Competing in the Desal Prize

Presented by Malynda Cappelle
w/ information from MIT and UNT

Presented at Texas Desal 2015 / 30 September 2015

Overview

- What was the Desal Prize?
- Top 3 teams
  - 1st Place: MIT & Jain Irrigation Systems
  - 2nd Place: UTEP's Center for Inland Desalination Systems
  - Honorable Mention: University of North Texas (aka Green Desal)
- Achieving 95%+ recovery
  - Zero Discharge Desalination
  - Solar Salt Recovery
  - Photovoltaics
- What's next?

The Desal Prize

- Goal: Enable environmentally sustainable small-scale brackish water desalination systems
- Requirements for competition:
  - Powered solely by renewable energy
  - High system recovery
  - Minimize environmental impact
  - Cost efficient, durable, and easy to maintain

The Desal Prize

Competition

Day 0: Equipment delivered, placed on pad

Day 1: Prototype assembly

Day 2: Prototype optimization, battery discharge, onsite presentations

Day 3: Competition

Day 4: Data Collection, Prototype optimization, battery discharge

Day 5: Competition

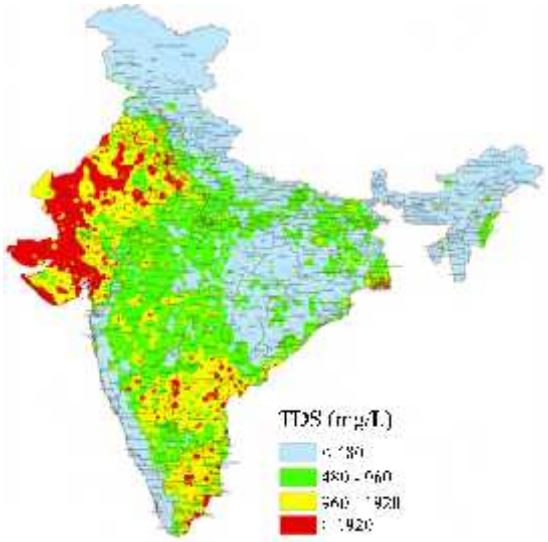
Day 6: Data Collection, pack

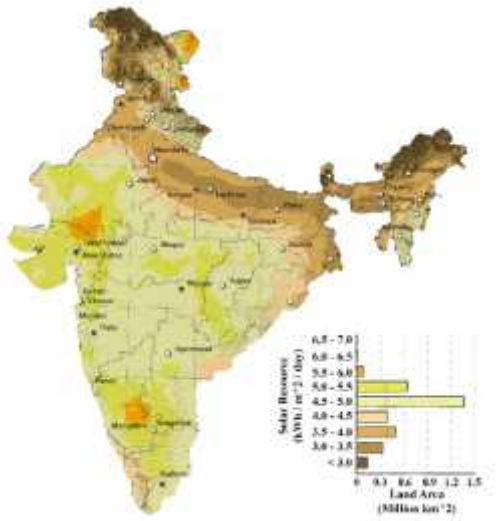
The Competition

Judging Metrics

Performance Criteria	Scale	Weight
Technological Approach	Yes/No	--
Water Quantity & Water Quality	Yes/No	--
Powered Solely by Renewable Energy	Yes/No	--
System Water Recovery	1-4	30%
Chemical Treatment	1-4	15%
Concentrate Minimization/Concentrate Disposal Process	1-4	20%
Durability, Reliability, and Practicality	1-4	15%
Life Cycle Cost Analysis	1-4	20%

MIT : Photovoltaic Powered Electrodialysis Reversal





Motivation: 60% of Indian groundwater to saline to be used for potable or agricultural use, more than half the rural population without access to grid power

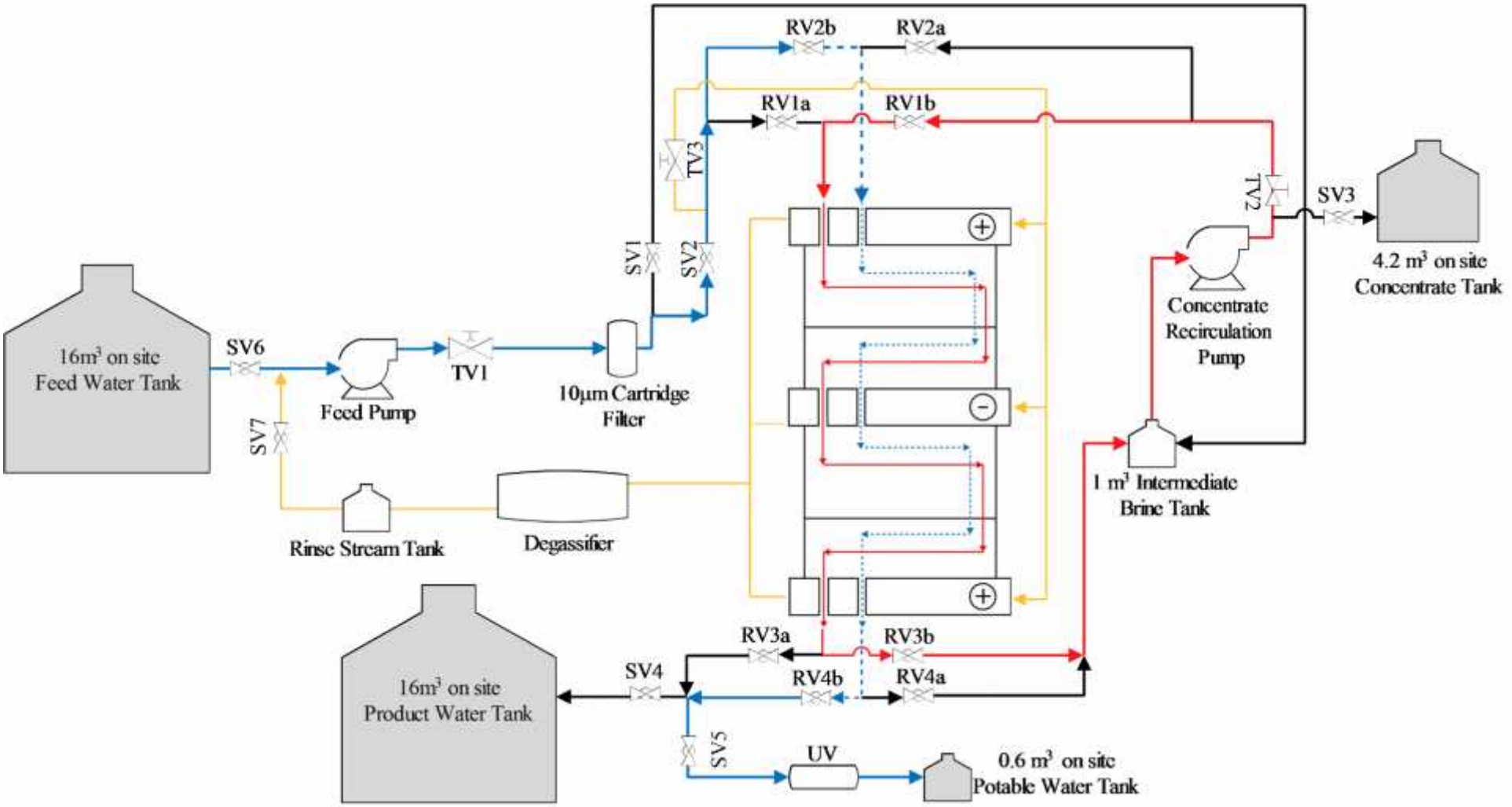
Partner: Jain Irrigation System, Ltd. – 2nd largest drip irrigation company in the work, 95% of business with < 5 acre farmers

Technology:

- PV-ED with combined batch/continuous operation, UV disinfection for potable supply
- 1.6 $m^{3/}$/hr product flow rate
- 84% recovery achieved on day of competition

Pilots over next year: India and Gaza


GEAR LAB
JAIN
Irrigation Inc


RV2b
RV2a
RV1a
RV1b
TV3
SV1
SV2
TV2
SV3
4.2 m³ on site
Concentrate Tank
Concentrate
Recirculation
Pump
16m³ on site
Feed Water Tank
SV6
Feed Pump
TV1
10µm Cartridge
Filter
SV7
1 m³ Intermediate
Brine Tank
Rinse Stream Tank
Degassifier
RV3a
RV3b
SV4
RV4b
RV4a
16m³ on site
Product Water Tank
SV5
UV
0.6 m³ on site
Potable Water Tank

GREENDESAL

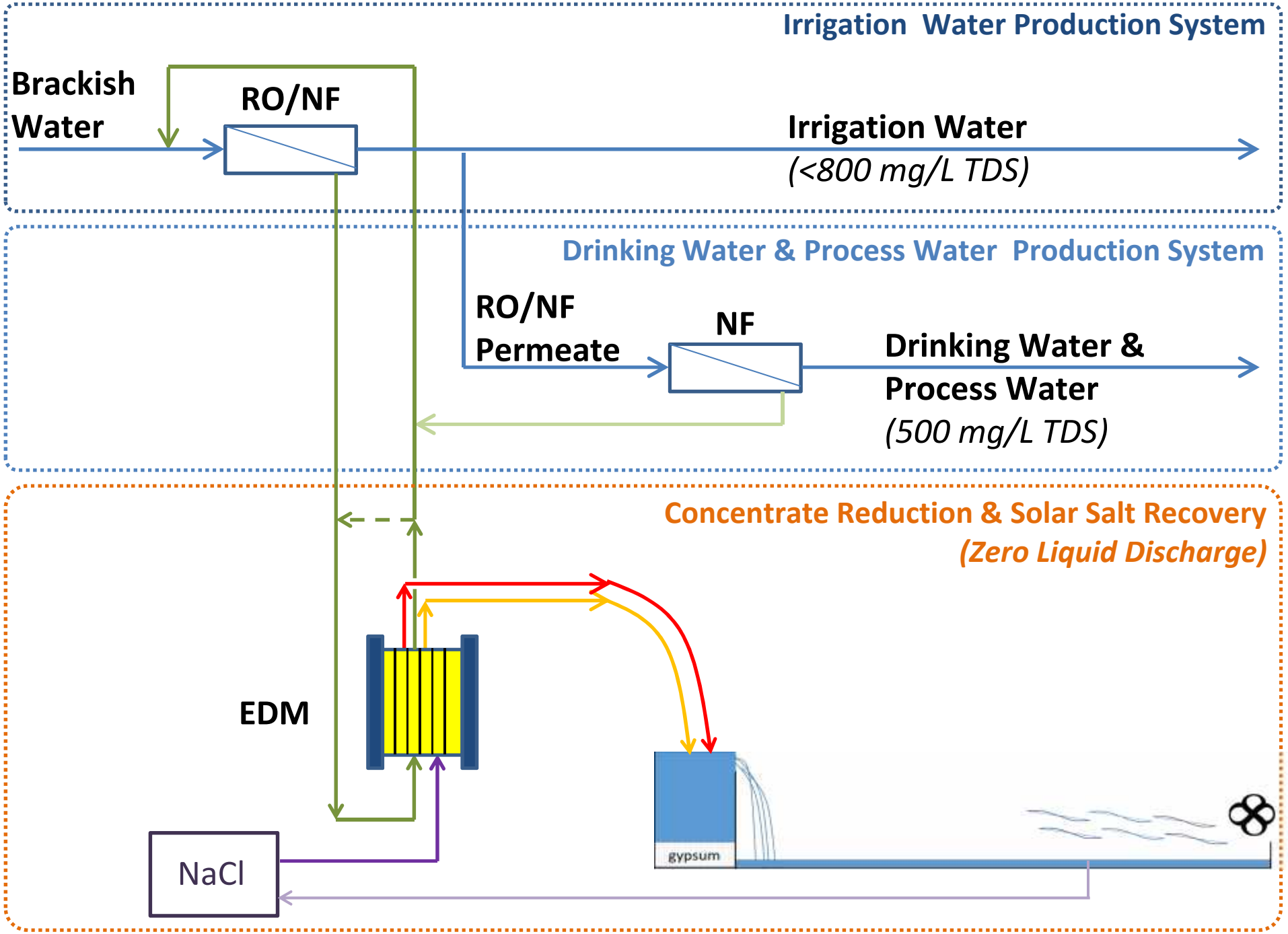
Autonomous sustainable brackish desalination system for smallholder farming households

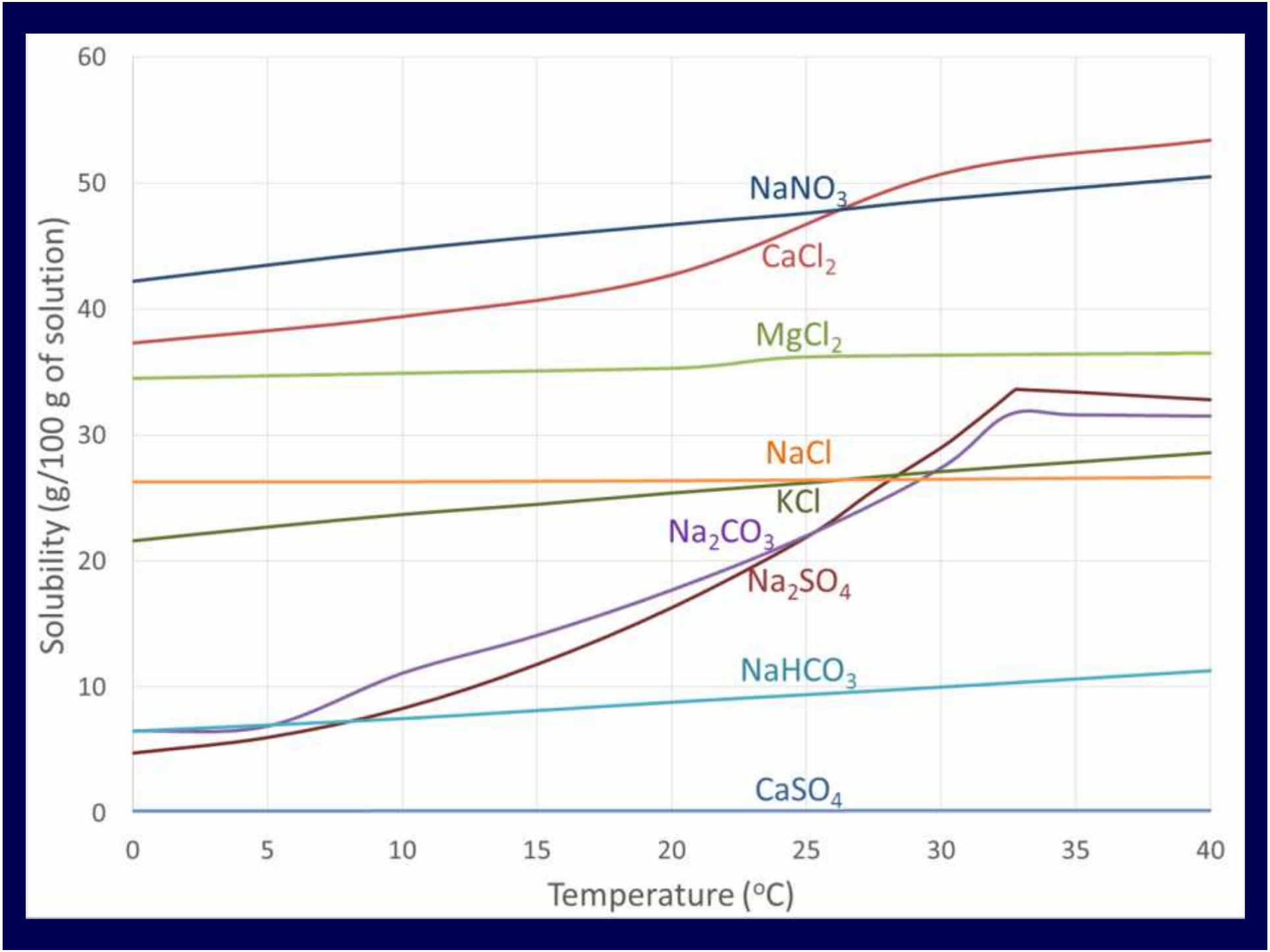
- Water treatment process based on proven technologies and smart use of available water
  - Reverse osmosis: high recovery ratio allows to generate the required amount of product water treating only 85% of the available raw water.
  - We use the remainder 15% to decrease salinity of the brines to that of brackish water which can be used
  - Ion exchange: to reduce the Ca^{2+} concentration in the water introduced to the RO system
  - Nano-filtration: to allow reuse of most of the regenerant (KCl) of the ion exchange process along with generation of $K^{+}/Mg^{2+}/Ca^{2+}$-rich fertilizer solution
- Electrical system
  - Hybrid wind/solar generation for off-grid applications offers flexibility
  - DC motors for pumping avoids DC/AC inverter
  - Control system options, PLC and low cost low power microcontrollers
- Potential brine usage: fertilizer, aquaculture, hydroponics
- Life Cycle Analysis: 2.44$/$m^3$ as an average of all 10 project years


GREENDESAL

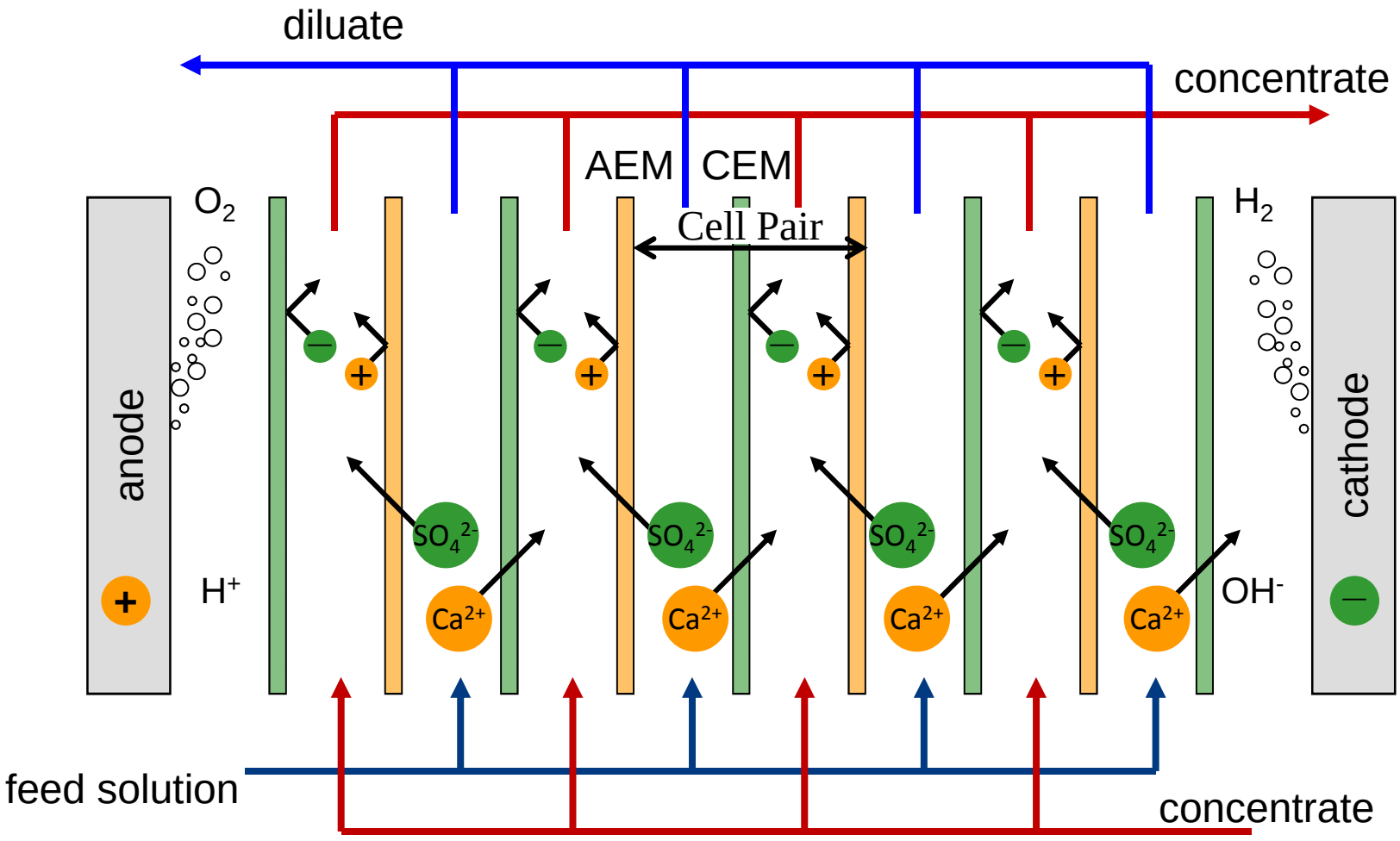
Our Approach (Honduras Pilot):
ZDD using PV and gypsum recovery

- Primary desalters:
  - NF for agricultural water
  - RO for drinking water (and/or process water)
- Secondary desalter/volume minimization
  - Electrodialysis metathesis (EDM) desalinates NF/RO concentrate
- Solar Salt Recovery & Enhanced Evaporation
- Photovoltaic System

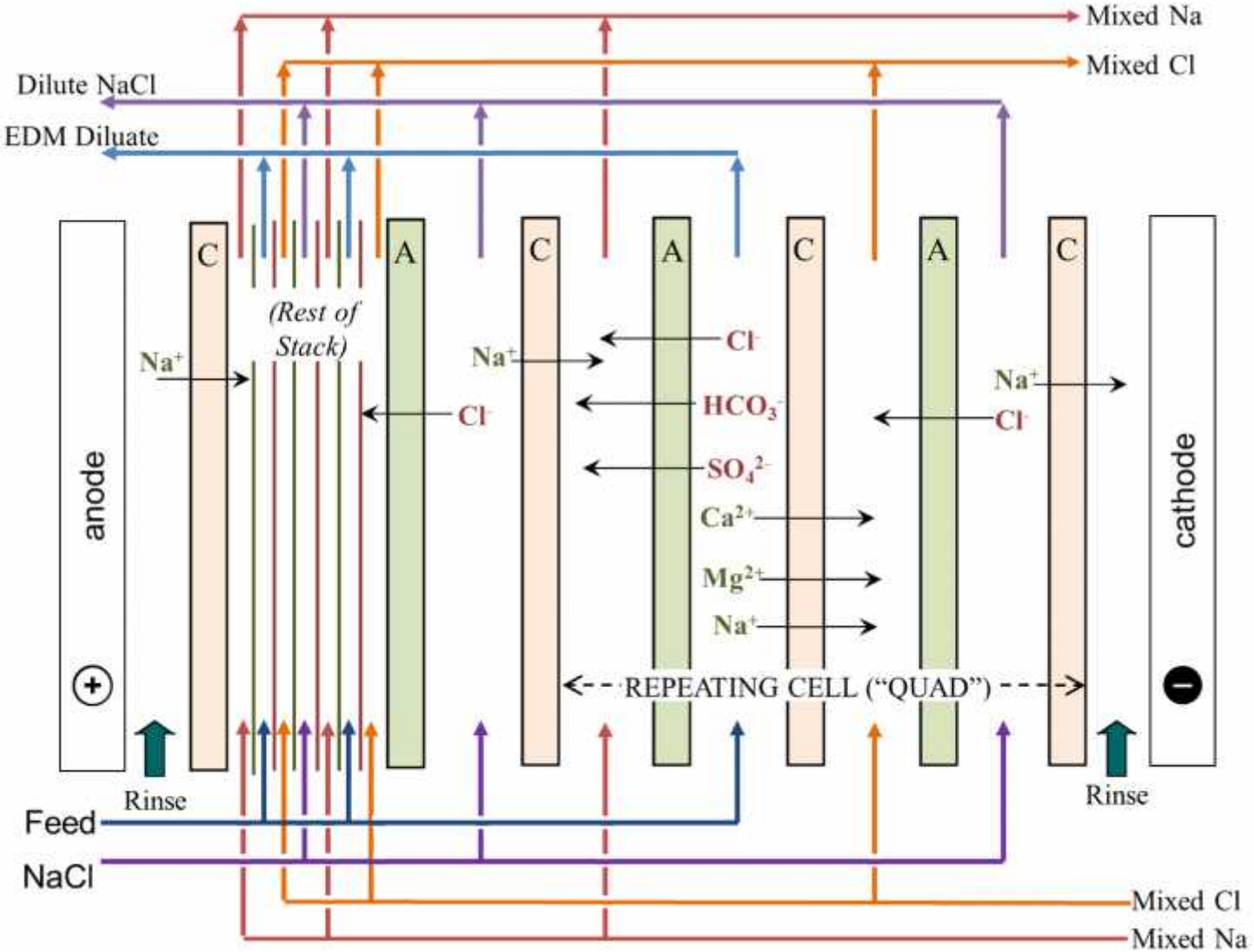

Irrigation Water Production System
Brackish Water
RO/NF
Irrigation Water
(<800 mg/L TDS)
Drinking Water & Process Water Production System
RO/NF Permeate
NF
Drinking Water & Process Water
(500 mg/L TDS)
Concentrate Reduction & Solar Salt Recovery
(Zero Liquid Discharge)
EDM
NaCl
gypsum


60
50
40
30
20
10
0
Solubility (g/100 g of solution)
0
5
10
15
20
25
30
35
40
Temperature (°C)
NaNO3
CaCl2
MgCl2
NaCl
KCl
Na2CO3
Na2SO4
NaHCO3
CaSO4

Calcium sulfate is problematic for electrodialysis (ED)



EDM: Switching Partners & Exploiting Solubility



Photovoltaic System (10 kW)

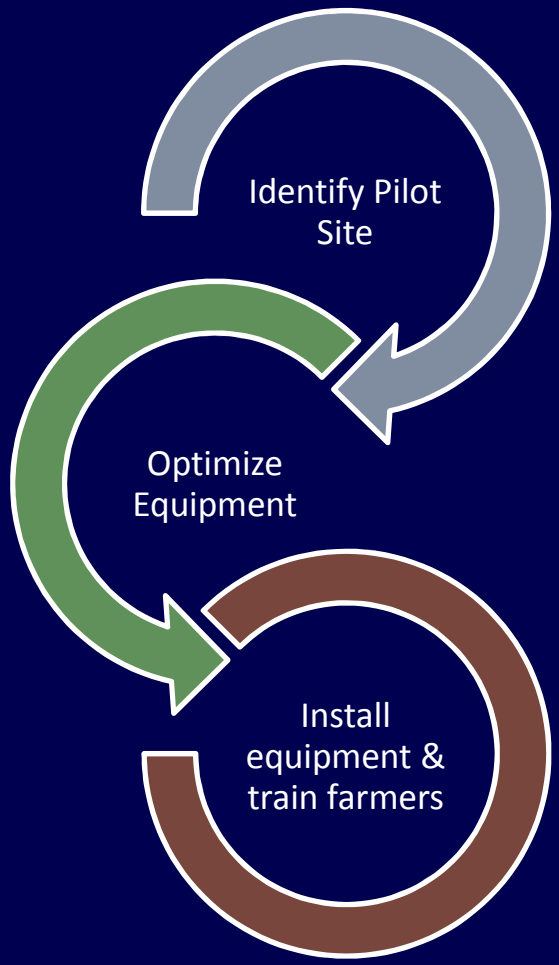
Achieving 95%+ Recovery

- EDM for concentrate volume reduction
- Zero Liquid Discharge:
  - Salt Recovery:
    - Gypsum (used to improve soil for agriculture)
    - NaCl (used in ZDD process)
  - Enhanced evaporation could reduce evaporative area by 50-90%

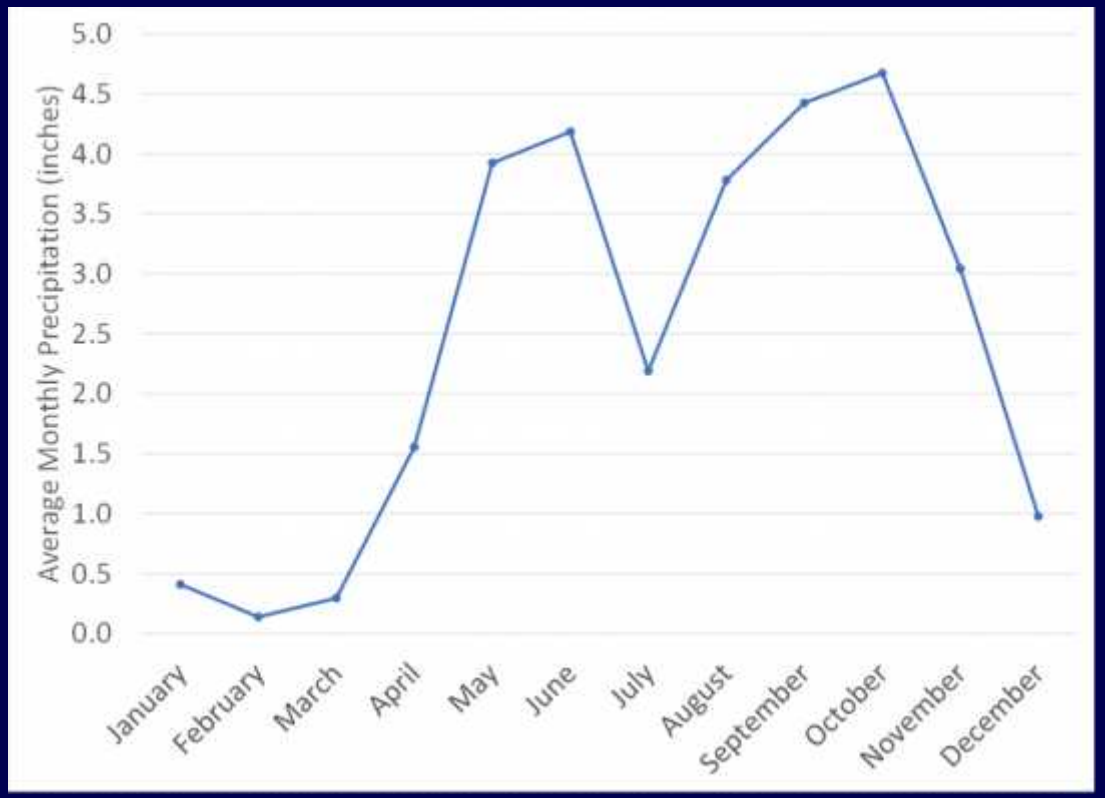
- 98% water recovery demonstrated in several locations

What's Next?

Pilot in Honduras



Average Rainfall (Tegucigalpa, Honduras)



PARTNERS:


El Paso Times

VITAL RESOURCE

Desal Prize: Team of UTEP engineering students is among 5 finalists in global competition

Desalination: Project goal is to transform salt water to clean, fresh water using solar power

Ebola mission a 'big-time success'


Your Money

GECU

UTEP team second in Desal Prize

The Desal Prize Welcomes You

From left: Tom Davis, Malynda Cappelle and Shane Walker

A team from UTEP's Center for Inland Desalination Systems took second place in the international Desal Prize competition, winning $60,000.

First place and the $100,000 went to a team from the Massachusetts Institute of Technology.

competition, hosted by Agency for International Development, asked engineers to create cost-effective, efficient and environmentally sustainable ways to produce safe drinking water.

prototypes were tested and rated by judges at the Bureau of Reclamation's Brackish Groundwater National Desalination Research Facility in Alamogordo, New Mexico.

Members of the UTEP are Tom Davis, director of the Center for Inland Desalination Systems, associate director Malynda Cappelle and Shane Walker, assistant professor of civil engineering.

The team is now eligible for up to $400,000 in grants to put their prototype in USAID pilot projects.

"I look forward to the next step, which will be piloting our system with farmers in a developing country hopefully somewhere in Latin America," said Cappelle.

CIDS

Center for Inland Desalination Systems

Our Team

- Dr. Tom Davis
- Dr. Shane Walker
- Malynda Cappelle
- Main Students: Lisa Haisan, Paulo Araujo, Jesus Placencia, Isadora Araujo, Gustavo Puaitti, Osvaldo Broesicke

Thanks for listening!

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