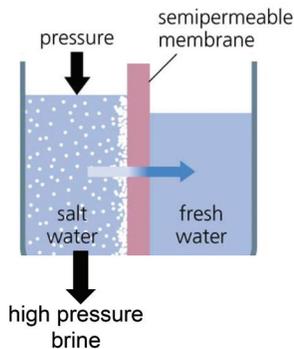


Flow-Through Electrode Capacitive Deionization

reducing the cost of brackish desalination and increasing water reuse

THE ISSUE: RO • High Energy Costs

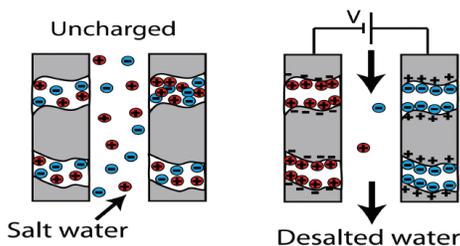
The primary desalination technology used today is reverse osmosis (RO), which incurs **high energy costs** by pushing water across a membrane to filter out the salt.



Reverse osmosis is the state-of-the-art technology, which pushes water through membranes.

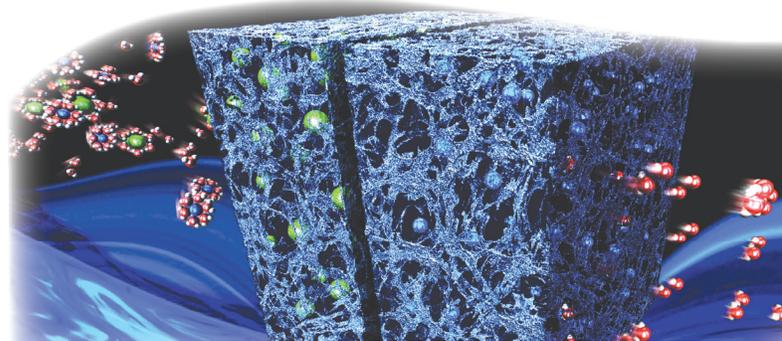
THE SOLUTION: FTE-CD • Lower energy costs

Lawrence Livermore National Laboratory (LLNL) developed a novel capacitive deionization (CDI) process called flow-through electrode capacitive deionization (FTE-CD), which can significantly reduce energy and desalination costs by using electric fields that pull salt from water.



CDI uses porous electrodes, to which voltage is applied, to pull salt from the water.

FTE-CD is generally more cost efficient than RO for treating low-salinity water, but the exact cost is highly dependent on the specific problem. For example, the estimated cost to reduce brackish water at 5,000 ppm (representative of salinity in the western Delta) to drinking water quality at 500 ppm would be about 50% of the cost to use RO on the same quality of water (i.e., \$672/acre-foot (AF) compared to \$1,190/AF¹ which includes capital costs, O&M and electricity).



PROJECT INNOVATION

Early CDI devices were plagued by low removal rates and long charge/discharge cycles. LLNL's FTE-CD process employs a new carbon material in a different geometry that overcomes this limitation and increases the process rate by almost an order of magnitude.

¹Baseline RO cost \$985/AF from April 2005 R.W. Beck report (Northern Contra Costa County Feasibility Level Desalination Facility Cost) adjusted to 2015 relative value using CPI. Report available at <http://www.deltadiablo.org/projects-innovations/regional-partnerships/western-delta-water-supply-studies>



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An innovative solution to water and energy challenges

ADDRESSES THE WATER-ENERGY NEXUS

The treatment of brackish water is expected to be the dominant type of desalination for California. FTE-CD can be deployed locally at relatively low scale, in an efficient manner, specific to the water treatment needs of each community.

FTE-CD is a new water treatment technology that will reduce energy needs and treatment costs.

FTE-CD will:

- optimize energy efficiency of brackish desalination
- enhance reliability and resilience of energy and water systems
- increase safe and productive use of non-traditional water sources

PROJECT OVERVIEW:

- **Pilot:** LLNL builds 2 pilot FTE-CD devices, with throughput of 10-20 L/hour, deployed at partner sites Delta Diablo and Los Angeles County.
- **Purpose:** Validate the projected performance of FTE-CD using industrial and municipal wastewater, and determine how this flexible device can improve the rate and efficiency of water treatment techniques.
- **Project Term:** 2.5 years
- **Project Cost/Funding Need:** \$1M
- **Phase II Scale-Up Funding Need:** \$10M
- **Market Readiness:** less than 5 years

FTE-CD has progressed to a stage referred to by investors as the “valley of death.” Its development has advanced beyond basic scientific concepts, but it has not yet achieved industrially relevant maturity, where investors will fund its development and introduction to the market. Grant funding will help bridge the gap and produce scaled-up devices to acquire performance data with water provided by industrial and municipal partners.

“As the population continues to increase, the demand for freshwater for use in industry and households is increasing. At the same time, freshwater supplies are decreasing as glaciers melt, rivers become polluted, and freshwater is simply wasted. Water scarcity is a national security issue, and new sources of freshwater are essential to ensuring peace and prosperity on a worldwide scale.”

- Lawrence Livermore National Laboratory

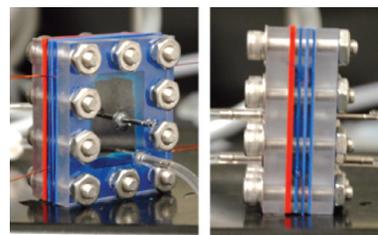
PROJECT BENEFITS:

Greater Reliability: FTE-CD uses robust carbon electrodes instead of fragile membranes used in RO. The electrodes are expected to last longer, require less maintenance than RO, and require minimal chemical pretreatment.

Substantially Lower Costs: **Studies indicate that FTE-CD devices can reduce water treatment costs by up to 50% and reduce energy use by 50% or more** when compared to use of RO technology to treat brackish water.

Environmental Benefits: FTE-CD is expected to produce less wastewater than RO, since higher water recovery ratios can be achieved. FTE-CD can remove nitrates and heavy metals from water, and could be deployed on varying scales locally to mitigate specific hazards. This water treatment approach works well with wind or solar energy.

Energy Security: Energy use is projected to be under 0.5 kWh/m³, compared to the energy use of RO at about 1 kWh/m³.



FTE-CD test cell. This cell uses three electrode pairs measuring 2 cm x 3 cm x 0.4 mm.