reliably and securely in challenging and harsh environments and under the most adverse operating conditions, *e.g.*, the urgency of restoring service during and after wildfires. The diverse needs presented by our system and customer needs are taken into account as we design and deploy our smart grid architecture.

For many utilities, the implementation of energy policies driving renewable resources and electric vehicles lie in their future. For SDG&E, that future is already here. Our customers are adopting distributed photovoltaic systems in record numbers, demonstrated by the sixty-percent increase our residential net energy metering program experienced during 2009. Further significant growth in central-station, at-scale renewable resources is expected upon the 2012 completion of our Sunrise Powerlink project, a new 500-kilovolt transmission line connecting the San Diego metropolitan area with the renewable-rich eastern areas of southern California. Through the Department-funded "EV Project", SDG&E is collaborating with ECOtality and other partners to deploy residential and public-charging infrastructure throughout San Diego in support of the initial deployment of Nissan LEAF and Chevrolet Volt electric vehicles. Successful integration of renewable resources and electric vehicles with the existing electrical grid requires new monitoring and power-management capabilities, such as synchrophasors and integrated volt/VAR management, to be placed throughout the electricity system. These new technologies, applications and capabilities all require communications components and systems capable of meeting the energy industry's demanding reliability standards and that are hardened against and secure from malicious intrusions.

In SDG&E's future, an increasingly decentralized system architecture, integrating distributed-energy resources and logically segregated into microgrids, will continue to increase the degree to which operations will depend on a sophisticated and flexible information and communications infrastructure. The evolution toward a distributed-energy management approach will require a contemporaneous evolution in communications systems, with even higher demands for system availability, capacity, security, and flexibility. The qualitative characteristics of SDG&E's communications needs are summarized in the following table:

Capacity	Electric utilities require unprecedented levels of bandwidth to support smart grid technologies. The bandwidth capacity is required to be available on a firm basis (*i.e.*, oversubscribed capacity delivered on a best-effort basis would provide an unacceptable level of service). Most existing private network solutions provide narrowband not suitable for smart grid technologies and availability of licensed spectrum for the electric industry is currently limited.
Latency/Quality of Service	Many utility applications, including system protection and functionality enabled by synchrophasors, require exceptionally low latency. Some smart grid control systems demand transactional latencies lower than one cycle on the power system, *i.e.*, less than 16 milliseconds.
Coverage	Electric utilities require communication solutions that have 100-percent coverage of their service territories, reaching all of their fixed assets and stations as well as providing access to the mobile workforces that build, repair and maintain the system infrastructure.
Reliability	Electric utilities require communication solutions that are always available, even during adverse events when utility crews are working to restore services; service restoration depends on voice and data communications for crew and public safety. Absolute reliability is critical for ensuring safe, integrated and secured electric operations, as well as compliance with regulatory requirements related to levels of service reliability and safety.
Security	Communications solutions used by electric utilities require the highest levels of security. Because electric-utility networks are used to manage and control critical infrastructure, the communications systems themselves become crucial and must be secure from disruptions and unauthorized accessing of or modifications to information as it traverses the network.

At present, no single communications technology, solution or provider has emerged that can meet the communications requirements of the broad range of smart grid components and applications SDG&E is deploying. Historically, energy utilities have built or acquired single-application communication systems that are physically separate and isolated from one another, although this approach is suboptimal in terms of enabling an integrated end-to-end smart grid comprised of diverse, interoperable technologies. SDG&E has developed a communications-system strategy that calls for the utilization of "right-enough" communications solutions meeting the requirements of individual smart grid applications. We then bind these discrete communications systems and networks together using a single control and security system. This system architecture, internally dubbed "GridComm", encompasses a series of radio-frequency networks that are integrated by a master "Control Service". This approach allows the continued use of legacy communications and information systems as we add new systems for new functions, technologies and services, all within a common control and security framework. In October 2009, the Department awarded SDG&E a grant of $28.1 million of the total cost of $63 million for GridComm under the American Reinvestment and Recovery Act (ARRA) Smart Grid Investment Grant program.

(2) 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?

In addition to the qualitative requirements described in our response to Question 1, the more specific network specifications required by smart grid applications include:

- Pervasive fixed coverage (at least 1 kbps) to certain utility assets, such as transmission and distribution lines, suitable for communicating to battery-powered devices installed both above and below ground;
- Selective broadband coverage (at least 5 Mbps) for major assets and locations;
- Pervasive fixed coverage (at least 1 Mbps) for all utility assets and customer-service locations;
- Pervasive mobile coverage (at least 100 kbps) for all utility assets and customer locations;
- Communication service availability at least 99.9 percent where not cost-prohibitive;
- Communication latency of less than 100 milliseconds for communications to locations where major assets are situated (*e.g.*, between utility data centers and substations);

- Communication latency of one cycle (16 milliseconds) for certain high-performance applications;
- Comprehensive provisioning, quality-of-service, and other network-management capabilities;
- Highly scalable and flexible network topologies that support low-latency, peer-to-peer communications;
- Communication services capacity that does not impose or implicate time-of-day limitations on application design and/or business functionality; and,
- Communication path accountability, *i.e.*, the ability of the provider to prove that each communications device and link in the path is properly managed, configured and secure pursuant to the critical infrastructure protection standards and regulations of the Federal Energy Regulatory Commission and the North American Electric Reliability Corporation.

In addition, the deployment of smart grid technologies has implications for spectrum, latency and security the Department should take into account as it reports the broadband needs of the electric-power industry and smart grid to the Federal Communications Commission.

The availability of broadband spectrum is critical to the development and deployment of smart grid technologies. Smart grid technologies and adjunct communications systems are currently being deployed using a variety of communications technologies, including public and private wireless networks using licensed and unlicensed spectrum. SDG&E has an abiding preference to use licensed spectrum for any communications involving grid monitoring and for grid-control systems in particular. Licensed spectrum provides the most suitable and scalable operating environment in which to support core, mission-critical communications since it is always available, fully controlled and protected from interference. There have been two notable exceptions to the use of licensed spectrum for these functions. First, SDG&E uses an unlicensed 900-MHz radio-frequency system for advanced metering "last-mile-to-the-meter" connections, including the transmittal of meter-shutoff signals. Second, we are considering the use of lightly licensed 3.65-GHz WiMAX as part of our broadband hot-zone network to support some applications on the transmission and distribution systems for both system monitoring and control. While these exceptions exist, it remains the case that we would prefer to use licensed spectrum where it is available at reasonable cost.

With respect to unlicensed spectrum, SDG&E prefers to use unlicensed spectrum only for applications that do not represent critical grid-control functions. In these instances, unlicensed spectrum offers the key advantage of being free of acquisition fees. This advantage does not provide sufficient reason, however, for SDG&E to adopt it for the transport of operationally critical signals and communications. Of the unlicensed bands available today, the lightly licensed 3.65- to 3.70-GHz band that allows non-exclusive use is of most interest to SDG&E for smart grid communications. Many manufacturers are making equipment using this spectrum available. We also envision making use of the 2.4/5.8-GHz ISM bands for Wi-Fi access points for basic, non-mission-critical wireless communications to portable appliances and with nomadic users in certain hot-spot locations. With respect to interference problems we have encountered using unlicensed spectrum, SDG&E does not have sufficient deployments of smart grid communications technologies using these frequencies to determine if interference is, or will become, a major or widespread issue. In certain areas, however, Wi-Fi throughputs are severely limited by elevated noise floors from surrounding non-utility users, a concern we are currently monitoring and evaluating. Due to our limited experience, we have yet to experiment with or focus upon any specific techniques that would address interference problems adequately, however, we currently anticipate that Contention-Based Protocols and other techniques implemented in the upper half of the lightly-licensed 3.65-GHz band offer potentially adequate solutions. In addition, we are collaborating with On-Ramp Wireless in a research-and-development project as part of our smart grid program to determine whether a digital-signal processing technique can overcome interference in unlicensed spectral bands.

The spectral bands currently used by SDG&E are not expected to be sufficient to meet the communications needs of our planned comprehensive smart grid strategy, architecture and functionalities. SDG&E expects either to acquire additional spectrum, at potentially considerable additional cost to the programs and services we plan to implement, or to gain access to new spectrum through Government action. In this regard, SDG&E strongly encourages the Department to recommend to the Federal Communications Commission to take such actions as might be necessary to speed the broadest and earliest deployment of the fullest range of smart grid technologies and assure the greatest exploitation of their benefits on a national level. As noted by Congress in the Broadband Data Communications Act and the Commission in its prior releases related to its responsibilities under the Act, there is a strong national interest in making broadband communications available to every citizen and every location. By making provision for the nation's energy utilities to utilize some portion of the broadband spectrum as part of the National Broadband Plan and a national communications policy, the Department and the Commission can leverage the ubiquitous reach of the power industry as a distribution channel to assure that existing availability gaps are addressed in part, at least for the functionalities and benefits represented by many smart grid services and technologies.

Analyses of the traffic we expect to carry over our smart grid communications network lead us to believe that SDG&E needs, at a minimum, access to at least two MHz of licensed spectrum and, ideally, at least five MHz of licensed spectrum to support our pervasive wide-area requirements. In addition, further spectrum would then be required to support broadband hot-zones. Due to expected spectrum lease or purchase costs, we expect the spectrum utilized for these broadband hot-zones will be lightly licensed or unlicensed, most likely at 3.65 GHz. Our internal studies have shown that frequency bands at or below 2.5 GHz, and ideally frequency bands that are sub-1 GHz, are best suited to meeting the challenge of providing wide-area, pervasive coverage across our service territory, particularly in areas that have challenging non-line-of-sight propagation characteristics.

With respect to spectrum allocation, there are no specific requirements associated with smart grid communications at present that require or rule out any specific band or duplexing schemes, although channel width is a key consideration to the use of broadband for smart grid applications. The existing and announced spectral efficiency techniques used in operations-sensitive communications links are expected to be satisfactory for the purposes of smart grid applications. As noted previously, our internal studies have shown that frequency bands at or below 2.5 GHz and, ideally, frequency bands below one GHz, are best suited to meeting our communications requirements. Further, licensed spectrum bearing exclusivity privileges provides the most suitable operating environment within which to establish these critical communications networks. For other communications needs, such as our broadband hot-zone layer, a much wider range of frequency bands can be utilized, including licensed, lightly licensed and unlicensed spectrum up to 5.8 GHz.

While both frequency-division duplex and time-division duplex spectrum are suitable for Smart Grid support, time-division duplex spectrum generally offers more flexibility and higher spectral efficiencies since downlink and uplink allocations can be dynamically allocated to meet the traffic requirement. A WiMAX-based solution has the appropriate control and configuration mechanisms to achieve these needs. For pervasive wide-area coverage, we believe the minimum requirement is for a two-MHz block of either frequency-division or time-division duplex spectrum.

That being said, a five-MHz or ten-MHz spectral block would allow energy utilities to utilize WiMAX profile-defined channel bandwidths and to take advantage of the availability of equipment being produced by a number of manufacturers. This would bring economies of scale to both radio-access networks and end-point solutions. If spectrum were to be allocated by the Federal Communications Commission for smart grid applications, smart grid deployments and operations would be simplified dramatically and significantly allay concerns related to risks associated with technological obsolescence. Energy utilities must consider spectrum suitability to applications, availability of endpoint and transmitter radios, total cost (including spectrum cost), and many other complex and interrelated factors as we consider the requirements of and specifications for smart grid communications solutions. The existing options are complex and fraught with some risk, particularly uncertainty risks related to changes in carrier offerings and government-managed spectrum. By proactively allocating spectrum in a manner consistent with the vision for the smart grid articulated by Congress, the Federal Energy Regulatory Commission and the Federal Communications Commission, the Department can address and resolve these risks, creating a rich, sustained, economically positive ecosystem of suppliers for a known radio-frequency solution in the energy-utility sector.

Although the Commission indicated in its National Broadband Plan that electric utilities could be allocated capacity on spectral bands used by public-safety agencies, the Plan also suggests that these bands would be subject to "cooperative" and joint development and use with commercial communications network providers, indicating that these bands could be "crowded" to the point of being unsuitable for many smart grid applications. Even if dedicated to use by public-safety agencies, these spectral bands are expected to become increasingly congested as those agencies increase their use of continuous video-surveillance and data-streaming technologies. Finally, cooperative uses could be difficult since it is rare that utility service areas and safety jurisdictions are perfectly coincident, complicating the development of workable sharing arrangements between the affected parties. Even where utility service territories and public-agency jurisdictions might be perfectly aligned, SDG&E believes it would be unrealistic to assume that utilities operating critical infrastructure and agencies charged with preserving public safety will be able to resolve issues related to organizational primacy and/or usage priorities.

Turning to latency requirements, the most stressing latency requirements for smart grid functionalities exist in wide-area measurement and control systems using synchrophasor instrumentation. Those applications often require less-than-100 millisecond round-trip communication latency from endpoint to data center. Other latency-sensitive applications include isochronous applications, *e.g.*, voice and video communications. Future microgrid and distributed-resource applications may demand latencies as low as sixteen milliseconds (16 ms, or one cycle of the sixty-hertz electric system). With respect to the maximum latency limits for communications to and from different nodes of these smart grid applications, existing carrier-provided wireless 3G services cannot deliver this level of latency on a reliable basis. While it is technically possible for announced 4G services – WiMAX and Long-Term Evolution (LTE) – to deliver this level of performance, SDG&E is reluctant to design and build our smart grid architecture based on assumptions and promises that may not come to fruition. It is our expectation that communications carriers will primarily design build their 4G services and networks around the needs (and revenue opportunities) represented by 300 million prospective consumer-subscribers rather than the more demanding communications needs of the local energy utility and its smart grid. Even if 4G networks are capable of performing to the requirements of the smart grid, there is, as would be the case with broadband spectrum shared between electric utilities and public-safety agencies, the question of how access and usage priorities, particularly during widespread emergency conditions, would be assigned and operationally managed. On the other hand, private networks can and will be built with customized performance for latency, availability, coverage, capacity, and security. These private networks are also the utilities' best option for the survivability and recoverability of communications services during and after adverse events, when customers and communities have the most urgent need for the restoration of utility services.

SDG&E is planning to build a private communications network using the equivalent cost of 3G- and 4G-carrier services as a "price benchmark" – our goal is to build and operate a custom communications system for the same long-term cost that we might pay for 3G- or 4G-carrier services, with the added benefit of assuring that our distinct and necessary requirements are met at levels of performance commensurate with best practices in the utility sector. SDG&E understands that most large energy utilities are following this same path for the same reasons.

Finally, with respect to the major security challenges and the relative merits and deficiencies of private utility networks versus alternative solutions provided by commercial network providers, SDG&E submits that carrier-provided Internet-based virtual private networks are vulnerable to the "best effort" nature of the publicly available Internet. Private networks, on the other hand, enable utility-controlled virtual networks, including those based on multi-protocol-label-switching virtual routing and forwarding, to benefit from higher quality and higher classes of service, improved traffic engineering, and increased security. While commercial solutions can sometimes provide cost-efficient solutions as compared to private utility networks, most commercial carriers have yet to adopt industry-standard and acceptable security practices meeting an energy utility's needs.

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

SDG&E operates and maintains an electric distribution system that serves over 3 million people via 1.4 million electric meters. Our service territory spans more than 4,100 square miles framed by the California-Mexico border on the south, the suburban areas of southern Orange County on the north, the Colorado Desert on the east, and the Pacific Ocean on the west. SDG&E's customer mix is approximately eighty-nine percent residential and eleven percent commercial, industrial and streetlighting. SDG&E's peak load was recorded in 2007, at 4,636 megawatts. SDG&E's system includes about 225 distribution substations, over 1,000 distribution circuits, some 220,000 poles, 10,100 miles of underground systems, 6,700 miles of overhead systems, and over 150,000 structures. Each circuit serves an average of 1,350 customers. There are approximately 400,000 trees in the proximity of SDG&E overhead lines that are maintained through SDG&E's vegetation-management program. SDG&E's service territory is a geographic mixture of urban and rural communities, consisting of twenty-six incorporated cities, two counties, and fifteen major military facilities. SDG&E's distribution facilities can be found in geographic locations ranging from coastal bays to inland valleys, from mountains to desert. SDG&E also has approximately 1,800 miles of overhead and 70 miles of underground transmission lines ranging from 500-kv, 230-kv, 138-kv to 69-kv.

Map of SDG&E's Service Territory

SDG&E's electric distribution system is predominantly undergrounded – about sixty percent (60%) of the distribution system is under ground, a much larger proportion than would be found in the systems of California's other investor-owned utilities. This combination of diverse geography and undergrounded systems creates exceptional challenges to meeting the demands and expectations of SDG&E's customers. SDG&E's high proportion of undergrounded systems has evolved over many years as the result of local undergrounding ordinances, new business underground extension rules and aggressive overhead-to-underground conversion programs. An underground system, although aesthetically pleasing, introduces challenges that affect the cost of doing business and the service reliability to SDG&E customers. An underground system is significantly more expensive to install as compared to an overhead system, has a shorter equipment life-expectancy, requires more time to troubleshoot problems, and takes longer to repair. In addition, it creates additional challenges with the integration of measurement and control systems because of wireless signal-propagation limitations below ground and the significant costs of connecting those facilities to wired communications networks.

Away from the more urbanized coastal zone of SDG&E's service territory (where the majority of the customers are served by an underground system), the geography of the territory is rural in nature. This rural area is characterized by inland valleys and mountainous areas with smaller communities, low-density development and significant wilderness areas. This area is predominantly served by an overhead electric distribution system that is subject to the most extreme weather in the service territory. In addition to the performance and safety challenges created by winter rains and snowfall, the system and employees located in this area face the safety and operational challenges brought on by the extreme Santa Ana wind conditions in this area. Fire risk is high during these events and the consequences of a fire can be catastrophic, as was demonstrated during the firestorms of 2003 and 2007 that devastated the community and caused significant damage and disruption to the electric-distribution system.[7] SDG&E has been aggressively seeking ways to improve the operations and maintenance of the electric-distribution system in these high fire threat zones, especially as it relates to summer/fall Santa Ana conditions.

Being located in southern California, the threat of seismic activity is another environmental condition that must be considered by SDG&E in selecting communications solutions. SDG&E is somewhat fortunate in that the largest and most well-known active faults do not pass through the population and infrastructure centers of our service territory, although there has been recent, significant and surprising seismic activity in the area. The Rose Canyon Fault passing through the communities of La Jolla, Mission Bay, Morena, and the San Diego Bay areas is generally the fault of most concern to seismologists. Though there has been no significant seismic activity in modern times on this fault, it is thought to be capable of generating a quake of greater than 6.0 in magnitude. The Elsinore Fault is an active fault which runs from the northwest to the southeast on the eastern edge of SDG&E's service territory. This is a lightly populated area and SDG&E has moderate amounts of infrastructure in the area. The remaining parts of SDG&E's service territory are free of significant known faults that would present an obvious concern.

(4) What are the use cases for various smart grid applications and other communications needs?

SDG&E has made substantial investments in smart grid applications, programs and projects. SDG&E has been installing supervisory control and data acquisition ("SCADA") devices throughout its transmission and distribution system since the early 1990s. Over seventy percent (70%) of SDG&E's distribution substations are operated using SCADA. This strategy has laid the foundation for distribution automation, remote operation of switches and improved system reliability; these are fundamental precursors to and the early forerunners of a host of smart grid functionalities such as self-healing circuits. SDG&E is deploying the technologies and equipment

[7] Some twenty percent (20%) of SDG&E's distribution facilities were destroyed by the firestorm of 2007.

enabling these functionalities wherever they are found to be cost-effective. SDG&E currently has seven distribution circuits that are self-healing, two of which use distributed intelligence with peer-to-peer communications (a decentralized approach to self-healing) and five of which are controlled by software algorithms residing in SDG&E's SCADA Master System (a centralized approach to self-healing) and that use Feeder Automation System Technologies (FAST) capable of isolating faulted feeder segments and transferring load between circuits without operator intervention (an automated approach to self-healing). SDG&E was among the first electric utilities to perform pilot tests on first-generation broadband-over-powerline technologies. Our experience with these tests informed our decision regarding the advanced-meter technologies we are now actively deploying.

On a larger scale, SDG&E has designed and begun to implement a number of strategic plans and projects we believe will transform our system and, more importantly, our relationship with our customers. As we were participating in the development of common standards and protocols for the constituent elements of the smart grid we envisioned and began our early tests and deployment of certain smart grid technologies, SDG&E was designing, with the encouragement and advice of the California Commission, the overarching business plans, system changes and enhanced services that are enabled by smart grid technologies. SDG&E's smart grid program is in the midst of launching ambitious plans and projects, including but not limited to the following use cases and projects:

Advanced Metering Infrastructure	SDG&E's Smart Meter program (Advanced Metering Infrastructure initiative) involves the installation and integration of some 1.4 million "smart" electric meters and 0.9 million "smart" gas modules by the end of 2011 (as of July 1, 2010, more than one million of the total 2.3 million endpoints have been installed). The associated Customer Energy Network will provide customers with the option to provide third parties access to customer-consumption information.
Home Area Network	SDG&E is developing advanced functionality and integration of premise networks at residential and commercial customer sites. SDG&E anticipates that device manufacturers, software developers, and marketing and installation vendors will collaborate to begin bringing cost-effective products to the marketplace by the end of 2010. SDG&E plans to have both smart meters and many components of a smart energy grid in place by 2015. This would include fully integrated smart homes with smart appliances, and customer access to energy-usage information and new services.
Demand	SDG&E has a Comprehensive Demand Response Program. The company

Response	conducted a "Participating Load Pilot Program" in 2009 aimed at providing demand response as a resource to the bulk-power markets operated by the California Independent System Operator. SDG&E is currently proposing a regular demand-response program under the California Independent System Operator's Proxy Demand Resource tariff. SDG&E has the overall goal of achieving a load impact of 265 megawatts for all of its demand-response programs in 2011.
Distributed Generation	The "Sustainable Communities" program provides utility capital for the integration of distributed energy resources located on customer premises into the SDG&E distribution system. This is related to the internal standards we have developed so as to ensure that distributed-generation applications are a fundamental element of the distribution-system-planning process. These guidelines were developed in concert with distributed-generation vendors and allows for both utility and third-party distributed resources to compete as "wire" alternatives. The project also incorporates broader "green building" concepts into the facilities and surrounding landscaping.
Plug-In Hybrid Electric Vehicles	The "Comprehensive Alternative-Fuel Vehicle Program" not only provides investment incentives to potential owners and operators of vehicles using nontraditional fuels but also encompasses system upgrades that enable the use of "plug-in" hybrid electric vehicles to mitigate generation variability associated with intermittent resources and absorb "excess" generation during certain periods of the day or at key locations on the distribution system.
Operations	The Sempra Energy Utilities "Operational Excellence 2020 Program" encompasses the upgrading and/or replacement of some twenty enterprise systems to bring SDG&E's computing and operating systems to "state of the art" condition and assure interoperability where those systems interface and data exchanges occur. The program also includes advanced outage- and distribution-management systems, a condition-based maintenance system for substations, and a geospatial information system designed to support smart grid applications, synchrophasors and remote automated weather stations. The program also implements major applications, optimizations and other improvements designed to further automate our extensive mobile workforce that provides construction, operations, and customer and emergency services throughout the utilities' service territories. // //

Microgrids	The "Microgrid" concept incorporates distributed-energy resources into the smart grid and permits the "islanding" and local balancing of certain resources and loads in the event of outages. SDG&E has initiated this three-year proof-of-concept, utility-scale project incorporating many elements of a smart grid, including leveraging elements of the smart meter and smart-substation projects SDG&E has also launched. SDG&E expects that the Microgrid project will reveal and demonstrate the potential pathway for a self-sustaining energy community. In recognition of the importance of this innovative initiative, SDG&E was awarded a $7.5 million grant by the Department under the Renewable and Distributed Systems Integration (RDSI) program, and another $3 million grant from the California Energy Commission to demonstrate the concept.
Renewable Energy	The "Renewable Resources Program" encompasses the efficient integration of the significant level of renewable resources needed to meet California's renewable portfolio standard, a standard that is among the most aggressive in the nation and that has to date precipitated the development of significant levels of new intermittent (or "variable") resources.

(5) What are the technology options for smart grid and other utility communications?

Many technology options for smart grid and other utility communications exist today. These options include high-capacity optical fiber and wireless point-to-point microwave systems, and a variety of radio-frequency technologies designed to provide point-to-point and point-to-multipoint connectivity. Because fiber and microwave network technologies are well-understood and widely implemented, for the purposes of these comments we have focused on those wireless networks we believe are most appropriate for smart grid applications.

Of the radio-access technologies available today, SDG&E has found orthogonal frequency division multiple access (OFDMA) technologies, such as mobile WiMAX (802.16e), to be well-suited to the provision of core communications functionality. These technologies provide good spectral efficiency, deployment flexibility in terms of frequency of operation, and supportable channel bandwidths. Equally important, they also have the required quality-of-service attributes necessary to support smart grid communication needs and applications.

With respect to the types of network technologies most commonly used in smart grid applications, there are a number of different communication technologies being proposed for smart grid communications. These technologies include WiMAX-based solutions for wide-area network technologies, mesh technologies, cellular carrier services technologies, and satellite services. The cost of implementation and operational capabilities of these systems vary widely and costs to the utility are, in part, dependent on whether the utility must buy or lease spectrum through which it operates its network. For SDG&E and the 1.4 million points of presence represented by our customers and their smart meters, this spectrum cost, whether leased or purchased, obviously could be significant. That being said, our current analysis favors the implementation of a wide-area private network augmented with broadband hot-zones. Having performed extensive technical and cost analyses for a number of solutions, it is highly likely SDG&E's final solution set will be based on OFDMA technology. With due respect for the Department's inquiry and interests, however, much of the detailed information we have collected is proprietary in nature and cannot be shared in this public forum, an issue the Department anticipated and acknowledged in its Notice.

<u>(6) 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?</u>

Ultimately, SDG&E recommends that the national broadband framework provide utilities with maximum flexibility in designing their communications solutions to meet their specific needs. As previously noted, utilities' requirements vary because of differing local and business policies, regulations, business models, and topographies and environments, among other reasons. Issues introduced by the rapid adoption and integration requirements of renewable-energy resources and electric vehicles are significant drivers of SDG&E's smart grid communications requirements. Weather- and topography-related risks represent additional significant influences. Utilities serving areas where these effects are less prevalent or likely, *e.g.,* where coal-fired generation represents a primary resource or where hurricanes or ice storms pose the prevalent weather-related threats, will have different communications requirements customized to their businesses and operating areas. No matter these differences, however, domestic electric utilities are subject to common and, in certain cases, identical regulations related to system security, cybersecurity and reliability, including those adopted by the North American Electricity Reliability Corporation. Based on its experience, SDG&E submits that the optimal way to meet these current and future requirements is with a hybrid approach to communications, custom-fit to a utility's specific requirements and incorporating wire-based and wireless solutions implemented through a combination of public-carrier services and private networks.

As stated throughout our comments, the combination of communications solutions supporting and binding a utility's smart grid will be determined by characteristics and preferences unique to each utility. The sophistication and breadth of the smart grid applications and functionalities being adopted will vary from utility to utility. The utility must evaluate the suitability of the available communications solutions to the smart grid application, the relative cost of the options and the flexibility a specific option might provide for future technologies and applications. The national attention to interoperability standards will facilitate these notions of flexibility and optionality and is an important aspect of the federal interest in establishing appropriate and necessary standards for smart grid equipment and technologies.

(7) To what extent can existing commercial networks satisfy the utilities' communications needs?

SDG&E has found that existing carrier-operated networks cannot adequately serve the full range of the smart grid's communications requirements. While SDG&E does and will use carrier services for those uses or applications where these services are adequate and available at a reasonable cost, carrier-operated services are generally deficient relative to our high-level requirements. The following table describes the fundamental problems we have encountered:

Coverage	Coverage area by commercial networks does not cover 100 percent of the service territory of SDG&E. The main focus of commercial networks is to provide coverage to consumer-subscribers and not electric-distribution and -transmission devices. Smart grid technologies require communication between devices that are likely to be located in areas with no or infrequent human traffic. In addition, even where smart grid devices are located in a commercial network's coverage area, these devices can reside in dead zones or areas subject to random drops.
Reliability	Commercial networks face reliability issues, especially during critical events such as natural disasters. SDG&E faces two primary natural disasters: earthquakes and wildfires. Previous experience shows that commercial networks stop operating during these events, precisely at the moment when they are most critical to the restoration of power operations. Electric utilities require communication 24x7x365 in order to provide reliable and safe services and to support service restoration during natural and human-caused disasters. // //

Capacity	Commercial networks were not built based on providing dedicated capacity to specific customers. Electric utilities require dedicated, *i.e.*, unshared, bandwidth that is instantaneously available for their operational needs on a 24x7x365 basis. The communication industry's "utilization-ratio" service model cannot meet an electric utility's need for reliable services. Commercial carriers cannot and will not provide guarantees that access to services can be assigned priorities depending on the use or user during periods of system oversubscription, congestion or stress.
Security	Communications solutions used by electric utilities require the highest levels of security. Because electric-utility networks are used to manage and control critical infrastructure, the communications systems themselves become crucial and must be secure from disruptions as well as unauthorized accessing of and/or modifications to information as it traverses the network.
Latency/Quality of Service	Commercial networks do not provide the configurable quality-of-service guarantees required for operating the critical components of the electric grid. As noted previously, many utility applications, for example, system protection and functionality enabled by synchrophasors, require exceptionally low latency. Some smart grid control systems demand transactional latencies lower than one cycle on the power system, *i.e.*, less than 16 milliseconds.

The following table compares the general smart grid network specifications identified earlier in these comments to the problems SDG&E has experienced with carrier networks:

Smart Grid Requirements and Carrier Services

Smart Grid Requirements	Commercial Carrier Services
Pervasive fixed coverage (at least 1 Mbps) to all utility assets and customer locations	Moderate adequacy - carriers typically cover ninety-five to ninety-seven percent of utility assets and customer locations. Performance in rural locations varies considerably and service is frequently unavailable or unreliable, which is unacceptable for smart grid applications and system reliability.
Pervasive mobile coverage (at least 100 kbps) to all utility assets and customer locations	Moderate adequacy - carriers typically cover an insufficient percentage of utility assets and customer locations. Because the mobile utility field workforce often travels between network coverage areas, mobile service is only adequate with add-on session-management software requiring additional capital investment and increased operating expense.

Selective broadband coverage (10 Mbps) to locations where major assets are situated	Unavailable and completely inadequate - no carrier option is currently available. Major carriers predict that Long-Term Evolution coverage will be available in the SDG&E service territory beginning in 2010. SDG&E estimates it will be five to seven years after initial offerings before 4G network coverage is equivalent to 3G network coverage.
Communication service availability at least 99.9 percent where financially feasible	Moderate adequacy – carrier data networks are increasingly available for use by energy utilities, however, those uses compete for capacity and performance with growing consumer use and traffic. 3G system providers do not offer quality-of-service guarantees or assign priorities to discrete uses or users, compromising the operation and/or reliability of smart grid functionalities. Additionally, service recovery after adverse events, such as earthquakes or wildfires, may not be adequate to support utility-system repair requirements or to otherwise ensure the safety of repair crews.
Communication latency of less than 100 milliseconds between utility communications centers and major assets	Poor adequacy – carriers do not provide latency guarantees on existing radio-frequency networks.
Communication path accountability – the ability to prove that each communications device and link in the path is properly managed, configured and secure under the terms of national standards and regulations related to critical infrastructure protection	Poor adequacy – 3G network providers either do not or cannot as a practical matter provide detailed path and operations information.

SDG&E has also found that the breadth and duration of commercial-carrier network outages render their services unsuitable for critical electricity equipment-control communications. Commercial-carrier wireless equipment failures and change-induced outages in the first half of 2009 have typically resulted in one to two hours of downtime for one hundred percent (100%) of affected devices, and an additional four to eight hours of disrupted communications for one (1) to five percent (5%) of those devices. The unreliability of carrier networks during and after emergency events is also a serious issue due to the limited battery and backup-generator resources located at carrier cell sites. Subsequent to the 2007 California wildfires, commercial carriers began deploying batteries and emergency generators to more of their cell sites, but typically with only an eight-hour battery life and/or limited generator fuel capacity. These matters raise significant concerns for energy utilities whose services are essential to their customers, particularly during widespread regional emergency conditions.

(8) What, if any, improvements to the commercial networks can be made to satisfy the utilities' communications needs?

The following areas require improvements in order to improve the consideration as viable solutions for supporting the operations of electric distribution companies:

Coverage	The nation's electric utilities offer near-universal service, including in many geographies where no existing suitable communications networks currently exist (*e.g*., for last-mile, aggregation-point data backhaul, and utility control systems). This gap has serious implications for many smart grid applications, whether related to the reliable operation of the utility's system or the services that could be made available to a customer. In terms of general access to communications networks, there is a marked difference between the coverage, availability and performance networks provide in urban or suburban areas compared to remote or rural areas. Rural areas present the greatest challenge in terms of providing pervasive coverage to smart grid assets. Internal studies performed by SDG&E show that coverage of grid assets by carrier services is as low as fifty percent (50%) in some inland areas we serve. This leads SDG&E to believe that only by building a private network can we essentially achieve coverage of all but the most remote of our grid assets. With respect to coverage of our customers' premises, approximately one to two percent of homes served by SDG&E have no access to suitable communications networks for smart grid applications, and expansion of those networks to these premises is not commercially viable, as recognized by the Federal Communications Commission in its evaluation of national availability gaps. Again, these are primarily customers in remote, rural areas where commercial cellular coverage is unavailable, intermittent or unreliable, and/or where carrier land-line services for smart grid purposes would be cost-prohibitive. // //

Reliability	Smart grid applications are wholly dependent upon the availability of reliable and secure communications to and from sensing, measurement and control devices installed on utility systems. In order for smart grid applications to be enabled at these system devices and for these functions, suitable communications must first be in place. If they are not, a suitable network system or service must be extended or created to provide those communications, increasing the cost to deploy that application. Where physically distinct or separate networks or services must be extended or created, communications costs are increased significantly beyond those that can be provided by networks designed and deployed for use by multiple applications. This can be a major barrier to deploying smart grid applications to those areas without communications coverage, as these increased costs may outweigh the customer or utility benefits provided by those applications. Consequently, the unavailability of a suitable broadband network has a significant impact on the cost of deploying smart grid applications in remote or rural areas and poses a major barrier to extensive smart grid deployment. As noted previously, commercial-wireline broadband is not available in many rural areas and cannot be deployed cost-effectively where provided for smart grid purposes alone. Even where commercial-wireline broadband services are or could be made available, infrastructure costs are likely to be high due to the need for additional data-security and –integrity measures required by smart grid applications.
Services	In most cases, the only communication networks available to homes are direct-subscriber lines, cable-television Internet services, or carrier-provided wireless 3G data services (*e.g.*, CDMA-, EDGE-, or HSPA-based services). SDG&E does not believe that direct-subscriber and cable-television services are viable channels for smart grid functions other than those related to certain home area network applications. As for carrier-provided wireless 3G services, these services are in several respects inadequate to meet the needs of smart grid applications; as shown in the previous table, these inadequacies include reliability deficiencies, insufficient or otherwise poor coverage or availability, vulnerability to performance or service disruptions caused by competing uses, uncertain survivability or recovery of those services during and after adverse events, and the impracticality of meeting national regulatory standards related to critical infrastructure protection.

(9) 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?

As previously stated, SDG&E's current experience with renewable-energy resources and the major rollouts of electric vehicles starting later in 2010 are already driving us to grow and expand our smart grid. Because these factors are already reflected in our planning assumptions, our communications strategy addresses the current and future requirements they pose. This strategy involves the integration of multiple technologies, depending on the use case – including

WiFi, WiMAX, future LTE, and both licensed and unlicensed spectrum. SDG&E anticipates dual- or tri-band base stations being installed at most sites, which will provide us the long-term flexibility to select the most appropriate technology for our needs. Consistent with our current operations, SDG&E will use carrier-provided 3G and 4G services when the use case fits and the cost/benefit analysis is positive. All of our radio-frequency services will be integrated via a custom "Control Service", providing fine-grained management and monitoring of all endpoints. For backhaul services, SDG&E will use utility-owned systems where possible, and will continue to explore partnerships with carriers or other network service providers. Adaptation and extension of our communications infrastructure and services will be realized and facilitated through the implementation of national interoperability standards. Our technology selections in any given case will be driven by considerations related to security, coverage, capacity, cost, reliability, manageability, and performance.

III. Summary and Recommendations

As the Department proceeds to develop its role and positions with respect to the development of smart grid rules and regulations, SDG&E strongly encourages the Department to assure that the communications requirements related to the national development of the smart grid are recognized and accommodated within the National Broadband Plan. The advent of the smart grid concept greatly increases the complexity of the communications architecture upon which electric utilities rely to deliver their services. Similarly, the explosion in smart grid technologies and applications greatly increases the need for electric utilities to create and manage a flexible communications architecture that is multiplexed, fully integrated and capable of serving both our current and future requirements. Broadband communications has the requisite attributes of reliability, security and cost-efficiency needed to support the smart grid applications and would be a superior option in many cases. Having access to broadband spectrum would, therefore, support the myriad public interests smart grid can serve and add to the operational flexibility utility communications networks must have in order to grow with the complexity and sheer number of smart grid applications and functionalities we foresee. A critical aspect of the regulatory framework governing the national smart grid and broadband services will be to assure that not only will electric utilities have access to broadband spectrum at reasonable cost, but that if and where broadband spectrum is to be shared among many purposes electric utilities will receive appropriate use priorities. SDG&E looks forward to contributing to the further deliberations of the Department and the Federal Communications Commission in any way the agencies would find helpful.

Respectfully submitted,

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