Written Testimony

Hearing of the Energy and Natural Resources Committee

United States Senate

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EPRI is an independent, non-profit research organization with close to $400 million in annual research funding principally from electric utility companies in more than 30 countries. EPRI was started 43 years ago with a mission to advance safe, reliable, affordable and environmentally responsible electricity for society through global collaboration, thought leadership and science and technology innovation. This remains the EPRI mission today.

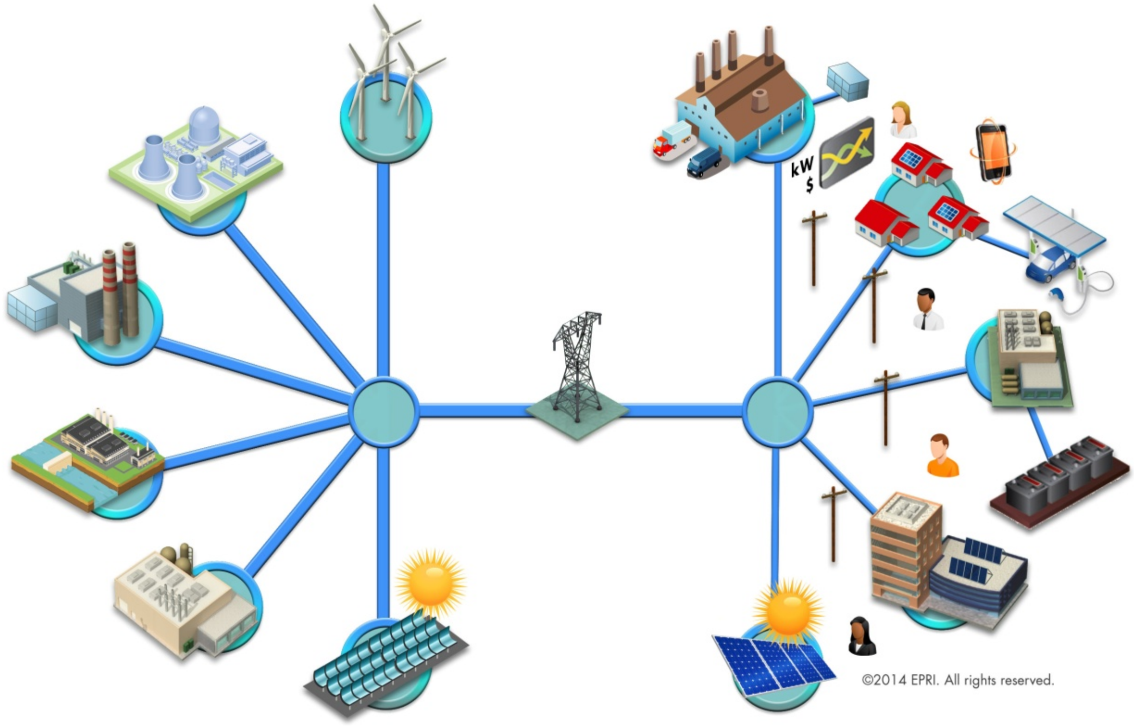
EPRI brings together electric utility companies, scientists and engineers, along with experts from academia, industry and other centers of research to:

- Collaborate in solving challenges in electricity generation, delivery and use;
- Provide technical, scientific, and economic analyses to drive long-range research and development planning;
- Support multi-disciplinary, objective research in emerging technologies; and
- Help accelerate the commercial deployment of advanced electricity technologies for the benefit of the public.

Early last year EPRI issued an in-depth technical look at the changing power system. This report, *The Integrated Grid: Realizing the Full Value of Central and Distributed Energy Resources*, was the first phase in a larger EPRI project to chart the transformation of the power system. Remarks today will focus on the Integrated Grid concept.

The power system is a complex machine that includes everything from how consumers use and interact with electricity to how electricity is delivered over a vast network of distribution and transmission wires and ultimately the generation of electricity. The end-to-end power system is an *interconnected* machine that is critically important to the economic well-being of this country. An interconnected machine or *power system* means that all devices are electrically connected together. With the tremendous advancements that are occurring in how electricity is generated, delivered and now personally managed, changes in regulations and management of the power system will also change.

Please take a look at the diagram below. This is a simplified drawing but a useful, high-level view of the power system.



Many of the innovations are occurring at the edge of the distribution system, the far right-hand side, where customers connect to the power system. Because the power system is interconnected, changes that occur at the edge can impact the entire power system, including the rest of the distribution system, the transmission system and central generation on the far left-hand side.

The power system was originally designed to connect large generation plants with customers ranging in size from small residential to major industrial manufacturers. The U.S. power system is anchored on the left-hand side by approximately 1,000 gigawatts (GW) of central generation and on the other end by customers who expect reliable and affordable electricity.

Electricity flows in one direction from power plants on the left to substations and then to customers on the right. The amount of generation is matched with the customer's needs on a second by second basis. This has been the cornerstone of reliable grid operation for more than 100 years.

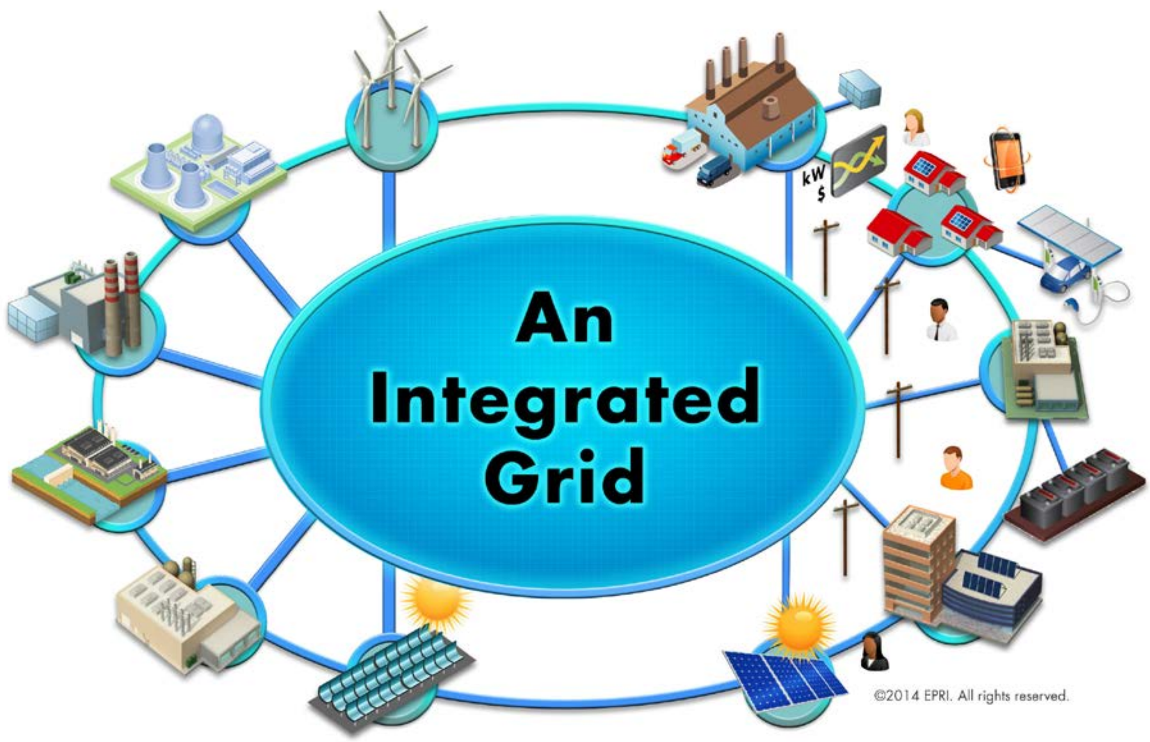
However, the entire power system is changing at a fast pace, driven by technology and customer expectations. For example, customer-sited generation is causing power to flow in some cases from the load, which is the right-hand side, to the substation further to the left-hand side, thereby introducing two-way power flows. Technologies like smart thermostats are resulting in unique ways customers can manage their energy. Variable generation that depends on wind and sun cannot be dispatched to meet customer demands, but is available when the resources are available.

Most of the changes occurring at the edge of the distribution system are related to a class of technologies called Distributed Energy Resources or DER. Customers, energy suppliers, and developers are increasingly adopting these DER technologies with the aim to supplement or supplant grid-provided electricity. These important resources include distributed generation resources as well as storage, demand response resources and a range of technologies that allow remote control of electricity use.

EPRI research suggests that **if** the various components of the power system are also ***integrated*** together, the entire power system can realize the full benefit of all the pieces including the significant innovations that are occurring with Distributed Energy Resources and central generation. This is outlined in much more detail in the EPRI study referenced earlier, *The Integrated Grid: Realizing the Full Value of Central and Distributed Energy Resources*, and provided to this Committee as part of written testimony.

EPRI research further suggests that the successful integration of DER begins with the existing power system. The existing power system, especially the distribution system, was not designed to accommodate a high penetration of DER while sustaining high levels of electric quality and reliability. The technical characteristics of certain types of DER, such as variability and intermittency, are quite different from central power stations.

To fully realize the value of distributed resources and to serve all consumers at established standards of quality and reliability, DER must be integrated into the planning and operation of the power system. Again, this is what is referred to as the *Integrated Grid*.



An Integrated Grid should not favor any particular energy technology, power system configuration or power market structure. Instead, it should make it possible for stakeholders to identify optimal architectures and the most promising configurations – recognizing that the best solutions vary with local or regional circumstances, goals, and interconnections.

Most grid-connected DER sources benefit from the electrical support, flexibility, and reliability of the grid but they are not integrated into the grid's operation. Consequently, the full value of DER is not realized in providing support for grid reliability, voltage, frequency, and reactive power - all essential for an integrated grid system.

Customers with distributed generation may not consume any net energy (KWH) from the grid, yet they need the grid at times when their generation does not provide them enough immediate electricity. Consumers need the ability **– or capacity –** to tap into the grid and even use grid power, though at different times of day they might return actual **energy** into the grid.

A consumer's intermittent need for electricity and the constant ability, or capacity, to deliver it by a utility has financial implications. For residential customers, the costs for generation, and transmission and distribution (T&D) components can be broken down into two parts:

1. Costs of the actual **energy** used by the customer, and
2. Costs to provide the **capacity** to deliver the energy and grid-related services.

Based on the U.S. Department of Energy's *Annual Energy Outlook 2012*, an average customer consumes 982 kWh per month, paying an average bill of $110 per month of which approximately $59 per month is the cost of actual energy and $51 per month is the cost to provide generation capacity and other services such as load following, voltage support (known as ancillary services) and transmission and distribution capacity.

Bottom line: A consumer with DER is not necessarily a self-sufficient energy consumer.

With the growing penetration of variable generation, capacity-and ancillary service-related costs will become an increasing portion of the overall cost of electricity. However, with an Integrated Grid, DER could more efficiently contribute to the capacity and ancillary services needed to operate the grid.

Policy and regulatory frameworks are needed to encourage the effective and efficient introduction of new technologies, and also provide equitable allocation and recovery of costs incurred to transform to an Integrated Grid. New market frameworks will have to evolve to assess potential contributions of distributed and central resources, allocate costs, and quickly integrate new interconnection and communication technologies to system capacity and energy costs.

EPRI views the following four items as important considerations for policymakers to enable an Integrated Grid:

1. Interconnection rules and communication technologies and standards;
2. Assessment and deployment of advanced distribution and reliability technologies;
3. Strategies for integrating DER with grid planning and operation; and
4. Enabling policy and regulation.

In addition, EPRI research results suggest that the policy and technology transformation of the power system has three important and concurrent paths.

First, while moving toward an Integrated Grid, ensure that the current power system assets continue to operate safely and with always improving performance. The need to <u>Perform</u> while changing is essential.

Second, the existing and emerging technologies must Adapt to a future state to make the most of current power system investments. This will include enabling central generation to perform flexibly as well as variable generation to contribute toward system capacity and ancillary services.

Third, while ensuring that the electricity system Performs well and Adapts, new technologies Create new ways to deliver safe, affordable, reliable and environmentally responsible electricity.

At EPRI, there is a pride in our objective and collaborative electric research, done across companies, service territories and the technology applications. The industry has an important job ahead to ensure the public has a supply of electricity that is clean, affordable, safe and secure. The utility industry, together with other stakeholders, is up to that challenge.

EPRI looks forward to offering continued technical support to the electricity sector, public policy-makers and other stakeholders to achieve the vision of an Integrated Grid.