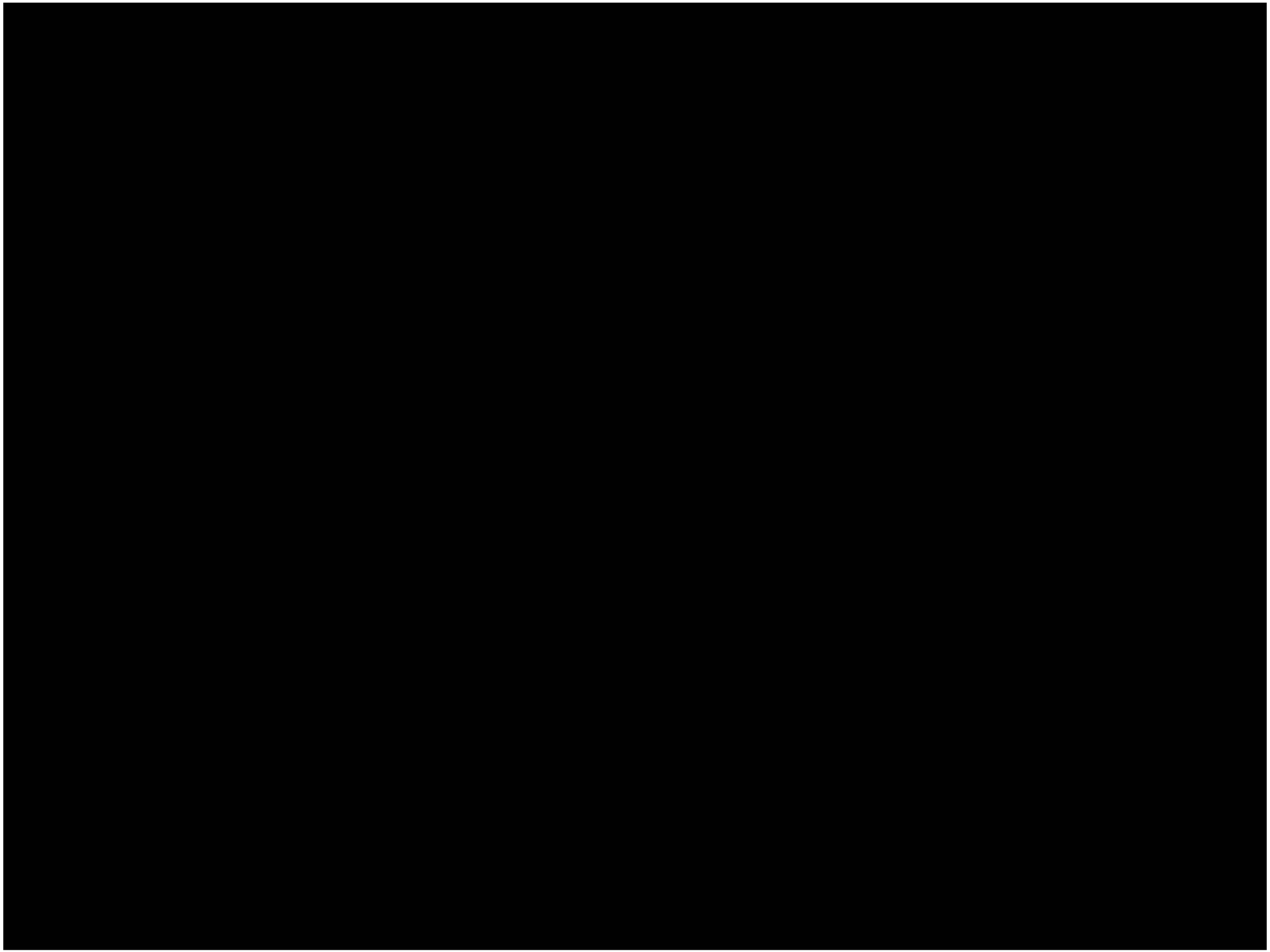


Today, still 1.6 billion people are without access to electricity in their homes,

2.3 billion suffering from water-related diseases, with over 2 million children dying each year,

**. . . and almost all of these people live in developing countries . . .**

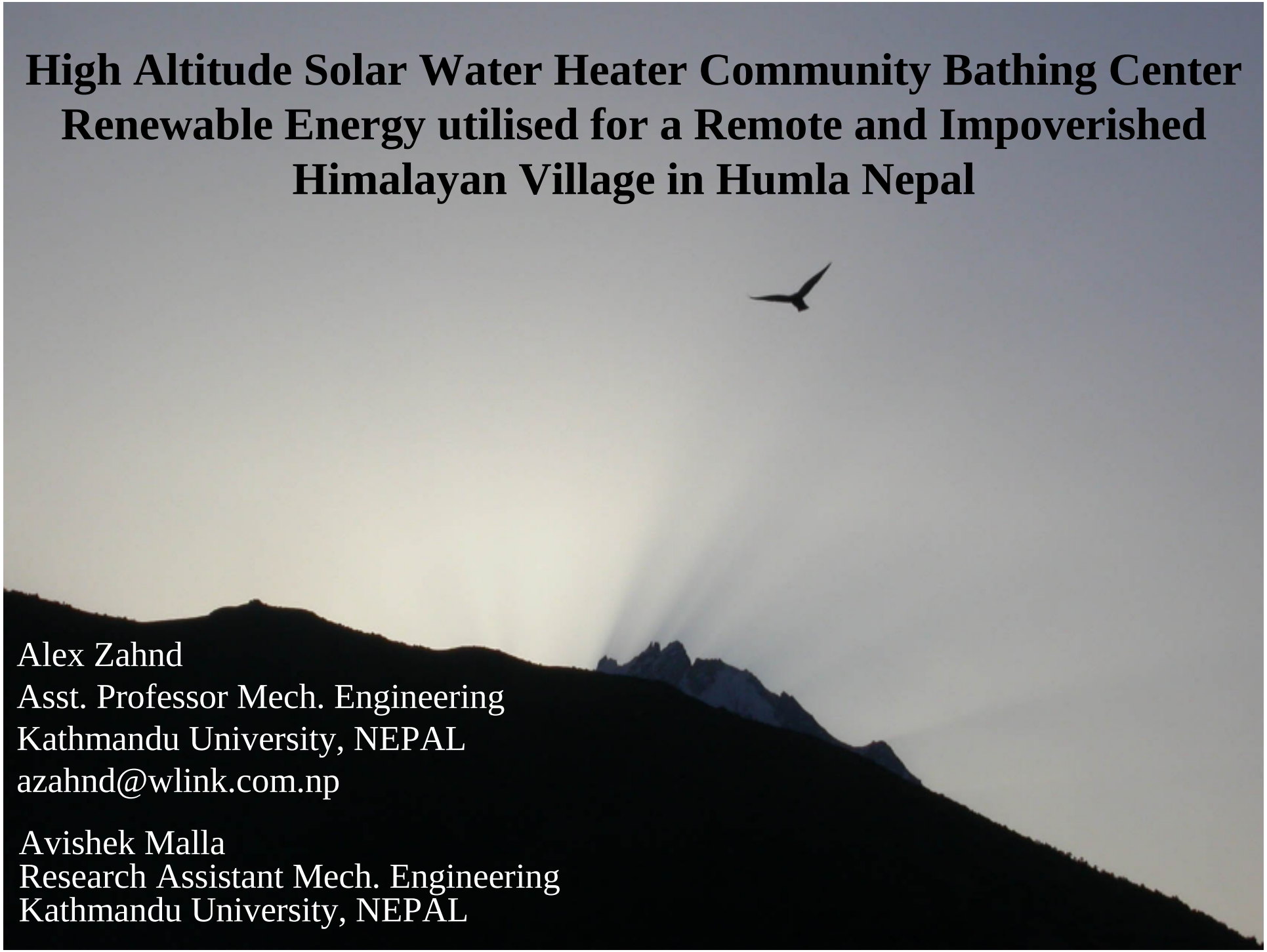
and 2.4 billion without adequate sanitation . . .

1.1 billion people are still without safe drinking water,


NEPAL


85% - 88% of Nepal’s 28 million people live in rural areas, with estimated half of them in such remote and difficult to access areas that neither a road nor any commercial energy services will reach them for decades to come.

# High Altitude Solar Water Heater Community Bathing Center Renewable Energy utilised for a Remote and Impoverished Himalayan Village in Humla Nepal



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The poor hygienic conditions in the remote Himalayan villages of Nepal are a major cause for many avoidable diseases such as scabies, worms and amoebic dysentery, under which the children in particular are permanent suffering.

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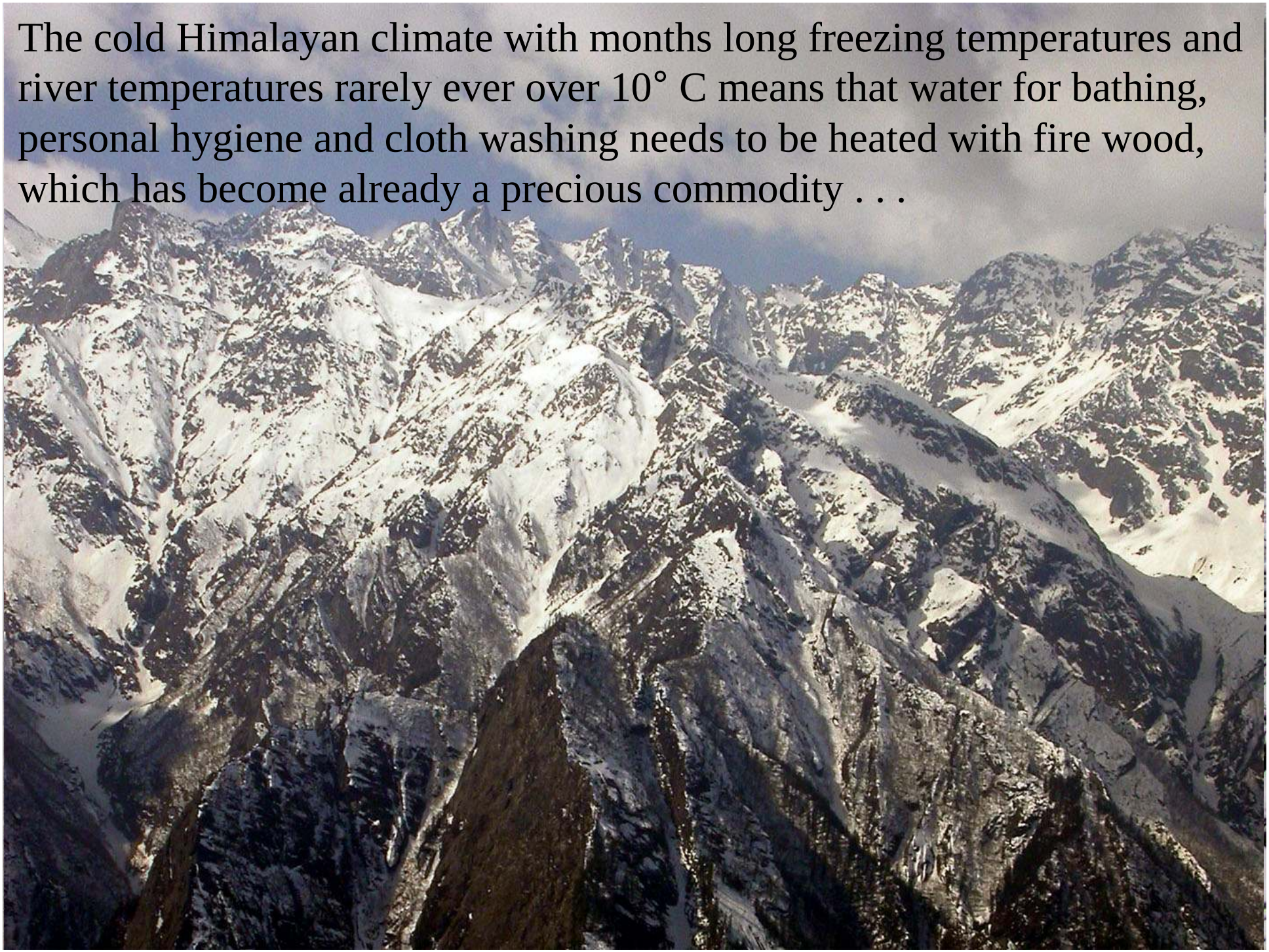
The cold Himalayan climate with months long freezing temperatures and river temperatures rarely ever over 10° C means that water for bathing, personal hygiene and cloth washing needs to be heated with fire wood, which has become already a precious commodity . . .



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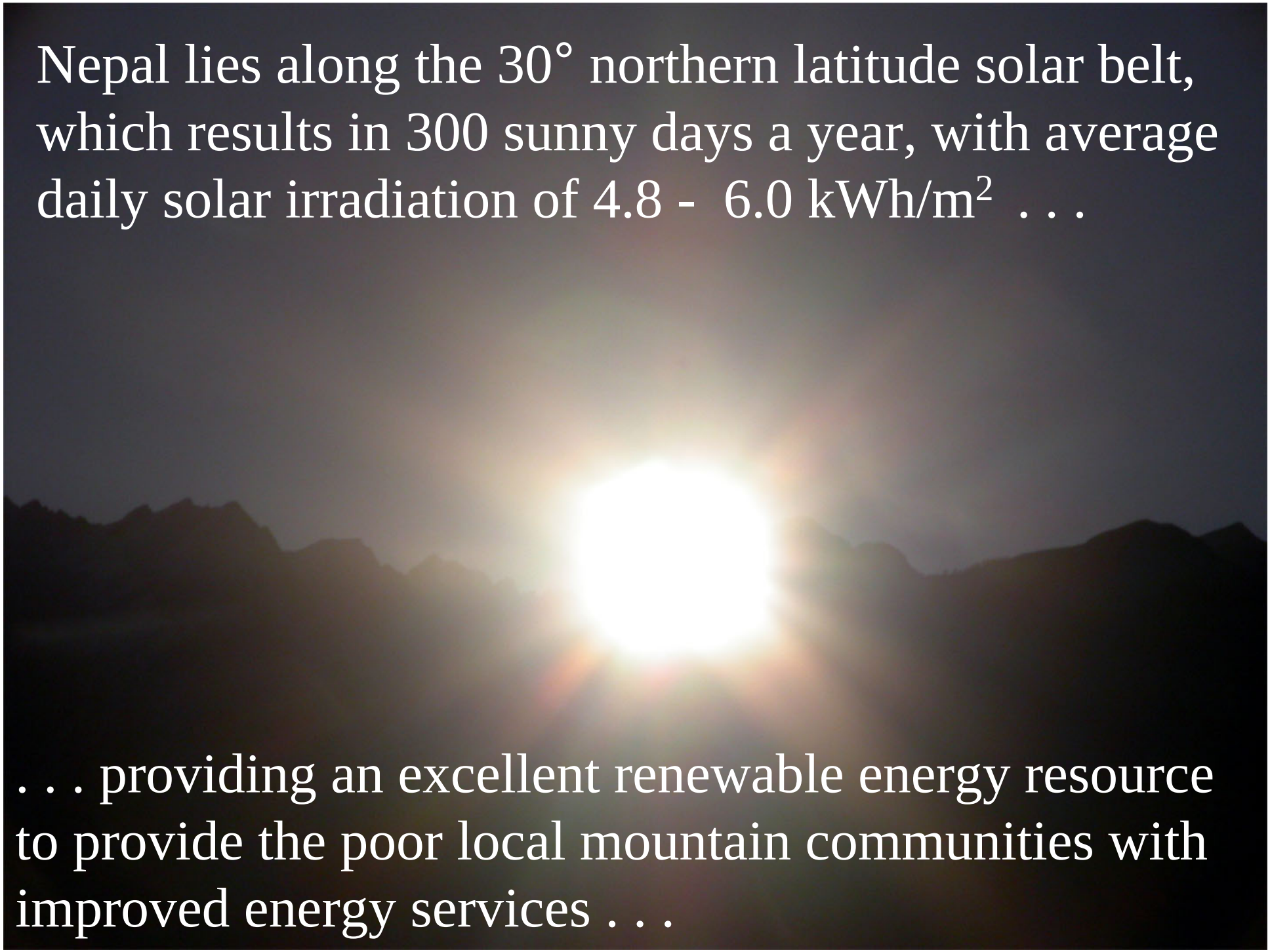
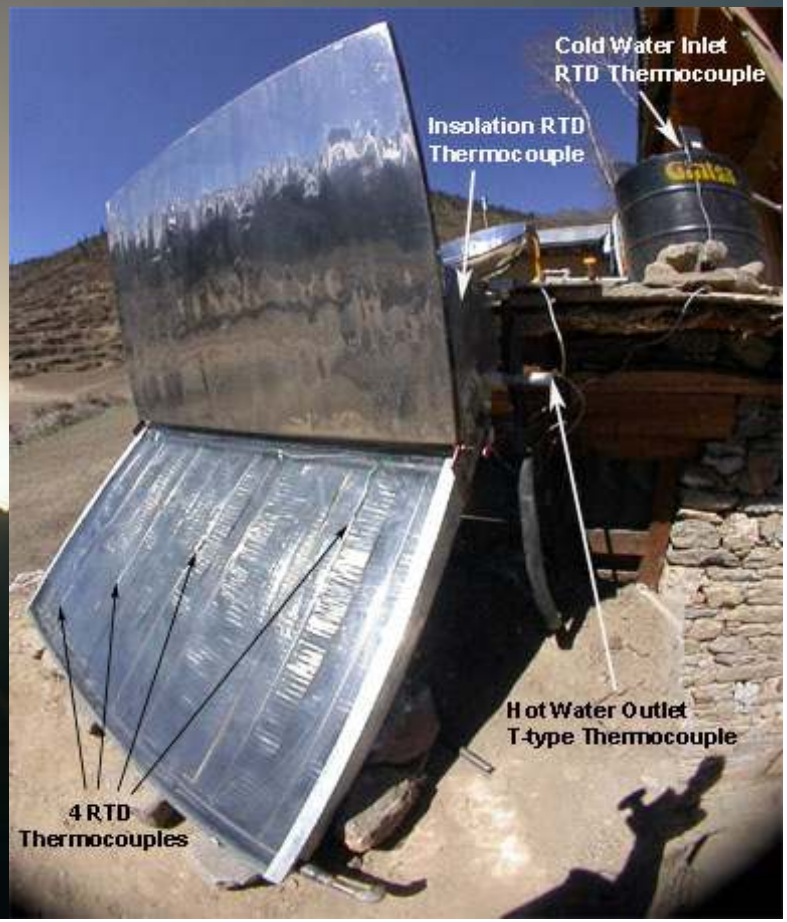

Nepal lies along the 30° northern latitude solar belt, which results in 300 sunny days a year, with average daily solar irradiation of 4.8 - 6.0 kWh/m$^2$ . . .
. . . providing an excellent renewable energy resource to provide the poor local mountain communities with improved energy services . . .

Kathmandu University (KU) started High Altitude Solar Water Heater Research and Development projects with students to address the urgent need for improved hygienic conditions of the remote and impoverished mountain communities through . . .

# High Altitude Solar Water Heater Bathing Center

First High altitude Solar Water Heater Prototype since 2003 under test

Hot Water



# . . through a High Altitude Solar Water Heater (HASWH)

. . . till an appropriate version has emerged . . .

utilising the Sun for Hot Water . .

. . . followed by improved versions and tests initially at the KU solar lab . . .

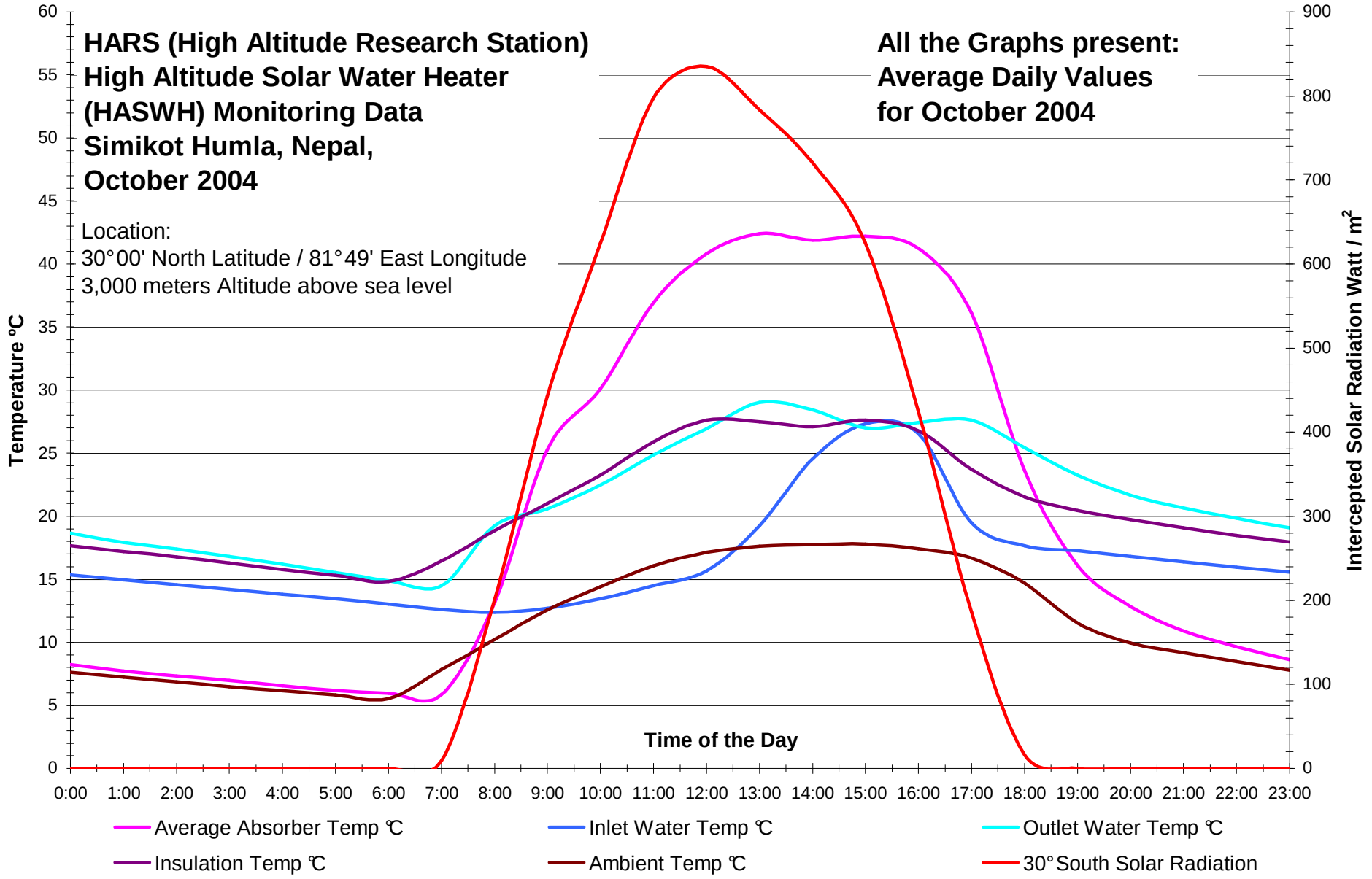
First HASWH in Simikot, Humla, at 3000 m altitude at 30° northern latitude under test and monitoring since 2003

The storage tank is integrated to limit pipe heat losses. The insulated, reflecting aluminum lid acts as a night time cover and day time reflector

# First HASWH under test and monitoring since 2003

As additional freezing protection to the insulated reflector lid, manual water drainage is possible.

The first HASWH in Simikot has copper fin absorbers with selective coating. 4 thermocouples at different heights record the absorber temperature profile. The normal window glass cover limits the incoming solar radiation to 80%-82%

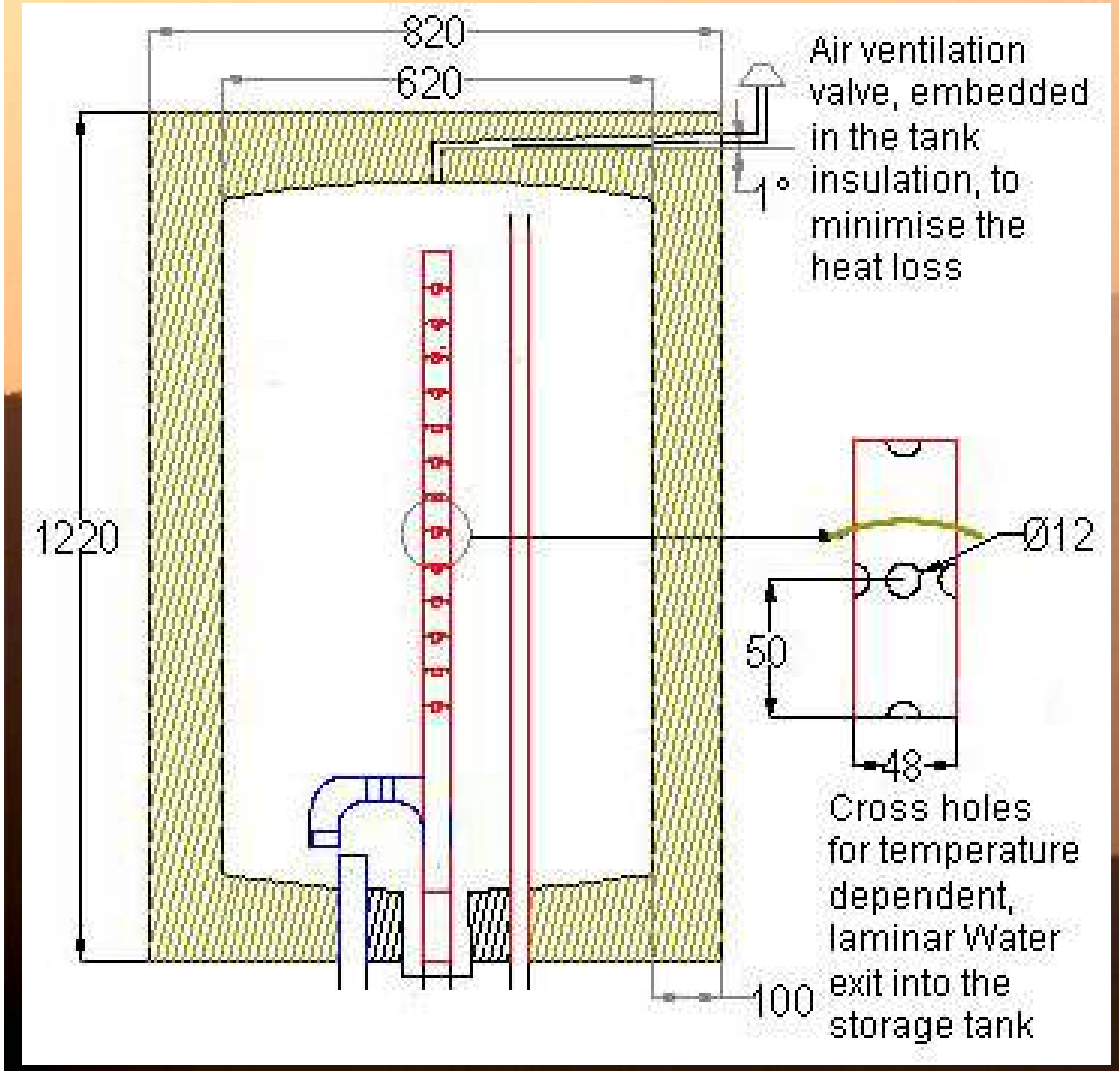


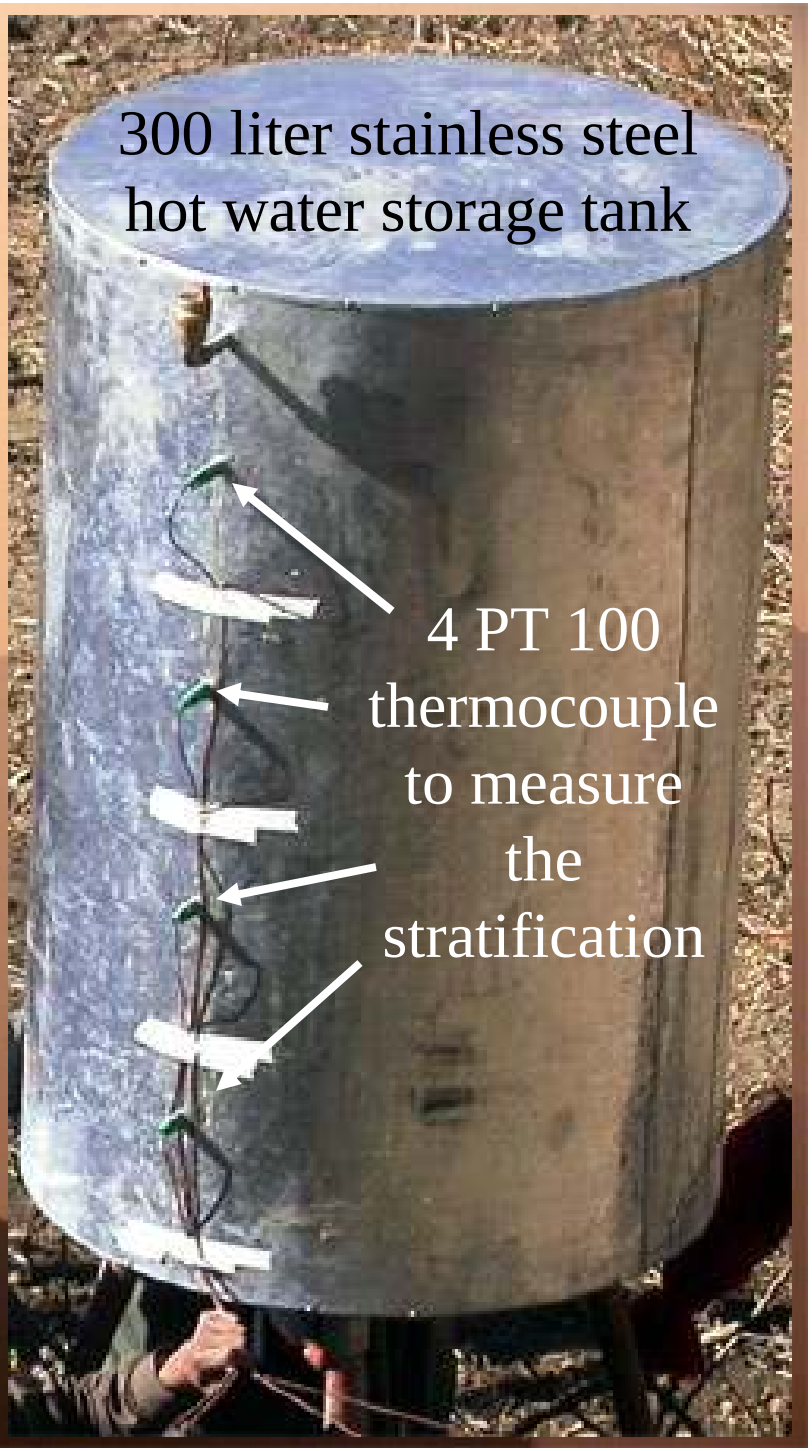

**First HASWH Average Daily Performance at 3000 m Altitude in Humla, Nepal, October 2004**

Based on the 2003 - 2005 monitoring data, the following major shortcoming of the 1st HASWH have been identified for improvement in the 2nd HASWH generation:

- Minimising the heat loss in the hot water tank through better insulation
- Bigger volume, vertical storage tank for better stratification
- Improved cover lid insulation and shape to cover the absorber
- Improved seasonal adjustment of the reflector lid
- Increased absorber surface to 1.5m$^2$ and combine 4 absorber to one unit
- Use of tempered absorber glass cover

# 2nd Generation HASWH Prototype Hot Water Storage Tank Manufacturing

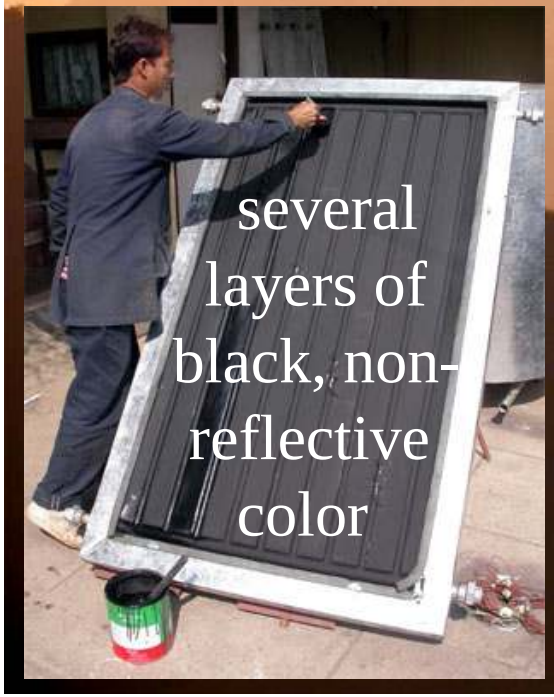


# 2nd Generation HASWH Prototype Absorber Manufacturing

two component polyurethane foam for the absorber insulation

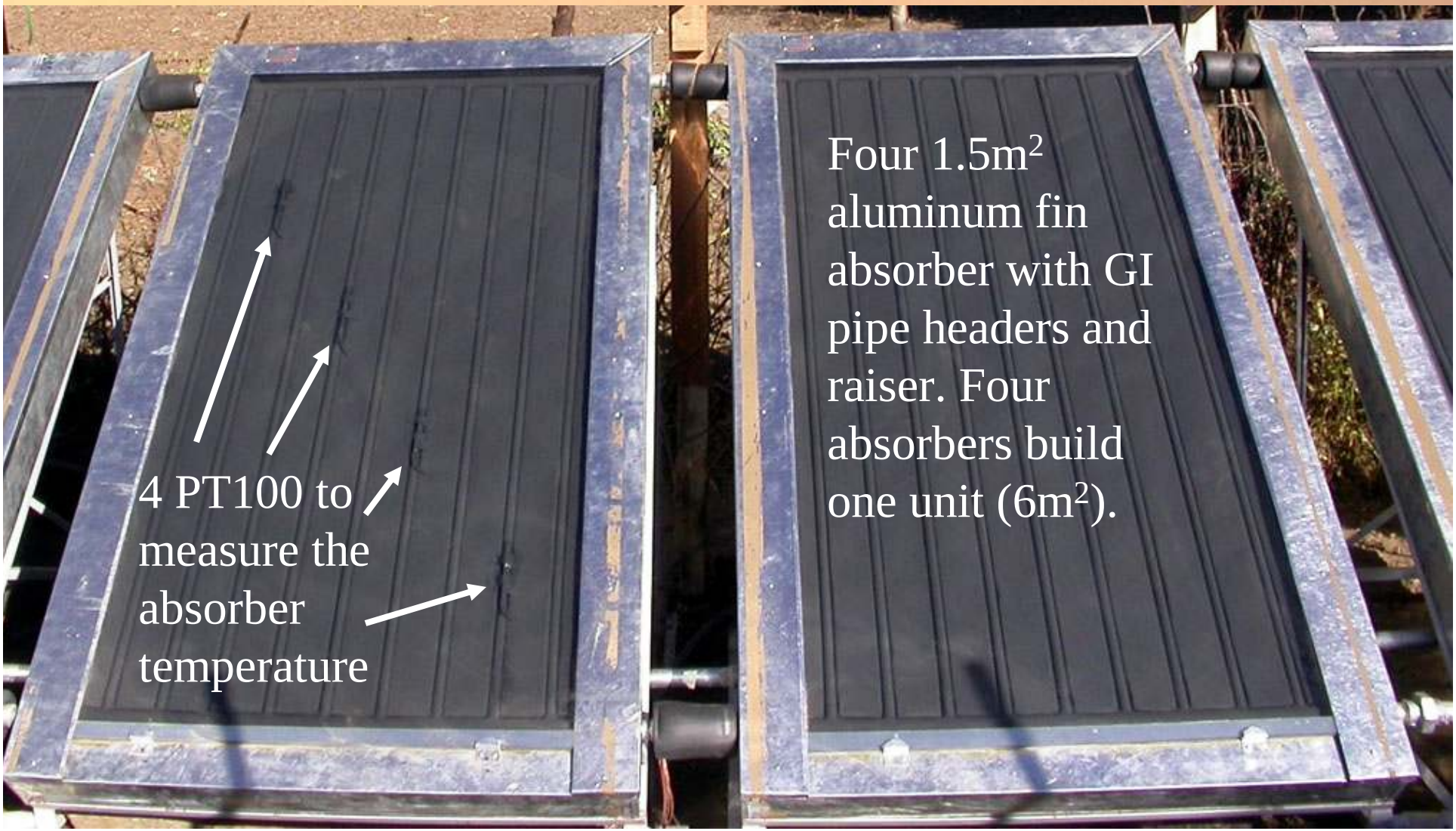
good thermal conduct through 220° overlapping of the absorber fins on the GI pipe raisers



several layers of black, non-reflective color

improved manufacturing quality

# 2nd Generation HASWH Prototype Testing & Monitoring in Simikot Humla



# 2nd Generation HASWH Prototype Testing & Monitoring in Simikot Humla

a DT605 dataTaker records defined HASWH data every minute

Since November 2005 the first unit of the 2nd generation HASWH is undergoing detail testing for its performance and impact on the community

# 2nd Generation HASWH Prototype Testing & Monitoring in Simikot Humla

The reflector lids also act as insulation of the thermosiphon system (beside the absorber drainage valves) during the freezing cold 7 winter months with temperatures down to – 20° C.

on the POA and the horizontal surface the received solar irradiation is measured

In the morning opening the reflector lids

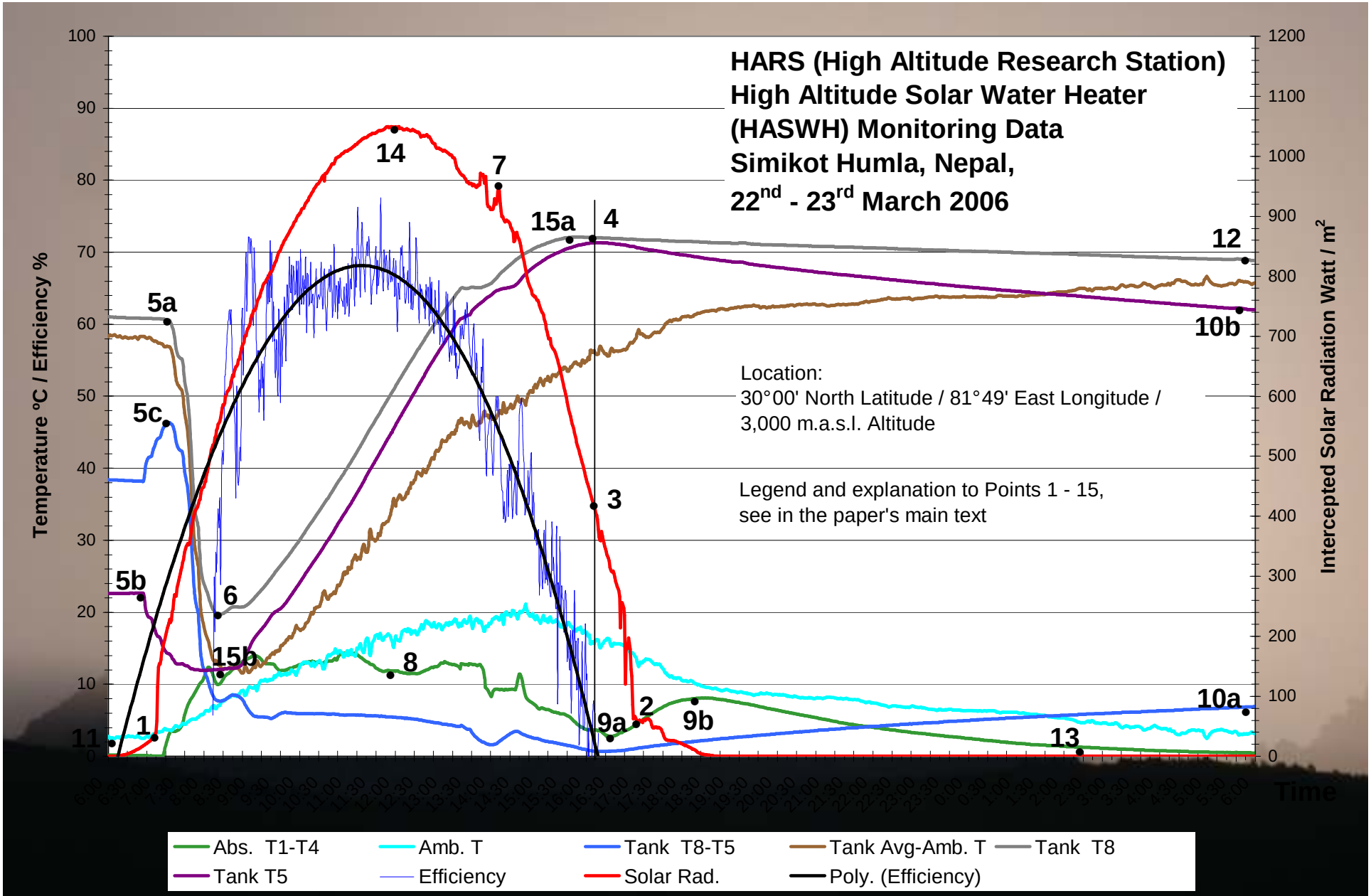
# New Features of the 2nd Generation HASWH Prototype

overlapping, styrofoam insulated reflector lid minimises night heat losses

40° south inclined to maiximise the winter sun's energy

the valve at the bottom allows the water in the absorber circuit to be emptied

for freezing protection, drain valve and hot water storage tank inlet closing valve are installed at the top of the absorber unit




12 defined parameters are monitored and recorded, allowing detailed performance graphs of the HASWH prototype, as e.g. above graph from the 22nd – 23rd March 2006.

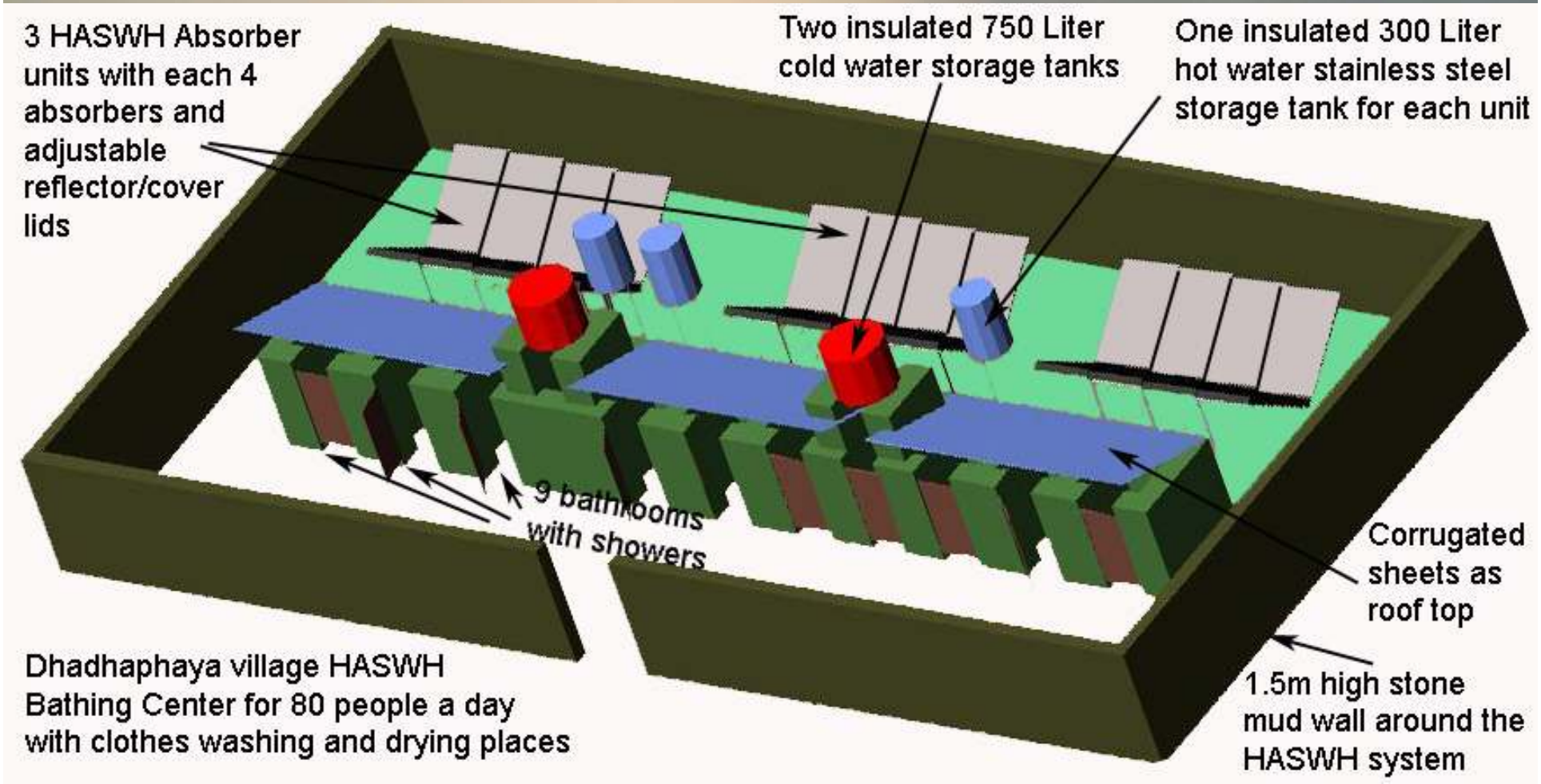
# Major Achievements of the 2nd Generation HASWH

- Overall efficiency (hot water energy gained/total received solar energy on the absorber) is ~45% in good sunny conditions (1st generation 22%-25%).
- Successful hot water storage tank insulation. Average heat loss 0.3°C - 0.4°C per hour at an average tank inside – ambient temperature ΔT of 60°C - 70°C.
- Good stratification in the vertical stainless steel tank, with > 40°C top-bottom temperature differences at 70°C hot water temperature.
- Improved insulation performance of the glossy insulation/reflector lid cover.
- Easy, seasonal adjustable reflector lid. One person can open/close/adjust it.
- The single absorber size of 1.5m$^2$ turned out to be the maximum size in regard to transportability in the mountain region by air planes and porters.
- The concept of 4 absorbers joint as one unit (6m$^2$) provides an appropriate flexibility to match the HASWH to the energy service a community identified.

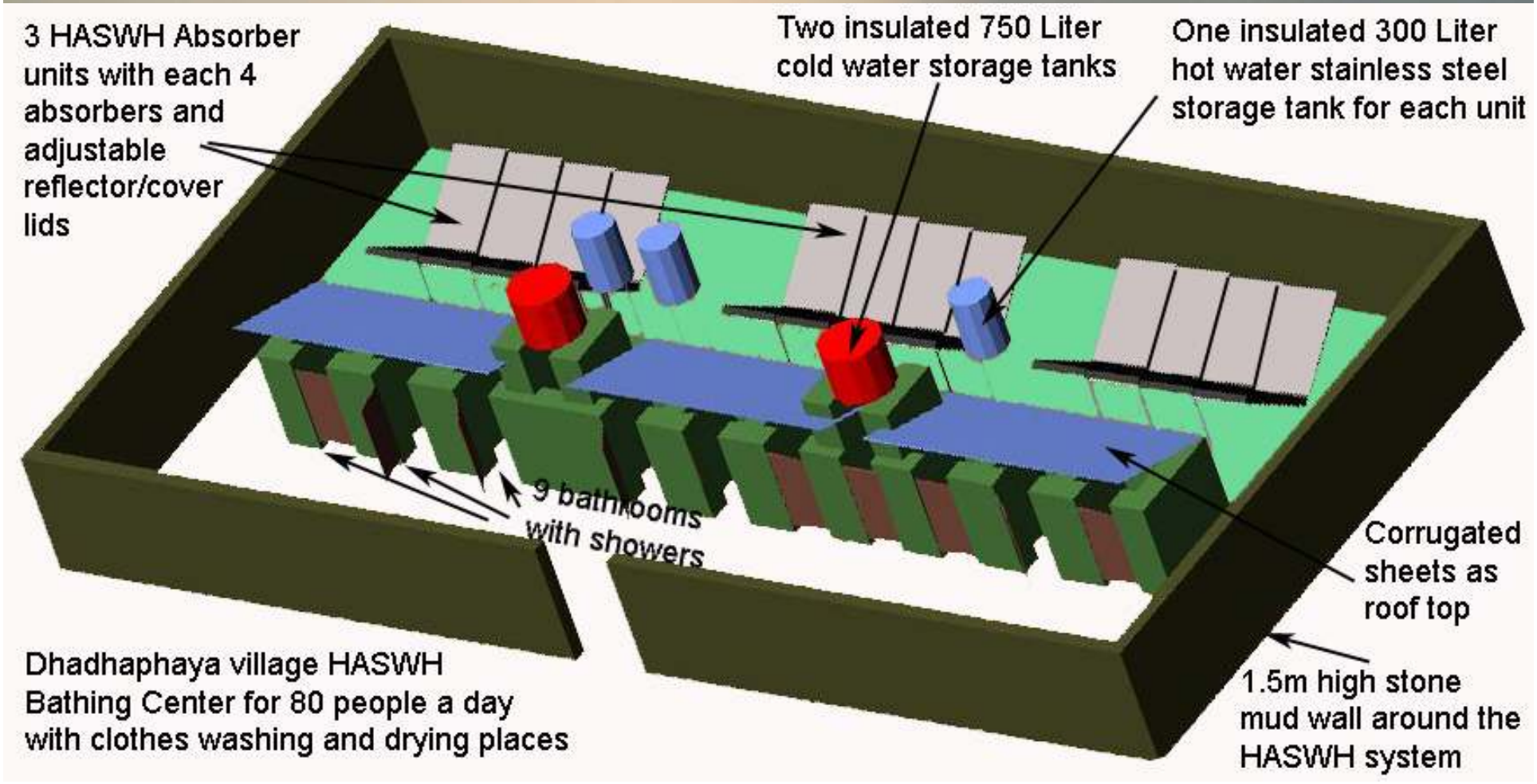
# What's the HASWH's intended Application ?

# . . . in the form of a Bathing Center . . .

enabling the 1,100 people from the Himalayan village Dhadhapahya in Humla to take a hot shower each once every two weeks . . .
and thus addressing the pressing need for improved hygienic conditions



The capacity of the HASWH bathing center is laid out for up to 80 people a day, each person using ~10 liters of 50°C hot water, which can be mixed with cold water at their convenience. An average daily 5.2 hours of full sunshine, or 5.2 PSH (Peak Sun Hours) with ~1,000W/m$^2$ solar radiation are needed to generate the daily hot water energy.



# The Dhadhaphaya village community participates in . . .

- 50% of the land cost purchase for the bathing center, which is registered in the name of the bathing center committee.
- providing all local available materials such as stones, mud, sand and wooden beams
- voluntary work in the building construction
- monthly user fee of 10 NRp (0.2 $AUS) per family

Experience and results show that an implemented rural community project, integrated in a Holistic Community Development (HCD) project, brings forth synergetic long-term benefits which can not be achieved otherwise.

Thus also the HASWH community bathing center is embedded in a community based, long-term HCD project, including . . .

rural village solar PV electrification

non-formal education

smokeless metal stove and heater

and . . .

pit latrine

and greenhouse

drinking water

# Lessons Learned

- **Understanding the local community's own identified needs and define each stakeholders responsibility in the project is crucial.**
- **Technology has to be contextualised according to the local resources and conditions. That demands ongoing development.**
- **The monitoring and testing of the HASWHs has paid off.**
- **A HCD project brings forth synergetic benefits otherwise not possible. It addresses and respects the community's interrelated needs, and thus increases appropriateness and sustainability.**
- **Local participation in all project steps increases their ownership of the project and long-term follow-up, data monitoring and environmental impact provide feedback for future projects.**
- **Sustainability is more important than highest efficiency.**
- **Local manufacturing brings awareness, skill and economic growth to the local community, increasing their confidence.**
- **Periodical users impact surveys for ongoing R & D.**

It would not be possible to run these research projects and HCD project in Humla among the poorest and remotest mountain communities without the sponsorship and partnership of donors.

Thus I would like to thank for the 2005 – 2006 project:

- *The ISIS Foundation* who sponsors the ongoing HCD project in Humla Nepal
- LiN (Light in Nepal) who sponsored the HASWH project
- LUTW (Light Up The World) for providing us with good quality and subsidised WLED diodes

with whom we feel called to live, work and share our lives . . .


THANK YOU
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