

Decentralized Renewable Off-grid Water Treatment (DROWT)

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SCOPE OF WORK



DESIGN OF SYSTEMS THAT ARE:

- Independent from the power grid
- Portable and robust
- Capable of treating Brackish water and Graywater

APPLICATIONS:

- Disadvantaged Communities
- Natural Disasters
- Remote Locations

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GLOBAL STATUS: WATER



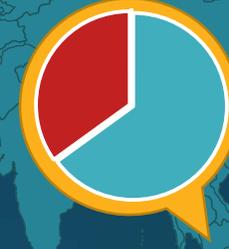
Haiti
4.3 Million People



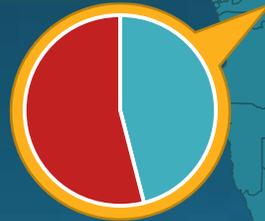
Somalia
7.5 Million People



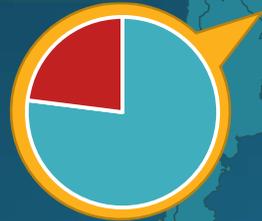
Cambodia
5.3 Million People



D.R. of Congo
36.5 Million People



Paraguay
1.6 Million People

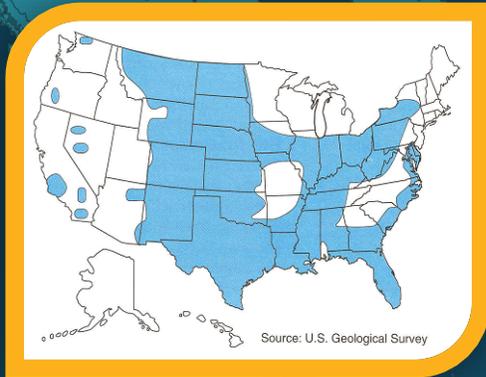


TOTAL: 1.2 BILLION PEOPLE

The population of the world is increasing while the supply of traditional water resources are limited.

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GLOBAL STATUS: WATER



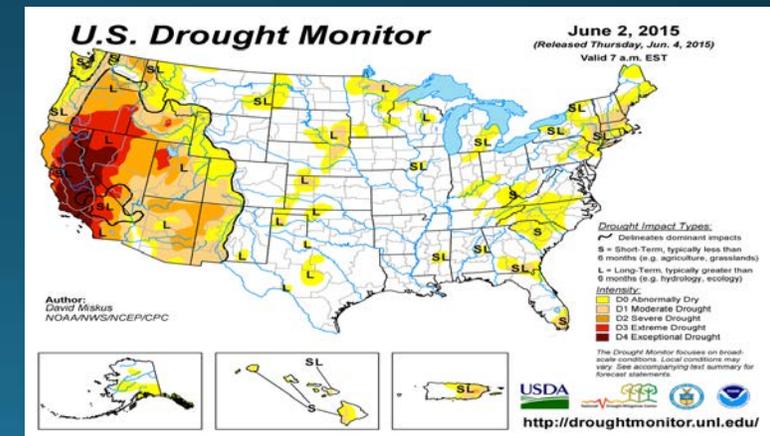
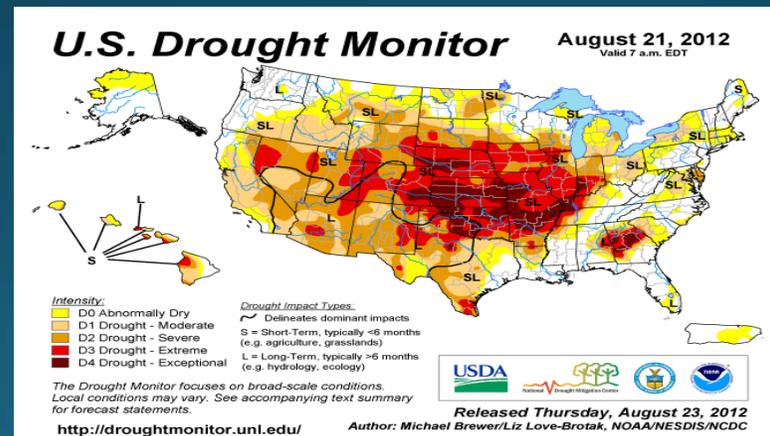
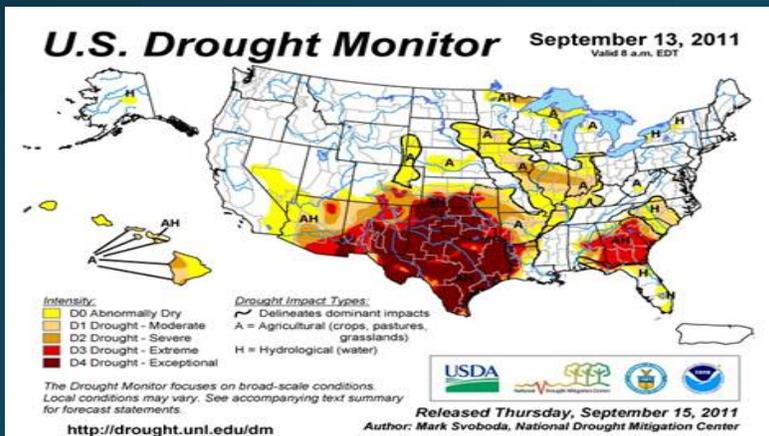
UNITED STATES

Sewer is abundant!

Areas without freshwater sources are rich with brackish groundwater

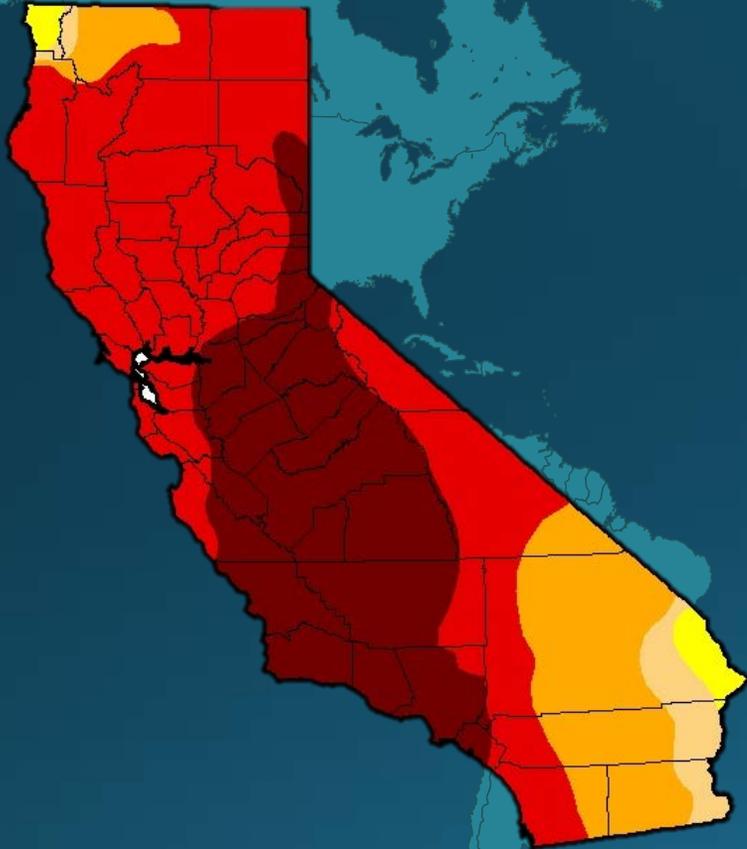
USA Recent Droughts

- Texas Drought: **2011**
- Mid-west Drought: **2013**
- California Drought: **2015**



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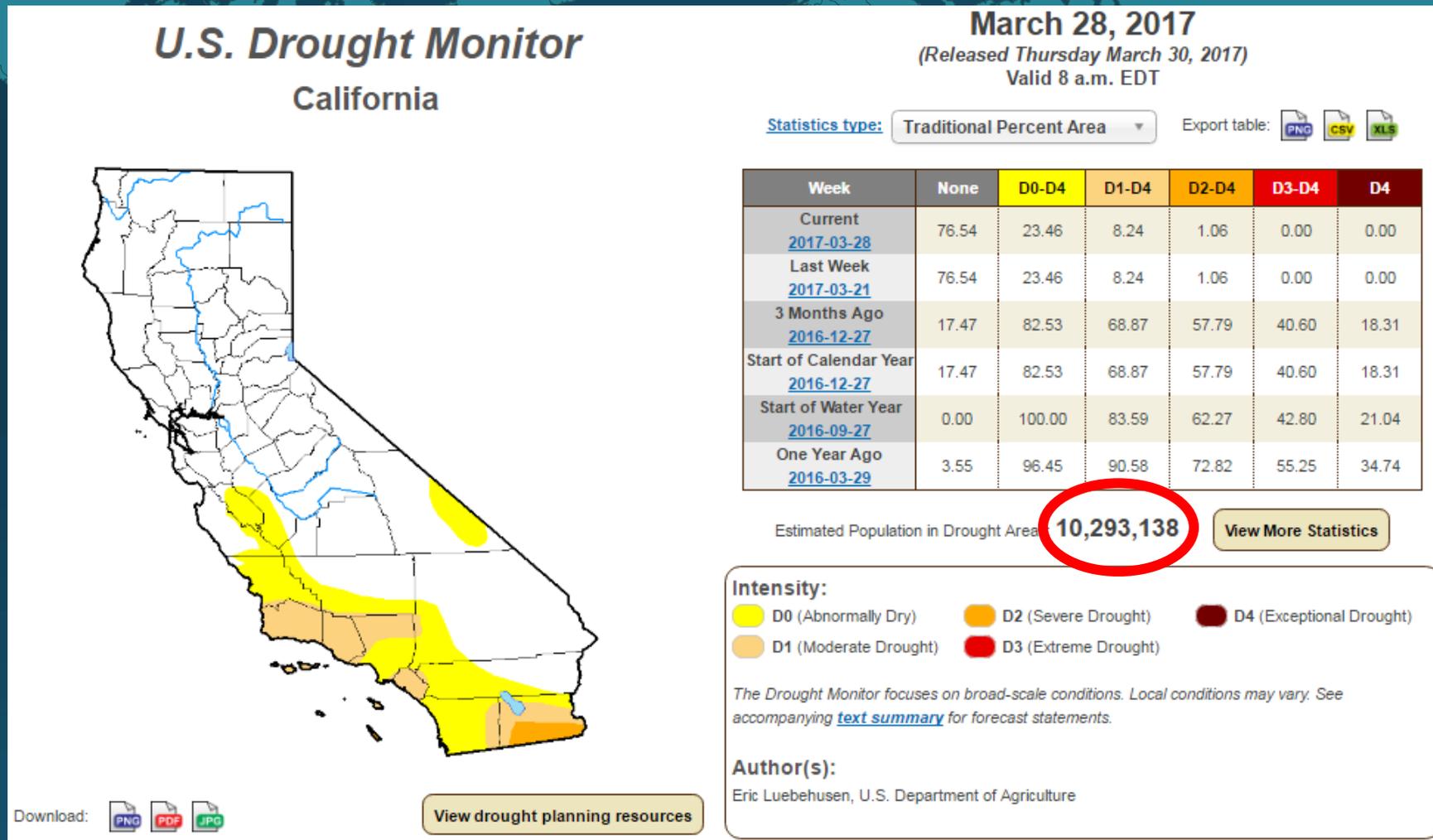
Recent Droughts: CALIFORNIA



CALIFORNIA DROUGHT

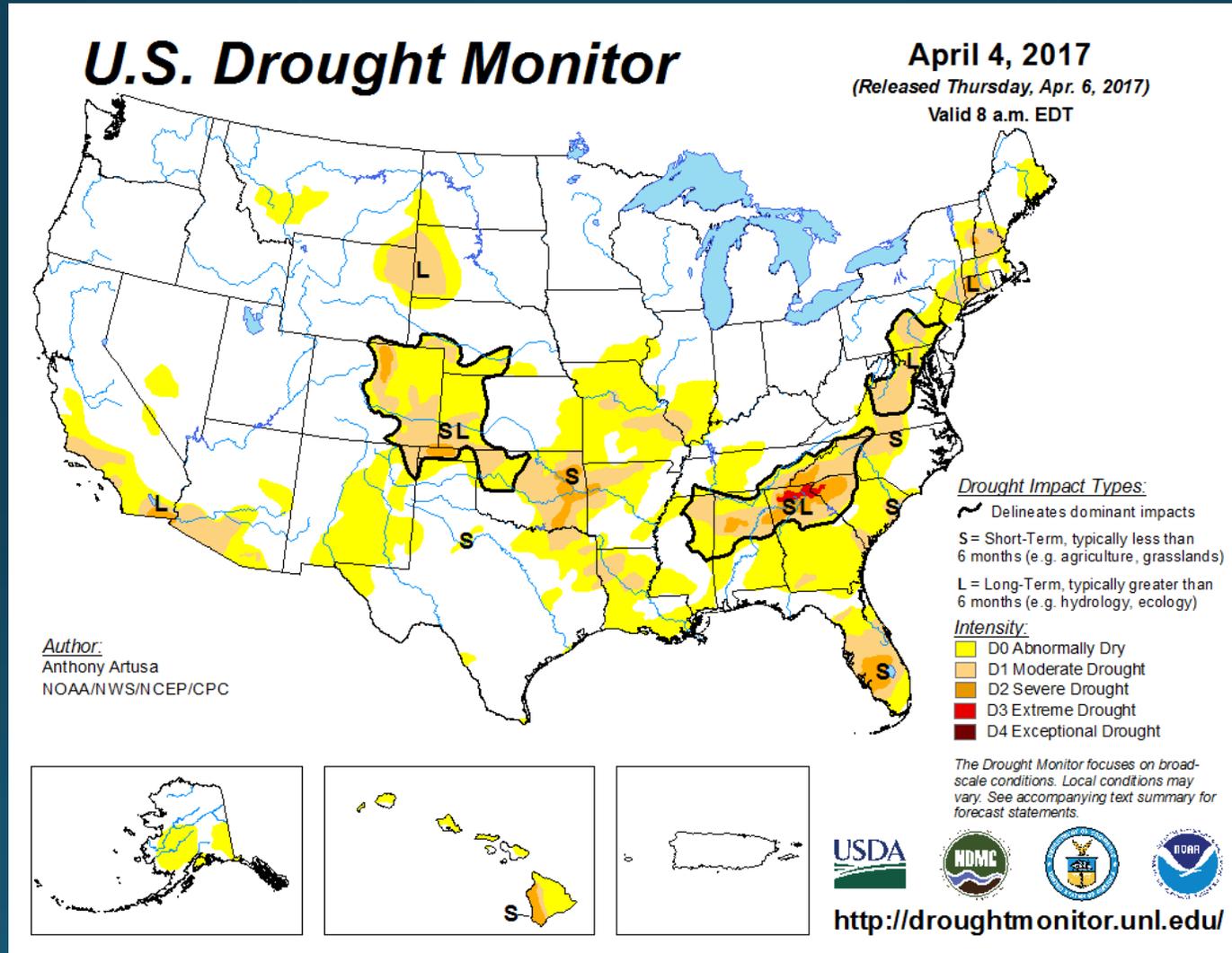
As of April 3, 2017: 8.2% of the state is in D₁ (Moderate Drought) status.

Recent Droughts: CALIFORNIA



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USA Current drought Map ?



x

GLOBAL STATUS: WATER

- Increasing population demands a greater need for clean drinking water resources.
- Climate change is expected to substantially increase the chance of future droughts. *
- Brackish water and Graywater are readily available.

* AghaKouchak, A., L. Cheng, O. Mazdidasni, and A. Farahmand (2014), *Global warming and changes in risk of concurrent climate extremes: Insights from the 2014 California drought*, *Geophys. Res. Lett.*, 41, 8847–8852,

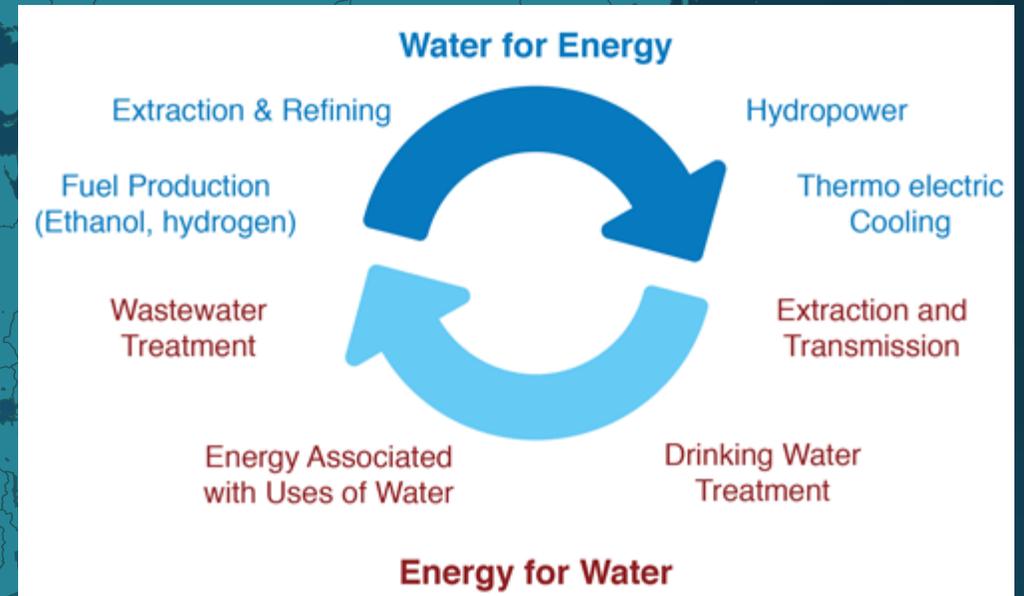
CURRENT SOLUTIONS

1. Water Conservation
2. Storm Water Capture
3. Water Reuse
4. Desalination



ENERGY-WATER NEXUS

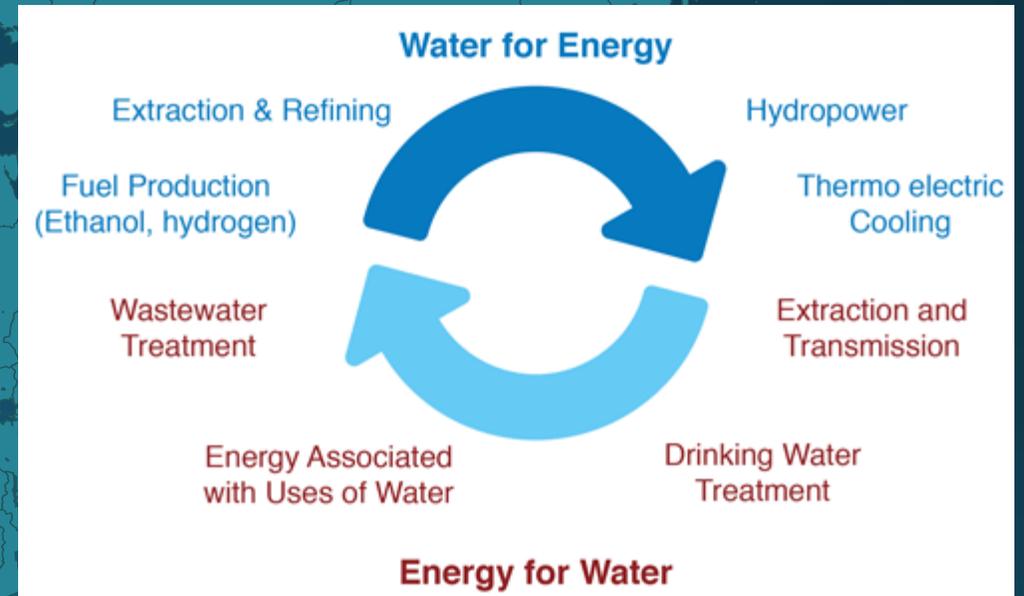
19% of electricity consumption in California is for pumping, treating, collecting, and discharging water and wastewater.



ENERGY-WATER NEXUS

How does California's water-sector energy consumption compare with the US average ?

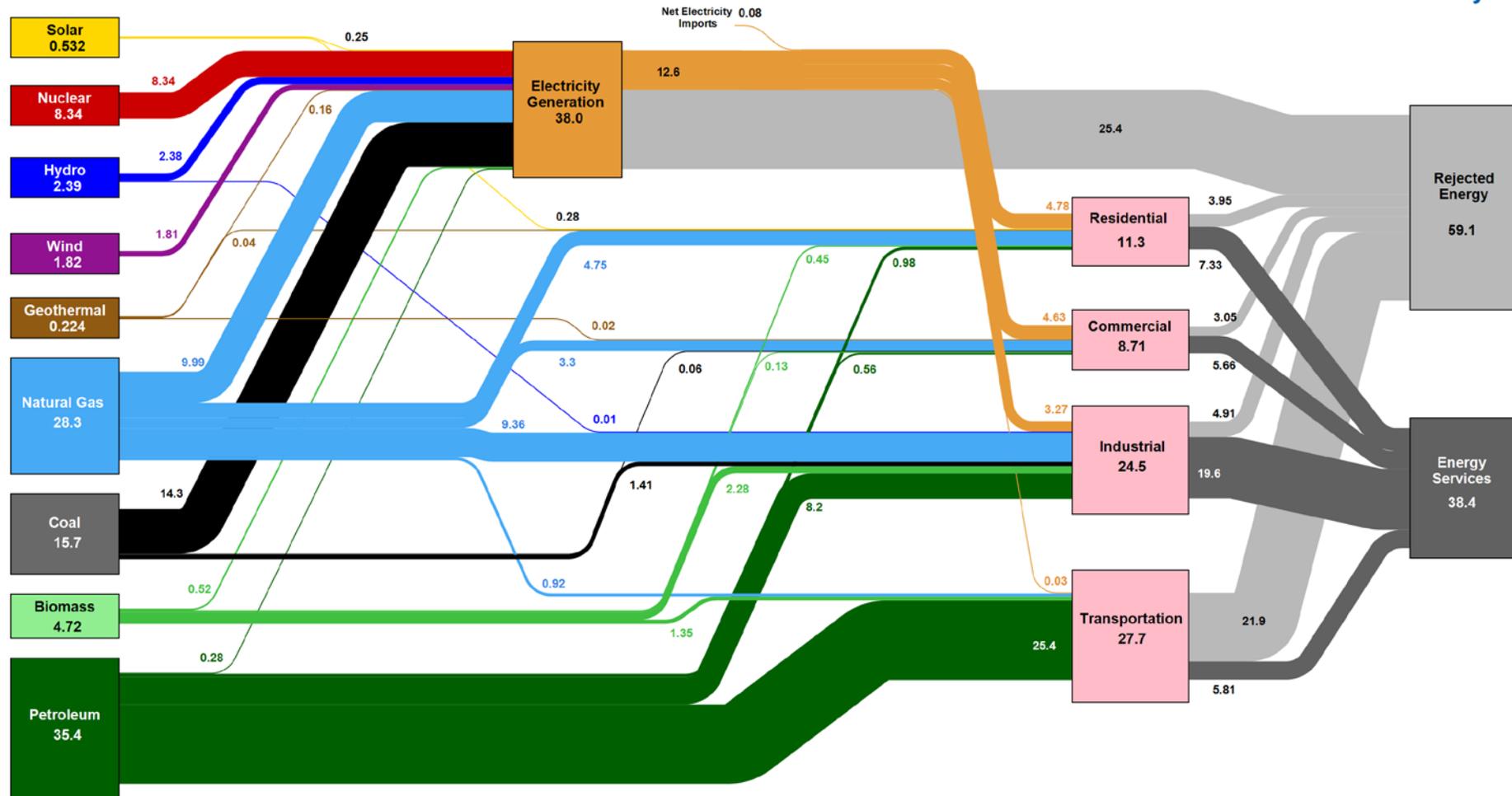
- ~~2x more~~
- ~~3x more~~
- ~~4x more~~
- 5x more



C. Copeland, N. Carter, *Energy-Water Nexus: The Water Sector's Energy Use*, Congressional Research Service, Washington, DC (2017)

ENERGY-WATER NEXUS

Estimated U.S. Energy Consumption in 2015: 97.5 Quads

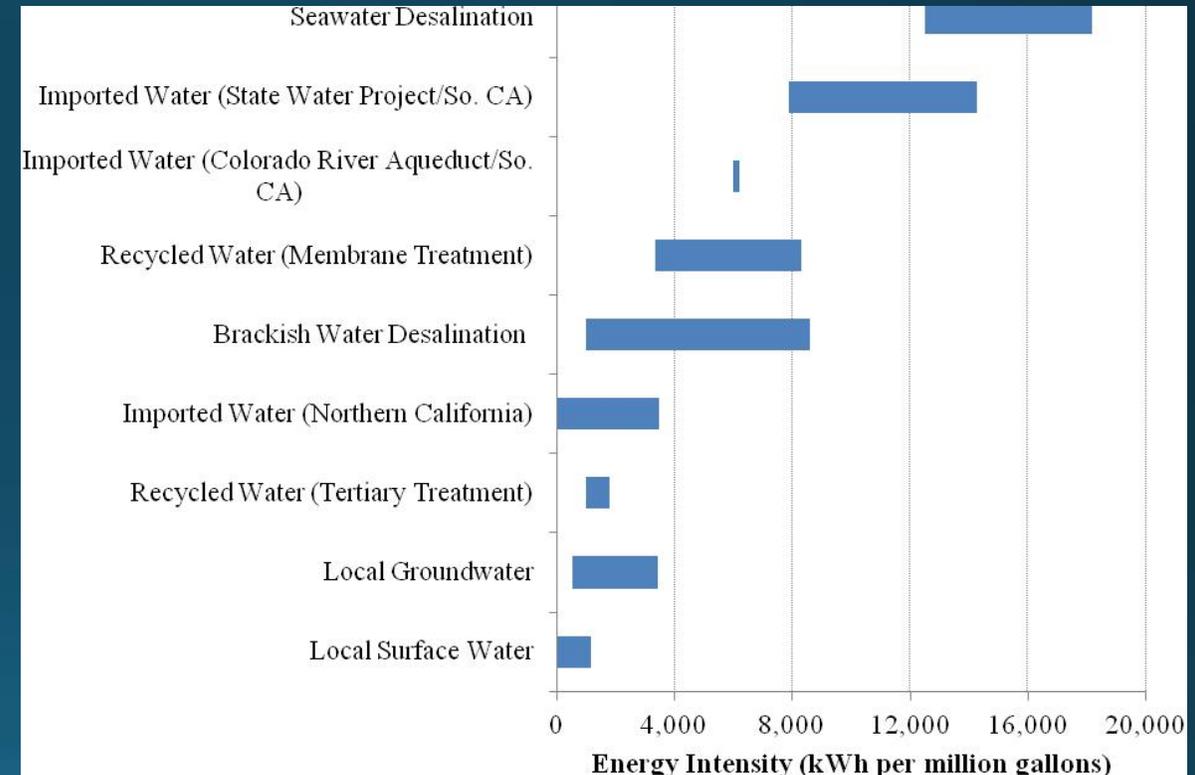


CARBON FOOTPRINT OF DRINKING WATER

Imported water requires more energy than local groundwater/surface water

Imported water requires more energy than membrane processes!!!

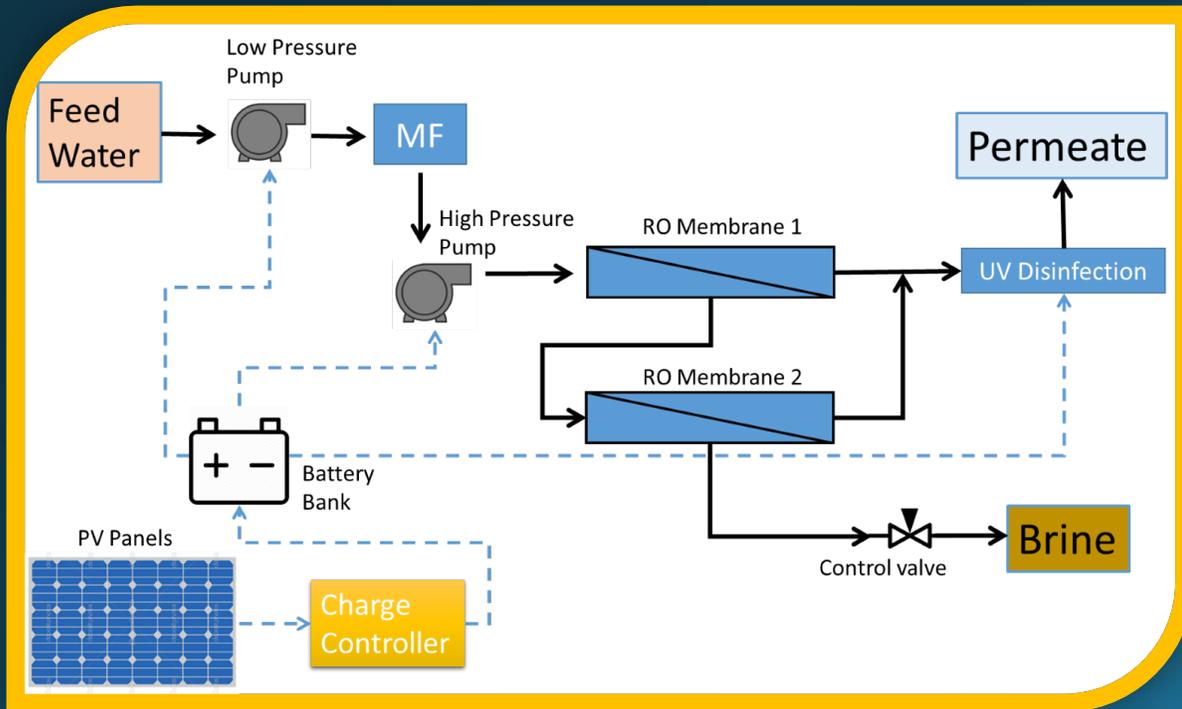
Water reuse and brackish water desalination are less energy intensive than importing water.



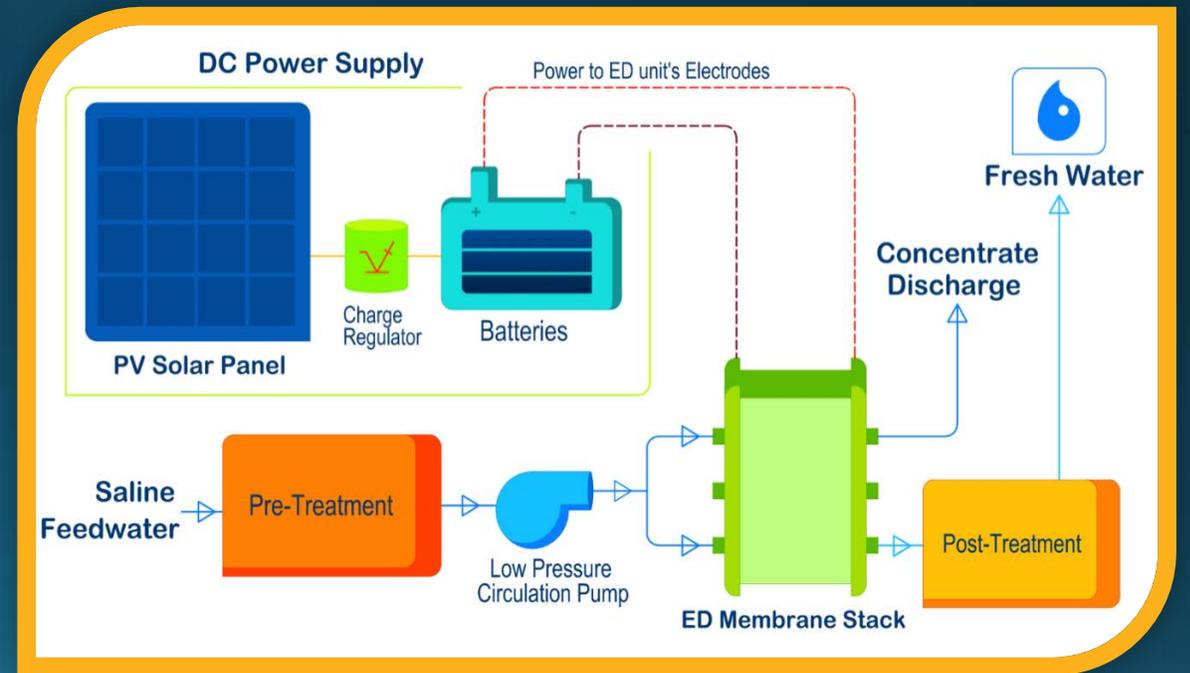
Source: http://www.pacinst.org/reports/desalination_2013/energy/

DROWT Technologies

PV-RO



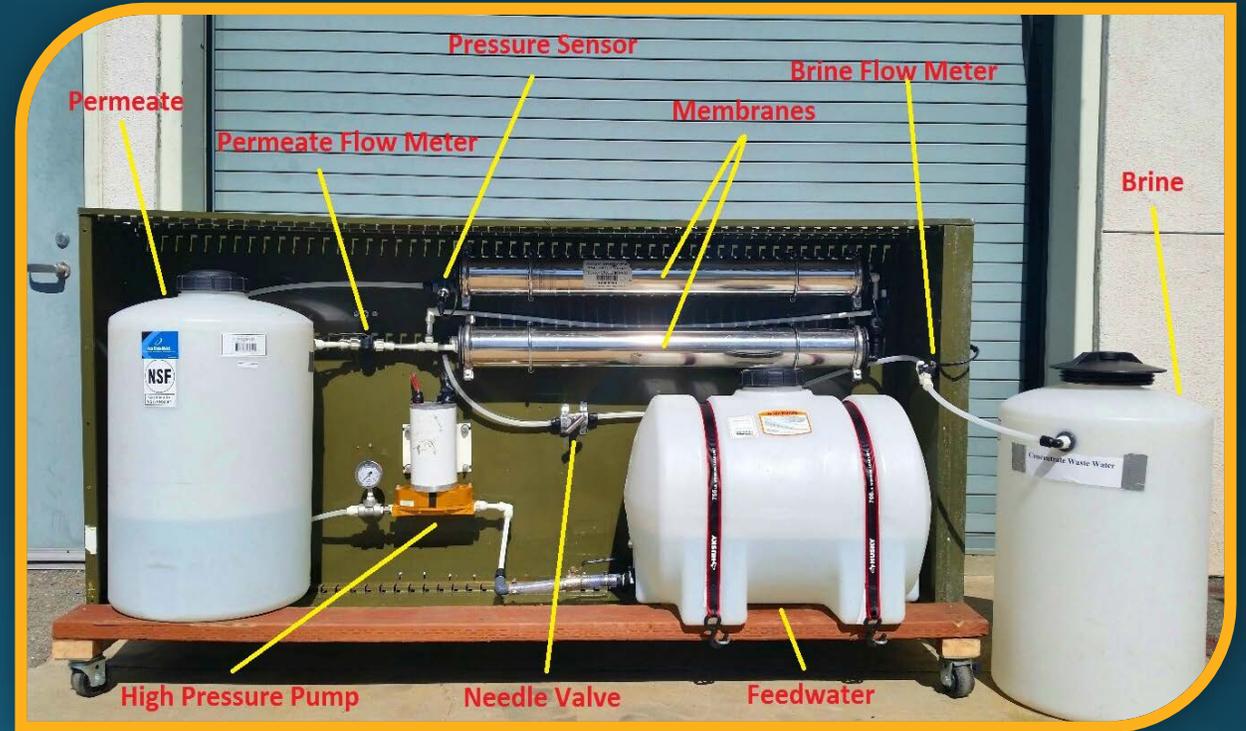
PV-ED



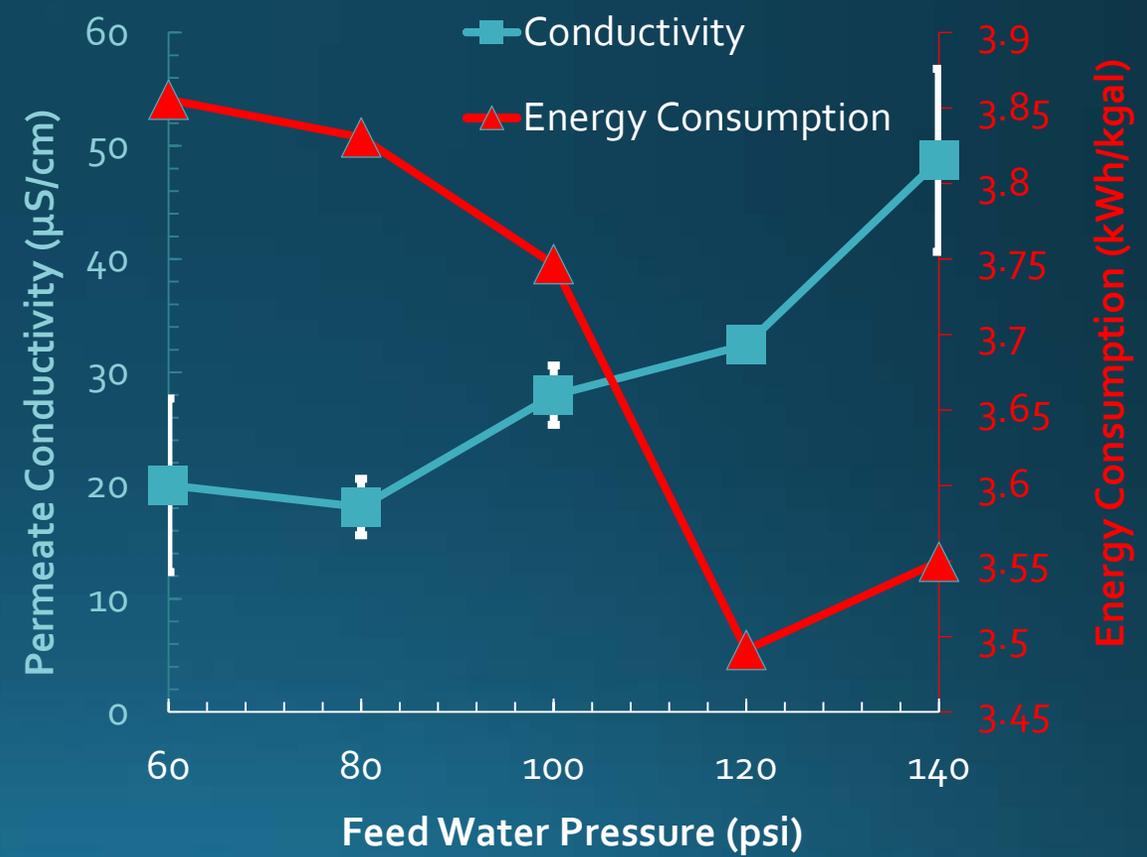
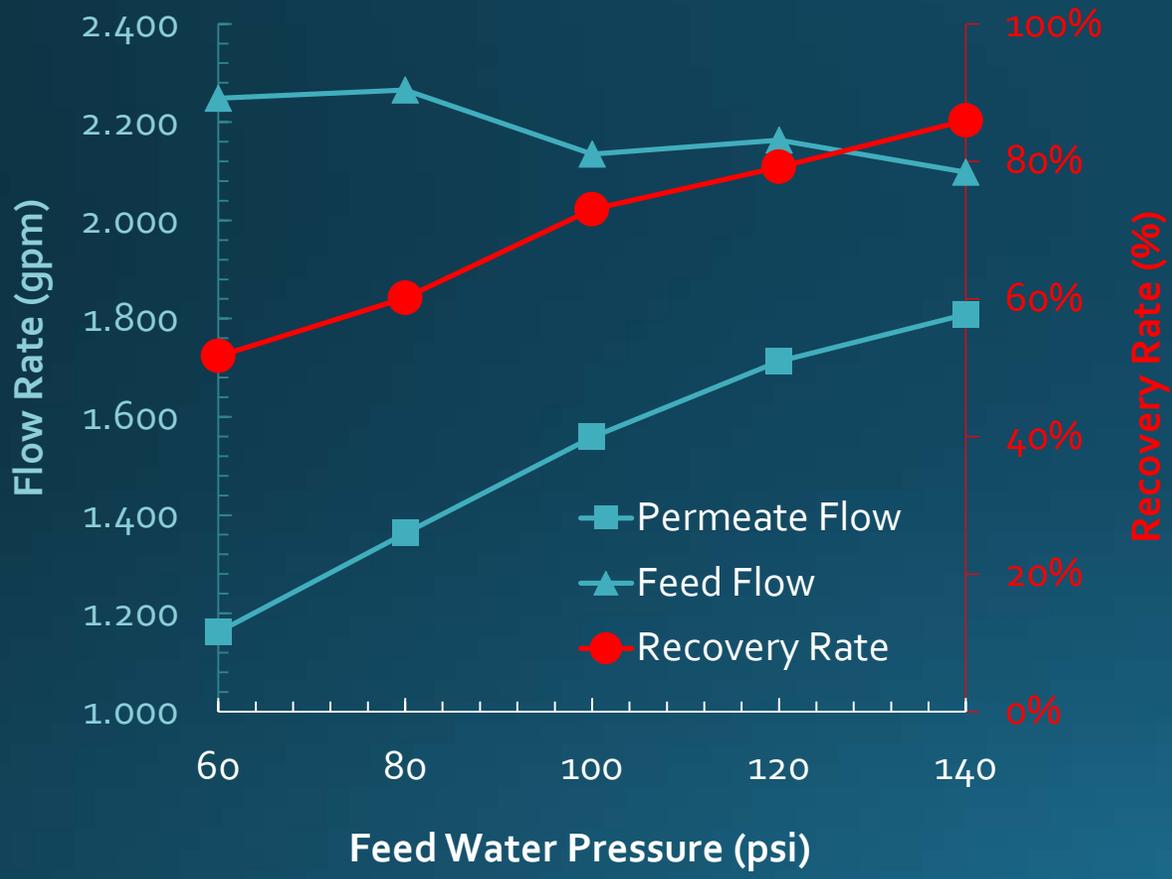
PV-RO (Preliminary Design)

FOUR SUBSYSTEMS

1. Reverse Osmosis
2. Hydraulics
3. Photovoltaic
4. Automation



PV-RO (Preliminary Design)



DROWT

CPP

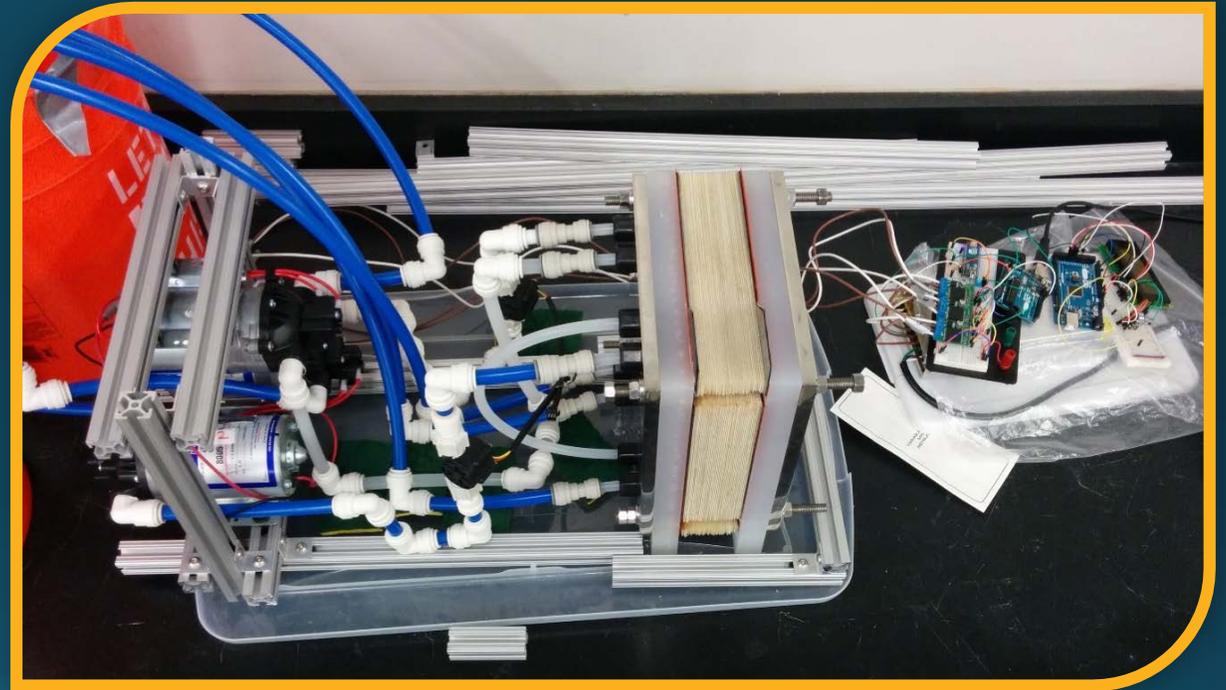
MWD

Reclamation

PV-ED

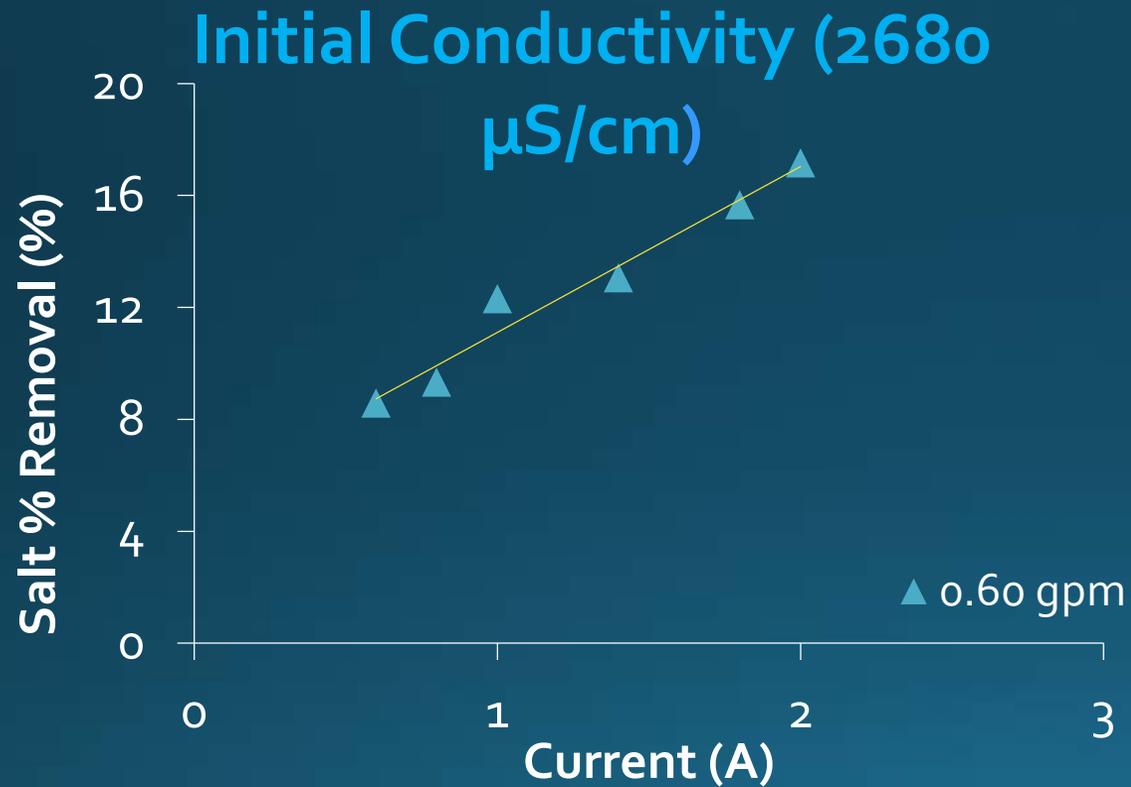
FOUR SUBSYSTEMS

1. Electrodialysis
2. Hydraulics
3. Photovoltaic
4. Automation



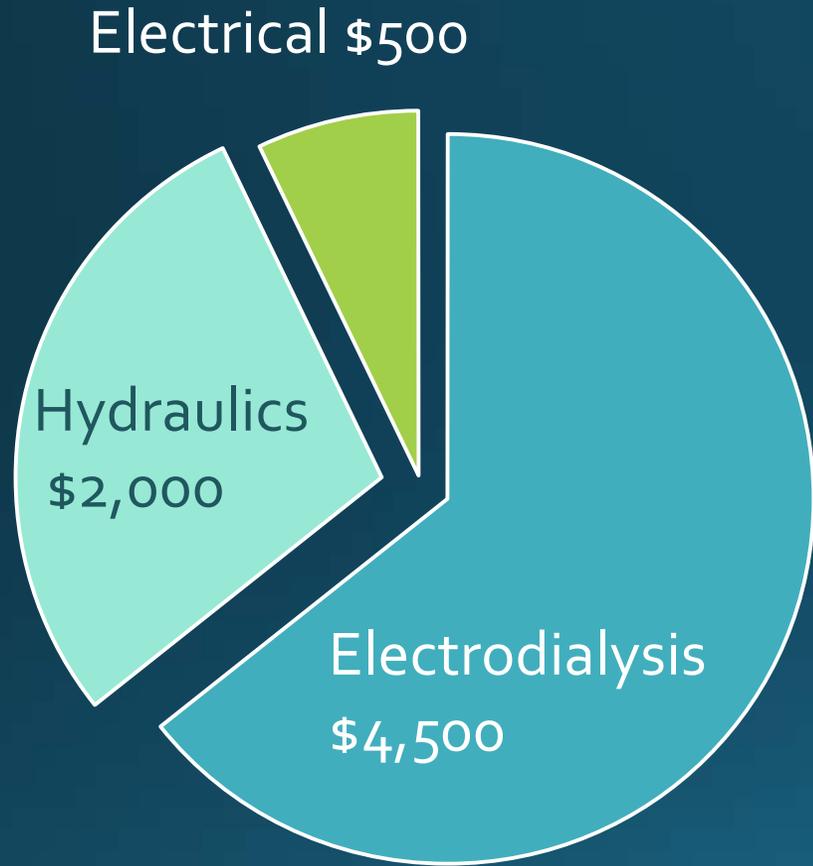
LABORATORY TESTING

UNIT TESTING RESULTS



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HOW MUCH DOES IT COST?



PILOT UNIT
TOTAL: \$7,000

IN-HOUSE
ESTIMATE:
\$4,000

CONCLUDING REMARKS

- Solar-powered and Off-grid Reverse Osmosis and Electrodialysis systems are viable alternatives to traditional desalination methods.
- Solar Optimization tests are further required for efficiency of the system



ACKNOWLEDGEMENTS

- U.S. BUREAU OF RECLAMATION
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- SOUTHERN CALIFORNIA GAS COMPANY
- GENERAL ELECTRIC
- CAROLLA ENGINEERS

