Addressing the Environmental Impacts of Chloride in Wastewater with a New Technology

Margaret Lumley

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2022 SALT SYMPOSIUM

BOLTON & MENK

Real People. Real Solutions.

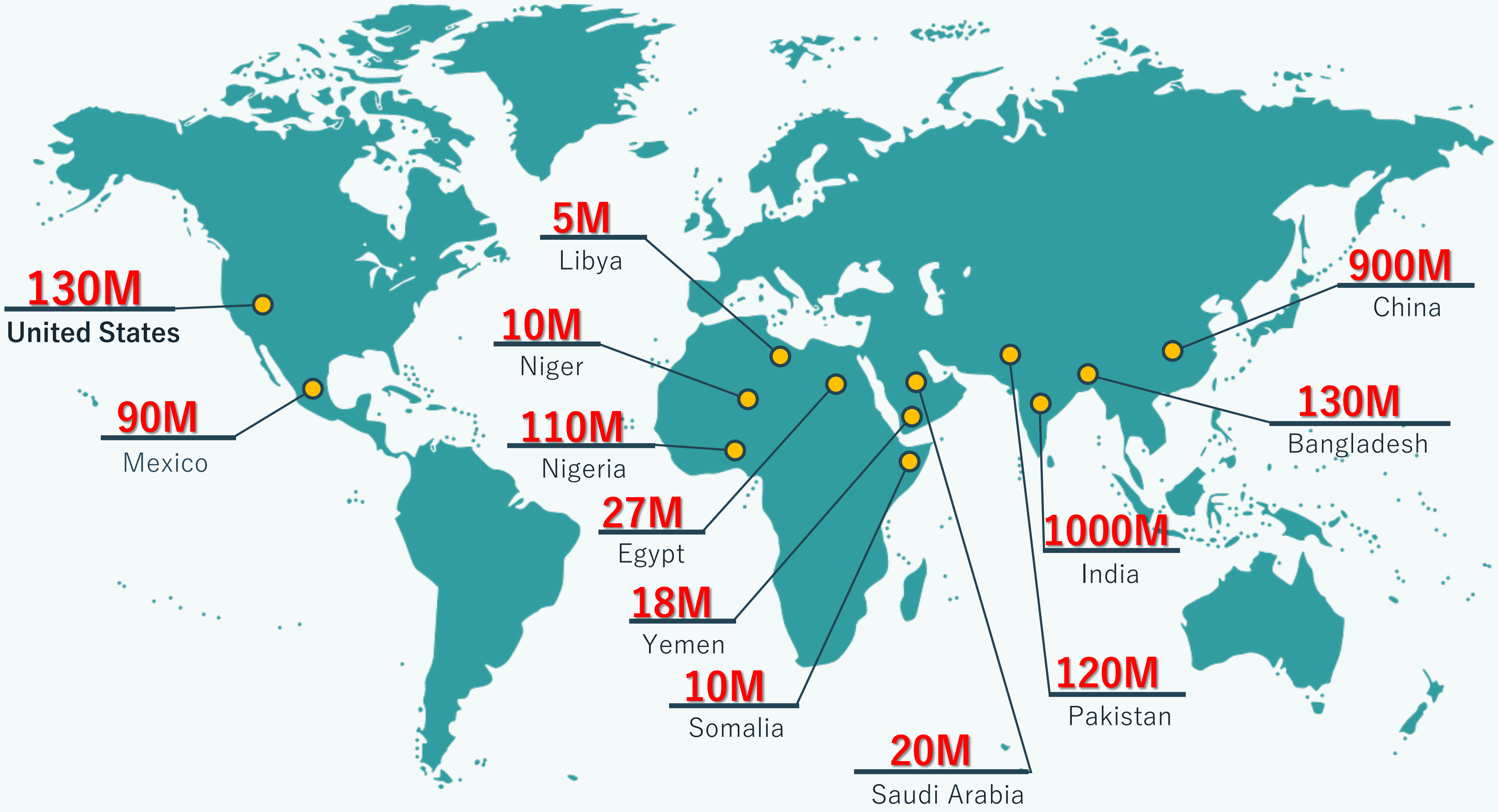
ChloBis Water

Water & Energy Solutions

The Problem: Lack of Access to Fresh Water

4.0 billion people live without sufficient access to fresh water at least 1 month of the year.

*Sci. Adv. 2016, 2, e1500323



The Problem: Water Is Getting Saltier

Colorado River Getting Saltier Sparks Calls for Federal Help

Feb. 1, 2021, 4:00 AM

Listen

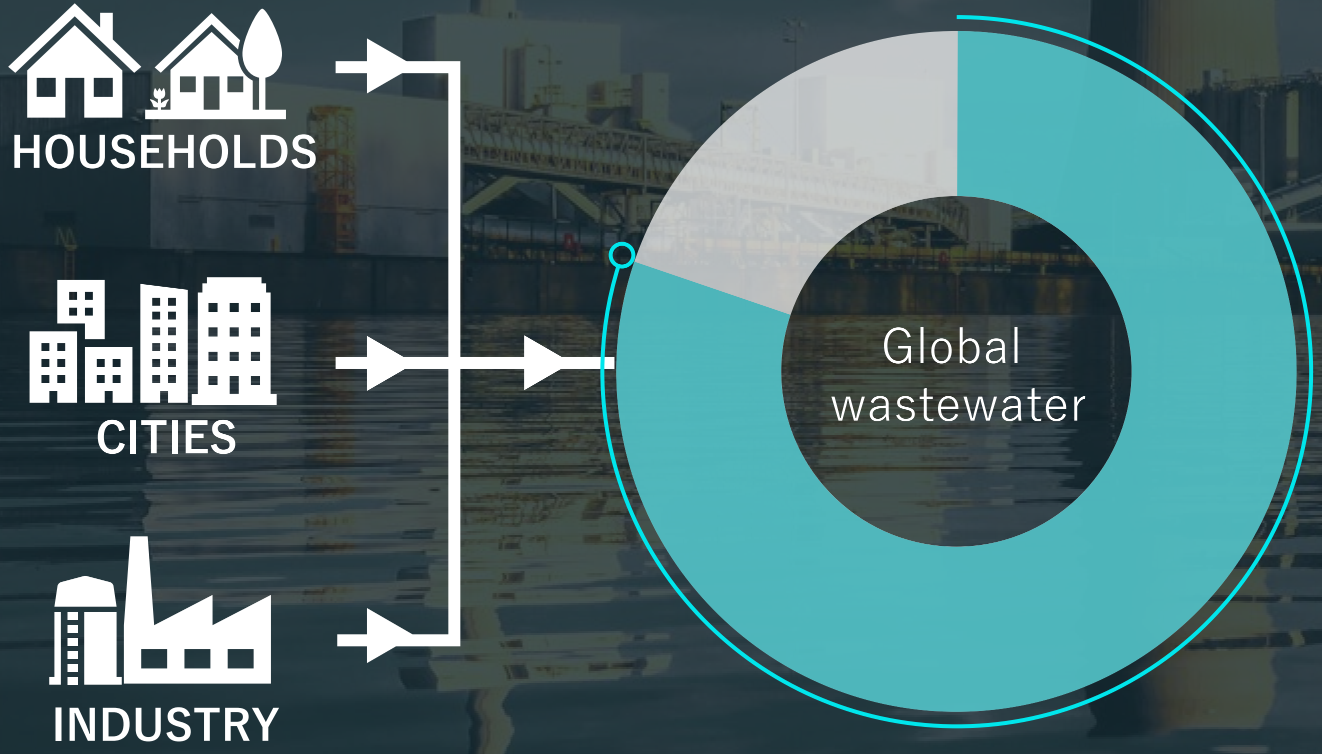
Study finds more than 1M tons of salt is flowing into Lake Michigan each year

Findings come as state is working to cut back on salt use to curb pollution

How salt pollutes Milwaukee's water system

Salt is an important part of keeping roads, sidewalks and driveways safe during the winter, but it also can cause pollution in our lakes, rivers and streams.

The Problem: Untreated Wastewater

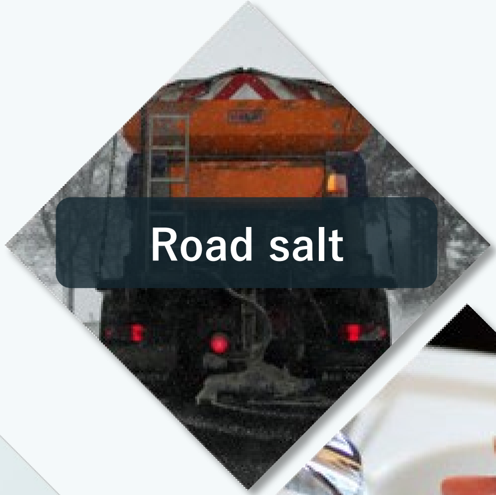


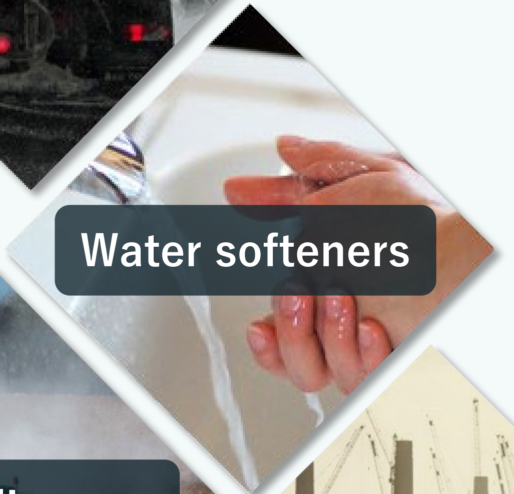
80%

of global wastewater is released to the environment without adequate treatment…

- 2017 UN World Water Development Report

Sources of Salt

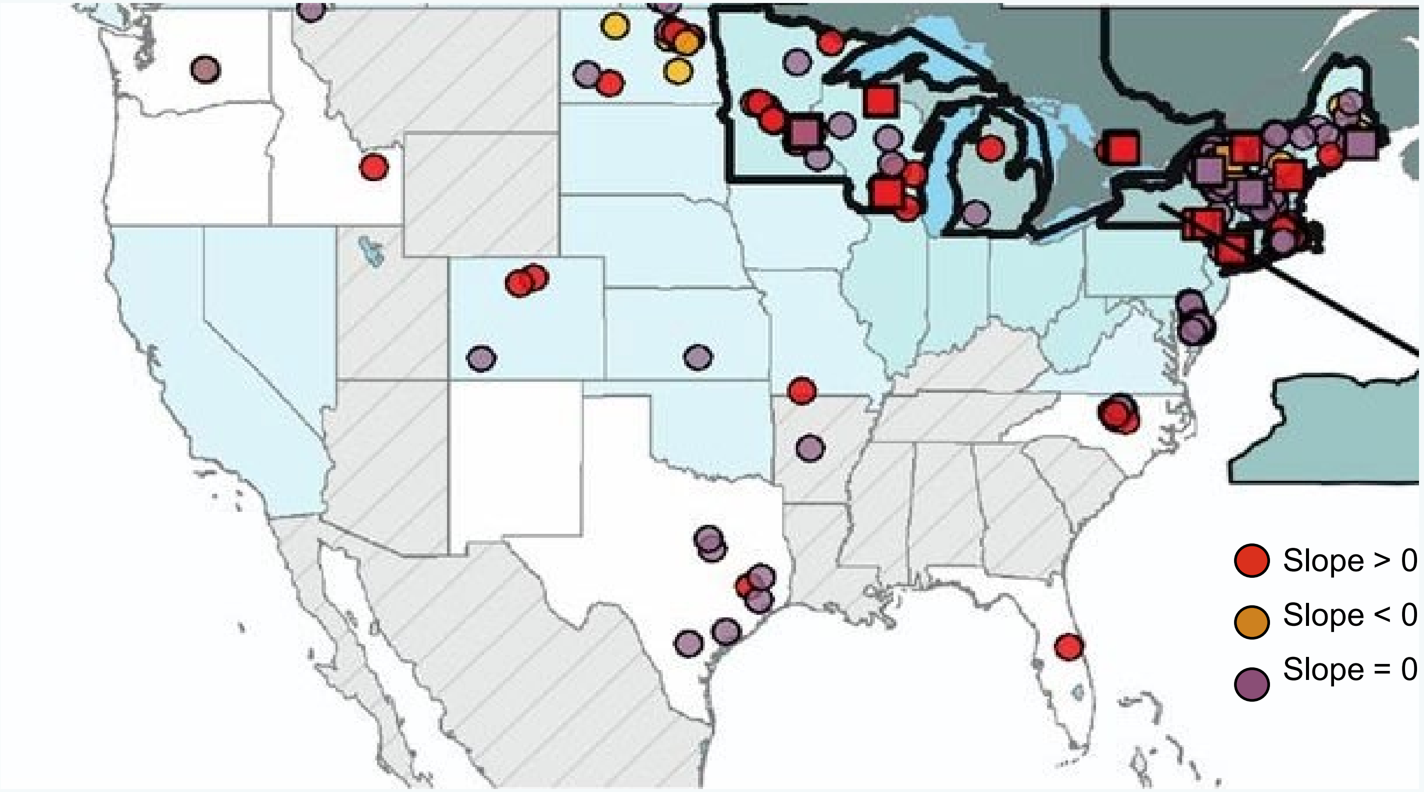




[70 tons of salt] pass through the Madison wastewater treatment plant every day…

- Madison Metropolitan Sewage District

Increasing Chloride Concentrations



7,700 lakes in the Midwest and Northeast are at risk for elevated chloride concentrations!

Dugan, H. et al. *PNAS*, **2017**, *144*, 4453-4458.

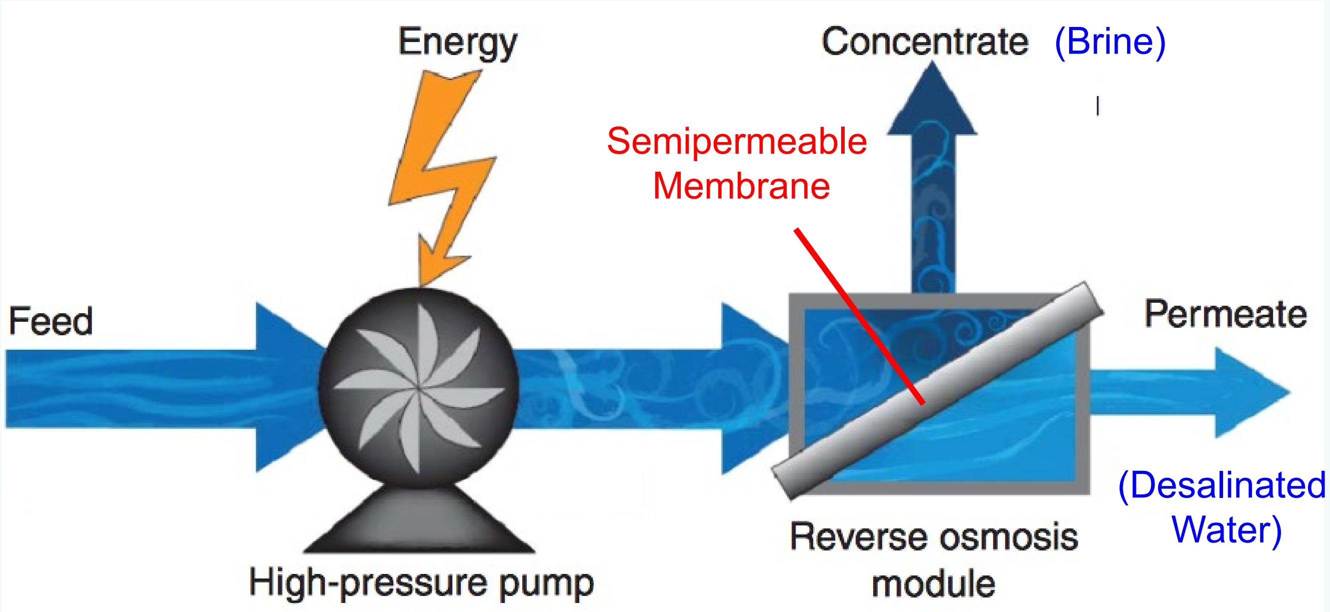
Chloride Effluent Limits

	Wastewater Effluent Chloride Concentration (ppm)	Target Effluent Chloride Concentrations(ppm)
Madison Metropolitan Sewerage District*	414 – 502	395
Alexandria Lakes Area Sanitary District**	515 – 863	230
Sand Creek Watershed***	521 – 618	230

*Chloride Compliance Study Nine Springs Wastewater Treatment Plant, **2015**.
Communities Addressing Chloride Case Study: Alexandria Lakes Sanitary District, **2014.
***Twin Cities Metropolitan Area Chloride Management Plan, **2016**.

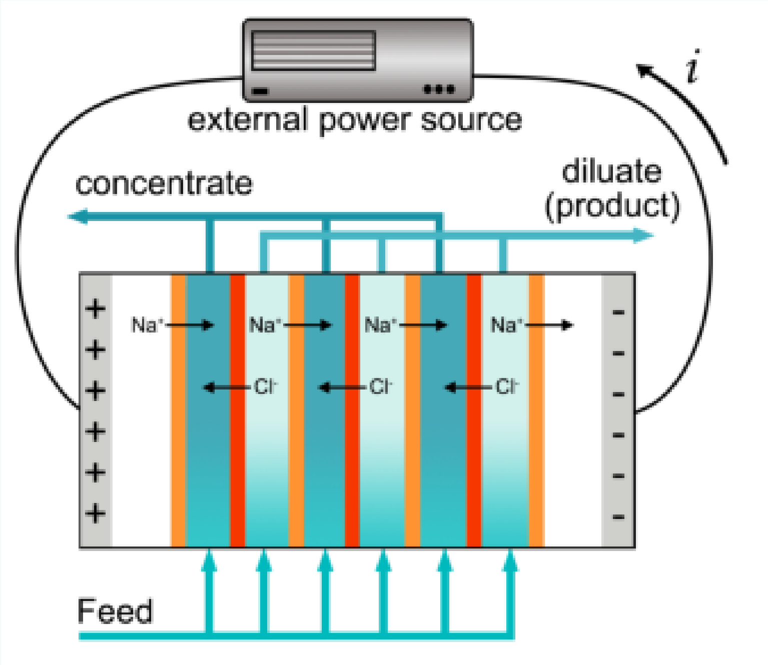
Conventional Desalination Methods

Reverse Osmosis (RO)



RO uses a high-pressure pump to force water through a semi-permeable membrane that allows water to pass but rejects salt

Electrodialysis (ED)



CEM: cation exchange membrane
AEM: anion exchange membrane

ED relies on an electric potential to drive electrochemical reactions, which forces salt to pass through ion-exchange membranes

Elimelech, M. et al. *Science*, **2011**, *333*, 712-717.
Tedesco, M. et al. *J. Membrane Science*, **2016**, *510*, 370-381.

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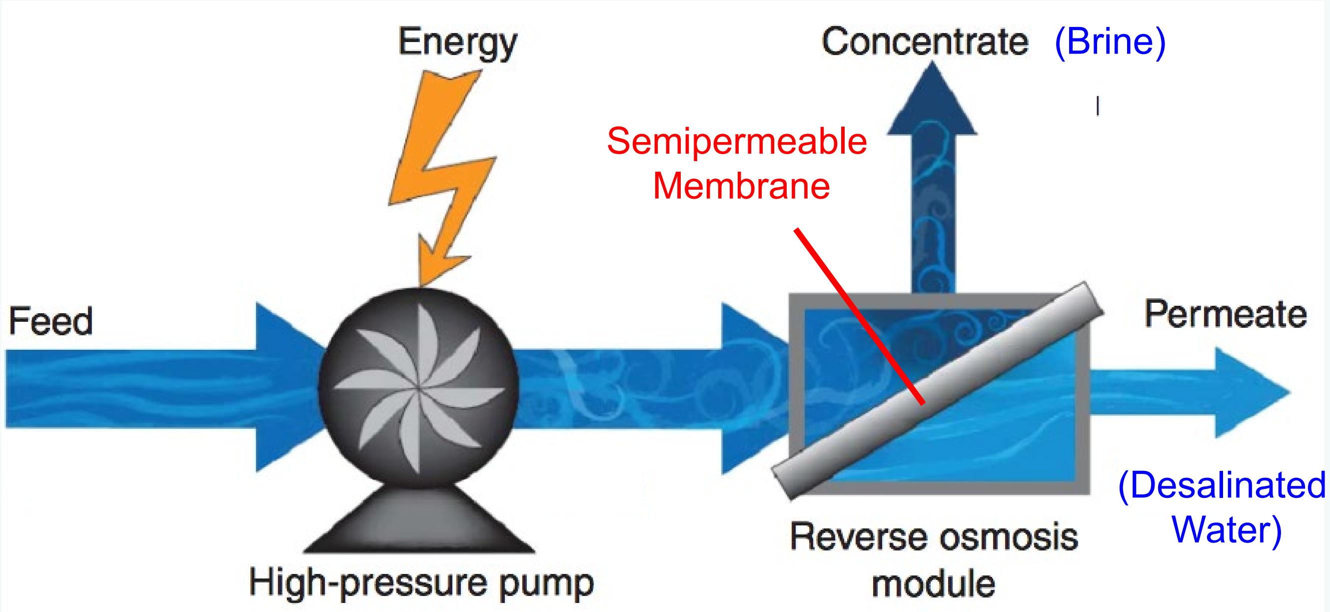

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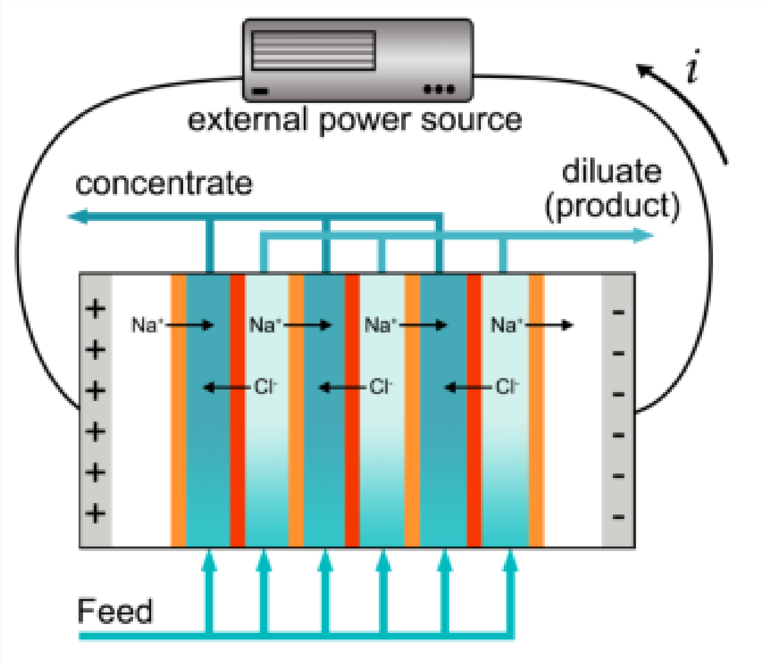

CEM: cation exchange membrane
AEM: anion exchange membrane

RO and ED are not selective for chloride and both processes produce a brine waste product

Elimelech, M. et al. *Science*, **2011**, *333*, 712-717.
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Our Solution: The Desalination Battery

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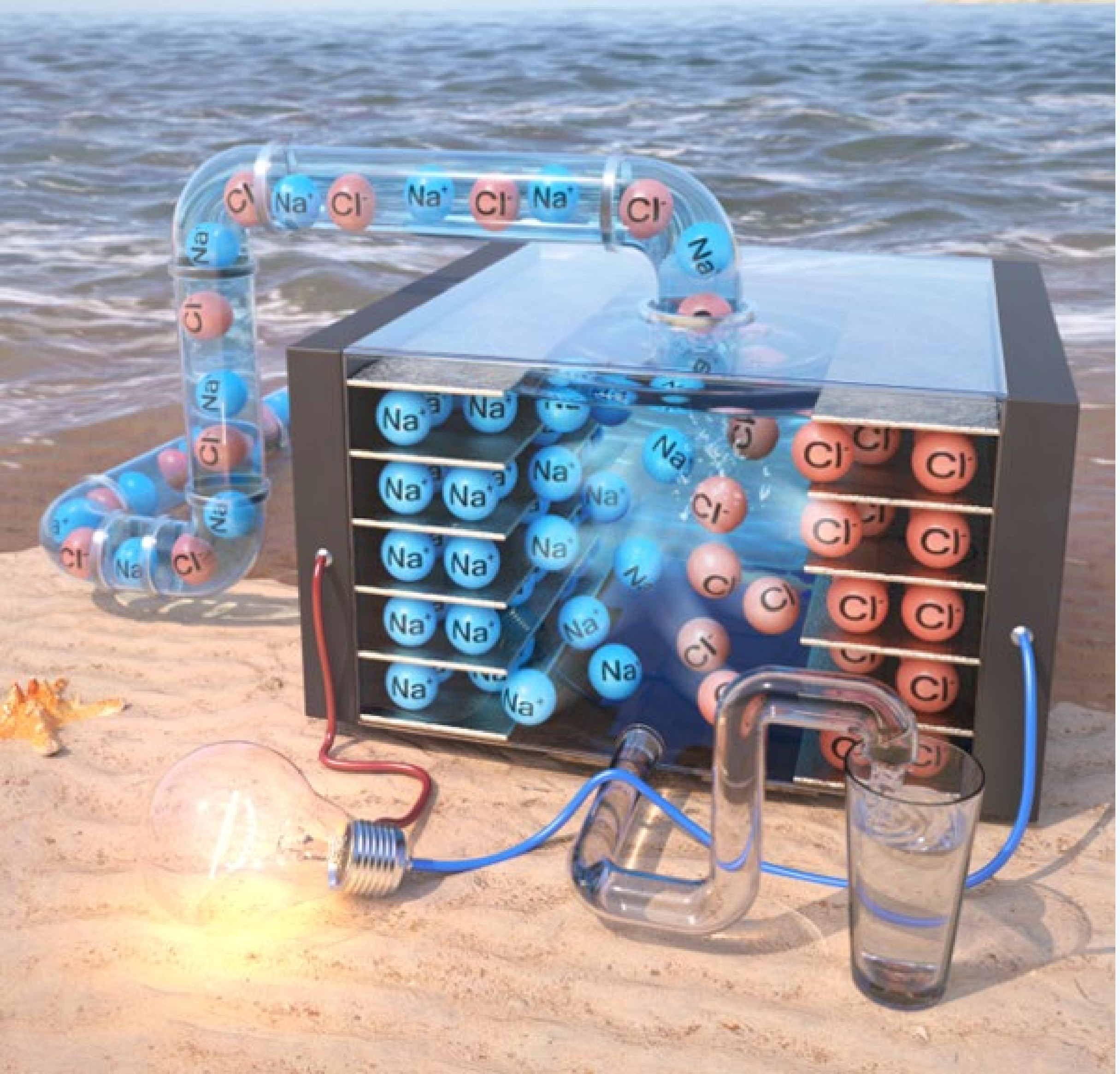


Technology Advantages

80%
Energy recovery

Energy generation/storage coupled with the storage and release of Cl^-

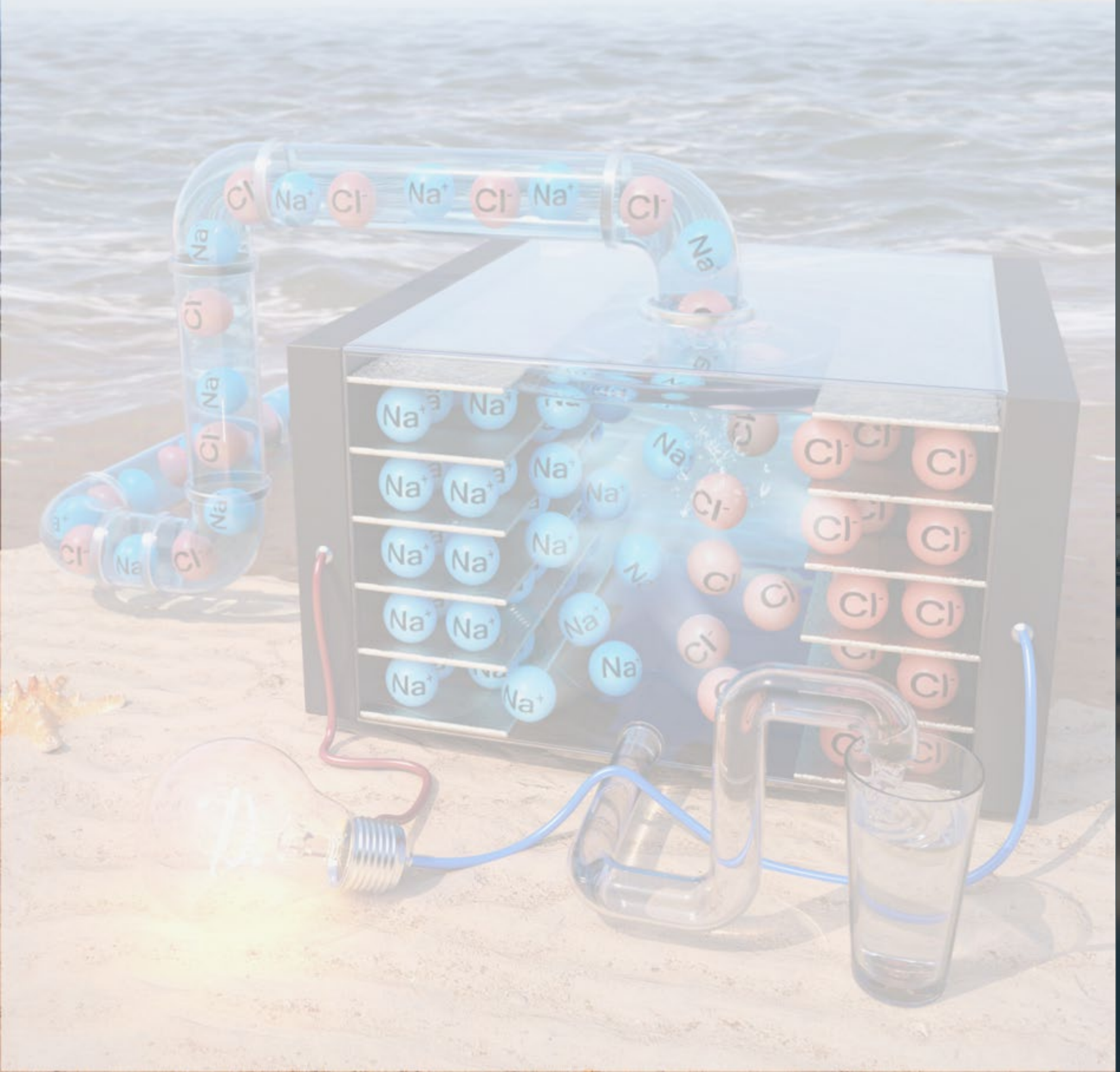
25%
Capital cost

Selective for the removal of Cl^-

$0
Waste disposal costs

Enables recovery of Cl^- as valuable chemical products

ChloBis Water’s Vision



Our Vision

Use the Cl-specific removal cell

to provide an affordable solution to address

the environmental impacts of chloride

HOUSEHOLDS

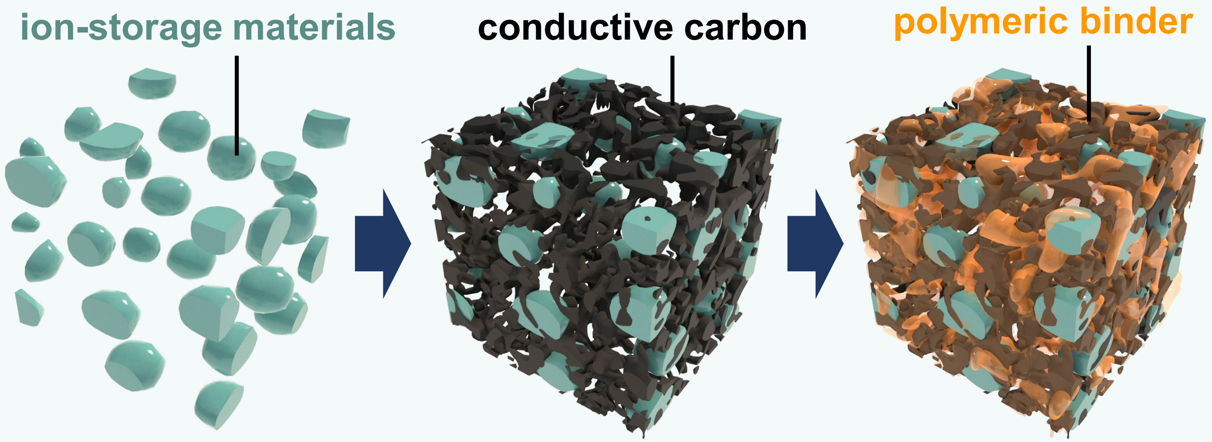
CITIES

INDUSTRY

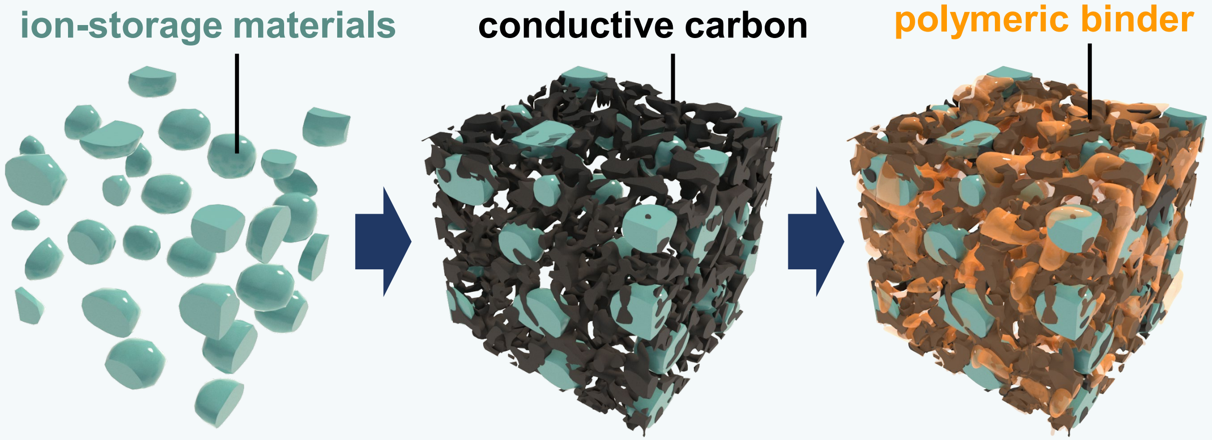
ChloBis Water

Water & Energy Solutions

Electrode Composition



Sheet-Type Electrodes



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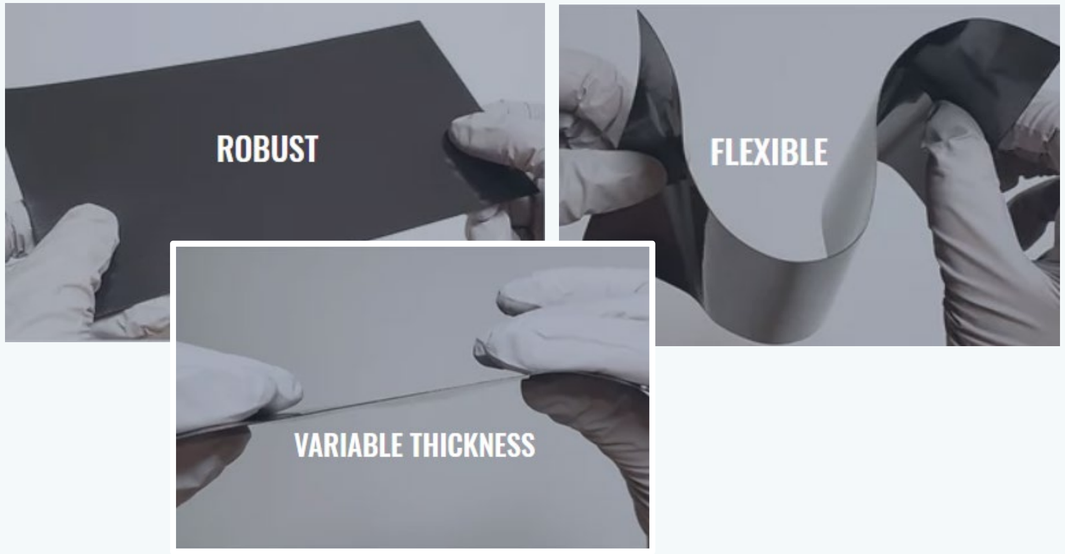
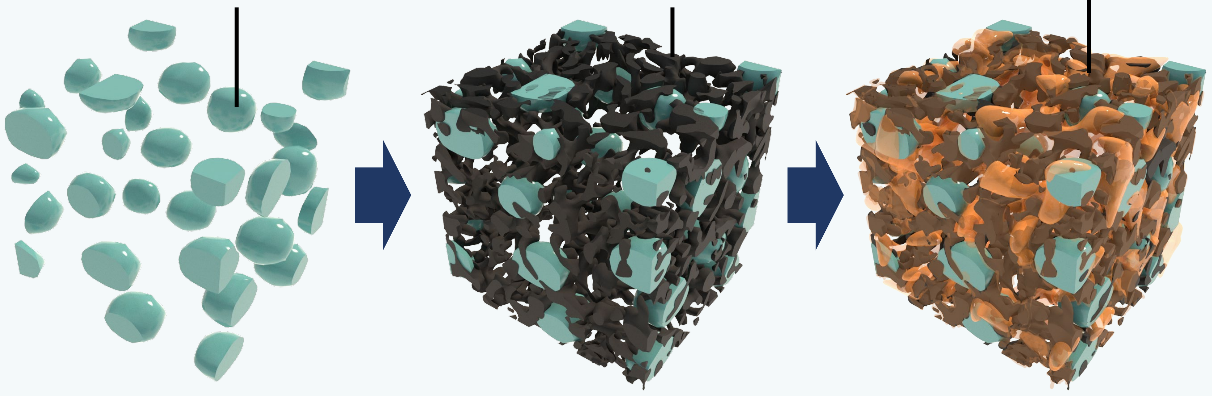


Current Development Status



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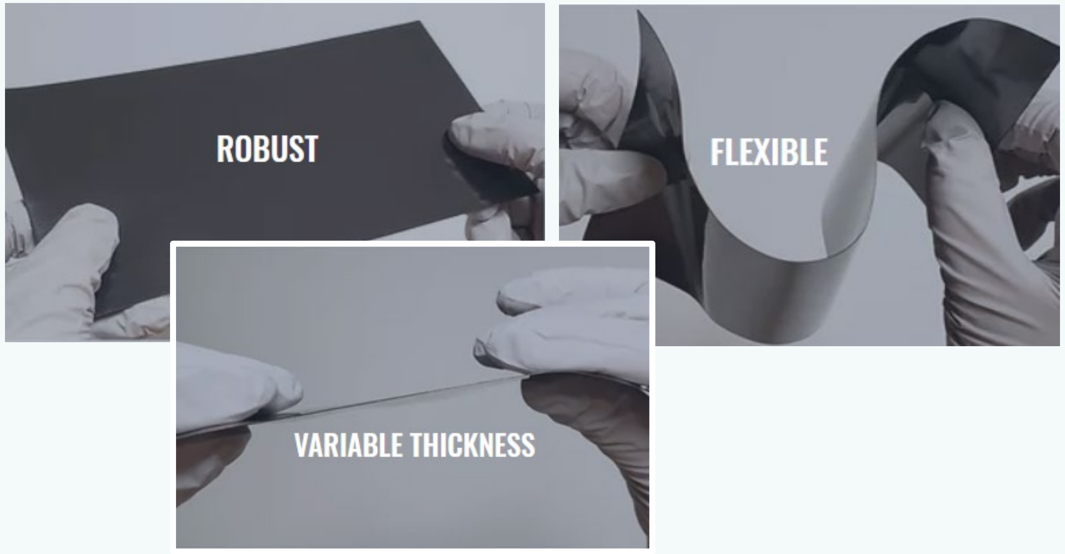
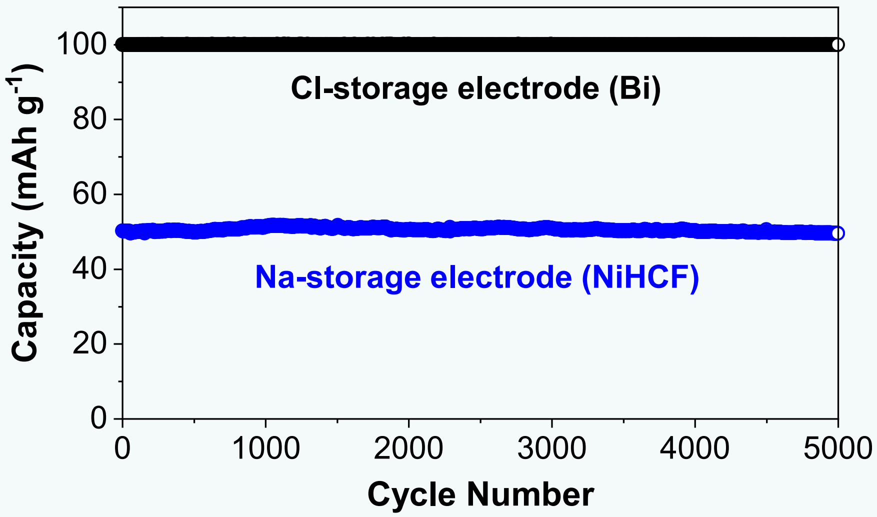


Electrode Lifetime



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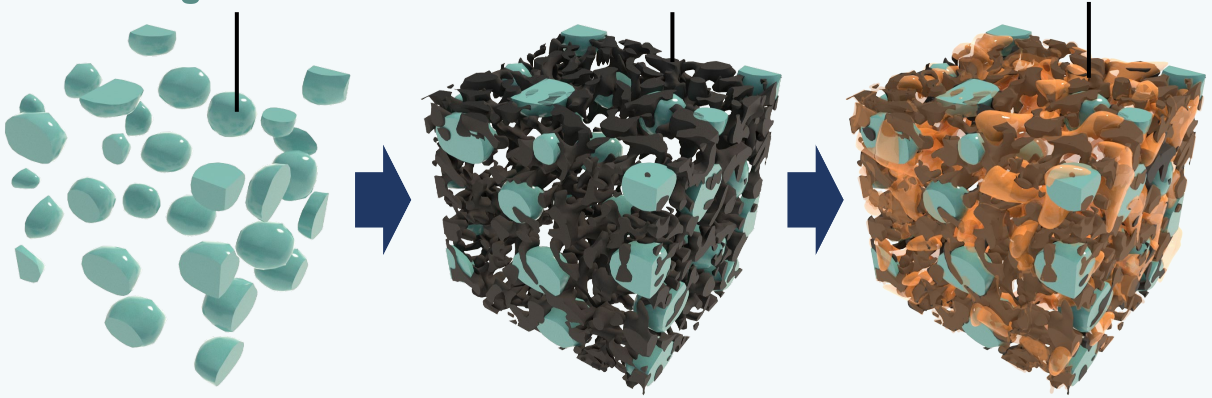

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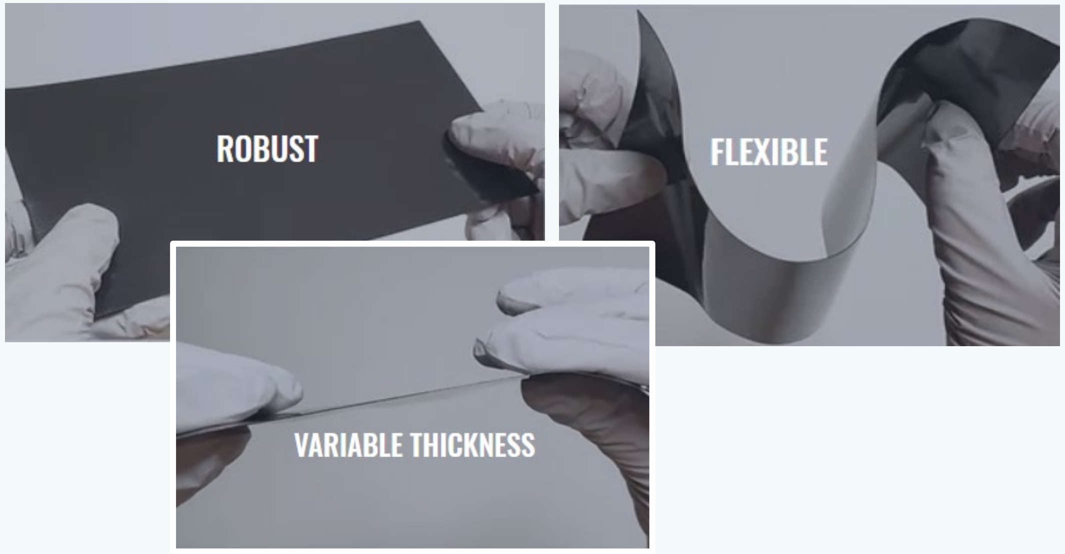

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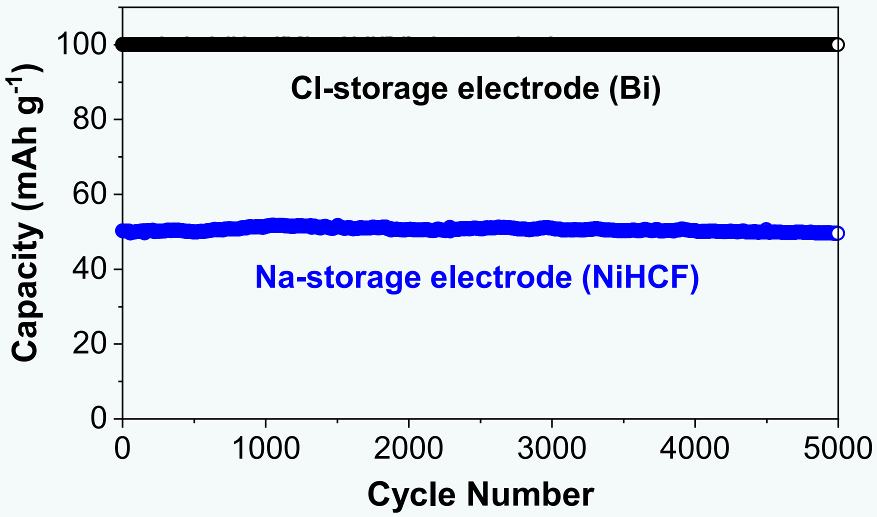
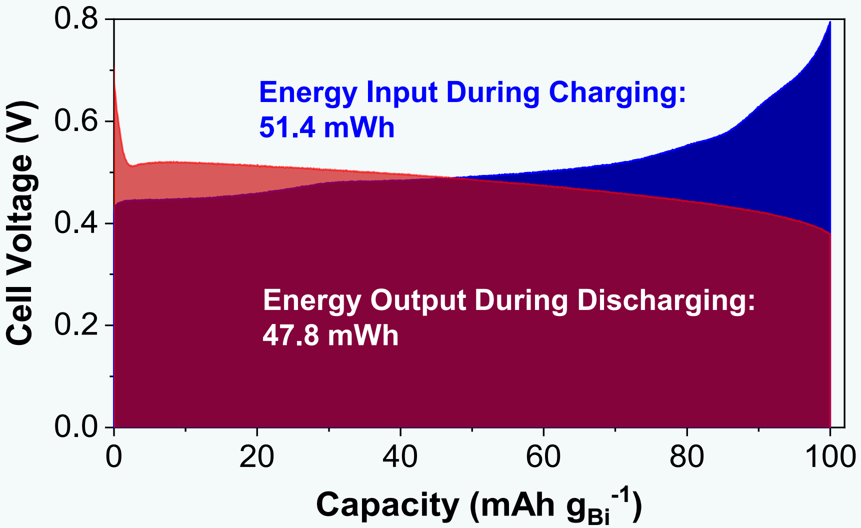
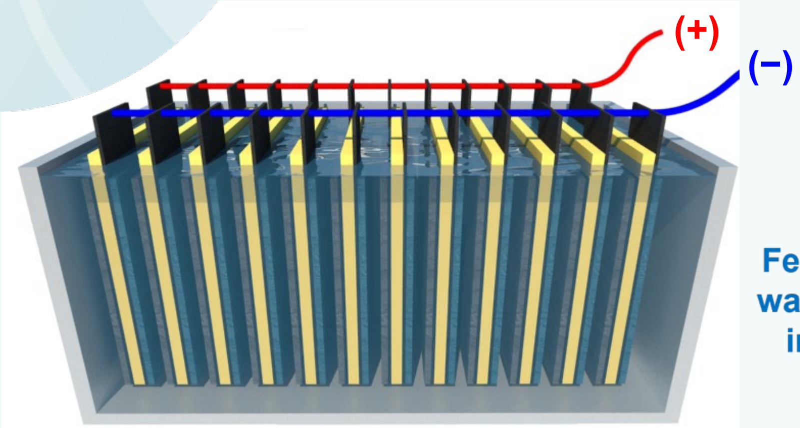


Energy Recovery (> 90%)

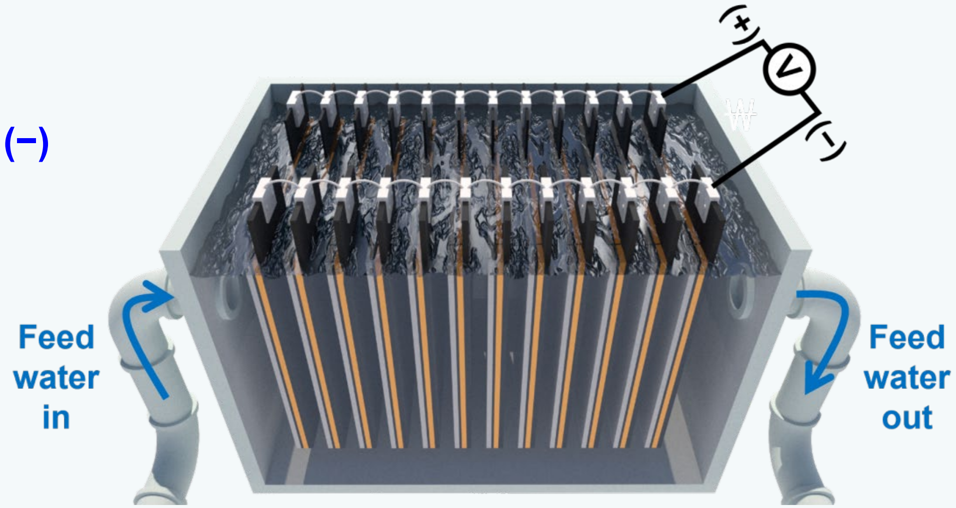


What's Next?

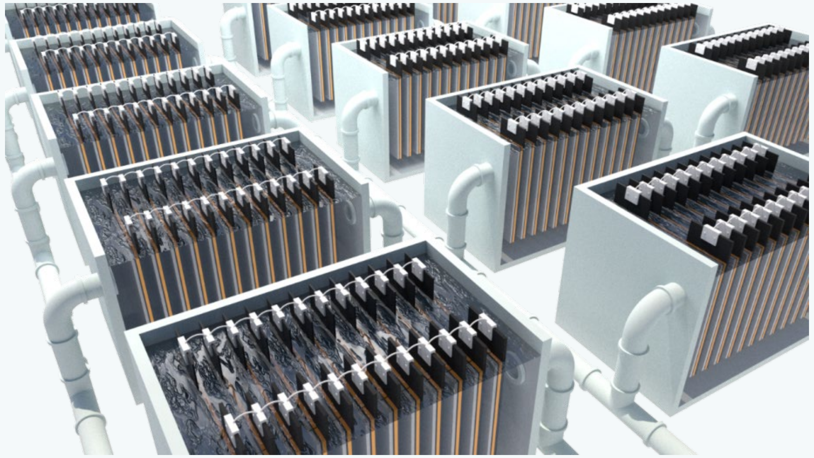
Prototype Batch-Type Cell
1 L of water in 20 minutes



Prototype Flow Cell
1 L of water per minute



Modular Flow Cell
50 L of water per minute



Building a flow cell to demonstrate the complete desalination and resource recovery process at an intermediate scale

Technology Applications

Benefits of the Desalination Battery

Cost	Reverse Osmosis (RO)	Electrodialysis (ED)	Desalination Battery
Capital Cost	$86 M	$80 M	**$20 M**
Annual Electricity Cost	$650,000	$450,000	**$100,000**
Annual Brine Disposal Cost	$131 M	$131 M	**$0**

Market Opportunity > $500 M in the Midwest alone

Notes

1. Cost calculations based on data from Madison Metropolitan Sewerage District with an avg. Cl^- conc. of 470 ppm and a target Cl^- conc. of 395 ppm (avg. flow rate = 45 MGD)
2. Calculated based on number of WWTPs with Cl^- variance permits in Wisconsin and extrapolated to other states in the Midwest

ChloBis Water Team

Dr. Margaret Lumley

Co-founder/CEO

- Business development lead
- Conducted over 200 customer discovery interviews
- Engaged in rigorous entrepreneurial training program

Dr. Dohwan Nam

Co-founder/Lead Scientist

- Technology development lead
- Electrochemical engineer
- Over 10 years of experience working with battery electrode materials and energy storage systems

Dr. Kyoung-Shin Choi

Co-founder/Advisor

- Electrochemistry pioneer
- Actively involved in technology transfer at UW-Madison

ChloBis Water Traction

Spun out from the University of Wisconsin-Madison

2017
First Technology Demonstration

8
Peer-Reviewed Journal Articles

4
Patents

2021
ChloBis Water Founded

$1.5M
Research Grant Funding

9
Awards Granted

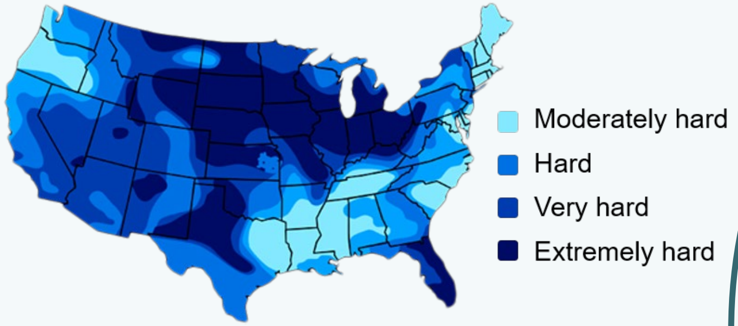
>200
Customer Discovery Interviews

ChloBis Water
Water & Energy Solutions

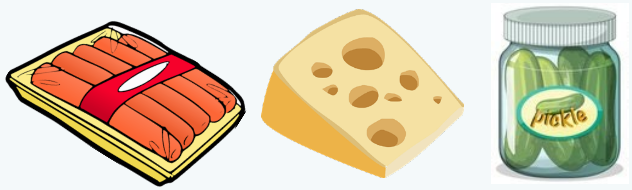
Ask: Connections

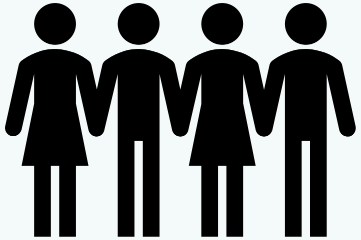
ChloBis Water
Water & Energy Solutions

Municipalities



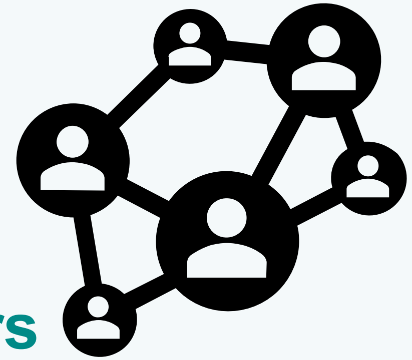
Food Processing Plants





Wastewater Engineers

Partners and Investors



[https://homewater101.com/articles/hard-water-across-us]

THANK YOU!

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