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Geothermal Desalination

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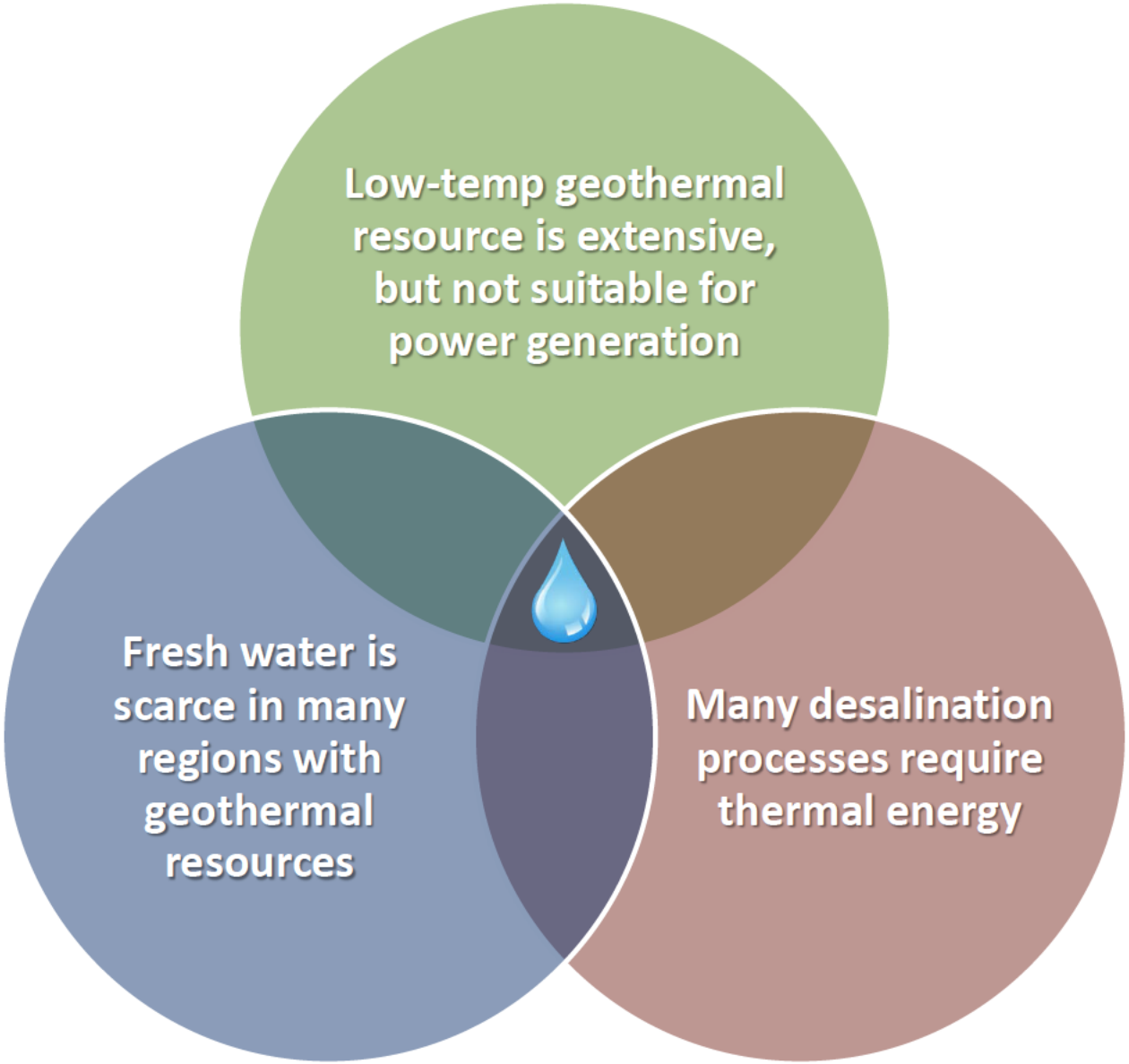
Workshop on Advances in Geothermal Direct Use
Matching Low-Temperature Geothermal Resources to End-Use Demand

Colorado School of Mines, March 18, 2015

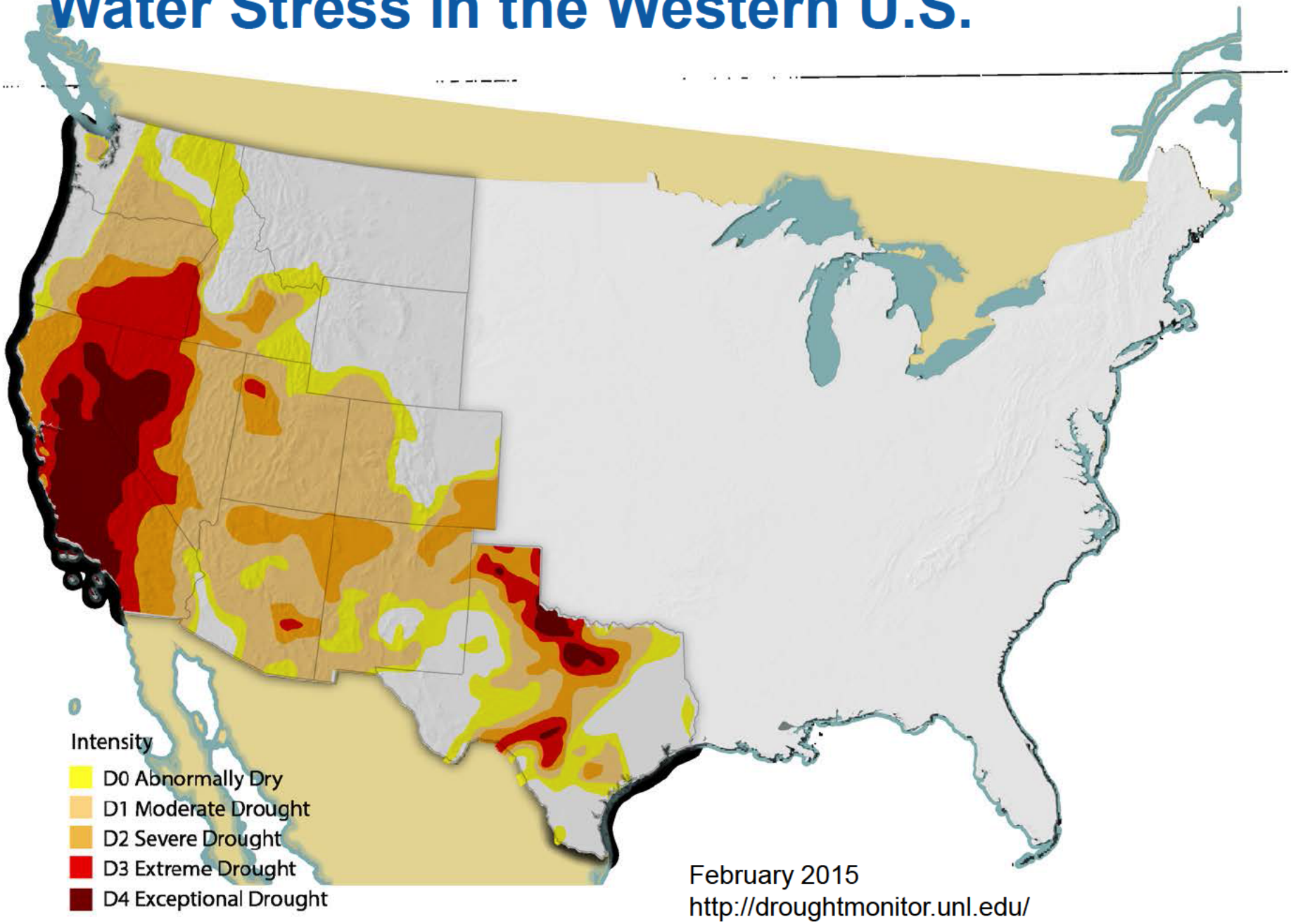
Motivation


Low-temp geothermal resource is extensive, but not suitable for power generation
Fresh water is scarce in many regions with geothermal resources
Many desalination processes require thermal energy

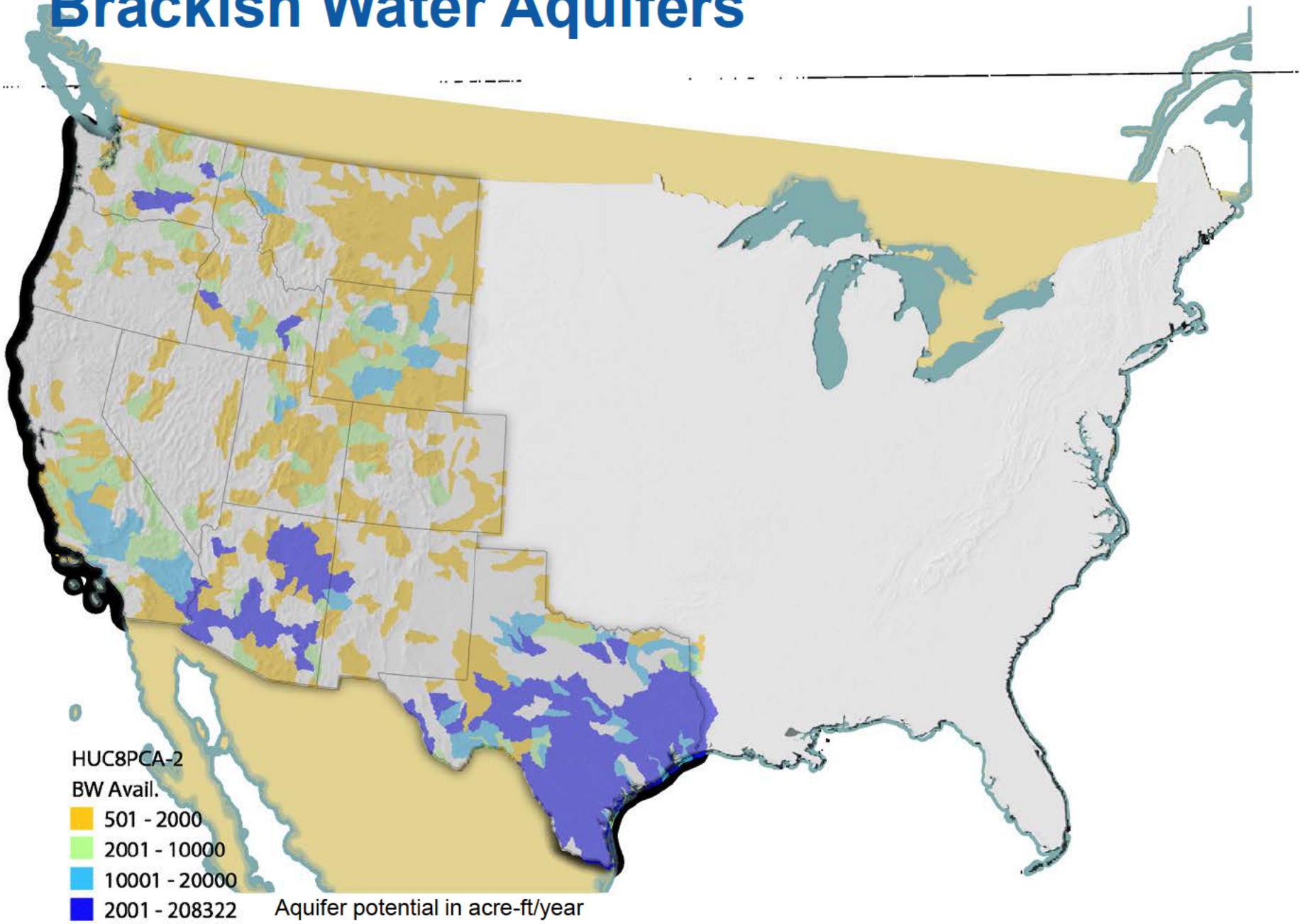
Outline

- Water scarcity and resources in the US
- Desalination technologies
- “GDsalt” decision support tool
- Project status and conclusions to date
- Future plans

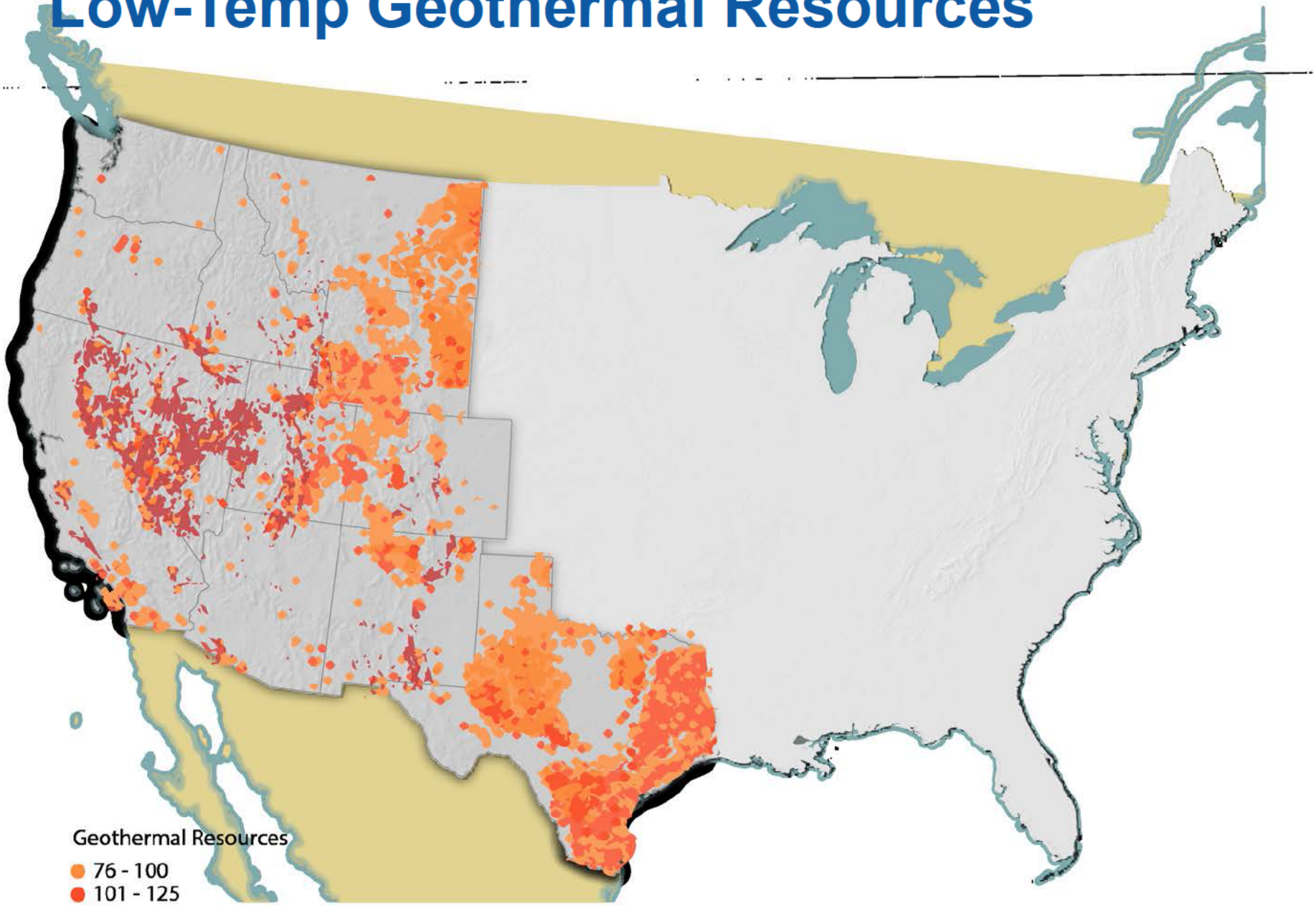
Water Stress in the Western U.S.



Brackish Water Aquifers



Low-Temp Geothermal Resources



Well temps (ºC) from SMU and AASG databases accessed via Geothermal Prospector at http://maps.nrel.gov/

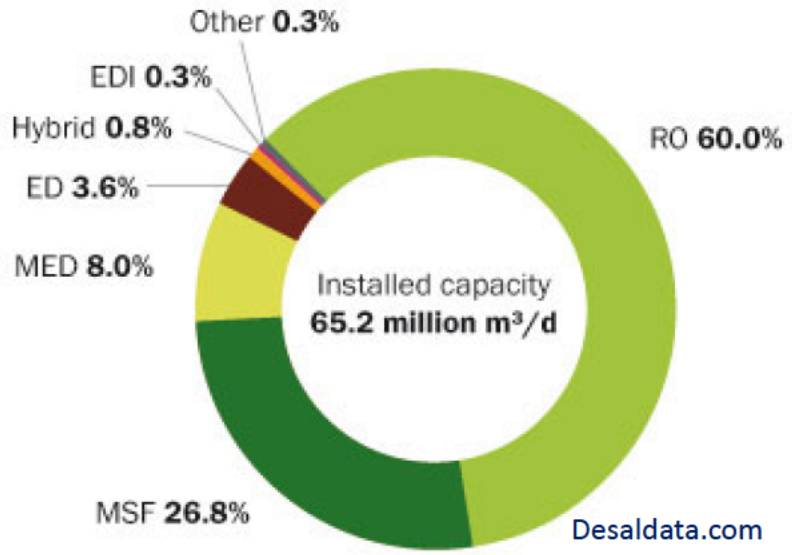
Desalination Technologies

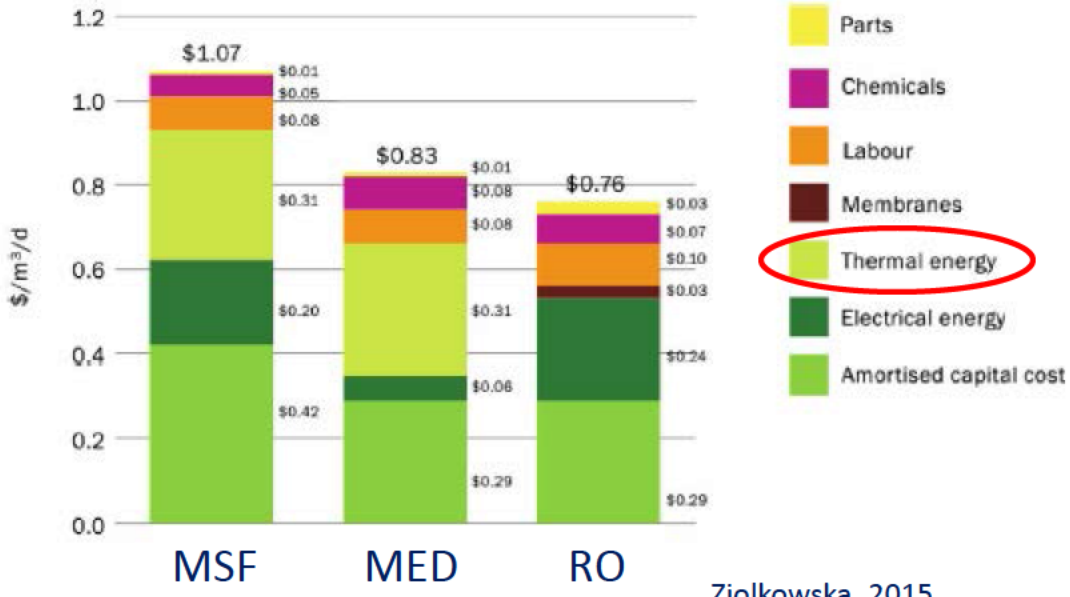
Electric

- Reverse Osmosis (RO)
- Electrodialysis (ED)

Thermal

- Multistage Flash (MSF)
- Multi-effect Distillation (MED)





Ziolkowska, 2015

Thermal energy can account for 30%-50% of desalination cost

NREL / Mines Partnership

Project Objective:

Identify promising options for using geothermal energy to desalinate water and characterize the technology performance, cost, and commercialization gaps.

NREL Team

- Craig Turchi and Michael Hillesheim

CSM Team

- Dr. Tzahi Cath, Civil & Environmental Engineering
  - Dr. Mengistu Geza, Research Assistant Professor
  - Dr. Johan Vanneste, Postdoctoral Associate
  - Bethany Grace Yaffe, Research Assistant
- Dr. John Persichetti, Chemical & Biological Engineering
  - Oversees senior-design course case study on geothermal desalination

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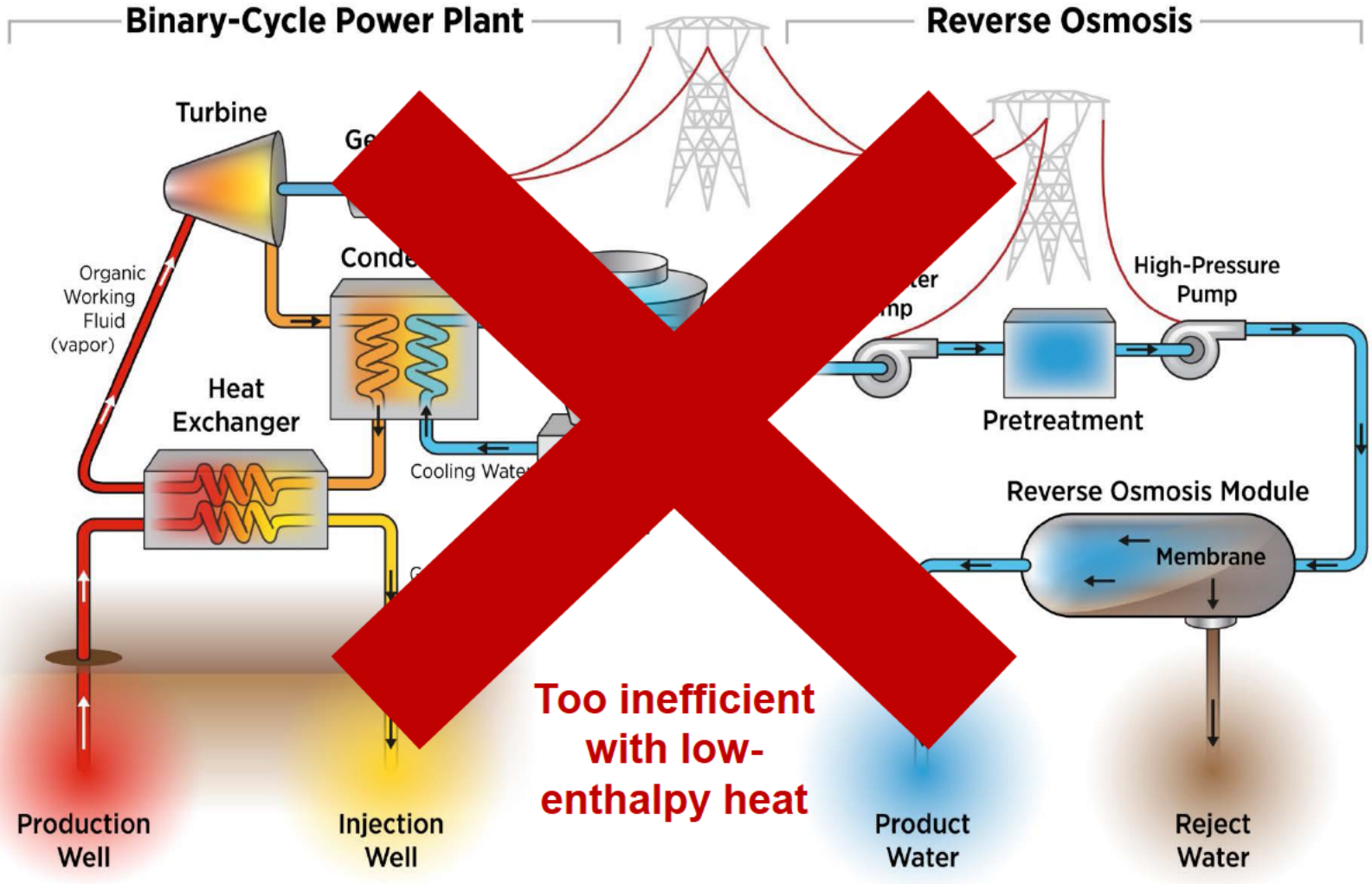
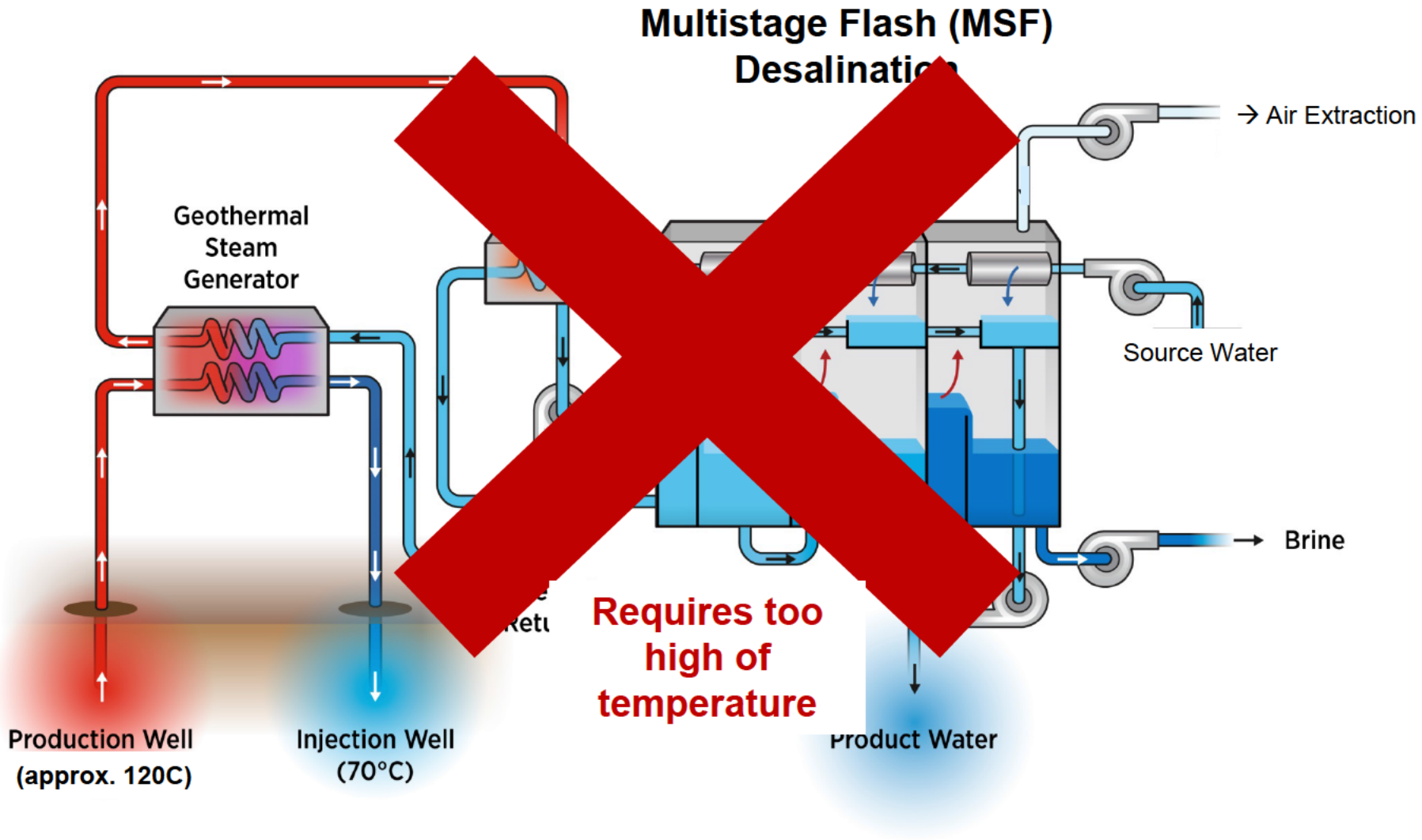
Geothermal Electricity for Desalination

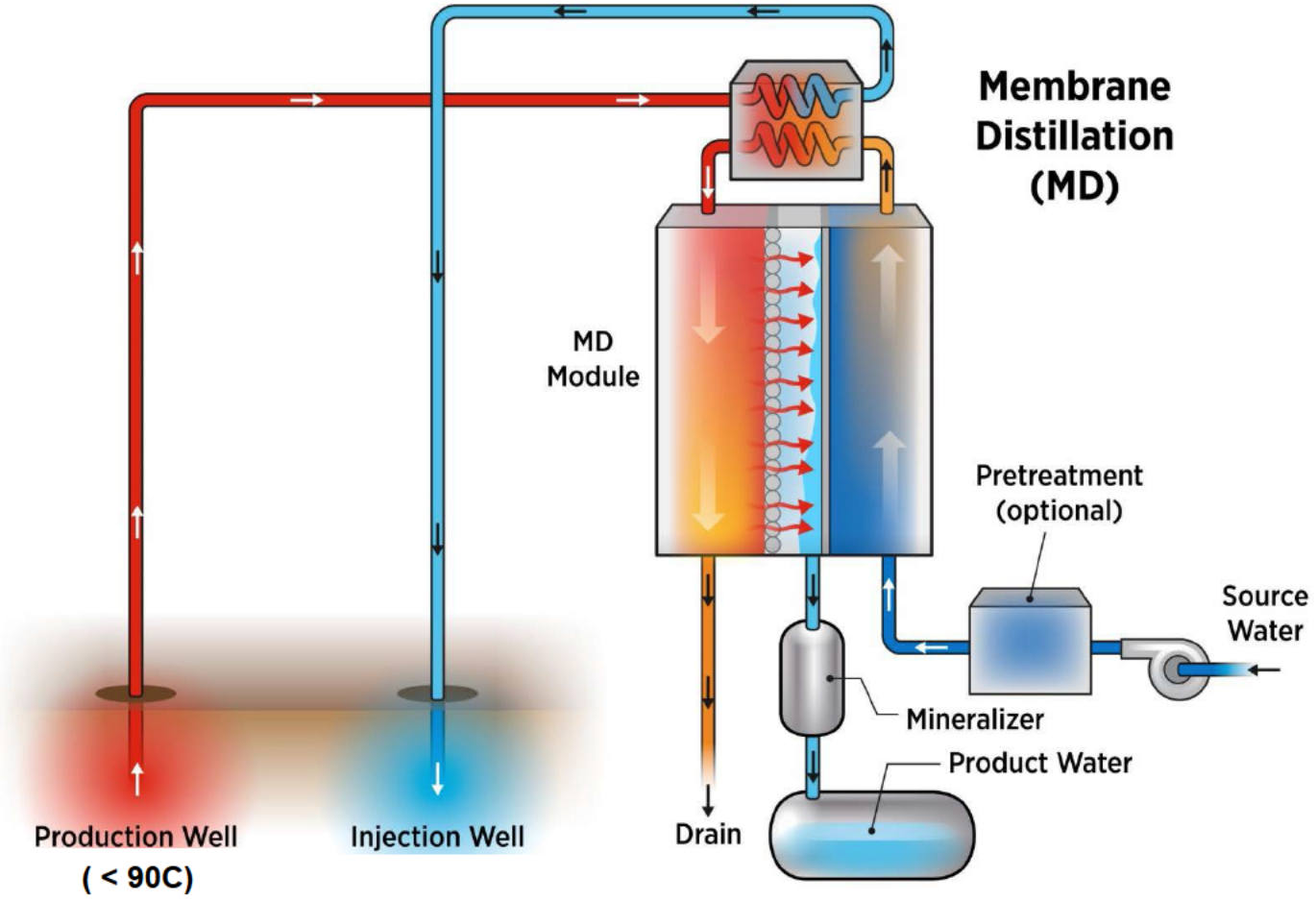


Geothermal Desalination

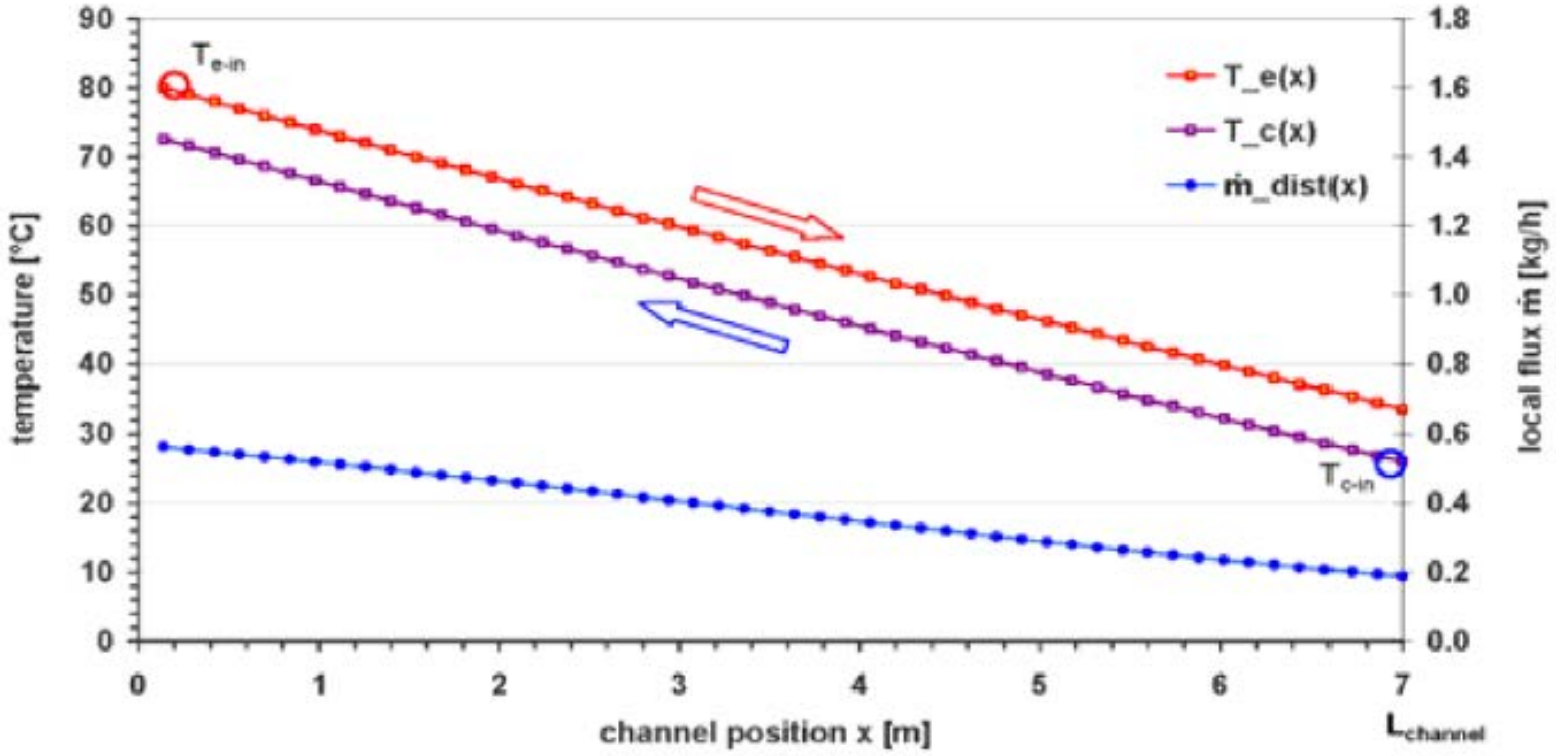


Geothermal Desalination

One Approach: Membrane distillation with heat exchanger



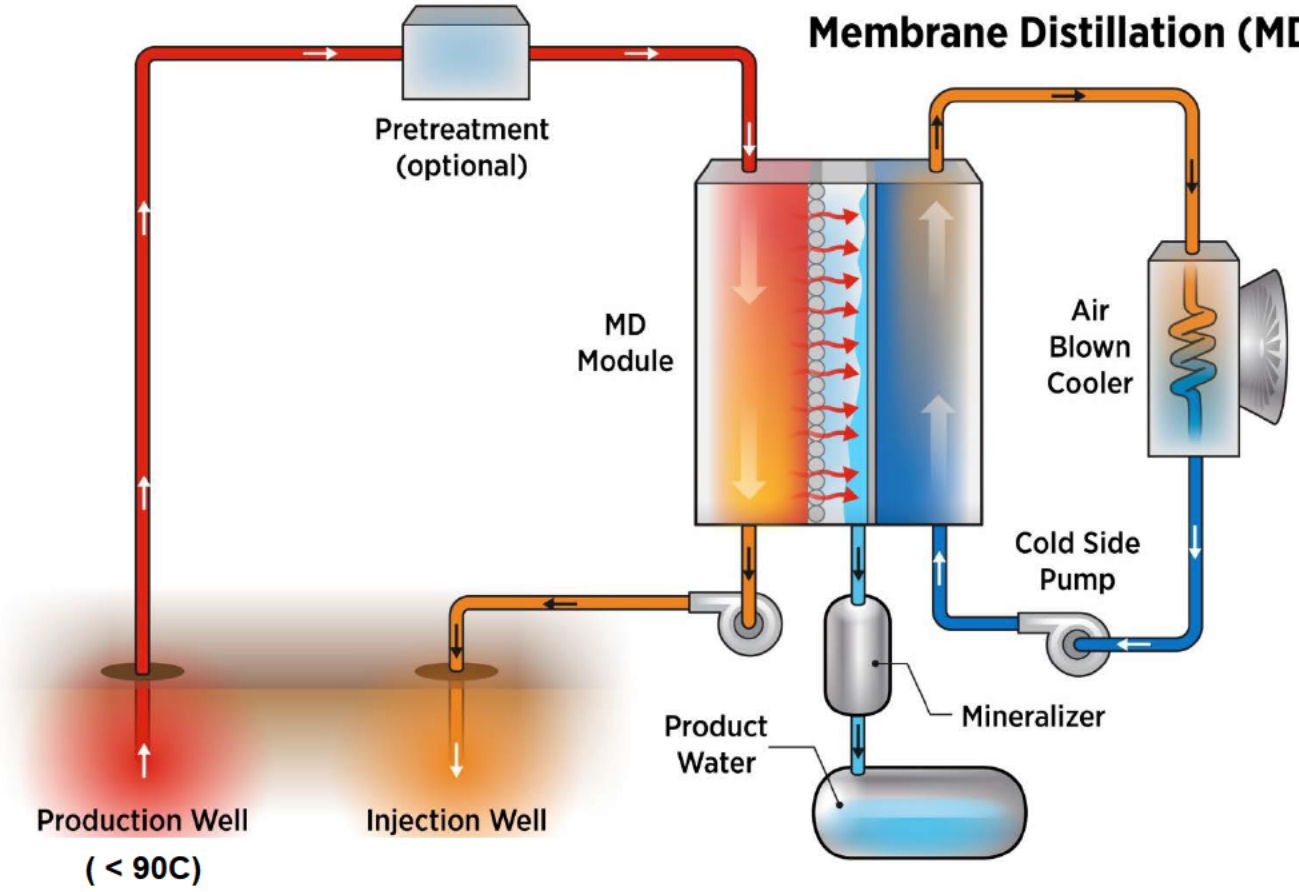
Membrane Flux vs. Temperature



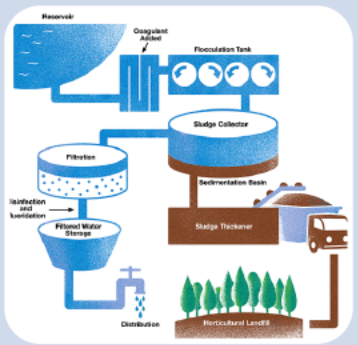
Koschikowski, 2015 (webinar)

Geothermal Desalination

Membrane distillation with direct heating and use of the geothermal brine



Geothermal-Desal Decision Support Tool



Inputs

Source-water composition

Geothermal resource

Product-water targets

Treatment Selection Module

Beneficial Use Screening Module

Beneficial Use Economic Module

Outputs

Conceptual design of suitable treatment train(s) with energy demand and estimated cost

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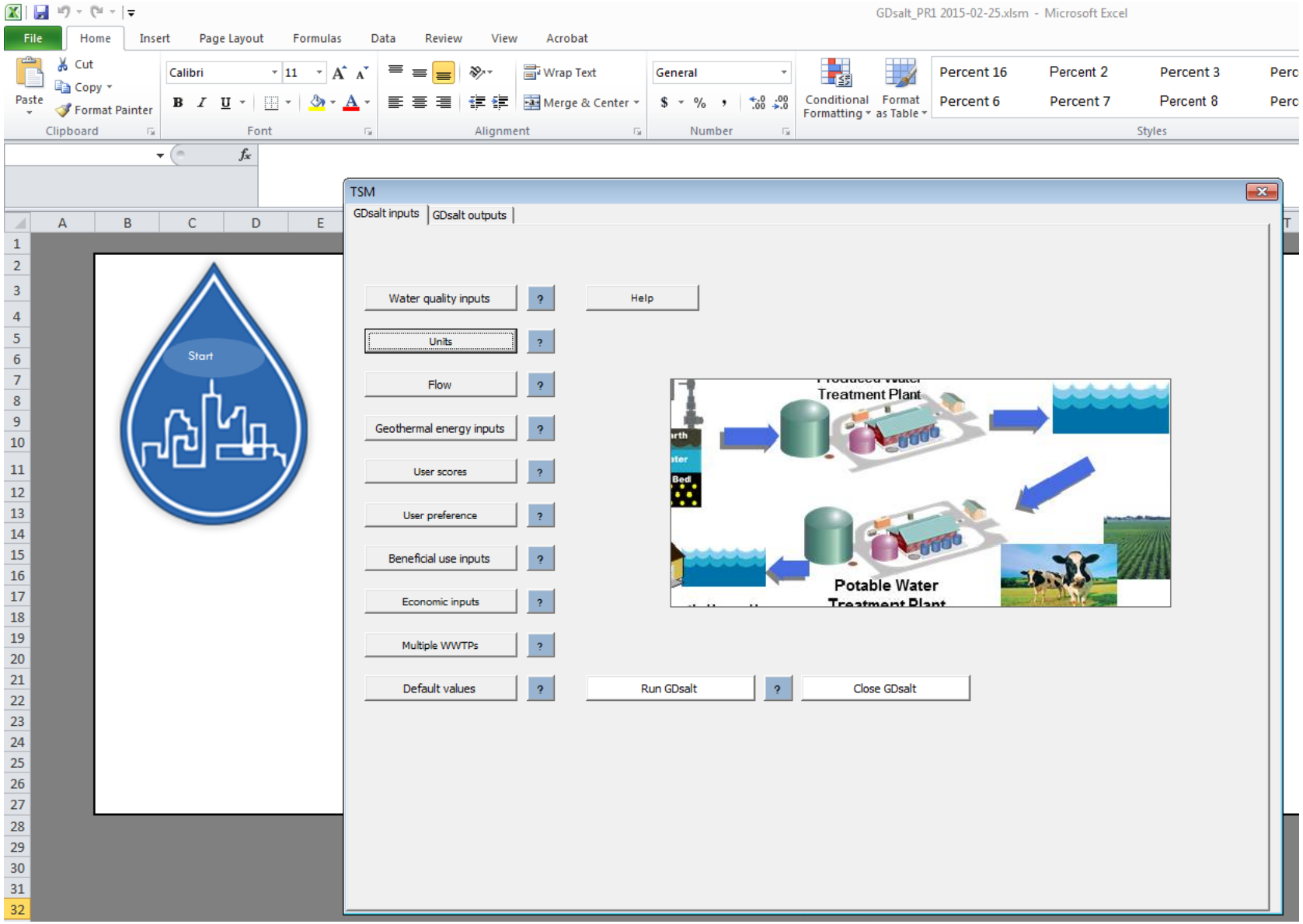
“GDsalt” Example – inputs page



Challenges

- Desalination is generally the option of last resort, *where there is an alternative*
  - Cost of desalinated water ranges from \$0.7/m^3 to \$2/m^3
  - Retail water cost in major US cities is \$0.6/m^3 to \$5/m^3
  - Water for industrial and agricultural users is often highly subsidized, for example agricultural water rates in CA's Imperial Valley are ~\$0.02/m^3
- Reverse Osmosis (all electric) is the leading and lowest cost desalination approach

Opportunities

- Use low-cost geothermal energy to drive down the cost of thermal desalination
  - Energy is 30-50% of the cost of thermal-desal methods
- Treat RO reject water
  - Disposing of reject brine can be difficult and costly
  - Zero-discharge requirements are becoming more common
- Treat highly contaminated water
  - Co-produced water disposal can cost several dollars per m^3
  - Treat geothermal brine directly

Project Status

- Refining and debugging GDsalt
- Assisting CSM senior-design projects on geothermal desalination
- Assessing thermal-desalination technologies for combination with geothermal energy
- Mapping collocated geothermal resources and brackish/impaired source waters
- Seeking candidate technology demonstration sites

Contact information

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