

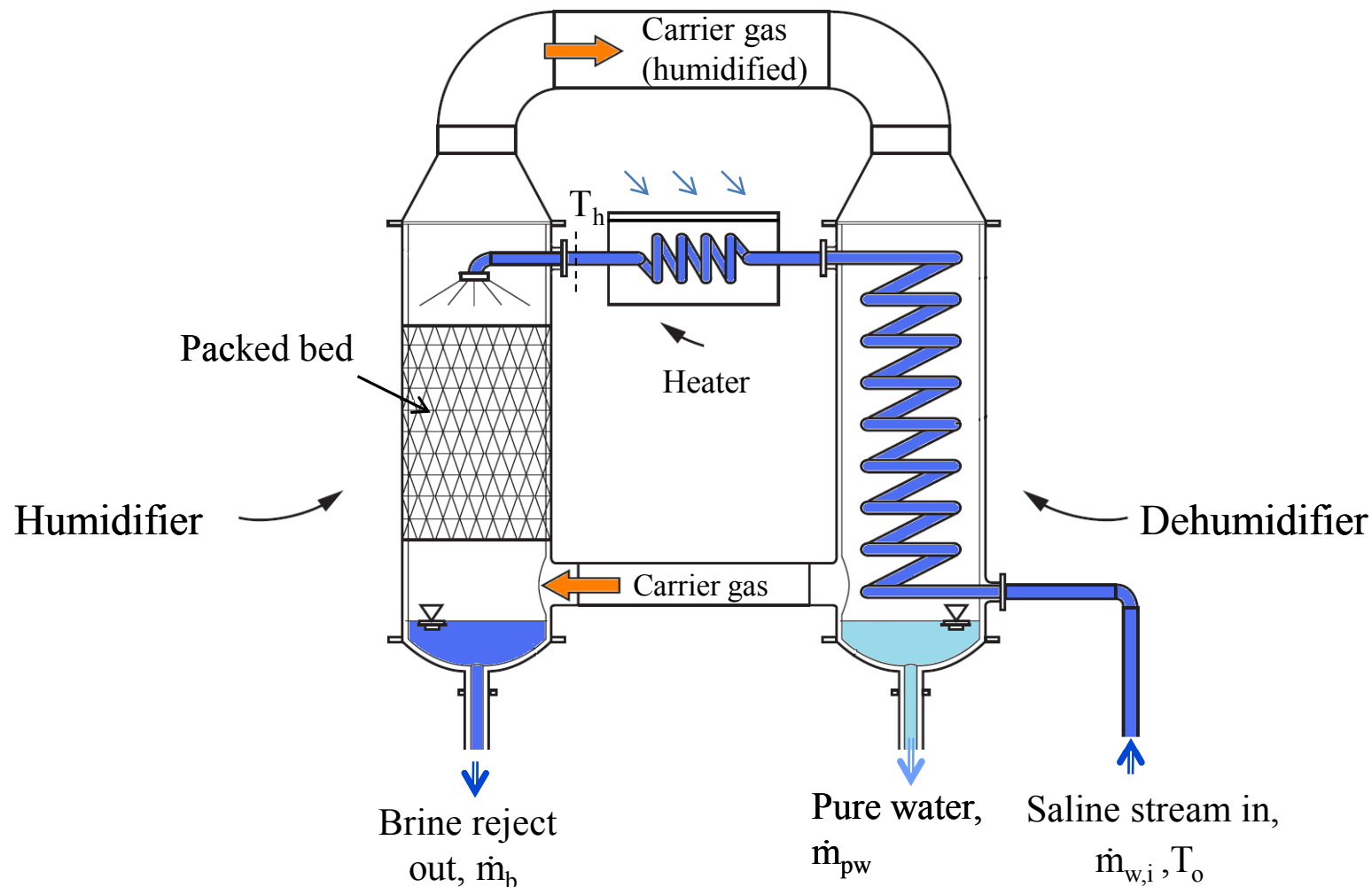
## **CARRIER GAS EXTRACTION (CGE™) PRODUCED WATER TREATMENT**



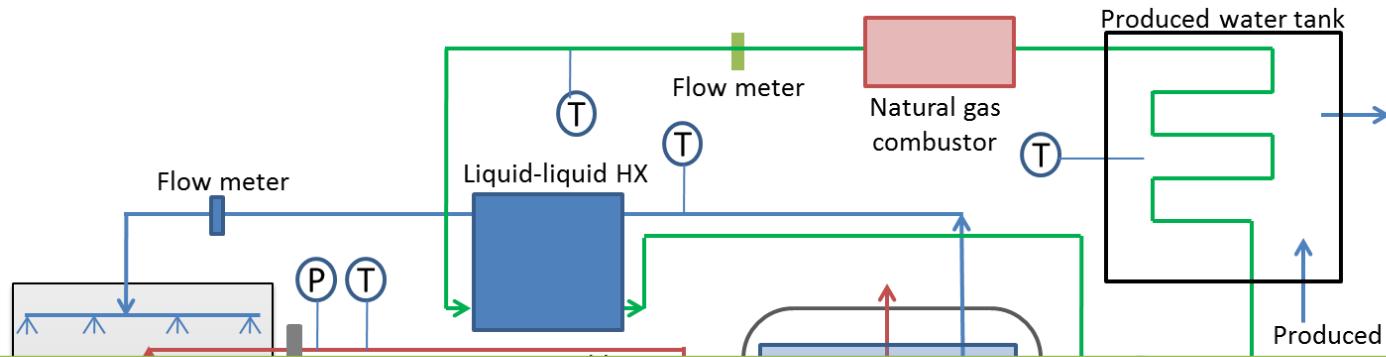
# Gradiant is a technology driven water treatment services to improve the economics and environmental profile of oil & gas

- **Carrier Gas Extraction (CGE™) is the affordable fresh water solution**
  - Operating 12,000 bpd produced water treatment plant in the Permian basin
  - Awarded Industrial Water Project of the Year at the 2014 Global Water Summit
  - Protected by 27 issued or pending patents
  - Well staffed and capitalized
    - Boston, Dallas, Midland staff across Field Services, Engineering/ R&D, Operations, & Construction
    - Backed by Natural Gas Partners (NGP)
- **Portfolio nature of water treatment requires customization**
  - Gradiant works with customers to determine the most effective and economic configuration
  - Flexibility and modularity of systems allows for easy scale-up and/ or upgrade over time
- **Gradiant's R&D team continues to improve current systems and develop new technologies**
  - Closed loop chemical softening systems under development
  - New membranes to perform high TDS desalination and Direction Solvent Extraction desalination part of IP portfolio

# Basic concept of the carrier gas extraction system: desalination at low temperature and atmospheric pressure

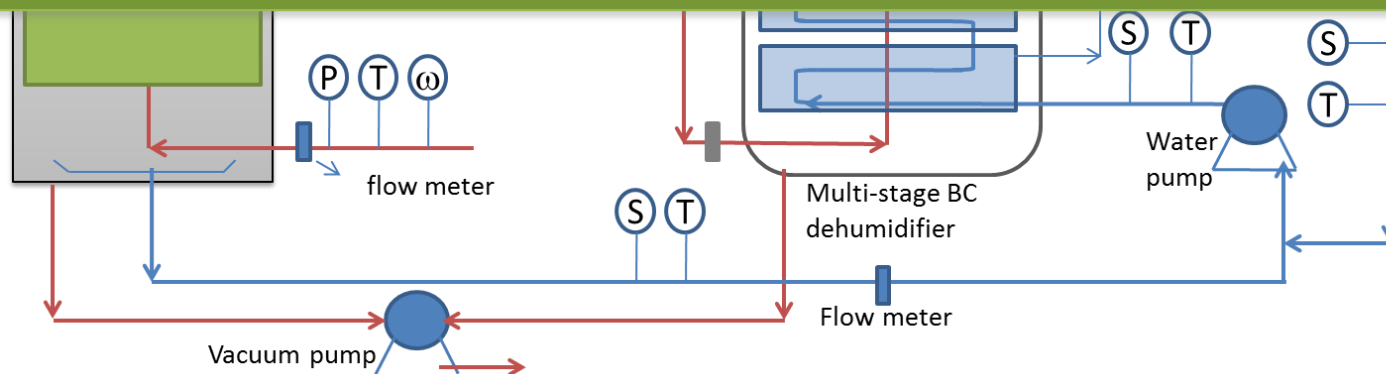


# CGE technology is simple, membrane-less, and robust under high TDS water

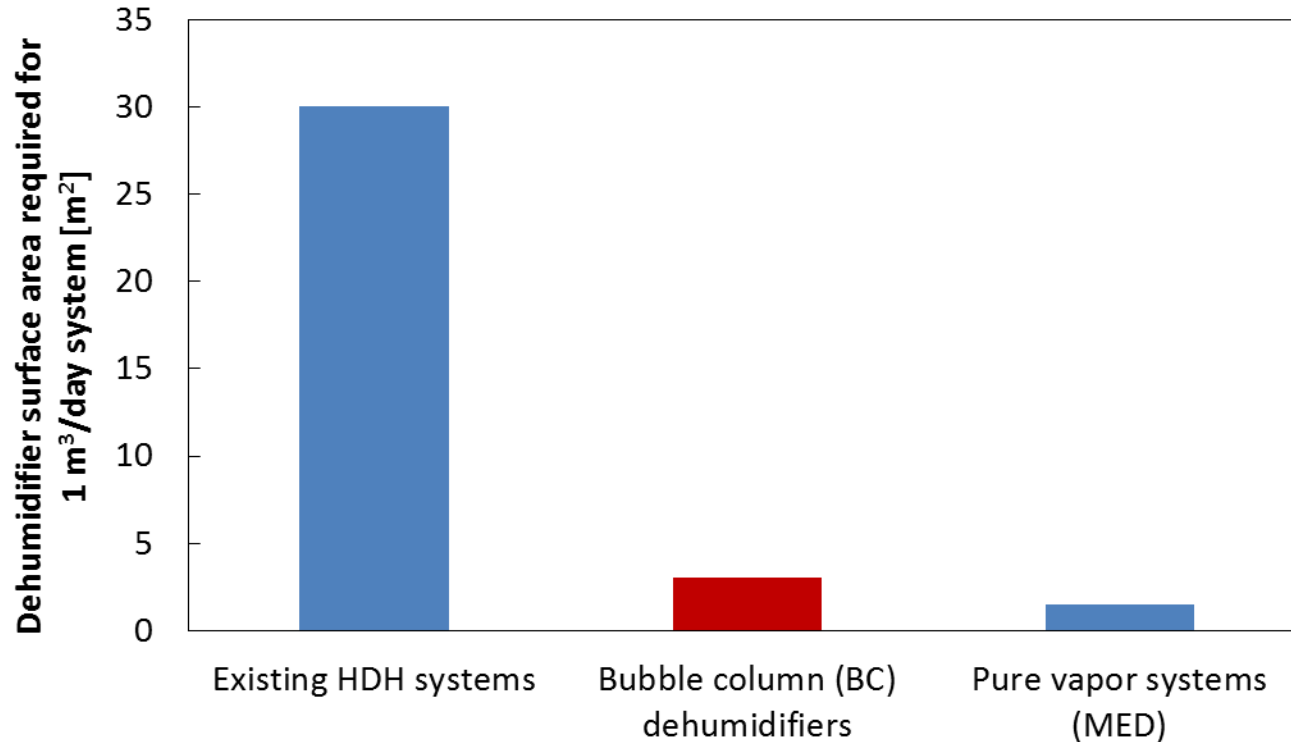


## Fundamental Improvements

- Multi-stage bubble column device for an order of magnitude lower CAPEX
- Novel method to attain multi-stage evaporator efficiencies in a single stage
- Decoupling of the valuable heat transfer surface from the sacrificial surface on which concentration occurs

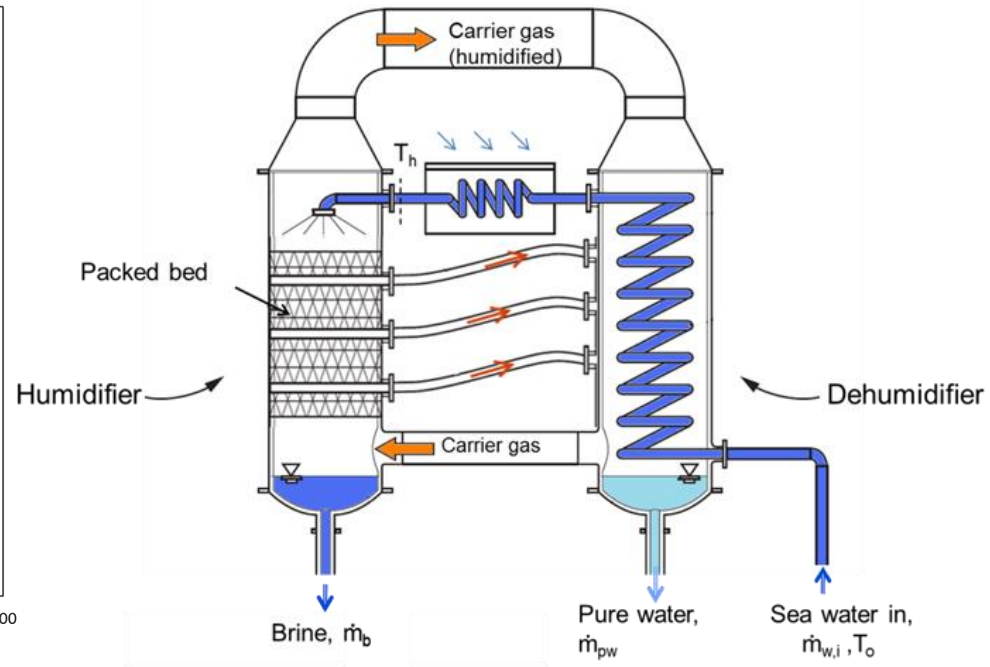
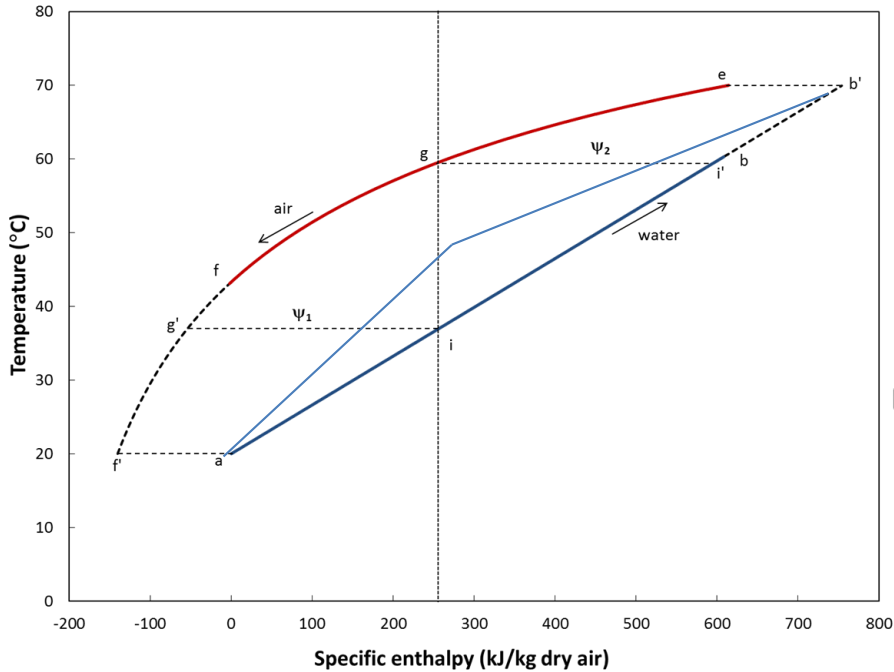


# Multistage bubble column for low cost condensation even in the presence of non-condensable gases



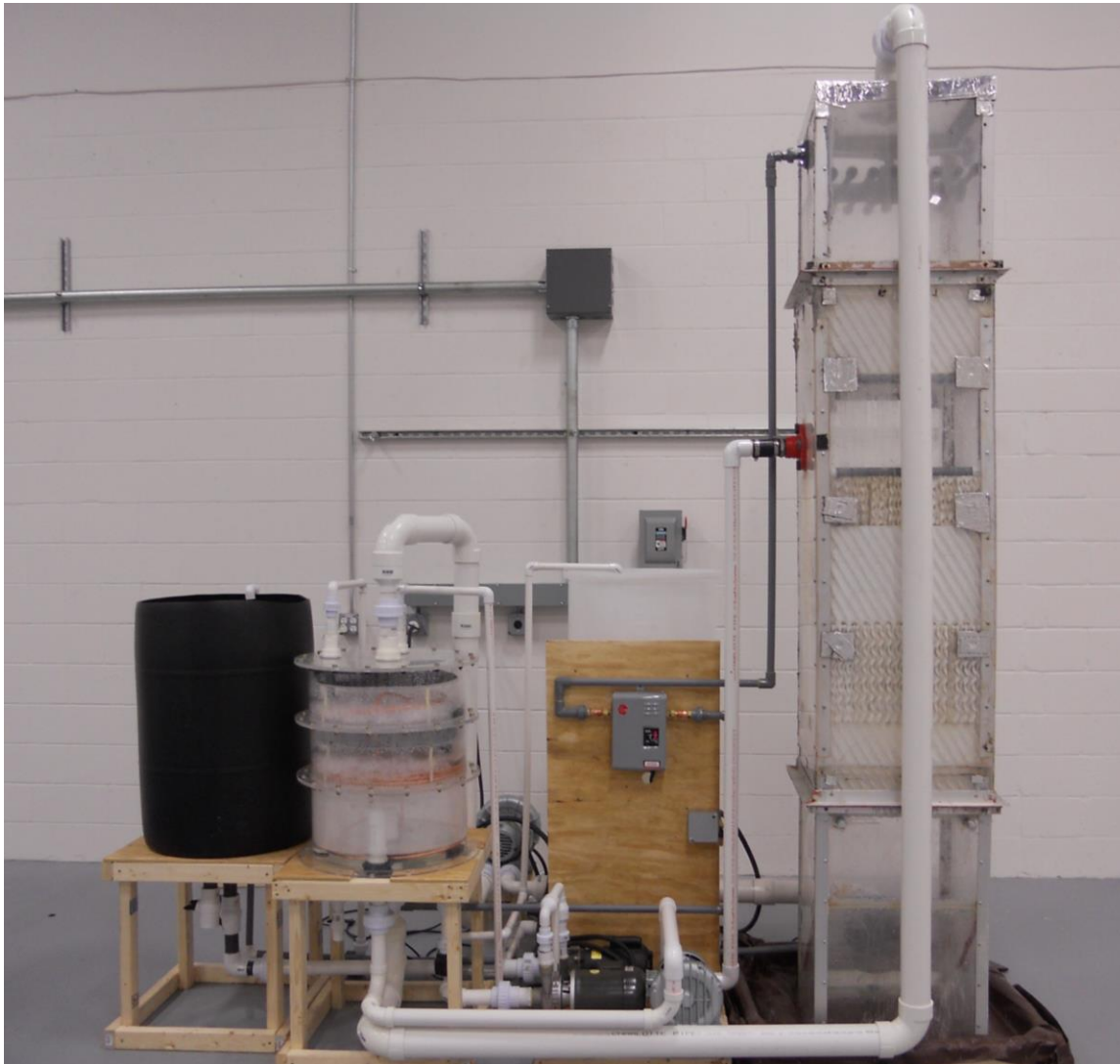
Brings down condenser area requirement to MED levels!!

# Thermodynamic balancing to attain low thermal energy consumption



Thermal energy consumption brought down to 6-stage MED levels!!

# 10 bpd pilot demonstrated to treat produced water



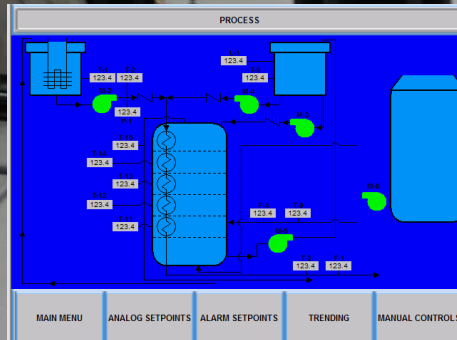
- Feed TDS >200,000 ppm
- Product TDS <100 ppm
- >85% recovery
- **Extensive testing program;** Successfully treated varying water qualities from **Permian, Barnett, Eagle Ford**, Horton Bluff, Haynesville, Bakken, Marcellus, Lost Hills, Mississippian Lime, Niobrara
- Technology validation over long-term continuous runs:  
*18+ month testing period*



# 50 bpd scale-up to mitigate technology risk



- Industrial-level testing facility
- Replica of commercial unit; built to field and safety specifications
- Skidded, ruggedized system
- Fully automated run of 15+ continuous days
- Verification of performance and operation parameters:
  - Energy consumption
  - Recovery ratio
  - Maintenance cycle
  - Varying feed quality
  - Continuous testing of product water





# Full scale Gradient treatment plant in Midland, TX



- **12, 000 bpd facility**
- **Produces fresh water, clean brine, and 10 lb. brine**
- **Uses site gas as fuel**

Global Water Intelligence

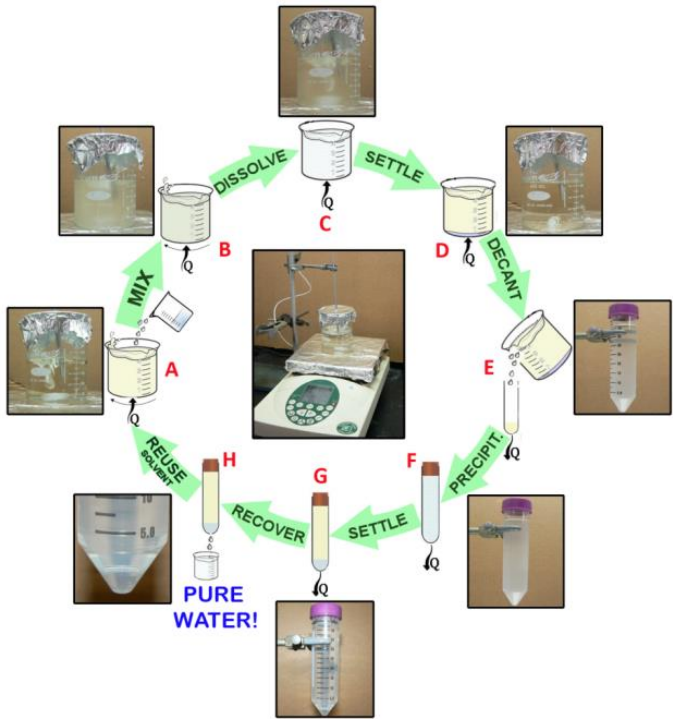
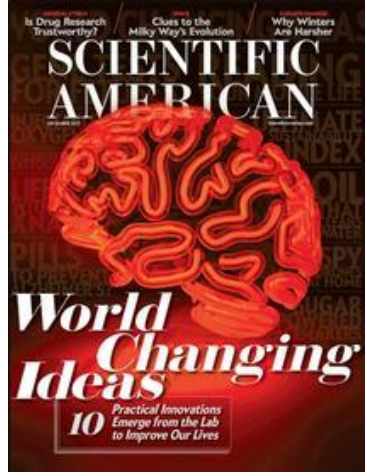
WINNER  
Water Technology  
2013

WINNER  
Water Technology  
2014

Global Water Intelligence  
**GWI's WATER TECHNOLOGY IDOL (2013) and INDUSTRIAL WATER PROJECT OF THE YEAR (2014)**

# Gradiant continues active R&D on complimentary technologies

- **Directional Solvent Extraction (DSE) for small scale desalination**
  - Technology in early stage of development
  - Liquid carrier fluid reduces footprint opening up smaller scale possibilities
  - Recognized by Scientific American as Top 10 World Changing Idea



- **Closed loop chemical softening technology also under development**

- **Carrier gas extraction is positioned to become a leading brine concentration technology**
- **Invented and developed by Gradiant's founders at MIT**
- **Current focus on produced water treatment application**
- **Licensing and partnership opportunities in other industries**

- **Strong relationships within water and oil and gas industries**
- **Fundamental understanding of water treatment science and technology**



govindan@gradientcorp.com | +1 479 236 2709