Efficient Transmission and Distribution Systems for a Low-Carbon Future - Program 172

Program Overview

Program Description

As utilities seek to increase transmission and distribution system efficiency they are also focused on reducing their overall greenhouse gas footprint.

The program has been developed to help utilities prepare for operating in a low-carbon business environment and deal with related impacts on transmission and distribution (T&D) system operation, maintenance, and planning. Key research and delivery (R&D) activities include integrating energy efficiency and demand response into a comprehensive planning process; assessing the costs, benefits, and performance of technologies capable of reducing T&D losses; and assessing the implications of climate change on future T&D systems to improve risk management of assets and improve reliability modeling.

Research Value

With the knowledge acquired through this research program, program members will have access to information that can help them in these ways:

- Demonstrates commitment to environmental issues through more efficient use of T&D resources
- Provides a framework for loss reduction on T&D systems, resulting in financial savings for utilities and improved life expectancy of equipment
- Helps utilities prepare to operate in a carbon-constrained business environment and deal with related impacts on T&D system operation, maintenance, and planning
- Defers capital costs associated with new T&D construction
- Supports regulatory actions with regard to energy efficiency mandates or monitoring
- Provides possible contribution to utility carbon dioxide (CO_2) emission reductions and overall greenhouse gas footprint
- Improves risk management of assets to better prepare for climate change

Approach

EPRI research in efficient T&D systems will yield a variety of data and knowledge that will be beneficial to program members. This information will come in a variety of forms and is expected to offer members short- and long-term value. A team of experts will gather data and information from a number of sources to develop strategic assessments and reports on a number of relevant subjects such as climate change impacts on T&D systems or ways to quantify temporal and spatial variation in losses across T&D systems. The team will also develop reports, case studies, and workshops to help capture and share this information with program participants.

Accomplishments

In the past, the efficient T&D systems program has delivered valuable information that has helped its members and the industry in numerous ways. Some examples include the following:

- *Utilization of Energy Efficiency and Demand Response as Resources for Transmission and Distribution Planning.* The project described in this report detailed the initiative's analytics element, which deals with methods and tools for analyzing aspects of the use of energy efficiency as supply resource, including measurement and verification, inclusion in generation planning, emissions reductions, and economic impacts.
- *Distribution System Losses Evaluation Reduction: Technical and Economic Assessment.* Currently, there is not an industry standard on how utilities calculate and account for electrical losses and reductions in

electric system losses. This report identifies current industry practices, develops a methodology for best practices in determining system losses, and provides guidelines for utilities to use in accounting for system efficiencies for reducing system losses.

- Trans*mission Efficiency Technology Assessment.* EPRI has not found an industry-wide strategy for the reduction of transmission line losses. Some utilities are studying line losses while others are investigating lower losses in large power transformers. Still other groups are focused on more efficient distribution transformers. This report is an effort to determine what loss reduction programs are in place, what strategies are in use, and how they are being applied.

Current Year Activities

In the coming year, this research program expects to accomplish these objectives:

- Assessments to quantify temporal and spatial variation in losses across T&D systems
- Strategic intelligence and technology watch newsletters
- Quantification of costs, benefits, and risks of using energy efficiency and demand response in T&D planning
- Case studies on energy efficiency and demand response in deferring T&D infrastructure buildup
- T&D system efficiency technology assessments and cost feasibility
- Workshops on potential impacts of irreversible warmer temperature and humidity, or other extreme weather conditions, on T&D operations, maintenance, and planning practices
- Strategy report on the impact of climate change on T&D systems

Estimated 2010 Program Funding

$1.3M

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Summary of Projects

PS172A Efficient Transmission Systems (065412)

Project Set Description

Adequate transmission capacity is a critical element to ensure overall grid reliability and proper functioning of electricity markets. However, building new transmission infrastructure is more difficult than ever. Increasing the efficiency of existing transmission systems and integrating energy efficiency and demand response as part of the overall transmission planning process could defer the need for new transmission infrastructure and reduce the CO_2 footprint of the electricity sector.

Utilities are under increasing pressure to evaluate all possible options to meet growing demand and energy transfer requirements. When load growth forecasts show that capacity limits of the existing transmission system may be exceeded, prudent planners evaluate both block and incremental solutions for providing energy. While a new transmission line or a new substation can add significant capacity, it also requires substantial capital investment. Deferring that investment for several years, or even indefinitely, by applying alternative solutions to meet demand could potentially save millions of dollars.

This project set builds on the work started in 2008 and continues to focus on constructing and operating more efficient transmission systems and integrating demand response and energy efficiency resources into a comprehensive planning process. The three projects comprising this set address all aspects of an efficient transmission system, including: reducing losses with new technologies, integrating non-wire alternatives into

the planning evaluation process, and providing comprehensive risk management strategies for transmission systems in a business environment with carbon constraints.

Transmission engineers can use the knowledge contained in the project findings and products to reduce losses, support transmission and distribution planning, respond to regulatory and other outside stakeholder inquiries, evaluate available technologies, and inform senior management on technologies that could impact business operations.

Project Number	Project Title	Description
P172.001	Transmission System Loss Evaluation, Reduction: Technical and Economic Assessment	This project builds on the work initiated in 2008 and 2009 and provides objective investigation, analysis, and strategic measures to reduce losses on transmission systems and equipment.
P172.002	Integrating Energy Efficiency and Demand Response in Transmission Planning: Technical, Economic and Risk Assessment	The guidebook will help members incorporateg energy efficiency measures and demand response programs into transmission system planning and operations systematically and comprehensively.
P172.003	Implications of Climate Change on Future Transmission Systems	This project investigates the potential impacts of changing climate and extreme weather on transmission reliability, design, maintenance and recovery schemes, and prepositioning of operations.

P172.001 Transmission System Loss Evaluation, Reduction: Technical and Economic Assessment (065414)

Key Research Question

Utilities need strategic and objective information on loss evaluation for reducing transmission system losses, as well as equipment using technology-based solutions. The implementation of technology-based solutions for reducing transmission losses requires utilities to study and assess not only the technologies, but their transmission systems. Utilities need a comprehensive evaluation methodology and strategic planning framework to accomplish this task. Indeed, transmission companies are realizing the need for a consistent analytical framework to evaluate the most cost-effective measures for achieving a specified reduced-losses goal or mandate. In addition, measurement and verification (M&V) procedures are needed after the implementation to be able to confirm that the anticipated improvements in losses are achieved.

Approach

This project provides investigation, analysis, and strategic measures to reduce losses on transmission systems and equipment through the following activities:

- Developing industry-accepted methods for evaluating transmission losses by taking the following steps:
  - Comparing transmission loss study approaches used by transmission companies and Regional Transmission Organizations (RTO)/Independent System Operators (ISO).
  - Developing an efficiency accounting methodology.
  - Selecting the most appropriate approach for adoption.
- Developing a value proposition, from a technical and economical perspective, for implementing the following practical means of reducing losses in transmission systems and equipment:
  - Evaluating the potential of replacing existing conductors with high-temperature, low-sag (HTLS) conductors to reduce transmission losses.

- Optimizing voltage profiles in systems, particularly during heavy load conditions, to reduce losses by using optimally located shunt capacitors/reactors, series capacitors/reactors, and secondary voltage regulation on generators to maintain higher voltage profiles at key transmission nodes.
- Using reactive power management (for example, improving load power factor and placing dynamically controlled reactive power sources such as Static Volt Ampere Reactive Compensators [SVCs] and Static Synchronous Compensators [STATCOMs] at large load centers remote from generation). These dynamic controlled reactive power compensators could be specifically designed to meet the dual objectives of improving voltage instability and reducing losses in transmission systems and equipment.
- Using power-electronics-based transmission controllers for power flow distribution to reduce megawatt losses on transmission corridors.
- Using optimal power flow analysis techniques to optimize voltage schedules, transmission substation transformer taps, and taps on phase-shifting transformers to minimize losses.
- Evaluating the potential for reducing losses by eliminating congestion.
- Evaluating the potential for upgrading lines to higher AC voltage levels to reduce losses.
- Evaluating the potential to locate generation assets, such as peaking units and distributed generation, closer to load and thus reduce transmission losses.

Impact

This project's results will benefits members in a number of ways, which can be summarized as follows:

- Provide a value proposition from a technical and economical perspective for implementing practical means of reducing losses in transmission systems and equipment.
- Having a consistent and uniform technique to determine transmission system losses would help companies target cost-effective approaches for reducing system losses. It would allow them to document those energy savings so they can be properly credited toward energy-efficiency savings goals.
- Various loss reduction methods result in increased power transfer capability, which may be applied to defer installation of new transmission facilities or to relieve some constraints. Increasing loading of existing transmission facilities may result in an increment in losses. Thus, a conflict between reducing losses versus increasing transfer capability may arise when these methods are implemented. The evaluation framework provided guidelines to properly address loss reduction technique without conflicting with expansion planning and incremental transmission upgrades objectives.

Improved transmission system efficiency results in additional rewards for a transmission utility that implements measures to improve transmission system efficiency:

- Demonstrates environmental commitment to regulators and the general public through more efficient use of transmission resources.
- Reduces utility CO_2 emissions and a company's overall greenhouse gas footprint.
- Reduces electrical losses, resulting in financial savings and improved life expectancy of some equipment.
- Supports regulatory actions related to energy-efficiency mandates.

How to Apply Results

The project results and deliverables are tools and guidelines that are designed to be used by engineers and managers for the assessment and implementation of measures to improve transmission system efficiency. In particular:

- Transmission engineers can use the knowledge contained in the project findings and products to: develop methods for loss reduction, support transmission and distribution planning, respond to regulatory and other outside stakeholder inquiries, evaluate available technologies, and inform senior management on technologies that could affect business operations.

- Planning engineers will use the framework as a guideline to assess projects for reducing transmission losses.
- Planners along with other engineering departments can use the framework as a basis to develop tailored methodologies and procedures for loss reduction project evaluation and implementation, to respond to company-specific needs and technical and business structure.
- Mnagers can use project results to implement measures and verification (M&V) procedures to test and account for the anticipated improvements in transmission system efficiency.

2010 Products

Product Title & Description	Planned Completion Date	Product Type
Strategic Intelligence and Technology Watch Newsletters: Core products include strategic intelligence reports, technology assessments, and online assessment guides. New assessments, tools, and tests will be developed with advisors.	12/31/10	Technical Update
Transmission System Efficiency Technology and Methodology Assessment: The technical report investigates practical means to lower transmission losses and document industry experience. The report provides quantifiable measures to assess the impact of loss reductions on energy efficiency improvements.	12/31/10	Technical Report

P172.002 Integrating Energy Efficiency and Demand Response in Transmission Planning: Technical, Economic and Risk Assessment (065413)

Key Research Question

Over the last several years, transmission planners have started to consider alternatives to traditional “wires” solutions, for example using strategically located distributed generation, targeted energy efficiency, and demand response programs to reduce loads to avoid or delay building a new substation or undertaking a line reinforcement or extension. Controlling or modifying loads provides temporally and spatially scalable options that will provide cost-effective and timely system improvements. If these measures cost less, then consumers enjoy the savings. Moreover, since both energy efficiency and demand response involve changes in consumer electricity usage, the benefits may also include emissions reductions.

For these demand-side measures to replace conventional asset investments, planners must be able to demonstrate that energy efficiency measures and demand response programs are substitutes to transmission equipment in terms of timeliness and reliability, as well as cost-effectiveness.

The lack of extensive and comprehensive characterizations of the compatibility of available demand response and energy efficiency measures with the specific nature of transmission system operational requirements acts as a barrier to treating these demand-side measures as viable resources. To elevate them to consideration, the compatibility of energy efficiency and demand response measures must be established so that transmission planners recognize situations where non-wires solutions are most likely to be viable and protocols can be developed to consider non-wires alternatives systematically.

Approach

This project will use the results of the previous three years' research to create protocols for integrating energy efficiency and demand response into transmission planning processes. A guidebook will be developed to assist transmission planners and their demand-side resources program counterparts in conducting an initial screening of energy efficiency and demand response measures as part of each planning exercise. In cases where alternatives might be viable, the guidebook can be used to help them integrate those alternatives into the transmission planning process.

Impact

- Expand the means available to transmission planners to respond to needs, to reinforce, bolster, or expand the system's capability
- Contribute to key system initiatives to reduce CO_2 emissions
- Expand the options available for reducing transmission congestion
- Reduce the cost of delivering electricity to consumers reliably, when they want it and where they want it
- Improve the quality of transmission service

How to Apply Results

Transmission planners will use the methods and protocols to screen energy efficiency and demand response programs to: determine which might defer or replace anticipated transmission system investments, incorporate the most promising into the planning process, demonstrate the savings attributable to those that become part of the company's investment portfolio, and define protocols for how they are dispatched or otherwise deployed. Strategic planners will incorporate the impacts of these investments in producing energy and demand forecasts, measuring the achievement of conservation and carbon emission goals, and achieving quality of delivered service goals.

2010 Products

Product Title & Description	Planned Completion Date	Product Type
Guidebook for Integrating Energy Efficiency and Demand Response into Transmission Planning: Detailed, comprehensive guidebook that describes how to screen transmission investments to ascertain if energy efficiency and demand response measures are likely to be viable. The guidebook will include protocols and methods for incorporating the appropriate measures when screening indicates that it is appropriate to do so.	12/24/10	Technical Report

P172.003 Implications of Climate Change on Future Transmission Systems (065415)

Key Research Question

Transmission systems could become vulnerable to climate changes and extreme weather conditions and need to be further hardened and enabled for quick recovery after related outages. The electricity industry, among others, is in need of a decision-making framework that balances costs, benefits, and risks associated with increasing obligations to precious system resources. Such a framework must be flexibly applied across organizations with different regional, regulatory, and business needs.

Approach

The project objective is to develop flexible strategies to climate-harden transmission systems against climate changes, giving them ride-through capability for extreme weather conditions and quicker recovery afterwards. The strategies need to be designed against the backdrop of rising issues like: constrained systems, increasing need for security and reliability, unprecedented additions of renewable energy sources, and possible mandates for higher efficiencies and lower CO_2. The approach is to execute and report on the following tasks:

- Harmonize with other ongoing new transmission systems research and enablers.
- Evaluate transmission system designs that better accommodate stresses from extreme weather conditions, including increased power flows and equipment failures.

- Assess changes needed in transmission and substation equipment and apparatus designs.
- Evaluate necessary changes in maintenance strategies and priorities.

EPRI plans to coordinate this research agenda with other efforts, nationally and internationally, for more effective use of resources and to realize synergies. Collaboration will also be sought with entities like: the U.S. government (Department of Energy, Department of Transportation, and National Oceanographic and Atmospheric Association), and the North American Electric Reliability Corporation (NERC). The issues are timely and require continued R&D focus to ensure that the electricity industry effectively tracks the situation, is aware of the potential for changes as they occur, and retains the option to make adjustments.

Impact

- Attain ride-through capability for transmission systems in the face of extreme weather effects
- Preposition for rapid recovery after extreme weather related disturbances
- Coordinate with loss reduction efforts
- Achieve balance between loss reductions, efficiency gains, system hardening, and rapid recovery
- Improve asset risk management and reliability modeling
- Improve reliability during extreme weather conditions
- Improve life expectancy of transmission components via enhanced loading practices
- Prepare members for new paradigms in planning and maintenance of transmission systems

How to Apply Results

Transmission system designers and planners, asset managers, and energy efficiency program managers can apply project findings and products to develop integrated strategies for extreme weather and define computational tools requirements, planning, changes needed in operations maintenance, training, and the personnel skill sets required.

2010 Products

Product Title & Description	Planned Completion Date	Product Type
Impact of Climate Change on Transmission Systems	12/31/10	Workshop, Training, or Conference
Technology Risk Management Strategies for Transmission Systems in a Carbon-Constrained World	12/31/10	Technical Report

PS172B Efficient Distribution Systems (065416)

Project Set Description

There may be significant potential to reduce distribution losses and take advantage of demand response infrastructures to manage distribution systems more efficiently. These measures can directly reduce the greenhouse gas impacts of distribution system operation. Furthermore, these measures can significantly reduce investment requirements for distribution system expansion. Better analysis and planning tools are needed to include evaluation of efficiency improvements and demand response impacts on the need for additional distribution capacity and on the greenhouse gas impacts of system operation. This program builds upon the work started in 2008 and will continue to focus on these evaluations, the tools for performing the evaluations, and the effect of distribution efficiency on reducing the CO_2 footprint of the electricity sector.

Project Number	Project Title	Description
P172.004	Distribution System Loss Evaluation, Reduction: Technical and Economic Assessment	This project provides analysis and strategic planning information on distribution system and distribution equipment efficiency. Research results include annual technology assessments and strategic intelligence reports.
P172.005	Integrating Energy Efficiency and Demand Response in Distribution Planning: Technical, Economic and Risk Assessment	Development of the Distribution System Integrated Planning Guide for incorporating energy efficiency measures and demand response programs into distribution system planning and operations
P172.006	Implications of Climate Change on Future Distribution Systems	This project investigates the potential impacts of changing climate and extreme weather on distribution reliability, design, maintenance and recovery schemes, and prepositioning of operations.

P172.004 Distribution System Loss Evaluation, Reduction: Technical and Economic Assessment (065418)

Key Research Question

Utilities need strategic and objective information on controlling distribution system losses, implementing energy efficiency initiatives, controlling voltage and VAR, improving management of transformer losses, and easily integrating energy-efficient end-use loads.

Approach

This project provides analysis and strategic planning information on distribution system and distribution equipment efficiency. Research results include annual technology assessments and strategic intelligence reports. Building on work in 2008 on distribution loss study guidelines and accounting for efficiency improvement, a number of options are possible. A member advisors group will direct particular activities, which may include the following:

- Assessing new technologies to reduce losses on distribution circuits
- Revising distribution transformer applications, design specifications/material considerations, and loading guides based on upcoming U.S. Department of Energy (DOE) standards on transformer efficiency
- Developing operational guidelines for improved management of distribution transformers
- Conducting low-loss distribution transformer research
- Using consumer modeling from automated meters to develop end-use profiles that can be connected to the utility's load management practice, enabling better decisionmaking and more efficient practices
- Using metering data to target end-use efficiency programs
- Conducting unbiased reviews of costs associated with distribution efficiency programs
- Employing state-of-the-art tools for measuring and estimating distribution losses, such as the possible use of state estimation to quantify losses, to determine where most losses occur and help evaluate options for reducing them
- Assessing emerging end-use technologies (for example, plug-in hybrid electric vehicles) to identify impacts on distribution systems
- Evaluating the effect of conservation voltage reduction programs on both distribution losses and overall system losses
- Reviewing and testing new end-use loads to identify impacts on traditional voltage control
- Evaluating the efficiency of various future distribution system architectures under consideration, such as networked systems and microgrids
- Using monitoring to evaluate distribution systems and end-use efficiency

Impact

- Demonstrates members' commitment to environmental issues through more efficient use of distribution resources
- Reduces utility CO_2 emissions and overall greenhouse gas footprint
- Reduces electrical losses, resulting in financial savings for utilities and improved life expectancy of some equipment
- Supports regulatory actions regarding energy-efficiency mandates or monitoring

How to Apply Results

Distribution system engineers and planners can use the knowledge contained in the project findings and products to reduce losses, support distribution planning, respond to regulatory inquires, evaluate available technologies, and inform senior management on technologies that could affect business operations.

2010 Products

Product Title & Description	Planned Completion Date	Product Type
Distribution Efficiency Technology Assessment: The technical report investigates practical means to lower distribution losses and document industry experience, including optimizing voltage profiles, modeling losses, using advanced meters, and optimizing transformer losses.	12/31/10	Technical Report
Strategic Intelligence and Technology Watch Newsletters: These core products include strategic intelligence reports, technology assessments, and online assessment guides. New assessments, tools, and tests will be developed with advisors.	12/31/10	Technical Update

P172.005 Integrating Energy Efficiency and Demand Response in Distribution Planning: Technical, Economic and Risk Assessment (065417)

Key Research Question

The results from the first three years of research must be made accessible to utilities for consumers to realize the energy efficiency gains that revised distribution planning methods can provide. A planning guidebook will ensure that the methods developed can be conveyed to planners so they can identify where energy efficiency and demand response process may be most valuable and rationalize the asset development decisions that result.

Approach

This project will incorporate the results of the previous three years' research into a planning guide that includes the protocols, methods, and analytics that planners need to integrate energy efficiency and demand response into utility distribution planning. These protocols will be packaged to enable users to prepare a business case that anticipates and responds to the need to meet reliability goals in principle, demonstrate how the demand response and energy efficiency resources will be deployed to meet this standard in practice, and produce the data required to establish that the approach is the least cost one The package will include including cost-effective demand response measures.

Impact

- Respond to expanded role of distribution in a Smart Grid to accommodate and take advantage of demand response capabilities
- Contribute to key system initiatives to reduce CO_2 emissions, foster customer demand response, and enable integration of distributed generation resources
- Reduce the cost of delivering electricity to consumers reliably—when they want it and where they want it

How to Apply Results

Distribution planners will use the methods and protocols to screen energy efficiency and demand response programs to: ascertain which might defer or replace anticipated distribution system investments, incorporate the most promising activities into the planning process, demonstrate the savings attributable to those that become part of the utility investment portfolio, and define protocols for how they are dispatched or otherwise deployed. Strategic planners will incorporate the impacts of these investments in producing energy and demand forecasts, measuring the achievement of conservation and carbon emission goals, and achieving quality of delivered service goals.

2010 Products

Product Title & Description	Planned Completion Date	Product Type
A Planning Guide of Methods and Protocols for Employing Energy Efficiency and Demand Response as Distribution System Resources: The report provides distribution planners with a handbook for 1) screening energy efficiency and demand response programs to determine which might displace or defer specified equipment investments, 2) configuring the best candidates so that they can be incorporated into establish planning tools and practices, 3) establishing performance goals for those selected for implementation, and 4) substantiating the choice by establishing that reliability will not be compromised, cost will be reduced, and contributions will be made to carbon-reduction goals.	12/31/10	Technical Report

P172.006 Implications of Climate Change on Future Distribution Systems (065419)

Key Research Question

As distribution systems become more constrained with increasing demand, they become more vulnerable to the impact of frequent and extreme weather conditions. Because the distribution systems represent large investments and are much more exposed to the elements compared to other parts of the power system, they will require special attention and consideration. Distribution planners need to reassess their planning processes to account for changing climate and more frequent extreme weather events. To accomplish this, they are asking for support for the following tasks:

- Designing primary and secondary distribution systems to accommodate stresses of extreme weather conditions, including higher loads and possible equipment failures.
- Changing equipment capabilities to accommodate higher load factors and challenging load shapes.
- Changing maintenance strategies based on knowing the risks involved and how to use that knowledge to establish priorities and strategies for successful and economical maintenance and recovery management.

Issues to be considered will include density of feeder, load growth, reliability and continuity of service required, and spare capacity/charges for extreme operation and losses.

Approach

The 2010 project will address the effects of extreme weather conditions on distribution design criteria, required equipment capabilities, challenges in maintenance and required strategies to accommodate them, and the economic implications of maintaining reliability at acceptable values. Since these may require changes in well-established paradigms, work will focus on minimizing disruption and economic impact. The EPRI team will coordinate with the related project for transmission systems, aiming to have a single strategy for utilities with both transmission and distribution systems. The approach is to execute and report on the following tasks:

- Harmonize the defense plan with other ongoing research and development aspects of distribution systems such as improved system efficiencies, Smart Grid, and plug-in hybrids.
- Evaluate required distribution system design changes (primary and secondary systems) that can accommodate stresses of extreme weather conditions, including increased loading and possible equipment failures.
- Assess changes needed in the distribution equipment and apparatus to accommodate higher load factors and challenging load shapes.
- Evaluate necessary changes in maintenance strategies, as well as priorities and strategies for successful and economical maintenance and recovery management.

Since these activities may require changes in well-established paradigms, work will focus on minimizing disruption and economic impact. EPRI plans to coordinate this research with other efforts (nationally and internationally) for more effective use of resources and synergies. Collaboration will also be sought with entities such as: U.S. government (Department of Energy, Department of Transportation, and National Oceanographic and Atmospheric Association), and the North American Electric Reliability Corporation (NERC). The issues require continued R&D focus to ensure that the electricity industry keeps track of the situation, is aware of the potential for changes as they occur, and retains the option to make adjustments.

Impact

This project's objective is to inform members about how planning methods and risk assessments change due to the added uncertainties of changing climate and more frequent extreme weather. This project helps members accomplish the following:

- Attain ride-through capability for the distribution systems in the face of extreme weather effects.
- Achieve rapid recovery after extreme weather-related disturbances.
- Coordinate with loss reductions, efficiency gains, and system hardening.
- Improve asset risk management and reliability modeling.
- Improve reliability during extreme weather conditions.
- Improve the life expectancy of transmission components via enhanced loading practices.
- Prepare members for new paradigms in planning and maintenance of transmission systems.

How to Apply Results

Asset managers, energy efficiency program managers, and distribution engineers can apply project findings and products to prepare a structured approach and methodology to deal with extreme weather effects. They can also use them to define computational tools required for planning, make necessary operations and maintenance changes, and address training and personnel skills.

2010 Products

Product Title & Description	Planned Completion Date	Product Type
Impact of Climate Change on Distribution Systems	12/31/10	Workshop, Training, or Conference
Technology Risk Management Strategies for Distribution Systems in a Carbon-Constrained World	12/31/10	Technical Report