IntelliGrid Smart Grid Roadmap
Methodology and Lessons Learned

December 2012
Introduction

This white paper summarizes the key findings of the EPRI Smart Grid Roadmap Guidebook which synthesizes the results of the company-specific Smart Grid roadmaps developed by EPRI from 2007 to 2011. The report’s major themes are the lessons learned and the methodologies used to develop the roadmaps. The methodologies have been distilled into a process called the Smart Grid Roadmap Methodology (SGRM). Also included in the Guidebook is a summary of the roadmaps, key points from follow-up interviews, distilled technology recommendations from the roadmaps, the purpose and benefit of developing a roadmap, the role of standards and a communications technology assessment.

Although each company-specific roadmap is confidential and available only to the company that it is developed for, EPRI’s IntelliGrid Program publishes lessons learned and best practices from the roadmaps for the benefit of its members. The IntelliGrid program also facilitates a Smart Grid Roadmap Interest Group and hosts an annual workshop. These activities are designed to bring together the people who are responsible for developing and maintaining smart grid roadmaps for their companies to share experiences, issues, and concerns.

In 2007 EPRI began working with utility members to develop company specific Smart Grid Roadmaps. To date, a total of eight roadmaps for seven different companies have been developed. These roadmaps defined or built upon each company’s vision for its Smart Grid and recommended actions for the company to take to achieve its vision. EPRI has now developed Smart Grid Roadmaps for FirstEnergy (initial and update versions), Salt River Project, Duke Energy, Southern Company, California ISO, TVA and TVPPA (for the distribution companies served by TVA). EPRI also worked with Pacific Gas & Electric, Southern California Edison and San Diego Gas & Electric to develop the Smart Grid Roadmap for California in 2020. In parallel, Southern California Edison used similar guidance from IntelliGrid in developing its own smart grid roadmap. Senior SCE staff members have indicated that the EPRI methodology helped them to zero in and understand what they wanted to accomplish and then build a timeline for the plan.

Background

When the concept of the Smart Grid was first introduced, it became clear that it was not a “one size fits all” situation. While the high level vision was commonly accepted, the specifics of the vision were different from country to country, state to state and company to company depending upon internal and external drivers. Drivers could be policy drivers or business drivers. It also became clear that the Smart Grid would be created through an evolutionary process that could take years or decades to fully realize. Therefore, each company would:

• Have a unique vision for their Smart Grid
• Have a unique strategy and evolutionary pathway for creating their Smart Grid
• Create their Smart Grid at a pace that would meet their needs as well as the needs of their customers, regulators and legislators.

As a result, EPRI and its advisors identified the need for a methodology that was flexible yet effective at helping companies chose, plan and ultimately deploy Smart Grid technology investments effectively. This is the objective of EPRI’s SGRM.

Overview

Given the day to day demands placed on utility management and staff it can be difficult to find the time to develop a sound technology implementation strategy for both the immediate and longer term. In addition, getting engagement, consensus and organizational support for a plan across different departments and businesses from the senior to operational levels can be extremely

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This white paper was prepared by Don von Dollen of EPRI.

1 http://smartgrid.epri.com/Roadmap.aspx
difficult and yet is essential for the success of any plan of this nature. An effective technology plan with strong cross functional support also enables the best possible economic business case because the benefits enabled by a technology investment are leveraged across the entire company.

EPRI’s overall goal for the IntelliGrid roadmaps using the SGRM is to help companies transition from a generic understanding of Smart Grid technology to achieving a highly effective adoption and deployment timing for Smart Grid technology. To be truly effective, this requires a unique plan that maximizes the benefits and minimizes risks for the company. The roadmap is essentially a technology portfolio optimization plan.

The Smart Grid Roadmap Methodology (SGRM)

Each of the eight roadmaps developed by EPRI were different for a variety of reasons, including different business objectives, policy and regulatory requirements, technology & communications infrastructures and objectives for the Roadmaps. Nevertheless, the roadmap developments had a lot in common in terms of the overall process.

The EPRI SGRM has five steps: Vision, Requirements, Assessment, Planning and Roadmap Implementation. Within each step there are three or four recommended tasks. However, depending on the Roadmap objectives, some tasks are optional. Drilling down further, each task is addressed by one or more possible task methodologies. The optimal methodology is selected depending on the company’s needs. For example, within the Assessment step there is a task called “Select Focus Technologies”. For some Roadmaps, the method used for selection involved scoring and ranking the technology by impact and effort/risk. In other cases a more detailed scoring method was used. The EPRI Methodology is summarized in Figure 1.

**Vision**

The first task in this step is the development of a Smart Grid vision statement. The process of defining a vision statement begins with identifying and evaluating the essential business objectives and drivers that can be addressed by technology investments. Any plan leading to investments in technologies needs to be grounded in the needs of the business. We begin this task by gathering key artifacts such as regulatory requirements; government policy; corporate policy; stated corporate objectives; reliability, operating, maintenance and efficiency issues; economic opportunities, risk assessments and other potential future opportunities and threats to the business.

The next task is to develop the initial set of high-level applications that address the priority business objectives. These applications are normally defined at a high level without stating specific references to technologies or standards. The application and technology vision statements are defined in the context of the business objective(s) or driver(s) to be addressed and must be able to be mapped to at least one business objective or driver. These statements will be used in the Requirements Step that follows to aid in the selection of use cases.

**Figure 1 – Smart Grid Roadmap Methodology (SGRM)**
The final task for the Vision Step is documenting assumptions. This is a useful way of communicating to the rest of the organization the basis on which the Roadmap is developed, the effort and support needed for a good Roadmap result and the key elements necessary for successful longer term technology adoption and deployment.

Requirements

The Requirements Step starts with the development of use cases. EPRI has developed a Use Case Repository² that includes all of the use cases developed in the roadmap projects as well as use cases developed in other EPRI projects.

Once the use case titles and narrative are developed and documented, the next task is to derive the requirements and primary actors. As part of use case development, it is recommended that the interactions between the primary actors be identified. This allows the documenting of the Actor Interfaces in the form of a bubble diagram. The final task of the Requirements Step is to identify the current projects and existing infrastructure. The IntelliGrid Requirements and Architecture development process is shown in Figure 2.

Use cases are a very useful methodology that originated in the software industry and has been tailored for use in the power industry as part of the EPRI IntelliGrid Methodology for Developing Requirements.³ This methodology is applicable in a wide range of situations for technology adoption and deployment. In simple terms, if the technology being considered is proven or presents a low business risk or is planned for a minimal deployment over a reasonable time frame, than a reduced scope use case approach is suggested. However, if the technology being considered is new or presents a high business risk, requires a thorough cost benefit analysis, or will interface with many other systems, than a rigorous use case approach is strongly suggested. The detailed cross functional requirements development, risk mitigation, business value identification and life cycle benefits are invaluable. An excellent example of using this rigorous use case approach is the work done by Southern California Edison for their Advanced Metering Infrastructure.⁴ The use cases devel-

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3 IEC PAS 62559 “IntelliGrid Methodology for Developing Requirements for Energy Systems” http://webstore.iec.ch/preview/info_iecpas62559%7Bed1.0%7Den.pdf
The requirements identified for the Roadmaps referenced in this document are of the simpler variety with one or two scenarios with a primary purpose of identifying higher level requirements and the primary actors. This approach has served well for the Roadmaps and is recommended for the SGRM. Figure 3 provides an example requirements list for a use case.

Primary actors (applications, equipment or people) are identified and their relationship with other actors documented in the form of interface diagrams for each use case. Links between each actor are numbered. Figure 4 provides an example actor list.

Once the actor list is developed the actor interface diagram can be developed. Information for each of the numbered links on the interface diagram can be documented to provide the utility guidance on the technologies, standards and communications performance that should be considered. Figure 5, on page 6, shows a typical interface diagram.

The final task in the Requirements step is the documenting of the existing infrastructure along with known deficiencies. Understanding the current situation is essential in developing the gap analysis task in the Assessment step as well as the starting point for the implementation plans task in the Planning Step.

**Actor/Component** | **Reqt ID** | **FR or NFR** | **Requirement Description**
--- | --- | --- | ---
Communications System | 1.0 | FR | Communications system shall securely support reliable remote access from the Distribution Load Shed application to the substation relays controlling the breakers.
Communications System | 1.1 | NFR | All aspects of the communications infrastructure used to enable the Distribution Load Shed application shall comply with the Cyber Security Policy and applicable NERC requirements.
Communications System | 1.2 | NFR | All aspects of the communications infrastructure used to enable the Distribution Load Shed application shall be designed for a high level of availability.
Distribution Load Shed application | 1.3 | NFR | All software and hardware equipment used operate the Distribution Load Shed application shall be designed for a high level of availability.
Operator – TCC or ISO | 2.0 | FR | The Distribution Load Shed application shall accept input data from the TCC operator.
Operators – TCC and SOC | 3.0 | FR | The Distribution Load Shed application shall accept an initiation command from either/or the TCC or SOC operators.

Figure 3 – Example Requirements List for Distribution Load Shed Use Case

<table>
<thead>
<tr>
<th>Actor</th>
<th>Type</th>
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</thead>
<tbody>
<tr>
<td>Operator - SOC</td>
<td>Person</td>
</tr>
<tr>
<td>SOC</td>
<td>System</td>
</tr>
<tr>
<td>Operator - TCC</td>
<td>Person</td>
</tr>
<tr>
<td>TCC</td>
<td>System</td>
</tr>
<tr>
<td>Reliability Coordinators / MISO</td>
<td>System</td>
</tr>
<tr>
<td>Bulk Power Marketing staff</td>
<td>System</td>
</tr>
<tr>
<td>DRAACS</td>
<td>Application</td>
</tr>
<tr>
<td>DLRC, TLRC</td>
<td>Applications</td>
</tr>
<tr>
<td>Planning</td>
<td>Person</td>
</tr>
<tr>
<td>OMS/CIS</td>
<td>System</td>
</tr>
<tr>
<td>Communications system</td>
<td>System</td>
</tr>
<tr>
<td>Communications processor and RTU</td>
<td>Device</td>
</tr>
<tr>
<td>Relays</td>
<td>Device</td>
</tr>
<tr>
<td>Customer</td>
<td>Person</td>
</tr>
<tr>
<td>GIS</td>
<td>Application</td>
</tr>
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Figure 4 – Example Actor List for Distribution Load Shed Use Case

**Assessment**

The first task for this step consists of identifying the candidate technologies, applications and standards. Sources for this list include the NIST Standards Framework and Roadmap, the SGIP Catalog of Standards, published industry technology roadmaps and discussion documents such as; the Massachusetts Institute of Technology Smart Grid Roadmap Technology and Lessons Learned.
The second task in this step addresses technology evaluation. A wide range of methods are used in the industry to evaluate candidate technologies, applications and standards. The method and criteria should be selected based on the needs of the utility but should be as broad as possible.

**Detailed Technology Assessment Criteria**

A highly ranked technology or standard will clearly exhibit one or more of the following:

- A key enabler for a Smart Grid vision
- Encouraged by a regulatory authority
• Addresses a safety concern or risk
• Essential in maintaining or substantially improving reliability
• Provides a substantial improvement in operational or energy efficiency
• Yields a significant cost reduction
• Addresses an important strategic or business need
• Supports a large enhancement in customer satisfaction

A highly ranked technology or standard will exhibit a minimum of:

• Life cycle cost to install and maintain
• Technology maturity risk (includes risk of a lack of wide adoption by the industry)
• Work-force skill challenges and training
• Obsolescence risk
• IT integration and management issues
• Customer acceptance risk
• Regulatory concerns
• Effort to understand or apply the resulting information or data

The following criteria are useful for evaluating communications standards:

• Level of Standardization - Who recognizes it as a standard?
• Level of Openness – How easy/costly is it to obtain and use?
• Level of Adoption – How widely used is it now? In the future?
• Users’ Group Support – Does someone promote it? Improve it? Test it?
• Security – Can it be secured? Is it inherently secure?
• Manageability – Can you control, monitor and/or upgrade it remotely?
• Scalability – Will it work when deployed at a large number of sites?
• Object Modeling – Does it group and structure data?
• Self-Description – Can it automatically configure and initialize itself?
• Applicability:
  – to the Power Industry – was it intended for use here?
  – to the Consumer Area – e.g. metering, building automation?

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**Figure 6 – Key Technology Domains for the Smart Grid**
A Simplified Technology Evaluation
This higher level approach scores each technology according to two key criteria: impact and difficulty. Scores can be assigned from 1 to 10 (where the higher number is most favorable). For this simpler method to work there must be a consensus definition for the impact and difficulty terms. The following are typical definitions:

Example Definition: Impact

- Operational reliability & improvements
- Increased customer satisfaction
- Deferred cost of resources
- Efficiency
- Multiple benefits enterprise wide
- Mitigate rate increases
- Risk Mitigation
- Minimize/avoid negative attention

Example Definition: Difficulty

- Cost
- IT integration
- Ease of interpreting information
- Maturity or capability of technology
- Risk of obsolescence
- Regulatory concerns
- Customer relations (acceptance)

Once the scoring is completed, the technologies being evaluated can be placed on a grid such as that shown in Figure 7.

Upon completing the assessments the third task is to select the technologies for special focus in the Roadmap. The utility’s Smart Grid Roadmap team collaborates to choose the top scoring candidate technologies, applications or standards. Upon selection, a vision or objective statement is developed for each of the focus technologies. This statement will be used in the development of the gap analysis as well as the implementation plans.

The final task for the Assessment Step is the Gap Analysis Task. Once the focus technologies are selected and the objective statements are developed, the next task is to assess the current status, issues, concerns, degree of deployment, plans underway for that technology. The simple form gap analysis is then assembled by comparing the current situation to the objective statement for each focus technology.

Planning
The first task of the planning step is to ensure that all stakeholders for a possible technology decision have the opportunity to have input in aspects of the decision. This step is optional but highly recommended. This can also be an opportunity for the subject matter experts, knowledgeable in the area of the technology, to assume ownership of the selected technology for the next tasks.
These individuals can present the needed material to the utility’s Smart Grid leadership team. The same individuals are central in the development of the Ishikawa diagrams for each of the selected technologies.

The second task of this step is the Leadership Team Workshop. This is the optional task of formally presenting the Roadmap findings to date to the utility’s Smart Grid Leadership team for validation. This task, if successfully completed, can have a significant impact on the successful adoption of the technologies. Possible outcomes of this workshop could be: approval to proceed to the next stage of adoption (per the Stage Gate process described below), funding and broad cross functional support for a program.

The EPRI team has found that Ishikawa (fishbone) Diagrams are a useful tool for the third task of implementation planning. The development of the Ishikawa diagrams occurs with close interaction with the utility’s subject matter experts and starts with the outcome of the gap analysis for each technology. Refer to Figure 8 for an example Ishikawa (fishbone) Diagram. The objective statement is placed as the head of the “fish” in green. The current situation is placed as the “tail” of the fish in yellow. The actions needed to move from the current situation to the objective are described in the blue boxes.

The last task for the Planning step is the management of risk by revisiting the technology adoption gate process. The discipline of having to meet a pre-determined set of detailed criteria before moving to the next stage is an excellent way of engaging a wider audience and managing risk. See Figure 9 (on the following page) for an example diagram.

**Roadmap Implementation**

This final step captures all of the tangible results and leverages the intangible impact such as cross departmental cooperation that may have resulted. The final report out is usually provided to multiple groups for maximum impact on the organization. It is also important to note that the Roadmap development should not be considered a static result but is far more useful if it is kept up to date through periodic refresh cycles.

The Roadmap Implementation Step consists of three tasks. The first task is the final review, editing and publication of the report. The next task is the final report out which is intended to ensure the largest possible benefit is derived from the Roadmap effort.
Ideally the final report presentations should be delivered to three key sets of stakeholders as follows:

- The C level sponsor or the Smart Grid Executive Oversight Committee.
- The Smart Grid Technology Steering Committee.
- Director, Manager, Engineering and other staff stakeholders.

The final task is the Roadmap governance and updating. Experience has shown that the leadership and governance policies and capabilities of an organization are by far the biggest determinants of the degree of impact of a Roadmap development. Key elements for this task are:

- Establish a visible, long term, Roadmap Leadership Team (RLT) with C-Level (VP or higher) support.
- Develop a RLT Governance Model.
- Develop personnel skills to support infrastructure.
- Participate in standards and industry groups.
- Manage the progress towards the Smart Grid Vision.
- Modify the Roadmap based on technology assessments and trials.
- Update or refresh the roadmap regularly.

### Role and Purpose of a Roadmap

It is important to make known the place of a Roadmap and the SGRM in the context of the bigger picture for the utility. The SGRM ideally commences after the overall corporate technology strategy is in place and the C-level sponsorship (ideally cross-functional) is in place. It is assumed that this strategy addresses key regulatory and policy mandates applicable to the utility. After the Roadmap is complete, the next steps may include: conceptual architecture, logical architecture, updated cost benefit analysis, continued progression of the technology stage gate process, technology testing and pilot implementations, component architecture, project planning and deployment. Figure 10, on the following page, shows the contribution of the Smart Grid roadmap in overall technology adoption for many utilities.

At its core, road-mapping is simply good planning. Business, technology and regulatory interaction related decisions are made as a fundamental part of the plan. The process itself leads to the creation of cross-departmental teams that can more effectively identify the potential for realizing utility wide value and minimizing business risk through efficient implementation of corporate strategy. With the experience gained in assisting member companies in the development of the eight roadmaps, we have made the following general observations on the purpose of road-mapping:

- A roadmap links regulatory policy, corporate business strategy, and customer needs with vendor, technology, and standards adoption decisions. Road-mapping allows a team to clearly relate planned features and system performance metrics in terms of value for the customer.
- As its name implies, roadmaps explicitly incorporate a time ordered string of events and actions. Road-mapping helps ensure that the team has access to technologies, personnel, best practices and other capabilities at the time they are needed to carry out the overall strategy.
• Roadmaps generally identify gaps in a company’s technology evolution and adoption plan, and organizational change management plan. These gaps become apparent quickly and can be addressed in a timely fashion.

• Road-mapping allows a disciplined approach to driver identification and prioritizing capital expenditures based on those drivers. At every step of the roadmap process, focus is maintained on the basics of customer needs, regulatory compliance, institutional capability and technology investment. Cross-functional teams are led to discover and implement the most important things first thus allocating time and resources in the most efficient manner possible.

• Roadmaps help set realistic targets for what can be accomplished given existing infrastructure, personnel, ability to adapt to and adopt new technology, and the regulatory environment. Realistic targets help build buy-in to the roadmap and underlying strategy and allow all stakeholders to see the positive results of the process.

• Road-mapping is an effective communication tool internal to the organization as well as externally for consumers, regulators, and vendors. Internally, a roadmap allows the team to clearly and consistently articulate the overall direction of the organization on many levels. It allows the team to send clear signals to the vendor community as to what technology is needed thereby reducing risk to both vendors and the utility. Engaging consumers and regulators reduces the risk associated with consumer disconnect and pushback that have been seen in some utility Smart Grid deployments.

• Roadmaps also allow the team to see when a detour is required to act on external events and other unforeseen circumstances. Part of the process involves identifying risks along the way so the events that might require a change in direction are not a complete surprise.

The utility industry has developed a spirit of collaboration over the past decade that includes the sharing of use cases, best practices and now roadmaps. This approach is facilitating a much more efficient use of industry resources to address a wide range of issues that many utilities have in common. Common requirements result in multiple choices of vendors supplying the needed technology and allowing multiple parties to share the technology adoption risk. Identifying common elements of roadmaps across utilities offers further opportunities to manage risk, prevent reinventing the wheel, and gain more leverage over development plans in the vendor community.

**Risk Mitigation**

An important role for the Roadmap is the mitigation of risk. Business risk mitigation can be enhanced by identifying early the potential impacts of technology change such as the adoption of distributed energy resources and electric vehicles. The SGRM provides essential methodologies and principles such as the development of cross-functional requirements and recommends the use of interoperable standards to minimize obsolescence risk.

The risk assessment matrix in Figure 11, on page 12, can form the basis for differing mitigation strategies. For example, a material
investment in an immature technology will require a far more rigorous requirements development and technology assessment effort than a low volume implementation of a mature technology.

**Specific Uses for Roadmaps**

The following is a list of specific uses of roadmaps based on the EPRI team’s experience:

- Optimize the planning of technology investments
- Identification of important technology, standards and application areas not yet addressed
- Provide organizational direction and cross-cutting cooperation on the Smart Grid efforts
- Identify technical requirements for specific technologies, applications and standards
- Increase collaboration and cooperation between departments
- Energize the organization
- Identify business values, rules or specific risks associated with a technology
- Risk mitigation
- Identify key enablers for specific technology adoption
- Highlight immediate actions that may be required related to technology planning and adoption such as capability assessments, lab testing, etc.
- Develop and justify short term budget requirements
- Provide useful inputs to the next phases of business case development and architecture design.
- Enhance technology life cycle management
- Identify “trigger scenarios” in advance for initiating the next step in the planning or stage gate technology deployment process
- Provide a template for evaluating projects already underway

- Define assumptions and sensitivities related to technology changes or investments
- Provide a starting place of requirements for reference when developing procurement specifications
- Identify specific issues, challenges and any impacts of delays related to specific technologies
- Enables the utility to discover the potential future impacts of technological change such as DER, EV
- Support the long term planning needed to achieve overall systems and data integration
- Can be a source of input for regulatory applications and general rate case documents

**Best Practices and Lessons Learned**

As part of the preparation of the Guidebook, EPRI was able to capture feedback from many of the utility managers that were involved in developing their original Roadmap. The feedback addressed a range of topics including the Roadmap development process, key success criteria, organizational impacts and deployment results. The best practices and lessons learned are summarized below.

- There is as much value from the “journey” as in the end product – there is tremendous value from the shared experience of defining the future vision and developing use cases
- A successful roadmap must be driven from the top – there needs to be an executive sponsor
- A successful roadmap must take a holistic view – it needs to look across the entire enterprise
- A successful roadmap puts the stakeholders at the center - it needs to identify who the stakeholders are, both within and outside of the company
- It is tremendously important to define the company’s current state - this can be difficult but is very useful as you define the future state and conduct a gap analysis
- Don’t get lost in technology - technology is a means to an end; decide first what you want to do then determine how you will do it
- Developing enterprise policies for cyber-security and integration are important early steps
- Don’t just add new technology; think about migration, transitions, scalability, future upgrades and replacements
- A successful roadmap is supported by a strong, well-defined governance structure

![Figure 11 – Risk Assessment Matrix](image)
Technical Recommendations

An important chapter in the Guidebook is the compilation of the primary technology recommendations which were made spanning EPRI’s Roadmap efforts. Although each Roadmap is unique to the company, there usually exists overlap in technology requirements and associated recommendations.

Each technology recommendation consists of the following five essential elements as follows:

- Objective Statement: the summary goal statement.
- Recommendation: the summary recommendations for this technology theme.
- Industry Best Practice: the best in class application and practice across the industry in this area of technology
- Benefit/Rationale: key benefits expected as a result of investing in the technology or the rationale to do so
- Challenge: anticipated difficulties, costs or risks that must be overcome to implement the technology

The following are the primary technology recommendations by overall theme:

1. Integrated Enterprise Architecture, Information Technology, etc.
   • Design for Information System Integration

2. Information Communications and Technology Infrastructure
   • Develop an infrastructure for Customer Systems Integration
   • Transition to IEEE Std 1815 (DNP3) and eventually full 61850 for fully integrated substation Local Area Network (LAN)
   • Transition to Wide Area Network (WAN) and LAN Technology Between and Internal to Transmission and Distribution Substations
   • Enhance Distribution Communication Infrastructure
   • Implement unified Advanced Metering Infrastructure (AMI) and Distribution Automation (DA) Communications

3. Advanced Grid Applications & Automation
   • Test and deploy Advanced Grid Applications
   • Implement new Distribution Management Applications company-wide

4. Cyber Security
   • Develop an Integrated Enterprise-wide Cyber Security Strategy
   • Define a Cyber-Security Strategy for DA
   • Implement Secure Remote Access

5. Information, Monitoring, and Management
   • Deploy expanded DA
   • Implement an infrastructure for Transmission System Applications
   • Implement an infrastructure for Distribution System Applications
   • Develop Advanced Control Strategies
   • Install Substation Data Managers (SDM)
   • Implement Fault/Disturbance Event Retrieval and Analysis
   • Implement Phasor Measurement Data Gathering and Storage
   • Increase the On-Line Monitoring of Key Assets such as Power Transformers and Lines
   • Implement automated tools for WAN Monitoring
   • Deploy Electric System Data Acquisition and Data Management
   • Install Broad Condition Monitoring of Key Transformers and Lines with Integrated Analysis

6. Advanced Forecasting and Modeling (Load and Variable Generation)
   • Study, research, test and implement Modeling and Analytical Tools for Planning and Operations

7. Enabling Distributed Energy Resources (DER)
   • Plan and pilot test new infrastructure elements for DER and Microgrids

Conclusion

The EPRI Smart Grid Roadmap Methodology has been found to be an effective tool in assisting utilities to move forward in their grid modernization efforts. The Smart Grid vision that these Roadmaps embrace should link electric operations, communications, and automated control systems to create a highly automated, responsive, and resilient power delivery system that should both improve services and empower customers to make informed energy decisions.

A Smart Grid with these characteristics would support a wide range of current and evolving energy policy goals, including increased penetration of renewable resources, reduced greenhouse gas emissions, increased energy efficiency, implementation of
demand response, increased use of distributed energy resources, maintained and/or enhanced grid reliability, and advanced transportation electrification.

The Roadmap process has also illuminated some of the challenges associated with Smart Grid development and deployment—such as maintaining and/or increasing reliability in the face of increased grid complexity and managing technologies.
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**EPRI Resources**

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