

# PROJECT facts

U.S. DEPARTMENT OF ENERGY  
OFFICE OF FOSSIL ENERGY  
NATIONAL ENERGY TECHNOLOGY LABORATORY

Innovations for  
Existing Plants

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## TECHNOLOGY TO FACILITATE THE USE OF IMPAIRED WATERS IN COOLING TOWERS PROMIS/PROJECT No.: DE-NT0005961

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### Background

Research and analysis are being conducted to evaluate and develop cost-effective approaches to using non-traditional (aka impaired or alternative) sources of water to supplement or replace freshwater for cooling and other power plant needs. Opportunities exist for the utilization of lower-quality, non-traditional water sources. Examples of non-traditional waters include surface and underground mine pool water, coal-bed methane produced waters, and industrial and/or municipal wastewater. The U.S. Department of Energy's (DOE) Innovations for Existing Plants (IEP) Program research is developing a coupled system for the removal of silica from impaired water for use in power plant cooling towers. Cost-effective technologies capable of treating non-traditional water sources for use in the power industry will greatly reduce the overall high-quality freshwater withdrawal.

### Description

To reduce high-quality freshwater withdrawal and consumption for power production, GE Global Research is developing new technologies aimed at promoting the use of impaired waters for power plant cooling operations. Using effective treatment methods to make non-traditional water sources available to power-plant water needs will allow power plants that are affected by water shortages to continue to operate at full capacity without adversely affecting local communities or the environment by limiting freshwater withdrawals.

### Primary Project Goal

The primary goal of this project is to reduce/minimize high-quality freshwater withdrawal and consumption through the development and use of non-traditional water treatment technologies.



## PARTNERS

GE Global Research  
GE Water and Process Technologies

## Objectives

The objective is to develop a new ligand-functionalized core material LFCM for the removal of silica from impaired water and couple this technology to electrodialysis reversal (EDR) for the 50 percent reduction of fresh water withdrawal at less than \$3.90 kgal of water (Figure 1). The project is divided into three phases with milestones and “go/no-go” decision points. The objectives of each phase of the proposed program are:

### Phase I: Material Selection and Synthesis

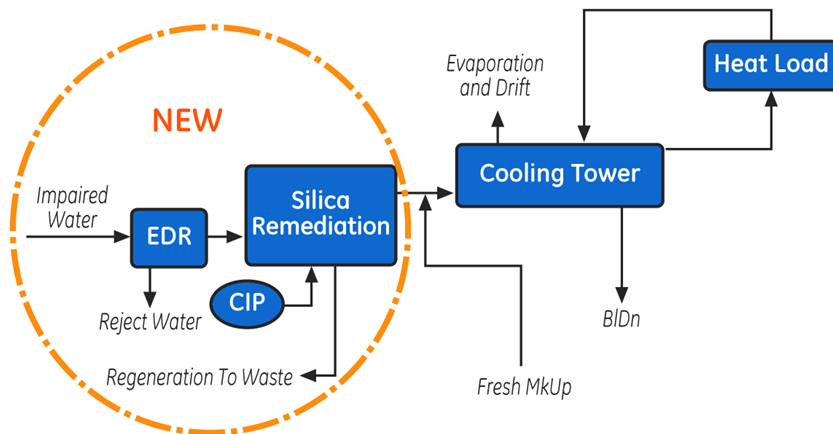
- Synthesize core materials that are easily isolated and can be used for attachment to silica removal ligands.
- Synthesize silica removal ligands.
- Chemically attach ligands to cores, making ligand-functionalized cores.
- Evaluate the ligand-functionalized core materials for their ability to reduce silica from 100 ppm to 20 ppm.
- Develop a cost model for the new process.

### Phase II: Material Recycle and Bench-Top Demonstration

- Develop a recycle protocol for the ligand-functionalized core materials.
- Demonstrate the silica removal process on a bench-top unit using EDR permeate simulant.
- Update cost model including bench-top and recycle results.

### Phase III: Design Engineering, Scale-Up, and Demonstration

- Scale-up synthesis of ligand-functionalized core materials for use in pilot plant operation.
- Engineer and implement changes in pilot plant to demonstrate EDR/silica removal process.
- Demonstrate completely integrated EDR/silica removal and core recycle protocol on a pilot plant cooling tower.
- Finalize cost model and develop a final cost of water for this process.



No Change Other Than Use of Impaired Water

State	Fresh MkUp	BDn	Impaired	EDR BDn	Regen BDn	Evaporation	% Savings of Fresh Water
Current	11,194	2,239	0	0	0	8,955	0
New	5,547	2,239	6,101	-554	-?	8,955	50

Recirculation Rate = 430,000 gpm Current Cycles = 5

Figure 1: Schematic of the Electrodialysis Reversal Process for use with Impaired Waters.

**PERIOD OF PERFORMANCE**

10/01/08 to 09/30/11

**COST**

**Total Project Value**  
\$1,934,723

**DOE/Non-DOE Share**  
\$1,354,306 / \$580,417

**Benefits**

The main benefit of this research will allow for treatment of non-traditional waters for use in power plant cooling operations, ultimately leading to reductions in overall high-quality freshwater withdrawal and consumption.

**Planned Activities**

GE Global Research will work with the GE Water and Process Technology team to prepare LFCMs. The GE Global Research team will develop a recycle protocol for releasing the silica and regenerating a reusable LFCM. The GE Water and Process Technology team will demonstrate the silica removal ability of the LFCM on a bench-top cooling tower simulation unit. The successful LFCM will be scaled-up by the GE Global Research team, and this material, along with the recycle protocol, will be provided to the GE Water and Process Technology team to use at a pilot scale to fully demonstrate the technology. Throughout the course of the program, a cost model will be developed, updated, and finalized to predict the final cost of water and percent reduction in fresh water withdrawal.

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This three-year program is divided into three, year-long phases and 12 individual tasks (including Project Management Task 1). At the end of Phase I, a "Go/No-Go" decision will be made based on the team's ability to demonstrate silica removal from water. At the end of Phase II, a "go/no-go" decision will be made based on the predicted cost of water being equal to or less than \$4.50/kgal. Phase III involves scaling-up of LFCMs for use at the GEWPT's Treviso pilot plant site.