170 End-Use Energy Efficiency — Preparing for a Low-Carbon Future

Program Overview

Program Description
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.

Industry Needs and Issues Addressed
- 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 of energy efficiency and demand response to utilities, customers, and society
- Development and refinement of a modeling approach to quantify the impact of energy efficiency on reducing carbon emissions, based on industry-standard calculation methodology, 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

Impact
- Enable customers to use energy (including electricity) most efficiently, thereby enhancing their productivity while reducing energy intensity and associated carbon emissions
- Enable customers to effectively manage energy by responding to utility signals, while enabling utilities to use load as a cost-effective resource based on grid conditions, thereby creating a win-win situation
- Enhance the electricity industry's ability to influence technological developments that serve the needs of both customers and utilities
- Ensure a no-regrets strategy for program and technology investment by members
- Enable members to effectively respond to regulators and policymakers with scientifically sound, unbiased information on emissions and economic impacts of energy efficiency and DR

Key Accomplishments
- Successful collaboration with manufacturers in 2007 to create an EPRI Energy Efficiency Initiative Vendor Network, and development of the vendor database
- Large-scale multiyear field deployment of advanced energy-efficient technologies in 2008
- Collaboration with manufacturers to develop and demonstrate numerous energy-efficient technologies
- Development of modeling approach to quantify marginal carbon offsets of key energy-efficient technologies

- Creation of a commercial and industrial efficiency technology database in 2007, web-based strategic intelligence updates, technology transfer expertise and data from EPRI experts, and transfer kits such as customized technology updates, industry guidebooks and online delivery mechanisms

Current Year Objectives

- 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 EE and DR measures
- 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

Industry Involvement

- Estimated 2009 funding: $4.5M

Program Technical Lead

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Summary of Projects

PS170A Analytical Frameworks (065578)

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. Participants will be well-positioned to quantify the full benefits of their energy efficiency and demand response portfolio and justify associated investments in regulatory filings through frameworks for designing dynamic electricity pricing plans, ascribing CO_2 offset credit to energy efficiency, valuing demand response, and gauging the persistence of customer response to direct energy feedback, as well as the measurement and assessment of residential plug loads.

Project Number	Project Title	Value
P170.001	Framework for Designing Dynamic Electricity Pricing Plans	Framework for designing efficient and effective dynamic pricing plans that reflect underlying supply cost, provide for recovery of all costs, and offer customers choice in how they purchase electricity and opportunities to save money relative to conventional rates.
P170.002	Accounting for the Impact of Energy Efficiency on CO_2 Emissions	Continued development and refinement of a modeling approach that enables utilities and policymakers to quantify the impact of major energy-efficient technologies on CO_2 emissions reductions.
P170.003	Persistence of Customer Response to Energy Usage Feedback	Captures the extent and persistence of energy management behavior according to customer type, display type, system type (e.g., advanced metering infrastructure), and pricing environment via a multiyear study of the energy consumption and load profiles of residences and small businesses.

Project Number	Project Title	Value
P170.004	Framework for Valuing Price and Demand Response	Development of comprehensive framework for valuing DR applicable to both single pricing plans and to the entire portfolio of offerings. This consistent, transparent valuation methodology will thoroughly capture the benefits and costs of a variety of DR program types.
P170.005	Residential Plug-Load Measurement and Management	Develop and test protocols for self-administered household plug load measurement using cost-effective technologies.

Project Descriptions

P170.001 Framework for Designing Dynamic Electricity Pricing Plans (065574)

Issue

A variety of recently developed or refined dynamic pricing plans give utilities new ways to offer their customers choices in how they purchase electricity. This is concomitant with the advent of technologies that enhance consumers' ability to adjust electricity consumption frequently and relatively effortlessly. However, to be both efficient and effective, these pricing plans must be designed to reflect underlying supply cost (either internal or market), provide for recovery of all costs, offer customers opportunities to save money compared to conventional rates, and promote behaviors consistent with conservation and environmental ethics. Traditional rate design tools are not equipped to account for the critical, highly time-differentiated implications of dynamic pricing plans. Developing reliable estimates of the load and subsequent financial impacts of dynamic pricing requires more detailed characterization of customer preferences, and how price influences consumption actions, than is currently available. The lack of tools that can integrate fully dynamic pricing plans into enterprise and market planning and operations acts as substantial barrier to their widespread use, at the cost of billions of dollars of benefits.

Description

This project will develop methods, protocols, and practices for estimating customer acceptance of and response to alternative pricing plans. Work will focus on estimating how such plans cause changes in the level and profile of consumption by households and businesses in a very detailed way—hour-by-hour where appropriate. The results will portray the impact (kilowatts and kilowatt-hours) of implementing alternative pricing and demand response plans on load shapes, including both estimating subscription to such plans and response to each plan's incentives to participants to modify their consumption pattern.

Value

- Provides utility pricing plan designers with the methods and protocols they need to develop and test new pricing plans and determine which are market-ready and which require further calibration through a pilot program.
- Together with the demand and price response valuation framework being developed in project 170.04, this framework provides a comprehensive, end-to-end framework for characterizing the system, customer, financial and societal impacts of electricity pricing plans
- Supports developing benefit/cost analyses in association with energy efficiency programs
- Supports the identification and quantification of the benefits of AMI and SmartGrid investments
- Supports load forecasting and provides inputs to scheduling and dispatch operations

How to Apply Results

Utility rates and pricing departments can use the framework to conduct comprehensive, in-depth assessments of alternative pricing plans, design specific plans that are fine-tuned to their market circumstances, and refine existing plans to improve their overall performance. More detailed characterization of customer acceptance and response to plans will help build support for their adoption, recruit participants and help them maximize the benefits of participation, and provide guidelines for evaluating program performance.

2009 Products

Product Title & Description	Planned Completion Date	Product Type
Protocols, Methods and Practices for Characterizing Customer Acceptance of and Response to Price and Demand Response Plans: Comprehensive framework for assessing the load impacts of price and demand response plans. The framework will a provide detailed guidance on how to produce load impact evaluations for virtually any price or demand response plan at the level of detail required to fully characterize load impacts and to support subsequent assessments of customer, utility, and societal benefits.	12/31/2009	Technical Report

Future Year Products

Product Title & Description	Planned Completion Date	Product Type
Applications of Protocols for Characterizing Customer Acceptance and Response to Price and Demand Response Plans: EPRI will work with utilities to apply the framework and protocols to actual price and demand response plan and portfolio analyses, summarize, compare and reconcile the results, and modify the initial framework to incorporate these experiences to improve the scope and accuracy of the methods.	2010	Technical Report

P170.002 Accounting for the Impact of Energy Efficiency on CO_2 Emissions (065580)

Issue

Estimating the impact of energy efficiency improvements can be difficult and complex, particularly with respect to how energy efficiency activities affect carbon dioxide (CO_2) emissions. Little consensus exists among experts and policymakers on how to estimate the emission reduction value of energy efficiency. In a politically charged environment, the utility industry and relevant stakeholder groups need to establish guidelines for quantifying these values. Through its Energy Efficiency Initiative in 2007, EPRI worked with utilities and stakeholders to develop standard methodologies for linking energy efficiency to marginal CO_2 reductions, and in 2008 embarked on an exercise to model selected major end-use technologies consistent with this basis. In 2009, the project will focus on refining the application of this modeling approach and expanding it to additional end uses. The objective is to apply and gain acceptance of this approach among utilities and policymakers to establish emission reduction figures for energy efficiency that will meet the requirements of prevalent carbon offset and trading markets.

Description

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_2 emissions reductions. This project will leverage the CO_2 emission reduction methodologies developed through EPRI's 2007 Energy Efficiency Initiative, methodologies developed by utilities around the world including EDF, and initial modeling work begun in 2008 by EPRI through its National Electric System Simulation Integral Evaluation (NESSIE). The product will be a technical report and set of data tables that ascribe marginal CO_2 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.

Value

- 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_2 impact that balances the need for analytical rigor consistent with prevailing emissions offset and trading markets with the practicality of utility implementation
- Reduces CO_2 emissions

How to Apply Results

The project's resulting data tables will provide marginal CO_2 emission impacts of a variety of major end uses as a function of U.S. NERC region and assumptions of the market penetration levels of end-use efficient technologies. This 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.

2009 Products

Product Title & Description	Planned Completion Date	Product Type
Accounting for the Impact of Energy Efficiency on Marginal CO_2 Emissions: Volume 2: A technical report will review the methodology of the EPRI modeling approach and produce a series of data tables indicating the marginal CO_2 offset of energy efficiency technologies as a function of end-use category, NERC region, and market penetration assumptions. Members can apply the data tables associated with their region, categories of end-use efficiency programs, and range of market penetration levels as a reasonable approximation of the marginal impact of their energy efficiency programs.	12/31/2009	Technical Report

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

Issue

Residential energy consumption reductions of 5–15% have been documented as a result of installing in-home displays that provide real-time energy demand and energy price information. However, the practical application of direct energy feedback—with and without advanced metering infrastructure (AMI) and other systems designed to influence energy management and demand response (DR)--is still unclear. More

information on the extent and persistence of customer behavior is needed so that members can determine whether direct energy usage feedback is suited to application in specific territories and regions.

Description
This multiyear effort, started in 2008, will provide analytic and coordination services to utilities and other organizations field testing the effect that direct energy information 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 study will assess data to help determine:

- The cost/benefit of direct energy feedback
- How various feedback technologies, features, and information influence customer energy consumption and peak power demand
- How the type of system (for example, AMI) and pricing environment in which devices are deployed influence customer behavior
- 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

Value

- 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 DR programs that reduce energy consumption and carbon emissions

How to Apply Results
Utility staff involved in the planning and design of energy efficiency programs, DR programs, and 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.

2009 Products

Product Title & Description	Planned Completion Date	Product Type
Interim Results of Direct Energy Feedback Device Tests: Future year products for this project will document the continuation of field tests through interim results and a final technical report.	12/31/2009	Technical Update

Future Year Products

Product Title & Description	Planned Completion Date	Product Type
Residential Direct Energy Feedback Devices, Field Tests	2010	Technical Resource

Product Title & Description	Planned Completion Date	Product Type
Assessment of Customer Response and Practical Application of in-Home Direct Energy Feedback Devices	2010	Technical Report

P170.004 Framework for Valuing Price and Demand Response (065581)

Issue
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.

Description
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.

Value
- 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.

2009 Products

Product Title & Description	Planned Completion Date	Product Type
Characterizing and Quantifying the Value of Price and Demand Response: This technical report will describe a framework for quantifying the value of demand response and provide examples of how it can be applied to a variety of market and customer circumstances. The report will be organized around a concise, results-oriented description of the framework and how it can be applied. Appendices will provide more in-depth technical and methodological subject matter and provide fully referenced documentation.	12/31/2009	Technical Report

Future Year Products

Product Title & Description	Planned Completion Date	Product Type
Methods and Practices for Valuing Price and Demand Response: 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.	2010	Technical Report

P170.005 Residential Plug-Load Measurement and Management (067472)

Issue

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.

EE and DR program 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 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.

Description

EPRI will 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 2009 initiative will involve three functional and interrelated efforts:

- Summarize the current understanding of household device holdings and trends in their acquisition, and what is known about their usage profiles
- Develop a statistical sampling plan that will collect the data needed to raise the confidence in estimates of device holdings and profiles to specified levels—for example, equivalent to 90%, 95%, and 99% confidence intervals on the mean values 95—to allow individual utilities to select the commitment level they deem appropriate for their circumstances. In addition, 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.
- Identify devices and establish protocols for their deployment to households that will produce the data specified as needed in Task 2. EPRI will select three to five utilities to serve as test beds for these protocols and technologies

The developmental work conducted in these initiatives will be documented in a report that serves as a user guide to help members move forward quickly to field their own surveys. The report will also summarize the field tests conducted and the resulting data.

Value

- 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 supports research agenda development and analysis for technology development benefits.

2009 Products

Product Title & Description	Planned Completion Date	Product Type
Methods and Protocols for Measuring and Managing Residential Plug Loads: EPRI report that summarizes what is known about household electricity device holdings and load profiles, and identification of gaps relative to what is needed by members to support strategic planning and EE and DR program design and implementation.	12/31/2009	Technical Report

Future Year Products

Product Title & Description	Planned Completion Date	Product Type
Revised Sampling and Analysis Plan for Household Plug-Load Measurement Survey: EPRI will continue to develop protocols based on the experience gained as surveys are implemented.	2010	Technical Report
Survey Data Synthesis and Interpretation: EPRI will collect data from utility surveys, incorporate the result into a master database, and provide updated information about household electricity usage	2010	Technical Report

PS170B Demand Response Systems (065571)

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	Value
P170.006	Enabling DR-Ready Appliances	Collaborative effort between utilities, government agencies, and manufacturers to define the functional requirements of major end-use devices that are designed to participate in demand response programs out-of-the-box (DR-ready), a development that carries the potential to increase the reach of demand response programs while reducing their implementation cost.
P170.007	Advances in Thermal Energy Storage	Advances in thermal energy storage
P170.008	Integrated Controls to Enable Smart Homes	Assessment and demonstration of an integrated energy management control system to coordinate the operation of smart residential appliances that can control loads and thereby enable "smart homes."
P170.009	Intelligent Building Control Systems	Assessment of communications and control infrastructure to enable intelligent building control systems, including advanced sensors and microprocessors, for optimal energy performance. The increased ability of microprocessors to perform complex computing on sensor data in real time needs to be exploited to improve the energy performance of building equipment.
P170.010	Lighting Control Systems	Establish protocols for the management of HVAC, lighting and other dispatchable office building technologies so they are more amenable to integration in demand response programs.

Project Descriptions

P170.006 Enabling DR-Ready Appliances (067473)

Issue
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").

Description
The focus of this project is to define functional requirements for selected categories of end-use devices and building energy management systems to be deemed "DR-ready" and 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 EPRI collaboration with the U.S. EPA and DOE in 2008 to identify opportunities to make DR-ready an attribute under the ENERGY STAR® label for selected categories of end-use devices going forward. This project will seek to establish a utility consensus for DR-ready functional requirements for selected end-use devices and work collaboratively with ENERGY STAR® and equipment manufacturers.

This project will feature a workshop among participating utilities, DOE and EPA representatives, and equipment manufacturers to establish a shared vision for the DR-ready concept, identify barriers to DR-ready, and identify actions to overcome these barriers. Project results will be documented in a technical report and will lay the foundation for continued work in future years to fulfill the DR-ready vision.

Value
- Have first-hand influence in shaping utility industry functional requirements for DR-ready end-use technologies to ensure alignment with your 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 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.

2009 Products

Product Title & Description	Planned Completion Date	Product Type
Enabling DR-Ready Appliances: A technical report detailing the functional requirements of DR-ready devices identifying barriers to DR-ready, and specifying actions to overcome those barriers. The report will lay the foundation for continued work in future years to fulfill the DR-ready vision.	12/31/2009	Technical Report

Future Year Products

Product Title & Description	Planned Completion Date	Product Type
Enabling DR-Ready Appliances: Testing and Demonstration: Continuation of 2009 project to assess, test, and demonstrate the capability of early-development DR-ready devices.	2010	Technical Report

P170.007 Advances in Thermal Energy Storage (067474)

Issue

Thermal Energy Storage (TES), an established technology for shifting cooling demand from on-peak to off-peak periods, is an often-overlooked means of responding to peak demand crises. It is also 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), adoption of TES technologies is expected to accelerate in the next few years.

Description

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 and will be the subject of this project. In TES, 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 cool storage, including water storage, ice storage and eutectics, to develop a system with the most attractive combination of cost, performance, and size.

This project is a continuation of 2008 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.

Value

- 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
- Position members as industry leaders in TES technology development
- 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 can also help customers improve energy efficiency, reduce pollution, enhance indoor air quality, and improve productivity.

2009 Products

Product Title & Description	Planned Completion Date	Product Type
Demonstration of advanced TES system for load shifting and demand response applications: Building on the initial technical report developed in 2008, this product will provide demonstrations of TES for load shifting and DR. Demonstrations will be carried out at the EPRI Living Lab and others selected locations. Note: Demonstrations may have started in 2008; however, results of the 2009 summer tests will be captured in this product.	12/31/2009	Technical Update
Assessment of the latest TES technologies and systems and performance/cost improvement recommendations: An update of the technical report produced in 2008, providing state-of-the-art assessment of thermal energy storage technologies, both for heating and cooling applications.	12/31/2009	Technical Update

Future Year Products

Product Title & Description	Planned Completion Date	Product Type
Demonstrations of state-of-the-art TES technologies in member utility service territory: Continuation of field demonstrations of the state-of-the-art TES technologies that will lead to large-scale deployment by members.	2010	Technical Update

P170.008 Integrated Controls to Enable Smart Homes (067475)

Issue
Automated energy management functions must be developed for the residential sector to enhance energy efficiency, minimize energy waste, and improve homeowner comfort. Automation will also help support utility programs such as demand response and provide benefits for home occupants who participate in such programs.

Description
The project is a multiyear effort, focused on developing and demonstrating the integration of energy-efficient technologies for the residential sector. This project will develop an integrated energy management system (EMS). The goal of the EMS will be to coordinate the operation of smart residential appliances that can control loads (smart thermostats, water heater controls, smart refrigerators, laundry equipment), along with on-site power generation such as solar photovoltaics) and electrical energy storage. The EMS will be capable of balancing available on-site power generation capacity with demand, either selling excess power back to the grid via net metering or storing it in battery systems. The EMS will also enable a home to participate in utility demand-response programs such as time-of-use rates or critical peak pricing. The EMS will be designed to receive demand response signals either through the utility meter (AMI) or through a secured Internet connection. Upon receiving a demand response signal, the EMS will initiate user-defined load-shed strategies such as thermostat adjustment, water heater shedding, or utilizing stored energy.

Value
- Gain opportunities to mass-deploy demand response and energy efficiency programs for the residential sector
- Use AMI to understand and tabulate residential load use patterns
- Optimize use of distributed generation and energy storage for enhancing residential energy efficiency
- Determine the feasibility of implementing a low-cost EMS for the residential marketplace
- Understand the loads residential customers are willing to shed if the process of shedding were automated
- Understand the factors involved with retrofitting existing homes with EMS
- Understand the capabilities and limits of existing controllers designed for the residential market
- Understand the efficiency improvement of residential homes controlled by an EMS

How to Apply Results
The results can be used to estimate the dollars-per-kilowatt of automated shed per resident and efficiency improvement percentage for both new and existing construction. This information can be used to determine if further research such as a pilot project should be performed to test the technologies and customer participation.

2009 Products

Product Title & Description	Planned Completion Date	Product Type
Technical Assessment of Energy Management Systems for Residential Buildings and Field Test Data on efficiency improvements, load shifting, demand response load shed strategies: Residential EMS research will determine the potential energy savings through residential automation plus interoperability of consumer goods, home power distribution, and area networks for the automation of demand response. Field test results of one or more homes with selected equipment such as EMS, meters, appliances, gateways, distributed generation, transfer switches, or energy storage will be published. The project will explore integrating the functions of a gateway into the design of a residential EMS.	12/31/2009	Technical Update
Technical Guide for designing an Energy Management System for the residential sector: Research findings will be compiled into a guidebook to help control companies design an interoperable energy management system for the residential sector.	12/31/2009	Technical Update

Future Year Products

Product Title & Description	Planned Completion Date	Product Type
Technical Guide for implementing an energy management system into new and existing homes: Research findings will be compiled into a guidebook to help residents understand the steps for installing an energy management system in new and existing homes.	2010	Technical Update
Technical Guide for improving the efficiencies of residential homes through control methods: Research findings will be compiled into a guidebook to help residents understand control strategies to improve the efficiency of their homes.	2010	Technical Update
Technical Guide for integrating residential equipment (appliances, HVAC, generation, energy storage) into the control of residential energy management systems: Research findings will be compiled into a guidebook designed to help residents understand the process of integrating residential equipment (appliances, HVAC, generation, energy storage) into the control of residential energy management systems.	2011	Technical Update
Technical Guide for defining residential load-shed strategies and automating their shed initiating through communications with local utilities: Research findings will be compiled into a guidebook designed to present residents with opportunities to shed load during times of high demand or automatically through EMS-utility connections.	2011	Technical Update

P170.009 Intelligent Building Control Systems (067476)

Issue

Building automation systems (BAS) are designed to efficiently utilize the energy use of buildings through advanced controls of building equipment. BAS optimizes building energy efficiencies by dynamically changing equipment set points based on real-time feedback. The introduction of new sensor technology and their integration into control loops has broadened the range of energy-efficient control methods for BAS. New control schemes based on recent advances in sensors, communications, and control algorithms could significantly impact energy use while providing the technology for automated demand response. Advancements in BAS communications, such as the use of web servers and Internet-based communication protocols, makes it possible to automate demand response through connections to demand response application servers. It may be possible for a demand response application server to reside within the BAS. The increased use of microprocessors for data manipulation and introduction of Internet protocol communications among sensors, panel boards, lighting controls, meters, and appliances can provide immediate intelligence using energy performance metrics through operator interfaces and displays for conservation or demand response intervention.

Description

This project will use advances in sensors and communications, and in microprocessor technology for complex computing, to immediately display performance metrics and provide information for automatic and manual control loops for energy performance. Energy management and control systems typically schedule and enable the on/off of equipment, but the advanced controls of modern microprocessor-based building controllers go beyond basic scheduling. They have the ability to perform open and closed loop controls by relying on data from sensors and devices to adjust set points for optimal operation in real time. Optimal operating set points could be influenced by input values from several sensors and could also be constrained by the operating range of the equipment. The increased ability of microprocessors to perform complex computing on sensor data in real time needs to be utilized to improve the energy performance of building equipment.

This project will review, assess, and investigate how advanced controls such as control algorithms, operator interfaces that provide feedback for manual control, advanced sensors, and the interoperability for both improve energy efficiencies and automated demand response readiness. Initially, work will focus on improving the performance of HVAC systems and subsystems, and will be expanded to other equipment and the whole building performance. Assessment will be performed using analytical models and will be supported with controlled field data when required. The project will leverage efforts with other research organizations and manufacturers of equipment and controls systems.

The project is focused on improving both energy efficiency and demand response capabilities in buildings, including demonstration of automated demand response technology.

Value

- Enables customers to use energy more efficiently, thereby enhancing their productivity while reducing energy intensity and associated carbon emissions
- Helps members institute demand response programs
- Reduces greenhouse emissions and contributes to the deferment of power plant additions through energy-efficient operation
- Improves economic development by reducing customer facility energy costs
- Enhances facility productivity by meeting business needs
- Enhances customer confidence by demonstrating the member’s value as an energy management partner
- Improves utilities load factor since advanced and intelligent controls can respond to peak demands by shifting electricity use

How to Apply Results

Project findings and deliverables will be employed by utility account representatives, marketing staff, and energy efficiency specialists as they work closely with their customers in key commercial market segments to transfer new technologies that can help customers by reducing energy costs, providing advanced and intelligent controls for cooling, heating and other end uses, and producing improved products that directly address commercial business needs.

2009 Products

Product Title & Description	Planned Completion Date	Product Type
Technical Assessment of Building Automation and Controls for Commercial Buildings and Field Test Data on Advanced Building Controls for automated demand response: The salient and differentiating features of leading building automation and controls systems will be reviewed, with an emphasis on advanced control schemes for optimal energy performance. The initial focus will be on complex HVAC systems and subsystems. Field test results from selected advanced control schemes for automated demand response will be published. The project will explore combining the auto-DR gateway within the building EMCS.	12/31/2009	Technical Update
Technical Assessment of Energy Performance Metrics and Benchmarks and Energy Performance Dashboards: This product will compare various metrics that can provide immediate information on the health and energy efficiency performance of equipment for potential use in dashboards. Project activities will develop performance metrics and dashboards that can be implemented by end users. Such systems could merge utility power meter data with end user characteristics and show energy performance on an easy to use web-based dashboard.	12/31/2009	Technical Update

Future Year Products

Product Title & Description	Planned Completion Date	Product Type
Integration of utility pricing gateways into building EMCS: Development and demonstration of integrating price signals within building energy management and control systems, so that buildings respond to real-time price signals from utilities and take appropriate action to improve energy efficiency. This will enhance continuous commissioning of buildings and accelerate the implementation of the smart grid.	2010	Assembled Package

P170.010 Lighting Control Systems (067477)

Issue

All traditional lighting sources are now available as electronic technologies with some type of integrated control to vary light output levels. These include halogen, compact fluorescent lamps (CFLs), linear fluorescent lamps (e.g., T5 and T8), high-intensity discharge (e.g., metal halide and high-pressure sodium), and light emitting diode (LED). The efficiency of these sources varies as they are controlled (dimmed). The demand for high-efficiency and high-reliability lighting and reduced lighting load has driven the demand for increased control of lighting sources and systems. No one standardized lighting control

protocol exists for all lighting sources. Functional compatibility between demand response and building control systems and the various lighting control systems has caused confusion among utilities and end users. In addition, including a lighting control system in a light source increases the susceptibility of the source to damage caused by electrical disturbances.

Description
Each type of lighting control protocol, whether hard-wired (Analog 10, DALI) or wireless, will be identified and described. Each type of controllable lighting source for use in commercial environments will be identified and procured for functional and compatibility testing. Tests to identify the immunity of each controllable light source will be conducted on each lighting protocol. Tests to identify the change in efficiency as a function of light output (degree of control) will also be conducted on each lighting source. The efficiency of the lighting control system will also be considered. EPRI will visit selected manufacturers of both lighting controls and controllable light sources for design reviews regarding efficiency, power quality, and compatibility with other building controls and the public power system. EPRI will work with members whose customers plan to convert their lighting system to a controllable system or already have done so.

Value
- Analyze the degree of energy and cost savings when using various lighting protocols and control systems for various commercial lighting scenarios.
- Understand the operation and limitations of all lighting control protocols and light sources in standard and demand response (DR) systems.
- Understand lighting control scenarios for use with mixed lighting technologies and building control systems, and communicate that understanding to customers.
- Gain access to experts and manufacturers of all domestic and international sources of lighting controls.

How to Apply Results
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 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 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.

2009 Products

Product Title & Description	Planned Completion Date	Product Type
Functional Analysis of Lighting Protocols and Control Systems: EPRI technical update describing results of functional analysis of all existing lighting control systems, including discussion of present protocols and what protocols hope to achieve with regard to energy savings and demand response. Also, a discussion on how protocols can be revised to be DR compatible with various DR systems, with examples.	12/31/2009	Technical Update

Product Title & Description	Planned Completion Date	Product Type
Performance and Demonstration of an Advanced Lighting Control System for DR Application: EPRI technical report on performance analysis and demonstration success of using advanced lighting control system in a commercial facility equipped for demand response activities. Discussion of the advantages and disadvantages of various methods of lighting/DR control.	12/31/2009	Technical Update

PS170C Energy Efficient Technologies

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 explosive energy growth today, such as data centers and power supplies for consumer electronics.

Project Number	Project Title	Value
P170.011	Web-Based Industrial Energy Management Tool	Development of a web-based energy management tool applicable to a wide range of industrial customers, which will capture many aspects of energy management and provide online analyzers and calculators to quantify the impact of such measures as energy-efficient process technologies, combined heat and power, waste heat recovery and reuse, thermal energy optimization (pinch analysis), and HVAC retro-commissioning.
P170.012	Efficient Data Centers	Address the needs for improved energy efficiency in data centers that account for over 1.5% of total electricity in highly concentrated, often urban locations
P170.013	HVAC Technologies	Identify and resolve barriers to the adoption of more efficient heat pump HVAC technologies in commercial buildings
P170.014	Residential Appliances & Commercial Equipment	Identify and develop new materials and manufacturing practices that will overcome first-cost barriers to the adoption of more efficient electrical equipment in buildings
P170.015	Advanced Lighting Technologies	Collect and synthesize performance data on LED and other advanced lighting technologies to identify research and development needs and achieve cost-effectiveness
P170.016	Power Supplies for Consumer Electronics	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.

Project Number	Project Title	Value
P170.017	Advanced Motors	Improves understanding and encourages adoption of new technologies to improve electric motor efficiency

Project Descriptions

P170.011 Web-Based Industrial Energy Management Tool (065565)

Issue
Many industrial customers understand the potential value of energy management to their productivity and bottom line, and look to their electric utility for tools to help implement energy management. However, many existing energy management software tools are too complex and cumbersome for busy facility managers to utilize on a regular basis. Feedback from utilities and their industrial customers indicates a need for an easy-to-use, web-based tool that would serve as an energy management dashboard for facility managers.

Description
A continuation of the 2007 Energy Efficiency Initiative and 2008 Energy Efficiency Program, this project entails the development and application of a web-based energy management tool applicable to a wide range of industrial customers. This tool captures many aspects of energy management by providing online analyzers and calculators to quantify the potential for a range of measures:

- Energy-efficient process technologies
- Waste heat recovery and reuse
- Thermal energy optimization (pinch analysis)
- HVAC retro-commissioning

This project will use existing energy management tools and software developed by DOE and other organizations.

Value

- Deployment of a web-based tool that can simplify energy management for industrial customers, enabling them to ramp up energy efficiency activities and reduce energy intensity and carbon emissions
- Greater understanding of how the tool functions in actual industrial applications
- Transfer of the technology to industrial customers in members' service territories

How to Apply Results
The web-based energy management tool can be used by facility managers as an online analyzer and calculator to quantify the energy efficiency potential for a range of measures. The field test version of the web-based energy management tool will be evaluated at selected industrial customer sites of participating members. The general release of this tool will be accessible over the web by industrial customers through their utility.

2009 Products

Product Title & Description	Planned Completion Date	Product Type
Web-Based Energy Management Tool, General Release: General release of the energy management tool as a web-based application.	12/31/2009	Assembled Package

Future Year Products

Product Title & Description	Planned Completion Date	Product Type
Web-based energy management tool – commercial version: The 2010 product will be a robust, fully commercial, industrial software product.	2010	Software

P170.012 Efficient Data Centers (067478)

Issue

Data centers energy use in the United States is projected to grow at a fast pace. It accounted for about 61 billion kWh in 2006—nearly 1.5% of total electricity use—and is expected to grow to 100 billion kWh by 2011. Provisioning power to new data centers, or for the expansion of existing ones, requires large investments in the utility power distribution infrastructure. Over-provisioning leads to loss from unutilized assets; under-provisioning leads to logistical problems since the around-the-clock operations of data centers do not permit enough downtime for upgrades. IT equipment power needs are continually changing with the hardware, while software developments such as virtualization also make a big impact on power use. There is also a large variation in power use by the cooling and UPS equipment that supports the IT equipment. Emerging energy use performance metrics for data centers need to be assessed and evaluated to support the efficient operation of existing data centers as well as the design of new ones.

Description

The data center industry is extremely dynamic, with rapid development and deployment in IT hardware and software that has a profound effect on energy use. The infrastructure supporting data center equipment, primarily cooling and uninterruptible power supplies, is also complex with multiple configurations, options, and equipment suppliers. Power use among data centers can vary by large amounts, as evidenced by Lawrence Berkley Laboratories field studies.

This project will review power and cooling flows in data centers, and identify and assess areas where efficiency gains can be made. Work will focus on two primary areas: cooling technologies and solutions to reject heat generated from IT equipment indoors to the outdoors; and power distribution from the incoming switchgears to the IT equipment, including power supplies in the IT equipment. Studies will identify pinch areas in the cooling and power flows, which would offer the most potential for energy efficiency, and assess the potential for the same. Cooling flow is very complex, with heat being transferred from the chip to the outside air in several steps such as: from the chip to room air; from room air to a CRAC unit cooling coil; from a CRAC unit cooling coil to a cooling fluid, such as secondary chilled water; from secondary chilled water to primary chilled water; from primary chilled water to refrigerant in the chiller; from refrigerant to condenser water; and from condenser water to outdoor air. While it is easy to optimize heat transfer in a single heat transfer loop, overall optimization is the key to energy efficiency. The optimal operating conditions for these heat transfer process loops may not necessarily be the same as in comfort air conditioning, around which most of the air conditioning equipment is optimized today. This project will review the latest technologies available for heat and power transfer for best overall energy performance.

Value

- Enables customers to use energy more efficiently, thereby enhancing their productivity while reducing energy intensity and associated carbon emissions
- Reduces greenhouse emissions and contributes to the deferment of power plant additions through energy-efficient operation

- Improves economic development by reducing customer facility energy costs
- Improves economic development by reducing utility infrastructure costs
- Enhances facility productivity by meeting business needs
- Enhances customer confidence by demonstrating the 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 commercial market segments to transfer new technology that can help customers by reducing energy costs, providing advanced and intelligent controls for cooling, heating and other end uses, and producing improved products that directly address commercial business needs.

2009 Products

Product Title & Description	Planned Completion Date	Product Type
Technical Brief on Latest Power Flow and Heat Transfer Technologies in Data Centers: This project will review the latest technologies available for heat and power transfer for best overall energy performance.	12/31/2009	Assembled Package

Future Year Products

Product Title & Description	Planned Completion Date	Product Type
Technical Brief on Latest Power Flow and Heat Transfer Technologies in Data Centers: This project will review the latest technologies available for heat and power transfer for best overall energy performance.	2010	Technical Update

P170.013 HVAC Technologies (067479)

Issue

Variable-speed air-source heat pumps (ASHPs) are highly efficient technologies that can significantly reduce space conditioning and costs for commercial and industrial customers, while also reducing greenhouse gas emissions such as carbon dioxide. Breakthrough commercial adoption of variable-speed ASHPs with a high coefficient of performance hinges on continued functional and cost improvements. Improved low-temperature performance is a priority for increasing the efficiency of this technology. Variable refrigerant flow technology is one means of advancing U.S. heat pump performance. Advanced compressor technology, such as systems with magnetic bearings, also increase heat pump efficiency. Geothermal, or ground-coupled, heat pumps (GeoHPs) could increase space-conditioning efficiency by almost 40%, thereby providing substantial benefits for members and their customers. Lower installation and equipment costs are keys to advancing this technology.

The widespread adoption of efficient electric dehumidification technologies can reduce carbon dioxide emissions while simultaneously improving indoor air quality and the comfort of building occupants. An independent, objective assessment and demonstration of efficient electric dehumidification systems versus gas-fired desiccant dehumidification systems is critical to establishing competitive performance.

Description
The project will consist of three subsets:

Variable-speed Air-Source Heat Pumps (ASHPs): This project will evaluate the performance of best available commercial and in-development equipment and demonstrate their performance at the Living Lab and other selected sites, particularly for low-temperature and defrost conditions. Project activity will also explore demonstrations of new and efficient compressor technology.

Ground-Coupled Heat Pumps (GeoHP): This project will build on a 2008 project exploring currently available GeoHPs and installation techniques that will determine their product characteristics and ownership costs. This project also analyzes a concept that changes the entire GeoHP investment outlook: utility installation, maintenance, and ownership of the geothermal piping network, similar to a district heating system.

Electric Dehumidification Systems: This project builds on assessments of commercially available dehumidification systems (including Trane CDQ and AAon Ventilators) to handle 100% outside air in selected building applications that were performed and documented in 2008. Based on the comparisons, existing/emerging electric dehumidification systems will be selected for field testing demonstrations in 2009. The field demonstrations will be conducted over the course of a year at the EPRI Living lab and selected customer locations of members. A workshop will also be held in 2009 after testing concludes to define the roles of the host utility and facility, as well as the desired attributes of the field installations.

Value
- Delivers unbiased technical assessment of new energy-efficient space conditioning technologies with the potential to substantially increase space heating/cooling efficiency and water-heating efficiency
- Increases understanding of how the technologies function in actual applications
- Positions participating members as industry leaders in heat pump technology development
- Establishes the capability to widely transfer the technology to developers and customers
- Reduces 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 reducing indoor humidity and improving air quality
- Enhances customer confidence by demonstrating the member's value as an energy management partner
- Accelerates the development and commercial penetration of improved electric dehumidification systems to reduce costs of facility dehumidification for commercial and industrial customers

How to Apply Results
Project findings and deliverables 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 improve energy efficiency, reduce pollution, enhance indoor air quality, lower peak demand, and improve productivity.

2009 Products

Product Title & Description	Planned Completion Date	Product Type
Demonstration of new ASHP and compressor technologies: Demonstrations and field tests will be conducted on advanced ASHPs in 2009, with technology assessment materials available for utility account representatives to share with their customers. The demonstrations will include advanced inverter-driven or variable-speed heat pumps and advanced compressor technologies, such as the Turbocor technology.	12/31/2009	Technical Update
Field test report on improved GeoHP: Field tests will be conducted on advanced GeoHPs in 2009. Construction of ground piping will facilitate a demonstration project in 2010 that will also feature coupling with a thermal energy storage system.	12/31/2009	Technical Update
Field tests and users workshop on new electric dehumidification system: Lab and field tests will be conducted on advanced electric dehumidification systems in 2009. The tests will build on the technical update produced in 2008 and field tests conducted in 2009 to deliver relevant perspectives for utility account representatives to share with their customers. A user workshop for new electric dehumidification system site selection and field test coordination will be conducted.	12/31/2009	Workshop, Training, or Conference

Future Year Products

Product Title & Description	Planned Completion Date	Product Type
Demonstration of advanced ASHP or GeoHP at a facility, along with thermal energy storage coupling: Demonstration of the most cost-effective solution for energy use in commercial facilities, such as advanced air source heat pump or geothermal heat pump combined with thermal energy storage	2010	Technical Update
Additional demonstrations of advanced dehumidification and indoor air quality systems: Demonstration of the most cost-effective solution for customer comfort and energy use in residential and commercial facilities	2010	Technical Update

P170.014 Residential Appliances & Commercial Equipment (067480)

Issue

In addition to space conditioning and lighting, residential and commercial building energy use is driven in large part by appliance and equipment technologies. These loads are continually growing. Examples of such equipment include residential water heaters; kitchen and laundry appliances; office equipment such as computers, faxes, copier and printers; refrigeration equipment for food service and grocery stores; laundry equipment for lodging, healthcare, and laundry facilities; and water heating for all types of buildings. The proliferation of home and office technologies and the growth of related plug loads is also an area that needs to be addressed in containing the growth of service sector demand and energy use. Refrigeration is an important load for many utilities, with refrigeration load shape improvement often resulting in improvements in utility load shapes. Water heating is also an important component of energy

use for residential and commercial buildings. In addition to residential use, laundries, hotels, healthcare facilities, spas and swimming pools and full-service restaurants use large quantities of hot water. Foodservice equipment is an integral part of restaurants, as well as cafeterias that are present in many types of commercial buildings.

Description
The first part of this project is a continuation of the Living Lab 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 tested will be used to develop guidelines for improved control/operation (response to real-time pricing signals, interoperability) and components such as compressors, heat exchangers, controls, and refrigerants of the next generation of heat pump water heaters. In addition to demonstrations, products will consist of a brochure or fact sheet showing the attributes of the heat pump water heaters tested, and a seminar/workshop to improve understanding of the technology. The event will include existing and prospective users of the technology as well as utilities, manufacturers, and researchers, and will form the basis for engaging with domestic and overseas manufacturers as well as prospective participants such as DOE, NYSERDA or the California Energy Commission (CEC) to plan future program.

The second part of this project will involve continued scoping of advanced residential appliances that were selected for demonstration in 2008. The product will be a technical update on advanced concepts for residential appliances, such as advanced cooking equipment like induction cookers, dishwashers such as heat pump washers, washers/dryers, and refrigerators such as inverter-driven non-CFC types.

The last part of this project will be an assessment of other energy use systems in commercial buildings. It will examine refrigeration, office technologies, foodservice and laundry equipment to determine potential improvement targets and means of achieving these targets. For example, office technologies could be improved using more efficient and higher power-quality power supplies. LED technology might be useful for some of the many lights used on computers and other office equipment. Better screens could be a target for improved computer display. Improved cooling technology will be increasingly important as devices become more compact and powerful.

Value
- Reduces greenhouse gas emissions and contributes to the deferment of power plant additions through energy-efficient appliance
- Improves economic development by reducing residential and commercial customer facility energy costs
- Enhances customer confidence by demonstrating the member's value as an energy management partner
- Accelerates the development and commercial penetration of improved electric appliances to reduce operating costs of commercial customers
- Enhances facility productivity by meeting business needs

How to Apply Results
Project findings and deliverables will be employed by utility account representatives, marketing staff, and energy efficiency specialists as they work closely with their customers in residential and key commercial market segments to transfer new technology that can help customers by reducing energy costs, providing cooling for comfort conditioning, and producing improved products that directly address customers' business needs.

2009 Products

Product Title & Description	Planned Completion Date	Product Type
Field test report on commercial HPWH and technical & economic Assessment of heat recovery water heating: Field tests will be conducted on advanced HPWH in 2009, with marketing materials available in 2010 for utility account representatives to share with their customers. Comparisons will be made based on operating cost and equipment cost for a range of climate zones, energy prices, and building types to develop recommendations for current applications as well as suggested development goals and actions.	12/31/2009	Technical Update
Technical and economic assessment of advanced residential appliances: A technical update on state-of-the-art residential appliance technologies worldwide. Energy-efficient technologies will be identified, and a roadmap for demonstrating and deploying such technologies will be provided.	12/31/2009	Assembled Package
Technical and economic assessment of advanced commercial office technologies: The product will be a technical update on state-of-the-art commercial office technologies throughout the world. Energy-efficient technologies will be identified, and a roadmap for demonstrating and deploying such technologies will be provided. Advanced commercial building equipment such as office technology, refrigeration, and foodservice will be examined to determine the most promising product improvement targets and the actions needed to accomplish those improvements.	12/31/2009	Assembled Package

Future Year Products

Product Title & Description	Planned Completion Date	Product Type
Product development plans for next generation residential appliances, and heat recovery water heaters: Strategic development and demonstration of technologies to drastically reduce energy usage in appliances in residential buildings.	2010	Assembled Package
Product development plans for next generation commercial appliances and office technologies: Strategic development and demonstration of technologies to drastically reduce energy usage in commercial offices and buildings.	2010	Assembled Package

P170.015 Advanced Lighting Technologies (067481)

Issue

Lighting is a very important part of the commercial and residential sectors, accounting for 28% and 16% of all electricity used in these sectors, respectively. In buildings, new energy-efficient technologies, such as compact fluorescent lamps (CFLs), linear fluorescent lamps (T5 and T8), high-intensity discharge (such as metal halide and high-pressure sodium), and light emitting diode (LED) are becoming increasingly popular as alternatives to standard lighting.

The Energy Independence and Security Act of 2007 (EISA) established lighting standards that will effectively make CFLs more cost effective to households compared to traditional incandescent bulbs, starting in 2012. As a result of EISA, experts envision that CFLs will become the predominant technology, replacing incandescents and resulting in substantial savings over the long run. However, public acceptance of CFLs is lagging due to unsatisfactory performance of early units and consumer perception that CFLs cannot produce an equivalent ambiance or aesthetic appeal.

Improving the efficiency of street lighting is another important issue for municipalities and utilities alike. The costs associated with operating and maintaining street and area lighting (SAL) continue to escalate with rising energy and labor costs. LED technologies represent energy-saving and cost-effective alternatives. Finally, there are continuous improvements in the efficiency of illuminated outdoor billboards and signage. More efficient alternatives, especially through the use of advanced LED technology, are possible.

Description

This project is divided into the following areas of research:

- Devising market transformation initiatives that utilities can adopt to jump-start the transition to advanced lighting technologies by one to two years.
- Continuing work in device and lighting system performance testing, which will be essential given the expected ramp-up in the number and types of bulbs that will be introduced starting in 2009.
- Investigating the impacts of high saturation of CFLs on local distribution system performance and operations, especially with regard to the potential for degradation due to harmonic distortion.
- Studying new technologies for billboards and signage. This work includes market, cost, and energy efficiency performance data for digital and LED-based signs and billboards. Subsystems used in these signs and billboards will be tested in the laboratory for energy performance, power quality, and compatibility.

Value

- Cost savings from the advanced adoption of CFLs will contribute to achieving utility goals for energy efficiency initiatives
- Market transformation initiatives will have high benefit/cost ratios
- Projects provide opportunities for members to demonstrate leadership in environmental stewardship
- Identification and cost-effective resolution of barriers to an advanced adoption of CFLs in households
- Testing of advanced lighting technologies (CFL, LED) will allow members to understand the actual performance of such systems
- Market, cost, and efficiency data will allow members to understand the potential impact of installing and connecting signs and billboards to the power systems in their service territories
- Compatibility, power quality, and energy analyses of signs and billboards will help members understand present and future energy and reliability requirements regarding energy usage and damage to signs and billboards caused by electrical disturbances.
- Members will gain knowledge regarding the use of powering digital LED billboards with alternative energy options such as photovoltaic systems

How to Apply Results

Comparing the electrical, mechanical, and photometric performance of traditional and CFL, LED, and other advanced lighting technologies will allow members to determine when and to what extent they replace traditional lighting. Project results will allow members to determine the effectiveness of using advanced lighting technologies for residential and commercial applications. Comparing the electrical, mechanical, and photometric performance of traditional and digital LED-based signs and billboard technologies will help members determine how growth in the number of installations will impact system

planning. Project results will allow members to determine future energy and power quality requirements for supporting these technologies and the benefits of using photovoltaic systems combined with line power systems. Project data will provide a foundation for members to compare field data from future installations with project and demonstration data.

2009 Products

Product Title & Description	Planned Completion Date	Product Type
Electrical, Mechanical and Photometric Performance of Digital LED Signs and Billboard: EPRI technical update describing tests of several LED signage and technologies in the Living Lab. Dissemination of results on photometric and energy efficiency characteristics, power quality and compatibility to the utility power system. Analysis of future DR capabilities to reduce signage load during non-peak advertising hours.	12/31/2009	Technical Update
Local System Impacts of High Saturation of CFLs in Neighborhoods: EPRI report describing modeling simulations conducted to determine the impact of high levels of CFL saturation in various types of neighborhoods of different population and lamp densities and physical system attributes, including their impact on distribution system performance.	12/31/2009	Technical Update

P170.016 Power Supplies for Consumer Electronics

Issue

Advances in consumer electronics technologies in the worldwide residential and commercial sectors create dramatic increases in load density that can be offset by power electronic efficiency improvements. 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 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 DOE's *Annual Energy Outlook 2007* report, electricity demand from 2005 to 2030 is projected to grow by 39% in the residential sector, 63% in the commercial sector, and 17% 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.

Description

This is a three-year research project, with the focus in 2009 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.

Value

- 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

How to Apply Results

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.

2009 Products

Product Title & Description	Planned Completion Date	Product Type
A Report on "Best-in-Class" Efficiencies of End-use Electronic Devices: A technical update that presents project findings, including detailed descriptions of the devices selected, the selection criteria, explanation of test protocol, results obtained from laboratory tests and applicable field tests, analysis of test results, analysis of power supply topologies, the merits and demerits of the best power supply topology/ architecture, and the selection of the best-in-class efficiency power supply technology.	12/31/2009	Technical Update

Future Year Products

Product Title & Description	Planned Completion Date	Product Type
Technical workshop on Best Energy Efficiency Designs: Based on 2009 findings, a promotional workshop will be organized in 2010 that will involve end-use electronics device manufacturers and utility members. The goal of the workshop is to highlight best-in-class efficiency products, present recommendations to improve efficiencies, and create awareness among manufacturers about the benefits of improving efficiency of power electronics.	2010	Technical Update
Field implementation of best in class power electronic end-use devices: 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.	2011	Technical Update

P170.017 Advanced Motors (065565)

Issue
Electric motors consume 67% of the energy used by the industrial sector. At present, NEMA is spearheading an effort to improve motor efficiency through its Premium™ efficiency motor program. NEMA Premium™ efficiency motors are about 0.6% to 4.0% more efficient than older generation motors. The typical efficiency of a NEMA Premium™ efficiency motor could range from 85% to 95% depending on the horsepower rating of the machine. While NEMA Premium™ efficiency motors are very efficient, there is still potential for improvement. Due to the widespread use of motors, even an incremental increase in efficiency would contribute to significant energy savings. As a result, manufacturers are working to develop "super premium" efficiency motors that would exceed the NEMA Premium™ efficiency motor standards. It is expected that the use of new technologies such as copper rotors, better lamination materials, and optimal motor rewinding can all help improve motor energy efficiency, and therefore reduce overall motor energy consumption and CO_2 emissions.

Description
This project quantifies and investigates new technologies and methodologies to improve motor efficiency. While there are several ways to improve motor efficiency, some innovative approaches that are being considered include using copper rotors instead of aluminum rotors, reducing the thickness of lamination, using better steel, and rewinding older motors. The most promising of these approaches are the copper rotor motor and improved motor rewinding. The 2009 project focuses on demonstrating the advantages of these technologies, along with a detailed investigation on issues that may affect the penetration of these technologies in the present as well as the future.

Value
- Significant opportunity for reducing energy consumption
    - Industrial electric motor-driven systems used in production account for about 747 billion kWh.
    - The Consortium for Energy Efficiency (CEE) reports that about 2.9 million motors fail each year, of which 600,000 are replaced. The rest are usually repaired. For every new motor sold, about 2.5 motors are repaired. DOE studies have shown that improved methods of rewinding can contribute to an energy savings of 4.8 billion kWh.
    - NEMA expects that motor efficiency upgrades can achieve potential savings of about 19.8 billion kWh per year.
    - Use of new technologies such as copper rotors can save an additional 108 TWh.
- Significant reduction in CO_2 footprint can be expected with increased efficiency motors. For example, NEMA anticipates that its Premium motor program would save 5,800 GW of electricity in the next 10 years per DOE estimates, preventing the release of nearly 80 million metric tons of carbon into the atmosphere.

How to Apply Results
Utilities can use the results of this project to create incentive schemes that encourage the use of new energy-efficient motor technologies. As most utilities are dependent on conventional generation sources such as coal, this would also enable members to determine the actual amount of CO_2 emission reduction that would be possible through adapting energy-efficient electric motors.

2009 Products

Product Title & Description	Planned Completion Date	Product Type
Assessment of the efficiency and application of advanced motor technologies: This assessment will identify field applications to demonstrate the benefits of new technologies such as copper rotor motors and improved motor rewinding techniques. Project activities will assess opportunities for reducing energy consumption and CO_2 emissions through the use of advanced motor technologies, and report results to participating members in a technical update.	12/31/2009	Technical Update

Future Year Products

Product Title & Description	Planned Completion Date	Product Type
Assessment of the efficiency and application of advanced motor technologies: Knowledge acquired from this project will help involve industries in the commercialization and increased adoption of advanced high-efficiency technologies.	2010	Technical Update