# Techno-Economic Assessment of Solar Water Heating Systems: A Proof-of-Concept for Large-Scale Deployment in Namibia

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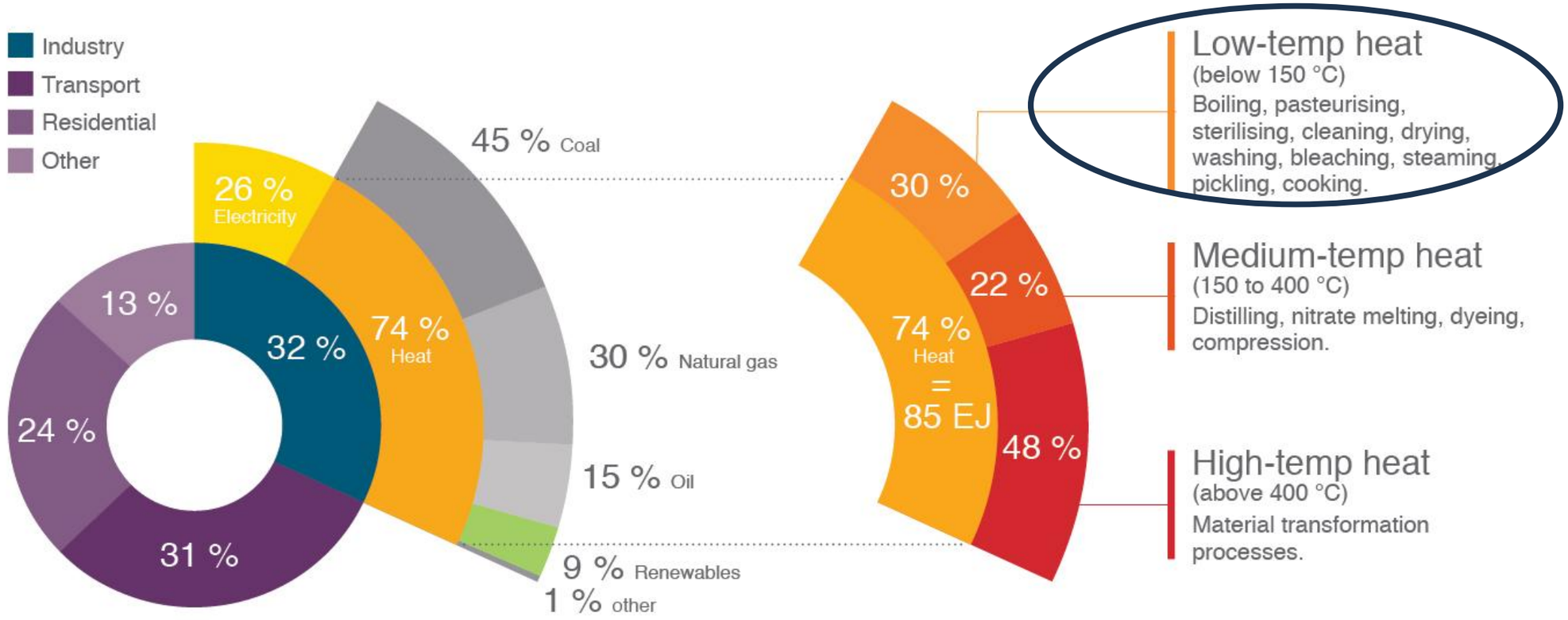
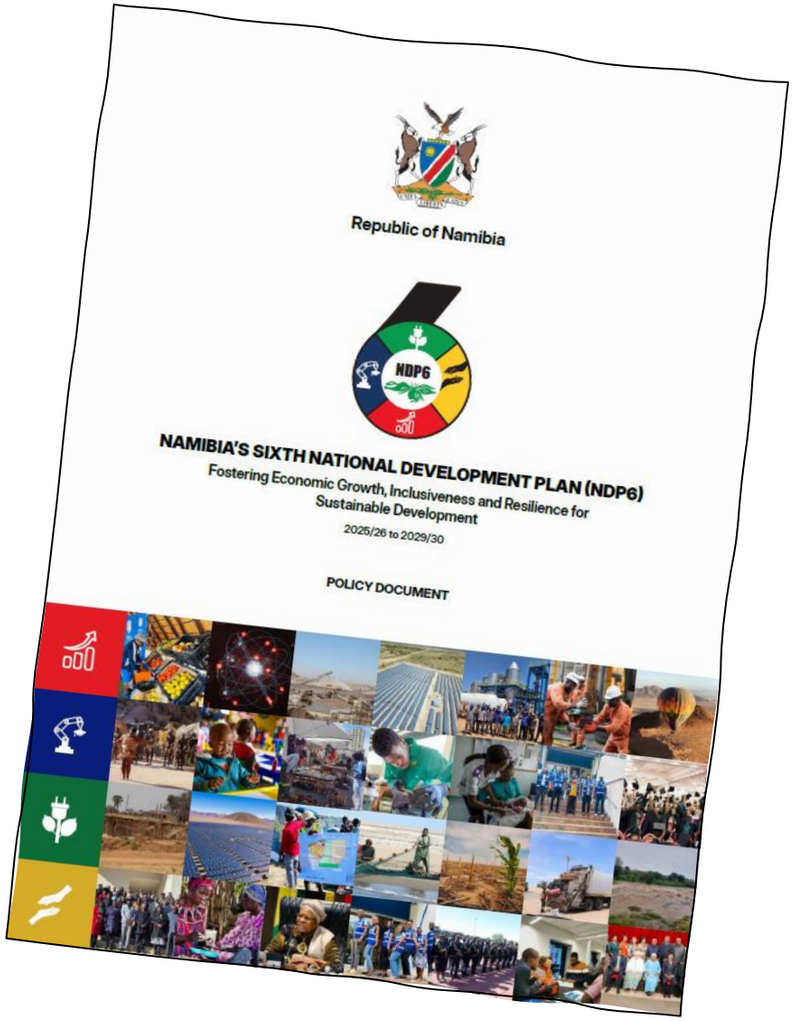
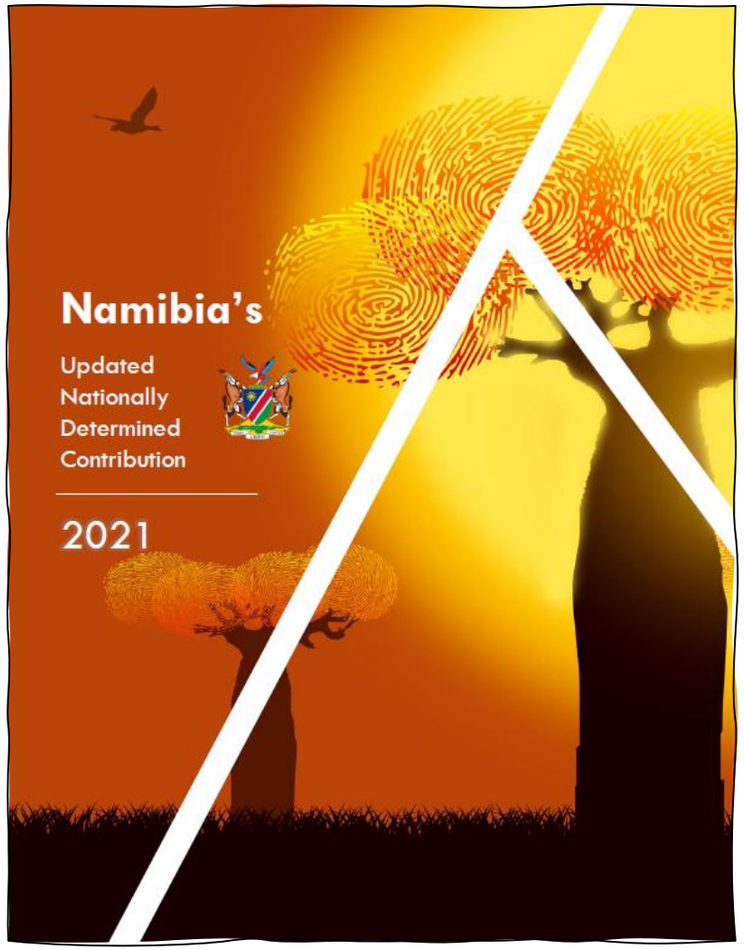
# Global Energy Demand – An Outlook

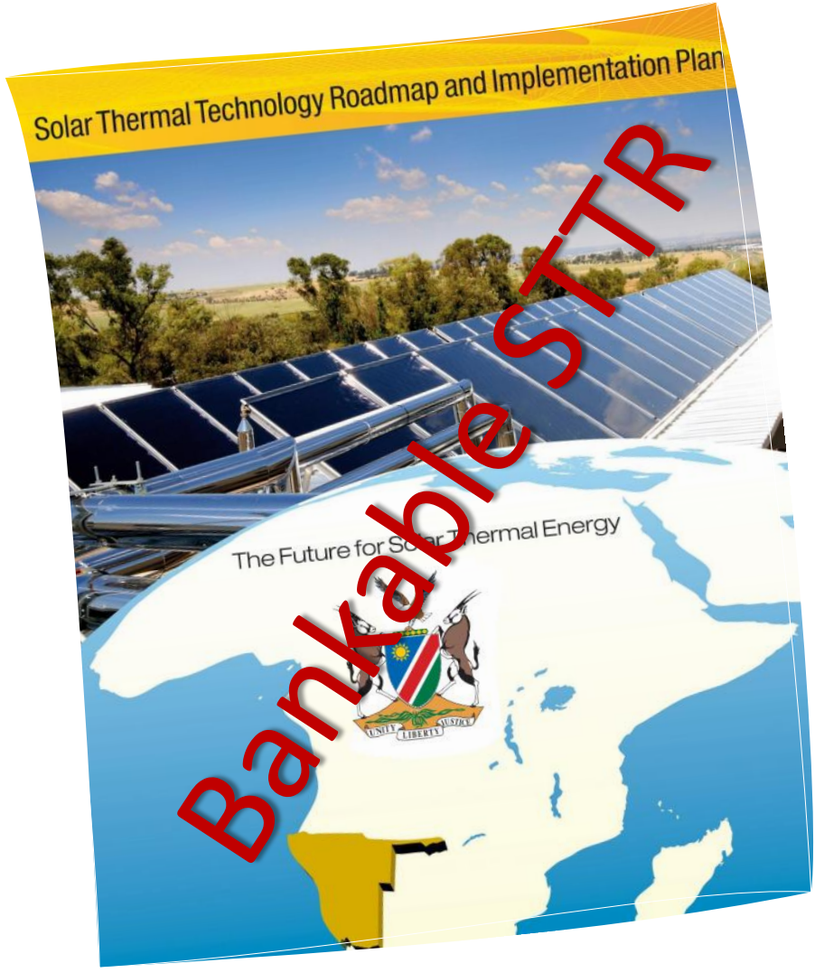



*Source: Solar Payback (2017), based on IEA statistics and calculation by IRENA*

# Relevance to Policy

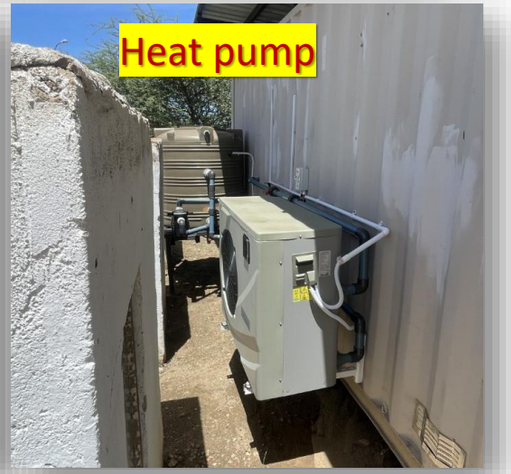


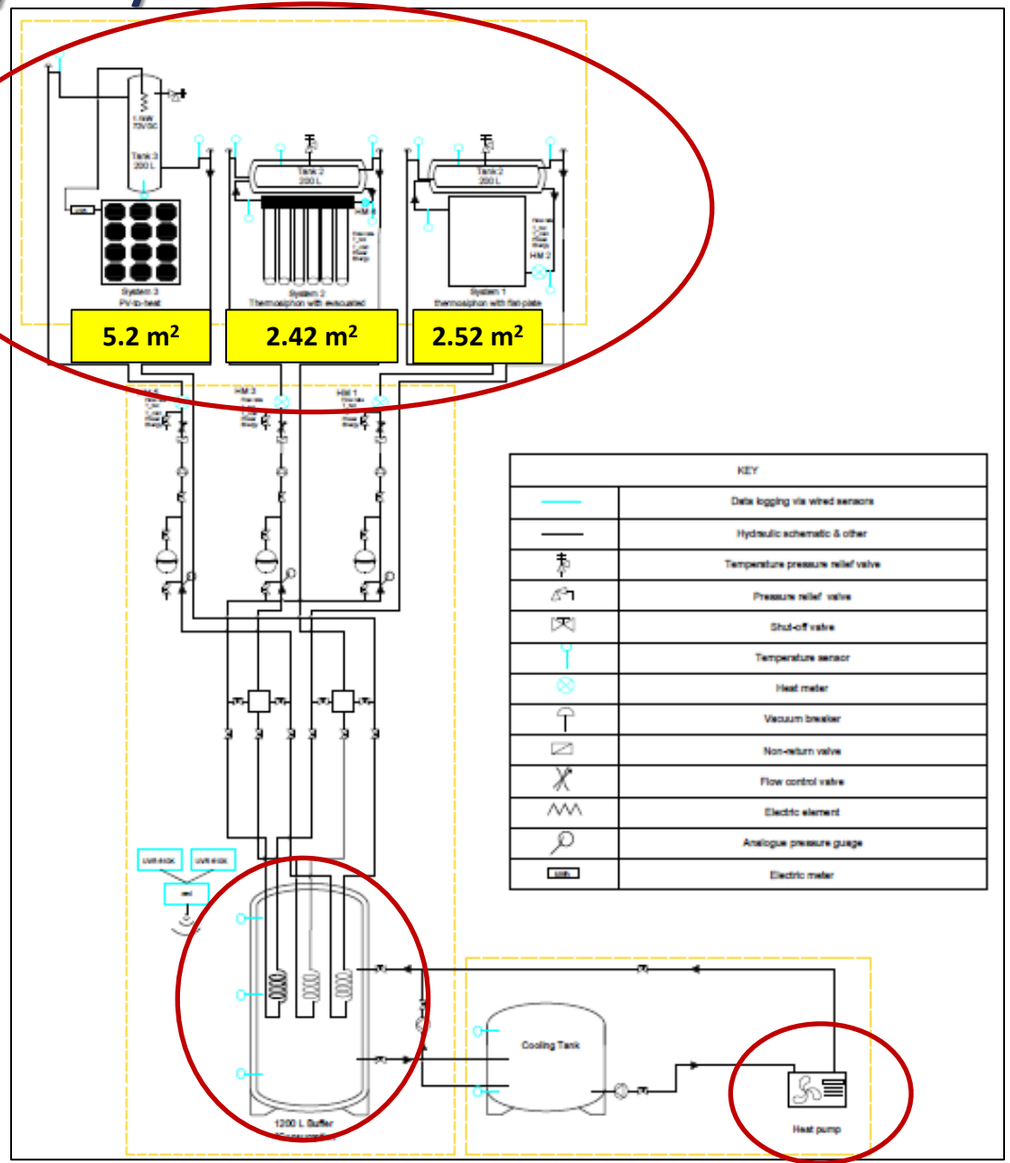



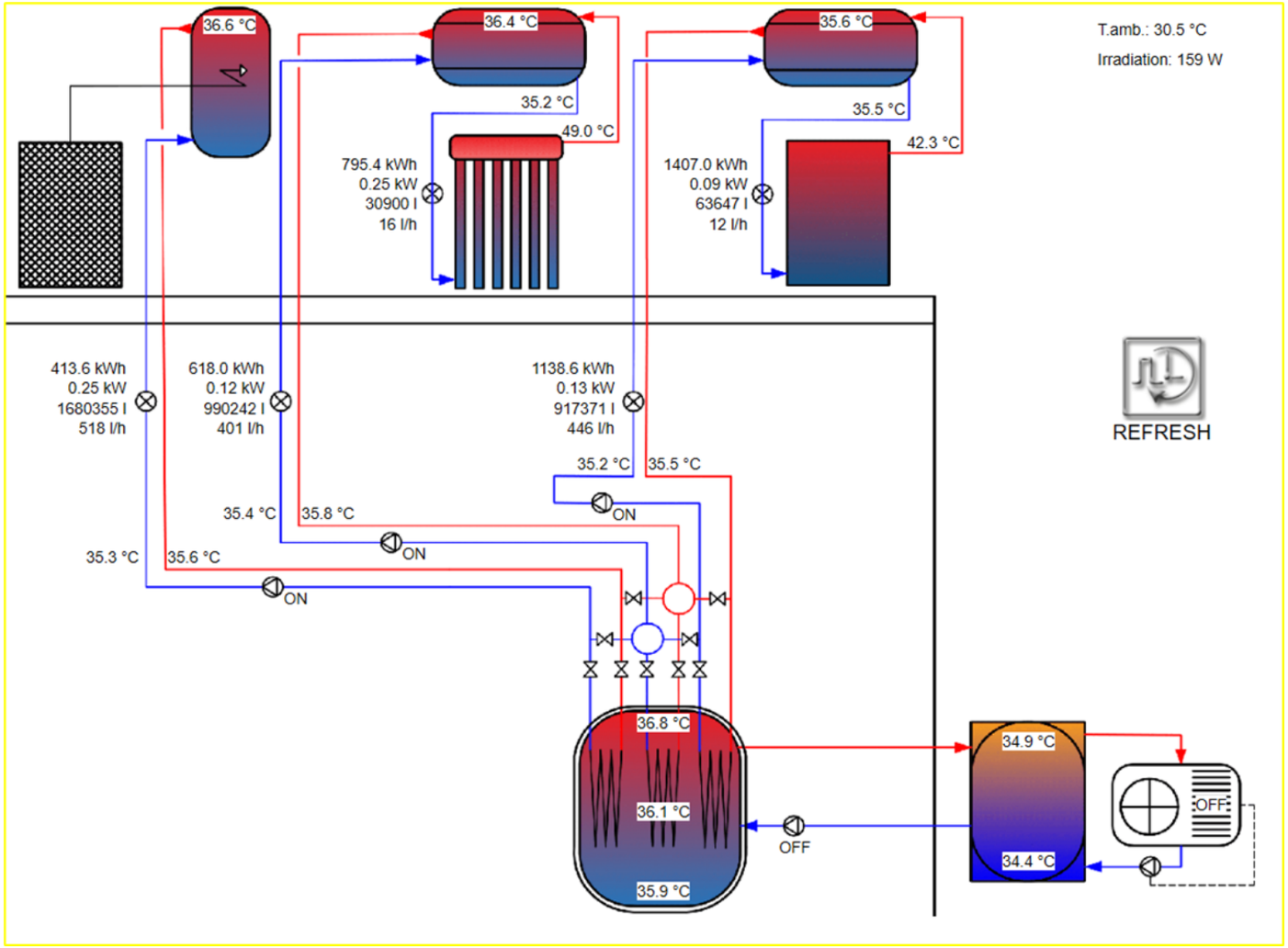
# The Side-by-side comparison study –System Architecture





# Online Monitoring



# Systems Performance - Production

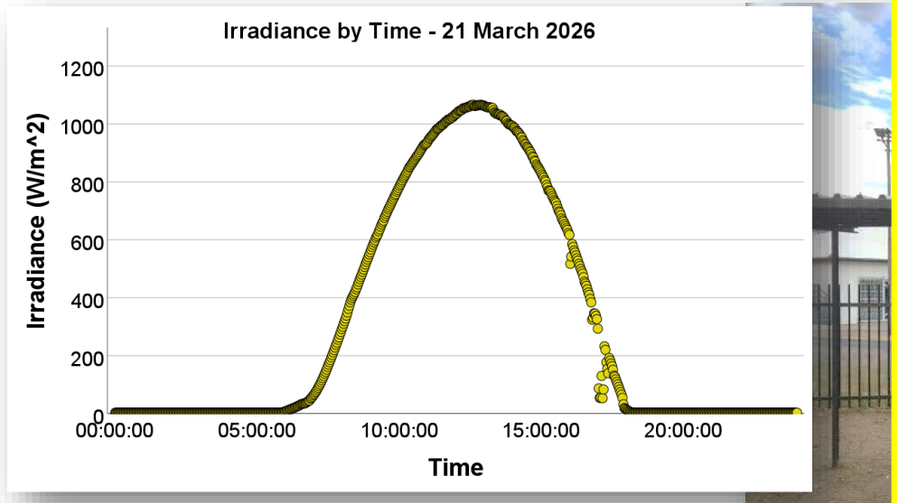

System not fully commissioned until December 2025

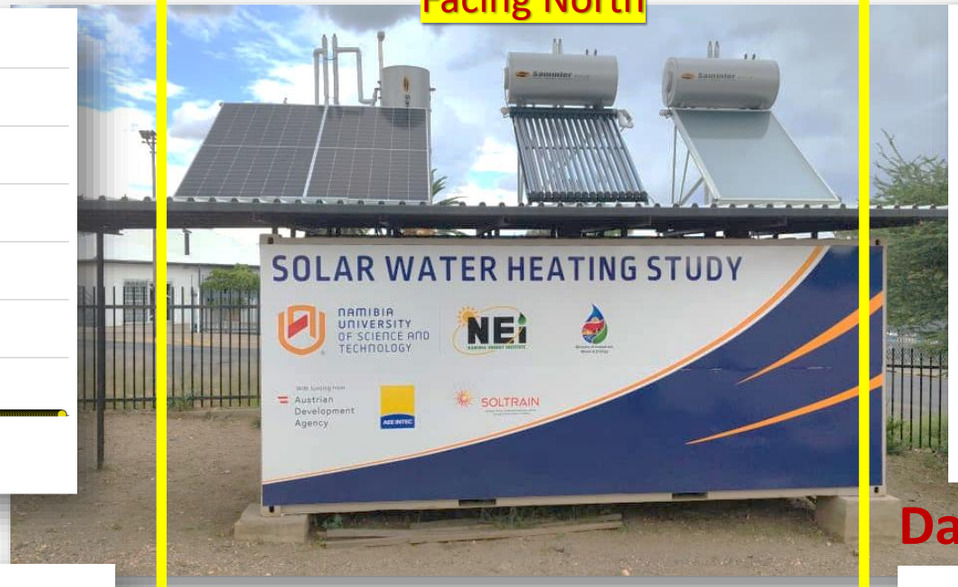

Average $\eta_{Flatplate}$ = 42 %  Average $\eta_{Evacuated\ Tube}$ = 29 %  Average $\eta_{PV\text{-}to\text{-}heat}$ = 10 %

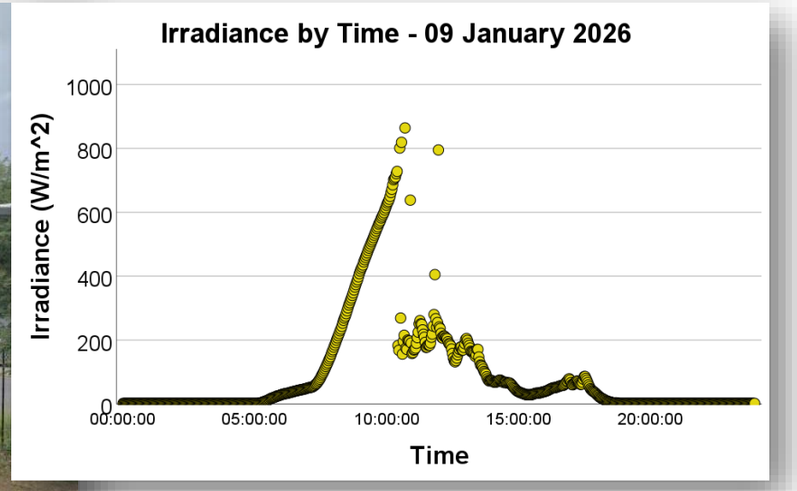
# Performance at High Radiation

Inclination: 35°
Facing North

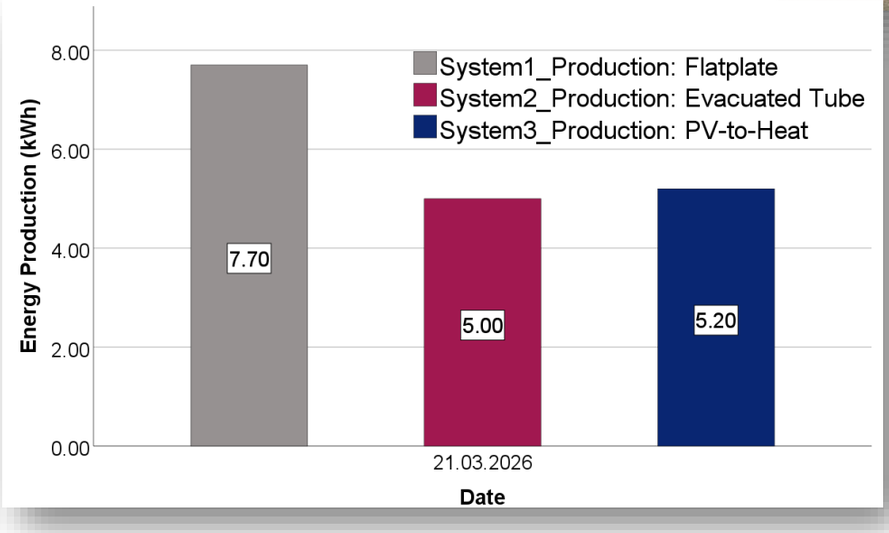
# Performance at Low Radiation



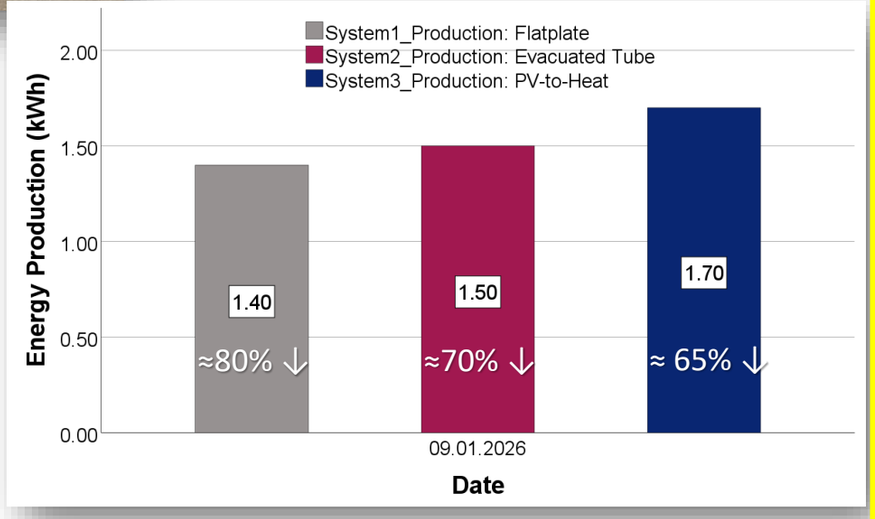

## Daily radiation: 7.43 kWh/m²



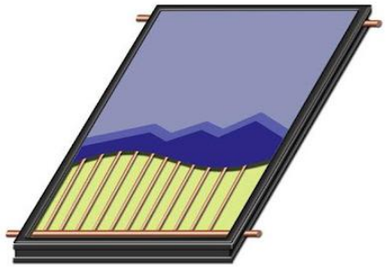
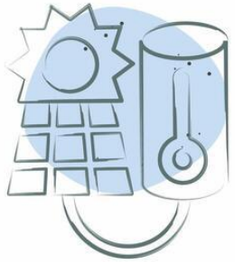

## ≈70% drop in radiation

VS

## Daily radiation: 2.18 kWh/m²



# Preliminary Takeaways (Performance Matrix)

| | Flat plate Collector | Evacuated tube collector | PV-to-Heat |
|---|---|---|---|
| |  |  |  |
| Cost | Similar | Similar | Similar |
| Performance | Varying performance under varying radiation levels | Resilient performance under varying radiation levels | Versatile technology |
| Suitable application | Off-grid/stand alone | Off-grid/stand alone | Off-grid/stand alone & auxiliary electrical services (a suitable technology in mini-grid application) |

# Conclusions

## KEY TAKEAWAYS

- The **flat plate collector exhibited the highest energy production under high irradiance** conditions; however, **its performance declines noticeably as radiation levels decrease**. Given Namibia's predominantly sunny meteorological conditions, flat plate collectors are expected to deliver higher overall energy output.
- **The evacuated tube collector demonstrated** moderate and **more stable performance**, with less variation under low irradiance conditions compared to the other systems.
- **PV-to-heat systems are the least affected by fluctuations in irradiance** and can be integrated into isolated electrical networks to provide auxiliary power. However, they are **less space-efficient in terms of energy output per unit area**. In the Namibian context—where land availability is relatively high and electricity access remains limited—**PV-to-heat systems can play a strategic role in hybrid energy system configurations.**

## FUTURE WORKS

- A detailed analysis of the performance of the three systems will be conducted using advanced **statistical methods** such as a Monte Carlo analysis to gain deeper insight into each system under varying operating conditions.
- Establishing the metrics: LCOH, energy production, efficiency, and specific energy yield of all systems – **supported by the availability of substantial dataset**.
- Conducting a **life cycle cost assessment** of all systems.

***There are various research question to answer from the study – the system flexibility support large scope of research on SWH***

# Project Partners

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SOLTRAIN

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Solar Hot Water For 2030

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