Solar Powered Desalination for Agriculture

Presented at 2nd Annual WIN Workshop
28 October 2019
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Outline

- Zero Discharge Desalination History at the BGNDRF
- PV vs PV/T Background
- Solar-Powered Desalination Research
- Desalination for Agriculture
- Next Steps

ZDD Research at the BGNDRF:
12 Years & Counting

- 2007-2009: Zero Discharge Desalination was the 1st technology piloted at the BGNDRF
- Recovery: 85 → 95%

ZDD Research at the BGNDRF:
12 Years & Counting

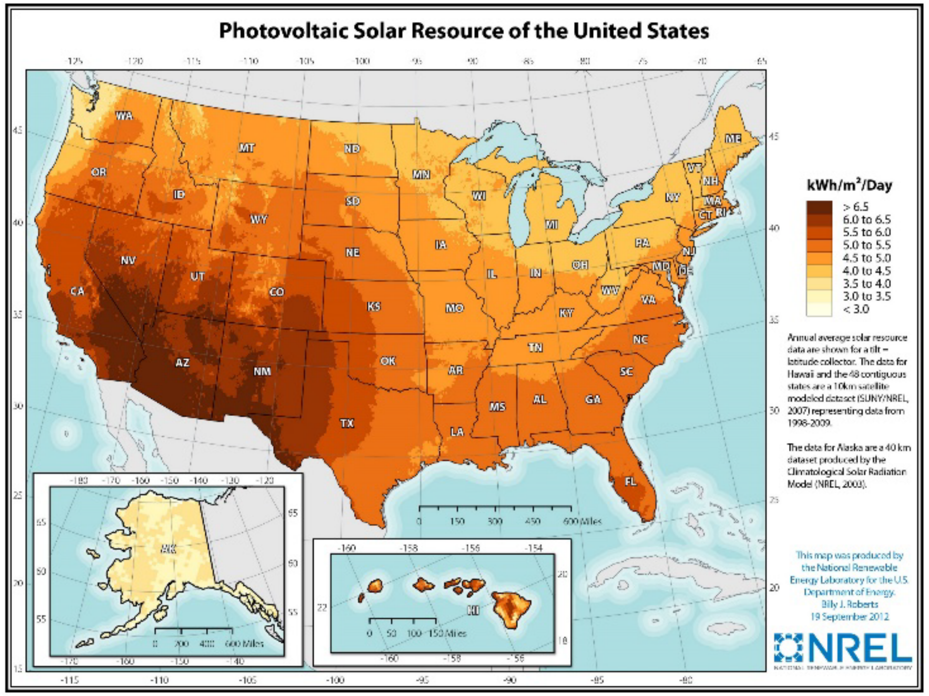
- 2011-2013: ZDD scaled up to 20-gpm, then 40-gpm at the BGNDRF (DWPR grant)
- Recovery: 95% → 98%

ZDD Research at the BGNDRF:
12 Years & Counting

- 2015-2020+: ZDD Desal for Agriculture Using Renewable Energy
- Recovery: 98% with ZERO liquid discharge, & produced solid gypsum byproduct for farmers

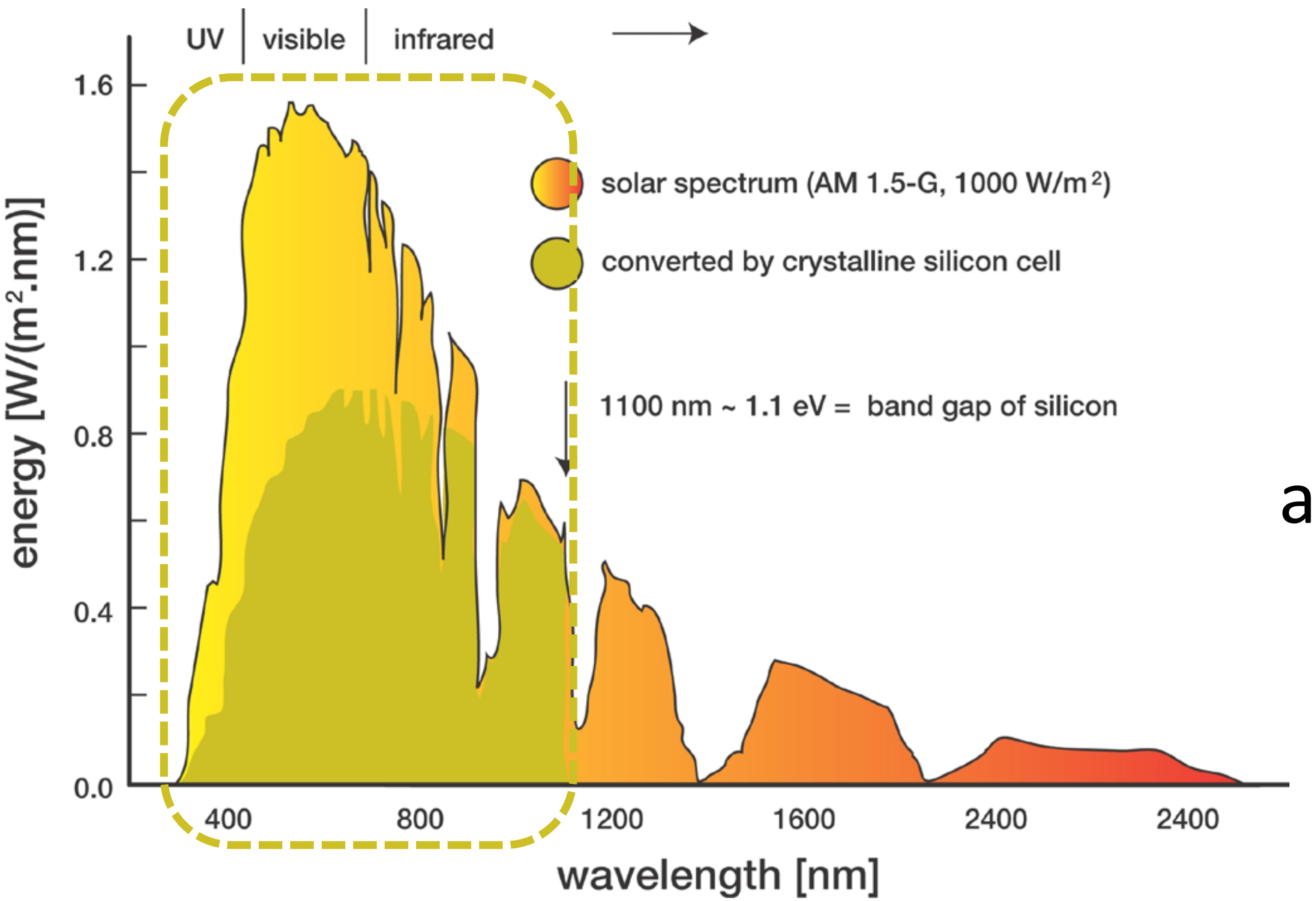
Photovoltaic power makes sense
(esp. in the West/Southwest)

- Abundance of solar resource
- Land availability



Source: NREL website (http://www.nrel.gov/gis/solar.html)

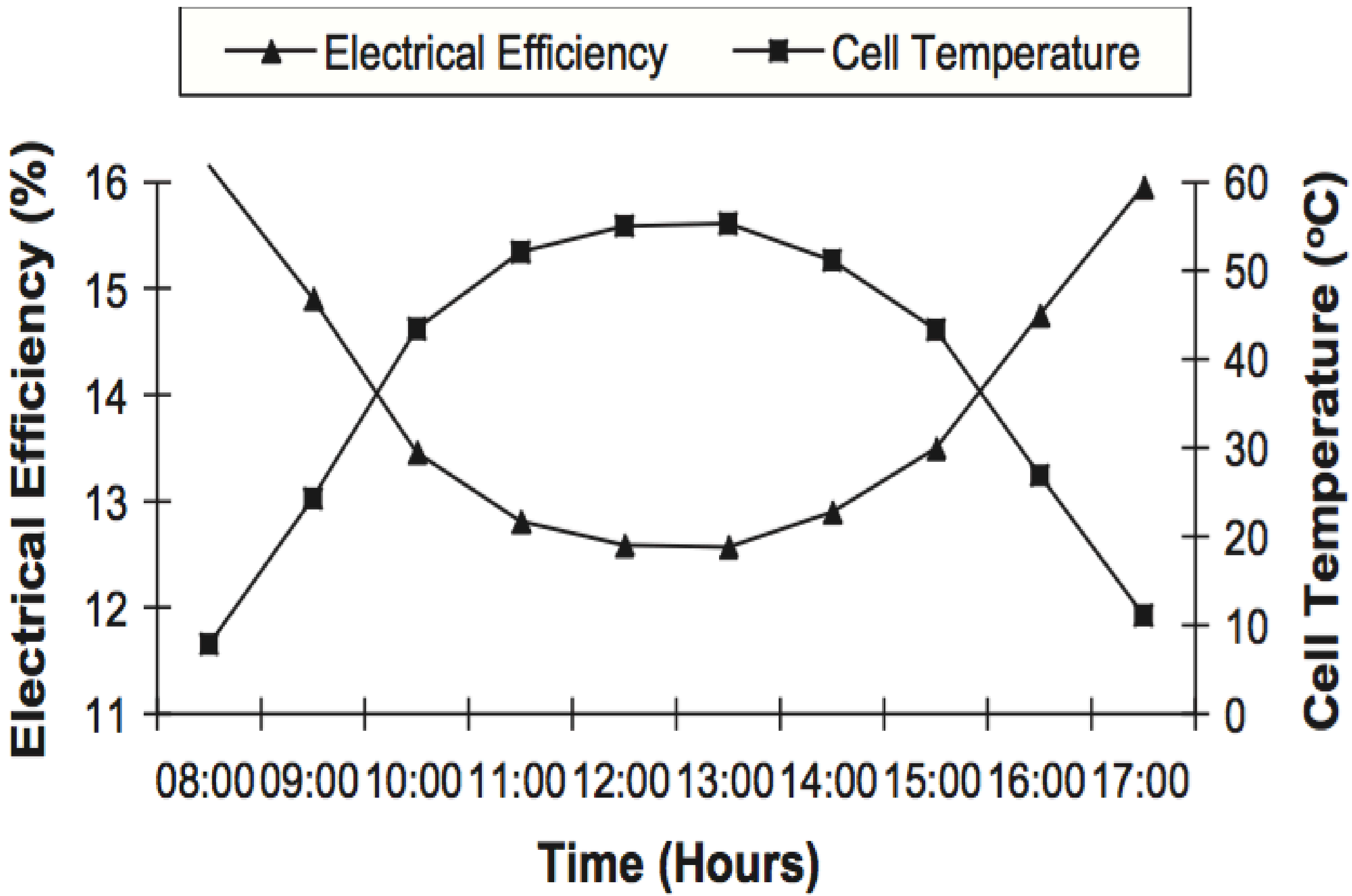
Silicon PV Panels



Source: P.D. Wallace (http://ffden-2.phys.uaf.edu/631fall2008_web.dir/wallace_webpage/8_Sun.html)

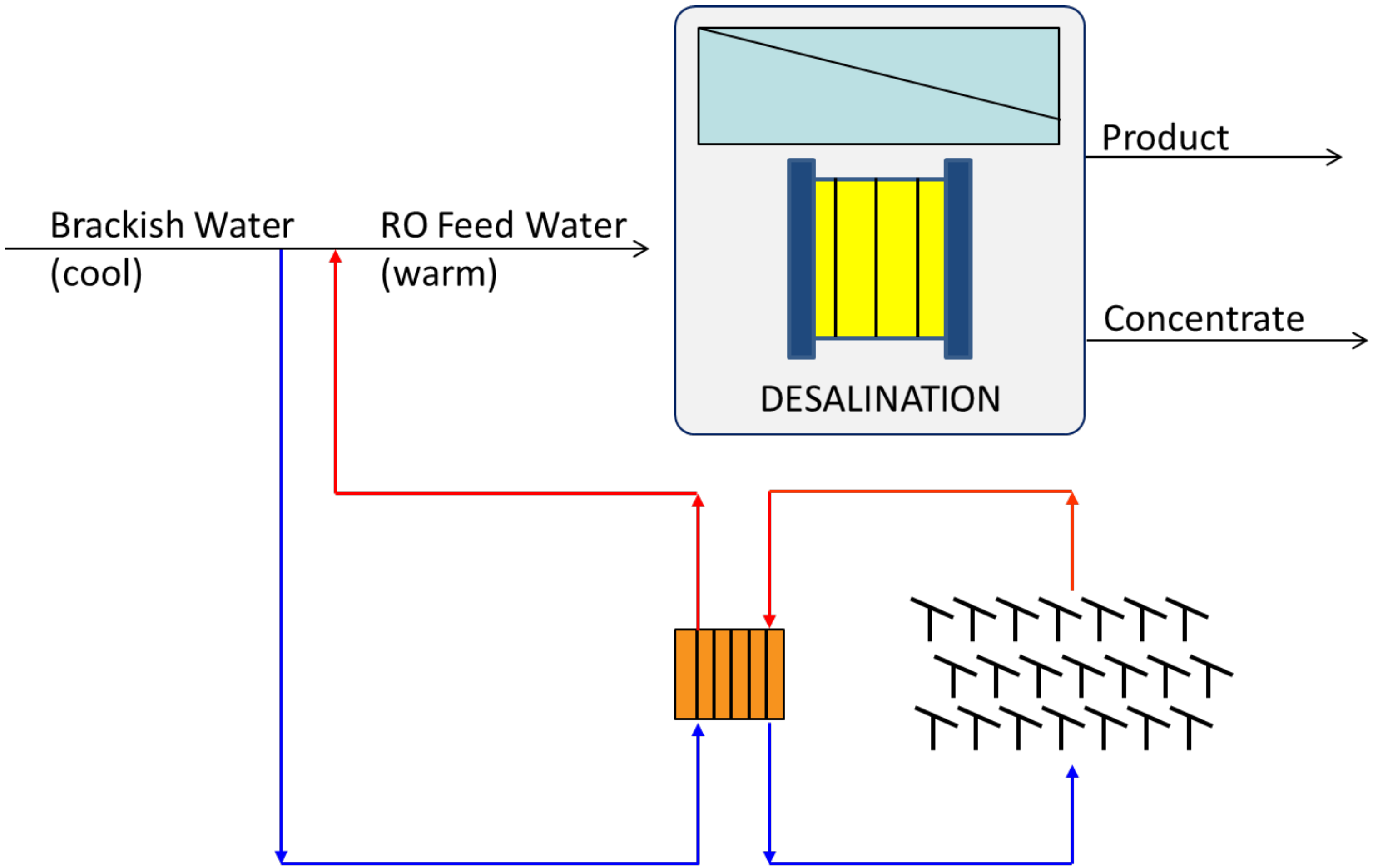
Silicon PV panels convert ~20% of the available solar power to electricity

Hot panels: ↓ energy production



Tiwari et al., 2011

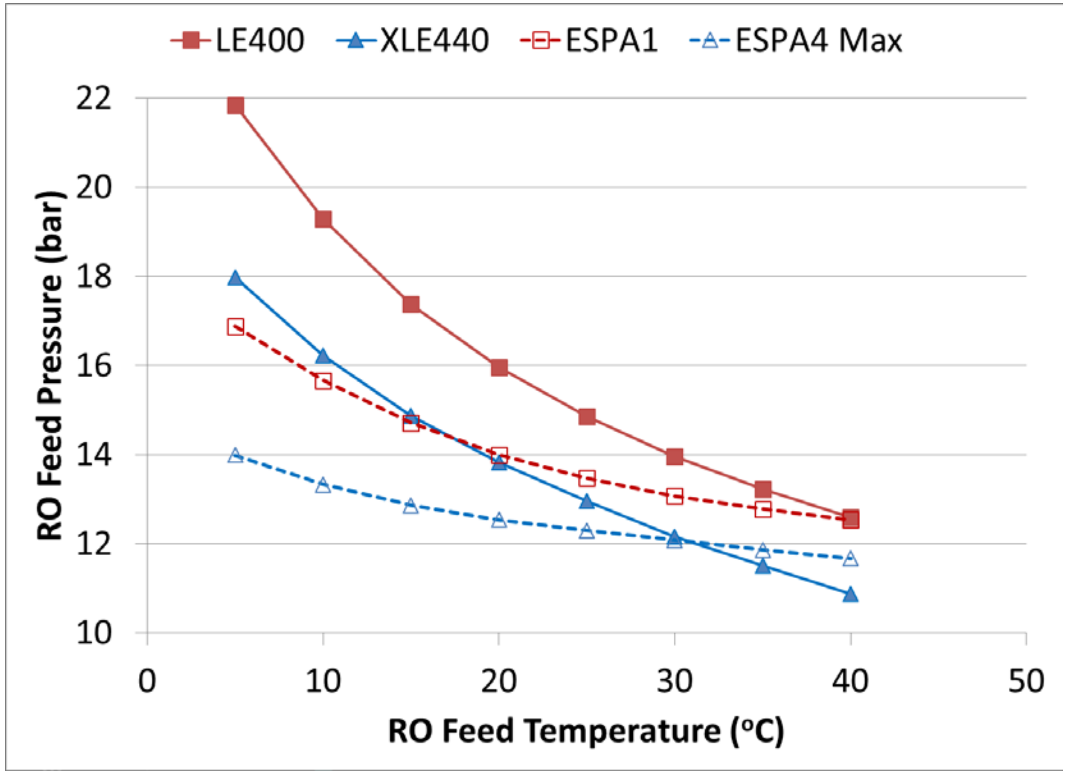
Solar-Powered Desalination

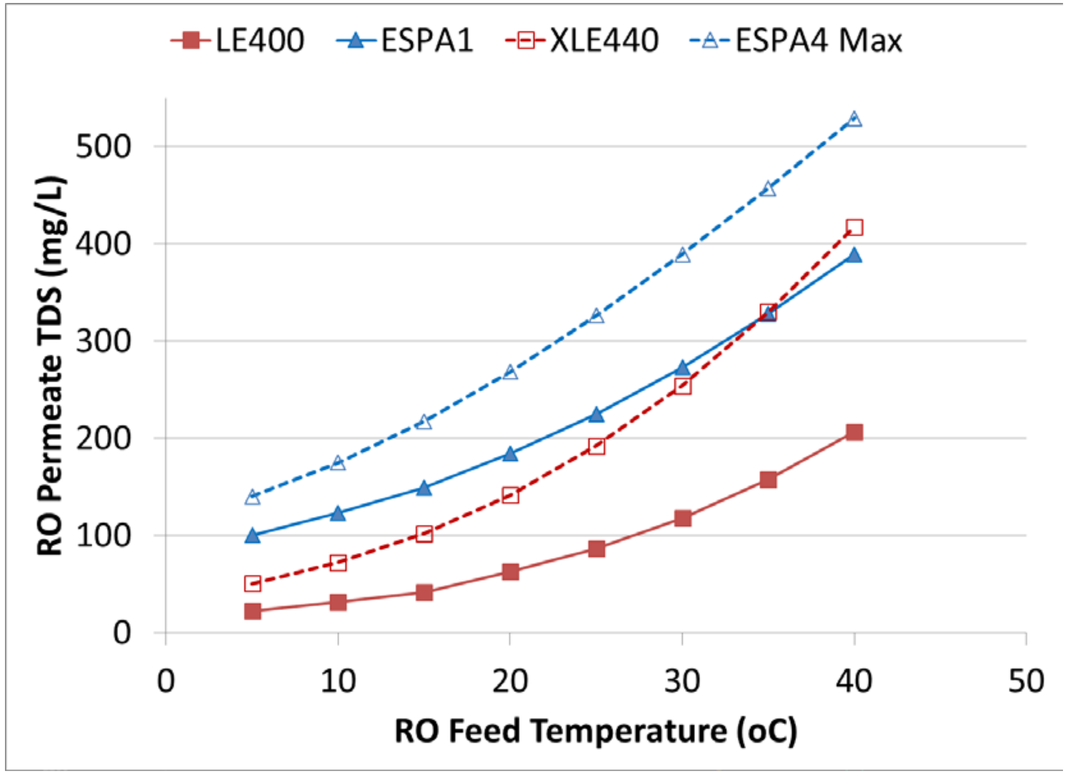


Research Goals

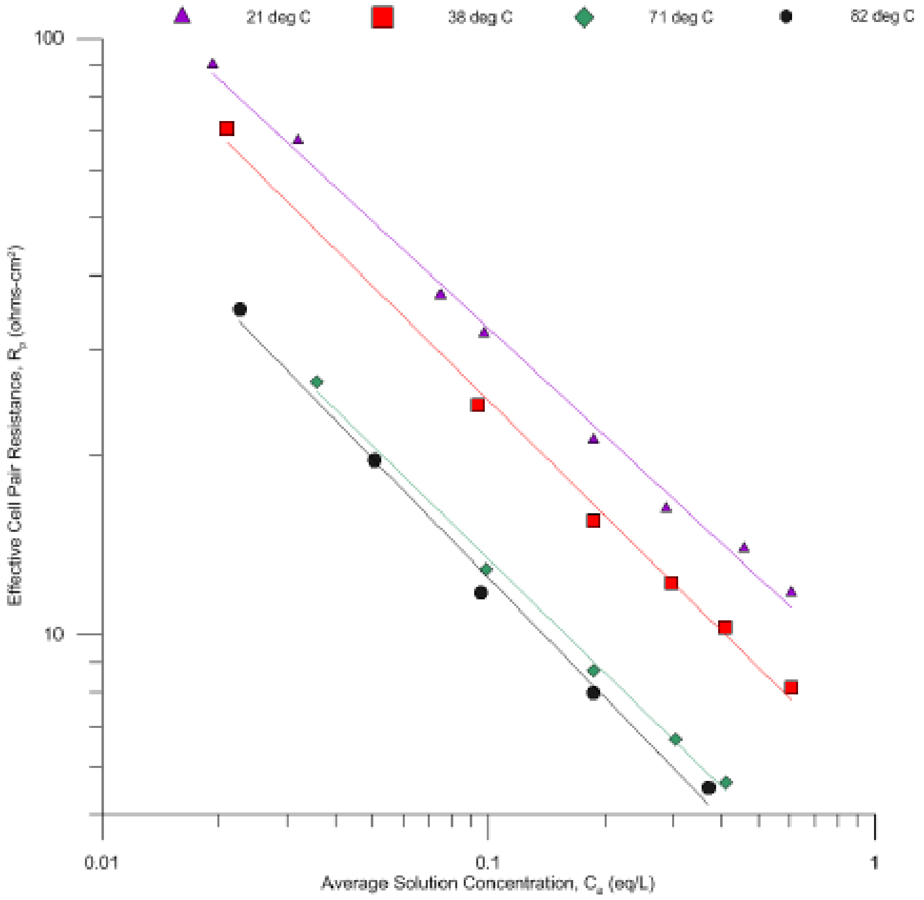
- Duration:
  - Summer 2019-Winter 2020 at BGNDRF
  - 2020-2022 in El Paso (proposed to USDA)
- Evaluate pressure-driven (RO, NF) and electrically-driven (ED, EDM) with warmer water
- Evaluate water quality for each method
- Evaluate cost of water

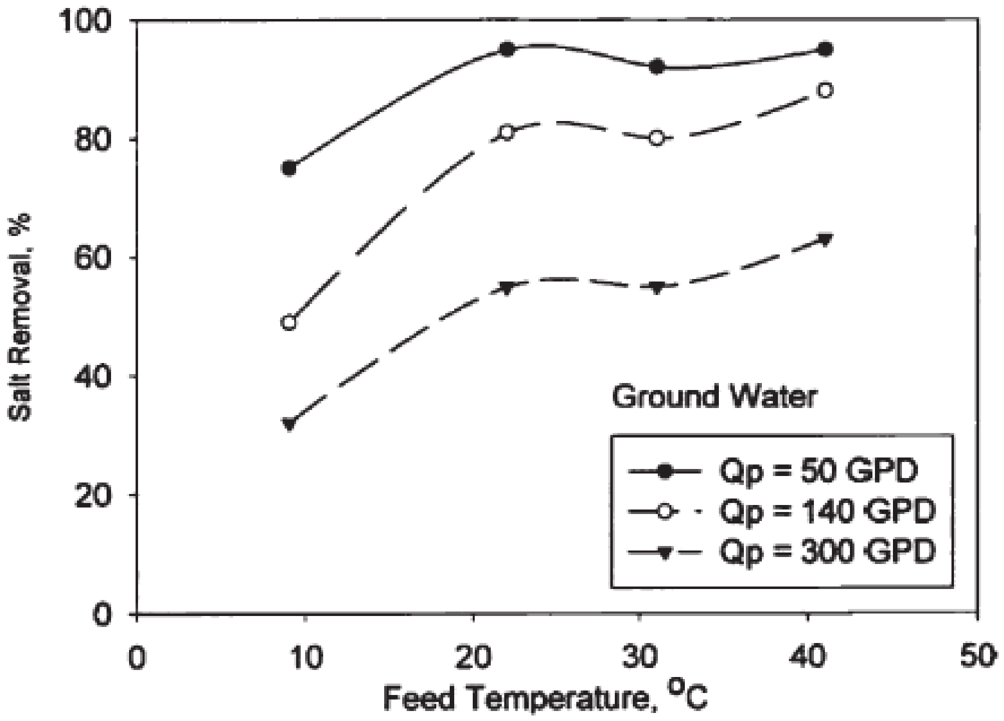
Reverse Osmosis and Nanofiltration:
↑temperature:↓ energy, but ↑ permeate salinity



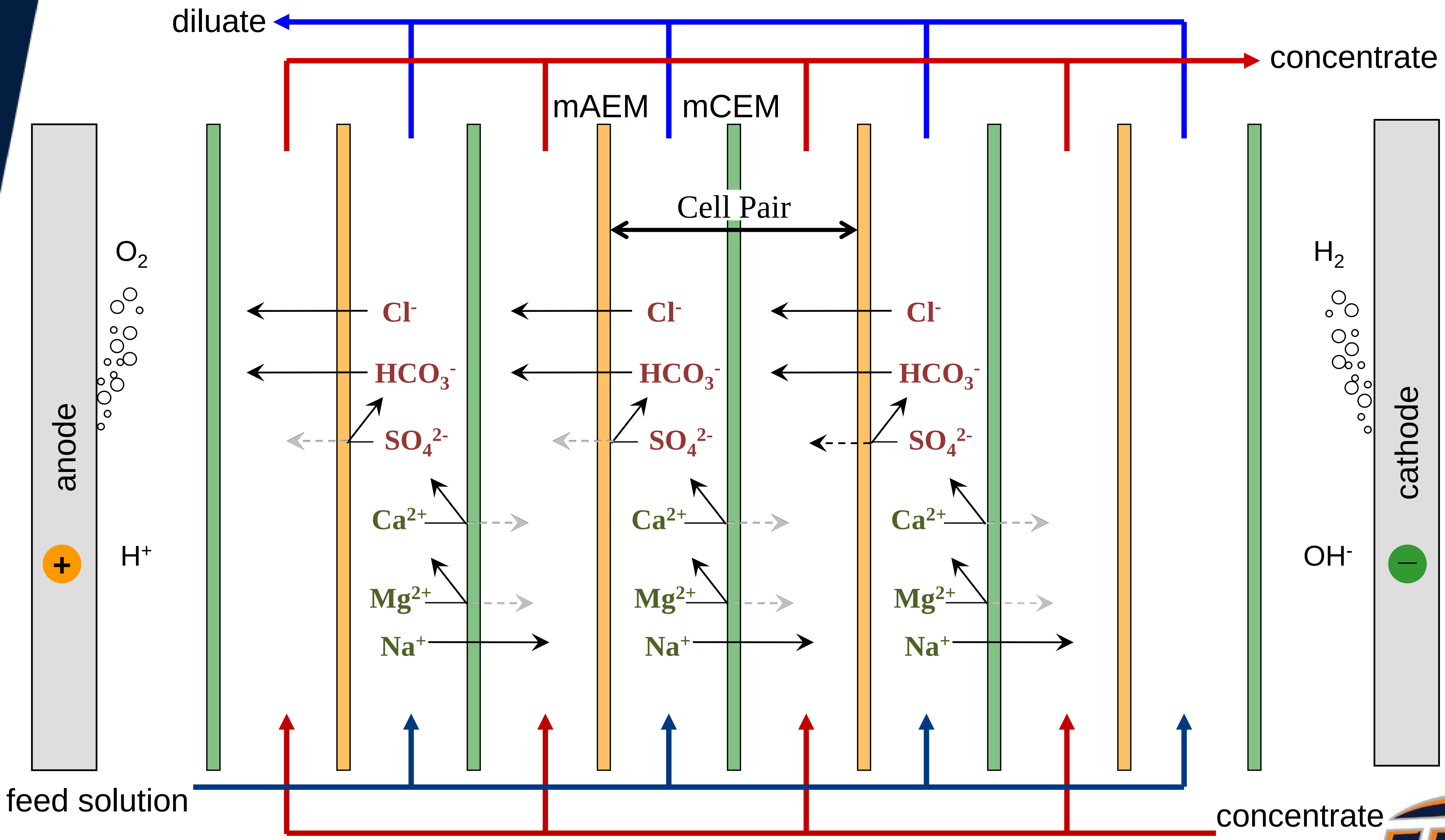


Electrodialysis:
↑temperature:↓ energy, ***AND*** ↑ ion transport



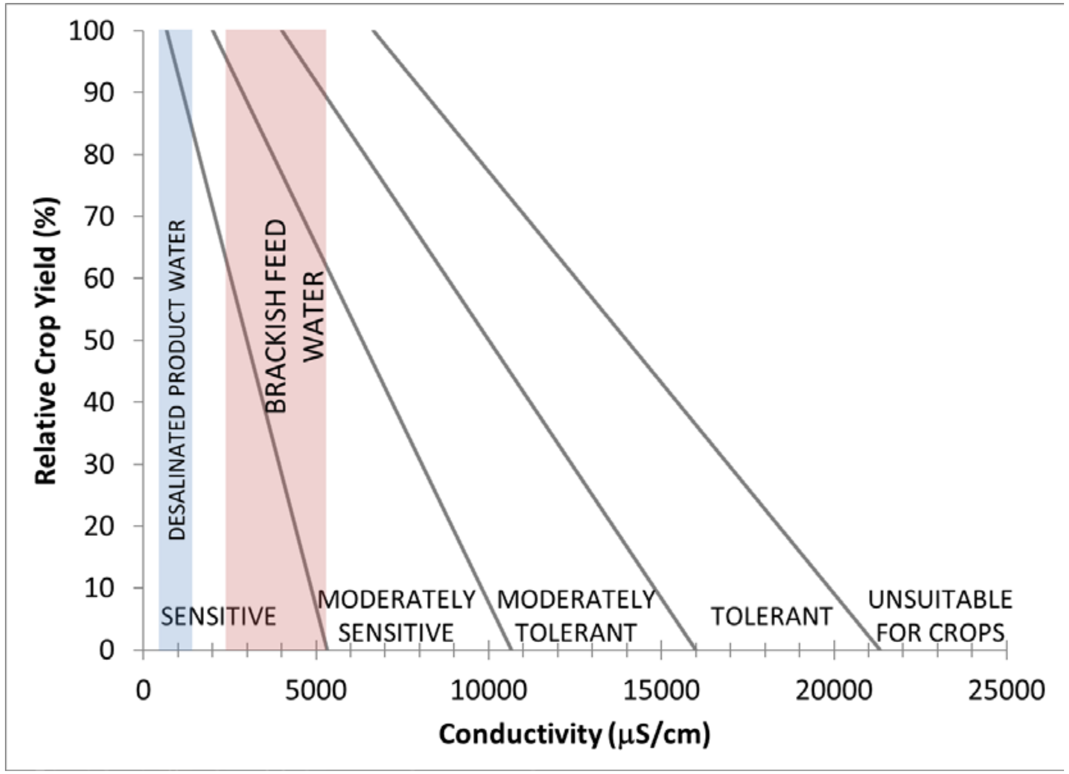


Desal for Agriculture

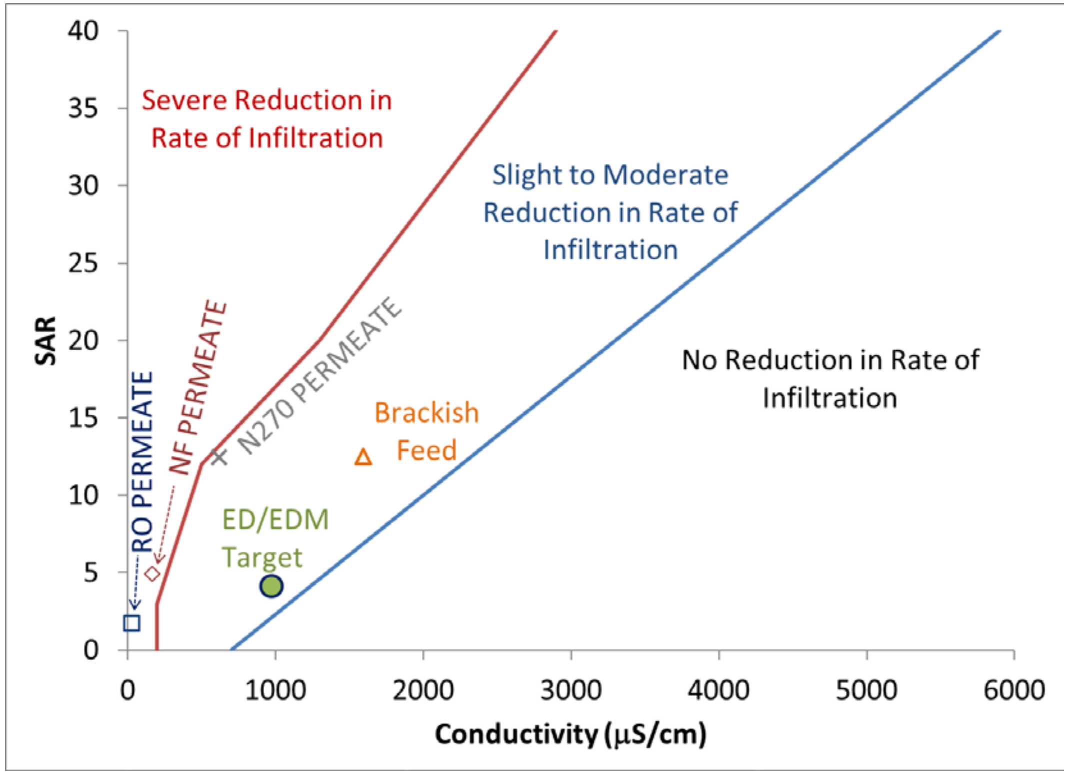


diluate
concentrate
mAEM
mCEM
Cell Pair
O2
H2
anode
cathode
Cl-
HCO3-
SO42-
Ca2+
Mg2+
Na+
H+
OH-
+
feed solution
concentrate

Treat-to-need: Desal for Agriculture



Remove just enough TDS to preserve crop yield



Selectively remove Na^+, Cl^- to improve SAR

Final Thoughts

- Reasonable water quality target
  - Consider > 500 mg/L TDS for drinking water
  - Lowest SAR, and possibly higher TDS than current practice
- Remove harmful trace contaminants
- Optimize recovery & energy consumption
  - Higher recovery → higher cost (usually)
  - Lower recovery → more concentrate disposal (OK in some cases)
- Site specific factors are important

Thanks for listening

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