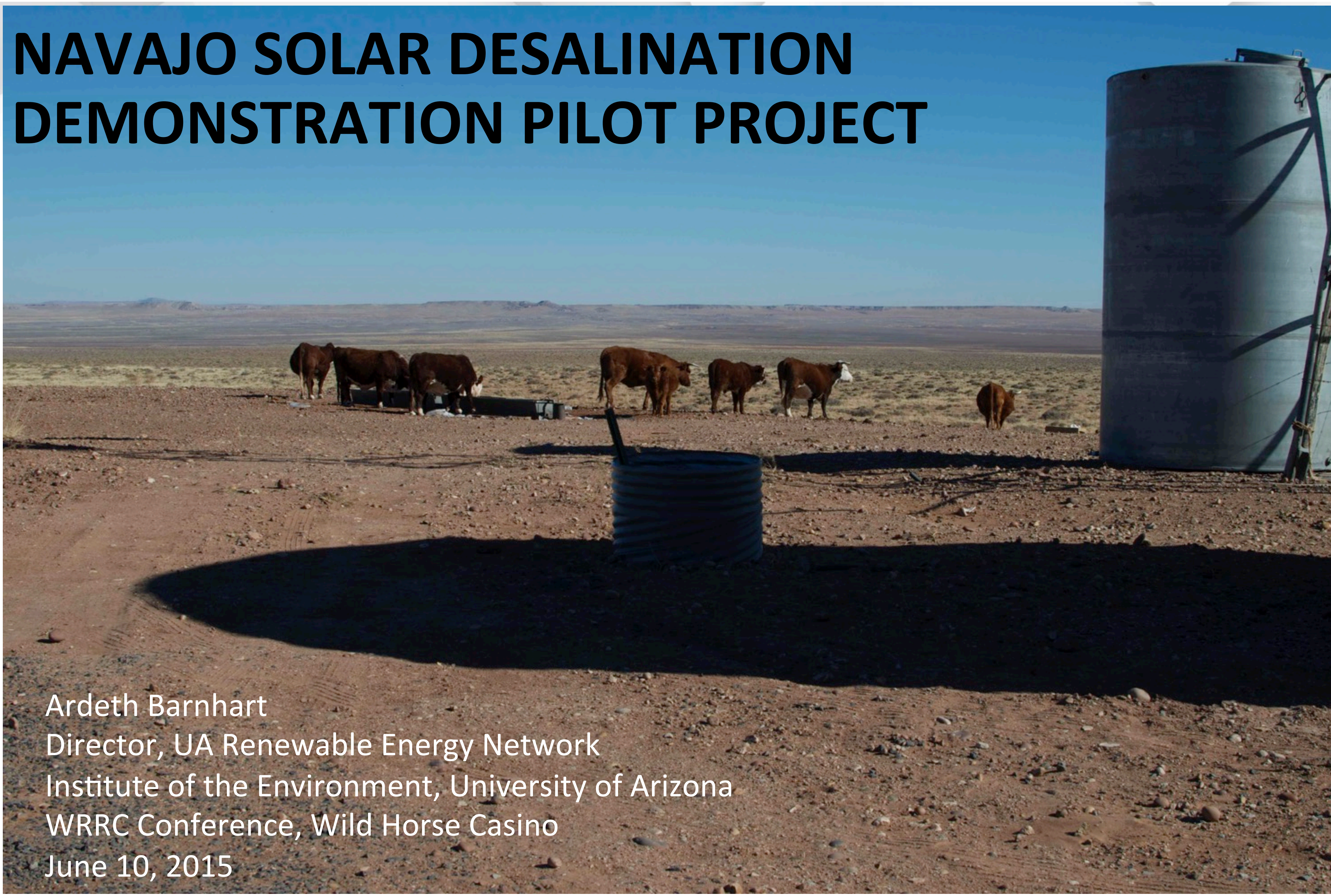
NAVAJO SOLAR DESALINATION DEMONSTRATION PILOT PROJECT



Ardeth Barnhart
Director, UA Renewable Energy Network
Institute of the Environment, University of Arizona
WRRC Conference, Wild Horse Casino
June 10, 2015

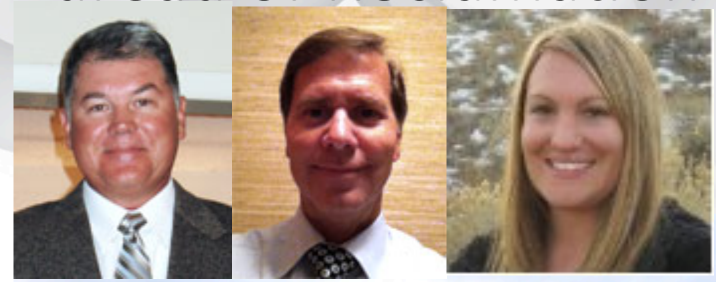
Project Partners & Community Members

- UA Renewable Energy Network, and College of Engineering
- Bureau of Reclamation
  - Phoenix Office, Denver Office Science & Technology
- Grand Canyon Trust
  - TEP, Renewable Energy Investment Fund
- Cogenra Solar, 3P Motor Controls
- Navajo Department of Water Resources, NRCS, Leupp Planning Committee and District Grazing committees,
- Tolani Lake Enterprises, Tolani Lake Water User's Association, Residents of Leupp and Tolani Lake

Research Team

University of Arizona

Bureau of Reclamation



University of Arizona Graduate Students

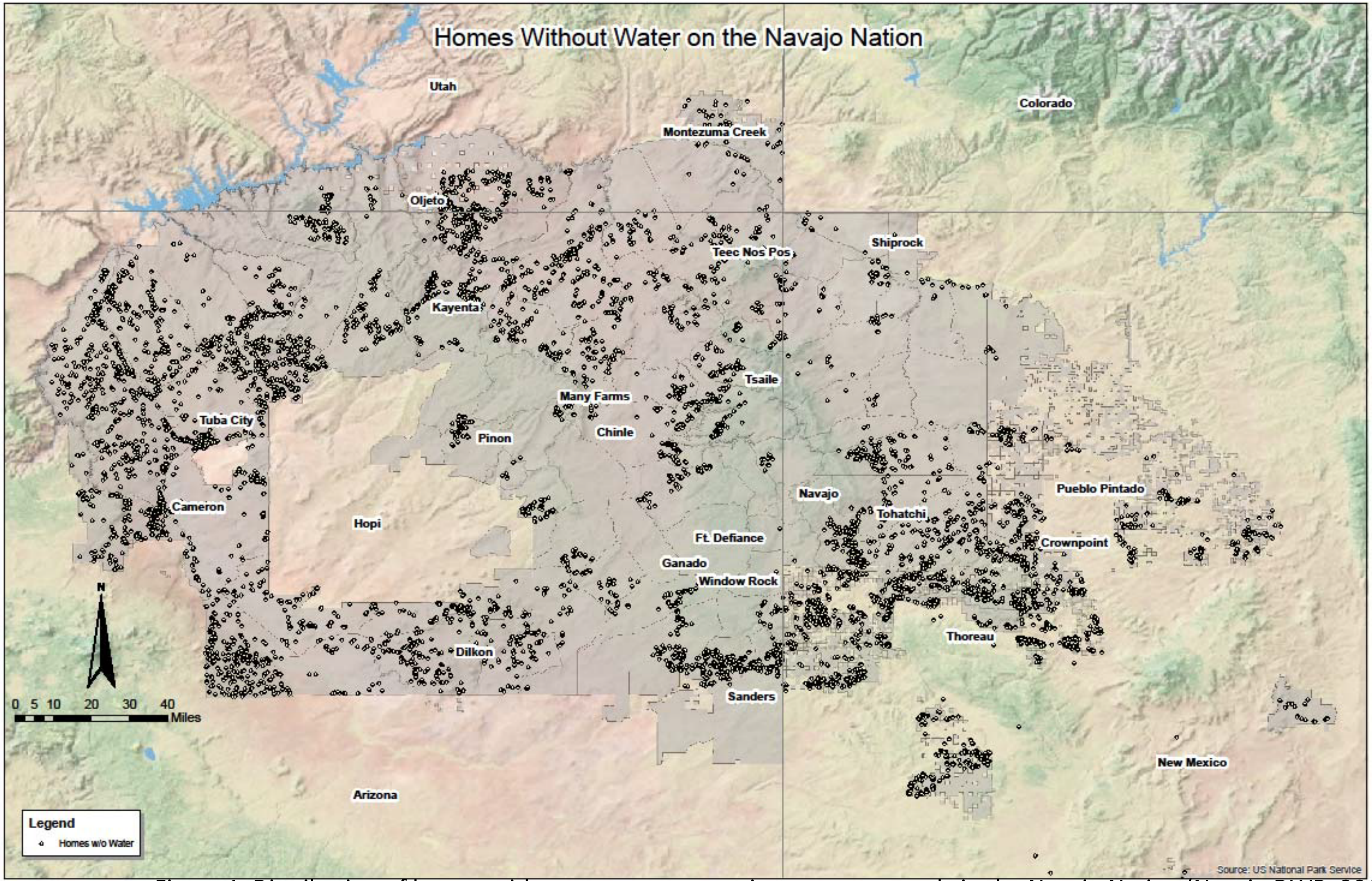
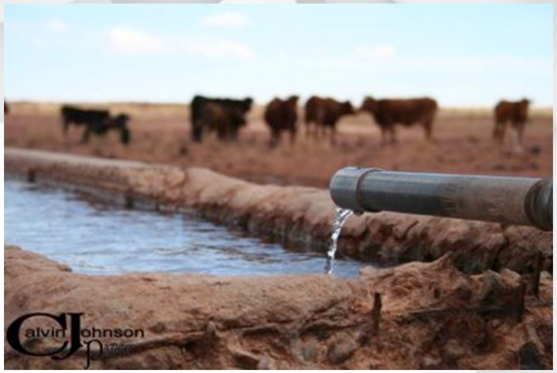


Figure 1. Distribution of homes without access to a proximate water supply in the Navajo Nation (Navajo DWR, 2011; provided by Mr. Ronson Chee). There are > 8000 such homes in the Nation, where the cost of obtaining potable water can be as high as $43,000/AF.

Navajo Nation Solar Desalination Demonstration Pilot Project

- Diminishing water supply , impaired brackish water supply, need to incorporate renewable energy
  - 40% population off-grid in Southwestern area
  - $10 - $35/1000 gallons
  - 1500 – 15000 TDS
  - Well depth 400 to 1,600 feet
  - Hauling water averages 40 miles round-trip
  - Residential gas generators used for temporary power

- Can a new water supply be developed incorporating an economically and culturally appropriate desalination technology that utilizes renewable energy to service areas lacking basic infrastructure for water and electricity?



On Site Pilot
Sustainability
Assessment
Technology Transfer

Listening Sessions & Solar Installation at Leupp

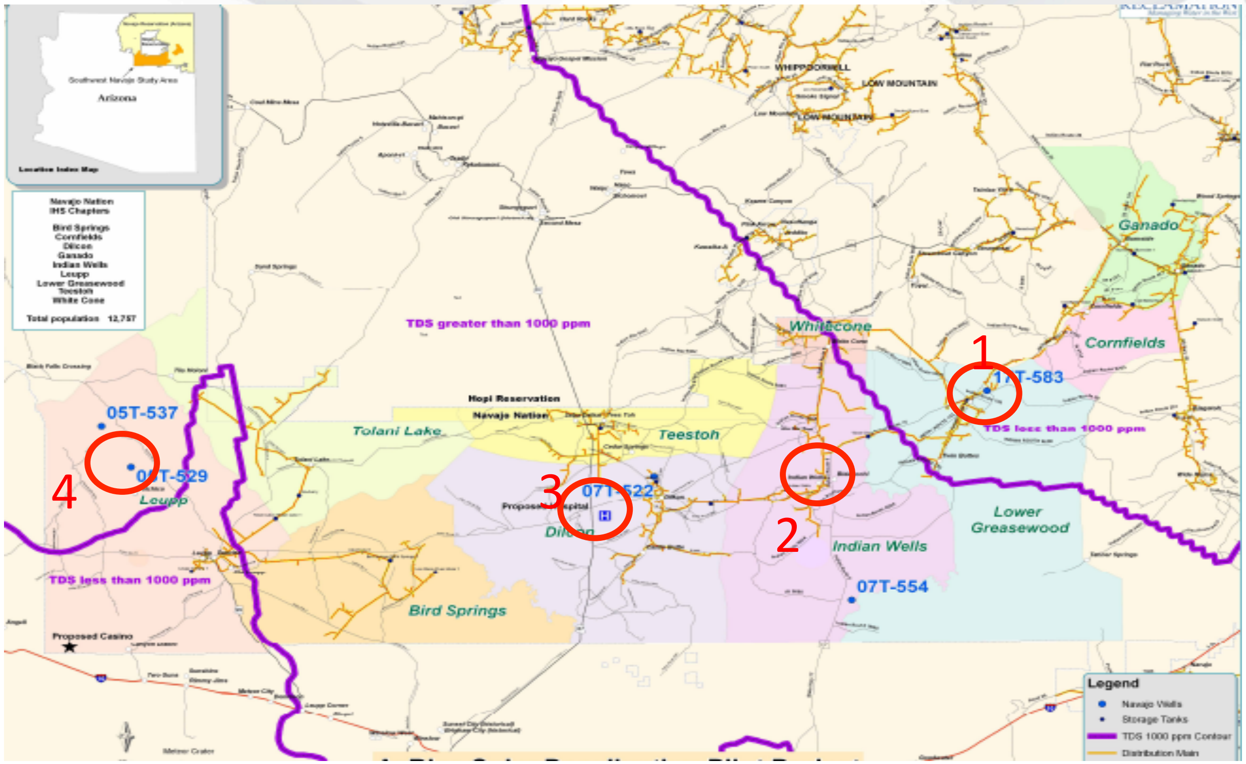
Testing & 1st Prototype at UA

Water Sampling

2011

2015

- Water collection and interpretation of C aquifer known “brackish” water quality areas



1 Lower Greasewood

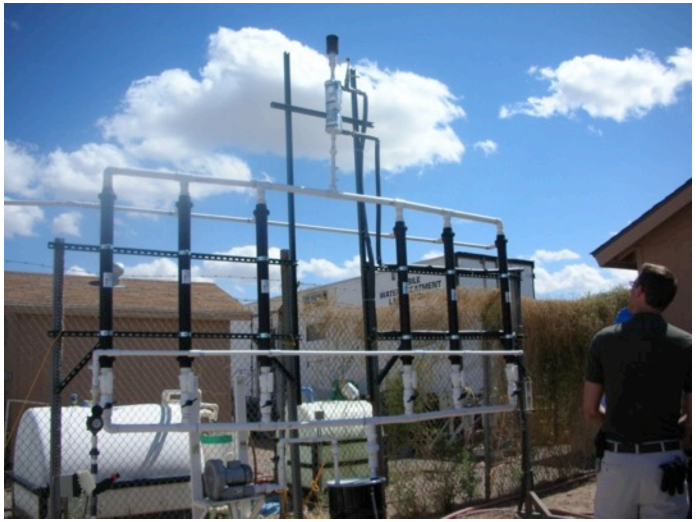
2 Bidahochi

3 Dilkon

4 Leupp

Solar Desalination Prototype

- Test solar power as the energy source for Membrane Distillation (MD) water purification and desalination processes
  - Concentrate on low maintenance, commercially available components, stand-alone operation, scalability for future growth needs
  - Economic analysis with cost and schedule to implement a pilot project with water quality suitable for livestock consumption



Integrated System Components

CoGenra Solar

- Concentrating Photovoltaic and Thermal System ideally suited for integration with MD desalination needs for low grade thermal energy (<100°C) and small amounts of electrical energy.

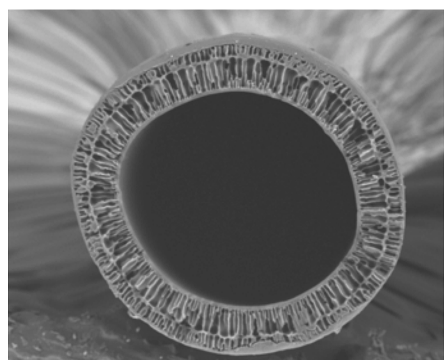
Membrane Distillation

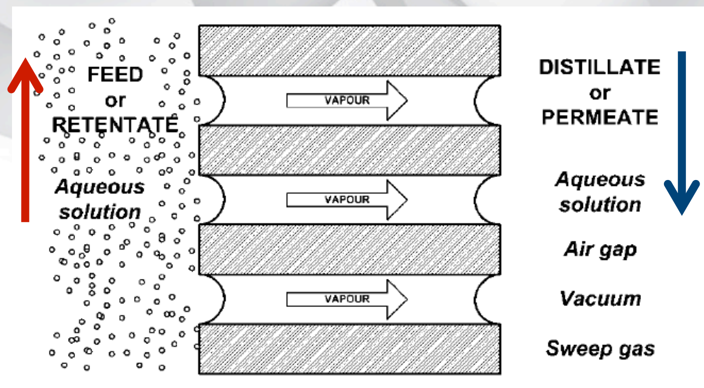
- Broad brush water purification technology capable of treating all water contaminants; salinity, metals, organics, pathogens
- Overcomes energy intensity demands by incorporating a fully integrated MD and solar integration system.
- Performs in low grade thermal energy less susceptible to scaling, requiring less O,M &R

Theory of Operation : Membrane Distillation

1. Water vaporizes and passes across the hydrophobic membrane and salt is returned

2. On permeate side, Airflow transports water vapor to the condenser





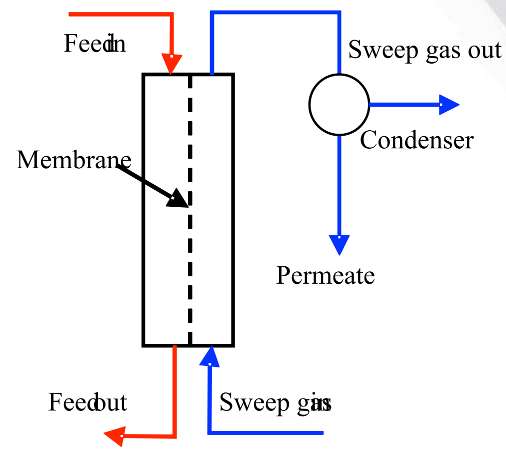
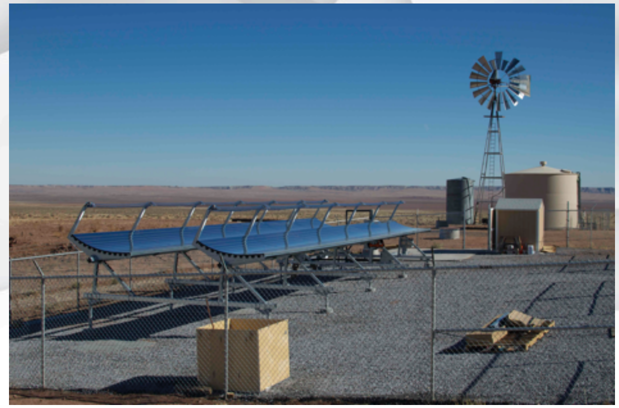
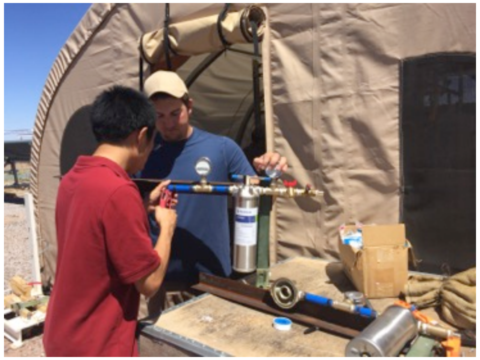


Figure 1 Sweeping Gas Membrane Distillation (Khayet, 2011 & Curcio 2005)


Listening Sessions

1. Water availability and reliability
2. Cost of water and water hauling
3. Willingness to pay for treated water

- Water was sometimes unavailable at primary well or spring source and required extending trips farther to search for alternative sources
- Averaging about 24 miles per week, 2x per week - ~$20/1000 gal travel and water costs ranged from $8 - $35/ 1000 gallons
- For residents that raised livestock, water from traditional sources was sometimes unavailable and of poor quality, they sometimes had to sell livestock at a low price or before they wanted to this - also correlated with seasonality and grazing conditions
- Farming, gardening, laundry, showers, and saving time in travel and cost of hauling water as things that they would participate in if they had access to more water
- Willing to pay a bit more for treated water closer to residence

Sustainability Assessment & Socio-Economic Study

- Developing a planning tool to help agencies and decision-makers track progress toward sustainability and assess viability of renewable energy and water treatment systems, it includes:
  - Current demand and growth projections
  - An economic cost/benefit analysis
  - Social impacts analysis
  - Environmental impacts analysis
  - Work with community members and agencies on which of these issues are most important in the assessment (TBL)
- Assessment goals
  - Better manage and make decisions about system viability in other areas, water availability and use, capacity to meet growing demand for water
  - Improve knowledge about water supply reliability to meet human and livestock needs while reducing energy demand
  - Inform drought planning
  - Determine economic opportunities, growth and jobs

Next Steps

- Working at the research site in Leupp
  - Work with UA/NAU students, community and agencies to refine system and better understand the impacts and opportunities
- Training and information sessions
- Develop site
  - Develop the demonstration site and pilot projects to inform a regional plan for Southwestern Navajo Nation Chapters and other locations
  - Evaluate different kinds of renewable energy, water treatment systems
  - Expand outreach to other chapters and communities
  - Work with local colleges and students on education and training

AN AZPM ORIGINAL

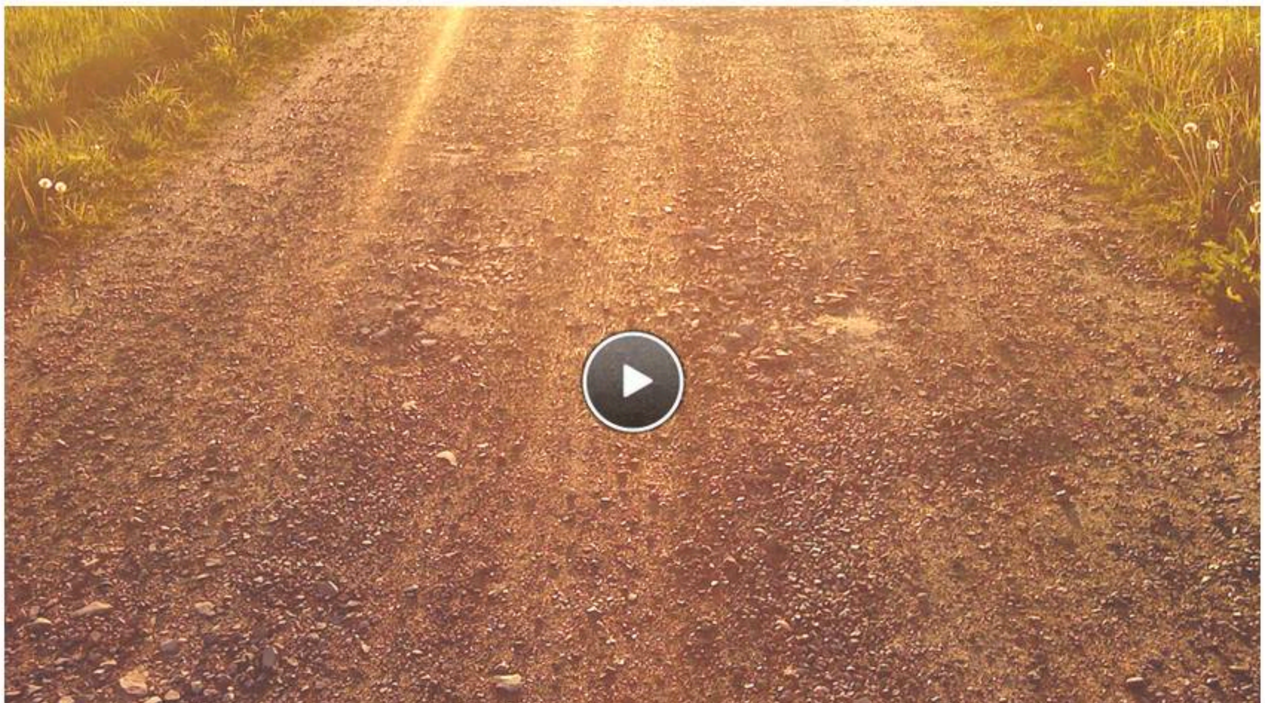
Seeking Water from the Sun

VIEW FULL SCHEDULE

MEDIA INQUIRIES

SEEKING WATER FROM THE SUN

The AZPM original documentary *Seeking Water From the Sun* ventures into university laboratories and across the Navajo reservation to explore a way of life that revolves around water—and its scarcity.



Navajo Solar Desalination Sustainability Assessment for the Triple Bottom Line Model
University of Arizona, Navajo Nation Chapters and the Bureau of Reclamation

Indicators and Sub-Component	Units	Indicator Value	Community Acceptable Value (weighting)
Economic Indicators			
Cost of investment			
Net income/average water rate	$/gal		
Operations, maintenance and replacement	$/gal/day		
NPV - cost sustainability	positive or negative value		
Performance and reliability - mass energy balance			
Affordability			
Cost Effectiveness			
Labor			
Water supply costs - wells			
Economic development impacts			
Institutional framework			
Environmental Indicators			
Energy Savings at point of water use			
Preference for solar energy in water treatment and pumping			
Water quality			
Climate variability			
Soil Quality			
Air Quality			
Water Treatment system impacts			
Biodiversity and grazing			
Social Indicators			
quality of infrastructure - roads			
%of households that utilize a natural water source	range +/- standard		
% households that do not have a consistent water supply	range +/- standard		
average roundtrip miles to primary water sources	range +/- standard	0.48	
average miles to secondary water sources	range +/- standard		
average miles to solar desalination well site	range +/- standard		
distance to nearest alternative distribution center	range +/- standard		
preserve and sustain a life way	scale (Likert)		
Improvement of household primary economic assets			
community involvement in the project providing feedback	scale (Likert)		
expert participation in the project	scale (Likert)		
provide training and build awareness	scale (Likert)		
potential for job creation	scale (Likert)