



SOLAR HEATING SYSTEM

A BOON FOR POOR RURAL HOUSES IN THE HIMALAYAN REGION

The Himalayan Research Group (HRG) took up the pilot project of developing solar passive retrofitting for space heating and solar water heaters for houses in villages of Mashobra Block of District Shimla.

SARITA BRARA

Moolkoti is a Gram Panchayat village 22 km from Shimla in Mashobra Block in Himachal Pradesh. With low temperatures prevailing almost throughout the year, one needs a constant supply of warm water for daily chores such as washing clothes and utensils, bathing, etc. It also becomes essential to keep the house warm in such cold weather. Due to limited resources and income of poor rural households, most families rely on fuel wood collected by women from nearby forests. This fuel wood is burnt in the traditional open cooking stove called 'Chulah', which is used for heating water, cooking food, as well as keeping the house warm. In fact in many households in the hilly areas, family members sit in the kitchen for most of the day because it is cold elsewhere in the house. Some even sleep in the kitchen when it becomes unbearably cold. What people are unaware of is the fact that the smoke emanating from these open stoves is harmful for their health. It is an additional burden for women who spend several hours a day collecting fuel wood. Most importantly the high dependence on fuel wood poses a potential threat to the ecology of the region.



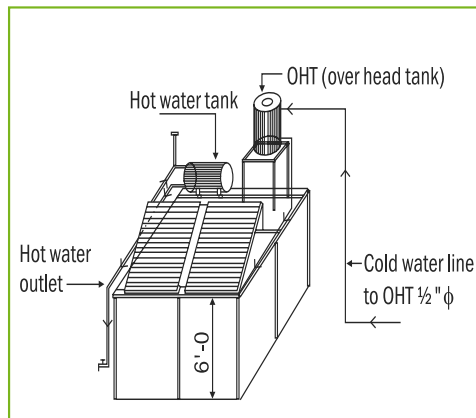
🔥 Woman filling hot water from community solar water heater

Leelawati, a homemaker in Moolkoti village, was not an exception. She says that she had to walk 3 to 4 km up and down the hill every day to collect fuel wood. But for the last four years, her drudgery has been considerably reduced by almost three-fourth, thanks to the Himalayan Research Group (HRG) that has installed innovative water heating systems meant for rural households. Her son says that his frequency of taking a bath has increased from once a week to every day now.

HRG, a core group under the Department of Science and Technology (DST), took up the pilot project with financial support from it to develop solar passive retrofitting for space heating and solar water heaters for household clusters in villages of Mashobra Block of District Shimla to reduce dependence on fuel wood.

So it is not just individual households such as Leelawati's which have benefitted but these solar water heaters have also been installed for use by the community as a whole. Three solar water heaters of 200 litre capacity each were installed for a cluster of households catering to the requirement of around 9-10 households in each of the villages to provide for the requirement of hot water for washing, bathing, and utensil cleaning.

This concept was mooted to popularize these modern technologies among rural masses keeping in view their individualistic approach and financial constraints despite heavy government subsidy.



Design of solar water heater



Community solar water heater

THIS CONCEPT WAS MOOTED TO POPULARIZE THESE MODERN TECHNOLOGIES AMONG RURAL MASSES WHICH THEY MAY NOT SEE AND USE KEEPING IN VIEW THEIR INDIVIDUALISTIC APPROACH AND FINANCIAL CONSTRAINTS DESPITE HEAVY GOVERNMENT SUBSIDY.

In Shilru, the villagers say that they have been using the community water heater since it was installed without any problem. Hot water is available any time of the day from morning till 10.30 at night, say homemakers with a smile on their faces.

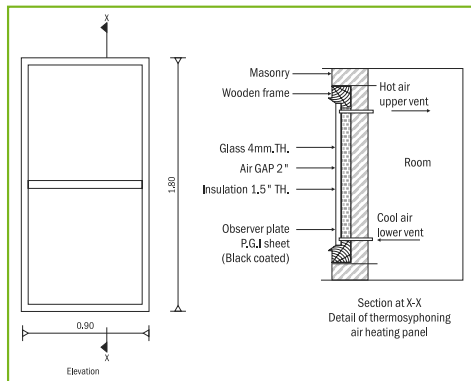
“So much time was spent earlier to get the fuel wood and we used to be so tired. Now we can utilize that time in a better way,” says one of the ward members of the village Panchayat.

The community water heater has been installed at a location in the village which is approachable by a number of households. What's more, a street light that runs on solar power, too, has been installed, so that when it is dark in the early morning and late in the evening, women and the children can fill their

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buckets with warm water without any fear. Under the projects, community water heaters were also installed in Kandi and Moolkoti villages. Care was taken to ensure that the poorest of the lot were able to benefit the most through this pilot project. The hamlets in hilly areas sometimes have just a few houses. Devaku, a widow, lives alone in a house on a hill with no other house in the nearby vicinity. With a tiny land holding it is not enough to even get two square meals a day.

To warm houses the HRG designed solar passive retrofitting locally. Local carpenters were trained and locally available wood, glass, and steel sheets were used. According to Director HRG Dr Lal Singh, this is a modification blended with modern material to tap maximum solar energy for warmth of the houses backed with scientific principles. He says that solar passive retrofitting, namely, Thermosyphoning Air Heating Panel (TAP), Trombe Wall (TW), and Sun Spaces (SS) were designed for existing houses keeping in view their orientation to the sun. Solar retrofitting was installed on the south facing wall of the houses.

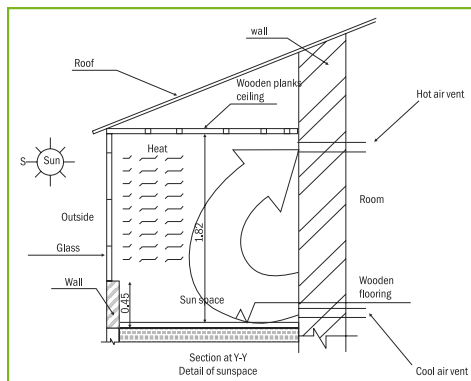


Design of Thermosyphoning Air Heating Panel (TAP)



TAP in a rural house

Sun Spaces were created through glazing of open spaces on south facing sides. Glazing of small portion of this open space on south facing side with 5 mm glass fixed in wooden grooves serves as the air heating unit. Inmates use this space for sittings during daytime, or air heated in this space was also introduced into the adjoining room through doors or vents as described in the case of TAP. Leakage of hot air through glass sides, roof, and between partitions was prevented with silicon and fevicol sealants. To exhaust the hot air during summer, ventilators or windows can be opened.



Design of Sun Space



Sun Space in rural house

Kundan Lal, an ex-serviceman, proudly showed the Air Heating Panel installed in his house. The house remains warm for most of the day and late at night, except on the days when it is raining or snowing, he says. His daughter-in-law says that she is blessed to be married to his son, because unlike other women she does not have to go up and down the hills to collect fire wood and the house is warm most of the time.

The HRG also plans to install eight solar street lights in two of the villages on village paths to provide illumination late in the evening. This not only gives them a sense of security while walking at night (from the wild animals) but also provides security for transportation of agriculture produce.

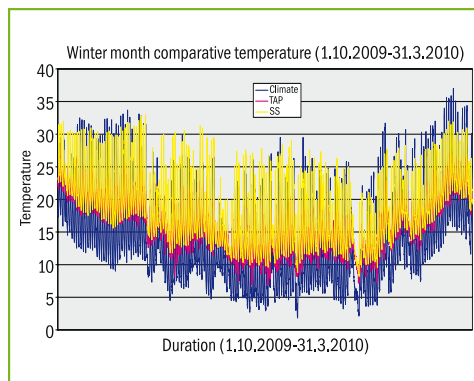
A survey was done by the HRG before the installation of solar devices in rural household in Mashobra Block of District Shimla to assess the energy needs in village Moolkoti, Mashobra, and Shimla.

Table 1. Energy needs in village Moolkoti, Mashobra, and Shimla

Sl. No.	Detail	Summer	Winter	Cost
1.	Quantity (kg) of fuel wood required/day/household	16.45	39.45	Free of cost
2.	Time (in hrs)/household /visit for collection of fuel wood (240 visits/annum)	1.57	1.59	Opportunity cost is Rs 15.0/hr
3.	Distance (km) covered/visit for collection of fuel wood	1.62	1.57	On foot
4.	LPG cylinder consumed/month	1.09	1.59	Rs 370/- cylinder
5.	Electricity (kwh/month)	23	68	Rs 2.83/kwh (subsidized)

After the survey, 45 Thermosyphoning Air Heating Panels were installed, 34 in Moolkoti village and 11 in Shilru, six Sun Spaces in Moolkoti village and one Trombe Wall type.

To get an idea of thermal efficiency and comfort evaluation of retrofitting, a data logger was installed in the living room of one of the houses fitted with Thermosyphoning Air Heating Panel and another one was installed to monitor the outside temperature for comparison.



Reading recorded in a data logger



A data logger

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IT IS ESTIMATED THAT INSTALLATION OF SOLAR RETROFITTING FOR SPACE HEATING AND SOLAR WATER HEATERS WILL REDUCE CONSUMPTION OF FUEL WOOD TO 40 PER CENT.

Temperature profile for thermal performance of two solar passive retrofitting units was recorded for more than one year. For the study, winter season of six months was considered from October to March. The data showed that the temperature tends to fall below 10 °C in the morning hours from mid October and till mid February. TAP and SS provided 8 °C–10 °C increase in temperature of the living space in comparison to the outside temperature. TAP and SS retrofitting were day features to provide thermal comfort during day time and save fuel wood and prevent compulsory sitting in the kitchen.

The HRG also did an analysis of consumption of fuel wood before and after the installation of these devices in the selected villages.

TABLE 2: Consumption of fuel wood and carbon savings

Sl. No	Specifications	Value
1.	Average monthly (winter) per capita consumption of fuelwood in Mashobra Block of Shimla (kg)	236.7
2.	Winter season (six months) per capita consumption (kg)	1420.2
3.	No. of households with Solar Passive Retrofitting and solar water heater	82
4.	Average household population	6
5.	Total average population of 82 households	492
6.	Total consumption of fuelwood of 82 households in winters (tonne)	698.74
7.	Carbon conversion @ 1.46/kg CO ₂	1020.16
8.	40 per cent efficiency during six month winter season through Solar Passive Retrofitting = savings (kg)	408063.22
9.	Saving in Carbon Tonnes during six month winter season	408.06
10.	Average household carbon saving in tonnes (six month winter)	4.97



» Devaku's house with solar heating system (Trombe Wall type)



Leelawati's house with solar water heating system

It is estimated that installation of solar retrofitting for space heating and solar water heaters will reduce consumption of fuel wood to 40 per cent and, on an average, there will be a reduction of 4.14 tonnes carbon per household in temperate rural households during the six winter months. This will provide respite to women from collection of fuel wood and reduce drudgery and help in saving natural resources.

The use of clean solar aided devices in space and water heating resulted in reduction of indoor pollution and women's drudgery in collection of fuel wood. The projection related to reduction in carbon emissions and saving of carbon per household is very encouraging, says Dr Lal. He says that the concept of such interventions needs to be further popularized across large sections of households to meet the increasing energy requirement in rural areas and reduce dependence on fuel wood.

The project initiated by the HRG has run successfully for over four years and has stood the test of time. There has not been any major problem so far except a bit of wear and tear that the locals have managed to plug by themselves.

There are a total of 6.66 million rural households in the Himalayan region in India. If these heating systems, with a cost-effective modification to suit the local conditions and availability of local resources, are installed, this will no doubt contribute to conservation of the natural resources, which is a priority for states such as Himachal Pradesh, and the Himalayan Region in particular. This will considerably bring down carbon emissions and reduce the drudgery of women in the Himalayan Region.

This is an effective technology and its implementation will mitigate household emissions. Exhaustive exercises on development, fabrication, and installation of solar retrofitting for existing houses in the Himalayan Region in India is expected to reduce dependence on fuel wood and help in reduction of women's drudgery. **AU**

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THE USE OF CLEAN SOLAR AIDED DEVICES IN SPACE AND WATER HEATING HAS RESULTED IN REDUCTION OF INDOOR POLLUTION AND WOMEN'S DRUDGERY IN COLLECTION OF FUEL WOOD.