WORKSHOP – UNITE!
CSP–IMT
Online Workshop 2026

Solar Still technology for sustainable water production

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Introduction
(URAER-CDER), Ghardaia City, Algeria

Renewable Energies Development Center (CDER)

The Applied Research Unit in Renewable Energies (URAER) is a public institution, the application of RE in Ghardaia region 600 Km from the capital (https://uraer.cder.dz/)

Applied Research Unit for Renewable Energies (UAER) Ghardaia city

Two divisions

Application of Renewable Energies in Arid and Semi-Arid Environments

- Hydrogen Technology
- Solar pumping
- Energy Systems for Agriculture
- Buildingand Bioclimatic

Mini Solar Power Stations MSPS

- **Electrical Control**
- **Mini Photovoltaic Plants**
- **Mini Thermodynamic Centrals**
- **Hybrid Energetics Systems**

Previous project: Small solar tower collector

- **Realized and currently in test: produce electricity using steam turbin**
- **Prototype for graduation and postgraduation sudent**
- **17 heliostats (1 m^2) and will be extended in future**

After the completion of 17 heliostats of the construction (2021)

Current projects

Solar water heating system

Solar Still system

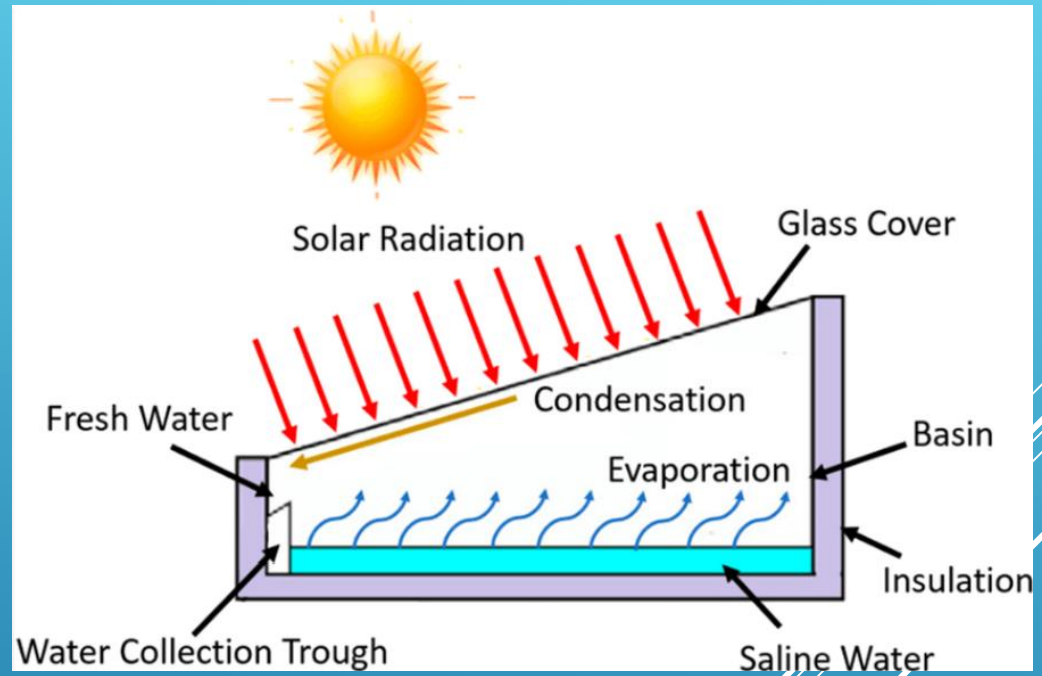
Photovoltaic thermal hybrid solar collector

Events in CDER, URAER, UDES, URERMS

- Conferences
- Day of studies
- Open days
- Workshops
- Many others activities

Solar still: working principles

1. Heating (Evaporation)
Sunlight heats the salty or dirty water.
The water changes into water vapor.
Salt and impurities remain in the basin.
2. Cooling (Condensation)
The water vapor touches the cool glass cover.
It changes back into clean water droplets.
3. Freshwater Collection
The droplets slide down the sloped glass.
Clean distilled water is collected in a separate channel.
The remaining salts and contaminants stay in the basin.

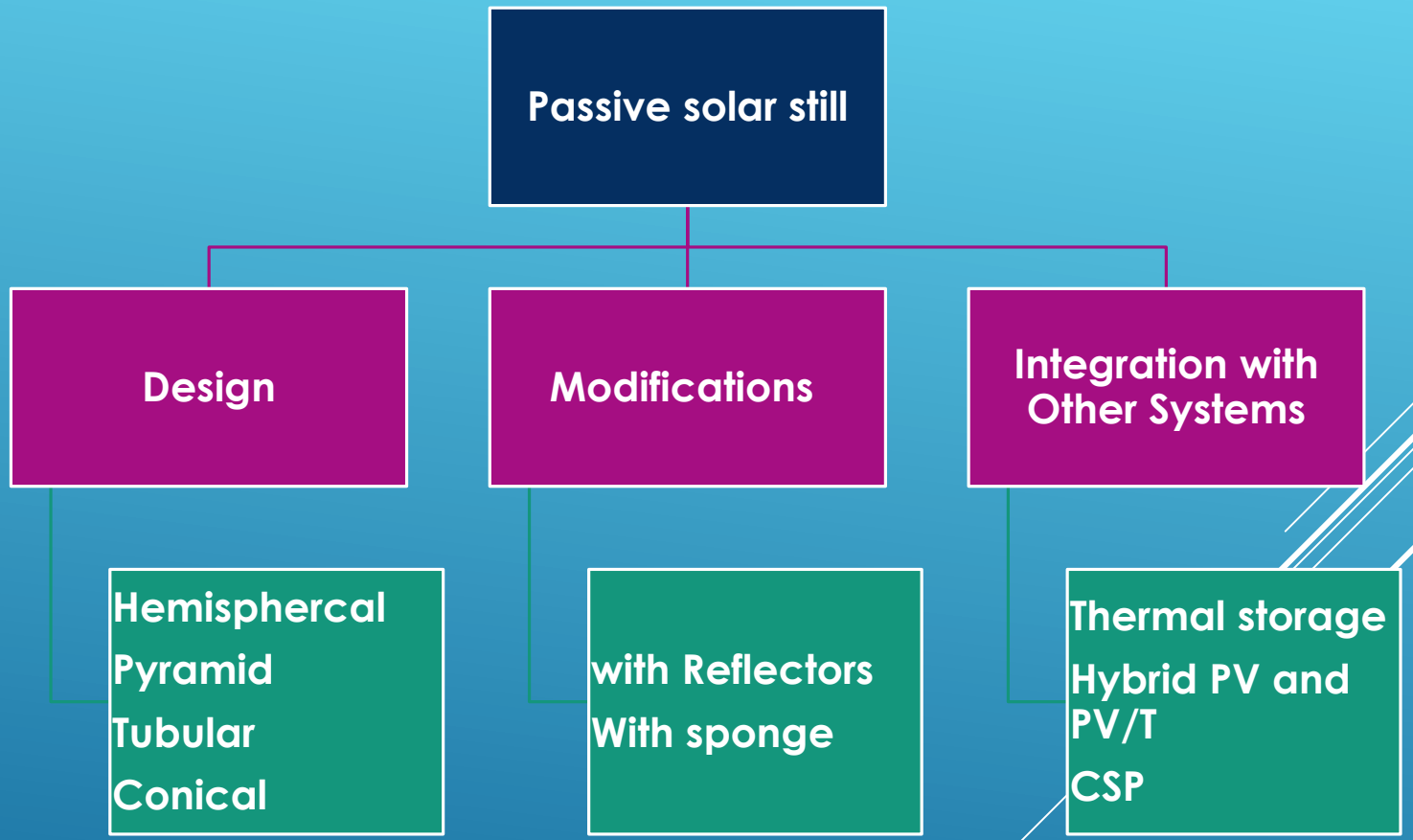


Two categories: Passive and Active Solar still

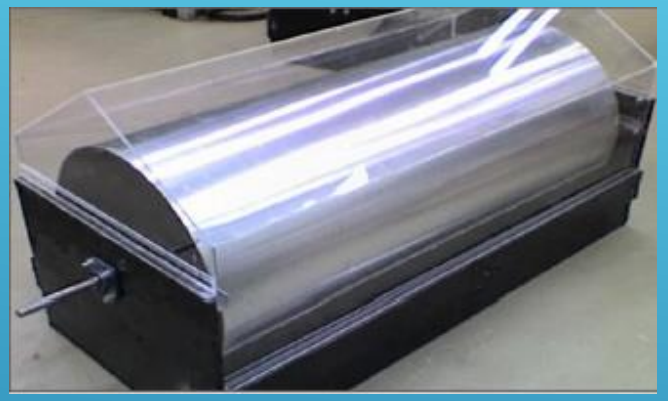
Passive Solar still

In passive SS: Water is purified through **natural processes**: heating, evaporation and condensation

without mechanical parts or external energy

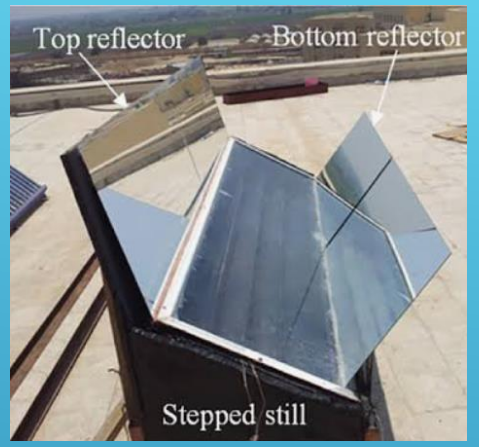


Some Real Passive Solar stills

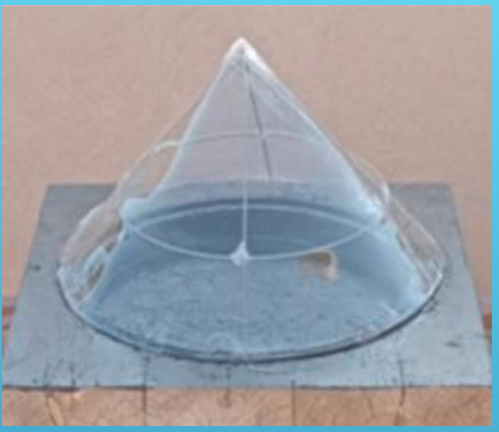


Rotating hollow drum inside the solar still

Spherical SS



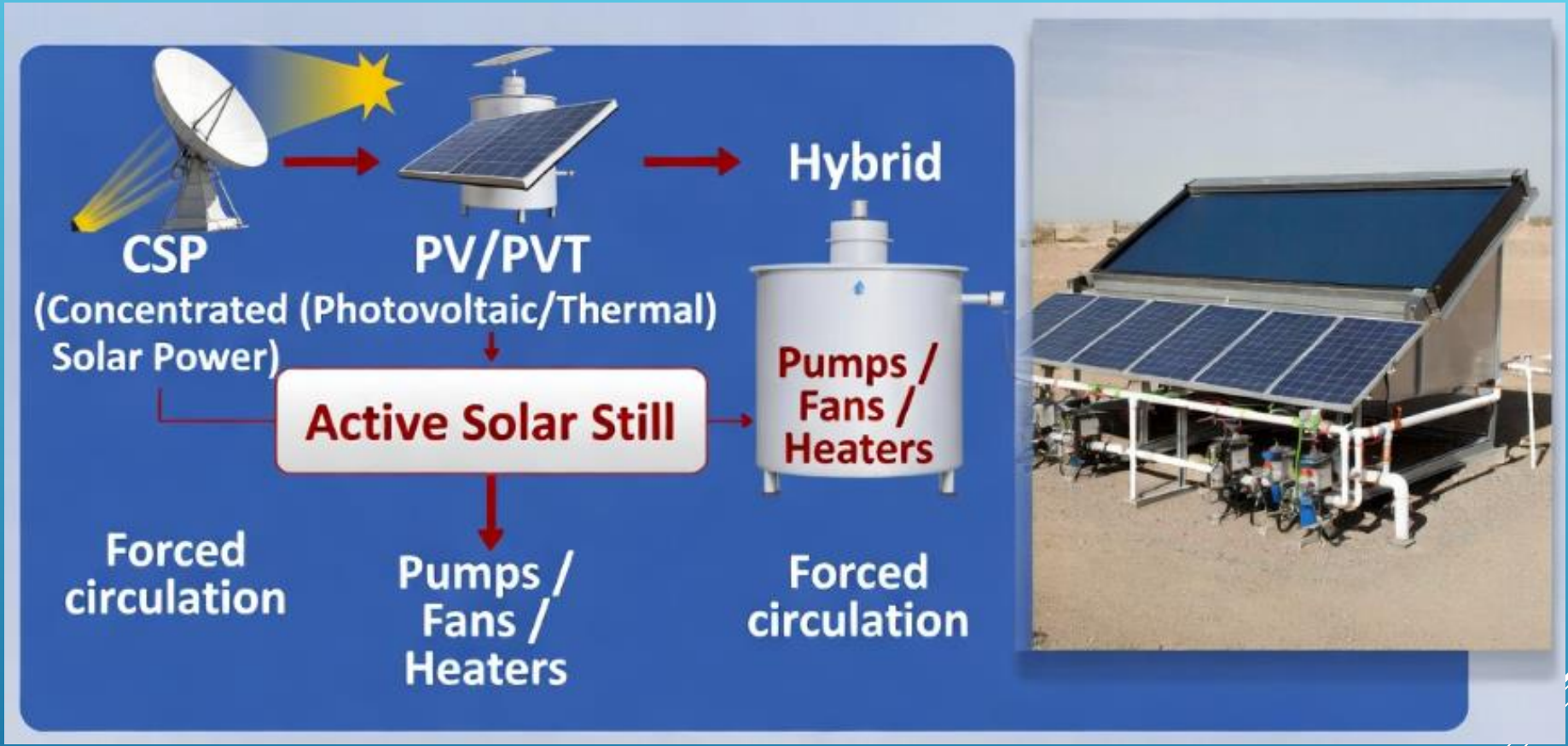
SS + Reflectors



Conical SS

In general, passive solar stills rely only on sunlight and simple materials to evaporate and condense water. Researchers have experimented with many shapes; rectangular, spherical, stepped, and conical, each designed to capture more sunlight, increase evaporation, or provide larger surfaces for condensation. Some designs also add reflectors or internal components to boost performance

Active Solar still

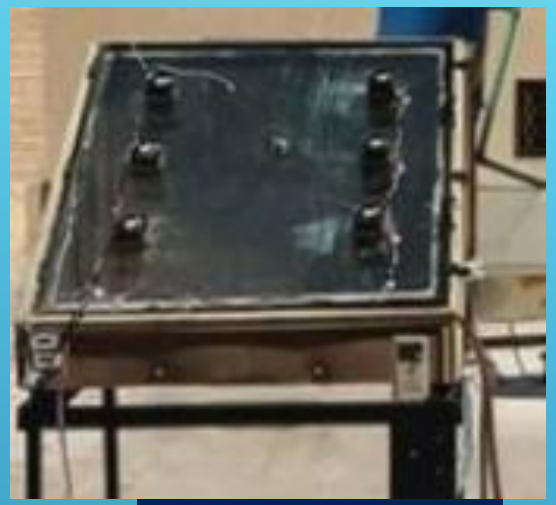


In active solar stills, extra power or parts help them work better. They might use pumps, fans, or heaters, which make them more effective but a little harder to manage. These are great for places that need more clean water.

Real Active Solar stills

Solar still + PV

Hybrid SS
(PTC+ETC)



SS+ glass cooling
and water heater

SS+ PTC

SS Performance enhancement

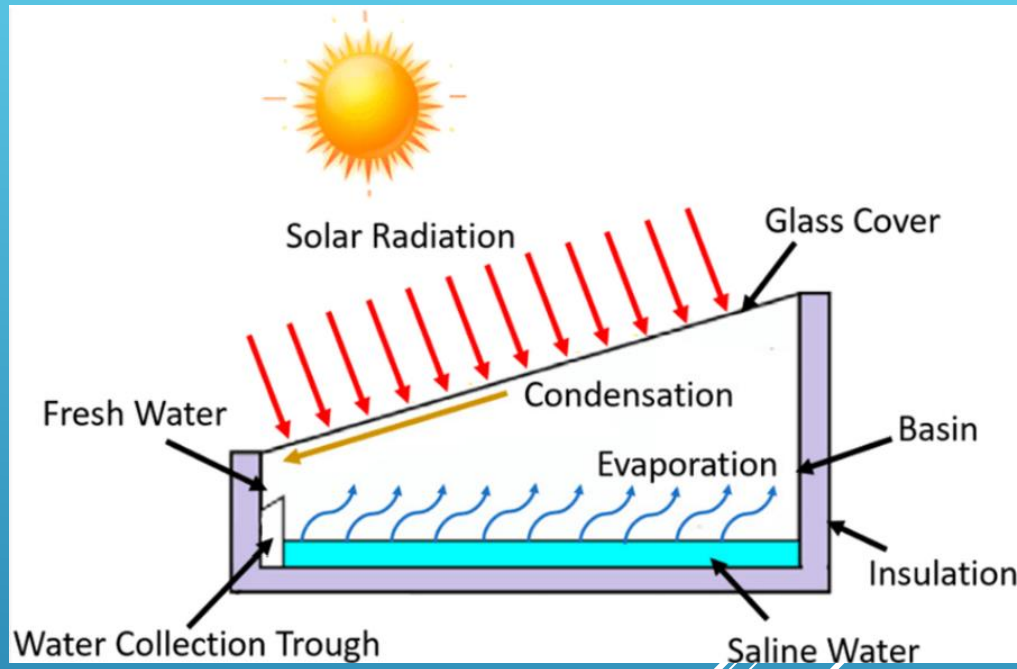
Process enhancement methods

Improve Evaporation

- Thermal storage material
- Nanoparticules
- Photovoltaic
- Heat exchanger

Boost Condensation

- Cover cooling
- External condenser
- Nanopartcles
- Air injection



Large-scale solar still desalination

Puerto Chale community plant

- **6 channels, each 1.6 m × 40 m.**
- **1000 L/day, serving ~100 people.**
- **Serving ~80 people.**

Puerto Chale community plant

- **Area: 54 m^2, length 38.75 m**
- **Summer output: 200 L/day (~3.7 L/m^2)**
- **200 L/day**

Advantages of Solar Stills

- ✓ **Low cost technology with simple design, inexpensive materials.**
- ✓ **Environmentally friendly (no fossil fuels).**
- ✓ **Easy operation: minimal maintenance, no skilled labor required.**
- ✓ **Scalable: from household units to community plants.**
- ✓ **Safe water supply: distilled water free of salts and contaminants.**
- ✓ **Suitable for Remote Regions**

Case study: Pyramid solar still

This slide shows pyramid solar stills tested with sand and Paraffine wax PCM.

. Sand provides simple sensible heat storage, while PCM stores latent heat around basin temperatures, extending distillation after sunset. The comparison highlights how material choice directly affects thermal performance and water yield

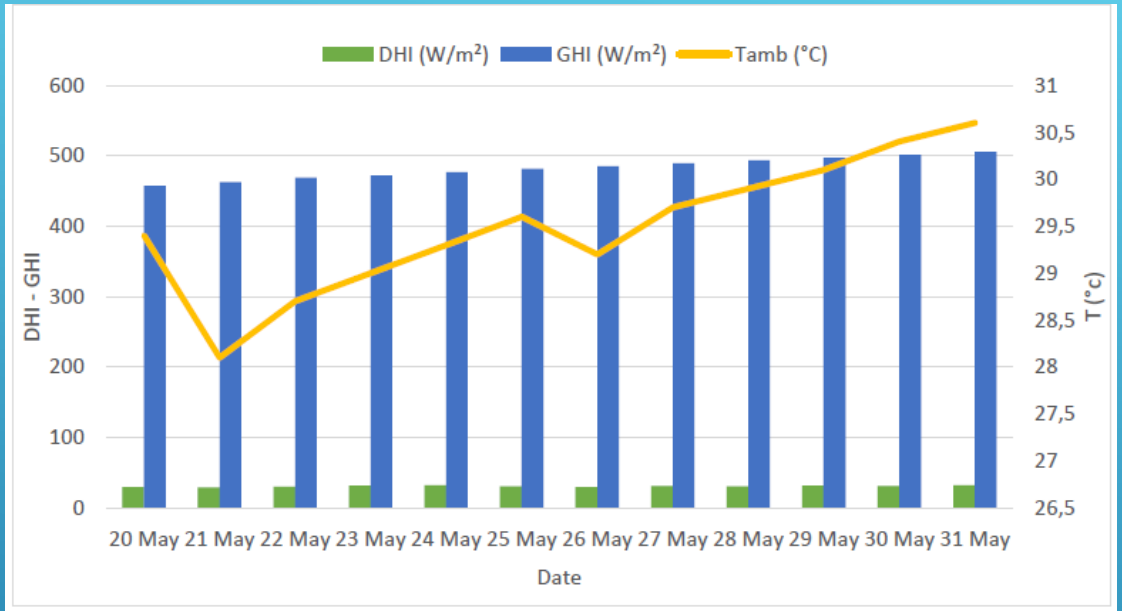
Property	Value	Relevance for PSS
Density (kg/m³)	1600	Provides bulk mass for sensible heat storage.
Specific Heat Capacity (J/kg·K)	830	Stores and releases heat gradually.
Thermal Conductivity (W/m·K)	0.27	Enhances heat transfer to basin water.
Water Absorption (%)	0.5	Low absorption ensures stability in saline conditions.
Chemical Composition (major)	92.5% SiO_2 (Quartz)	Chemically inert and durable for repeated cycles.

Sand

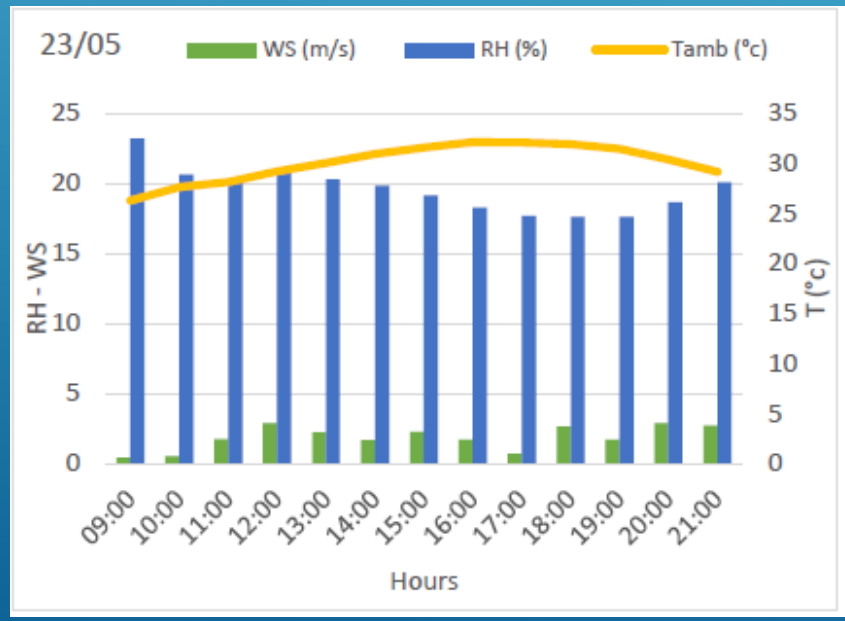
Property	Value	Relevance for PSS
Onset temperature	57.3 °C	Beginning of melting, when PCM starts absorbing solar heat.
Peak temperature	62.1 °C	Maximum melting point, aligns with typical basin water temperatures in PSS.
Offset temperature	64.1 °C	End of melting, defines the full latent heat storage range.
Density	890 kg/m³	Solid phase at 25 °C.
Thermal Conductivity	0.24 W/m·K	Solid phase at 25 °C.
Latent heat of fusion (ΔH)	175.8 J/g	High energy storage capacity, prolongs distillation after sunset.

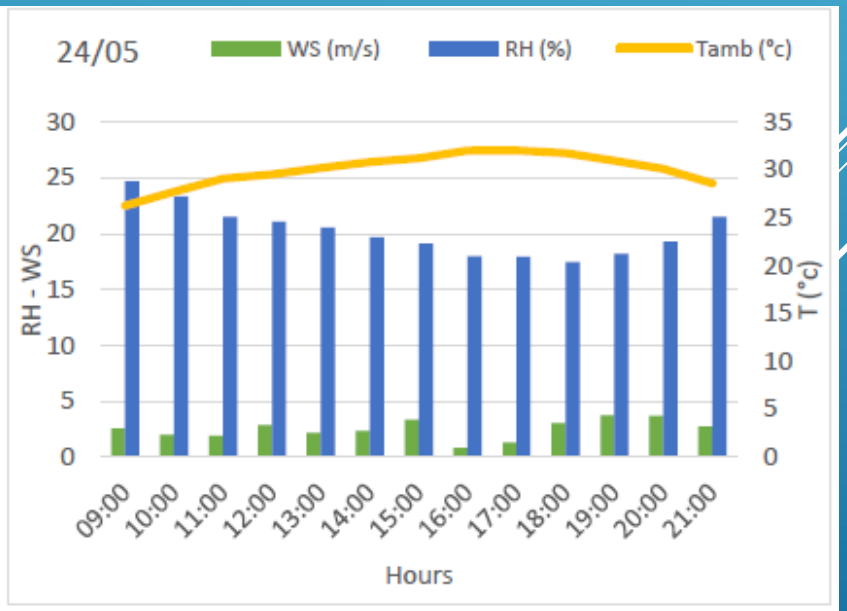
PCM

Weather conditions suitability



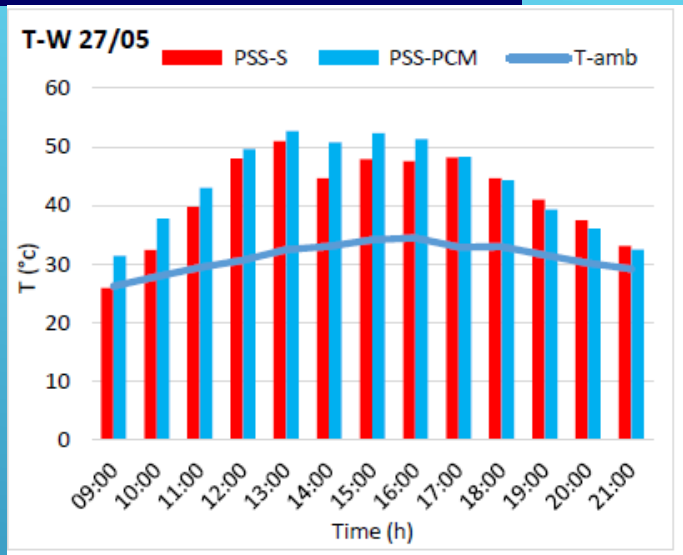
At midday, sunlight reached about 800 W/m² GHI, giving strong energy for evaporation. Temperatures rose from 12 °C in the morning to 22 °C in the afternoon, then cooled to 15-17 °C by evening, which helps both evaporation and condensation. Humidity dropped from 34% to 20%, making evaporation faster. Winds stayed gentle, around 3–5 m/s, with a peak of 5.25 m/s at 11 AM.

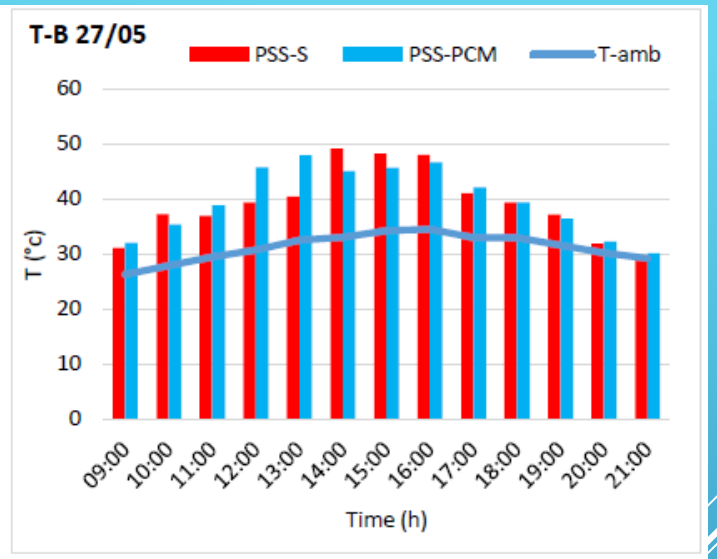


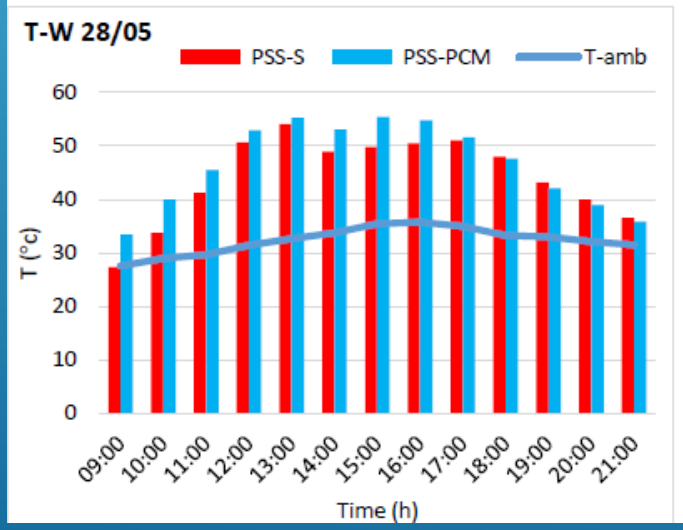


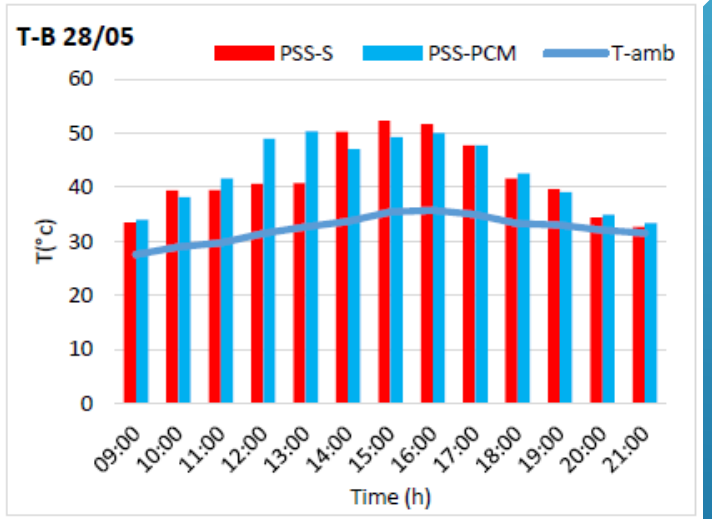
PSS-Sand and PSS-PCM comparison

The sand system reaches **higher peak** temperatures, while the PCM system moderates temperature **fluctuations** and stores heat for longer periods. This highlights how PCM can stabilize operation and **extend distillate** production into evening hours, whereas sand provides stronger daytime heating

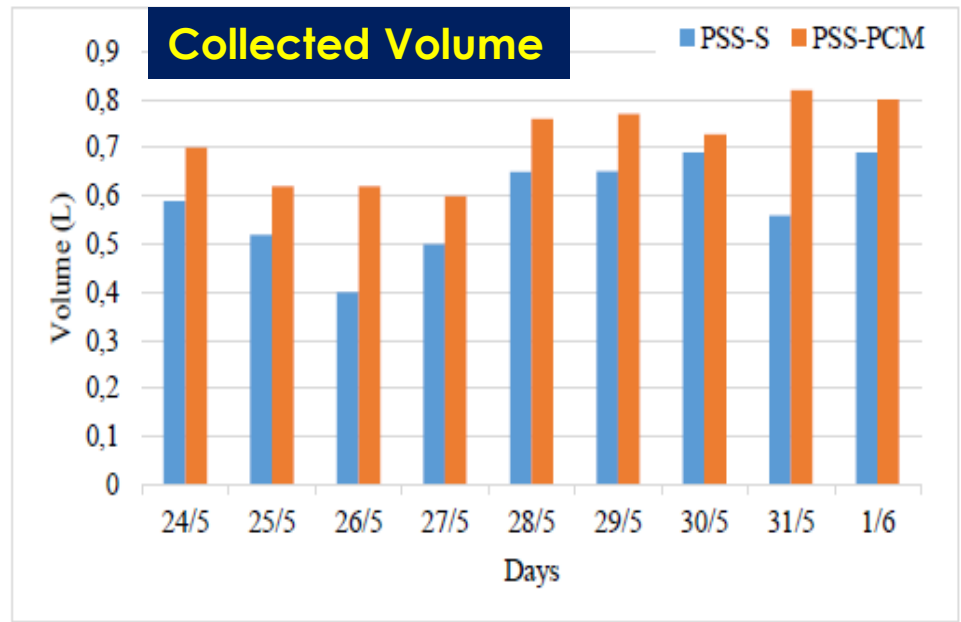








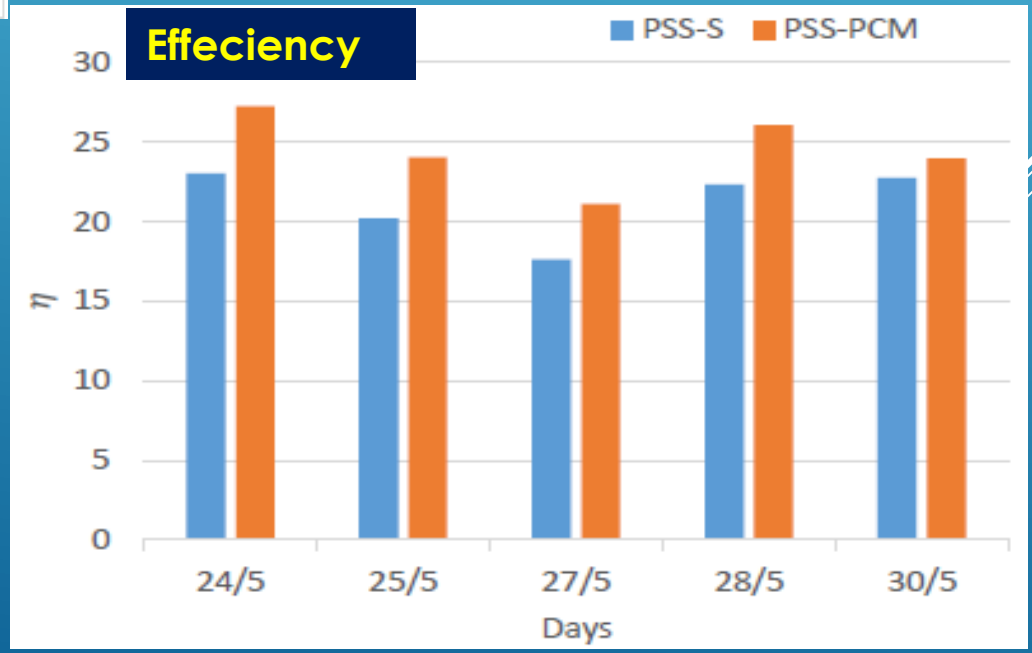
Collected volume and thermal performance



Collected volumes for 1 m^2:

- **9.7 for PSS-S**
- **13.9 PSS-PCM**

The PCM system consistently shows **higher collected** water volumes and better thermal efficiency than the sand system. This demonstrates that PCM improves energy storage and utilization, leading to more stable performance and greater freshwater output

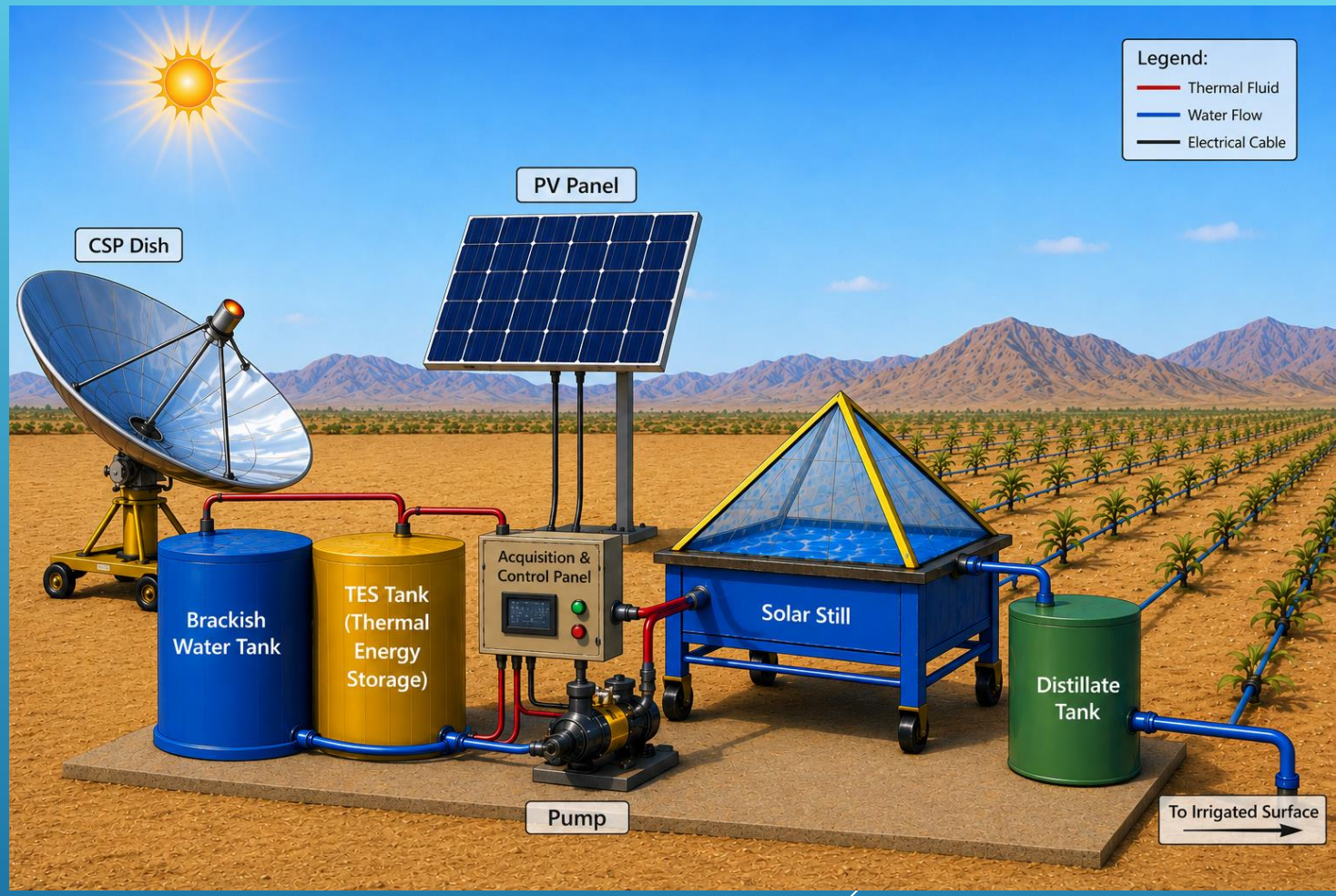


Limitations of Solar Stills

- **Low freshwater production compared with conventional desalination systems.**
- **Performance depends strongly on solar radiation and weather conditions.**
- **Water production decreases significantly after sunset.**
- **Heat losses reduce the overall efficiency of the system.**
- **Large land area is required to produce high volumes of freshwater.**

Example of future work

- Solar still for: drip irrigation in remote region.
- Multiple unit to produce 200 L for 10 Ha
- With AI integration for management
- Can be mobile system.



Thank you

Any questions?

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