RESEARCH BRIEF
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NAWI National Alliance for Water Innovation

# Concentrate Treatment and Chemical Production using Innovative Electrodialysis Processes for Near Zero-Waste Discharge

**Pei Xu** | New Mexico State University

pxu@nmsu.edu

## Challenge

Implementing and expanding inland water desalination and reuse, especially in arid and semi-arid inland areas, is challenging because the desalination process generates a large flow of waste, which is inefficient and expensive to manage. Reducing the brine volume and recovering resources from desalination concentrate are of the utmost importance because advances in these methods have the potential to increase water recovery, reduce the cost of disposal, and enable a more circular economy. The main goal of this project is to reduce the levelized cost of water (LCOW) to a value that achieves pipe parity for the treatment (and valorization) of reverse osmosis (RO) concentrate. The general approach for achieving this goal is to:

1) Develop a lower-energy-demand treatment train that consists of innovative electrodialysis processes to reduce energy consumption,

2) Utilize treatment processes that increase the total water recovery by 10% overall (e.g., from 82% of primary RO to 92%),

3) Generate acids and bases on-site from salt brines created from the treatment process to reduce chemical costs and enhance the sustainability of non-traditional water treatment by turning a waste stream into a resource.

## Research Approach

Based on our previous pilot-scale testing of selective electrodialysis (ED) treating RO concentrate and the new state-of-the-art ED membranes and stack design, we propose a near zero-waste discharge and cost-effective treatment train of treating RO concentrate for enhanced water recovery and chemical production. This project is built upon the existing collaboration with El Paso Water to solve the concentrate management challenges faced by many inland desalination facilities. We propose to conduct a pilot project at the Kay Bailey Hutchinson Desalination Plant (KBHDP) to treat RO concentrate from the facility using a combination of conventional and emerging pre-treatment technologies coupled with several innovative ED processes, including selective ED, brine ED, and bipolar ED.

## Impact

There are several advantages associated with the beneficial reuse of RO concentrate, such as (1) reducing volume and operating cost of brine disposal; (2) providing additional water for beneficial use; and (3) producing chemical products from the RO concentrate for onsite use and offsetting treatment costs. The successful completion of this project will generate updated baseline performance and cost data, laying the foundational work to develop cost-effective, environmentally sustainable technologies that can be applicable to municipalities, industries, as well as small, rural communities with adaptable, modular, and autonomous systems.


**Figure 1.** Overview of the pilot system treating RO concentrate at the KBHDP for water recovery and chemical production.

### RESEARCH PARTNERS

New Mexico State University: Pei Xu, Huiyao Wang, Zachary Stoll, Punhasa Senanayake, Abdiel Lugo, Carolina Saucedo, Fuwad Ahmed.

### REFERENCES

1. Xu, et al. (2018). Study of polyethyleneimine coating on membrane permselectivity and desalination performance during pilot-scale electrodialysis of reverse osmosis concentrate. *Separation and Purification Technology*, 207, 396-405.

2. Xu, et al. (2022). Brackish water desalination for municipal uses: current state-of-the-art, challenges, opportunities, and future prospects. *ACS ES&T Engineering*. 2, 3, 306-322.

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