

Water Availability and Resource Risk Management - Program 55

Program Overview

Program Description

Water and power industry operations and financing are threatened by constraints on water and other natural resources, such as endangered species and ecosystem services. Several factors are focusing more attention on water availability/use and are putting pressure on the electric power industry to increase its water use efficiency and minimize overall water consumption and withdrawal. These factors include population increases coupled with regional population shifts; competing demands among municipalities, agriculture, and industry; climate variation; and aquatic ecosystem protection. This scrutiny has significant implications for electricity generation and transmission operations and growth, including power plant siting. If existing power plants cannot access sufficient water for cooling or other needs, power companies may be forced to reduce power output or shut down plants. At the same time, siting and construction of new generation capacity may be stalled by water availability and other natural resource constraints.

The Electric Power Research Institute's (EPRI's) Water Availability and Resource Risk Management Program helps industry, regulators, financial institutions, investors, the public and other natural resource stakeholders develop and implement cost-efficient, risk-based strategies for improved power plant water use efficiency, reduced power plant water demand, and management of climate variability impacts. The research focuses on developing and evaluating integrated resource risk management and forecasting tools, evaluating measures of resource stewardship, assessing the usefulness of nontraditional water resources, understanding multimedia phenomena impacts on natural resources, and learning how to use ecosystem services.

Research Value

This program develops tools, knowledge, and data that electric power companies will require to understand the perspectives of all water resource stakeholders, participate in evolving water and electric power policy development, build strategies for a natural resource-constrained future, and address questions raised by lending institutions and investors concerning potential natural resource-based limitations on business operations and growth. Water resource sustainability is receiving increased interest from many constituencies. Examples include

- The U.S. Environmental Protection Agency's (EPA's) Office of Water request to the Science Advisory Board to provide a consultation on the data, information, and analytical methodology to evaluate the value of water to the U.S. economy and provide a resource for future decision making;
- Requests from financial institutions, stakeholders, and stockholders for utilities and other companies to develop water use data (water footprinting) and water sustainability plans; and
- The United Nations-adopted Falkenmark Water Stress Indicator, the most widely cited measure of water scarcity, which indicates that global water stress conditions will increase over the next decade.

This research helps to develop and implement cost-efficient, risk-based strategies for improved power plant water use efficiency, reduced power plant water demand, and management of the increasing climate variability impacts on utility operations. The focus is on developing and evaluating resource management and forecasting tools, integrated engineering/economic risk management plans, nontraditional water resources, and ecosystem service opportunities. Whether used domestically or in an international setting, these tools can promote more-effective plans for managing water and other natural resources. This research will help power companies site future thermal generation facilities as well as consider location of other generation sources such as renewable technologies. The public will benefit from such proactive planning measures and may see considerable savings in the cost of electricity over time through active management of water and other natural resources.

Approach

The program delivers scientific knowledge, practical guidance, proven decision-support tools, resource risk management strategy evaluations, and technology assessments. Program information and research results are disseminated through reports, papers, webcasts, briefs, and presentation materials. The program delivers

- Decision-support tools for water resource and other natural resource use management, development of water and other natural-resource knowledge bases, and integrated sustainability assessments of regional power and water supplies;
- Guidelines, tools, and information to evaluate watershed benefits of water-saving technologies and strategies;
- Strategies for and information on use of nontraditional water resources, such as sewage treatment plant discharge, saline groundwater, produced water from oil and natural gas extraction, agricultural drainage, and stormwater runoff;
- Data, information, and tools to assess and manage ecosystem services to offset regulatory constraints; and
- Efficient natural resource management for maintenance and growth of electric power generation capacity.

Accomplishments

For the last decade, EPRI has been a leader in creating and communicating understanding of the emerging issue of energy/water sustainability. EPRI has published more than 20 technical reports on the subject, covering research needs, national water availability assessments, water resource risk management methodologies, and technical evaluations to reduce power plant water use. EPRI has played a key role in numerous professional society, foundation, and government workshops and conferences to address the energy/water nexus. Existing EPRI research suggests that facility-specific savings can range from tens of thousands to tens of millions of dollars. Program accomplishments include

- Engineering and economic analyses of advanced cooling technologies and use of nontraditional water sources,
- Analyses of trends in water resource quantity and quality and implications for the electric power sector,
- A national assessment of water availability for thermoelectric power generation,
- Assessment of stormwater use by thermoelectric generation, and
- Management and assessment methodologies for energy/water sustainability.

Current Year Activities

Program R&D for 2013 will address enhancement and application of an EPRI cross-sector risk framework for managing water availability, a national analysis of water consumption trends and projections, methodologies to estimate forced evaporation, a review of nontraditional water source applications in the electric power sector, linkage of multimedia models, and a comparative analysis of ecosystem service models. This program's research agenda is an integral component of EPRI's Technology Innovation Cross-Sector Water Research, which includes demonstrations and pilots of emerging technologies and proof-of-concept studies of novel technologies to reduce power plant freshwater use. This program evaluates the efficacy of these different technologies to meet community and regional electric power/water resource sustainability needs. Specific program efforts will include

- Enhancement and testing of a new decision-support methodology, Water Prism, to assess and manage regional water resources, forecast water availability and shortages, and evaluate alternative multisector water use reduction strategies and technologies;
- Expansion of EPRI's previous analysis of national freshwater withdrawal trends and projections to water consumption;
- Initiation of a study to evaluate methodologies to calculate forced evaporation;

- Initiation of a review of specific nontraditional water source applications by electric power generating stations;
- Initiation of a study to link and test atmospheric, watershed, food web, and ecological population models; and
- Completion of a comparative analysis of ecosystem service models.

Estimated 2013 Program Funding

\$1.5M

Program Manager

Robert Goldstein, 650-855-2154, rogoldst@epri.com

Summary of Projects

Project Number	Project Title	Description
P55.001	Water Availability	This project evaluates and creates planning strategies to address current and future water availability constraints on electric power generation. The project provides data, information, and tools to analyze and project water demand and supply within watersheds and regions under multiple future scenarios, including population and economic growth, land use change, new-technology development, and climate variability. The research also analyzes alternative management plans,
P55.002	Nontraditional Water Use	By creating new knowledge bases and conducting case studies, this project provides guidelines, strategies, tools, and information for use, and for dollar- and energy-cost optimization, of nontraditional water sources to meet water conservation requirements of permits, regulations, and policies.
P55.003	Cross Media Issues	The project produces and uses knowledge centers, analytic tools and case studies to conduct risk assessment and management studies for ecological habitat, populations, communities and ecosystems exposed to interacting stresses, the sources of which may be located in multiple media.
P55.004	Ecosystem Services	The project evaluates the role of ecosystem services in the power industry and where corporate risks and opportunities may be present. The project includes analysis of ecosystem service modeling tools, case studies of other industries, and evaluation of the business case for incorporating ecosystem services into corporate decision making.

P55.001 Water Availability (073490)

Key Research Question

Rapidly growing demand for clean, fresh water, coupled with the need to protect and enhance the environment, have made many areas of the United States vulnerable to water shortages. Such shortages could cause reductions in current supplies of electricity and could have direct impacts on power system planning and expansion. Water and energy shortages can occur relatively suddenly and can have adverse impacts on local and regional economies. To address this critical issue, research needs include creation and demonstration of decision-support tools for watershed management and power plant water use, development of water resource knowledge bases, and integrated sustainability assessments of regional power and water supply.

Approach

This project evaluates and creates planning strategies to address current and future water availability constraints on electric power generation. The project provides data, information, and tools to analyze and project water demand and supply within watersheds and regions under multiple future scenarios, including population and economic growth, land use change, new-technology development, and climate variability. The research also analyzes alternative management plans, including siting and design of new plants and retrofits of existing plants, for increased water use efficiency and minimization of water use.

Impact

- Develops cost-effective business strategies to address current and future water availability limitations
- Provides strategies for increased water and energy use efficiency, water conservation, and cost savings
- Leverages government-funded research to address industry needs
- Leverages public water supply and wastewater treatment sector-funded research

How to Apply Results

Power company environment, generation, and planning staff will extract information from project reports, papers, issue briefs, and presentation material. This information will also be disseminated to community water resource stakeholders and government agencies. Members will use results to support decision making with respect to meeting community and government pressures to increase water use efficiency and reduce water use in both existing and new plants. Members will use results to guide design and siting of new generation. In addition, EPRI will facilitate broader use and awareness of the results by presenting webcasts; briefing key stakeholders, including EPA and state agencies; developing materials for the trade press/media; and continuing service on various government, academic, and professional organization advisory panels.

2013 Products

Product Title & Description	Planned Completion Date	Product Type
Water Prism: Phase Two - Year 2: Water Prism is an EPRI-developed decision support tool that evaluates alternative multisector, community/regional water resource sustainability management plans over a 50-year time horizon. Under Phase Two, the tool will be enhanced by adding new data handling and manipulation routines, graphics, and a help system. In addition, new case studies to test overall tool functionality will be performed in water-constrained regions, the feasibility of adding economic and temperature analyses to the tool will be evaluated, and a user manual will be produced. Progress will be periodically reported by webinar and advisory committee presentations. A final report and user manual will be published in Year Three.	12/31/13	Technical Report

Product Title & Description	Planned Completion Date	Product Type
National Water Consumption Assessment and Projection - Year 2: In 2011, EPRI completed and published an analysis of recent trends and future projections of nationwide, multisector water withdrawals by county. In 2012, EPRI started the current project, which will be completed in 2013, to extend its previous analysis to water consumption, to evaluate projection scenarios that include changes in agriculture, and to compare EPRI's methodology and results with those of other organizations conducting similar analyses.	12/31/13	Technical Resource
Methodologies for Assessing Forced Evaporation - Year 1: Power plants with once-through cooling consume water by increasing evaporation in the waterbody that receives their thermal discharges. This additional evaporation is commonly referred to as forced evaporation. In constructing and evaluating watershed and regional water resource budgets and plans, it is necessary to be able to estimate and account for forced evaporation. Forced evaporation is dependent on numerous site-specific factors. This is the first year of a two-year project to technically review and compare different methodologies for estimating forced evaporation.	12/31/13	Technical Resource

Future Year Products

Product Title & Description	Planned Completion Date	Product Type
Water Prism: Phase Two - Year 3: Water Prism is an EPRI-developed decision support tool that evaluates alternative multisector, community/regional water resource sustainability management plans over a 50-year time horizon. Under Phase Two, the tool will be enhanced by adding new data handling and manipulation routines, graphics, and a help system. In addition, new case studies to test overall tool functionality will be performed in water-constrained regions, the feasibility of adding economic and temperature analyses to the tool will be evaluated, and a user manual will be produced. Progress will be periodically reported by webinar and advisory committee presentations. A final report and user manual will be published in Year Three.	12/31/14	Technical Report
Methodologies for Assessing Forced Evaporation - Year 2: Power plants with once-through cooling consume water by increasing evaporation in the waterbody that receives their thermal discharges. This additional evaporation is commonly referred to as forced evaporation. In constructing and evaluating watershed and regional water resource budgets and plans, it is necessary to be able to estimate and account for forced evaporation. Forced evaporation is dependent on numerous site-specific factors. This is the concluding year of a two-year project to technically review and compare different methodologies for estimating forced evaporation.	12/31/14	Technical Report
Case Studies of Water Stewardship Metrics - Year 1: In a previous EPRI study completed in 2012, approximately twenty different proposed metrics for evaluating a facility's water stewardship were reviewed. Commonalities and differences were highlighted. Four case studies, one a power plant, were conducted to evaluate how several factors in the metrics worked. The objective of this project is to apply the common factors to a diverse group of power plants to better understand the strengths and weaknesses of the different factors. Note that financial institutions, investors, and shareholders are increasingly asking power companies to document their water usage. Institutions and shareholders may not lend money to or invest in organizations whose operations are constrained by available water nor in communities whose economic growth is constrained by available water. This is the first year of a two-year effort.	12/31/14	Technical Resource

Product Title & Description	Planned Completion Date	Product Type
Case Studies of Water Stewardship Metrics - Year 2: In a previous EPRI study completed in 2012, approximately twenty different proposed metrics for evaluating a facility's water stewardship were reviewed. Commonalities and differences were highlighted. Four case studies, one a power plant, were conducted to evaluate how several metrics worked. The objective of this project is to apply the common factors to a diverse group of power plants to better understand the strengths and weaknesses of the different factors. Note that financial institutions, investors, and shareholders are increasingly asking power companies to document their water usage. Institutions and shareholders may not lend money to or invest in organizations whose operations are constrained by available water nor in communities whose economic growth is constrained by available water. This is the concluding year of a two-year effort.	12/31/15	Technical Report
Non-Power Sector Water Conservation -Year One: In developing a sustainable water resource management plan for a community/watershed/region, it is important to examine scenarios that consider water conservation technologies and strategies for all water-using sectors. Hence, it is critical for the electric power sector to understand how other sectors use water, and how their use can be reduced by existing technologies and anticipated future technologies. This study will collect and evaluate data on current and potential future water-saving technologies and strategies that can be employed by the agriculture, municipal, and industrial sectors. This is the first year of a two-year study.	12/31/15	Technical Resource

P55.002 Nontraditional Water Use (070655)

Key Research Question

Thermoelectric power plants need sufficient water supplies to meet generation demands. Most of the water used by thermoelectric power plants is fresh water. Power companies are experiencing growing pressure to reduce their freshwater use. One strategy for accomplishing this goal is to use nontraditional sources of water, such as sewage treatment plant discharge, saline groundwater, water produced in association with oil and gas extraction, agricultural drainage, mine water, and stormwater runoff. There is also potential for generating plants to recycle their own wastewater streams. Depending on the quality of nontraditional water sources and their intended use within the plant, the source water may require pre- or post-use treatment, reduction of cycles of concentration, or, in the case of retrofits, replacement of existing cooling system materials. Hence, nontraditional water sources have potential energy and dollar costs associated with their use that go beyond those for freshwater use. Research needs include regional identification, quantity/quality assessment, and site-specific risk management case studies of nontraditional source potential.

Approach

By creating new knowledge bases and conducting case studies, this project provides guidelines, strategies, tools, and information for use, and for dollar- and energy-cost optimization, of nontraditional water sources to meet water conservation requirements of permits, regulations, and policies. The project addresses siting and construction of new plants and retrofitting of existing plants. This project is closely integrated with a supplemental project on advanced cooling technologies and the Technology Innovation project on novel water-saving technologies. The supplemental project focuses on technologies that are far advanced with respect to development and are either ready or nearly ready for demonstration and pilot testing. The Technology Innovation project focuses on technologies that are in the discovery or early-development stages.

Impact

- Reduces impacts of nontraditional water sources on power plant performance and on operations and maintenance costs
- Expedites permitting by providing guidelines, tools, strategies, and information for the use and optimization of nontraditional water sources to meet water conservation requirements
- Evaluates innovative freshwater-conserving technologies for use at thermoelectric power plants

How to Apply Results

Power company environmental and generation staff will apply project results to evaluate the use of nontraditional water sources to reduce water consumption for cooling and other power plant needs, thus reducing vulnerability to future water shortages. U.S. Department of Energy and vendor cost sharing will be solicited. Workshops and webcasts will be held to foster communication of results to members, vendors, the public and government agencies.

2013 Products

Product Title & Description	Planned Completion Date	Product Type
Review of Current Nontraditional Water Use Applications - Year One: This is the first year of a two-year study to evaluate the latest research and application results regarding the use of nontraditional water sources and water recycling for power plant use.	12/31/13	Technical Resource

Future Year Products

Product Title & Description	Planned Completion Date	Product Type
Review of Current Nontraditional Water Use Applications - Year Two: This is the second year of a two-year study to evaluate the latest research and application results regarding the use of nontraditional water sources and water recycling for power plant use.	12/31/14	Technical Report
Innovative Uses of Nontraditional Water Sources - Year One: This is the first year of a two-year study to develop innovative strategies among water using sectors (electric power, industrial, agriculture, municipal) to use degraded waters in a cooperative manner that would reduce overall freshwater use within the watershed/region.	12/31/15	Technical Resource

P55.003 Cross Media Issues (073491)

Key Research Question

Traditionally, regulatory agencies have segregated issues by medium (e.g., water, land, air); however, often a pollutant created in one medium will have potential consequences in another medium. For example, heavy metals and nutrients emitted to the atmosphere can potentially impact endangered and threatened species in streams, rivers, lakes, estuaries, and coastal waters. In order to conduct risk assessments and management studies regarding such issues, it is critical to be able to link the states of science with respect to intermedia cycling and effects of specific substances.

Approach

The project produces and uses knowledge centers, analytical tools, and case studies to conduct risk assessment and management studies for ecological habitats, populations, communities, and ecosystems exposed to interacting stresses, the sources of which may be located in multiple media. A key research gap is the linking of state-of-the-art atmospheric deposition, meteorological, watershed cycling, food web, and ecological population models and demonstration of their utility through application to field data. Model linking research will be conducted collaboratively with EPRI's Air Quality Research Area.

Impact

- Increased understanding on how to secure operating permits in the face of challenges regarding ecological population impacts
- New tools to conduct risk assessment and management studies of endangered and threatened species
- Powerful frameworks that allow the placement of power plant emissions and discharges into perspective with other pollutant sources and stressors

How to Apply Results

Power company environment, generation, and planning staff will extract information from project reports, papers, issue briefs, and presentation material. This information will also be disseminated to community water resource stakeholders and government agencies. Members will use results to support decision making with respect to meeting community and government pressures to protect ecological habitat and species. Members will use results to guide design and siting of new generation. In addition, EPRI will facilitate broader use and awareness of the results by presenting webcasts; briefing key stakeholders, including EPA, the U.S. Department of Interior, the U.S. Department of Energy, the U.S. Army Corps of Engineers, and state agencies; developing materials for the trade press/media; and continuing service on various government, academic, and professional organization advisory panels.

2013 Products

Product Title & Description	Planned Completion Date	Product Type
Link and Demonstrate Multimedia Models - Year One: The objective of this study is to develop a multimedia tool by linking state-of-the-art atmospheric, watershed, and ecological population models that can be used for risk assessment and management studies of multimedia phenomena. The tool will be tested on specific case studies where a pollutant (e.g., nutrient, heavy metal) can have several sources of origin in multiple media. Progress will be reported periodically in webcasts and advisory meeting presentations. A final report will be published in the third year.	12/31/13	Technical Resource

Future Year Products

Product Title & Description	Planned Completion Date	Product Type
Link and Demonstrate Multimedia Models - Year Two: This is the second year of a study to develop a multimedia tool by linking state-of-the-art atmospheric, watershed, and ecological population models that can be use for risk assessment and management studies of multimedia phenomena. The tool will be tested on specific case studies where a pollutant (e.g., nutrient, heavy metal) can have several sources of origin in multiple media. Progress will be reported periodically in webcasts and advisory meeting presentations. A final report will be published in the third year.	12/31/14	Technical Resource

Product Title & Description	Planned Completion Date	Product Type
Link and Demonstrate Multimedia Models - Year Three: This is the third year of a study to develop a multimedia tool by linking state-of-the-art atmospheric, watershed, and ecological population models that can be use for risk assessment and management studies of multimedia phenomena. The tool will be tested on specific case studies where a pollutant (e.g., nutrient, heavy metal) can have several sources of origin in multiple media. Progress will be reported periodically in webcasts and advisory meeting presentations. A final report will be published in the third year.	12/31/15	Technical Report

P55.004 Ecosystem Services (073492)

Key Research Question

Humanity benefits from a multitude of ecosystem services, such as pollination, decomposition of wastes, water filtration, climate regulation, and others. The power industry itself relies on the predictable supply of these services. Many have argued that the financial value of ecosystem services should dictate corporate management decisions, especially land management decisions. However, the business case for such an argument has not been sufficiently tested, especially in the power industry. Given the focus of agencies and environmental groups on ecosystem services, there is corporate risk for not understanding how corporate management decisions are affecting underlying ecosystem service functions. This project will analyze the role of ecosystem services in corporate management in the power industry.

Approach

This work will deepen the understanding of and communication on ecosystem services on the part of EPRI members. It will evaluate the role of ecosystem services in the power industry and where corporate risks and opportunities may be present. This will include analysis of ecosystem service modeling tools, case studies of other industries, and evaluation of the business case for incorporating ecosystem services into corporate decision making.

Impact

The results of this effort will demonstrate the potential to use ecosystem service evaluations to increase revenue, facilitate response to regulatory demands, and meet corporate stewardship targets. Further, the work will demonstrate the extent to which companies should incorporate ecosystem service into strategic management decisions and will provide examples of how other industries are maximizing value by evaluation of ecosystem services.

How to Apply Results

The results of this effort will support strategic corporate asset assessments, natural resources management decisions, and corporate property management.

2013 Products

Product Title & Description	Planned Completion Date	Product Type
Evaluation of Ecosystem Service Models: This report will compare available ecosystem service models to support strategic land management planning.	12/31/13	Technical Report
Consideration of Business Value of Ecosystem Services: The objective of this workshop will be to evaluate the corporate business case for ecosystem service valuation and how this valuation affects land management decisions.	12/31/13	Technical Resource

Future Year Products

Product Title & Description	Planned Completion Date	Product Type
Business Case for Ecosystem Services: Case Study of Power Industry: While many academic articles suggest the mammoth financial value of ecosystem services, it is not yet clear how this theoretical value alters day-to-day decision making. A journal article will evaluate the actual economic value and costs of incorporating ecosystem services into corporate decision making in the power industry.	12/31/14	Peer Literature
Integrating Ecosystem Services into Property Appraisals: This resource will identify the specific changes to traditional property appraisals needed to incorporate ecosystem service values and will summarize the circumstances in which a company needs to conduct an "eco-asset" appraisal versus a traditional property appraisal.	12/31/15	Technical Resource

Supplemental Projects

Assessment of Water Availability Risk to Power Generation (072161)

Background, Objectives, and New Learnings

Along with other societal and economic sectors, electric power generators use significant quantities of water and therefore must manage accompanying environmental, regulatory, reputational, and financial risks. Many technologies and strategies are available to the electric power, municipal, industrial, and agricultural sectors that potentially could be implemented to reduce freshwater use—especially under critical drought conditions—and could help water users accommodate future demands. The establishment of a roadmap for meeting water demands under available water resources is complex due to many combinations of technologies and strategies that can be applied across sectors to achieve water savings. Assessment of water limitations for power generation and evaluation of benefits of multisector water-saving strategies to reduce risk can be addressed through application of a decision-support system called Water Prism.

Water Prism uses a water balance approach to compare water demand with water availability within a watershed under current and projected “business as usual” conditions. A background watershed model and information regarding groundwater resources inform the Water Prism system regarding available water supply. Water Prism also accounts for ecological water needs within the system (e.g., minimum flows or reservoir levels). Data input requirements for the application of Water Prism include climate, land use, current water withdrawal and discharge records, and projected water demands.

Project Approach and Summary

Water Prism will support decision making for power plant siting and retrofit options by letting users consider current and future electric power sector water demands and explore opportunities to reduce water needs with various generation types, advanced cooling technologies, nontraditional water sources, and in-plant water reuse. The tool will recognize watershed and regional hydrology characteristics, water demands of competing water resource stakeholders, and community water-sharing strategies. Water Prism will help evaluate potential benefits of water risk reduction for the electric power and other sectors and represent results through graphical output similar to EPRI’s Prism analysis (which focuses on potential electricity-sector greenhouse-gas-emission reductions).

Water Prism scenarios will be constructed to forecast water availability constraints for existing and proposed generation plants and to evaluate how implementation of various water-saving strategies may result in a shift of the demand curve so that water needs will be met within the bounds of available supply. Strategies may include opportunities within one or more sectors such as

- Electric power: in-plant reuse, nontraditional water sources, advanced cooling technologies
- Agricultural: low-water-use crops, water-efficient irrigation, retirement of agricultural land
- Municipal: water-efficient fixtures, low-water-use landscaping, distribution system maintenance
- Industrial: nontraditional water sources, in-plant reuse, rainwater capture
- Ecosystem demand: flexibility within a range of ecosystem constraints

Benefits

This project will allow electric power companies as well as the public to assess and manage risk of water shortages. The outcomes of this work will be evaluations of existing or planned generation, and of alternative technologies and strategies for reducing risk. The research will also assist participants in better understanding the potential benefits of water-saving technologies in all water-using sectors within the context of available supply.