SYSTEMS

END™ Field Testing

In partnership with BGNDRF and UTEP

The Water Crisis

- Over 800 million people struggle daily without safe, clean drinking water.
- The United Nations (UN) General Assembly instituted seventeen Sustainable Development Goals (SDGs), the sixth of which calls for universal access to clean water for all people.
- Part of solving this challenge is reducing *industrial water consumption* to conserve water resources.

MI Systems' Vision

We are dedicated to enabling solutions to the world's water crisis through technology innovation

- **Passionate Team**
- **Solving the Toughest Problems**
- **Focused on the Mission**

MI Systems' Near-Term Mission

Maximum Recovery. Minimum Energy.™

- Removal of dissolved contaminants from water is energy intensive
- High water recovery is necessary to conserve water and drive economics

Introducing END™ electro-desalination

END™ 5-25 gpm System

- Transformation of legacy electrodialysis reversal (EDR)
- Contemporary Ion-Selective Membranes
- Innovative Membrane Spacers
- Advanced Electrode Materials
- Modern Real-Time Digital Controls
- Low-Pressure Operation: 15-50 psig
- High Recovery: up to 98%
- Low Energy: as low as 0.1 kWh/m3/mS
- ***Up to 50% Lower OPEX***
- ***Up to 30% Higher Water Recovery***

END Applications

Brine Recovery

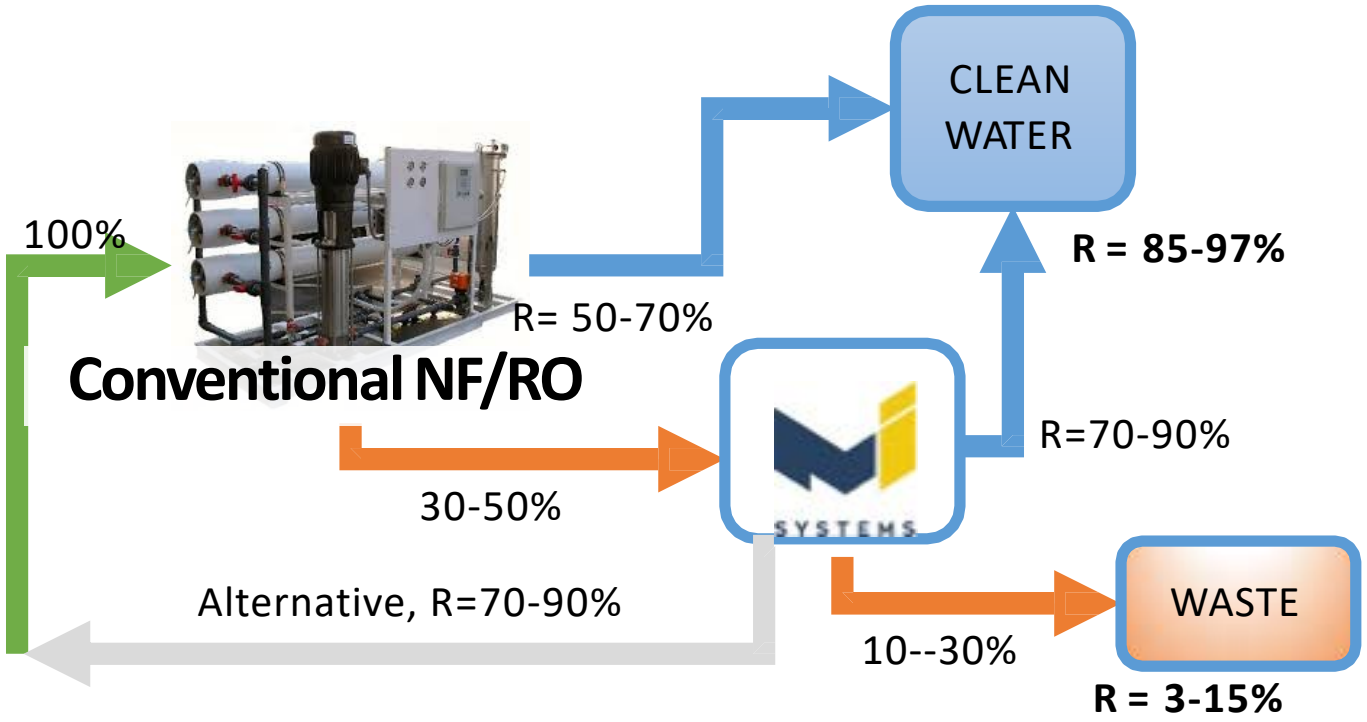
- Recycle Brine from existing RO/NF systems
- Increase recovery >90%
- Reduce Waste Volume & Disposal Cost
- Improve Sustainability

- Key Drivers: Water Scarcity, Water Cost, Energy Cost, Waste Disposal Limits / Cost, Sustainability
- Market / Application: Food & Beverage, Industrial, Municipal, Potable Water
- Geography: Any, Water Scarcity / Cost,

END™ Brine Treatment

Treatment Performance

PARAMETER	CONVENTIONAL NF/RO	END™ TREATMENT	END™ BENEFITS
Clean Water	50-70%	85-97%	***30-70%***
Brine Waste	30-50%	5-15%	



TARGET NF/RO MARKETS

- Industrial Process and Wastewater
- Desalting
- Food & Beverage Makeup / CIP Water

END Applications

Hi Silica Brackish Water:

- Hi Silica waters foul RO/NF systems
- Improve production, lower fouling, lower OPEX, Less chemicals
- Market / Application: Potable & Process Water
- Geography: CA, TX, FL, NM, AZ, CO, HI

Brackish Water Treatment:

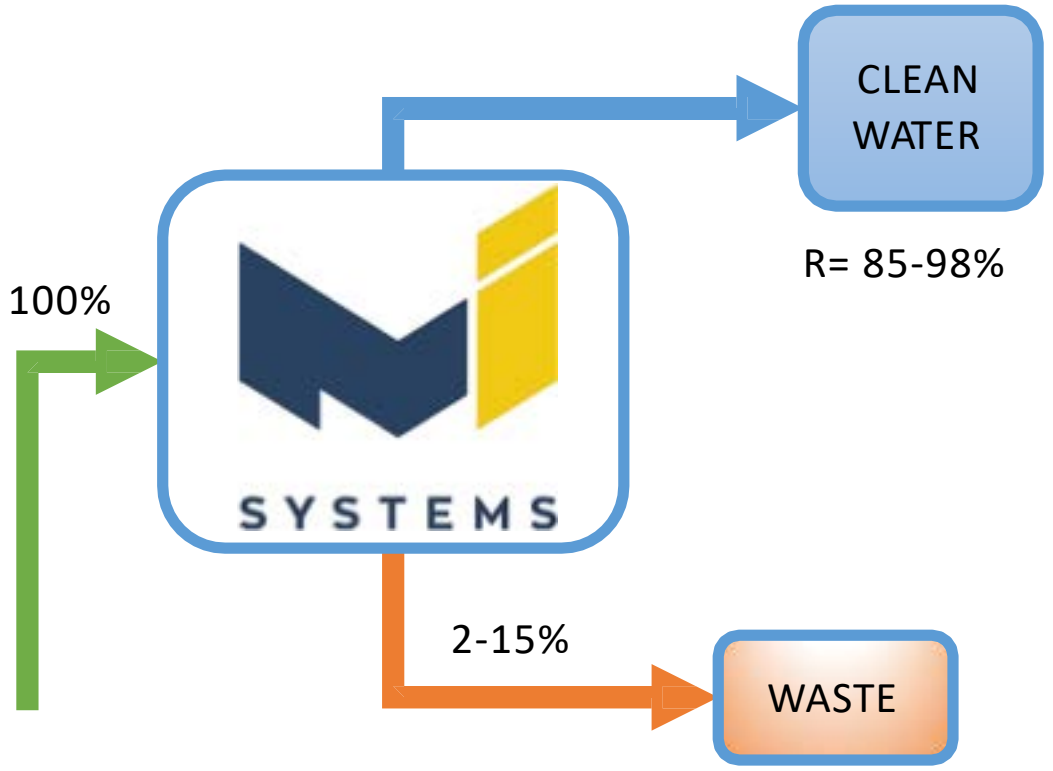
- Treatment of low salinity water (typ. Groundwater)
- Increased recovery and energy savings vs NF/RO
- Focus on Multiple Issue Sites (Arsenic +Fluoride +Ammonium + Nitrates, etc.)
- Market / Application: Food & Beverage, Industrial, Potable Water
- Geography: Any, Water Scarcity / Cost,

END™ Brackish Desalination

Treatment Performance

PARAMETER	CONVENTIONAL NF/RO	END™	END™ BENEFIT
Clean Water	70-90%	85-98%	***10—25%***
Brine Waste	10-30%	2-15%	

Conventional NF/RO



END Applications

Hi Silica Brackish Water:

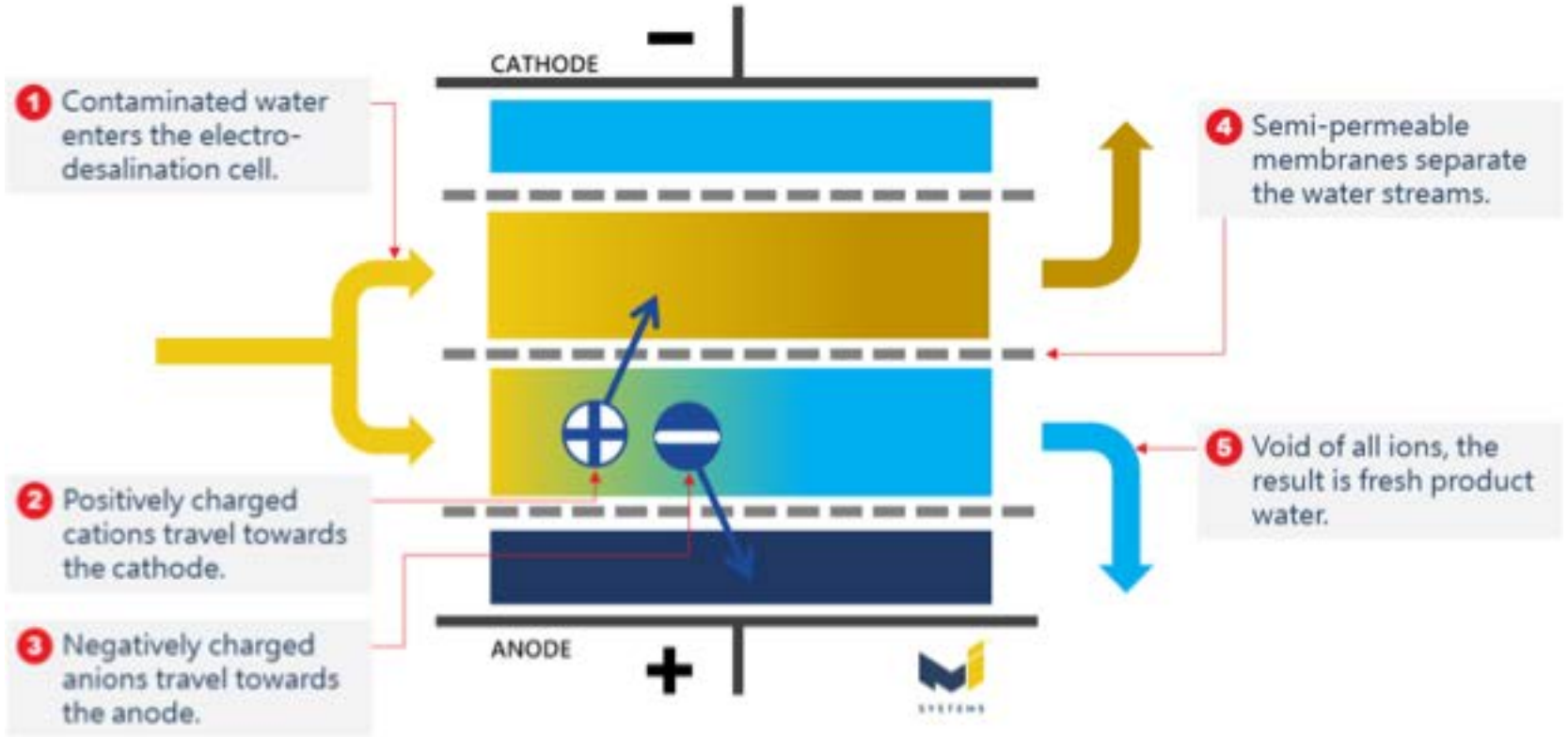
- Hi Silica waters foul RO/NF systems
- Improve production, lower fouling, lower OPEX, Less chemicals
- Market / Application: Potable & Process Water
- Geography: CA, TX, FL, NM, AZ, CO, HI

Brackish Water Treatment:

- Treatment of low salinity water (typ. Groundwater)
- Increased recovery and energy savings vs NF/RO
- Focus on Multiple Issue Sites (Arsenic +Fluoride + Ammonium + Nitrates, etc.)
- Market / Application: Food & Beverage, Industrial, Potable Water
- Geography: Any, Water Scarcity / Cost,

How END™ Works

Operating Principles



Water Introduction

- Low pressure
- Fills voids between sheets

Charge Applied

- Attracts / repels ions thru membrane
- Salts concentrated between layers

Charge Reversal

- "Cleans" electrodes and membranes
- Reduces scale buildup

Concentrated Brine

- Extracted from brine channel
- High concentration

Clean Water

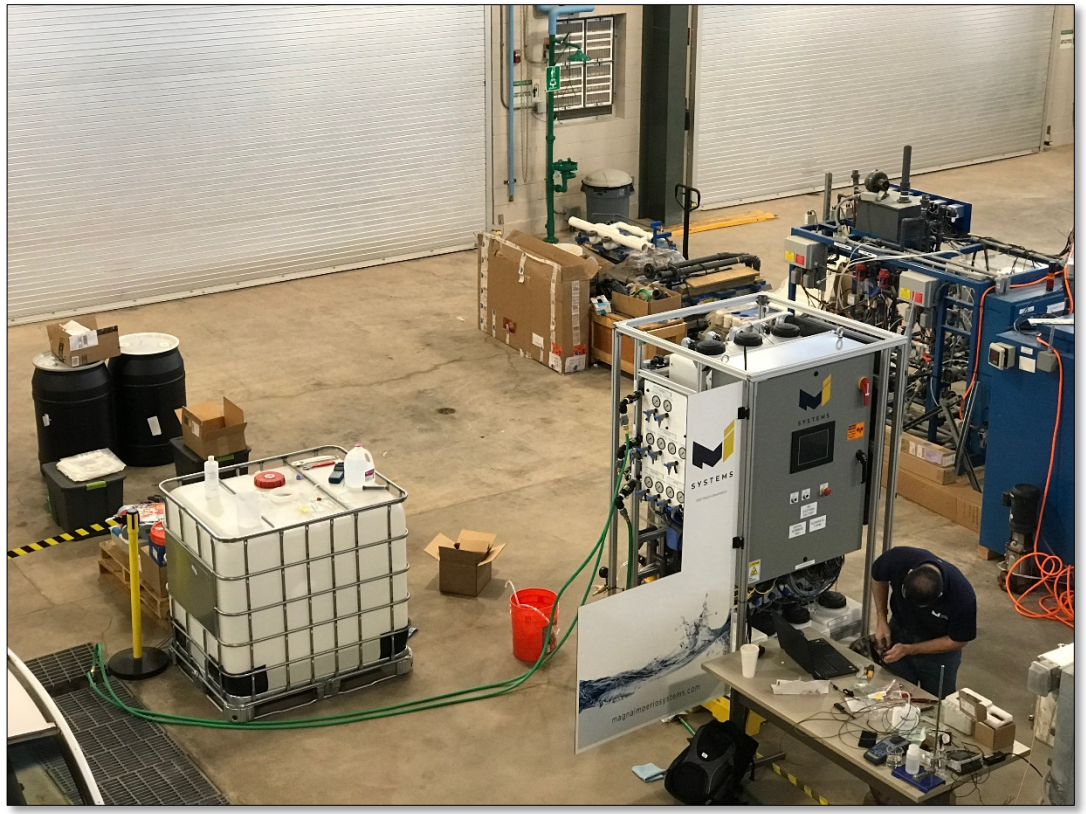
- Extracted from stack
- Ready for conditioning or use

Periodic Cleaning

- Per application requirements

MIS-BGNDRF Collaboration

1. Demonstrate END™ performance on real water
2. Develop reliability around process under real-world conditions
3. Benchmark performance against existing technologies
4. Develop strategies around desalinating for high hydraulic recovery



BGNDRF Pilot-Background

- Installed and commissioned 5/7/18
- 1 GPM installed capacity
- Operated for >2300 hrs on Well-1
- Pilot Features:
  - Continuous/Batch operation
  - High degree of autonomous control
    - Automated CIP
  - Remote connectivity
  - Accepts multiple cell sizes
  - Small Footprint
  - Mobility
  - Quiet operation

BGNDRF Pilot-UTEP Collaboration

- Collaborated with Dr. Shane Walker, Dr. Malynda Cappelle and Shahrouz Ghadimi
- Benchmark Study
  - 1 week study on BGNDRF Well-1
  - 90% Hydraulic Recovery
  - 60-70% conductivity removal
    - Inlet: 1700-1800 µS/cm
    - Outlet: <800 µS/cm

- Results
  - Normalized SEC: 0.2-0.23 kWh/m^3/mS/cm

CIDS
Center for Inland Desalination Systems

NEWT

UTEP

BGNDRF Pilot-UTEP Study Comparison to GE EDR

"The END system was able to achieve a higher recovery and greater average conductivity reduction than the GE system. The Total SEC values are in a similar range for both systems, including when the conductivity removal is used to normalize the SEC values."

	END™	Kirimi et al.[1]
Conductivity Reduction	68-70%	55-60%
Hydraulic Recovery	91-95%	87-92%
Total Normalized SEC (Pump+Desal) Normalized Desal SEC	0.20-0.23 kWh/m^3/mS/cm 0.14-0.16 kWh/m^3/mS/cm	0.30-0.43 kWh/m^3/mS/cm 0.13-0.20 kWh/m^3/mS/cm

[1]-L. Kirimi, L. Abkar, M. Aghajani, A. Ghassemi, Technical feasibility comparison of off-grid PV-EDR and PV-RO desalination systems via their energy consumption, Seperation and Purification Technolgo 151 (2015) 92-94.

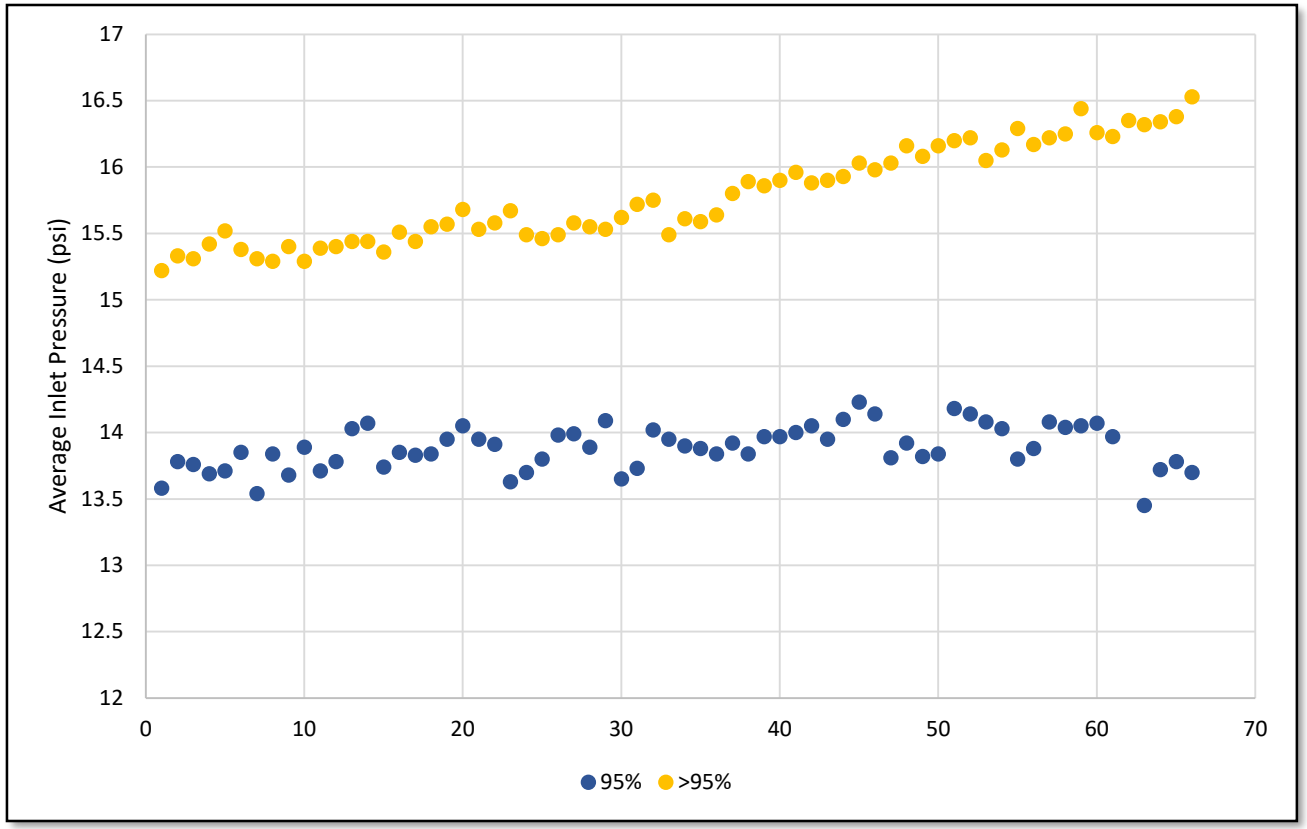
BGNDRF Pilot-High Recovery Testing

- High recovery testing
  - Demonstrated continuous operation >90% hydraulic recovery

	Hydraulic Recovery	SEC ($kWh/m^3/mS/cm$)	Time (hrs)
Set point 1 (6/5)	90%	.24	24
Set point 2 (7/16)	93%	.26	109
Set point 3 (8/15)	94%	.28	107
Pilot Composite	91%		2350

BGNDRF Pilot-Scale Control

- Anti-scalant Strategies
  - Primary scalants: $CaSO_4$ and $CaCO_3$
  - Off-the-shelf vs. Commercial Anti-scalant
  - pH control
  - Reversal Time
  - Brine Batch Size



BGNDRF Pilot-Future Work

- Deploy next generation of END™ core technology
- Demonstrate high recovery on different source water (Well 3 and 4)
- Demonstrate RO concentrate recovery