An Efficient Solar Thermal-Powered Evaporation System for Salt Harvesting and Wastewater Treatment

The University of California Advanced Solar Technologies Institute (UC Solar)

Research—Innovation—Education

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Project Background

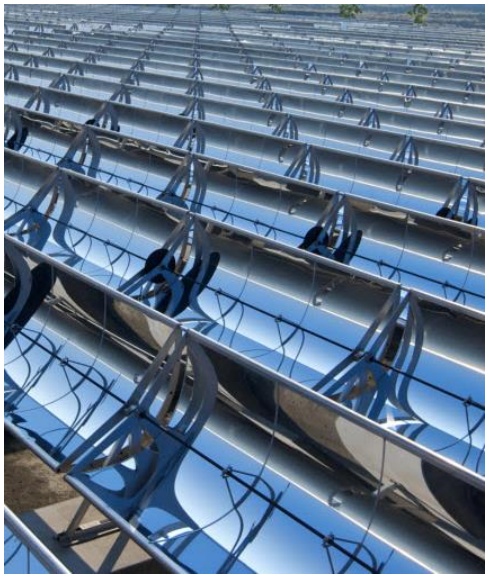
- Wastewater evaporation is a proven method for reducing the water portion of water-based waste streams

Project Background

- Evaporation systems are widely used by the manufacturing and food processing industries for the treatment of "adverse" wastewater
  - To reduce the water content of waste prior to shipping it for offsite disposal
  - To reduce the water content of reverse osmosis and desalination/distillation waste streams (brine)
  - To recover distilled water (condensate)
  - To reclaim valuable dissolved solids
- However, these systems are energy-intensive and are powered exclusively by fossil fuels

Project Background

- To substitute solar energy for fossil fuels, evaporation systems require input temperatures in excess of 150ºC ("process heat")
- There are commercially-available solar thermal systems that produce these temperatures, but they have significant drawbacks, including:
  - Requiring tracking, which reduces system reliability and increases maintenance costs
  - Stringent installation requirements
  - Don't perform well on hazy or partially cloudy days
  - High cost (~$2,000 per kWt installed)

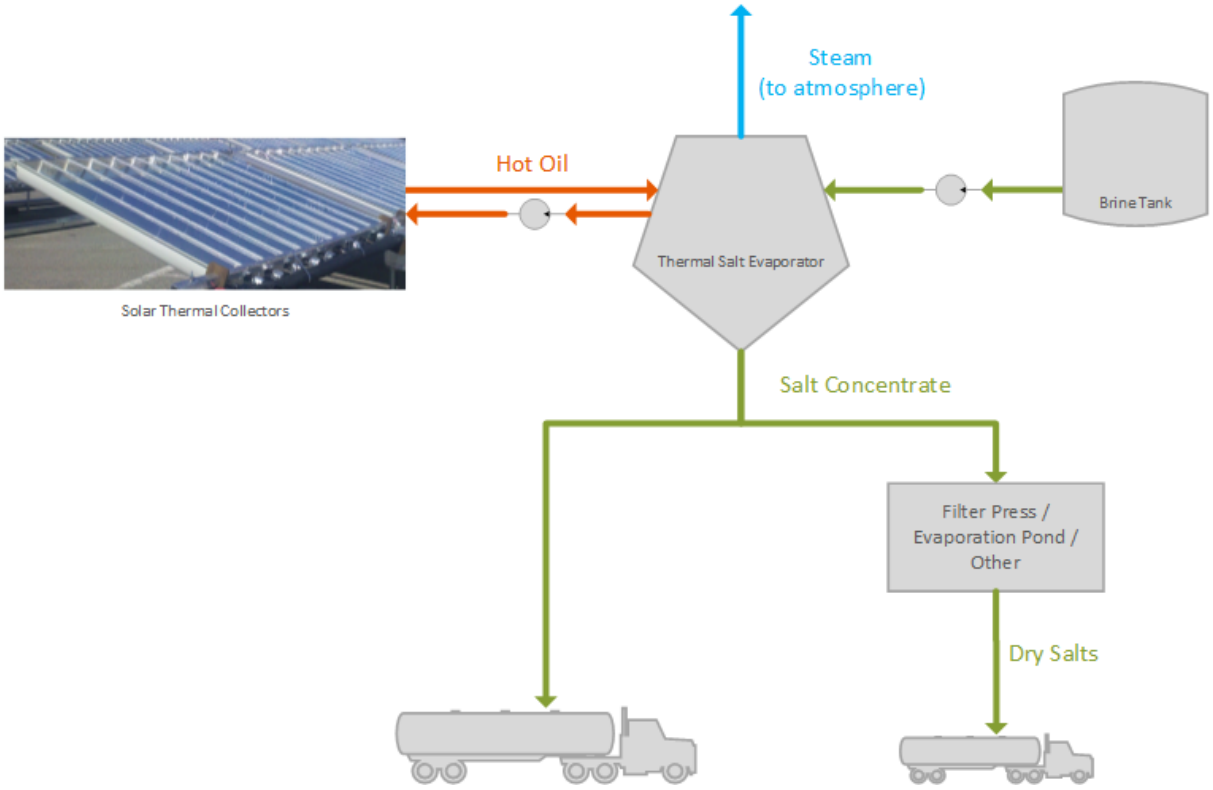


Project Background

- With CEC support, researchers at UC Merced have designed, tested and demonstrated the External Compound Parabolic Concentrator (XCPC), a novel non-tracking solar thermal collector for industrial process heat (120º-200ºC)

Project Overview

- This project will combine the XCPC technology with a commercial evaporator to create an efficient solar thermal-powered evaporation system



Project Goals

- Demonstrate the ability to directly power a 10 gph capacity thermal evaporator using UC Merced's XCPC technology
  - Substitute solar-powered heat transfer fluid (mineral oil) for 30 psig steam
- Test the system's effectiveness in processing a variety of Central Valley waste streams, including:
  - RO discharge
  - Industrial and food processing waste streams
  - Agricultural drainage
- Study the economic and environmental benefits of solar-powered evaporation

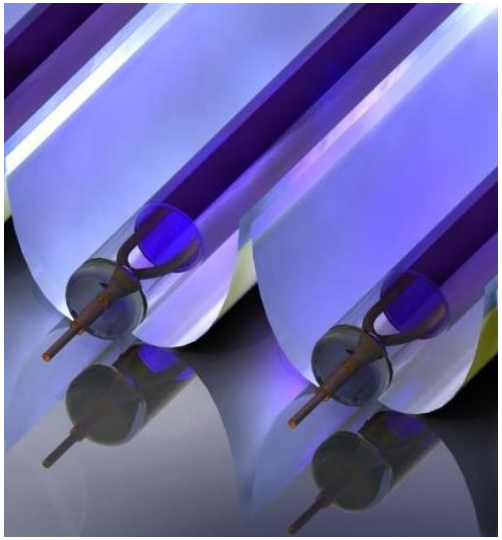
Project Partner

- UC Merced's research partner is ENCON Evaporators, a leading manufacturer of wastewater evaporators
- The ENCON Thermal Evaporator product line ranges in capacity from 8-400 gal/hr
- These systems typically use natural gas, propane, steam, #2 fuel oil, diesel, spec gas, waste oil or electricity
- They reduce waste stream volumes by 90-95%

- ENCON customers include Ford, Pepsi, 3M, Bayer Crop Science, Goodrich, Alcoa, DuPont, GE and LLNL

The XCPC

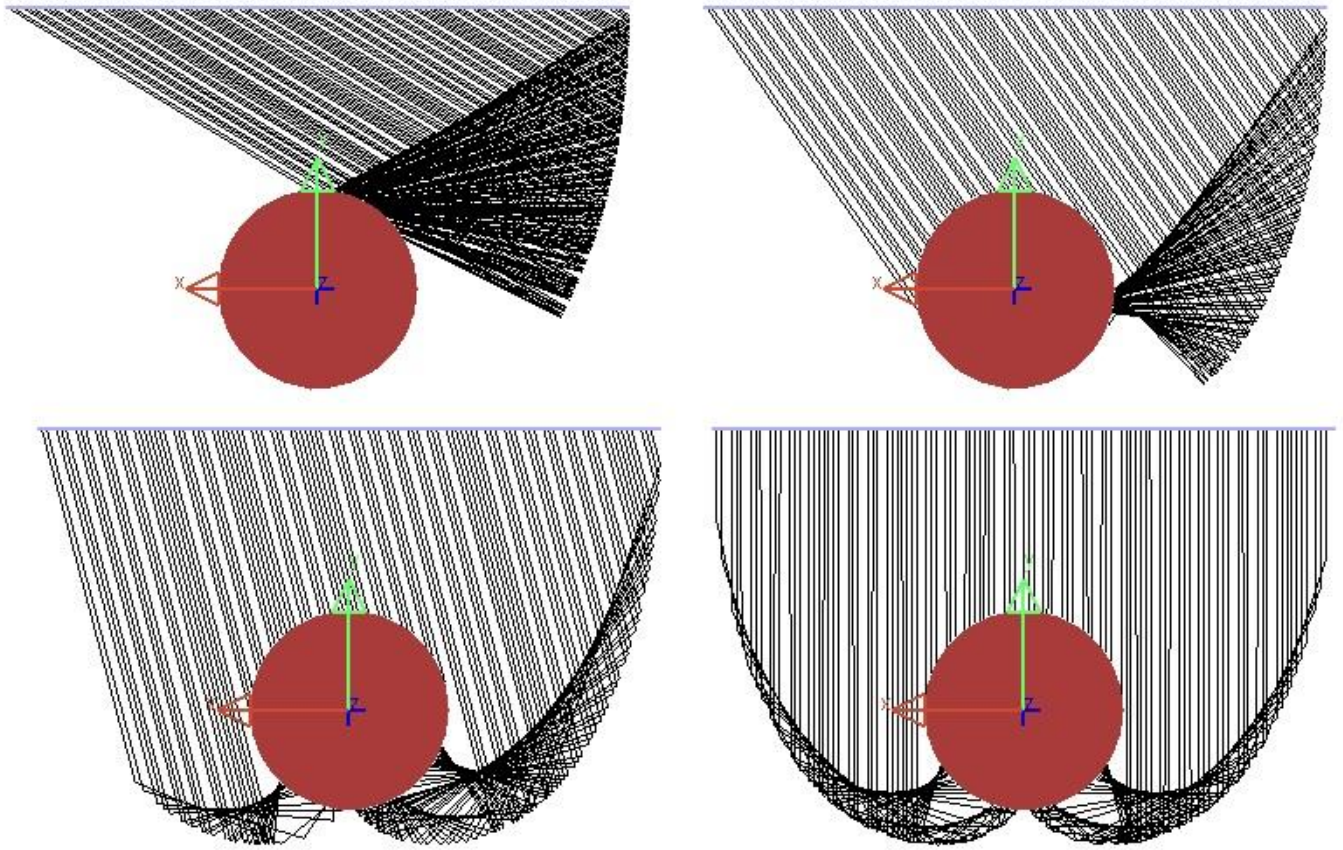
- The XCPC targets commercial applications such as double-effect absorption cooling, boiler preheating, dehydration, sterilization, desalination, oil field steam extraction and adverse water treatment
- XCPC features include:
  - Fixed, non-tracking design
  - High thermal efficiency
  - Installation flexibility (lightweight)
  - Performs well on diffuse (hazy) days
  - East-west and north-south designs
  - Can utilize water or heat transfer fluid



- Supplements or eliminates fossil fuel consumption and reduces greenhouse gas emissions

The XCPC

- The XCPC uses non-imaging optics to track the sun, while the XCPC hardware remains stationary



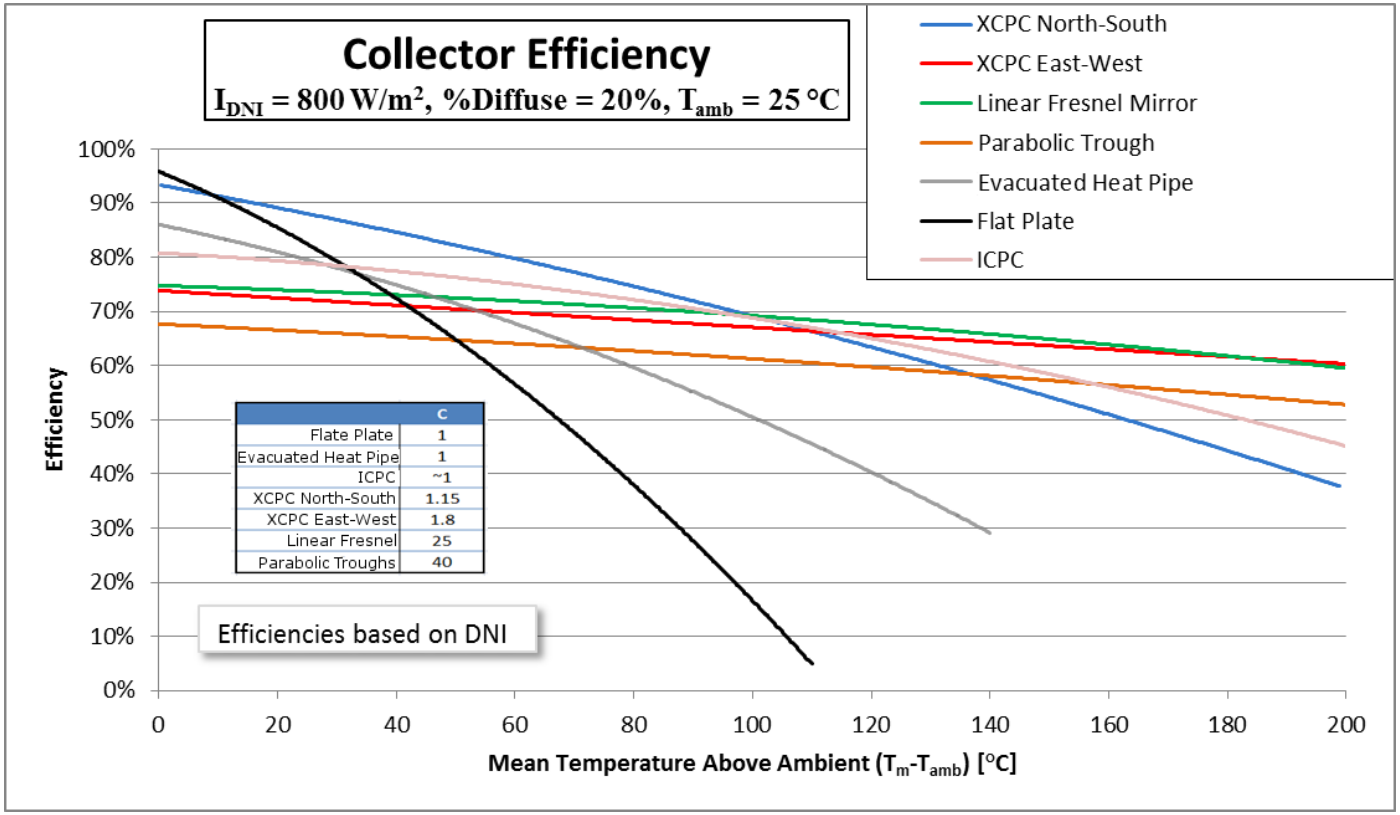
The XCPC

- For the past three summers, the XCPC has been powering the UC Merced Solar Cooling Demonstration Project
  - 160 north/south XCPCs
  - 50 sqm aperture area producing 19 kWt at >165ºC
  - 6.5-ton Broad double-effect absorption chiller
  - Direct solar-powered cooling for six hours per day (plus two hours extended cooling)

- XCPC demonstration systems have also been installed at Purdue University, GTI, NASA Ames, and Delhi, India

The XCPC

- The XCPC matches the performance and efficiency of tracking solar thermal collectors



The XCPC

- Solar array cost estimates for a 100 kWt array (28 gph evaporator capacity)

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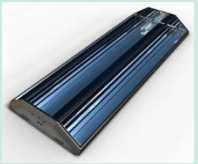
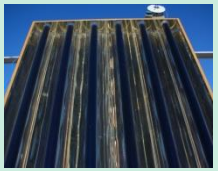
Type			
Purchase Price per kWt	$1000	$1250	$500 (est.)
Total Cost	$100,000	$125,000	$50,000

- 1600 hours of operation per year produces 5,460 therms and offsets 29 tons of CO_2
- CSI process heat rebates of $1.57 to $7.27 per therm are now available ($8,572 to $39,694 for 100kWt system)

Project Needs

- UC Merced researchers have the space, manpower, and working XCPC array to move quickly on this project
- Currently preparing proposals to the CA DWR and other state and federal funding entities
- We need external partners to:
  - Sponsor the research (primary or match funding)
  - Provide letters of support
  - Supply wastewater samples for testing and treatment
  - Provide potential test beds for future demonstrations
- The research will take 12 months at a cost of ~$150,000
- Future on-site demonstration projects may be funded by state and federal RD&D grants

Contact Us

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- To learn more about the UC Solar Institute, please visit the UC Solar website at: www.UCSolar.org