

## End-Use Energy Efficiency and Demand Response in a Low-Carbon Future - Program 170

### Program Overview

#### Program Description

The electricity industry faces growing power demand coupled with the need to emit less carbon. One of the key contributors to meet this challenge is more efficient use of energy. This program furthers applied research in efficient energy utilization through the assessment, testing, and field demonstration of advanced energy-efficient technologies and integrated demand response systems and the development of robust analytical frameworks to appropriately value their economic, environmental, and societal impact.

#### Research Value

- Robust research, development, and demonstration (RD&D) on advanced end-use technologies that enable and enhance energy efficiency, which is at the forefront of the nation's plan for energy independence and sustainability
- Robust RD&D on advanced technologies and tools that enable demand response (DR), which can provide relief for the nation's electricity grid while enhancing customer choice
- Collaboration with equipment vendors to improve performance and reduce costs of energy-efficient equipment and demand response systems through assessment, lab testing, and field demonstrations
- Development of analytical frameworks to value the economic and environmental benefits and costs of energy efficiency and demand response to utilities, customers, and society
- Development and refinement of an industry-standard modeling approach to quantify the impact of energy efficiency on reducing carbon emissions, to inform utilities, policymakers, and regulators
- Reliable, comprehensive, easily accessible data on the nature of plug loads, which constitute the least understood and fastest growing segment of electricity consumption
- Easily understandable, concise, and technically accurate information and tools on existing and emerging energy efficiency and DR technologies for utility account representatives and their customers

#### Approach

- Development of a national energy efficiency potential study, released in January 2009, estimating the economic, maximum achievable, and realistic achievable potentials for energy efficiency and peak demand reduction in the United States through 2030
- Published public version of a guidebook on energy efficiency in commercial buildings for members to co-brand and share with their end-use customers
- Large-scale multiyear field deployment of advanced energy-efficient technologies in 2009
- Knowledge transfer through topical webcasts provided throughout the year
- Collaboration with manufacturers to develop and demonstrate numerous energy-efficient technologies
- Development of a modeling approach to quantify marginal carbon offsets of key energy-efficient technologies
- Creation of a commercial and industrial efficiency technology database, web-based strategic intelligence updates, technology transfer expertise and data from Electric Power Research Institute (EPRI) experts, and transfer kits such as customized technology updates, industry guidebooks, and online delivery mechanisms

#### Accomplishments

- Risk Mitigation and Avoided Costs
  - Assessment, testing, and demonstration of energy-efficient technologies to determine efficacy prior to deployments in utility pilots or programs

- Assessment, testing, and demonstration of demand-response-enabling technology to determine efficacy and interoperability prior to deployments in utility pilots or programs
- Synthesis of research on customer response to feedback to provide predictive insight on expected savings in particular circumstances
- Input into Standards Development
  - Use case functional specifications of demand-response-ready end-use devices through a multi-disciplinary process involving utilities, equipment manufacturers, public agencies, and other industry stakeholders
- Regulatory Compliance
  - Establishment of national and regional benchmarks for energy efficiency and peak-demand reduction potential to inform discussions of state energy efficiency targets between members, policymakers, and other stakeholders
  - Analysis and recommendations for standardized measurement and verification (M&V) protocols for energy efficiency and demand response programs that can improve the cost-effectiveness of program M&V and reduce the ambiguity of impact attribution

### Current Year Activities

- Expand the scope and breath of activities of the Living Lab to keep pace with the introduction of new devices and members' need to understand how they work and characterize them in business cases
- Extend behavior research to better characterize drivers for customer adoption of energy efficiency (EE) and DR measures and response to energy-use feedback
- Develop methods for characterizing changes in household end use of electricity in a timely and cost-effective way
- Strategic technology briefs, industry briefs, workshops, and other practical knowledge transfer tools for members

### Estimated 2010 Program Funding

\$4.0M

### Program Manager

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## Summary of Projects

### PS170A Analytical Frameworks (65578)

#### Project Set Description

This project set develops and advances analytical frameworks, tools, and methodologies to assign value to the impact of energy efficiency and demand response technologies and programs. Participants will be well-positioned to quantify the full benefits of their energy efficiency and demand response portfolios and justify associated investments in regulatory filings through frameworks for valuing energy efficiency and demand response, ascribing CO<sub>2</sub> emissions reductions to energy efficiency, gauging the persistence of customer response to direct energy feedback, as well as the characterization of electronic "plug loads."

Project Number	Project Title	Description
P170.002	Accounting for the Impact of Energy Efficiency on CO <sub>2</sub> Emissions	Refinement of EPRI NESSIE model as a potential industry-standard approach to converting energy efficiency savings to carbon emissions reductions.
P170.003	Persistence of Customer Response to Energy Usage Feedback	This project strives to resolve gaps in household energy consumption behavior that have frustrated the design of effective feedback and pricing mechanisms and forestall the adoption of communication and control technologies.
P170.004	Framework for Valuing Price and Demand Response	EPRI will develop a comprehensive framework for valuing demand and price response plans that applies equally well to a single pricing or demand response plan, and also to an entire portfolio of such offerings.
P170.005	Residential Plug-Load Measurement	Perform household plug-load measurements within funding utility territories using a sampling plan and measurement protocol developed in 2009.

### P170.002 Accounting for the Impact of Energy Efficiency on CO<sub>2</sub> Emissions (069236)

#### Key Research Question

Little consensus exists among experts and policymakers on how to quantify the carbon dioxide (CO<sub>2</sub>) emission reduction value of energy efficiency measures. The lack of a standardized and accepted methodology for this conversion inhibits broader acceptance of end-use energy efficiency projects from consideration in carbon trading markets. Since 2007, the Electric Power Research Institute (EPRI) has been examining this issue, establishing in 2008 a proof-of-concept approach to calculating the marginal emissions reduction impact of selected major commercial end uses. In 2009, EPRI expanded the model to include major residential and industrial end uses and, with advisory input from utilities and peer review of other industry stakeholders, further refined this methodology to account for the impact of energy efficiency on capacity expansion. In 2010, this project will further refine this model into a generally accepted methodology among utilities and policymakers to establish carbon emission reduction figures for end-use energy efficiency that will meet the requirements of prevalent carbon offset and trading markets. Further, this project will deliver a web-accessible version of the National Electric System Simulation Integrated Evaluator (NESSIE) tool for utilities to perform customized analyses for their region.

#### Approach

This project entails the continued development and application of a modeling approach to help utilities and policymakers assess the impact of energy-efficient technologies on CO<sub>2</sub> emissions reductions. This project will leverage previous EPRI modeling work in 2008 and 2009 that applied EPRI's National Electric System

Simulation Integrated Evaluator (NESSIE) load dispatch and capacity expansion model to model marginal CO<sub>2</sub> emission reduction by end use. The product will be a technical report and set of data tables that ascribe marginal CO<sub>2</sub> impacts for specific categories of energy efficiency as a function of U.S. region and market penetration, taking into account end-use load shapes and generation mix as a function of time.

### Impact

This project provides utilities with an analytical basis to convert electricity savings from energy efficiency programs by end use into reductions in carbon emissions with a level of rigor suitable for consideration in broader carbon trading or offset markets.

- Enables quantification of the emission reduction impact of energy-efficient technologies
- Provides members with a framework to work effectively with customers, regulators, and policymakers to establish a societal business case for new technologies, enabling greater adoption of energy-efficient technologies
- Provides a bounded set of values for marginal CO<sub>2</sub> impact that balances the need for analytical rigor consistent with prevailing emissions offset and trading markets with the practicality of utility implementation
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### How to Apply Results

The project's resulting data tables will provide marginal CO<sub>2</sub> emission impacts of a variety of major end uses as a function of U.S. North American Electric Reliability Council (NERC) region and assumptions of the market penetration levels of end-use efficient technologies. These data can be applied by utility energy efficiency professionals as well as regulators, policymakers, and other interested stakeholders to more precisely link energy efficiency efforts to carbon offsets. In this way, energy efficiency projects can achieve greater acceptance as a carbon offset strategy that meets the criteria of rigor imposed by prevalent carbon offset and trading markets while maintaining a level of practicality for utility implementation.

### 2010 Products

Product Title & Description	Planned Completion Date	Product Type
<p><b>Accounting for the Impact of Energy Efficiency on Marginal CO<sub>2</sub> Emissions: Volume 3:</b> This technical report will review the evolved methodology of the Electric Power Research Institute (EPRI) National Electric System Simulation Integrated Evaluator (NESSIE)-based modeling approach, including the input of utility advisors and peer review of industry stakeholders. The report also will feature a set of data tables indicating marginal CO<sub>2</sub> emissions reductions of energy efficiency activities as a function of end-use category and region.</p>	12/31/10	Technical Report
<p><b>Online Conversion Tool for Converting Energy Efficiency Savings to Carbon Emissions Reductions: Alpha Version:</b> Alpha version of an online conversion tool based on the Electric Power Research Institute (EPRI) National Electric System Simulation Integrated Evaluator (NESSIE model), which EPRI members can apply to convert energy efficiency savings to carbon emissions reductions.</p>	12/31/10	Software

## Future Year Products

Product Title & Description	Planned Completion Date	Product Type
<b>Online Conversion Tool for Converting Energy Efficiency Savings to Carbon Emissions Reductions, Beta Version:</b> Beta version of an online conversion tool based on the Electric Power Research Institute (EPRI) National Electric System Simulation Integrated Evaluator (NESSIE) model, which EPRI members can apply to convert energy efficiency savings to carbon emissions reductions.	12/31/11	Software

## P170.003 Persistence of Customer Response to Energy Usage Feedback (065582)

### Key Research Question

Information is a critical element in increasing the efficiency of energy utilization. Consumers can be provided information, or feedback, in a variety of ways using mechanisms that range from bill inserts that compare the consumer's electricity usage over time to ones that use benchmarks to help consumers compare their efficiency efforts with those of similar circumstances to the provision of information closely following the time of consumption. Additionally, new control and communication technology allow consumers to achieve desired behaviors by devising scripts that control technologies. All of these feedback mechanisms are behavior modification tools whose success depends on how well diverse consumer preferences and needs can be defined, categorized, and characterized. The Electric Power Research Institute (EPRI) is embarking on a three-year initiative to fill the gaps in the understanding of how feedback influences behavior and utilize that knowledge to design and evaluate effective feedback mechanisms.

### Approach

This multiyear effort will provide analytic and coordination services to utilities and other organizations field testing the effect that feedback has on consumer energy consumption and load profiles. Services will include test design, analytic tools, and a collective database. The primary objective is to utilize and coordinate individual utility test results, ensure consistent test methods, and provide analytic frameworks that enable development of a robust database of comparable test result data. In addition to a collective database, a simple analytic tool to support individual utility business analyses will be provided.

This initiative will provide data to help determine the following:

- The costs and benefits attributable to the full range of feedback mechanisms
- How to integrate measurement and verification (M&V) protocols into program design to ensure success
- How various feedback technologies, features, and information influence customer energy consumption and peak power demand
- How price and other influences augment or are redundant to feedback effects
- How the use of direct energy feedback devices in conjunction with residential control systems influences customer behavior
- How these devices can be used for other purposes, such as assessing the most cost-effective efficiency measures for residential applications
- How feedback impacts may vary across different demographic segments
- The persistence of feedback effects

### Impact

This project may have the following impacts:

- Reduces costs of residential efficiency program and dynamic energy management system design
- Ensures a no-regrets technology investment strategy

- Assists in implementing effective residential efficiency and demand response (DR) programs that reduce energy consumption and carbon emissions
- Informs technology manufactures about what features impart the greatest value
- Assists Smart System designers in determining what information needs to flow to whom and when

### How to Apply Results

Utility staff involved in the planning and design of energy efficiency programs, DR programs, and advanced metering infrastructure (AMI) systems can apply the project findings and products to better understand customer behavior and reactions to displayed information on energy usage and energy cost. Such data will help members make investment decisions and plan, design, develop, and market more effective energy efficiency and DR programs.

### 2010 Products

Product Title & Description	Planned Completion Date	Product Type
<b>Residential Direct Energy Feedback Devices, Field Test Results:</b> The product will describe the analyses conducted with feedback pilots that have been designed and how they have contributed to resolving the key research gaps.	12/31/10	Technical Resource

## P170.004 Framework for Valuing Price and Demand Response (065574)

### Key Research Question

Utilities are increasingly employing price response and demand response as a virtual resource to meet system objectives, such as peak load capacity and operating reserve requirements. In addition, they are counting on such pricing plans to achieve more efficient resource utilization, especially to cope with the proliferation of disruptive technologies in households and commercial facilities. However, they lack a generally accepted methodology for valuing such plans that properly captures the full economic and societal benefits and costs. Today, there is no standard framework for valuing demand and price response program, as evidenced by the substantial inconsistencies among the methodologies employed in utility filings around the country. This shortcoming is especially troublesome to utilities that are evaluating AMI investments that could enable demand response, but whose benefits are not generally accepted.

### Approach

EPRI will develop a comprehensive framework for valuing demand and price response plans that applies equally well to a single pricing or demand response plan, and also to an entire portfolio of such offerings. Moreover, it will be designed to reflect markets characterized by vertically integrated utilities as well as markets that have adopted customer choice. This consistent, transparent valuation methodology will capture the benefits and costs of a variety of program types, including real-time pricing (RTP), critical peak pricing (CPP), time of use (TOU) rates, interruptible/curtailable rates, direct load control (DLC), demand bidding, and demand subscription services; in other words, almost any conceivable pricing plan, including traditional flat and inclining block rates. A technical report will provide a detailed characterization of a framework for valuing price and demand response plans, including: avoided generation costs, avoided transmission and distribution costs, market risk impacts, bill savings for participating customer and ratepayers at large, portfolio hedge value, reliability impact, and overall social welfare. The report will propose a methodology that meets all the criteria and provides practical and actionable results.

## Impact

- A robust and universally applicable industry standard valuation methodology for demand and price response plans will facilitate internally consistent analyses under different markets and customer circumstances
- It will facilitate more consistent and expedited regulatory treatment of utility filings involving price and demand response
- It will overcome shortcomings in current integrated resource planning and enterprise financial and accounting analyses
- It will provide a mechanism for consistent reporting plan and program performance that will direct program development and refinement and portfolio optimization

## How to Apply Results

Utility resource planners and energy efficiency and pricing specialists will use the framework to conduct comprehensive, market-directed, and customer-specific studies to quantify the level and distribution of benefits attributable to current and prospective plans and portfolios. Program analyses conducted using this framework will deliver a comprehensive characterization of who benefits and by how much, which is essential both for the design of practical and sustainable programs, and will facilitate expedited regulatory review and approval and advance the realization of benefits.

## 2010 Products

Product Title & Description	Planned Completion Date	Product Type
<p><b>Methods and Practices for Valuing Price and Demand Response:</b> Applying the valuation protocols developed by members in 2009 will create future opportunities for EPRI to support utility analyses, summarize and compare the results of these initiatives, and use the results to refine and advance the framework and develop an application guide that includes instructive case studies.</p>	12/31/10	Technical Report

## P170.005 Residential Plug-Load Measurement (067472)

### Key Research Question

Energy Information Administration (EIA) household consumption forecasts indicate that manageable plug loads, like electronic equipment and other convenience devices, are growing in importance. However, utilities are still relying on household load profile data collected several years ago, plus even older and sparser end-use data. As a result, there is a growing and troublesome disparity between how utilities plan to serve household electricity loads, which involves large—and in many cases indivisible—investments in generation, transmission, and distribution plants and the loads they actually will serve. The consequences are that already overworked peaking equipment will be even further stressed and investments to bridge the gap will be required, in many cases resulting in redundancy that raises prices.

Energy efficiency (EE) and demand response (DR) programs are heralded as solutions to many of these problems because they provide flexibility in the load to be served. But if the character of the loads being served is itself erroneous, then even these initiatives will not be fully effective. The advent of advanced metering infrastructure (AMI) universal technology will correct this problem, but it won't be in place for several years, leaving utilities blind to trends in usage that must be responded to immediately. Fielding load studies at this time seems excessive, since they are exorbitantly expensive. But, lacking an alternative, utilities may be forced to undertake another wave of load research to bridge the knowledge and technology gap.

## Approach

The Electric Power Research Institute (EPRI) will conduct a program to measure plug loads based on results of research done in 2009 to develop protocols and identify technologies and processes that can be used to acquire up-to-date information about household electric devices holding and usage profiles. The 2010 initiative will involve three functional and interrelated efforts:

- Measure plug loads within test sites at member utility territories based on the sampling and measurement protocols developed in the 2009 phase of this project. Measurement technologies that are identified in 2009 will be used to conduct the measurements in 2010. The sampling plan will provide for pooling all the data collected and developed from individual sampling initiatives to improve the overall precision of the estimates and characterize how differences among households, climate, and other circumstances influences device holding and usage.
- Synthesize and interpret data from field measurements.
- Refine the sampling and analysis plan based on 2010 measurement experiences so that it can be used for ongoing household plug-load measurement studies.

## Impact

- Provides a way to fill a critical gap in the understanding of changes in household electricity consumption that supports actionable results cost-effectively
- Supplants the need to conduct costly end-use studies
- Creates protocols and practices that can be ported over an AMI environment once it has been fully implemented
- Provides needed data to support EE and DR program design and implementation initiatives

## How to Apply Results

Improved data on household electricity consumption will be valuable to every aspect of utility enterprise business activities, from system planning to pricing planning and EE program design to system operations and financial and accounting activities. Moreover, the results will be valuable for public policy inquiries aimed at improving sector performance and achieving economic and environmental policy objectives optimally. Finally, EPRI itself will be a beneficiary of better usage data that support research agenda development and analysis.

## 2010 Products

Product Title & Description	Planned Completion Date	Product Type
<b>Revised Sampling and Analysis Plan for Household Plug-Load Measurement Survey:</b> The Electric Power Research Institute (EPRI) will continue to develop protocols based on the experience gained as surveys are implemented.	12/31/10	Technical Report
<b>Survey Data Synthesis and Interpretation:</b> The Electric Power Research Institute (EPRI) will collect data from utility surveys, incorporate the result into a master database, and provide updated information about household electricity usage.	12/31/10	Technical Report

## PS170B Demand Response Systems (65571)

### Project Set Description

The projects in this set assess, test, and demonstrate the application of technological advances in integrated energy management control systems, linking smart thermostats, lighting controls, and other load control technology with smart end-use devices to enable more sophisticated and effective demand response, such as dynamic energy management, in homes and buildings. The project set also examines technological advances in thermal storage and its integration into demand response systems for load shaping and peak load management. Finally, it provides participants with a unique opportunity to work collaboratively with other utilities, government agencies, and manufacturers to define the requirements of end-use devices that are designed to participate in demand response programs “out of the box,” which carries the potential for dramatic operational and cost benefits to members.

Project Number	Project Title	Description
P170.006	Enabling DR-Ready Appliances	This project continues the activities started in 2009 to develop use cases for DR-ready functionality for selected end-use devices. An EPRI-facilitated workshop will bring together diverse stakeholders—including DOE, EPA, utilities, equipment manufacturers, policy makers, and regulators—to define the attributes that will define DR-ready for the most applicable categories of end-use appliances. A report will document the developments of this workshop and other supporting activities conducted during the year.
P170.007	Advances in Thermal Energy Storage Technology	This project assesses and demonstrates the state-of-the-art in TES technologies.
P170.018	Intelligent Homes and Buildings	This is a third-party examination of lighting control systems identifying realistic performance, market potential, energy impact, and improved quality of light combined with the use of intelligent lighting control. The project also integrates demand response gateways into existing building energy management systems that have interoperable and open standards communication technologies.

### P170.006 Enabling DR-Ready Appliances (067473)

#### Key Research Question

Despite its well-documented and demonstrated benefits to society, utilities, and consumers, demand response (DR) remains a critically underutilized resource in the United States. One of the key barriers to greater participation is the cost to utilities of installing equipment in buildings and homes to enable load control and demand responsiveness, such as programmable communicating thermostats and sensors on air conditioners, appliances, water heaters, pool pumps, lighting, and other large end uses that contribute to peak demand. Experience also suggests that customer reluctance to have unknown controls installed in their homes or businesses represents another barrier to more widespread participation in utility DR programs. However, these barriers would be overcome if major energy consuming appliances came ready to participate in DR programs out-of-the-box (“DR-ready”).

#### Approach

The focus of this project is to continue the effort commenced in 2009 to specify functional requirements for selected categories of end-use devices and building energy management systems to be deemed “DR-ready” and to develop a roadmap for industry migration towards ubiquitous demand response. DR-ready is the

capability of end-use devices to receive signals from a utility, such as price information or other instructions, and respond automatically by modulating operation to reduce or shift demand.

The project builds on Electric Power Research Institute (EPRI) collaboration with the U.S. Environmental Protection Agency (EPA) and Department of Energy (DOE) in 2008 and 2009 to identify opportunities to make DR-ready a labeled attribute—possibly under the ENERGY STAR® brand—for selected categories of end-use devices going forward. This project will seek to establish consensus for DR-ready functional requirements for selected end-use devices, principally residential air conditioners, programmable communicating thermostats, water heaters, clothes washers, dishwashers, and pool pumps. This effort will take into account continuing developments in communications protocols and common information models that may provide standardized syntax for price signals and other utility-to-device communications. Building on DR-ready progress in 2009, this project will include lab testing and field demonstration of emerging DR-ready equipment to gauge functionality, reliability, and responsiveness to utility signals. EPRI will be open to assess both physical layer connection architectures as well as integrated circuit-based communication architectures based on emerging application layer protocols.

### Impact

- Have first-hand influence in shaping the utility industry's functional requirements for DR-ready end-use technologies to ensure alignment with members' current and future DR objectives
- Work through utility collaborative to influence EPA and DOE ENERGY STAR® standards to include DR-ready functionality
- Work through utility collaborative to influence equipment manufacturers to develop DR-ready equipment
- Improve the cost-effectiveness of future DR programs by avoiding the expense of installing on-site equipment for participating customers through DR-ready end-use devices
- Increase DR capability and expand the potential market of DR program participants through the market entry of DR-ready end-use devices

### How to Apply Results

Members will have first-hand access to influence the utility industry's functional requirements defining what constitutes a "DR-ready" end-use device. Utility staff involved in the planning and design of DR programs and advanced metering infrastructure (AMI)/Smart Grid systems can apply the project findings and deliverables to match DR program requirements to desired end-use equipment attributes that would allow for "out-of-the-box" program compatibility. Equipment manufacturers will apply the functionality guidelines established through this project to develop prototype DR-ready technologies, which can, in turn, be tested in EPRI's Living Laboratory and could be deployed in field trials in members' service territories in conjunction with their DR programs. The eventual advent of DR-ready devices into the marketplace can expand members' DR potential, increase dispatchability and reliability, and lower program operating costs.

### 2010 Products

Product Title & Description	Planned Completion Date	Product Type
<b>Enabling DR-Ready Appliances: Volume 2:</b> Continuation of 2009 project to assess, test, and demonstrate the capability of early-development demand response (DR)-ready devices.	12/31/10	Technical Report

## P170.007 Advances in Thermal Energy Storage Technology (067474)

### Key Research Question

Thermal Energy Storage (TES), an established technology for shifting cooling and heating demand from on-peak to off-peak periods, is an often-overlooked means of responding to peak demand crises. It also is an option that can efficiently enhance the productivity of cooling, heating, and refrigeration systems. Many

experts agree that TES technology is poised to become a more important part of heating, ventilating, and air conditioning (HVAC) markets. However, TES remains an underutilized technology, in spite of the fact that cool storage is an appropriate technology in approximately 60–80% of new commercial installations. With the rising importance of demand response (DR) and peak load reduction, adoption of TES technologies is expected to accelerate in the next few years.

### Approach

This technology is used to shift load from peak periods to on-peak periods. Since most U.S. utilities are summer peaking, cool storage has been of most interest to utilities and will be the main subject of this project. In cool storage, a vapor compression system cools a storage medium during off-peak hours. During peak periods, a heat transfer fluid or the storage medium itself is pumped through the delivery system, discharging the storage medium while avoiding compressor operation. Many different approaches have been taken to develop a cool storage system with the most attractive combination of cost, performance, and size, including water storage, ice storage and eutectics.

This project is a continuation of 2008 and 2009 activities. TES technology will be examined with the goals of identifying the features of available units, testing the most promising systems, publicizing the results, and acting on any improvement opportunities that are uncovered in the evaluation. Also included in the 2010 activities is an update to the Electric Power Research Institute (EPRI) software tool *COOLAID*, which computes cost-benefit evaluation of cool storage for utilities and customers.

### Impact

- Benefit from unbiased technical assessments of new TES technologies with the potential to reduce demand and shift substantial load to off-peak hours
- Assess state-of-the-art TES technologies for DR applications
- Increase understanding of how TES technologies function in actual applications
- Establish capability to transfer new TES technologies to utility customers, building operators, and commercial customers
- Enhance customer confidence by demonstrating a member's value as an energy management partner

### How to Apply Results

Project findings and products will be employed by utility account representatives, marketing staff, and energy efficiency specialists as they work closely with customers in key residential, commercial, and industrial market segments and transfer new technology that can help utilities shift/lower peak demand. Members also can help customers improve energy efficiency, reduce pollution, enhance indoor air quality, and improve productivity.

### 2010 Products

Product Title & Description	Planned Completion Date	Product Type
<b>Demonstrations of state-of-the-art TES technologies in the Living Lab and member utility service territories:</b> Continuation of field demonstrations of the state-of-the-art thermal energy storage (TES) technologies that will lead to large-scale deployment by members.	12/31/10	Technical Update
<b>Update to the EPRI COOLAID Tool:</b> Beta version of a web-based tool, which is an update to the Electric Power Research Institute (EPRI) COOLAID tool that was developed in the 1990s.	12/31/10	Software

## P170.018 Intelligent Homes and Buildings (069237)

### Key Research Question

An intelligent building can be defined as one that has the capacity to provide a safe and comfortable environment for its occupants, improve operational efficiencies for its owners, while at the same time respond to grid conditions to help utilities manage demand. Moreover, the level of intelligence can be determined by the capability of the building to deliver the maximum benefit to all three user groups: occupants, owners, and utilities. There are two main enabling components of intelligent homes and buildings:

- Building control systems
- Lighting control systems

Due to the inherent flexibility of building and lighting control systems, efforts must be made to evaluate their performance using basic customer requirements and, in turn, the results could be used to improve their performance. Such research may foster their widespread use in residential, commercial, and industrial buildings, helping to meet the needs of future energy requirements. Control systems used in intelligent buildings should support configurable control strategies whereby users are able to program or select subroutines to optimal performance levels based on a variety of parameters, such as external ambient conditions, time of year, consumer habits and preferences. These systems also need to be able to execute subroutines automatically upon the receipt of external signals including Real-time Pricing (RTP), time-of-use (TOU), and reliability-driven demand response events.

### Approach

This project consists of two subsets:

**Building Control Systems:** This activity is a continuation of 2007, 2008, and 2009 projects that build upon the technical assessment and demonstration of building automation and control systems for demand response applications. The 2010 activity will integrate demand response gateways into building energy management and control systems. The activity will pursue open standards and interoperable communication technologies.

**Lighting Control Systems:** The identification of lighting control systems is carried out by conducting extensive product searches, attending lighting control fairs and conferences, demand response expos, and engaging with existing and new manufacturers of lighting controls. New technologies will be procured for testing and evaluation in the Electric Power Research Institute's (EPRI's) Living Laboratory in Knoxville. Lighting control research engineers also will be engaged to understand the direction of standards efforts and the requirements to support emerging lighting control technologies.

### Impact

Comprehensive evaluations of building and lighting control systems can be used by energy, lighting, and control engineers to aid in the decision process before lighting control technologies are considered for listing for energy efficiency and rebate/incentive programs. Additional value can be realized through

- providing opportunities for utilities to demonstrate leadership in environmental stewardship through deployment of vetted lighting control systems,
- understanding the impact of allowing lighting control systems to manage lighting loads in facility power systems,
- providing opportunities for utilities to integrate pricing gateways into smart building management systems,
- gaining knowledge regarding the use of more intelligent yet easy-to-operate building management and lighting controls,
- understanding which technologies are more favorable for use with future demand response systems, and
- helping ensure realistic performance that can be matched with product warranty expectations.

## How to Apply Results

Project findings and products will be employed by utility account representatives, marketing staff, and energy efficiency and demand response specialists as they work closely with their customers in key residential and commercial market segments to transfer new technologies and implement dynamic pricing models that can help customers by reducing peak demand, energy costs, and directly address their comfort and business needs. Comparison of electrical, efficiency, and photometric performance among traditional non-controlled light sources and lighting systems and those that are controlled in various commercial environments will allow members to determine expected energy reduction for system planning purposes. Project results will allow members to determine future energy and power quality requirements for supporting these technologies and the benefits of using lighting control systems combined with line-based building control and demand response systems. Project data will provide a foundation for members to compare field data from future installations with project and demonstration data.

## 2010 Products

Product Title & Description	Planned Completion Date	Product Type
<b>Integration of demand response gateways into building energy management and control systems:</b> Comparison between demand response gateways and energy management and control system (EMCS) capabilities to identify commonalities that may result in the integration of the gateways into the EMCS.	12/31/10	Technical Update
<b>Assessment of modern lighting control systems:</b> Examination of lighting control systems identifying realistic performance, market potential, energy and demand impact, and improved quality of light associated with the use of intelligent lighting control.	12/31/10	Technical Update

## PS170C Energy Efficient Technologies (067430)

### Project Set Description

This project set assesses, tests, and demonstrates the application of advanced energy-efficient technologies in major and rapidly expanding end uses across the residential, commercial, and industrial sectors. Participation in this project set provides first-hand performance data on novel efficient technologies and can facilitate field demonstrations in members' own service territories and eventual programs to increase energy efficiency to meet regulatory energy efficiency goals. Activities will test the performance of, and examine opportunities to remove adoption barriers for, novel heat pump technologies for space conditioning and water heating, advanced lighting technologies, and "hyper-efficient" residential appliances and office equipment that together represent significant energy savings potential. The project set addresses the industrial sector through the extension of an energy management tool into new industrial market segments as well as the assessment of advanced motors and motor-drive technology. Finally, it addresses opportunities for energy efficiency in areas of energy growth, such as data centers and power supplies for consumer electronics.

Project Number	Project Title	Description
P170.013	HVAC Technologies	Unbiased technical assessment and laboratory and field demonstrations of new energy-efficient space conditioning technologies with the potential to substantially increase HVAC efficiency.
P170.019	Industrial Energy Efficiency	The industrial energy efficiency project will develop case studies and application documents in four specific areas of opportunity that include motors and drives, process heating, industrial waste heat recovery and combined heat and power, and air and water treatment.

Project Number	Project Title	Description
P170.020	High Performance Homes and Buildings	Unbiased technical assessment, laboratory and field demonstrations, and collaboration with federal and state agencies to improve energy efficiency in buildings, improve productivity and comfort of occupants, and decrease energy intensity of data centers. This research also will provide third-party evaluations of building energy management systems and engage vendors, end users, and standards bodies in the development of useful metrics.
P170.021	Electronics, Plug Loads and Lighting Efficiency	<b>Electronics and Plug Loads</b> This research is part of an ongoing effort to engage vendors, utility programs, and standards bodies to push the efficiency limits of electronics products to ever higher levels, saving billions of kWh per year in the process. <b>Advanced Lighting Technologies</b> This research is a third-party examination of new advanced lighting technologies identifying realistic performance, market potential, energy impact, and improved quality of light.

## P170.013 HVAC Technologies (067479)

### Key Research Question

Heat pumps with high coefficient of performance or high seasonal energy efficiency ratings (SEER) are efficient technologies that can significantly reduce energy use in heating, ventilation, and air conditioning (HVAC) applications for residential and commercial customers, also reducing costs and greenhouse gas emissions such as carbon dioxide. Breakthrough commercial adoption of advanced air-source heat pumps (ASHPs), such as the use of advanced inverter drives, hinges on continued functional and cost improvements. Improved performance at very high and very low outdoor temperatures are priorities for many applications, especially in hot/dry, hot/humid, and sub-zero conditions. Variable refrigerant flow systems and new evaporative cooling technologies are examples of advancing U.S. heat pump performance. Advanced compressor technology, such as systems with integrated inverter drives and magnetic bearings, also increases heat pump efficiency. Geothermal, or ground-source, heat pumps (GeoHPs) could increase space-conditioning efficiency by almost 40%, thereby providing substantial benefits for members and their customers. Lower equipment installation and maintenance costs are keys to advancing the implementation of high-efficiency heat pump technology in the United States. New components and systems are being developed in the United States and overseas, but there is lack of independent testing, demonstration, and evaluation of heat pumps that use advanced motors, inverter drives, new refrigerants, advanced control schemes, installation techniques, and other advancements. Research questions, such as reliability, performance, durability, and system efficiency, especially in harsh outdoor weather conditions, need to be answered.

The widespread adoption of efficient dehumidification technologies, where latent and sensible cooling efficiencies are optimized, can reduce energy use while simultaneously improving indoor air quality and the comfort of building occupants. Similar to ASHPs, objective assessment, testing, and demonstration of new and efficient dehumidification systems (for example, electric, desiccant, and hybrid) are critical to establishing the most cost-effective performance.

### Approach

The project will consist of four subsets:

**Variable-Speed Air-Source Heat Pumps (ASHPs):** This project will evaluate the performance of best available and in-development equipment and demonstrate their performance at the Living Lab and other selected sites, particularly for hot, humid, and low-temperature conditions. Project activity also will explore demonstrations of new and efficient compressor technology, especially using inverter drives. Finally, the

project will demonstrate retrofit opportunities to increase seasonal energy efficiency ratios (SEER) in existing products.

**Ground Source Heat Pumps (GSHPs):** This project will build on the 2008-09 project exploring currently available GSHPs and installation techniques that will determine their product characteristics and ownership costs. This project also demonstrates the concept that changes the entire GSHP investment outlook; this will include advanced technology demonstration, utility installation, maintenance, and ownership of the geothermal piping network.

**Evaporative Coolers:** This may be a good alternative technology to ASHPs and GSHPs in hot/dry climatic environments. The project will explore cost-effective energy efficiency opportunities. Minimization of environmental impact with optimum water use also will be explored. Advanced Dehumidification Systems: This project builds on assessments and tests of commercially available dehumidification systems to optimize outside air and energy use in selected building applications that were performed. Based on the 2009 demonstrations, advanced dehumidification systems will be selected for further lab testing and field demonstrations in 2010.

## Impact

The project delivers unbiased technical assessment and laboratory and field demonstrations of new energy-efficient space conditioning technologies with the potential to substantially increase HVAC efficiency. The project achieves the following:

- Increases understanding of how the technologies function in actual applications
- Establishes the capability to widely transfer the technology to vendors, developers, and customers
- Helps reduce greenhouse gas emissions and contributes to the deferment of power plant additions through energy-efficient space conditioning
- Improves economic development by reducing customer facility energy costs
- Enhances facility productivity by optimizing indoor humidity and improving air quality

## How to Apply Results

Project findings and products will be employed by utility account representatives, marketing staff, and energy efficiency specialists as they work closely with their customers in key residential, commercial, and industrial market segments and transfer new technology that can help customers reduce costs and improve energy efficiency, reduce pollution, enhance indoor air quality, lower peak demand, and improve productivity.

## 2010 Products

Product Title & Description	Planned Completion Date	Product Type
<b>Testing and demonstration of advanced air source heat pump components and systems at the Living Laboratory or a field site facility:</b> Testing, demonstration, and workshop of advanced heating, ventilation, and air conditioning technologies that are energy efficient and cost-effective for residential and commercial customers of member utilities.	12/31/10	Technical Update
<b>Demonstration and assessment of advanced ground-source heat pumps at the Living Laboratory or a field site facility:</b> Demonstration of the most cost-effective solution for energy use in commercial facilities using advanced ground-source heat pump technology. The project will develop economic options for selected field demonstration sites and evaluate the field performance of the system, especially related to ownership of the geothermal piping network.	12/31/10	Technical Update

Product Title & Description	Planned Completion Date	Product Type
<b>Assessment and testing of advanced evaporative coolers:</b> Assessment of the state of the art in evaporative cooler technology; testing of new coolers at the Electric Power Research Institute (EPRI) Living Lab	12/31/10	Technical Update
<b>Workshop on advanced dehumidification and indoor air quality systems:</b> Workshop for member utilities focused on advanced dehumidification technologies and opportunities for improving indoor air quality while enhancing energy efficiency at the same time.	10/31/10	Workshop, Training, or Conference

## P170.019 Industrial Energy Efficiency (069238)

### Key Research Question

As global competition intensifies, industrial customers are looking for ways to cut energy costs, improve efficiency, improve productivity and yield, and address increasingly stringent environmental regulations. Utilities, by providing the knowledge, tools, and support that industrial customers need to optimize their energy expenditures, can create "win-win" opportunities -- enhancing customer relationships, retaining market share, creating business opportunities, and developing new markets for energy efficiency.

Advanced, efficient electric technologies for industrial applications bring about unique opportunities for utilities to help improve overall energy efficiency of customer processes and reduce their operating costs. In fact, recent Electric Power Research Institute (EPRI) research indicates that efficiency improvements in small industrial motors (1-5 hp) could save as much as 40 billion kWh by 2030. Similarly, just the top eight efficient industrial power supply technologies represent savings of 88 million tons of carbon dioxide and 27.4 billion dollars in annual consumer electricity costs. The industrial opportunities for energy efficiency and emissions reduction are even more significant with the substantial improvement in reliability and efficiency of power electronic component technology and the better understanding of areas such as advanced process heating, waste heat recovery, water utilization, and the efficient application of combined heat and power.

New technologies and processes in these areas are being developed in the United States and overseas, but there is lack of independent testing, demonstration, and evaluation of advanced motors, power electronics, new electric/hybrid heaters, process control schemes, advanced waste treatment techniques, and other advanced technologies. Research questions, such as overall process efficiency improvements, cost effectiveness, technology performance and reliability, and overall effect on the carbon footprint, need to be answered.

### Approach

The industrial energy efficiency project will consist of four specific areas of opportunity. They include motors and drives, process heating, waste heat recovery (including combined heat and power analysis), and effluent and emissions treatment. The major focus will be on CO<sub>2</sub> reduction in industrial plants, based on applications of these new technologies.

- **Motors and Drives:** The work will assess state-of-the-art technologies and applications and will provide insights into replacing second-generation drives where an estimated five to ten percent savings can be achieved with simple retrofits.
- **Electric Process Heating:** EPRI will prepare a set of technical updates and case studies describing existing and emerging heating technology, physical principles, rules for application, required shielding, and safety-related issues. The technical work will analyze and rank energy efficiency of specific electric heating technologies.
- **Waste Heat Recovery:** EPRI will quantify proven and new process waste heat recovery technologies and explore the cost/benefit analysis of combined heat and power (CHP) systems. CHP applications for industrial facilities will provide guidelines on a basic CHP evaluation methodology. With the guidelines,

the process can be quantified in terms of basic suitability for CHP, and a subsequent assessment of the full economic and environmental benefits can be undertaken. The work will evaluate new and emerging waste heat recovery (and CHP) opportunities, identify industrial customer segments where the greatest opportunities exist, and develop economic assessment criteria.

- Effluent and Emissions Treatment: Under this effort, the work will quantify the energy-related cost to transport water to an industrial facility from treatment at the water supply plant to treatment at the sewage facility. The work will then investigate unique applications for effective utilization of water resources in industrial facilities and provide insights into the most significant opportunities to more efficiently use a water resource. Particular focus is on re-use of chilled or heated water. In addition, the work also will focus on reduction of air emissions by the use of advanced electric technologies.

## Impact

The industrial energy efficiency work will result in direct and measurable energy and cost savings opportunities for electric customers in each of the four research areas, including potential reductions in CO<sub>2</sub> emissions. The energy and CO<sub>2</sub> reduction impact will include the following:

- New and retrofit drive applications
- New applications for advanced heating technologies
- Additional opportunities for waste heat recovery and CHP applications
- Unique water conservation, emission reduction, and energy savings opportunities

## How to Apply Results

This research will provide application support to utility energy efficiency groups and specialists. The primary application will be the technical application documents and case studies developed under this work.

## 2010 Products

Product Title & Description	Planned Completion Date	Product Type
<p><b>Advanced Motors and Drives for Industrial Applications:</b> Adjustable speed drives (ASDs) are an integral part of today's electric motor world for industrial applications. Adoption of new technologies has the potential to reduce up to 40% in energy usage. The prominent strengths of the ASDs are superior performance, precision control, and elevated efficiency. This work will evaluate advanced technologies that offer several advantages that will result in improved efficiencies for both drive retrofits and other motor replacements. The work will continue to assess state-of-the-art technologies and applications and will provide insights into the second-generation drive replacement opportunities where a 5 to 10 percent savings can be achieved with a simple retrofit.</p>	12/31/10	Technical Update
<p><b>New Heating Applications for Industrial Processes:</b> The Electric Power Research Institute (EPRI) in cooperation with utility industrial customer Technology Centers will prepare a set of technical updates describing different heating technologies (for example, induction, infra-red, and resistance). The updates will contain physical principles, rules for applications (for example, some of them are preferred for specific industrial processes, such as direct resistance heating is primarily used to heat glass-and metal-melts, and electrical heating elements), required shielding, and other operations, as well as safety-related issues. The final technical report will analyze the energy efficiency of each heating technology from a heat recovery point of view (heating technologies will be ranked by the effectiveness and ease of recovering wasted heat from the process and forms of re-using it). Industry-based examples (case studies) will be described.</p>	12/31/10	Technical Update

Product Title & Description	Planned Completion Date	Product Type
<p><b>Waste Heat Recovery and CHP Applications for Industrial Facilities:</b>            Opportunities to recover and reuse waste heat, especially by the use of heat pumps, will be explored, including the economics of combined heat and power (CHP) systems. This project quantifies and investigates proven and new waste heat recovery and CHP applications for industrial facilities and provides guideline on a basic waste heat recovery and CHP evaluation methodology. With the guidelines, the process can be quantified in terms of basic suitability for CHP and a subsequent assessment of the full economic and environmental benefits can be undertaken. The work will</p> <ul style="list-style-type: none"> <li>• evaluate new and emerging waste heat recovery opportunities in industrial facilities,</li> <li>• identify the industrial customer segment where the greatest opportunities exist, and</li> <li>• develop economic assessment criteria for CHPs.</li> </ul>	12/31/10	Technical Update
<p><b>Effluent and Emissions Treatment Technologies for Efficiency Improvement Opportunities:</b> The effective utilization of water resources in industrial and agricultural settings presents the most significant energy savings opportunities out of any market segment. Opportunities to impact the efficient utilization of this resource include water conservation, which is the minimization of the first use of water for a given process, re-use of water that has been retained and has already been cycled at least one time previously, and water reclamation or use of otherwise non-useful water sources. According to recent Electric Power Research Institute (EPRI) research, the greatest opportunity for unique savings opportunities are for industrial processes. This project quantifies the full energy-related cost to transport water to an industrial facility from first treatment at the water supply plant to final treatment at the final sewage facility. The work also investigates unique applications for effective utilization of water resources in industrial facilities and provides insights into the most significant opportunities to more efficiently use a water resource. Particular focus is on re-use of chilled or heated water. With the guidelines and recommendations developed under this work, the water utilization process can be quantified in terms of economic and environmental benefits.</p>	12/31/10	Technical Update

## P170.020 High Performance Homes and Buildings (069239)

### Key Research Question

In the United States, buildings account for approximately 40% of total energy consumption and 40% of greenhouse gas emissions. Half of this is attributable to the residential sector and the other half to the commercial sector. Dramatic improvements in the energy performance of residential and commercial buildings have the potential to reduce greenhouse gas (GHG) emissions more quickly and more cost-effectively than many other options along with helping to reduce the impact of rising energy needs.

In the commercial buildings sector, state and federal government buildings offer some of the greatest opportunities for energy efficiency improvements. Buildings used by several departments—for example, defense, education, energy, and health care—are several decades old and have been through several retrofits. Such buildings offer great opportunities for improving comfort and the use of energy. One opportunity to improve efficiency in buildings is the widespread use of heat recovery heat pumps to manage space conditioning load, while heating water at the same time.

Also, data centers' energy use is projected to grow at one of the fastest paces in the United States; it was about 61 billion kWh—nearly 1.5% of the total electricity use (in 2006) and is estimated to grow to over 120 billion kWh by 2011. The ancillary loads, such as cooling and other infrastructure, use as much or more

energy than the actual servers that the data center is designed to house. In addition, many data centers have reached the limit of their cooling system capacity, which means they can no longer add servers to the space. With such limits to their productivity, data center operators have a desperate need to address the heat load and improve their building efficiency.

## Approach

This project consists of four subsets:

**Zero net energy (ZNE) homes and buildings:** There are many initiatives around the world to reach the goal of 'energy neutral' or zero net use of energy in homes and buildings. This project will review the 'state-of-the-art' in ZNE buildings around the world, explore the use of cutting edge technologies, and provide the value proposition for utility involvement in the area of building energy management systems. Future year programs will be developed to demonstrate selected technologies in the

**Living Lab. Heat pump water heaters for commercial buildings:** This project is a continuation of the Living Lab testing and field demonstrations of heat pump water heaters (HPWHs) started in 2008. Demonstrations will continue with the integration of advanced concepts such as heat recovery HPWHs, desuperheater water heaters, and integrated space conditioning/water heating (triple-function) equipment. The features and performance (heat recovery, water temperature, noise) of the units will be tested for application in small and large commercial buildings.

**Data centers:** The project will continue to review power and cooling flows in data centers and identify and assess areas where efficiency gains can be made. Building on this research, recommendations will be made for the most effective measures for energy savings in both the cooling systems and the power chain. From these recommendations, and using the metrics developed with the industry, the EPRI will help to establish performance specifications for individual components, systems, or whole buildings. Members can then use these specifications in their energy efficiency programs.

**Energy efficiency in federal buildings:** This project will focus on partnerships with state and federal organizations and with national laboratories to demonstrate energy efficiency opportunities in federal and state facilities, thus improving the performance of such buildings. Recommendations provided by the *Energy Efficiency Guidebook* (produced under the Energy Efficiency [EE] Initiative) will be demonstrated in selected applications.

## Impact

Project results will help utilities to better understand overall energy efficiency opportunities in buildings. It also will help residential, commercial, and data center industry customers overcome their biggest problems through technical improvements and standards development. The project results will include the following:

- Establish industry metrics that allow consistent measurement and comparison of energy performance
- Enable customers to use energy (and electricity) more efficiently, thereby enhancing their comfort, productivity, and performance while reducing energy intensity and associated carbon emissions
- Reduce greenhouse emissions and contribute to the deferment of power plant additions through energy-efficient operation
- Improve economic development by reducing customer facility energy costs
- Improve economic development by reducing utility infrastructure costs
- Enhance facility performance by meeting business needs

## How to Apply Results

Project findings and products will be employed by utility account representatives, marketing staff, and energy efficiency specialists as they work closely with their customers in key residential and commercial market segments. Efforts will be aimed at transferring new technologies that can help customers to optimize energy

use, reduce energy costs, use advanced and intelligent controls for cooling, heating, and other end uses, and produce performance improvements that directly address their comfort and business needs.

## 2010 Products

Product Title & Description	Planned Completion Date	Product Type
<b>Assessment of technologies and systems leading to zero net energy residential and commercial buildings:</b> Integration of advanced devices technologies (for example, for heating ventilation and air condition [HVAC], water heating, and lighting) with the thermal envelope of buildings, leading to dramatic reduction of energy use in buildings—thereby leading to the zero net energy use concept.	12/31/10	Technical Update
<b>Assessment and demonstration of advanced heat pumps for commercial building water heating applications:</b> Assessment, testing, and demonstrations of advanced concepts such as heat recovery heat pump water heaters (HPWHs), desuperheater water heaters, and integrated space conditioning/water heating (triple-function) equipment.	12/31/10	Technical Update
<b>Development and demonstration of advanced power electronic and space conditioning systems in data centers:</b> Continuation of assessments, testing, and demonstration of advanced concepts for substantially increasing energy efficiency in data centers.	12/31/10	Technical Update
<b>Demonstration of advanced building energy management systems and technologies at a federal field site facilities:</b> Demonstration of building energy management systems with building automation systems and building commissioning systems.	12/31/10	Technical Update

## P170.021 Electronics, Plug Loads and Lighting Efficiency (069240)

### Key Research Question

#### Electronics and Plug Loads

The proliferation of consumer electronics is creating dramatic increases in load density that can be offset by efficiency improvements in power electronics, principally power supplies. Examples include gaming consoles such as XBOX 360 or Playstation 3, big-screen high-definition LCD and plasma televisions, and Blu-ray Disc™ players. The backbone of these end-use devices is the ac-to-dc power supply. The Environmental Protection Agency (EPA) estimates that 1.5 billion power supplies are used in various devices in the United States, constituting about 300 billion kWh, or approximately 11%, of national annual electricity usage. According to the Department of Energy's (DOE's) *Annual Energy Outlook 2008* report, electricity demand from 2005 to 2030 is projected to grow by 27% in the residential sector, 49% in the commercial sector, and 3% in the industrial sector. *These projections dictate that more importance must be given to energy efficiency to achieve a sustainable global growth of the digital economy with minimum environmental impact. It also should be noted that these projections are significantly lower than those of 2007 as a direct result of initiatives such as this program.*

#### Advanced Lighting Technologies

Lighting manufacturers are under pressure to develop new advanced lighting technologies to meet the efficacy requirements of the Energy Independence and Security Act of 2007, while meeting consumers' aesthetic expectations. As the use of incandescent lamps diminishes, advancements in lamp materials, power electronics, and methods of utilizing AC power are ushering in new and improved compact fluorescent lamps (CFLs), linear fluorescent lamps, high-intensity discharge (HID) lamps, and light-emitting diodes (LEDs). The Electric Power Research Institute (EPRI) will continue to assess, test, and evaluate new lighting and ballast

technologies and new circuit and lamp designs with regard to their efficacy, color and quality, and suitability for various lighting applications.

## Approach

### Electronics and Plug Loads

This is a three-year research project, with the focus in 2010 to continue to identify and promote the best-in-class efficiencies for residential and commercial power supply technologies. This project analyzes and evaluates a variety of power supply topologies and architectures used in various common end-use power supplies. Through laboratory and field testing, the best-in-class energy devices available in the market today will be identified. Design changes for efficiency improvements will be developed or suggested in conjunction with vendors. Devices that are considered for this project include, but are not limited to, video gaming consoles, gaming computers, high-definition televisions with screen sizes greater than 37 inches, Blu-ray Disc™ players, and other devices that impact the energy profile in residential and commercial sectors. This is an on-going project, which will include survey instruments to update usage profiles each year, allowing energy savings to be estimated.

### Advanced Lighting Technologies

The identification of advanced lighting technologies is carried out by conducting extensive product searches, attending lighting product fairs and conferences, and engaging with existing and new manufacturers of lighting devices. New technologies are procured for testing and evaluation in EPRI's Lighting Laboratory. Lighting research engineers also engage in standards efforts where the standards for new products are drafted. Technology evaluation also includes understanding failure mechanisms and defining the reasoning behind breaking performance barriers.

## Impact

### Electronics and Plug Loads

The efficiency of power supplies affects the energy consumption of nearly all electronic devices. With the growing proliferation of consumer and commercial electronics, efficiency improvements in power supplies will have a profound impact on overall energy consumption in the United States and the world.

- Show leadership in energy efficiency by developing paths to more efficient solutions.
- Promote the best-in-class efficiency devices to customers, thereby reducing greenhouse gas emissions.
- Reduce peak electricity demand, which contributes to the reliability of transmission and distribution networks.
- Receive possible tax credits for promoting energy efficiency.
- Use valid third-party data to help influence energy efficiency policy through such groups as the Consortium for Energy Efficiency (CEE), California Energy Commission (CEC), and Environmental Protection Agency (EPA).

### Advanced Lighting Technologies

Energy and compatibility performance evaluations of new technologies can be used by energy and lighting engineers at utilities to further aid in the decision process before new technologies are added to their approved product listing for energy efficiency and rebate/incentive programs. Those promising technologies will enable high benefit-to-cost ratios. Additional value is realized through

- understanding the impact of installing new technologies on the power system,
- gaining knowledge regarding the use of lighting technologies that are become more digital,
- understanding which technologies are more favorable for use with lighting controllers and future demand response systems, and
- helping ensure realistic performance that can be matched with product warranty expectations.

## How to Apply Results

### Electronics and Plug Loads

The technical update provides members with knowledge of existing power electronic devices that are best-in-class and that impact peak electricity demands. This document will help personnel in the demand management area promote certain products or product categories that have exceptional efficiency.

### Advanced Lighting Technologies

Comparing the electrical, mechanical, and photometric performance of traditional, fluorescent, high-intensity discharge (HID), LED, and other advanced lighting technologies will allow members to determine when and to what extent they replace traditional lighting in their efficiency rebate and incentive programs. Project results will allow members to determine the effectiveness of using advanced lighting technologies for residential and commercial applications. Project results will allow members to determine future energy and power quality requirements for supporting these technologies. Project data will provide a foundation for members to compare field data from future installations with project and demonstration data.

## 2010 Products

Product Title & Description	Planned Completion Date	Product Type
<p><b>Assessment of Advanced Lighting Technologies:</b> Overview of latest lighting technologies, their efficacies, and system compatibility. The development of advanced lighting technologies is a continuing effort in the lighting industry. New technologies that are more energy efficient, incorporate advanced light sources, utilize advanced lighting controls, and make use of hybrid technologies are being introduced each year. These include fluorescent, high-intensity discharge (HID), light-emitting diode (LED), and other hybrid systems. The development of such technologies warrants Electric Power Research Institute (EPRI) investigations into their design, operation, performance, immunity to power quality, and potential market penetration.</p>	12/31/10	Technical Update
<p><b>Power Supply Efficiency Improvements:</b> Overview of power supply research on improving efficiency of servers and consumer electronics.</p> <p>Promotes best-in-class efficiencies for residential and commercial power supply technologies. Includes analyses of power supply topologies and architectures used in various end-use devices. Leverages laboratory and field testing, as well as identification of the best-in-class energy efficiency devices available today.</p> <p>This is a three-year research project, with the focus in 2010 to continue to identify and promote the best-in-class efficiencies for residential and commercial power supply technologies. This project analyzes and evaluates a variety of power supply topologies and architectures used in various common end-use power supplies. Through laboratory and field testing, the best-in-class energy devices available in the market today will be identified. Design changes for efficiency improvements will be developed or suggested in conjunction with vendors. Devices that are considered for this project include, but are not limited to, video gaming consoles, gaming computers, high-definition televisions with screen sizes greater than 37 inches, Blu-ray Disc™ players, and other devices that impact the energy profile in residential and commercial sectors. This is an on-going project, which will include survey instruments to update usage profiles each year, allowing energy savings to be estimated.</p>	12/31/10	Technical Update

## Future Year Products

Product Title & Description	Planned Completion Date	Product Type
<b>Field implementation of best in class power electronic end-use devices:</b> In 2011, the field deployment of best-in-class electronic devices will be carried out in selected communities. Based on interest generated by the 2010 workshop, members will be solicited for possible field deployment in their territory. A field deployment procedure will be generated to assist members and consumers. The project will involve six months of data collection, with three months of data before and after field deployment of the devices. The results will be presented in detail as a technical update.	12/31/11	Technical Update