MARKET ASSESSMENT OF SOLAR WATER HEATING SYSTEMS IN THE HIMALAYAN REGION

Final Report

Submitted to

Project Management Unit
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Executive Summary

Market Assessment of Solar Water Heating Systems in Himalayan Regions

1 Background and Objective

At present, use of SWH is rather limited and scattered in Indian Himalayas. Most of the existing systems are in commercial and institutional buildings (hotels, resorts, hospitals, defense establishments, etc); in general the use of solar water heaters in the domestic sector is very scarce. Northern Himalayan region constituting the states of J&K, Uttarakhand & Himachal Pradesh has generally better solar radiation availability and has more SWH systems compared to the eastern and north eastern Himalayan region.

The objective of the study is to carry out sector and segment-wise market assessment studies and surveys; to gain an insight into the current market for solar water heaters in the Himalayan region, to project realizable market potential in each sector and segment till the year 2022 and to prepare an action plan to increase penetration of Solar Water Heating systems in the Himalayan Region after identifying the barriers.

Following sectors and demand segments were identified for the study:

- Residential (Urban and Rural)
- Commercial (Hotels/Guest Houses/Restaurants)
- Institutional (Hostels, Hospitals, Places of Worship)
- Industry

Following states were covered in the study:

- Jammu and Kashmir
- Himachal Pradesh
- Uttarakhand
- Jharkhand
- Sikkim
- Hilly districts of West Bengal
- Hilly districts of Assam

- Tripura
- Meghalya
- Mizoram
- Manipur
- Nagaland
- Arunachal Pradesh

2 Work Organization

For effective conduct of the fieldwork, primary survey and stakeholder interview work was divided among regional partners of the consultant consortium. The work was carried out as follows.

Organisation	**Office Location**	**Districts covered**
GKS	New Delhi	Jammu, Srinagar, Kangra, Kullu, Dehradun & Nainital
NBIRT	Guwahati, Kolkata and Agartala	Darjeeling, East Sikkim, Tawang, Papumpare, East Khasi Hills, Tinsukia, Dibrugarh & Ranchi

3 Methodology

In addition to secondary research, we utilized the following instruments for the study:

- Workshops in Chandigarh and Kolkata including the inputs and views of SNAs, manufacturers, integrators, potential and current SWH users from different categories.
- Interaction with stakeholders in 15 districts- SWH manufacturers, dealers, integrators, SNA-officials, bank managers, dealers of competing water-heating devices.
- Primary survey of residential users and non-users of SWH and non-residential users and non-users of SWH.
- Case-studies of SWH-users-households, hotels, hospitals, hostels, institutions, swimming pool etc

The analysis integrates findings from all of the above.

4 Representative Clusters for the Study

We have based our market-assessment on extensive secondary research for the regions and primary research focused on the following 15 representative clusters. The districts were selected in consultation with MNRE and cover all the three regions based on altitude variation.

Mountainous Regions

- East Sikkim
- Srinagar

Hilly Regions

- Kullu
- Kangra
- Dehradun
- Nainital
- Tawang
- Papumpare
- Shillong
- Darjeeling

Tarai Regions

- Jammu
- Udham Singh Nagar
- Tinsukhia
- Dibrugarh

Sub-Himalayan Regions

- Ranchi

5 Present status of SWH in Himalayan Region

The total installed capacity of SWHs in the Himalayan region (including Jharkhand) is estimated at around 33000 sq. m, which is less than 1% of the total installed SWH capacity in the country. The state-wise break-up is provided in table 17.1.

5.1 State-wise:

The situation for SWH varies across the states.

- Around 90% of the installations are concentrated in three states – Himachal Pradesh, Uttarakhand and Jharkhand.
- Himachal Pradesh as a market is better developed primarily on account of well developed sales and service network of a few manufacturers and success achieved in the hotel sector. Manali, Dharmshala and Shimla account for most of the installations.
- In Uttarakhand and Jharkhand the market is showing signs of development but still needs to consolidate to become a sustainable business. The two capital cities of Dehradun and Ranchi have the maximum number of installations.
- In Jammu as well as in Kashmir valley, the situation is not-encouraging with very few working installations outside of the defence establishments. Ladakh has longer history and experience with a variety of SWH systems due to the sustained efforts of the MNRE, Ladakh renewable energy development agency and NGO's like LEDeG. Ladakh Renewable Energy Developmet Agency (LREDA) under Ladakh Autonomous Hill Development Council has set a target of installing SWH 15000 m^2 by the year 2012, i.e. 7500 m^2 collector area in 2011 and the rest 7500 m^2 in 2012.Tenders for procuring the 7500 m^2 for 2011 has already been floated and work is expected to start by the end 2010. Subsidy of 50% of the cost of the system for residential, 90% for government buildings, educational institutions, hospitals etc and 40% for the hotels, lodges and other commercial establishments is being provided by LREDA. Refer Annexure-III
- The Solar Water Heating programme in the Eastern and North Eastern India is yet to pick up. This region receives less solar radiation and has lesser number of sunny days. In Darjeeling and Sikkim the market is at a very nascent stage and only few installations are present. In the other North-Eastern states like Arunachal Pradesh, Assam, Manipur, Mizoram, Nagaland, Meghalaya and Tripura the SWH installations are very few. Most of the existing installations are in the government organizations or installed under government programmes.

Table 11: Estimated installed capacity of SWHs* in the Himalayan States (in m^2)

States	2010
Himachal Pradesh	14,460
Jharkhand	8,900
Uttarakhand	5,480
J&K	1,680
Mizoram	650
Sikkim	400
Nagaland	340
Meghalaya	330
Arunachal Pradesh	326
Manipur	250
Tripura	214
West Bengal (Hilly Region)	160
Assam (Hilly Region)	66
Grand Total	**33256**

* Does not include army installations

5.2 Sector-wise

The adoption of solar water heating has not been uniform across all market segments.
The commercial and institutional sector comprising of hotels and hostels have been more forthcoming in adopting this technology. There has been some success achieved in hotels in Himachal Pradesh (Manali, Shimla and Dharmshala), but in other large tourist destinations (Jammu, Leh, Srinagar, Mussoorie, Nainital, Haridwar, Rishikesh, Darjeeling, Shillong, Tawang, Gangtok etc) the penetration of SWH remains very low.

The spread in the residential sector has been very limited. This is on account of the low level of awareness coupled with the low/ subsidized electricity tariffs being given by most of the state electricity boards to domestic consumers which acts as a disincentive. Though the requirement of hot water is a necessity in most of the rural areas particularly those located in the higher altitudes, in the absence of an appropriate product, the SWH use is almost non-existent.

In the industrial segment the market is yet to develop. A few installations are reported in industries in Haridwar but most of them are used to provide hot water for industrial canteens. The integration of SWH to provide hot water for process heat is not yet reported in any industrial clusters falling under the scope of this project. However this market (Jammu,

Haridwar, Rudrapur, Dibrugarh, Tinsukia, Parwanoo) seems to be a major potential area for the SWH technology.

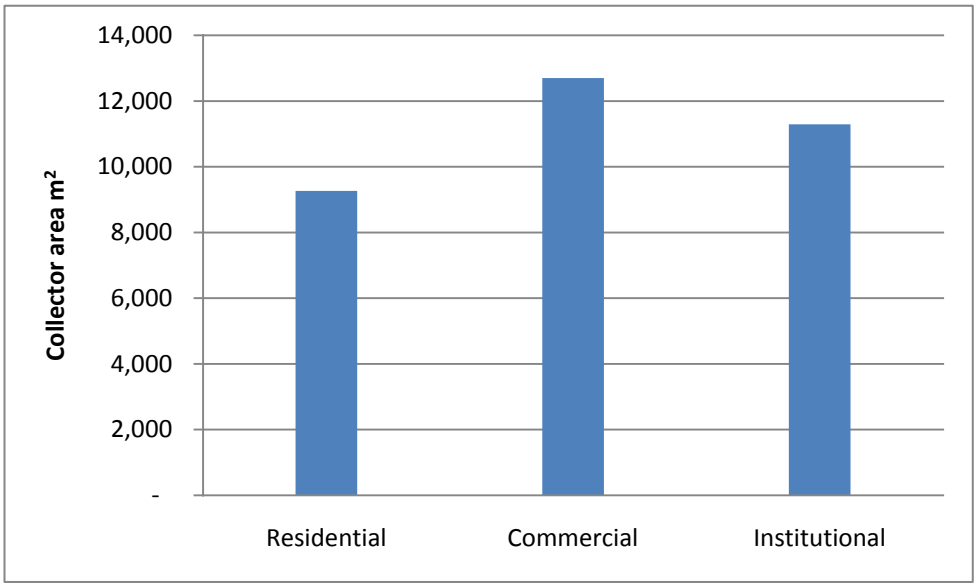


Figure1: Category Wise Break-up of present installation

6 Main Barriers

The main barriers in use of SWH systems in Himalayan region are:

6.1 Technical

Lack of Appropriate Product to address issues such as:

- Low solar insolation in several parts (e.g. Kashmir valley, Sikkim, North-Eastern states)
- Small capacity requirements
- Low purchasing power of the people
- Technical problems associated with freezing in colder regions
- Difficulty in installing conventional SWH systems on sloping roofs made of metal sheets, stone tiles, etc.
- Lack of piped water supply, particularly in rural areas and quality of water, particularly presence of silt and hardness.

6.2 Financial

- High initial capital cost of the system, primarily due to high transportation, installation and marketing costs. Typically, capital cost of SWH system increases 2 fold than of the same system in plains due to the above factors.
- Low electricity tariff resulting in longer pay-back for SWH systems. Refer table.2
- Delays in disbursement of the subsidy and problems in accessing subsidy for the users living in remote areas.

6.3 SWH supply chain

- Lack of local manufacturing, with only one manufacturer located in the Himalayan region
- Weak SWH supply chain resulting in difficulty in procuring the systems as well as in poor after-sales service.
- Difficulty in transportation of the systems to remote areas

6.4 Awareness related barriers

- Poor awareness across states and segments, except perhaps hotel segment.
- Limited number of successfully operating SWH systems, thus the positive demonstration effect is low

7 Observations on the current SWH market

7.1 Solar Resource Availability

The solar resources vary across the Indian Himalayan Regions because of large variations in topography, altitude, climate etc. Leh-Ladakh regions are cold desert with radiation level in the range of 5.8-6.2 kWh/m^2/day and around 300 days of clear sunshine in a year providing ideal conditions for solar utilization. The Srinagar Valley receives a solar radiation of approximately 4.2-4.3 kWh/m^2/day with high number of overcast days. However the Jammu region experiences a tropical climate and has an average radiation of 5.3-5.4 kWh/m^2/day. The solar radiation level in Himachal Pradesh and Uttarakhand varies across the state but as

most these potential areas are tourist destinations having summer periods as a peak period and solar resource availability matches with the peak demand period.

The Himalayan belt of North Eastern and Eastern India gets more number of cloudy days. At several places the Solar Hot Water systems work for hardly 150 days in a year. The systems may work for 180 – 200 days provided larger collector areas are used for smaller quantity of hot water. Typically, a 200 LPD Solar Hot Water System in North Eastern Region and Sikkim provides same quantum of hot water like a 100 LPD hot water system installed in Ranchi. This means a 4 Sq. Mt. Collector area in North East is equivalent to 2 Sq. Mt. Collector area in plain. The Cost / Lt. of solar hot water is almost double in the North East. As such the Solar Hot Water system which is financially viable device in Ranchi is not viable in North East. Moreover, cheap fire wood is available in the North Eastern Hills making Solar Water Heating System less popular.

7.2 Electricity tarriff

Several of the states lying in Indian Himalayan regions have low domestic electricity tarrifs which hinders the growth of SWH industry. For details about the electricity tariffs in different states please refer to table 2.

7.3 Local industry and supply-chain

Another observation across the states was that the development of the industry in any region is contingent on the presence of strong local supply chain. In many regions having immense potential, due to the absence of technically qualified local dealers, the SWHS industry was not able to make a visible impact.

The spread of systems wherever it has occurred in the Hotel segment has been by positive user feedback and endorsement which has encouraged new users to try out the system. The primary motivation seems to be rising commercial electricity tariffs coupled with rising fossil fuel costs. No brand building or sustained publicity campaigns were carried out by any individual manufacturers. Some publicity campaigns have been carried out by SNA to publicize the subsidy schemes and this has helped create some level of awareness especially among domestic users.

The manufacturing base for SWHS is largely absent except for a lone manufacturer i.e. SOLCHROME in Parwanoo, Himachal Pradesh. At present there is no manufacturer and very few dealers of Solar Water Heating system in the North Eastern Region. The after sale support of the dealers operating in North eastern states is also very poor.

7.4 Mandatory regulations & state policies

Mandatory regulations with common features have been notified in several states for SWH (refer table 2) but across all states there don't seem to have had any appreciable impact on the development of the industry. This is primarily on account of the lack of any sustained administrative effort to implement these notifications as well as lack of initial ground work to create a positive and healthy image of SWH, which needs to be done before implementing the mandatory provisions

7.5 Subsidy Administration

SNA's have had a major role in the administration of the subsidy schemes of the MNRE. In this study we found that the expected positive impacts of previous subsidy regimes have been largely diluted because of the poor administration of the scheme. Delays in subsidy disbursement have bred a lot of resentment in the manufacturers and dealers as capital gets blocked for months and sometimes years. Another recurring issue for SNA is the lack of a proper evaluation and monitoring of the SWH systems availing the subsidy. This issue can be partially addressed by providing installation norms and standards along with third party monitoring and verification.

7.6 Technology

Flat plate technology seems to be the technology of choice for most of the large establishments especially in the hotel segment. ETC technology has been used in a lot of domestic installations as well as in some commercial establishments but on account intrinsic high maintenance requirement of this technology juxtaposed with poor service levels of dealers a substantial number of poorly designed and non functional systems proliferate. Also the lack of standards and quality certificates for the ETC tubes has created a bad image about the quality and the life of the tubes.

Technology solutions like low-cost storage cum collector type SWH for rural areas, hybrid Solar Water Heaters (solar + biomass), etc are required.

7.7 Credit availability

Availability of easy and collateral free low interest finance can be a major factor in the development of the technology in the region. Case study of SWH in hotels of Manali shows how low interest rates and easy access of finance to the hotel owners for SWH technology has resulted in the development of the SWH market. Banks here have provided easy collateral free financing using various RBI credit guarantee schemes which have funds earmarked for SSI sector. The main instrument used for providing these loans has been the RBI's CGTMSE (Credit Guarantee trust for Medium and small enterprises). Loans have also been speedily sectioned at the branch level as the manager has used his knowledge of local conditions and the credit history of the customers to provide hassle free loans.

Table 2: Summary table on main barriers

States	Solar Resource Availability	Awareness	Mandatory provisions	Subsidy Disbursement	Supply chain	Electricity Tarriff	Access to credit
J&K	Ladakh (Excellent) Jammu (Good) Kashmir (Low)	Poor	No	Poor	Poor	Low	Poor
Uttarakhand	Good	Fair	Yes	Fair	Fair	Domestic (Low) Commercial (Medium)	Poor
Himachal Pradesh	Good	Good	Yes	Fair	Good	Commercial (High) Residential (Low)	Fair (Good example at Manali and Dharmshala)
West Bengal (Hilly part)	Low	Poor	No	Poor	Poor	High	Poor
Sikkim	Low	Poor	No	Poor	Poor	Medium	Poor
Assam	Low	Poor	No	Poor	Poor	High	Poor
Arunachal Pradesh	Low	Poor	No	Poor	Poor	Domestic (High) Commercial (Medium)	Poor
Tripura	Low	Poor	No	Poor	Poor	Low	Poor
Nagaland	Low	Poor	No	Poor	Poor	Medium	Poor
Manipur	Low	Poor	No	Poor	Poor	Domestic (Medium) Commercial (Low)	Poor
Mizoram	Low	Poor	No	Poor	Poor	Medium	Poor
Meghalaya	Low	Poor	No	Poor	Poor	Low	Poor
Jharkhand	Good	Fair	Yes	Fair	Poor	Medium	Poor

8 Demand Projections

For SWH projections, three scenarios were considered. Details for each scenario are given in the sub-sections below:

Business As Usual (BAU) Scenario

BAU scenario assumes that the SWH market would follow the same trend as it had followed in the last 15 years. SWH market has shown a CAGR of 16.8% in the cumulative SWH installations during 1995-2008.

Based on the above facts, we have assumed that the **SWH cumulative installation would grow by 15% per annum under the BAU scenario** limited to 25% penetration in the non-residential segments.

Optimistic-I Scenario

Under this scenario, we have considered different parameters for the growth of SWH market in the city/state as given below:

- Economic Viability (Based on the solar radiation availability, climate, electricity tariff and hot water demand)
- Policy & Enforcement (State/city regulation and enforcement, now and next 5 years)
- Supply Chain (Availability of SWH suppliers, installers and maintenance provider, now and next 5 years)
- Access to Credit (Availability and availment culture of finance, now and next 5 years)

These factors were given a certain weightage and assigned a number in the scale of 1-4 (4 is most favourable) for each location and category to come up with a composite score (higher the score, better for SWH market).

These parameters were ranked for two cases: BAU scenario and Optimistic-I. Ranking for the BAU scenario is based on the present scenario while Optimistic-I assumes that certain parameter would get improved due to improvement in economic viability, Government interventions, increased awareness, improved supply chain for SWH, improved financial arrangement for SWH loans and finance. Based on the composite score for BAU &

Optimistic-I scenario, a new CAGR for the cumulative SWH installations is estimated as given in the formula below.

$$Optimistic - I\ CAGR\ = BAU\ CAGR\ \times \frac{Composite\ score\ for\ Optimistic - I\ scenario}{Composite\ score\ for\ BAU\ scenario}$$

Optimistic-II Scenario

This scenario is built from the demand side and takes in to account launch of low cost batch type SWH systems. Under this scenario, we have assumed that due to the launch of a new appropriate product that matches the needs and demands of the Himalayan population, SWH penetration would reach to certain level in each state and sector by 2022. The states like Uttarakhand & Himachal Pradesh have a good SWH market base and it is assumed that they may reach penetration levels of 5% in residential sector and 25% in non-residential sector. The other states except Tripura are assumed to reach penetration of 2.5% in residential sector and 25% in non-residential sector. Tripura being an exceptional case because of its warm weather conditions is assumed to have 1% penetration in residential and 25% in non-residential sectors. The projections of the representative districts in optimistic II scenario takes same penetration rate in residential sector as per their respective states and 35% penetration in non residential sector in all the states.

Based on the 2010 penetration and assigned 2022 penetration levels, penetration levels for in between years is estimated. Based on the projection of unit base (household, hotel and hospitals) and SWH penetration, forecasting of SWH installations has been done for each location and category.

Table 3: Cumulative installed collector area under three scenarios in m^2

Scenario	2010	2013	2017	2022
BaU	33,256	74,374	115,537	200,493
Optimistic-I	33,256	74,374	145,123	303,600
Optimistic-II	33,256	74,374	497,350	1,149,970

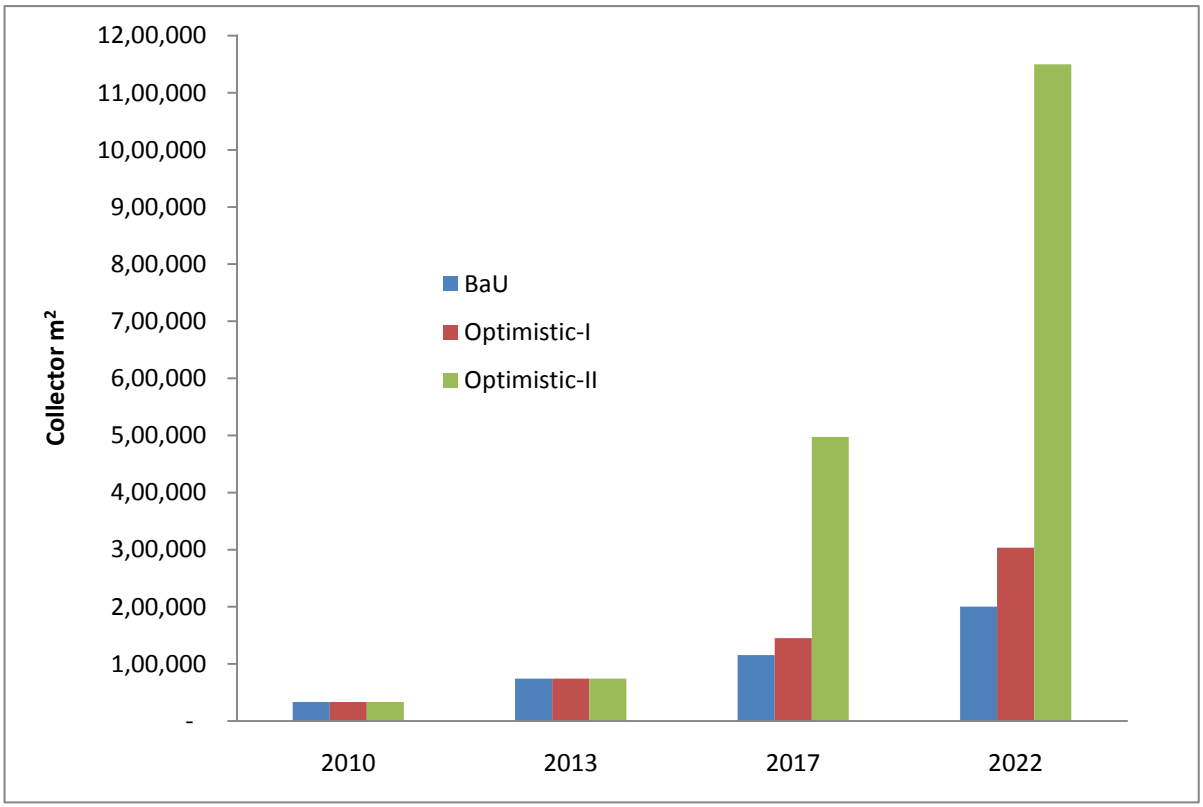


Figure 2: Total installed collector area under three scenarios in 2013,2017 & 2022

9 Action Plan

An action plan is proposed for increasing the deployment of SWH in the Himalayan region. An activity chart for the action plan is provided in the table 6. The main programmes and activities are stated below

9.1 Programme for Commercial (Hotels), Institutional (Hostels, Hospitals) and Industry:

A three year (2011-2014) focused programme aiming to increase the deployment of SWH in 15 identified high potential districts, as shown in table 17.4, in commercial, institutional and industrial sectors is proposed. It would develop a base for long-term development of SWH in the Himalayan states.

Table 4: High potential districts in Himalayan Region

High Potential District	State
Jammu	J&K
Srinagar	J&K
Leh	J&K
Dehradun	Uttarakhand
Nainital	Uttarakhand
Udham Singh Ngr	Uttarakhand
Haridwar	Uttarakhand
Kullu	Himachal Pradesh
Kangra	Himachal Pradesh
Shimla	Himachal Pradesh
Darjeelling	West Bengal
East Sikkim (Gangtok)	Sikkim
East Khasi Hills (Shillong)	Meghalaya
Tawang	Arunachal Pradesh
Ranchi	Jharkhand

Table 4 shows the hot water requirement in hotels (totaling to around 53 Lakh LPD) for some of the major tourist/religious clusters in Himalayan Region.

Table 5: Hot Water Requirement in Hotels& Guest houses in major tourist destinations

City	State	Hot Water Requirement (lakhs LPD)
Katra	J&K	10.8
Leh	J&K	5.2
Manali	Himachal Pradesh	9.6
Nainital	Uttarakhand	5.7
Dehradun-Mussoorie	Uttarakhand	11
Haridwar-Rishikesh	Uttarakhand	6
Darjeelling	West Bengal	2.6
Shillong	Meghalaya	2

Source: Based on Primary Survey and key stake holders interview

The programme would aim at increasing awareness, improving access to credit and removing other technical and commercial barriers. The specific activities for this programme are described below

- **Creating awareness** among the Hotel, Hostel and Industry owners about the environmental and financial benefits of the technology and the subsidy regime of the government to promote the SWH technology by organizing focused seminars, campaigns and study tours in all the major potential districts**.**

- **Improving Access to Credit**: Creating awareness about the benefits of financing SWH technology among banks and other financial institutions and identifying and tying up with at least one key bank per cluster for facilitating easy delivery of bank credit.
- **Capacity Building**: Conducting training and capacity building programmes for local technicians, dealers and manufacturers for proper installation and maintenance of SWHs.
- **New Niche areas/sectors for SWH**: Investigation of new niche areas for application of SWHs and proposing new and innovative technical designs for integration of SWH in those new areas/sectors

This programme can be implemented through Cluster/State level Solar Water Heater Facilitation Cells. These cells should be responsible for running the campaign, providing technical support to existing and potential users, sample checking and third party monitoring and verification of the installed SWH systems.

9.2 Focused Programme for the Residential Sector

The residential sector is the largest potential market but its development would be slow and would require sustained efforts to improve technology (offer wider variety of product to residential end-user) and market development. This market would also depend on the electricity tariff and electricity supply situation in the states. The activities that can increase the deployment of SWH in residential sector are:

a) **Low-cost domestic solar water heaters**: it is strongly recommended that UNDP-GEF solar water heating project along with the Ministry of New and Renewable Energy should launch a large initiative to disseminate Solar Water Heaters in the rural areas of the Himalayan region. Main activities of the initiative have been summarized below (refer table 16.4)

   Activity 1: Design competition to select appropriate designs for promotion in rural areas

   Activity 2: Pilot testing of the prototypes:

   Activity 3: Evaluation of the community SWH models:

   Activity 4.Technology transfer, training and promotion of local manufacturing capacity:

Activity 5. Pilot projects in around 30 villages (around 3000 SWH systems) through local entrepreneurs/ NGOs

Activity 6. Launching of a dissemination programme

Activity 7. Implementation of the dissemination programme to reach atleast 5% of the rural population by 2022 (50000 systems/ year)

b) **Bank credit**: Availability of easy and low interest loans by banks for small capacity systems

c) **A balanced and gradual approach to mandatory provisions**: Mandatory provisions for all government housing, public-sector housing, industrial housing, etc. to begin with and gradual expansion to housing in capital and large cities once the necessary capacities and awareness is well established.

9.3 Strengthening local manufacturing and SWH supply chain

UNDP/GEF Solar Water Heater project should focus on strengthening local manufacturing and supply chain.

a) **Programme for developing manufacturing base in the Himalayan region**: Provide technical support, training and devise an incentive programme for manufacturers for setting manufacturing base in the Himalayan region. MNRE/SNAs may partner with MSME (Ministry of medium, small and micro enterprise) or state industries departments for implementation and execution of this programme.

b) **Training and capacity building of local technicians for installation and maintenance of SWHs**: UNDP/GEF Solar Water Heater Project is already supporting development of training modules for technicians. It is suggested that UNDP/GEF Solar Water Heater Project can tie up with selected polytechnic/ITIs in each Himalayan state for delivery of the training modules.

9.4 Effective and Efficient delivery of capital subsidy

JNNSM has provision for higher subsidies in the Himalayan region. The previous experience with disbursement of subsidies across all states has been poor. Corruption, slow-processing, lack of inspection and verification, favouring certain suppliers, have been reported from most of the states. During stakeholder's consultations, a large number of participants reported confusions/absence of clarity about the provisions and modalities of the new capital subsidy

scheme. It is suggested that **MNRE and SNAs should take immediate steps to look into the problems in disbursing capital subsidy and come-out with an effective, efficient and corruption free delivery mechanism**.

Table 6: Activity chart for the Action Plan for Himalayan States

Activities/Year	2011	2012	2013	2014	2015	2016	2017
Programme for Commercial, Institutional and Industrial Sector in 15 identified districts							
➢ Formation of Solar Water Heater Facilitation Cell in each of the identified high potential District/Cluster.							
➢ Awareness Creation through Seminars, Focused workshops and study tours							
➢ Improving Access to Credit by tying-up with at least one bank per cluster							
➢ Training & capacity building of local technicians, dealers and manufacturers							
➢ Technical Support to the existing and potential Users							
➢ Sample checking and verification of the installed SWH systems							
➢ Finding new niche areas/sectors for the use of SWH							
➢ SWH demand creation through innovative and new designs that can cater the needs new niche areas/sectors							
Focused programme for Residential Sector: Low cost domestic solar water heater							
➢ Design competition to select appropriate designs for promotion in rural areas							
➢ Pilot testing of the prototypes							
➢ Evaluation of community SWH models & currently available SWH technologies for residential applications							
➢ Technology transfer, training and promotion of local manufacturing capacity and NGOs							
➢ Pilot projects in around 30 villages (around 3000 SWH systems)							
➢ Launching of a dissemination programme							
➢ Dissemination programme to reach atleast 5% of the rural population by 2022 (50000 systems/ year)							

CONTENTS

Chapter 1. Introduction

1.1 Solar Water Heaters in Indian Himalayan Region

Total Population living in Himalayan region is around 40 million (2001 Census). There are around 95 districts which fall under the category of Himalayan region[1] & 24 districts in Jharkhand, these were the focus of the study. As per 2001 census, out of 95 districts, only 10 districts are densely populated (population > 10 lakhs), highest being Darjeeling with 16 lakh population. Most of the densely populated districts are in the sub Himalayan and terai region.

Due to cold climate prevailing in the Himalayan region, the region has year-round requirement for hot water. At present, use of SWH is rather limited and scattered in Indian Himalayas. Most of the existing systems are in commercial and institutional buildings (hotels, resorts, hospitals, defense establishments, etc); in general the use of solar water heaters in the domestic sector is very scarce. Northern Himalayan states of J&K, Uttarakhand & Himachal Pradesh have more SWH systems compared to the eastern and north eastern Himalayan states.

The main barriers in use of SWH systems in Himalayan region are:

- Technical
    - Lack of appropriate products to suit the requirements of different end-use applications
    - Technical problems associated with freezing in colder regions
    - Difficulty in installing conventional SWH systems on sloping roofs made of metal sheets, stone tiles, etc.
    - Lack of piped water supply, particularly in rural areas
    - Quality of water, particularly presence of silt
    - Low solar insolation in several parts of the Himalayan region during winter months when the requirement of hot water is the highest

[1] Resource Information Database of the Indian Himalayas, G B Pant Institute of Himalayan Environment and Development

- Financing
    - High initial capital cost of the system
    - Limited access to credit
    - Cumbersome process for availaing capital subsidy and problems associated due to delay in release of subsidy
- SWH supply chain
    - Weak SWH supply chain, with very limited number of active dealers
    - Lack of local manufacturing capacity
    - Difficulty in transportation of the systems to remote areas, which also results in higher cost of the SWH systems.

1.2 Objective of the Study

The objective of the study is to carry out sector and segment-wise market assessment studies and surveys; to gain an insight into the current market for solar water heaters in the Himalayan region, to project realizable market potential in each sector and segment till the year 2022 and to prepare an action plan to increase penetration of Solar Water Heating systems in the Himalayan Region after identifying the barriers.

Following sectors and demand segments were identified for the study:

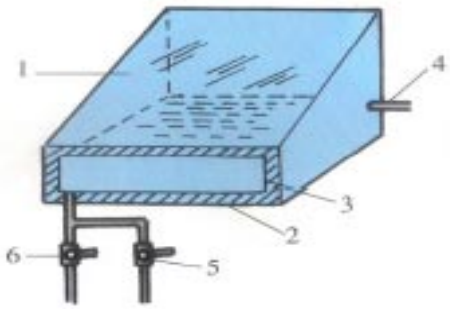
- Residential (Urban and Rural)
- Commercial (Hotels/Guest Houses/Restaurants)
- Institutional (Hostels, Hospitals, Places of Worship)
- Industry

1.3 International Experience of SWH in Similar Climatic Conditions

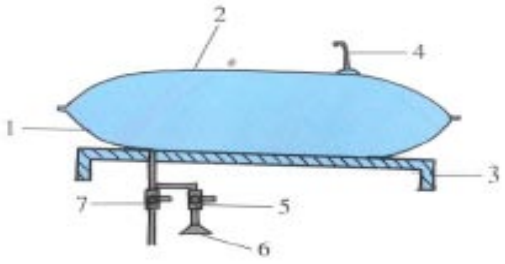
Several parts of China and Nepal have similar climatic conditions like Indian Himalayas. Thus it is interesting to review experience of SWH in these countries.

India's neighbor China has emerged as the world leader in the use of SWHs. In the last 3 years 2007-10, the installed collector area was projected to increase from 108 million m^2 to

150 million m^2 i.e. around 40% market growth[2]. China has a strong manufacturing base with around 5000 manufacturers; mass production and competition have been able to drive down the costs of the systems considerably. Majority of the systems installed in China are in urban areas, it is still a challenge to reach out to poorer sections of the population, particularly those living in rural areas [1]. A paper published in 2004[3], reports that China had 6 million m^2 of batch type SWHs (out of total installation of 61 million m^2 in the year 2000) . Low-cost batch type SWH could be an important technology route in the Indian Himalayas (Refer Figure 1)



a) Shallow water tank SWH



b) Plastic bag SWH

Double-cylinder built-in SWH

Figure 1.1: Some examples of batch type SWH used in China

SWHs were introduced in Nepal in the 1970s. A report published in 2002 states that SWHs were not subsidized as it was considered a viable and mature technology. The stress was on low cost systems which could meet basic requirements however quality was a concern as many manufactures were trying to reduce costs and compromising on the quality. In 2006,

[2] J. Han et al, Energy Policy 38 (2010), 383-391
[3] C. Xiao et al, Renewable Energy 29 (2004), 1549 -1556

there were around 220 small manufacturers and some of these were seasonal[4]. The most widely available, locally made SWH system consists of a 2 x 2m^2 absorber with galvanized steel pipes and steel absorber fins, painted with a simple black, non-reflective blackboard paint. A SWH unit typically has a 150 liter storage tank with 50mm glass wool insulation, to provide minimal insulation. The overall efficiency [energy gained in the hot water (MJ)/incoming solar irradiation (MJ)] is rather low, around 22%-25%. It is believed that approximately 80,000 SWH units are operational in urban areas all over Nepal. The penetration of SWH is low in rural areas, however, the use of SWH is quite widespread in guest houses along various trekking routes. The paper also describes the development of improved SWHs for applications in the high altitude regions (figure 2)

Figure 1-2: SWH system in Nepal having reflectors which acts as cover during night time

[4] Zahnd Alex and Avishek Malla, High Altitude SWH community bathing Centre, Paper presented in ANZSES 2006 conference

The experience of both Nepal and China points towards important role played by local manufacturing and simple technological solutions (e.g. batch type SWH or GI pipe solar collector) in keeping the cost of the product low and expanding the market for SWHs. Though it should be mentioned that SWH has remained more of an urban product in both these countries.

1.4 Limitations of the Study

Due to lack of availability of published literature and data on solar water heater market, as well as in some cases about the future growth trends of certain segments, the study team has made several assumptions while projecting the demand for solar water heaters. We have tried to state these assumptions clearly in various chapters. The readers are advised to consider these assumptions carefully, while interpreting the results presented in the study.

1.5 Outline of the Report

The report has seventeen chapters. Chapter 2 explains the methodology used for the survey, chapter 3 to chapter 15 presents the profile of 13 states lying in the Himalayan and sub Himalayan region. Chapter 16 deals with the primary survey results in the rural villages that lead to identification of model villages for demo projects. The summary of the report along with the draft action plan is presented in chapter 17.

Chapter 2. Methodology, Primary Survey Design & Approach to Demand Projections

2.1 Methodology & Approach Followed

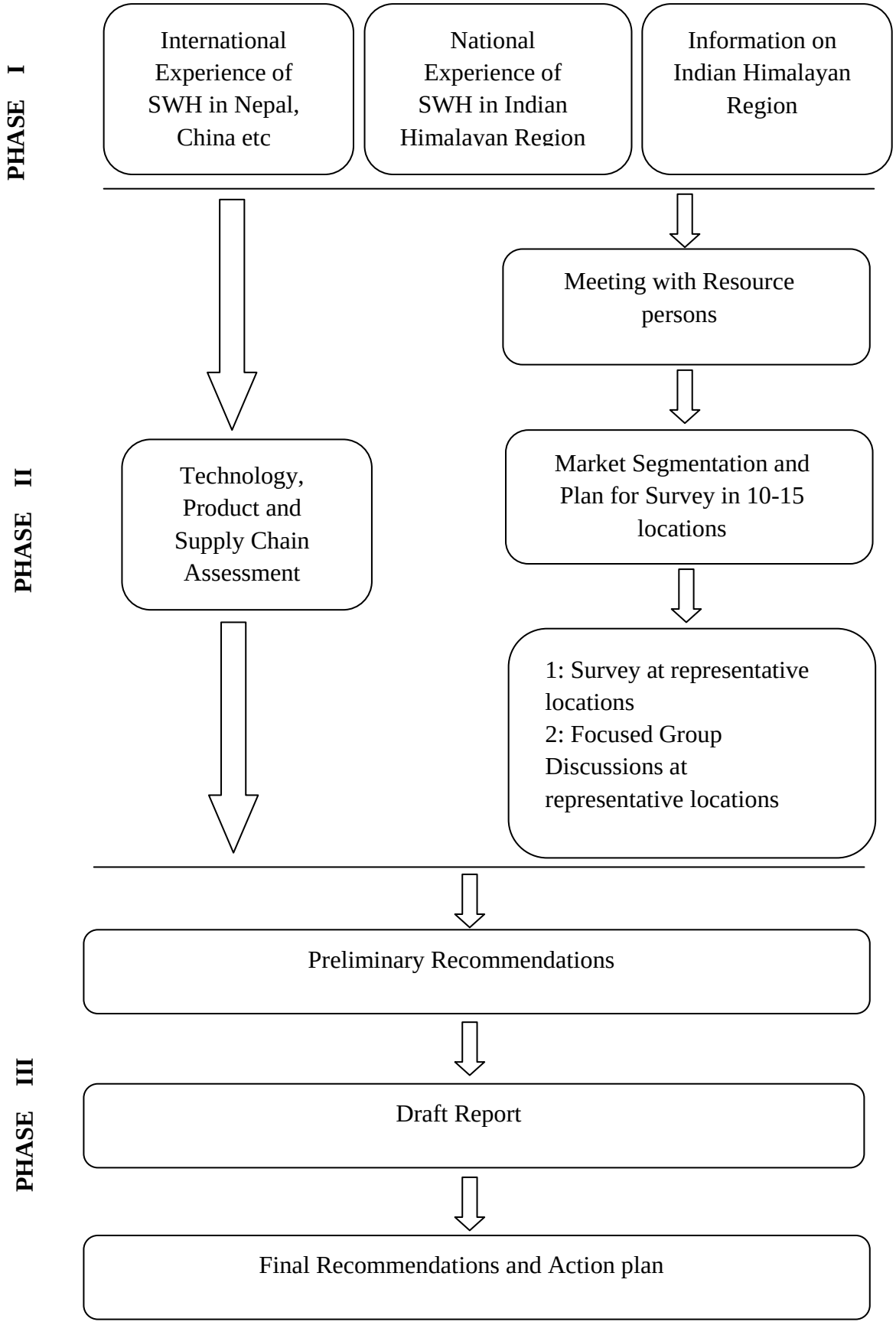
The general approach and methodology followed is represented in the figure below.
The assignment was divided into three phases: (i) Secondary information collection; (ii) primary survey; (iii) assessment of market potential. Specific tasks are outlined below:

Phase I: Literature Survey, Secondary Information Collection & Planning of Survey

In this phase, literature survey on assessment of the international experiences and best practices for Solar Water Heating in similar climatic conditions was done, and published papers on China and Nepal were reviewed

Based on the information collected, and the inputs provided by the project management committee during the inception meeting, the locations for primary survey and focus group interactions were selected and a plan for carrying out the field work was drawn. The total number of locations selected for the survey was 15 (Figure 2.2). While some of the larger states like J&K have three locations, some of the smaller states of North-East were clubbed together. To carry out the primary survey, we have followed an altitudinal zonation process. The Himalayan Region is categorized in three zones, Mountainous, Hilly and Tarai regions. Efforts were made to balance between the places of tourist interests (religious places, hill stations) and other places. Data collection formats, structured interview formats were drafted and pilot-tested and sample size for different categories of stakeholders were finalized at this stage.

Through stakeholders interviews and field vists information on manufacturers, products, policies, barriers and markets were collected. The collected information was used for planning of survey (phase II) of the study.


PHASE I
International Experience of SWH in Nepal, China etc
National Experience of SWH in Indian Himalayan Region
Information on Indian Himalayan Region
Meeting with Resource persons
PHASE II
Technology, Product and Supply Chain Assessment
Market Segmentation and Plan for Survey in 10-15 locations
1: Survey at representative locations
2: Focused Group Discussions at representative locations
Preliminary Recommendations
PHASE III
Draft Report
Final Recommendations and Action plan

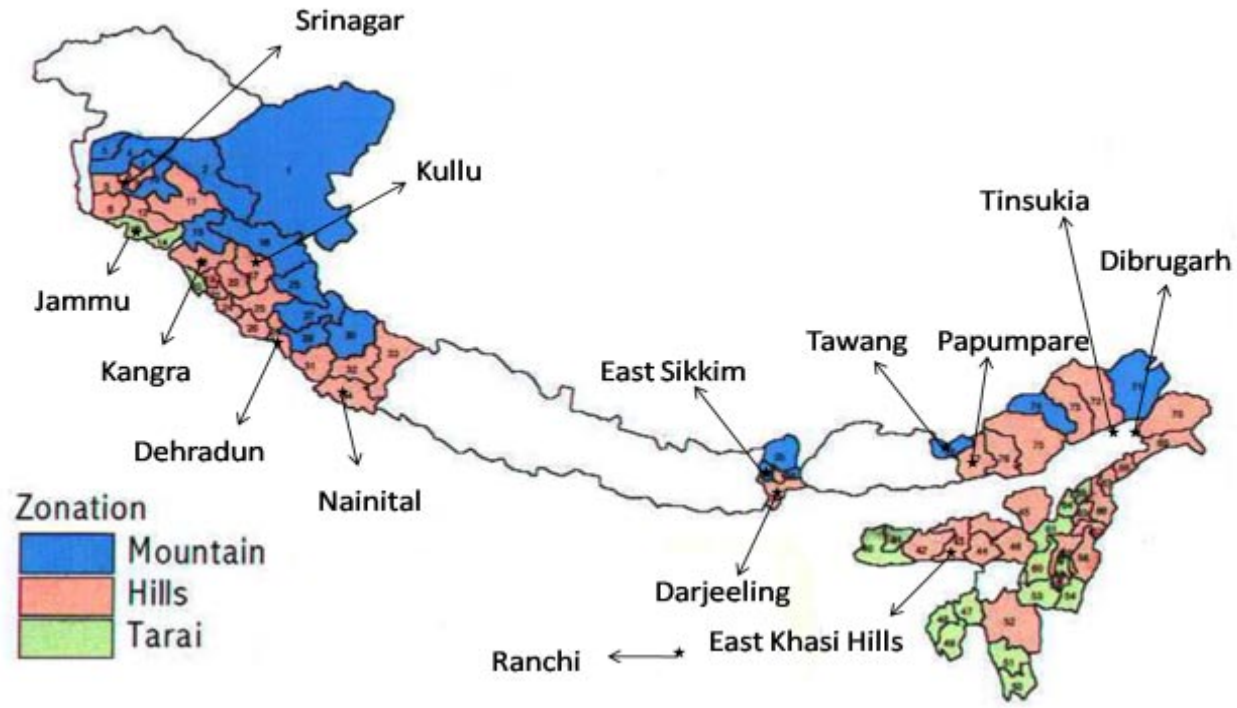


Figure 2.2: Selected Districts for Primary survey

Phase II: Survey (primary data collection) & Focused Group Interactions

Focus group interactions

We organized two focus group discussions, one at Chandigarh for northern Himalayan states and other at Kolkata for North-Eastern states and Jharkhand, in the form of small workshops. Representatives of different stakeholders groups like SWH users, potential demand segments, rural energy experts, SWH manufacturers and dealers, State agencies, research institutions, banks, micro – finance companies, NGOs etc were be invited in these workshops. The focus group interactions were used to get a better understanding of the barriers and to get secondary information from various stakeholders.

Primary Survey

The primary purpose of the survey and stakeholder interviews was to collect information on:

- Hot water demand for different segments (present as well as growth trends)
- Fuel/energy source/technology used
- Current status of solar water heater markets
- Existing supply-chain of SWH market

- Appropriateness of the currently available SWH products
- Local policies and their enforcement
- Gain insights into technical issues that are relevant for application of SWH (water quality, resource available, space availability, etc)
- Case-studies on previous experiences of SWH applications and profile of the users
- Awareness and users perception and feedback about SWH

For conducting the primary survey, 2 regional teams were deployed.

Phase III: Assessment of market potential & Preparation of Action Plan

2.2 Primary Survey

The SWH installations in Indian Himalayan Region are distributed across the following market-segments.

- Households (residential sector) – Urban and Rural
- Commercial and institutional buildings e.g. hotels, hospitals, hostels, religious complexes, etc.
- Industries

SWH owners as well as non-owners in each of the above mentioned categories were interviewed using a structured questionnaire. The focus and other details of work, segment-wise, are elucidated below.

2.3 Households

At least 8-12 households were interviewed per district. In addition, 225 household interviews in the villages from Uttarakhand, Himachal Pradesh and J&K were conducted.

For SWH non-owners, the objective was to get an understanding of consumption of hot water, purpose of water-heating, consumption pattern through the year and present arrangement for water-heating

In respect of SWH owners, we looked into SWH experience in terms of hot water availability through the year, specific problems encountered, SWH and subsidy acquisition process, installation process and after-sale support process. We also secured feedback on SWH in terms of product-usefulness/standard, price, main positive/negatives and suggestions. The SWH owner household interviews in a district were done largely across SWH manufacturers to avoid bias implicit in a single-supplier sample.

2.4 Hotels & Guesthouses

For hotels and guesthouse, in addition to issues cited earlier, the salient points of enquiry were

- Present fuel
- Purposes of water-heating- bathroom, kitchen, other uses
- Roof suitability and availability for SWH
- Availment of soft term loan/incentives in case of SWH owners.

The guideline was to interview at least 5-7 hotels/guesthouses per district, 2 of which should be SWH owner.

2.5 Hospital, Nursing Homes and Hostels

The approach was identical to the one for hotels and guesthouses. The target was to interview one SWH owner and two to three non-SWH owner hospitals/ nursing homes per district. For hostels and other establishment, the number of interviews per district is five to seven.

2.6 Industry

In the industrial sector, the objective was to cover atleast six industries per district. The industries prioritized were-dairy, auto component manufacturing, textile, drugs and pharmaceuticals, food processing.

2.7 Stakeholder Interviews

The stakeholders, in addition to those listed under the primary survey are as follows.

- State nodal agencies (SNAs)
- SWH manufacturers/dealers
- NGOs
- Architects and builders
- Banks
- Municipal corporations
- Electricity distribution companies

The SNAs and SWH manufacturers/dealers are the most important stakeholders.

We set out to interview the stakeholders with the aid of a checklist of issues. The checklist was meant to be a guide rather than an exhaustive or compulsory coverage framework. We focused on the following issues.

SNAs:

- State-level statistics on SWH installations
- Database on SWH manufacturers and dealers
- SWH schemes/promotional programmes in vogue and details of utilization and achievement
- Perspective on SWH

SWH Manufacturers/Dealers

- Estimate of SWH installations, annual growth, segment-wise break-up and SWH type wise break-up of the market for the given district
- Promising geographical areas, segments and reason for this
- Significance of SWH in relation to their overall business operations
- Understanding of SWH market drivers/barriers and competition
- Perspective on SWH, including sale projection for the city

Other Stakeholders

We restricted ourselves to specific issues, while holding discussions with architects/builders, banks, municipal corporations, electricity distribution companies, etc.

The future projections were carried out taking in to account the growth rates of Residential households in urban and rural sector, hotels, hospitals and hostels and combining the growth rates with the terminal penetration of SWH in the year 2022 in each category. The growth rates were estimated with the help of the study conducted by LBNL on Residential and Transport Energy Use in India Past Trend and Future Outlook and interviews with key resource persons.

2.8 Work Organization

For effective conduct of the fieldwork, primary survey and stakeholder interview work was divided among regional partners of the consultant consortium. The work was carried out as follows.

Organisation	**Office Location**	**Districts covered**
GKS	New Delhi	Jammu, Srinagar, Kangra, Kullu, Dehradun & Nainital
NBIRT	Guwahati, Kolkata and Agartala	Darjeeling, East Sikkim, Tawang, Papumpare, East Khasi Hills, Tinsukia, Dibrugarh & Ranchi

2.9 Approach to Demand Projections

We have adopted the following approach to demand projection.

- Utilizing learning from the primary survey and stakeholder interviews
- Putting together the present configuration of SWH market in Himalayan states (2010)
- Prioritizing market- segments for SWH
- Estimating the present size of market- segments in terms of hot water requirement and projecting future hot water requirement.
- Estimating SWH growth-segment-wise and state-wise under each scenario.
- Building alternative market scenarios in terms of performance of key parameters which drive SWH growth.
- Developing SWH growth- estimates, segment-wise, from 2010 to 2022

The estimation of market-segment volume entailed determining the present stock of customer- base under each segment, projecting growth in such base and determining hot water requirement in each segment till 2022.

The future projections were carried out taking in to account the growth rates of Residential households in urban and rural sector, hotels, hospitals and hostels till the year 2022 in each category. The growth rates were estimated with the help of the study conducted by LBNL on Residential and Transport Energy Use in India Past Trend and Future Outlook and interviews with key resource persons.

2.9.1 SWH Projection Scenario

For SWH projections, three scenarios were considered. Details for each scenario are given in the sub-sections below:

Business As Usual (BAU) Scenario

BAU scenario assumes that the SWH market would follow the same trend as it had followed in the last 15 years. SWH market has shown a CAGR of 16.8% in the cumulative SWH installations during 1995-2008.

A recent study[5] shows that the electric water heating market for India grew by 13.7% during 2008-2013. The details are given in Table below

Table 2.1 Electric geyser market projections

2008 Cumulative installations (millions)	10.46
Sales in 2008 (millions)	1.70
Sales in 2013 (millions)	3.12
Cumulative installation in 2013 (millions)	19.89
CAGR of cumulative installations (%)	13.7

Based on the above facts, we have assumed that the **SWH cumulative installation would grow by 15% per annum under the BAU scenario** limited to 25% penetration in the non-residential segments.

[5] Energy saving potential in Indian households from improved appliance efficiency, Prayas Energy Group, Pune

Optimistic-I Scenario

Under this scenario, we have considered different parameters for the growth of SWH market in the city/state as given below:

- Economic Viability (Based on the solar radiation availability, climate, electricity tariff and hot water demand)
- Policy & Enforcement (State/city regulation and enforcement, now and next 5 years)
- Supply Chain (Availability of SWH suppliers, installers and maintenance provider, now and next 5 years)
- Access to Credit (Availability and availment culture of finance, now and next 5 years)

These factors were given a certain weightage and assigned a number in the scale of 1-4 (4 is most favourable) for each location and category to come up with a composite score (higher the score, better for SWH market).

These parameters were ranked for two cases: BAU scenario and Optimistic-I. Ranking for the BAU scenario is based on the present scenario while Optimistic-I assumes that certain parameter would get improved due to improvement in economic viability, Government interventions, increased awareness, improved supply chain for SWH, improved financial arrangement for SWH loans and finance. Based on the composite score for BAU & Optimistic-I scenario, a new CAGR for the cumulative SWH installations is estimated as given in the formula below.

$$Optimistic - I\ CAGR\ = BAU\ CAGR\ \times \frac{Composite\ score\ for\ Optimistic - I\ scenario}{Composite\ score\ for\ BAU\ scenario}$$

Composite score for all state/cities and the estimated CAGR for Optimistic-I scenario is given in table2.2

Table 2.2 Estimation of CAGR for Optimistic-I Scenario for Himalayan states

	BAU Scenario						Optimistic Scenario-I					
	Economic Viability	Policy & Enforcement	Supply Chain	Access to Credit	Composite Score	CAGR	Economic Viability	Policy & Enforcement	Supply Chain	Access to Credit	Composite Score	CAGR
Weightage	35%	15%	25%	25%			35%	15%	25%	25%		
J&K	1	1	1	1	1	15%	2	2	2	2	2	**30.0%**
Uttarakhand	2	1	2	1	1.6	15%	3	2	3	3	2.85	**26.7%**
Himachal Pradesh	3	1	2	2	2.2	15%	4	2	4	3	3.45	**23.5%**
West Bengal (Hilly part)	1	1	1	1	1	15%	2	2	2	2	2	**30.0%**
Sikkim	1	1	1	1	1	15%	2	2	2	2	2	**30.0%**
Arunachal Pradesh	1	1	1	1	1	15%	2	2	2	2	2	**30.0%**
Assam (Hilly part)	1	1	1	1	1	15%	2	2	2	2	2	**30.0%**
Meghalaya	1	1	1	1	1	15%	2	2	2	2	2	**30.0%**
Manipur	1	1	1	1	1	15%	2	2	2	2	2	**30.0%**
Mizoram	1	1	1	1	1	15%	2	2	2	2	2	**30.0%**
Nagaland	1	1	1	1	1	15%	2	2	2	2	2	**30.0%**
Tripura	1	1	1	1	1	15%	2	2	2	2	2	**30.0%**
Jharkhand	2	2	2	2	2	15%	3	3	3	3	3	**22.5%**

Table 2.2: Estimation of CAGR for Optimistic-I Scenario for representative districts

	BAU Scenario						Optimistic Scenario-I					
	Economic Viability	Policy & Enforcement	Supply Chain	Access to Credit	Composite Score	CAGR	Economic Viability	Policy & Enforcement	Supply Chain	Access to Credit	Composite Score	CAGR
Weightage	35%	15%	25%	25%			35%	15%	25%	25%		
Jammu	1	1	1	1	1	15%	2	2	2	2	2	30.0%
Srinagar	1	1	1	1	1	15%	1	2	2	2	1.65	24.8%
Dehradun	3	1	2	2	2.2	15%	4	2	3	3	3.2	21.8%
Nainital	2	1	1	1	1.35	15%	2	2	2	2	2	22.2%
Udham S Ngr	3	1	1	1	1.7	15%	3	2	2	2	2.35	20.7%
Kullu	3	1	2	3	2.45	15%	4	2	3	3	3.2	19.6%
Kangra	3	1	2	3	2.45	15%	4	2	3	3	3.2	19.6%
Darjeeling	2	1	1	1	1.35	15%	2	2	2	2	2	22.2%
East Sikkim	2	1	1	1	1.35	15%	2	2	2	2	2	22.2%
Papumpare	1	1	1	1	1	15%	2	2	2	2	2	30.0%
Tawang	1	1	1	1	1	15%	2	2	2	2	2	30.0%
Tinsukhia & Dibrugarh	1	1	1	1	1	15%	2	2	2	2	2	30.0%
East Khasi Hills	1	1	1	1	1	15%	3	3	3	3	3	45.0%
Ranchi	2	2	2	2	2	15%	3	3	3	3	3	22.5%

Based on the Optimistic-I scenario CAGR in SWH cumulative installations as shown in the table above, projections for SWH installations were done under this scenario. Further is assumed that these interventions would 2-3 years to implement. Hence, the improved CAGR is applied from year 2013 onwards. The penetration level in non residential sectors is forced to limit to 25% in states projection and 35% in districts projection.

Optimistic-II Scenario

This scenario is built from the demand side and takes in to account launch of low cost batch type SWH systems. Under this scenario, we have assumed that due to the launch of a new appropriate product that matches the needs and demands of the Himalayan population, SWH penetration would reach to certain level in each state and sector by 2022. The states like Uttarakhand & Himachal Pradesh have a good SWH market base and it is assumed that they may reach penetration levels of 5% in residential sector and 25% in non-residential sector. The other states except Tripura are assumed to reach penetration of 2.5% in residential sector and 25% in non-residential sector. Tripura being an exceptional case because of its warm weather conditions is assumed to have 1% penetration in residential and 25% in non-

residential sectors. The projections of the representative districts in optimistic II scenario takes same penetration rate in residential sector as per their respective states and 35% penetration in non residential sector in all the states.

Based on the 2010 penetration and assigned 2022 penetration levels, penetration levels for in between years is estimated. Based on the projection of unit base (household, hotel and hospitals) and SWH penetration, forecasting of SWH installations has been done for each location and category.

The projected numbers are shown in state chapters i.e. chapter 3 to chapter 15.

Chapter 3. Jammu & Kashmir

3.1 Introduction

Jammu and Kashmir is located between 32^{o} 17'- 36.58^{o} North latitude and 37° 52' – 80^{o}30 East latitude. The state has a geographical area of 22, 22,236 km^{2} which falls in the altitudes ranging from 300 to 7000 meters. The state can be classified under three regions - Jammu, Kashmir and Ladakh which are climatically, geographically and culturally distinct. As per Census 2001, the state has a population of 10,143,700 (almost 1% of India's population) of which 24.8% is classified as Urban and rest Rural.

Jammu Region comprises of the areas lying south and west of the mighty Pir Panjal range which separates Kashmir valley from the plains of the subcontinent. This region comprises of 10 districts amongst which Jammu holds a prominent position in terms of trade, population and is also the winter capital of the state – Jammu Tawi.

Figure 3-1: Map of J&K, Source: Wikipedia

Vaishno Devi (Reasi district), which is a popular pilgrimage, is situated at an altitude of 1560 m. At the base is the town Katra which has grown rapidly over the years as the economy of the place is linked with the pilgrimage and tourist arrivals for Vaishno devi. Patnitop/Sanasar (Udhampur District) is a much visited hill station during the summer months mostly by local tourists. The other important towns are Udhampur, Kishtwar, Poonch, Rajouri, Doda which are situated on the hills and mountains.

Kashmir Region comprises of 10 districts which are located around the central and western part of the state. Srinagar, situated at an average altitude of 1585 m and with a population close to 9 lakh (Census 2001) is the major city and the summer capital. Other important cities are Baramulla and Anantnag. The other major hill stations are Gulmarg, Sonemarg and Pahalgam which are favoured by general tourists, trekkers and adventure sports enthusiasts.

The Ladakh region covers 70% of the state's area and houses a population of about 2.7 lakh, as per census 2001 data, which is less than 3% of the state's population. It is commonly referred to as a 'Cold Desert' because of the cold and arid conditions that prevails almost round the year. This region is further divided into districts Kargil and Leh and these lie between elevations 2750-7672 m. Leh and Kargil are the major towns which hold the maximum population. Leh is now a famous tourist destination. It has a rich Buddhist culture and many ancient monasteries. There are many trekking routes which connect this region with Himachal Pradesh and the Kashmir region. The solar radiation in Leh is one of the highest in the country.

The climate of Jammu and Kashmir varies from tropical climate in Jammu plains to semi-arctic cold in Ladakh with Kashmir and Jammu mountainous tracts having temperate climatic conditions. During the hottest month in Jammu city i.e. May the temperature may vary between 28 to 40^{o}C in a day. Summers usually last for 2-3 months (May-July) in this region barring the mountainous region where these months also have pleasant weather conditions. The winters may start from October and last up till March, again the duration and onset of the season depending on the altitude. The annual rainfall is around 1116 mm. Highest rainfall in monsoon July-September and many days are overcast during this time. Even in winters mornings can be hazy especially in the plains.

In Kashmir region, the climate is different in the valley and the mountains. In Srinagar city which lies in the valley temperature variation is between 15 to 32^{o}C in May and around -4 to 5^{o}C in January. The weather is cold for 6 months October to March and the valley experiences snow anytime between Nov-Jan when harsh winters set in. The weather is warm during daytime between May-July in the valley and cool in the mountains surrounding it. The annual rainfall is about 650 mm. The solar insolation received in Srinagar varies between

1.32 kWh/m^2/day in January to 6.16 kWh/m^2/day in June. The average global solar radiation is 4.26 kWh/m^2/day[6].

Temperatures in Ladakh, range from -3 to 30^{o}C in the summer and from -20 to 15^{o}Celsius in the winter. However, the average global solar radiation level is around 5.8-6 kWh/m^2/day which is one of the highest in the country and contains a high proportion of beam radiation. This is on account of the plateau being located at high altitude and having rarified air. Annual rainfall is about 100 mm which is mainly in the form of snow and the region gets more than 300 sunny days in a year.

The state is primarily dependent on agriculture and allied activities. Kashmir valley is known for sericulture, cold water fisheries, horticulture and handicraft exports (paper mache, copperware, carpets, shawls etc.). Major industrial development in the state has taken place in the Industrial estates setup in Jammu and Kathua districts. The four industrial agencies are State Industrial Development Corporation (SIDCO), Small Industrial development Corporation (SICOP), Small Industries Service Institutes (SISI) and Directorate of Industries and Commerce (DI&C). SIDCO is the agency with which most of the medium to large industrial units are registered. Due to acute power shortage and infrastructure development, the development of industries has been slow paced. Industrialists have been skeptic about investing here due to the political conflicts in the state and due to the fact that it is located at the northern corner of the country which creates logistics problems.

Table 3-1: No of industrial units registered under the industrial agencies

	Units Functional	Units Non-Functional
SICOP	324	211
SIDCO	217	103
J&K DI&C	425	267

Source: www.jknoblehelpline.com

Following the issue of the Central Government's Industrial Incentive Package in 2004 which included exemptions on VAT, Excise, CST amongst a tax holiday for 10 years and Central Investment Subsidy up to 30%, there was some thrust in industrial activity. However, due to recent dilution of the incentives many of these units have reportedly decreased there production capacities. This has also affected the willingness of national level industries to enter the state.

[6] Source: Solar Radiation Handbook, Solar Energy Center

Table 3-2: Types of Industries in different industrial regions in J&K

Jammu/Bari Brahman *Metal & Alloy, Pharma*	**Samba** *Pesticide, Pharma*	**Kathua** *Cement, Paint, Textile, Paper & Pulp*
Sun Pharma	Indo – Swift	Chenab Textile
Lupin Pharma	Cadila	Oswal Mill
Medley Pharma	Surya Pharma	Berger Paint
Jindal Drugs	Ochoa Laboratories	Nerolac Paint
Saraswati Agro Industries	Nordiac Formulations	
Dabur India	United Phosphorous	
	Vinayak Synthetics	

Tourism and allied industries is still a prime source of employment and revenue for the state. Though tourist arrivals has been badly hit in Kashmir following insurgency, Ladakh and Jammu are still having high tourist influx.

3.2 Present Status of SWH

Primary survey was conducted by the Project Team in Jammu city. A survey of households and hotels was conducted with the help of a resource person in Srinagar, Rawalpora and Bemina. The data on Ladakh region was procured from secondary sources.

Despite availability of capital and interest subsidy for different categories of users, the SWH market is still at a nascent stage of development in the state on account of poor promotion, limited number of successful demonstrations and poor supply chain including unavailability of local installers. JAKEDA, the implementing agency in Jammu and Kashmir region had empanelled J&K Bank (for providing credit for SWH systems) as the supporting financial institution but the bank had not financed many projects until now. No other benefits such as electricity rebate or property tax rebate were being rendered to the SWH users.

The Solar Water Heater market is at different stages of development in the three regions of the state.

Jammu region: In Jammu, SWHs had been installed some years back as part of the government program. These were mostly pilot projects. They were found to be non functional now due to improper care and maintenance structure. There have only recently been some installations of SWHs and a new thrust to the market seen. At the time of the survey most of

them had not even been commissioned. In Jammu there have been some installations in Hotels and the same has followed in Katra. However, the use in residential sector was negligible. The installations have taken place on account of active dealers from the state and elsewhere that have recently set up base here. The major installers were SunTechnics, TataBP Solar, Inter Solar, Racold and J&K Solar (a local Unit). It seemed that they were targeting the Hotel, Army and Government SWH market as of now and were not so keen on promoting it amongst the residential users. From the survey and information gathered by the dealers, it was estimated that the functional cumulative installation in the cities of Jammu and Katra was less than 20,000 LPD out of which one installation for swimming pool heating in Jammu Club accounted for 12,000 LPD. This figure has not taken into consideration the installations that might have been in Army bases.

Kashmir: In Kashmir region, except army, SWH use is almost totally absent. A survey of local hotels revealed that despite awareness, there are no installations of SWH. Due to unrest and political uncertainty, the installation of SWH is not high on agenda of hotel owners. LPG along with electricity are the main sources for heating water. The supply chain for SWH do not exist, while some of the SWH companies have representatives at Jammu and Leh, there are no active dealers in Kashmir.

Ladakh: The scenario in Ladakh is encouraging. The Central govt. has promoted the use of solar technologies in the region due to problems and costs associated with transmitting conventional power there. Ladakh Renewable Energy Development Agency (LREDA) is quiet active in promoting these technologies along with certain NGO's such as LEDeG, GERES, and LEHO. Leh had total installed capacity of more than 40000 LPD. For the details of SWH status in Leh please refer to Appendix-III. Apart from these around 30 systems had been installed in Army camps. To summarize there is active promotion by Government, NGOs and Industry in this region along with a will of the users to find a better solution to the existing cumbersome and expensive one. Till now, approximately 84000 LPD of SWH systems have been installed in J&K.

The number of months of hot water requirement for different categories of users in the three regions of J&K is presented in Table 3.3.

Table 3-3: Hot Water Requirement months

Districts	Residential	Hotel	Hospital	Hostel
Jammu	6 Months (Oct to March)	12 Months	12 Months	6 Months (Oct to March)
Srinagar	8-10 Months	4-6 Months	-	-
Leh	12 Months	12 Months	12 Months	-

Source: Primary Survey & Report on Solar Energy Master Plan for Ladakh region by TERI

3.2.1 Residential

The total number of households in J&K as per the Census 2001 is given in the table below

Table 3-4: Households in J&K as per census 2001

Total No. of Households	Urban Households	Rural Households	Avg. Number of persons/ Household
4,461,360	1,006,395	3,454,965	5.35

Hot water is required in households for bathing, utensil washing and even for washing clothes especially in areas which are cold. The current method of heating water is predominantly by decentralized electric geysers and electric immersion rod in Jammu city. In Srinagar lots of households were using LPG stoves as well. In Ladakh diesel fuel and LPG stoves are used widely.

The awareness level of the SWH technology is very poor especially in the Jammu and Kashmir regions. People are skeptical about the performance and expect that the SWH should provide a 100% solution to their needs. The general public is not aware of the subsidies and incentives offered by the state and central government. The project team was not able to locate any SWH dealer in Srinagar district. As the electricity cost in the state is quiet low i.e. Rs. 1.3/kWh and because of the predominant electricity theft not many people are as yet conscious about saving electricity.

Only 2-3 functional domestic SWH system of capacity could be located in Jammu city**.** Some systems were installed around 10 years back during the time subsidies were released for the first time but their use was not replicated and these systems were not fuctional at the time of survey.

3.2.2 Commercial

Hotels

Presently the major tourist arrivals in the state are on account of Ladakh, Vaishno Devi and Amarnath Yatra. Vaishno Devi has daily arrivals of between 20,000-35,000 pilgrims presently and the peak season is from March-August and the Navratras. There are in total around 22750 hotel rooms available in the state. Apart from the hotels there are around 2750 rooms available on houseboats in Srinagar.

Table 3-5: Houseboats room capacity in Srinagar

Room Type	Room Capacity
Deluxe	1000
A Grade	350
B Grade	200
C Grade	300
D Grade	900
Total	2750

The total hot water requirement in hotels is calculated in the table below:

Table 3-6: Total hot water demand in hotels

Total No. of Hotel Rooms	Hot Water Requirement (LPD)	Total Hot Water Requirement (Million LPD)
22750	100	2.275

The penetration of SWH in the hotel segment is calculated in the table below

Table 3-7: Penetration of SWH in hotels

Total Hot water demand (LPD)	Installed capacity of SWH in Hotels (LPD)	Penetration
2275000	37000	1.6%

From the survey of different category hotels in Jammu and Katra (Appendix I), it was found that some of the hotels had in fact installed the system recently. A 12,000 LPD system was installed by InterSolar in Jammu Club which was to supply hot water for swimming pool heating. The system had not been functional as yet and hence no performance record was available. While some users were partially satisfied as they had had maintenance problems others were optimistic about the system and recommended it. It was seen that upcoming

hoteliers were in fact taking this water heating option seriously and going ahead with the installation.

For deluxe hotels the conventional way of heating water was through diesel/electric boiler. These hotels were supplying hot water to their customers through-out the year. The smaller hotels were usually supplying hot water only during the winter months and were using electric geysers or electric immersion rods.

The main barriers up till now to their use in this industry are –

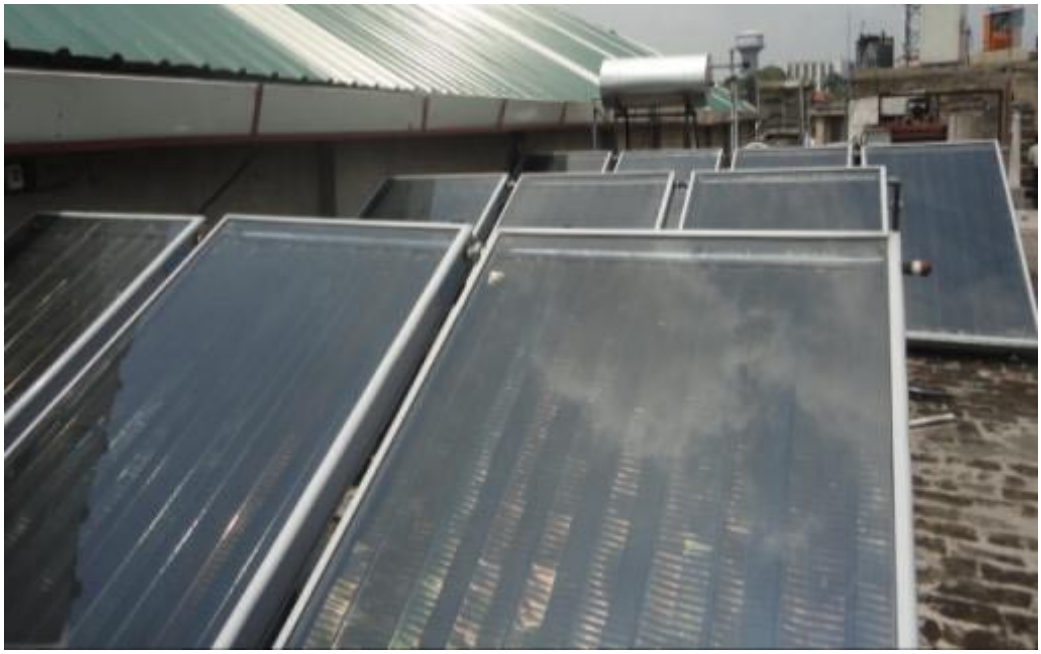
- Lack of awareness: Limited awareness on the technology coupled with reluctance to change.
- Limited/non-availability of local solar water heater dealers.
- Low electricity tariff (Avg. tariff Rs. 2.69/unit) and electricity theft. (though most hoteliers would not agree to this it is believed that many just pay a fraction of their electricity bill)

Case Study: Hotel K.C, Katra, 2400 LPD

Hotel K.C. in Katra which is a new hotel has installed a 2400 LPD system with the help of subsidized finance from PNB Bank. The system had a 2000 LPD storage tank connected in series with a set of 2 auxiliary tanks (with electric backup) of capacities 500 and 300 liters. They had reported savings of Rs. 8000-9000/month even though they had to switch on the electric boiler for sometime in the mornings and evenings. Refer Appendix-II

Case Study: Hotel Asia, Jammu, 1000 LPD

A 20 room hotel in the heart of the city has a 1000 LPD flat plate SWH system supplying hot water against a daily requirement of 3000 LPD which was totally being supplied by the diesel boiler previously. The system was installed 1.5 years back and roof space constraints the capacity was limited to 1000 LPD. Although the management reported estimated savings of Rs. 1 lakh yearly they were only partially satisfied as they had encountered maintenance problems and didn't receive quality after sale service. Also, they were not pleased with the fact that they had to use the backup heater often as they hadn't expected this.



3.2.3 Institutional

Hospitals

There are more than 3900 hospital beds in J&K including the small clinics and primary health care centers. To estimate hot water requirement in hospitals, per bed requirement of 30 lpd is assumed. The total requirement is estimated at 0.12 million lpd.

Table 3-8: Hospitals and health centers in J&K

Provincial Hospital	1
District Hospital	19
General Hospital	2
Sub-district Hospital/CHC	77
Emergency Hospital	6
Primary Health Center	427

Table 3-9: Total hot water demand in Hospitals

Total No. of Hospital beds	Hot Water Requirement (LPD)	Total Hot Water Requirement (Million LPD)
3945	30	0.12

The penetration of SWH in hospital sector is calculated in the table below

Table 3-10: Penetration of SWH in Hospitals

Total Hot water demand (LPD)	Installed capacity of SWH in Hospitals (LPD)	Penetration
120000	2200	1.8%

The demand for hot water is for almost round the year. The predominant way of heating is individual geysers in operation theaters, wards etc. Some large hospitals have boiler based on wood or diesel to meet their hot water demand. Major consumption of hot water in hospitals are for bathing of patients and their attendants in wards, hand washing and sterilization of equipments in operation theatre, kitchen and laundry purposes. However most of the hospitals are outsourcing the laundry to the traditional dhobi walas. Awareness level of SWH technology in hospitals is low. There is a significant potential of using SWHs in the state's hospitals and health centers.

Residential Hostels & Monasteries

This may be the most realizable potential segment for SWH in J&K. There are around 75-80 residential hostels and more than 25 large Monasteries in J&K. The approximate number of

residents in these hostels & Monasteries in J&K is about 22000. The per resident hot water demand is estimated to be around 15-20 lt/student for bathing and 6-10 lts/student for cooking purposes. The total hot water demand in residential hostels and monasteries is estimated in the table below

Table 3-11: Total hot water demand in Hostels

Total No. of residents	Hot Water Requirement (LPD)	Total Hot Water Requirement (Million LPD)
22000	25	0.55

The penetration of SWH in Hostels and religious establishments is calculated in the table below

Table 3-12: Penetration of SWH in Hospitals

Total Hot water demand (LPD)	Installed capacity of SWH in Hostels and religious establishments(LPD)	Penetration
550000	9300	1.7%

The hot water demand months in these residential hostels and other religious establishments depends on the altitude of the place for eg Hostels in Jammu have a 4 -6 months hot water requirement on the other hand a monastery based in Leh has round the year hot water demand. The predominant way of heating water is by using electricity or biomass. The normal bathing time in monasteries and other religious establishments is in the early morning at around 6-6.30 am.

3.3 Future projections

The projections for Leh region were carried out separately considering the plans of LREDA to install 15000 m^2 by 2012, as well as assuming that most of the existing market will be saturated by 2013 and after that the SWH installation will be done in new construction. For detailed projections of Leh district refer to Appendix II. As explained in Chapter 2, SWH demand projections are done under three scenarios. The projections are summarized in Table3.13, 3.14, 3.15 for J&K, Jammu & Srinagar respectively.

Table3.13: SWH Demand Projection for J&K (Cumulative installation in m^2 of collector area)

Scenario	Category	2010	2013	2017	2022
BAU	*Residential*	710	20,350	22,980	26,870
	Hotels	740	4,780	6,830	9,950
	Hospitals	40	140	200	330
	Hostel+ Others	190	1,070	1,500	2,110
	Total	**1,680**	**26,340**	**31,510**	**39,260**
Optimistic-I	*Residential*	710	20,350	23,770	31,940
	Hotels	740	4,780	7,400	13,620
	Hospitals	40	140	270	760
	Hostel+ Others	190	1,070	1,550	2,430
	Total	**1,680**	**26,340**	**32,990**	**48,750**
Optimistic-II	*Residential*	710	20,350	57,140	112,970
	Hotels	740	4,780	12,820	28,200
	Hospitals	40	140	490	1,100
	Hostel+ Others	190	1,070	2,520	4,760
	Total	**1,680**	**26,340**	**72,970**	**147,030**

Table3.14: SWH Demand Projection for Jammu (Cumulative installation in m^2 of collector area)

Scenario	Category	2010	2013	2017	2022
BAU	*Residential*	140	210	370	750
	Hotels	300	460	800	1,610
	Hospitals	4	10	10	20
	Hostel+ Others	60	90	160	320
	Total	**504**	**770**	**1,340**	**2,700**
Optimistic-I	*Residential*	140	210	610	2,260
	Hotels	300	460	1,300	4,810
	Hospitals	4	10	20	60
	Hostel+ Others	60	90	260	970
	Total	**504**	**770**	**2,190**	**8,100**
Optimistic-II	*Residential*	140	210	9,800	25,710
	Hotels	300	460	1,910	4,810
	Hospitals	4	10	250	680
	Hostel+ Others	60	90	940	2,310
	Total	**504**	**770**	**12,900**	**33,510**

Table3.15: SWH Demand Projection for Srinagar (Cumulative installation in m^2 of collector area)

Scenario	Category	2010	2013	2017	2022
BAU	*Residential*	10	20	30	50
	Hotels	10	20	30	50
	Hospitals	4	10	10	20
	Hostel+ Others	4	10	10	20
	Total	**28**	**60**	**80**	**140**
Optimistic-I	*Residential*	10	20	40	110
	Hotels	10	20	40	110
	Hospitals	4	10	10	40
	Hostel+ Others	4	10	10	40
	Total	**28**	**60**	**100**	**300**
Optimistic-II	*Residential*	10	20	5,360	14,220
	Hotels	10	20	2,090	6,410
	Hospitals	4	10	140	380
	Hostel+ Others	4	10	710	1,850
	Total	**28**	**60**	**8,300**	**22,860**

Chapter 4 Uttarakhand

4.1 Introduction:

Uttarakhand state lies in the northern part of India and has a total geographic area of 51,125 km², of which 93% is mountainous and 64% is covered by forest. Most of the northern parts of the state are part of Greater Himalaya ranges, covered by the high Himalayan peaks and glaciers, while the southern part consists of lower foothills and plains. Two of India's mightiest rivers, the Ganga and the Yamuna take birth in the glaciers of Uttarakhand.

Uttarakhand lies on the southern slope of the Himalayan range, and the climate of Uttarakhand is sharply demarcated in case of its two distinct divisions: the predominant hilly terrain and the smaller plain region. The type of climate that is mainly to be found in the plains and valleys in the foothills closely resembles the climate in the Gangetic plain. Summers are hot with temperatures crossing the 40°C mark with considerable humidity. Winters can be chilly with temperatures going below 5°C at times. These places include Dehradun, Haridwar Udham Singh Nagar and parts of Nainital district.

Figure 4-1: Districts of Uttarakhand

[Source: http://www.topnews.in/uttarakhand-forest-rangers-get-trained-counter-poachers-2138195]

The climate in the northern part of Uttarakhand is typically Himalayan. This mountain range itself exerts an appreciable extent of influence on monsoon and rainfall patterns. Climate ranges from subtropical in the southern foothills, averaging summer temperatures of about 30° C and winter temperatures of about 18° C. Warm temperate conditions prevail in the

Middle Himalayan valleys having areas above Southern Uttarkashi, Tehri, Chamoli, Almora & Pithoragarh, with summer temperatures usually hovering about the mark of 25° C and cooler winters. Cool temperate conditions dominate the higher areas of the Middle Himalayas, where the summer temperatures are usually around 15 to 18° C and winters drop below the freezing point. At altitudes over 5000 meters the climate is bitterly cold with temperatures consistently below the freezing point and the area perennially shrouded in snow and ice.

Leisure, adventure, and religious tourism play a prominent role in Uttarakhand's economy. Haridwar, Rishikesh, Badrinath, Kedarnath, Gangotri are important pilgrimage centres. Corbett National Park and Tiger Reserve and the nearby hill-stations of Nainital, Mussoorie, Almora, Kausani, Bhimtal and Ranikhet being amongst the most frequented tourist destinations of India. The state also is home to numerous peaks of interest to mountaineers. Other national wonders include the Valley of Flowers, which along with Nanda Devi National Park, form a UNESCO World Heritage Site.

In recent years, Uttarakhand has emerged as one of the most attractive industrial destinations in India. The New Industrial Policy of Uttarakhand has resulted in the setting up of Integrated Industrial Estates across Uttarakhand. The following are the major industrial estates in Uttarakhand

1. Integrated Industrial Estate, Pantnagar
2. Integrated Industrial Estate, Sitarganj
3. Integrated Industrial Estate at BHEL, Haridwar
4. IT Park, Dehradun
5. Pharma City - Selaqui, Dehradun
6. Growth Centre at Pauri

These industrial estates have presence of several major Automobile industries like Tata Motors and 76 vendors in a vendor park, Bajaj Auto, Mahindra and Mahindra, Ashok Leyland, Hero Honda (located in Haridwar) etc; FMCG (Fast Moving Consumer Goods) majors like Nestle, Dabur, Perfetti, Reckitt Benkiser, Calvin Care Pvt Ltd etc; Pharmaceutical and Biotech units; Ayurvedic Medicines; Plywood and Paper Industry.

According to 2001 India census, Uttarakhand had a total population of approximately of 8.48 million. A population exceeding 10 million is expected by the next census of 2011. There are 13 districts in Uttarakhand which are grouped into two divisions – Kumaon division and Garhwal division. The Kumaon division includes six districts: Almora, Bageshwar, Champawat, Nainital, Pithoragarh, Udham Singh Nagar; the Garhwal division includes seven districts Dehradun, Haridwar, Tehri Garhwal, Uttarkashi, Chamoli, Pauri Garhwal, Rudraprayag. The table below shows the population of the two regions of Uttarakhand

Table 4-1: Population of Kumaon and Garhwal regions (2001 census)

Region	Population
Kumaon	3,557,580
Garhwal	4,089,631

For the sake of primary survey, 3 districts were chosen from the state of Uttarakhand as representative clusters; Dehradun, Nainital and Udham Singh Nagar. In addition, information on hot water requirement was collected from 5 villages located in Rudrapryag, Uttarkashi and Dehradun districts.

4.2 Present status of SWH

As per information received from Uttarakhand Renewable Energy Development Agency (UREDA), in the last ten years, approximately 5.3 lakh lpd of SWH systems have been installed in Uttarakhand. Most of the installations are in and around the capital Dehradun.

Summary district wise reports have been prepared for all the surveyed districts and are presented in Annexure I. The Sector-wise main findings are presented in this chapter.

Table 4-2: Category wise Installation of SWH in Uttarakhand from 2000 to 2010

Category	Capacity Installed from 2000 till March 2010 (LPD)	No.of Installation
Residential	60200	300
Hotel	62250	87
Hostel	131150	70
Hospital	15400	14
Ashram	163000	32
Army	19800	24
Commercial	47400	33
Industrial	8100	5
Others	21500	56
Total	**528,800**	**621**

Source: UREDA

Table 4-3: District wise Installation of SWH in Uttarakhand from 2000 to 2010

District	Capacity Installed from 2001 till March 2010 (LPD)	No. of installations
Dehradun	215600	321
Nainital	38200	39
Haridwar	172800	38
Chamoli	19000	16
Uttarkashi	16100	44
Almora	12750	41
Tehri Garhwal	10950	23
Champawat	10100	36
Udham S Ngr	9200	11
Pithoragarh	9100	22
Bageshwar	8700	11
Pauri Garhwal	4300	12
Rudraprayag	500	2

Source: UREDA

Table 4-4: Hot Water Requirement months

Districts	Residential	Hotel	Hospital	Hostel
Dehradun (Urban)	6 Months (Oct to March)	12 Months	6-8 Months	6 Months (Oct to March)
Nainital (Urban)	5 Months (Oct to Feb)	12 Months	12 Months	12 Months (except holidays)
Udham Singh Nagar (Urban)	5 Months (Oct to Feb)	6 Months (Oct to March)	---	---

Source: Primary Survey conducted by project team

4.2.1 Residential:

The total number of households in Uttarakhand as per the Census 2001 is given in the table below

Table 4-5: Household data on Uttarakhand by Census of India 2001

Total No. of Households	Urban Households	Rural Households	Avg. Number of persons/ Household
1,586,321	390,164	1,196,157	5.25

In comparison to other districts, the concentration of domestic systems is higher in Dehradun, this perhaps can be attributed to better awareness and supply chain of SWH because of Dehradun being the state capital and the presence of UREDA as well as most of the manufacturers and installers having their base in Dehradun. Almost 67% of the total domestic systems in Uttarakhand are installed in Dehradun. This attributes to the fact that the relatively affluent people who can afford a SWH system are based here and awareness level of the people are also higher as compared to other districts. Most of the domestic systems are of 100 lpd to 300 lpd capacity. The users are partially satisfied with the product, most of them complaint about the poor after sale support of the dealers and routine breaking of tubes in case of ETC systems. Use of low quality rubber pipe insulation is quite prevalent and since proper metal cladding is not done on the insulation, this wears off in less than 6-8 months leaving the pipes non-insulated.

Hot Water Demand

The major hot water requirement in the residential sector is for bathing purposes. However some of the demand also exists for kitchen purposes during winters. The bathing routine and frequency of bathing also varies by altitude. The people in tarai and plain regions like Dehradun and Udham Singh Nagar bathe at least once or twice in day however the people living in higher altitude areas like Uttarkashi, Rudraprayag, Nainital etc take a bath once in two or three days, hence the hot water demand per person for bathing in the higher altitude areas is approximately one third to that of plain or terai region. However significant amount of hot water is required for kitchen and washing purposes in the higher altitude regions. The predominant way of heating water in the urban areas is either by using Electric Geysers or Immersion rods while in rural areas wood is used as the predominant fuel to meet heat water. The power supply scenario in the urban areas is satisfactory and the cost of electricity is very cheap.

4.2.2 Commercial

Hotels

This is one of the largest hot water consuming segments of the state, there are around 2500 hotels and guest houses, approximately 800 Dharmshalas, 175 Tourist Rest Houses and approximately 30 Rain Baseras. To calculate the overall hot water demand, we have estimated around 50000 hotel rooms with an average consumption of 100 lpd per room.

Table 4-6: Total hot water demand in Hotels

Total No. of Hotel Rooms	Hot Water Requirement (LPD)	Total Hot Water Requirement (Million LPD)
50000	100	5.00

The penetration of SWH in the hotel segment is calculated in the table below

Table 4-7: Penetration of SWH in Hotels

Total Hot water demand (LPD)	Installed capacity of SWH in Hotels (LPD)	Penetration
5000000	62250	1.25%

The demand for hot water is for almost round the year irrespective of the altitude of the place. The predominant way of heating is boilers based on wood and diesel. Individual geysers in rooms are also prevalent in the smaller capacity hotels. Major consumption of hot water in

hotels is for bathing, kitchen and laundry purposes. However most of the hotels except most high end hotels are outsourcing the laundry. These are usually the traditional *dhobi* services. Awareness level of SWH technology in hoteliers varies from place to place, in Dehradun awareness level is quite high but the inferior quality of installations is creating a bad publicity for the technology. Following deficiencies were found by the project team in some of the hotel SWH installations:

- No proper insulation of the pipes and solar tanks; use of unprotected rubber insulation for the pipes
- Leakages in outer aluminum cladding resulting water logging inside the insulation which defeats the purpose of insulation.
- Under sizing or over sizing of the systems.
- Incorrect orientation of many systems .
- No proper maintenance or de-scaling of the systems.

Overall, there is a poor compliance to the mandatory regulations for installing SWH in all new hotels.

Case Study: Hotel Maggi Star, Dehradun (2000 LPD)

Hotel Maggi star is a 22 room hotel situated on the Rajpur road in Dehradun. To reduce the operating cost, a 2000 LPD ETC based SWH system is installed to supply hot water to each bathroom. The system consists of 4 manifolds of 60 tubes each. There is an electric back-up heater inside the solar tank and apart from that they have individual electric storage geysers in 7 rooms. The installation is an example of a bad installation with no maintenance support. The rubber based pipe insulation was not able to withstand the harsh climatic conditions for more than 3-4 months and has hence withered away. The electric heating element used was not of a good quality and stopped working after 5-6 months. The tank was not properly insulted and huge heat losses are reported resulting in temperature drop of water. They are also facing problems of calcium deposition inside the tubes. Breaking of tubes was also reported to be a major problem encountered by the hotel manager, they also complaint about the bad after sale support of the dealer.

Rubber pipe insulation in Hotel Maggi star

Lack of proper insulation on the solar tank

This inturn is creating aprrehension about the performance of the system and creating a bad publicity about the technology.

However, during the primary survey project team also got in touch of some experienced and competent dealers of SWH. They have done good quality installation and provided very useful insights for the study.

Case Study: Hotel Laxmi Palace, Dehradun (2200 LPD)

Hotel Laxmi palace has 20 rooms and as an energy conservation measure they have installed a 2200 LPD Flat plate system. The system is properly sized, well insulated, with proper piping insulation and aluminum cladding to protect the insulation. In order to tackle the problem of scaling, water softner is being used. The user is totally satisfied with the performance of the system.

4.2.3 Institutional

Hospitals: This segment is also a major hot water consumer; there are more than 8500 hospital beds in Uttarakhand. To estimate hot water requirement in hospitals, per bed requirement of 30 lpd is assumed. The total requirement is eastimated at 0.255 million lpd.

Table 4-8: Total hot water demand in Hospitals

Total No. of Hospital beds	Hot Water Requirement (LPD)	Total Hot Water Requirement (Million LPD)
8500	30	0.255

The penetration of SWH in hospital sector is calculated in table 4.9

Table 4-9: Penetration of SWH in Hospitals

Total Hot water demand (LPD)	Installed capacity of SWH in Hotels (LPD)	Penetration
255000	15400	6%

The demand for hot water is for almost round the year irrespective of the altitude of the place. The predominant way of heating is individual geysers in operation theaters, wards etc. Some large hospitals have boiler based on wood or diesel to meet their hot water demand. Major consumption of hot water in hospitals is for bathing of patients and their attendants in wards, hand washing and sterilization of equipments in operation theatre, kitchen and laundry purposes. However most of the hospitals except the most high end ones are outsourcing the laundry. Awareness level of SWH technology in hospitals is low. Following observations about the systems were found by the project team.

Most of the installations in Hospitals are in Government hospitals or primary health centers or a PSU governed hospitals like ONGC hospital. Most of the private hospitals in Uttarakhand are small size hospitals of capacity of 10-25 beds and their total hot water requirement is not very large. They avoid hassles of installing a SWH system as electricity tariff is cheap and electric geysers are easy to install. Also hot water cost is not a major component of the total operating cost of the hospital therefore preference is more inclined towards electric geysers.

The ONGC hospital, Dehradun has a total installed capacity of 9000 LPD and is used to provide hot water in wards and Operation Theater. They are facing a serious problem of breakage of tubes, the major reason being the shortage of water due to which the system remains dry for prolonged periods and when the cold water is recirculated, many tubes cracks or breaks down due to thermal shock.

Case Study: B.D. Pandey Hospital, Nainital (200 LPD)

A 200 LPD flat plate SWH system was installed in the B.D.Pandey hospital of Nainital in 2004-05. However the system was dismantled after 6-8 month of installation. The present Chief Engineer was not even aware that SWH system existed in the hospital and the chief engineer at that time was also not able to provide any substantial reason for dismantling the system. However some of reasons stated were nonperformance of the system due to no maintenance. The project team has a view that since it was an open circuit system and due to high amount of lime in the water, calcium would have deposited inside the plates and due to that system had stopped performing. Lack of proper knowledge about the system has probably led to the dismantling of the system.

Hostels and Residential Schools:

One of the largest potential segment for SWH in Uttarakhand is Residential schools and Hostels. There are around 130 residential schools and colleges in Uttarakhand. The approximate number of boarding students in Uttarakhand is about 75000. The per student hot water demand is estimated to be around 20-25 LPD. Most of the residential schools have evening bathing time which is ideal for solar water heaters as the systems are at their maximum temperature at this stage and it reduces the night losses. Also during harsh winter seasons residential schools have vacations and that too matches with the low temperature output of the SWH system. The total hot water demand in Hostels and residential schools segment is estimated in the table below

Table 4-10: Total hot water demand in Hostels

Total No. of boarding students	Hot Water Requirement (LPD)	Total Hot Water Requirement (Million LPD)
75000	25	1.875

The penetration of SWH in Hostels and Residential schools is calculated in the table below

Table 4-11: Penetration of SWH in Hostels

Total Hot water demand (LPD)	Installed capacity of SWH in Hotels (LPD)	Penetration
1875000	131150	7%

The hot water demand in hostels and residential schools depends on the altitude of the place. Most of the Residential schools are located in Dehradun and a few are located in Nainital. The schools in Dehradun provide hot water from October to April i.e. 7 months, however in Nainital the demand is for almost round the year except during vacations. The predominant way of heating water is by using boilers based on wood/diesel. Awareness level in this segment is good, but supply chain deficiencies and poor after-sales support by the dealers is creating a hindrance in the penetration of SWH in this segment.

The SWH market in hostels segment has great potential due to the following factors .

- Results in large savings in terms of diesel and wood.
- Compatibility: Most of the boarding schools have evening bathing time, which matches with the maximum solar water heater output.

- Finance: Almost all of these educational schools and institutes are cash rich entities and generally have adequate financial capacity.
- Incentives: The upfront subsidy and electricity rebate of Rs 75 per 100 lpd system are attractive incentives
- Large roof spaces: Most of the hostels have large empty roof spaces and adequate roof space is available for the proper sizing of the solar system.
- Ease of Maintenance: As most of the hostels already have a dedicated staff for maintenance of the common facilities.

Case Study: Welham Boys School, Dehradun (5500 LPD)

Welham boys school has installed a total of 5500 (2500 + 1500 +1500) LPD ETC based system in 2009. The system provides hot water to three of the hostels of 200, 150 and 150 student capacity respectively. The system is properly designed and insulated and is performing up to the mark. The SWH system replaced the wood boiler and it is now acting as a back-up heating system, incase of overcast or rain etc.

The total cost of the system was Rs 12 lacs and they were able to get the central subsidy, but are still waiting for the state subsidy.

Some of factors which seem to be holding back the developments in this segment are

- Supply chain deficiencies and poor after-sales support by the dealers
- Delays in disbursal of subsidy by the SNA were one of the major complaints of the SWH user hostels.

- Incomplete installation. Some of the hostels have also reported leaks in the outer aluminum cladding of the insulated pipes through which rain water seeps inside and results in heat losses in piping

- Proper Backup heating is also critical. The auxiliary heating is required for 40-50 days in a year. The sizing of the backups was not done scientifically.

Case Study: Birla Vidya Mandir, Nainital (1500 LPD)

Birla Vidya Mandir, Nainital is situated at the top of a hill where clear sunshine is available from early morning to late evening. In 2009 they have installed a 1500 LPD ETC based SWH system in one of the senior students hostel to provide hot water to the students for the purpose of bathing. Because of the non availability of a even a single SWH dealer in Nainital, **they got the system from a dealer in Delhi.** The SWH system replaced the wood boiler which is now acting as a back-up heating system, whenever there is overcast or rain etc.

The total cost of the system was Rs 2.5 lacs. They were able get the central as well as the state subsidy but are facing problems in availing the electricity rebate of Rs. 75 per 100 LPD.

The performance of the system is not up to the mark and users are partially satisfied with the system. They complained about breakage of tubes (mainly due to thermal shock, which the authorities were not aware of) and deposition of lime inside the tubes. However they were satisfied with the temperature of the hot water and the after sale support of the dealer.

Stake holder's Interviews:

The project team interviewed around 4-5 major dealers of SWH, 10 current and potential users, major banks and financial institutions and other utilities.

The main points emerging from the interviews with the SWH dealers were:

- Hostels and Hotels are the main market segments for them. Approximately, 70% of the sale is in commercial sector and 30 % in Residential sector. According to the sales figure residential market is also catching up.

- Some of the dealers were worried about the quality of ETC systems being installed and favoured more rigorous testing and certification of the ETC tubes and balance of systems.
- Complained about the delays in the disbursement of subsidy by SNA.
- Banks and other financial institutions are not very active in the solar thermal field in this region. They hesitate to do all the paper work for small amounts.
- Reported major problems of calcium deposition in the FPC system. Descaling is required every 3 years.
- According to them users are very happy with the electricity rebate scheme, it is acting as a prime mover for the residential systems. Electricity rebate is Rs 75/ 100 lpd per month.
- Most of the dealers and installers are against the capital subsidy type incentive and are in favor of indirect incentives directly given to the users without the involvement of the dealer or installer.
- Some of the dealers also proposed negative incentive scheme, as prevalent in Israel, according to the **negative incentiv**e the non user of SWH will have to pay higher electricity prices as they are wasting energy.

4.2.3 Industries

Due to heavy industrialization the power demand of the industrial sector has grown by another 20-30 per cent this year putting extra burden on the Uttarkhand Power Corporation Limited (UPCL), the government-run sole distribution company in the hill state. This summer UPCL faced an acute power shortage after the steep fall in the power generation of Uttarakhand Jal Vidyut Nigam Limited (UJVNL). The power generation of UJVNL fell to 7-8 million units, which is the lowest this season owing to falling discharge in major rivers in the wake of prolonged dry spell. The power demand in the state has reached 26 to 27 million units per day this season mainly due to heavy industrialization The total availability of power from UJVNL and other shares like central pool stands at 18 to 19 million units. In addition this, the UPCL is also resorting to power banking. With the return of the banked power, the

demand supply gap has increased to 10 to 11 million units per day for which UPCL is forced to overdraw power and resort to rostering.

Most of the top companies, which have set up units in the state, have also reported 15 to 20 per cent production loss owing to the power shortage, the industry sources said. Power cuts peaked at over 16 hours per day resulting in most units having to run entirely on Captive DG sets. Power tariffs are revised every 1st April and have also been rising steadily owing to the growing shortfall and now stand between Rs 4-4.50 per unit. The status of SWH installation of Industries in Uttarakhand is as follows

- There has been only a few SWH installation in industry and these projects are limited to use in Industrial Canteen. (Tata Motors and ITC Haridwar)
- Uttarakhand is a special category state under JNNSM and hence is eligible for a 60% capital subsidy. Hence project paybacks could be very attractive
- Industrial Applications for solar hold immense scope given the bleak power shortfall scenario in peak summer months which are peak shortage months and are also peak solar radiation months.
- Auto and Auto Component/ Pharma and biotechnology and food processing industries are major hot water consumers and may become thrust areas for use of SWH.
- Initially demonstration projects will need to be developed along with Industry as these applications will be relatively complex and require skilled project management.

Case Study: Aanchal Dairy, Lalkuan, Udham Singh Nagar

The Uttarakhand Cooperative dairy Federation Ltd (UCDF) came into existence as a successor body to the Uttar Pradesh Co-operative Dairy Federation Ltd. after the formation of Uttarakhand. Two SWHS units 15000 LPD each were installed in these dairies one of which was which was in Lalkua near Haldwani and the other in Dehradun.

The unit visited had previously installed 15000 LPD located in Lal Kuan near Haldwani . This unit was set up taking advantage of the capital subsidy scheme of the MNRE in the early eighties and was decommissioned in the 90's. These units were supplied by BHEL and worked satisfactorily initially. However over time there was no routine maintenance and the systems stopped functioning. Subsequently the unit was scrapped.

This experience with this unit highlights many learnings especially in the context of long term usage in public sector units and high capital subsidies.

One of the upcoming potential areas for introduction of SWH could be Residential Multi Storied apartments for the industrial executives and workers. Over 4000 odd residential apartments are coming in Udham Singh Nagar district and this can be an area to introduce this technology. Mandatory provisions are required to be drafted and strictly enforced to develop this niche market. Industrialization has also created a lot of hotels near the industrial estates. Two hotels Rudra Continental and APax were visited at Rudrapur, which have systems of 1500 and 1000 LPD. Both the installations are working satisfactorily.

4.3 Future Projections

As explained in Chapter 2, SWH demand projections are done under three scenarios. The projections are summarized in Table4.12 to4.15 for Uttarakhand, Dehradun, Nainital & Udham Singh Nagar respectively.

Table4.12: SWH Demand Projection for Uttarakhand (Cumulative installation in m^2 of collector area)

Scenario	Category	2010	2013	2017	2022
BAU	*Residential*	1,300	1,980	3,470	6,980
	Hotels	1,250	1,890	3,310	6,660
	Hospitals	310	470	820	1,650
	Hostel+ Others	2,620	3,990	6,980	14,030
	Total	**5,480**	**8,330**	**14,580**	**29,320**
Optimistic-I	*Residential*	1,300	1,980	5,110	16,710
	Hotels	1,250	1,890	4,880	15,950
	Hospitals	310	470	1,210	2,280
	Hostel+ Others	2,620	3,990	10,290	21,470
	Total	**5,480**	**8,330**	**21,490**	**56,410**
Optimistic-II	*Residential*	1,300	1,980	82,740	205,630
	Hotels	1,250	1,890	20,000	57,250
	Hospitals	310	470	1,210	2,280
	Hostel+ Others	2,620	3,990	10,290	21,470
	Total	**5,480**	**8,330**	**114,240**	**286,630**

Table4.13: SWH Demand Projection for Dehradun (Cumulative installation in m^2 of collector area)

Scenario	Category	2010	2013	2017	2022
BAU	*Residential*	1,080	1,640	2,860	5,760
	Hotels	1,270	1,930	3,380	6,790
	Hospitals	180	270	480	960
	Hostel+ Others	1,790	2,710	4,750	8,270
	Total	**4,320**	**6,550**	**11,470**	**21,780**
Optimistic-I	*Residential*	1,080	1,640	3,610	9,680
	Hotels	1,270	1,930	4,250	11,410
	Hospitals	180	270	600	1,500
	Hostel+ Others	1,790	2,710	5,980	11,570
	Total	**4,320**	**6,550**	**14,440**	**34,160**
Optimistic-II	*Residential*	1,080	1,640	16,300	40,580
	Hotels	1,270	1,930	9,280	24,040
	Hospitals	180	270	730	1,500
	Hostel+ Others	1,790	2,710	6,060	11,570
	Total	**4,320**	**6,550**	**32,370**	**77,690**

Table4.14: SWH Demand Projection for Nainital (Cumulative installation in m^2 of collector area)

Scenario	Category	2010	2013	2017	2022
BAU	*Residential*	90	130	230	460
	Hotels	270	420	730	1,470
	Hospitals	20	30	60	120
	Hostel+ Others	380	580	1,020	1,650
	Total	**760**	**1,160**	**2,040**	**3,700**
Optimistic-I	*Residential*	90	130	290	800
	Hotels	270	420	930	2,540
	Hospitals	20	30	70	200
	Hostel+ Others	380	580	1,300	2,310
	Total	**760**	**1,160**	**2,590**	**5,850**
Optimistic-II	*Residential*	90	130	9,120	24,030
	Hotels	270	420	2,660	7,210
	Hospitals	20	30	130	300
	Hostel+ Others	380	580	1,300	2,310
	Total	**760**	**1,160**	**13,210**	**33,850**

Table4.15: SWH Demand Projection for Udham Singh nagar (Cumulative installation in m^2 of collector area)

Scenario	Category	2010	2013	2017	2022
BAU	*Residential*	20	30	50	110
	Hotels	50	80	130	270
	Hospitals	10	20	30	50
	Hostel+ Others	100	160	280	560
	Total	**180**	**290**	**490**	**990**
Optimistic-I	*Residential*	20	30	60	170
	Hotels	50	80	160	410
	Hospitals	10	20	30	80
	Hostel+ Others	100	160	340	860
	Total	**180**	**290**	**590**	**1,520**
Optimistic-II	*Residential*	20	30	13,250	35,180
	Hotels	50	80	1,360	4,010
	Hospitals	10	20	110	260
	Hostel+ Others	100	160	450	930
	Total	**180**	**290**	**15,170**	**40,380**

Chapter 5: Himachal Pradesh

5.1: Introduction

Himachal Pradesh is located between 30"22' and 30"12' north latitude and between 75"47' and 79"4' east longitude. The state has a geographical area of 55673 km^2 which falls in the altitudes ranging from 350 to 7000 meters. Most of the area lies above 1000 meters and is mountainous. Kangra, Mandi and Shimla districtsv which lie at medium altitudes with respect to the state constitute almost 50% of the total population. The districts lying on the lower altitudes i.e. Una, Hamirpur, Bilaspur, Solan although smaller in terms of area, have higher population densities.

Figure 5-1: Map of Himachal Pradesh, Source: Wikipedia

The major contributor to the GDP of the state is Agriculture. Tourism also plays a predominant role. Himachal Pradesh is one of the most popular tourist destinations in India. The districts of Kangra, Chamba, Shimla and Kullu have popular hill stations. Lahaul Sapiti and Kinnaur are favored by adventure seekers. In 2009 HP attracted 1,14,37,155 tourists and has registered 17% growth in the tourist footfall.

The state has seen recent industrial growth with Solan, Sirmour and Una being the major industrial centers. Out of the 36849 registered industrial units in the state, 444 are medium and large scale units. About 900 new industrial units are coming up every year for the last 4 years.

Table 5-1: Population and household statistics of Himachal Pradesh as per census 2001

Population 6077248	Urban	594963
	Rural	5482285
Households 1229164	Urban	141582
	Rural	1087582

The climate in Himachal Pradesh changes drastically with the altitude. Generally at altitudes below 1000m i.e. districts of Una, Sirmaur, Solan, Hamirpur, Bilaspur and partly Kangra, the summers are warm with average temperatures around 30^{o}C and the winters are cold with average temperatures reaching 10^{o}C. The districts lying above 1000m constitute a major chunk of the tourist spots and experience heavy snowfall during winters.

5.2 Present Status of SWH

The total installed capacity of SWH in Himachal Pradesh was around 7.5 lakh LPD[7] till march 2010. Recently the Himachal government has made mandatory provisions for SWH in all the new housing complexes, hospitals and nursing homes, hotels and banquet halls, educational institutions and universities and hot water driven industries. However, the installation of SWH in new multistory residential buildings is still optional. These developments are expected to give major thrust to the growth of SWH industry in the state. For the sake of primary survey the districts of Kullu and Kangra were chosen as representative clusters

[7] Source: Himurja

Table 5-2: Distributions of installation wrt size in Himachal Pradesh

System Capacity (LPD)	No. of Installations
100	2981
200 -500	169
500 -1000	411
1000 -2000	81
2000 and above	43

Source: HIMURJA

The hot water usage months in the representative clusters of Himachal Pradesh is given in the table below

Table 5-3: Hot water usage months in representative clusters of Himachal Pradesh

Districts	Residential	Hotel	Hospital	Hostel
Kullu	8-12 Months	12 Months	12 Months	8-12 Months
Kangra	6-12 Months	12 Months	12 Months	6-12 Months

Source: Primary Survey conducted by project team

5.2.1 Residential

The total number of households in Himachal Pradesh as per the Census 2001 is given in the table below

Table 5-4: Household data of Himachal Pradesh as per Census of India 2001

Total No. of Households	Urban Households	Rural Households	Avg. Number of persons/ Household
1,529,664	203793	1325871	5

The installed capacity in residential sector is only 6638 m^2 at present which approximately caters to 1.6% of the total hot water demand in residential sector in the state. This sector accounts for almost 45% of the total installed capacity of SWH in the state and can be considered as a high potential market. Lack of awareness and marketing and cheap electricity tariff for residential sector are acting as major barriers in the growth of technology. Electricity is provided at a subsidized rate of Rs.1 to Rs.2.75 depending on the usage and therefore most people are not bothered about saving electricty. Most of the people using SWHs were quite satisfied with the performance of the system and have reported substantial

decrease in their electricity bill. The newer systems were mostly installed with the help of bank financing.

5.2.2 Commercial

Hotels

Owing to the high tourist footfall there are a number of hotels and guest houses established in different districts. There are almost 2150 hotels and guest houses in Himachal Pradesh. Almost 70% of these hotels exist in Kullu, Kangra and Shimla as these are the most prominent tourist destinations in Himachal Pradesh. Owing to their high altitudes they also have a perennial hot water requirement. To calculate the overall hot water demand, we have estimated around 52000 hotel rooms with an average consumption of 100 lpd per room.

Table 5-5: Total hot water demand in Hotels

Total No. of Hotel Rooms	Hot Water Requirement (LPD)	Total Hot Water Requirement (Million LPD)
51928	100	5.2

The penetration of SWH in the hotel segment is calculated in the table below

Table 5-6: Penetration of SWH in Hotels

Total Hot water demand (LPD)	Installed capacity of SWH in Hotels (LPD)	Penetration
5200000	450000	8.67%

The demand for hot water is for almost round the year irrespective of the altitude of the place. The predominant way of heating is boilers based on wood and diesel. Individual geysers in rooms are also prevalent in the smaller capacity hotels. Major consumption of hot water in hotels is for bathing, kitchen and laundry purposes. However most of the hotels except most high end hotels are outsourcing the laundry. These are usually the traditional *dhobi* services.

Awareness level of SWH technology in hoteliers is satisfactory. Himachal Pradesh hotels present a peculiar case of the deployment of SWH technology. In the districts of Kangra and Kullu alone around 15-20% hotels were using SWHs and the use has been growing constantly for the last 5 years. Even though the mandatory regulations are applicable only for the new hotels, many existing hotels have retrofitted installations. Banks have played an

instrumental role in increasing their deployment by providing subsidized loans. Users were quiet satisfied with the system performance and monetary savings. With the rising trend of the prices of electricity for commercial sector the penetration the SWH technology has become a prominent cost saving option for hotels owners with paybacks less than 3 years in most cases.

Case Study: Manali Hotels

Case study of SWH in hotels of Manali acts as a perfect example of results obtained by low interest and easy access of finance to the hotel owners for SWH technology. Banks here have provided easy collateral free financing using various RBI credit guarantee schemes which have funds earmarked for SSI sector. The main instrument used for providing these loans has been the RBI's CGTMSE (Credit Guarantee trust for Medium and small enterprises). Loans have also been speedily sectioned at the branch level as the manager has used his knowledge of local conditions and the credit history of the customers to provide hassle free loans. Meetings with the Local manager of the PNB bank reveal that they have provided loans over the last 3-4 years exceeding Rs 8000000 (8 million) for SWHs of total capacaity of approximately 50000 lpd. Their repayment record has been very good and they are willing to finance solar proposals in the future. Further information about the Manali experience can be found in Appendix-IV

Case Study – Meghavan Holiday Hotel, Mcleodganj, 1000LPD

Located at Bhagsu near McLeodganj, this was the first establishment of the area to install the system back in 2006. A 1000 LPD flat plate system with heat exchanger is providing hot water to 6 rooms out of the 15 in the hotel in order to just provide for the average occupancy. They were quiet satisfied with all aspects of the system and estimated the pay-back period of the system to be about 2.7 years. However, the insulation job didn't seem to have been done so well considering that the area even experienced snowfall and was susceptible to higher overnight heat losses. The electrical heating system is provided as a back-up support in the solar tank itself, however it is not considered as a best practice.

5.2.3 Institutional

Hospitals

This segment is a major hot water consumer; there are more than 310 health facilities in Himachal Pradesh, the total hospital beds including Nursing homes and primary health centers are more than 9000.

Table 5-7: Health care facilities and beds in Himachal Pradesh

Total no. of Health Facilities	317
Facilities with 20 or more In-Patient Beds	98
Total In-Patient Beds	9012

Source: http://www.hphealth.gov.in

To estimate hot water requirement in hospitals, per bed requirement of 30 lpd is assumed. The total requirement is estimated at 0.27 million lpd.

Table 5-8: Total hot water demand in Hospitals

Total No. of Hospital beds	Hot Water Requirement (LPD)	Total Hot Water Requirement (Million LPD)
9000	30	0.27

The penetration of SWH in hospital sector is calculated in the table below

Table 5-9: Penetration of SWH in Hospitals

Total Hot water demand (LPD)	Installed capacity of SWH in Hospitals (LPD)	Penetration
270000	25000	9.26%

The predominant way of heating is through individual geysers in operation theaters, wards etc. Major consumption of hot water in hospitals is for bathing of patients and their attendants in wards, hand washing and sterilization of equipments in operation theatre, kitchen and laundry purposes.

Most of the systems installed in hospitals are undersized and are used to provide for a part of their hot water requirement i.e. mostly for the In-patient wards.

Installations in government hospitals face another challenge. Proper maintenance both from the user and the installer is not done. Even large installations (10,000 LPD) have been done without a maintenance contract and many systems were not working after a while as they were in a state of neglect.

Case Study: Zonal Hospital, Dharamsala, 10000 LPD

A 10,000 LPD system in Zonal Hospital, Dharamsala. Reportedly non-functional according to people of the town. This gives a bad perspective about the technology to the local people.

5.3 Future Projections

As explained in Chapter 2, SWH demand projections are done under three scenarios. The projections are summarized in Table5.10, 5.11& 5.12 for Himachal Pradesh, Kullu and Kangra.respectively.

Table 5.10: SWH Demand Projection for Himachal Pradesh (Cumulative installation in m^2 of collector area)

Scenario	Category	2010	2013	2017	2022
BAU	*Residential*	4,660	7,080	12,390	24,930
	Hotels	9,000	13,690	23,940	48,150
	Hospitals	500	760	1,330	2,420
	Hostel+ Others	300	460	800	1,610
	Total	**14,460**	**21,990**	**38,460**	**77,110**
Optimistic-I	*Residential*	4,660	7,080	16,500	47,440
	Hotels	9,000	13,690	31,870	59,450
	Hospitals	500	760	1,770	2,420
	Hostel+ Others	300	460	1,060	3,050
	Total	**14,460**	**21,990**	**51,200**	**112,360**
Optimistic-II	*Residential*	4,660	7,080	53,220	119,750
	Hotels	9,000	13,690	31,870	59,450
	Hospitals	500	760	1,770	2,420
	Hostel+ Others	300	460	2,670	7,160
	Total	**14,460**	**21,990**	**89,530**	**188,780**

Table 5.11: SWH Demand Projection for Kullu (Cumulative installation in m^2 of collector area)

Scenario	Category	2010	2013	2017	2022
BAU	*Residential*	700	1,060	1,860	3,750
	Hotels	3,500	5,320	8,010	10,990
	Hospitals	200	300	430	540
	Hostel+ Others	400	610	710	830
	Total	**4,800**	**7,290**	**11,010**	**16,110**
Optimistic-I	*Residential*	700	1,060	2,180	5,330
	Hotels	3,500	5,320	10,890	15,390
	Hospitals	200	300	610	750
	Hostel+ Others	400	610	990	1,160
	Total	**4,800**	**7,290**	**14,670**	**22,630**
Optimistic-II	*Residential*	700	1,060	5,570	13,000
	Hotels	3,500	5,320	10,890	15,390
	Hospitals	200	300	610	750
	Hostel+ Others	400	610	990	1,160
	Total	**4,800**	**7,290**	**18,060**	**30,300**

Table 5.12: SWH Demand Projection for Kangra (Cumulative installation in m^2 of collector area)

Scenario	Category	2010	2013	2017	2022
BAU	*Residential*	800	1,220	2,130	4,280
	Hotels	1,900	2,890	4,170	5,720
	Hospitals	200	300	390	480
	Hostel+ Others	600	910	990	1,160
	Total	**3,500**	**5,320**	**7,680**	**11,640**
Optimistic-I	*Residential*	800	1,220	2,490	6,090
	Hotels	1,900	2,890	5,840	8,010
	Hospitals	200	300	550	680
	Hostel+ Others	600	910	1,390	1,620
	Total	**3,500**	**5,320**	**10,270**	**16,400**
Optimistic-II	*Residential*	800	1,220	18,100	46,080
	Hotels	1,900	2,890	5,840	8,010
	Hospitals	200	300	550	680
	Hostel+ Others	600	910	1,390	1,620
	Total	**3,500**	**5,320**	**25,880**	**56,390**

It is evident that there is high demand of hot water and hence potential for SWH in Himachal Pradesh. The market of these has grown rapidly for the last 5 years commensurate with the participation of private companies. However the awareness levels within different class of users is still varying. Among these the hoteliers seem to have grasped the benefits that the product ensures. However, the use of SWHs is still limited to places where a supply chain exists and users are assured about the after sales services. SWH can however only become a success if the largest class of users i.e. residential sector starts accepting the product and it becomes common place. Within these it is observed that the current users of SWHs are those who are aware or concerned about the energy shortages and environment and not necessarily those who can easily afford it. Some interventions that could help are –

1. A dedicated national or state level website exclusively on SWHs. It could provide all relevant information on SWH, Case Studies, Promotional Videos, List of Manufacturers approved by MNRE, Troubleshooting guide, Blog etc. A space where potential users could ask for price quotes or about system designs from installers. Could be also used as a portal where the users could register their systems so that the performance at district or state level can be measured.

2. Government can sponsor pilot projects for different kinds of users and also for different classes of users in each district of the state. These projects could be used to demonstrate the benefits of SWHs and should be open to scrutiny for public. Performance of these should be logged on site and be made available to anybody. It should be ensured that these are maintained well to achieve optimum performance. Among these hostels should be taken up seriously as they can bring awareness to a larger population spread over a larger area. HIMURJA could also organize interaction sessions in schools.

3. District level workshops for all kinds of users have to be organized on a regular basis till the market can sustain on its own.

4. Best Practices code should be formulated in different languages which can be used as a guide for installers. The systems should come with a checklist which the user can fill while installation to evaluate the quality of work done. This will also help him understand the drawbacks or advantages of his system's design or components.

5. The systems should be installed with a minimum components and performance warranty like any other product in the market.

6. Need to shortlist potential SWH companies interested in up scaling their production capacities or desiring to setup units in the state and promote them.

HIMURJA should consider it an important task to commission the systems installed in govt. buildings/institutes and formulate proper maintenance mechanisms for these with the help of the private companies. As these have been non functional for various reasons, they have given bad press to the technology.

Chapter 6 West Bengal

6.1 Introduction

West Bengal is a state in eastern regions of India and is the nation's fourth most populous with a population of 90,310,785 with an annual growth 1.4 % of population. West Bengal is the third largest contributor to India's GDP and ranks second in terms of number of voters in India. The Urban population is about 30 % whereas Rural Population of the state is about 70 % (No. of Urban Households is 45.54 Lakhs and no. of Rural Households is 111 Lakhs). As the scope of the project is limited to the Himalayan region therefore we have limited our work to the Darjeeling district only. The Darjeeling Himalayan hill region in the northern extreme of the state belongs to the eastern Himalaya.

West Bengal's climate varies from tropical savannah in the southern portions to humid subtropical in the north. The main seasons are summer, monsoon, a short autumn, and winter. While the summer in the delta region is noted for excessive humidity, the western highlands experience a dry summer like northern India. The Maximum temperature of the state observed in Purulia District is 47 ^{0}C in summer. Winter is mild over the plains a cold and dry northern wind blows in the winter, substantially lowering the humidity level. However, the Darjeeling Himalayan Hill region experiences a harsh winter. Minimum temperature has been observed as Sub Zero in the Darjeeling District. The average rainfall of the state varies from 800 mm in Purulia District to 2500 mm in Darjeeling District.

Darjeeling, a district of West Bengal state, spreads over 3149 km^2 of land. As per census of 2001, the population of the district was 1,609,172 with an urban share of 32.3%. Annual growth rate in population during 1991-2001 was 2.1%. As per census 2001, total numbers of households were 318,737 with an average household size of 5. Almost, 37.6% of the households are of permanent construction.

Figure 6-1: Map of West Bengal

6.2 Present Status of SWH

The existing installations in the Darjeeling city are around 7500 lpd. Annual sale is around 2500 lpd in the city. Households share 25% of the existing installation. FPC-ETC split up of existing installation is 90:10 while the split up for annual sale is 85:15. There are 3 assemblers, 3 national brand dealers and 1 other dealer in the city.

Table 6-1: Hot Water Demand Months

Districts	Residential	Hotel	Hospital	Hostel
Darjeeling (Urban)	12 Months	12 Months	12 Months	12 Months

Source: Primary survey conducted by project team

6.2.1 Residential

The total number of households in West Bengal as per the Census 2001 is given in the table below

Table 6-2: Household data from Census 2001

Total No. of Households	Avg. Number of persons/ Household
3 18,737	5

The total installed capacity of SWH in West Bengal is around 1.5 lakh LPD in domestic sector. The hot water demand varies with altitude; most of the West Bengal except Darjeeling and Jalpaiguri has a hot water requirement for 4-6 months, whereas Darjeeling and hilly parts of Jalpaiguri have round the year hot water requirement. The predominant ways of meeting the hot water requirement in residential sector in Darjeeling is through LPG (geysers & stoves), electric storage geysers and biomass. Mostly the hot water is required for bathing and kitchen cleaning purposes. The people in tarai and plain regions like Kolkata bathe at least once or twice in day however the people living in higher altitude areas like Darjeeling and Jalpaiguri take a bath once in two or three days, hence the hot water demand per person for bathing in the higher altitude areas is approximately one third to that of plain or tarai region. Most of the domestic systems are of 100 lpd to 300 lpd capacity. The users are partially satisfied with the product, most of them complaint about the poor after sale support of the dealers. The power supply scenario in the urban areas is satisfactory but cost of electricity is as high as Rs 4.27 per unit for the domestic consumer.

Case Study: Dr. Rajlawot Residence, Darjeeling (200LPD)

In view of the high cost of heating water through electric geysers, due to high electricity tarrifs and shortage of electricity, Dr. Rajlawot has installed a 200 LPD flat plate SWH system in 1999. The already installed electric geyser is now acting as a back-up system. The SWH has supply point in bathroom as well as in kitchen. The system is in a very good shape and its performance is up to the mark till now. The 200 LPD system in 1999 costs around Rs. 40000 and no subsidy was provided to them. As per the owners view they are able to get hot water from SWH system for 200-250 days in a year.

6.2.2 Commercial

Hotels:

This may become one of the high potential segment for SWH in Darjeeling. Darjeeling being the hilly area, the penetration analysis has been done only for the Darjeeling district. The breakup for the hotel rooms in Darjeeling is provided in the table below

Table 6-3: Hotels in Darjeeling

No. of Star Hotel	8
No. of Non Star but Registered Hotel	34
No. of Unregistered Hotel	70
No. of Guest Houses & Circuit Houses	22
No. of Rooms in all Categories	2,580
Annual Growth	9 %

The total hot water demand in Hotels in Darjeeling is estimated in the table below

Table 6-4: Total hot water demand in Hotels

Total No. of Hotel Rooms	Hot Water Requirement (LPD)	Total Hot Water Requirement (LPD)
2580	100	258000

The penetration of SWH in the hotel segment in Darjeeling is calculated in the table below

Table 6-5: Penetration of SWH in Hotels

Total Hot water demand (LPD)	Installed capacity of SWH in Hotels (LPD)	Penetration
258000	4000	1.55%

The demand for hot water is for almost round the year in Darjeeling. The predominant way of heating is through individual electric or LPG geysers in rooms. Major consumption of hot water in hotels is for bathing and kitchen purposes.

Case Study: Sinclairs Retreat, Darjeeling (3600 LPD)

Hotel Sinclairs Retreat was established in the year 1999 and consists of 69 rooms and is one of the most luxurious hotels in Darjeeling. Out of these 69 rooms, 18 are in the form of small cottages. As a measure to reduce the consumption and dependence on electricity, the hotel owners decided to install SWH in all the 18 cottages. A 200 LPD flat plate system was installed in each cottage in 2009. The SWH system provides hot water to bathrooms only. The user is partially satisfied with the performance of the system. The already installed geysers as well as a electric heating element in the solar tank acts as auxiliary support for the non sunny days. The hotel owners complaint about the poor after sale support and maintenance service of the dealer.

The overall cost of the cumulative 3600 LPD installed SWH system was around Rs. 8 Lakhs, they still have not received any kind of subsidy, rebate or benefits from the state or central govt or any other utility. Piping and installation has a share of 18-20% in the total cost, which roughly comes out to be around Rs. 45 per liter of installed capacity.

Case Study: Triveni Lodge, Darjeeling (300 LPD)

Triveni lodge is a guest house which was established in the year 1996 in the Kalimpong area of Darjeeling district and consists of 7 rooms. As a measure to reduce the consumption and dependence of electricity, the guest house owners decided to go for a environment friendly way to heat the water and hence installed a SWH system of 300 LPD capacity in 2004. The SWH system provides hot water to bathrooms and in the kitchen for cooking purposes. However the SWH system is not able to meet the full requirement of hot water and can be regarded as an undersized system. The user is partially satisfied with the performance of the system. The already installed geysers in individual rooms act as auxiliary support for the non sunny days. The Guest house owner complaint about the poor after sale support and maintenance service of the dealer.

The overall cost of the 300 LPD installed SWH system was around Rs. 70000, they still have not received any kind of subsidy, rebate or benefits from the state or central govt or any other utility. Extra piping and installation due to retrofitting has a share of around 15% in the total cost, which roughly comes out to be around Rs. 35 per liter of installed capacity.

6.2.3 Institutional

Hospitals:

The total hospital beds including Nursing homes in Darjeeling are about 250. However the use of hot water in small nursing homes is minimal therefore to calculate the hot water requirement we have considered only the beds of hospitals and major nursing homes. To estimate hot water requirement in hospitals, per bed requirement of 30 lpd is assumed. The total requirement is estimated at 0.87 million lpd.

Table 6-6: Total hot water demand in Hospitals

Total No. of Hospital beds	Hot Water Requirement (LPD)	Total Hot Water Requirement (LPD)
250	30	7500

The penetration of SWH in the hospitals segment in Darjeeling is calculated in the table 6.7

Table 6-7: Penetration of SWH in Hospitals

Total Hot water demand (LPD)	Installed capacity of SWH in Hospitals (LPD)	Penetration
7500	500	6.67%

The demand for hot water is for almost round the year in Darjeeling. The predominant way of heating is through individual geysers in operation theaters, Wards etc. Major consumption of hot water in hospitals is for bathing of patients and their attendants in wards, hand washing and sterilization of equipments in operation theatre, kitchen and laundry purposes. Awareness level of SWH technology in hospitals is very low. The hurdles in the penetration of SWH in Hospital sector are

- Very low awareness and skepticism about the performance of the technology due to less number of sunny days.
- The supply chain of the SWH is very weak. Most of the dealers have a history for providing poor maintenance and after sale support.

Hostels and Mess:

One of the largest potential segment for SWH in Darjeeling is Hostels and Messes. There are around 12-15 boarding schools in Darjeeling. The approximate number of residents in hostels in Darjeeling is about 2000. The per student hot water demand is estimated to be around 15-20 lt/student for bathing and 6-10 lts/student for cooking purposes. The total hot water demand in Hostels and mess segment is estimated in the table 6.8

Table 6-8: Total hot water demand in Hostels

Total No. of boarding students	Hot Water Requirement (LPD)	Total Hot Water Requirement (LPD)
2000	25	50000

The penetration of SWH in Hostels and Residential schools is calculated in the table 6.9

Table 6-9: Penetration of SWH in Hostels

Total Hot water demand (LPD)	Installed capacity of SWH in Hotels (LPD)	Penetration
50000	2000	4%

The hot water demand months in hostels and residential schools is almost round the year. The predominant way of heating water is by using individual electric geysers in bathrooms and kitchen.

Case Study: Garrison Engineers (MES), Darjeeling (1200 LPD)

Garrison Engineers is a Hostel for army representatives and was established in the year 2009 in the Sukna area of Darjeeling district and consists of 12 rooms. As per the new mandatory provisions by Military Engineering Services, a 1200 LPD SWH system is installed to take care of bathing and kitchen hot water requirements. The SWH system provides hot water to individual bathrooms for bathing and in Mess for cooking and washing purposes. However the SWH system is not able to meet the full requirement of hot water and can be regarded as an undersized system but the user is satisfied with the performance of the system. Electric geysers in individual rooms act as auxiliary support for the non sunny days. The after sale service by the dealer is poor and the users are facing problems with the maintenance of the system.

The overall cost of the 1200 LPD installed SWH system was around Rs. 2.5 lakhs, they still have not received any kind of subsidy, rebate or benefits from the state or central govt or any other utility.

6.3 Future Projections

As explained in Chapter 2, SWH demand projections are done under three scenarios. The projections are summarized in Table 6.10 for West Bengal (Hilly Part).

Table6.10: SWH Demand Projection for West Bengal (Hilly part) (Cumulative installation in m^2 of collector area)

Scenario	Category	2010	2013	2017	2022
BAU	*Residential*	30	50	80	160
	Hotels	80	120	210	430
	Hospitals	10	20	30	50
	Hostel+ Others	40	60	110	210
	Total	**160**	**250**	**430**	**850**
Optimistic-I	*Residential*	30	50	130	480
	Hotels	80	120	350	1,290
	Hospitals	10	20	40	70
	Hostel+ Others	40	60	170	570
	Total	**160**	**250**	**690**	**2,410**
Optimistic-II	*Residential*	30	50	8,990	22,770
	Hotels	80	120	1,050	2,950
	Hospitals	10	20	40	70
	Hostel+ Others	40	60	230	570
	Total	**160**	**250**	**10,310**	**26,360**

Chapter 7 Sikkim

7.1 Introduction

Sikkim is a landlocked Indian state nestled in the Himalayas. It is the least populous state in India having a population of 5,40,493 and the second-smallest state after Goa. The Annual Growth of Population is 3.3 %. This thumb-shaped state borders Nepal in the west, the Tibet Autonomous Region of the People's Republic of China to the north and the east and Bhutan in the southeast. The Indian state of West Bengal borders Sikkim to its south. The rural population in Sikkim is about 89 %,(No. of Urban households is 18,888 and no. of Rural households is 1,09,955).

Despite its small area of 7,096 sq. kilometers , Sikkim is geographically diverse due to its location in the Himalayas. The climate ranges from subtropical to high alpine. Kangchenjunga, the world's third-highest peak, is located on the border of Sikkim with Nepal. Sikkim is a popular tourist destination owing to its culture, scenic beauty and biodiversity.

The climate ranges from sub-tropical in the south to tundra in the northern parts. The state has five seasons: winter, summer, spring, and autumn, and a monsoon season between June and September. Sikkim is one of the few states in India to receive regular snowfall. During the monsoon, heavy rains increase the possibility of landslides. The State receives an Annual Rainfall of 2000mm to 4000mm. In the northern region, because of high altitude, temperatures drop below −40 °C in winter. Fog also affects many parts of the state during winter and the monsoons, making transportation perilous. Most of the inhabited regions of Sikkim, however, witness a temperate climate, with the temperatures seldom exceeding 28 °C in summer.

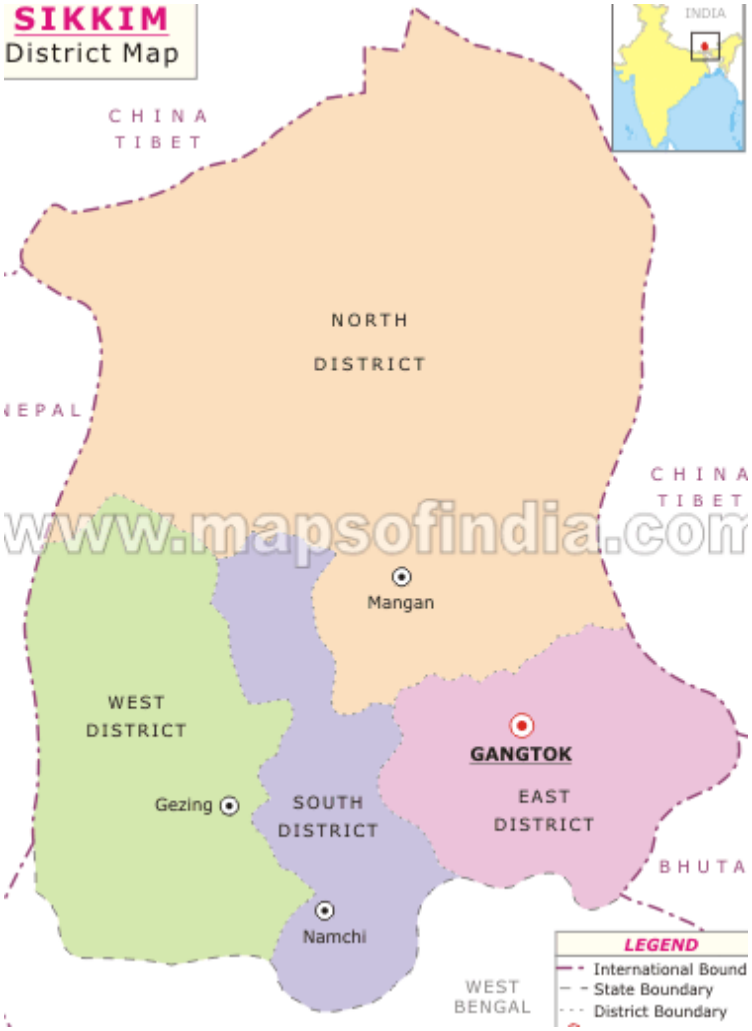


Figure 7-1: Map of Sikkim, Source: www.mapsofindia.com

7.2 Present Status of SWH in Sikkim

The total Installed capacity in Sikkim is around 20000 LPD. Households share 15% of the existing installation. For the sake of primary survey, East Sikkim district was selected as a representative cluster for the state of Sikkim. Overall 29 interviews were conducted from different categories of SWH users and non users.

Table 7-1: Hot Water Demand Months

Districts	Residential	Hotel	Hospital	Hostel
East Sikkim (Urban)	6-12 Months	12 Months	12 Months	12 Months

Source: Primary Survey data collected by project team

7.2.1 Residential

The total number of households in Sikkim as per the Census 2001 is given in the table below

Table 7-2: Household data for Sikkim by Census 2001

Total No. of Households	Urban Households	Rural Households	Avg. Number of persons/ Household
99247	11740	87507	5

The total installed capacity of SWH in Sikkim is around 4500 LPD in domestic sector. The hot water demand varies with altitude; most of the Sikkim except North district has a hot water requirement for 6-12 months, whereas North district has round the year hot water requirement. The predominant ways of meeting the hot water requirement in residential sector is through, electric storage geysers or electric immersion rods and LPG stoves. Mostly the hot water is required for bathing, kitchen (cooking & cleaning) and washing purposes. However the people living in higher altitude regions of Sikkim take bath once in two or three days, hence the hot water demand per person for bathing in the higher altitude areas is approximately one third to that of plain or lower altitude region. Most of the domestic systems are of 100 lpd to 300 lpd capacity. The users are partially satisfied with the product, most of them complained about the poor after sale support of the dealers. The power supply scenario in the urban areas is satisfactory and the electricity tariff is Rs 2.66 per unit for the domestic consumers.

Case Study: Mr. S.P.Wangdi, Residence, Gangtok (200LPD)

In view of the high cost of heating water through electric geysers, due to high electricity tarrifs, and shortage of electricity, Mr. Wangdi has installed a 200 LPD flat plate SWH system in 2009. The already installed electric geyser is now acting as a back-up system. The SWH has a supply point in the bathroom as well as the kitchen. The system is in a very good shape and its performance is up to the mark till now. The 200 LPD system costs around Rs. 40000 and no subsidy was provided to them till now. As per the owners view they are able to get hot water from SWH system for 200-250 days in a year. They are completely satisfied with the performance of the system. However the user feels that the technology is quite costly and is not in the affordable range for majority of the population.

7.2.2 Commercial

Hotels:

This is one of the largest hot water consuming segments of the state, there are around 100 hotels and more than 42 guest houses, in total there are around 1800 hotel + guest house rooms in Sikkim.

Table 7-3: Hotels in Sikkim

No. of Star Hotel	6
No. of Non Star but Registered Hotel	30
No. of Unregistered Hotel	65
No. of Guest Houses & Circuit Houses	42
No. of Rooms in all Categories	1800
Annual Growth	9 %

The overall hot water demand for hotels in the state is calculated in the table below:

Table 7-4: Total hot water demand in Hotels

Total No. of Hotel Rooms	Hot Water Requirement (LPD)	Total Hot Water Requirement (Million LPD)
1800	100	0.18

The penetration of SWH in the hotel segment in Sikkim is calculated in the table below

Table 7-5: Penetration of SWH in Hotels

Total Hot water demand (LPD)	Installed capacity of SWH in Hotels (LPD)	Penetration
180000	8000	4.4%

The demand for hot water is for almost round the year in Sikkim. The predominant way of heating is through individual electric storage geysers in rooms. Major consumptions of hot water in hotels are for bathing and kitchen purposes.

The project team visited around 4 SWH using hotels in East Sikkim and most of the users were complaining about the poor after sale service and maintenance support by the dealer. Weak supply chain in the state can be regarded as a main barrier for the deployment of SWH technology.

Case Study: The Junction Hotel, Gangtok (500 LPD)

The Junction Hotel was established in the year 2007 and consists of 18 rooms and is one of the main hotels in Gangtok. To reduce the consumption and dependence on electricity in an environment friendly way, the hotel owners decided to install SWH for its bathroom and kitchen requirements. A 500 LPD flat plate system was installed in 2010. The SWH system provides hot water to bathrooms and kitchen for cooking and washing purposes. The user is partially satisfies with the performance of the system. The already installed geysers act as auxiliary support for the non sunny days. The hotel owner complained about the poor after sale support and maintenance service of the dealer and delay in disbursement of subsidy by the govt.

The overall cost of the 500 LPD installed SWH system was around Rs. 90000, till now they have not received any kind of subsidy, rebate or benefits from the state or central govt or any other utility. Piping and installation has a share of 20-25% in the total cost. According to the user the SWH system can provide hot water for 200-250 days in a year.

7.2.3 Institutional

Hospitals:

This segment is also a major hot water consumer; there are more than 4 district hospitals, 2 referral hospitals, 4 community health centers, 171 primary health centers and 2 specialized health centers in Sikkim, the total hospital beds including primary health centers are around 1550. To estimate hot water requirement in hospitals, per bed requirement of 30 lpd is assumed. The total requirement is estimated at 46500 lpd.

Table 7-6: Total hot water demand in Hospitals

Total No. of Hospital beds	Hot Water Requirement (LPD)	Total Hot Water Requirement (LPD)
1550	30	46500

The penetration of SWH in Hospitals in Sikkim is calculated in the table below.

Table 7-7: Penetration of SWH in Hospitals

Total Hot water demand (LPD)	Installed capacity of SWH in Hospitals (LPD)	Penetration
46500	2500	5.38%

However, the project team was not able to identify a single installation in the hospitals in east district of Sikkim.

The demand for hot water is for almost round the year in Sikkim. The predominant way of heating is individual geysers in operation theaters, wards etc. Major consumption of hot water in hospitals is for bathing of patients and their attendants in wards, hand washing and sterilization of equipments in operation theatre, kitchen and laundry purposes. Awareness level of SWH technology in hospitals is very low. The hurdles in the penetration of SWH in Hospital sector are

- Very low awareness and skepticism about the performance of the technology due to less number of sunny days.
- The supply chain of the SWH is very weak. Most of the dealers have a history for providing poor maintenance and after sale support.

Monasteries governed Residential Schools :

This may be the most realizable potential segment for SWH in Sikkim. There are around 50 Monasteries governed residential schools in Sikkim. The approximate number students in Sikkim are about 2500. The per student hot water demand is estimated to be around 15-20 lt/student for bathing and 6-10 lts/student for cooking purposes. The total hot water demand in Monasteries governed residential schools is estimated in the table below

Table 7-8: Total hot water demand in Hostels

Total No. of boarding students	Hot Water Requirement (LPD)	Total Hot Water Requirement (Million LPD)
2500	25	62500

The penetration of SWH in Hostels and Residential schools is calculated in the table below

Table 7-9: Penetration of SWH in Hostels

Total Hot water demand (LPD)	Installed capacity of SWH in Hostels (LPD)	Penetration
62500	3500	5.6%

The hot water demand months in these residential schools may depend upon the altitude of the place but mostly in Sikkim the hot water demand is almost round the year. The predominant way of heating water is by using individual electric geysers in bathrooms and kitchen. The normal bathing time of the students is early morning at around 6-6.30 am.

Some of the factors which seem to be holding back the developments in this segment are

- Delays in disbursal of subsidy by the SNA were one of the major complaints of the SWH user hostels.
- The over-night heat losses are large, due to which they are not able to get the required temperature in the morning. This may be due to low quality of insulation on the tank and pipes or gaps in the pipeline or tank left un-insulated.
- In the morning the temperature of the inlet water is very low and when it gets mixed in the solar hot water tank, it lowers the temperature of the tank drastically.

Case Study: Dharma Chakra Center, East Sikkim (2000 LPD)

Dharma Chakra Center is a monastery governed residential school established in East Sikkim in the year 1965. It has an approximate capacity of 180 students and a morning bathing schedule. The hot water requirement is for bathing, kitchen cooking and washing purposes. In order to reduce the consumption and dependence on electricity in an environment friendly way, a 2000 LPD SWH system is installed to take care of the bathing and kitchen hot water requirements in 2009. The SWH system provides hot water to bathrooms for bathing and in Mess for cooking and washing purposes. Already installed Electric geysers in bathrooms and kitchen act as auxiliary support for the non sunny days. The user is partially satisfied with the performance of the system as they are not able to get the requisite temperature of water due to high over-night heat losses and cold water mixing in the tank.

The overall cost of the 2000 LPD installed SWH system was around Rs. 3 lakhs, they still have not received any kind of subsidy, rebate or benefits from the state or central govt or any other utility.

7.3 Future Projections

As explained in Chapter 2, SWH demand projections are done under three scenarios. The projections are summarized in Table7.10 & 7.11 for Sikkim & East Sikkim.

Table 7.10: SWH Demand Projection for Sikkim (Cumulative installation in m^2 of collector area)

Scenario	Category	2010	2013	2017	2022
BAU	*Residential*	120	190	320	640
	Hotels	160	240	430	860
	Hospitals	50	80	130	270
	Hostel+ Others	70	110	190	370
	Total	**400**	**620**	**1,070**	**2,140**
Optimistic-I	*Residential*	120	190	520	1,930
	Hotels	160	240	700	2,060
	Hospitals	50	80	220	420
	Hostel+ Others	70	110	300	720
	Total	**400**	**620**	**1,740**	**5,130**
Optimistic-II	*Residential*	120	190	2,100	4,870
	Hotels	160	240	860	2,060
	Hospitals	50	80	220	420
	Hostel+ Others	70	110	310	720
	Total	**400**	**620**	**3,490**	**8,070**

Table 7.11: SWH Demand Projection for East Sikkim (Cumulative installation in m^2 of collector area)

Scenario	Category	2010	2013	2017	2022
BAU	*Residential*	120	180	320	640
	Hotels	140	210	370	750
	Hospitals	50	80	130	270
	Hostel+ Others	50	80	130	270
	Total	**360**	**550**	**950**	**1,930**
Optimistic-I	*Residential*	120	180	410	1,110
	Hotels	140	210	480	1,300
	Hospitals	50	80	170	410
	Hostel+ Others	50	80	170	410
	Total	**360**	**550**	**1,230**	**3,230**
Optimistic-II	*Residential*	120	180	1,850	4,610
	Hotels	140	210	820	2,020
	Hospitals	50	80	200	410
	Hostel+ Others	50	80	200	410
	Total	**360**	**550**	**3,070**	**7,450**

Chapter 8 Arunachal Pradesh

8.1 Introduction

Arunachal Pradesh earlier an Union Territory, attained its statehood on 20th February 1987. It is situated in the North-Eastern part of India and has a long international border with Bhutan to the west (160 km), China to the north and north-east (1,080 km) and Myanmar to the east (440 km).

It stretches from snow-capped mountains in the north to the plains of Brahmaputra valley in the south. Arunachal is the largest state area-wise in the north-east region, even larger than Assam which is the most populous.

A distinct feature of the climate at Arunachal Pradesh is rainfall. In fact, Arunachal Pradesh experiences a heavy rainfall during May to September. The average annual rainfall recorded in Arunachal Pradesh is around 2800 mm.

Table 8-1: General information about Arunachal Pradesh

State	Arunachal Pradesh
Total Geographical Area	83,743 sq. km
Latitude	26028' and 29030' North
Longitude	97030' and 97030' East
No. of Districts	16
Population (2001)	1, 091, 117
Average Rainfall	2,782 mm

The climate of Arunachal Pradesh varies with elevation. Areas that are at a very high elevation in the Upper Himalayas close to the Tibetan border enjoy an alpine or Tundra climate. Below the Upper Himalayas are the Middle Himalayas, where people experience a temperate climate. Areas at the sub-Himalayan and sea-level elevation generally experience humid, sub-tropical climate with hot summers and mild winters.

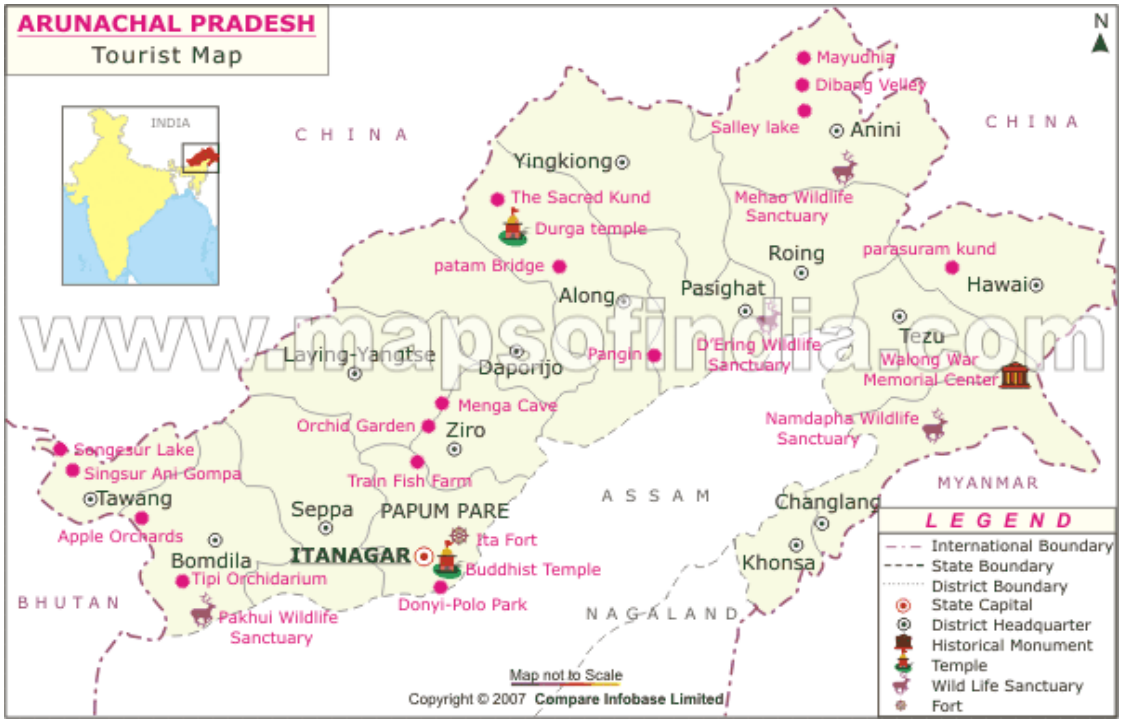


Figure 8-1: Map of Arunachal Pradesh, Source: www.mapsofindia.com

8.2 Present Status of SWH

The total Installed capacity in Arunachal Pradesh is around 24600 LPD. For the sake of primary survey, Papumpare and Tawang districts were selected as a representative cluster for the state of Arunachal Pradesh. Overall 20 interviews were conducted from different categories of SWH users and non users in each district.

Table 8-2: Hot Water Demand Month

Districts	Residential	Hotel	Hospital
Papumpare	12 Months	12 Months	12 Months
Tawang	12 Months	12 Months	12 Months

Source: Primary data collected by project team

8.2.1 Residential

The total number of households in Arunachal Pradesh as per the Census 2001 is given in the table below

Table 8-3: Household data as per Census 2001

Total No. of Households	Urban Households	Rural Households
198,281	45,006	153,275

The hot water demand varies with altitude; most of the Arunachal Pradesh has a hot water requirement for 6-12 months, whereas areas at very high elevation have round the year hot water requirement. The predominant ways of meeting the hot water requirement in residential sector is through, electric storage geysers or electric immersion rods and LPG stoves. Mostly the hot water is required for bathing, kitchen (cooking & cleaning).However about 40% land area of Arunachal Pradesh experiences highland climate with below sub zero temperature in winter. In these areas people want both hot water and room heating and as such, wood based water cum room heater is extensively used. This heating arrangement is commonly called Bukhari. However the people living in higher altitude regions of Arunachal Pradesh take bath once in two or three days, hence the hot water demand per person for bathing in the higher altitude areas is approximately one third to that of plain or lower altitude region. The SNA of Arunachal Pradesh as well as the project team was not able to find out any domestic SWH system in use. Hence we assume that the penetration of SWH in Residential segment in Arunachal Pradesh is nearly Nil. The power supply scenario in the urban areas is unsatisfactory and cost of electricity is as high as Rs 3.15 per unit for the domestic consumer.


Some photographs of Bukharis

It is found that even in Tawang almost 100% households use Bukharis. The households having room heaters keep Bukharis, as power supply in the town is quite erratic. In the above background there may not be much immediate demand of SWHs in the domestic segments in cold areas of Arunachal Pradesh.

8.2.2 Commercial

Hotels:

There are around 1600 hotel + guest house rooms in Arunachal Pradesh.

Table 8-4: Total hot water demand in Hotels

Total No. of Hotel Rooms	Hot Water Requirement (LPD)	Total Hot Water Requirement (Million LPD)
1600	100	0.16

The penetration of SWH in the hotel segment in Sikkim is calculated in the table below

Table 8-5: Penetration of SWH in Hotels

Total Hot water demand (LPD)	Installed capacity of SWH in Hotels (LPD)	Penetration
160000	8000	5%

The demand for hot water is for almost round the year in Arunachal Pradesh. Tawang being a major tourist spot and having clear sun in cold winter days has a good potential for solar hot water system particularly in hotels, guest houses and the monastery. The predominant way of

heating is through individual electric storage geysers, LPG stoves and LPG geysers. Major consumption of hot water in hotels is for bathing, kitchen and laundry purposes.

Case Study: Tawang Monastry Guest house, Tawang (2000 LPD)

Tawang monastery is one of the largest monasteries in Arunachal Pradesh. There are approximately 500 inhabitants in the monastery. The hot water is required for bathing, cooking, washing utensils and the requirement is round the year. To reduce the consumption and dependence on LPG for cooking in an environment friendly way, the hotel owners decided to install SWH for preheating the water required for cooking purposes. A 2000 LPD ETC based system was installed in 2007 and it preheats around 30% of the cooking water. The user is completely satisfied with the performance of the system

According to the user the SWH system can provide hot water for 200-250 days in a year.

8.2.3 Institutional

Hospitals:

This segment is also a major hot water consumer, the total hospital beds including primary health centers are more than 2850. To estimate hot water requirement in hospitals, per bed requirement of 30 lpd is assumed. The total requirement is estimated to be around 86000 LPD.

Table 8-6: Total hot water demand in Hospitals

Total No. of Hospital beds	Hot Water Requirement (LPD)	Total Hot Water Requirement (LPD)
2872	30	86160

The penetration of SWH in Hospitals in Arunachal Pradesh is calculated in the table below:

Table 8-7: Penetration of SWH in Hospitals

Total Hot water demand (LPD)	Installed capacity of SWH in Hospitals (LPD)	Penetration
86160	3500	4%

The demand for hot water is for almost round the year in Arunachal Pradesh.. Awareness level of SWH technology in hospitals is very low. The hurdles in the penetration of SWH in Hospital sector are

- Very low awareness and skepticism about the performance of the technology due to less number of sunny days.
- The supply chain of the SWH is very weak. Most of the dealers have a history of providing poor maintenance and after sale support.

Case Study: General Medical Hospital, Tawang (2000 LPD)

General medical hospital is one of the oldest and largest hospitals in Arunachal Pradesh. The hot water is required for bathing of patients and their attendants in wards, hand washing and sterilization of equipments in operation theatre, kitchen and laundry purposes. The requirement of hot water is round the year. To reduce the consumption and dependence on electricity for heating water in an environment friendly way, a 2000 LPD ETC based solar water heater system is installed to provide hot water in the operation theater in 2009. The already installed electric storage geysers act as an auxiliary support for the non sunny days. The user is partially satisfied with the performance of the system and is unhappy with the after sale service and the maintenance requirements of the system.

Residential Schools :

This may be the most realizable potential segment for SWH in Arunachal Pradesh. The approximate number of residents in hostels in Arunachal Pradesh is about 4620. The per student hot water demand is estimated to be around 15-20 liter/student for bathing and 6-10 liter/student for cooking purposes. The total hot water demand in Monasteries governed residential schools is estimated in the table below

Table 8-8: Total hot water demand in Hostels

Total No. of hostel residents	Hot Water Requirement (LPD)	Total Hot Water Requirement (LPD)
4620	25	115500

The penetration of SWH in Hostels and Residential schools is calculated in the table below

Table 8-9: Penetration of SWH in Hostels

Total Hot water demand (LPD)	Installed capacity of SWH in Hostels (LPD)	Penetration
115500	4500	3.9%

The hot water demand is almost round the year. The predominant way of heating water is by using individual electric geysers in bathrooms and kitchen. The normal bathing time of the students is early morning at around 6-6.30 am.

Some of the factors which seem to be holding back the developments in this segment are

- Weak supply chain leading to poor after sale and service support.
- Huge over-night heat losses, due to which they are not able to get the required temperature in the morning. This may be due to low quality of insulation on the tank and pipes or gaps in the pipeline or tank left un-insulated.
- In the morning the temperature of the inlet water is very low and when it gets mixed in the solar hot water tank, it lowers the temperature of the tank drastically.

Case Study: Tawang Public School, Tawang (2000 LPD)

Tawang Public School is a residential school established in Tawang. It has an approximate capacity of 212 students. The hot water requirement is for bathing, kitchen cooking and washing, laundry and drinking purposes. In order to reduce the consumption and dependence on electricity in an environment friendly way, a 2000 LPD ETC based SWH system is installed to take care of bathing and kitchen hot water requirements in 2009. The SWH system provides hot water in Kitchen for cooking and washing purposes. Already installed Electric geysers in kitchen act as auxiliary support for the non sunny days. The user is partially satisfied with the performance of the system and are unhappy with after sale service and maintenance requirements of the system. They also feel that system is undersized and therefore it is not able to meet the demand.

Other Observations

1. Poor compliance to the mandatory regulations: In the Building By-Laws 2010 of the State, installation of Solar Assisted Water Heating System in certain class of buildings has been made mandatory. The provision in the By Laws is quoted below-

"No new building in the following categories in which there is a system of installation for supplying hot water shall be built unless the system of the installation is also having an auxiliary solar assisted water heating system: heating system:-

- Hospitals and Nursing Home Government and private Hotels, Motels, Lodges, Guest Houses, Tourist complex and Group Housing with the plot area of 3000 sq m with the plot area of 3000 sq m.
- Hostels of Schools, Colleges Universities and Training Centers with more than 100 Students.
- 3 Barracks of armed forces paramilitary forces police and Jails.
- Individual and Government residential buildings having more than 150 sq m. plinth area
- Functional Buildings of Railway Stations and Air Ports like waiting retiring rooms, rest rooms, inspection bungalows and catering units."

However these regulations are not being followed strictly. If the above provision of the Bylaws is properly implemented, a big market for SWH system will be automatically created in the State.

8.3 Future Projections

As explained in Chapter 2, SWH demand projections are done under three scenarios. The projections are summarized in Table8.10, 8.11 & 8.12 for Arunachal Pradesh, Tawang & Papumpare respectively.

Table 8.10: SWH Demand Projection for Arunachal Pradesh (Cumulative installation in m^2 of collector area)

Scenario	Category	2010	2013	2017	2022
BAU	*Residential*	6	13	15	30
	Hotels	160	240	430	860
	Hospitals	70	110	190	370
	Hostel+ Others	90	140	240	480
	Total	**326**	**503**	**875**	**1,740**
Optimistic-I	*Residential*	6	13	30	90
	Hotels	160	240	700	1,830
	Hospitals	70	110	300	770
	Hostel+ Others	90	140	390	1,320
	Total	**326**	**503**	**1,420**	**4,010**
Optimistic-II	*Residential*	6	13	4,930	12,390
	Hotels	160	240	780	1,830
	Hospitals	70	110	350	770
	Hostel+ Others	90	140	530	1,320
	Total	**326**	**503**	**6,590**	**16,310**

Table8.11: SWH Demand Projection for Tawang (Cumulative installation in m^2 of collector area)

Scenario	Category	2010	2013	2017	2022
BAU	*Residential*	2	3	5	10
	Hotels	10	20	30	50
	Hospitals	4	10	10	20
	Hostel+ Others	40	60	110	170
	Total	**56**	**93**	**155**	**250**
Optimistic-I	*Residential*	2	3	10	30
	Hotels	10	20	40	160
	Hospitals	4	10	20	40
	Hostel+ Others	40	60	170	230
	Total	**56**	**93**	**240**	**460**
Optimistic-II	*Residential*	2	3	270	700
	Hotels	10	20	130	350
	Hospitals	4	10	20	40
	Hostel+ Others	40	60	170	230
	Total	**56**	**93**	**590**	**1,320**

Table 8.12: SWH Demand Projection for Papumpare (Cumulative installation in m^2 of collector area)

Scenario	Category	2010	2013	2017	2022
BAU	*Residential*	30	40	70	150
	Hotels	60	90	160	320
	Hospitals	20	30	50	70
	Hostel+ Others	60	90	160	250
	Total	**170**	**250**	**440**	**790**
Optimistic-I	*Residential*	30	40	120	450
	Hotels	60	90	260	560
	Hospitals	20	30	80	90
	Hostel+ Others	60	90	260	350
	Total	**170**	**250**	**720**	**1,450**
Optimistic-II	*Residential*	30	40	810	2,080
	Hotels	60	90	260	560
	Hospitals	20	30	80	90
	Hostel+ Others	60	90	260	350
	Total	**170**	**250**	**1,410**	**3,080**

Chapter 9 Assam

9.1 Introduction

Assam is a northeastern state of India with its capital at Dispur. Located south of the eastern Himalayas, Assam comprises the Brahmaputra and the Barak river valleys along with the Karbi Anglong and the North Cachar Hills with an area of 30,285 square miles (78,438 km²).It is known for Assam tea, large and old petroleum resources, Assam silk and for its rich biodiversity. It is becoming an increasingly popular destination for wildlife tourism, and Kaziranga and Manas are both World Heritage Sites. Assam was also known for its Sal tree forests and forest products. A land of high rainfall, Assam is endowed with lush greenery and the mighty river Brahmaputra, whose tributaries and oxbow lakes provide the region with a unique hydro-geomorphic and aesthetic environment.

With the 'Tropical Monsoon Rainforest Climate', Assam is a temperate region and experiences heavy rainfall and humidity. Winter lasts from late October to late February. The minimum temperature is 6 to 8 degrees Celsius. Nights and early mornings are foggy, and rain is scanty. Summer starts in mid May, accompanied by high humidity and rainfall. The maximum temperature is 35 to 38 degrees Celsius, but the frequent rain reduces this. The peak of the monsoons is during June. Thunderstorms known as *Bordoicila* are frequent during the afternoons. Spring and Autumn with moderate temperatures and modest rainfall are the most comfortable seasons.

For the sake of primary survey two districts of Assam i.e. Karbi Anglong and N.C. Hills District which falls under the Indian Himalayan Region were selected. However, the two towns do not have much commercial activity or are not places of tourist attraction. Therefore they do not have much potential of using Solar Water Heater System (SWHS) at present.

Figure 9-1: Map of Assam, Source: Wikipedia

In view of the above Tinsukia and Dibrugarh districts (undivided Dibrugarh district) of upper Assam was taken under the study .

Following are the rationale of selecting the two districts

a) The upper Assam districts Tinsukia and Dibrugarh are situated in the foot of the Himalayan range and have similar geo-climatic characteristics as of the Himalayan region such as

i) High rain fall

ii) Low availability of solar energy

b) In order to have a more representative and realistic picture of Solar Hot Water Market potential in the upper Assam, both the districts of upper Assam were selected.

c) The two districts of Assam consists of a major industrial hub of the NE Region having concentration of –

i) Tea Estates

ii) Oil Industry

iii) Power Generating plants

iv) Coal Industry

v) Ancillary small industries and commercial activities incidental to the above mentioned industries

9.2 Present Status of SWH

The total Installed capacity in hilly parts of Assam is around 3300 LPD. For the sake of primary survey, Tinsukia and Dibrugarh districts were selected as a representative cluster for the state of Assam.

Table 9-1: Hot Water Demand Months

Districts	Residential	Hotel	Hospital	Industrial
Tinsukia	12 Months	12 Months	12 Months	12 Months
Dibrugarh	12 Months	12 Months	12 Months	12 Months

Source: Primary data collected by project team

9.2.1 Residential

The total number of households in Assam as per the Census 2001 is given in the table 9.2. However the scope of this project is limited to the hilly regions of Assam and for the calculation purposes it is assumed that 15% of the population of Assam lives in the hilly regions.

Table 9-2: Household data from Census 2001for Assam

Total No. of Households	Urban Households	Rural Households
4,781,863	683,807	4,098,056

The hot water demand varies with altitude; most of the Assam has a hot water requirement for 6-12 months, whereas areas at very high elevation have round the year hot water requirement. The predominant ways of meeting the hot water requirement in residential sector is through, electric storage geysers and LPG (stoves and geysers). Mostly the hot water is required for bathing and kitchen (cooking & cleaning) purposes. The project team was not able to find out any domestic SWH system in use in the selected districts. The power supply scenario in the urban areas is unsatisfactory and cost of electricity is as high as Rs 3.15 per unit to the domestic users.

9.2.2 Commercial

Hotels:

There are in total around 2520 hotel + guest house rooms in hilly regions of Assam.

Table 9-3: Total hot water demand in Hotels

Total No. of Hotel Rooms	Hot Water Requirement (LPD)	Total Hot Water Requirement (LPD)
2550	100	255000

The penetration of SWH in the hotel segment in Sikkim is calculated in the table below

Table 9-4: Penetration of SWH in Hotels

Total Hot water demand (LPD)	Installed capacity of SWH in Hotels (LPD)	Penetration
255000	750	0.3%

The demand for hot water is for almost round the year. The predominant way of heating is through individual electric storage geysers, LPG stoves, LPG geysers and natural gas geyser. Major consumption of hot water in hotels is for bathing, kitchen and boiled water for drinking purposes.

9.2.3 Institutional

Hospitals:

The total hospital beds including primary health centers are around 3000 in hilly regions of Assam. To estimate hot water requirement in hospitals, per bed requirement of 30 lpd is assumed. The total requirement is estimated at 0.6 Million LPD.

Table 9-5: Total hot water demand in Hospitals

Total No. of Hospital beds	Hot Water Requirement (LPD)	Total Hot Water Requirement (LPD)
3000	30	90000

The penetration of SWH in Hospitals in Assam (Hilly region) is calculated in the table below:

Table 9-6: Penetration of SWH in Hospitals

Total Hot water demand (LPD)	Installed capacity of SWH in Hospital (LPD)	Penetration
90000	1100	1.25%

The demand for hot water is for almost round the year. The predominant way of heating is through individual geysers in operation theaters, wards etc. Major consumption of hot water in hospitals is for bathing of patients and their attendants in wards, hand washing and sterilization of equipments in operation theatre and kitchen purposes.

9.2.4 Industrial

The major industries of the Oil refining, Coal and Power sectors as well as about 1/3 of the Tea Garden of the State are situated in the Tinsukia and Dibrugarh districts (undivided Dibrugarh district). The primary survey was carried out in 13 tea states and hot water demand for tea industry in the process is investigated. There are 182 Tea Gardens in Dibrugarh district and 75 in Tinsukia district (excluding small tea gardens)

In the Tea Estates hot water is used for the following

- Clean floor & machine
- In bungalows of Executives
- In Hospitals
- In canteens (preheating for cooking)
- For preparing tea served to the field workers

From the primary data collected from the 13 Tea Estates and projections made from these information, it is estimated that there are around 3800 electric geysers in the Tea Estates of the district. Further, the estimated demand for hot water for cleaning the floors and machine of factories and for making tea for field workers (preheating)is huge. The predominant way of heating the water for cleaning the floors and machines is through natural gas or Furnace oil.

The undivided Dibrugarh district has highest number of factories in the State. Though these industries do not have much direct requirement of hot water, the hospitals, Guesthouse and Bunglows / residence of executives /officers of the industries are the major hot water demand

segment. At present in the undivided Dibrugarh district requirement of hot water is met either by piped gas, electric geyser, LPG geyser or by burning fuel wood / waste materials.

From available information (from State Nodal Agency and other sources) it is found that there is only two solar hot water system of 200 LPD capacities in the undivided Dibrugarh district. These are in two Executive Bunglows of Oil India Ltd, Duliajan. The two systems are installed in mid 2009 are reportedly functioning satisfactory. In Guwahati, a dairy is reported to have a 2500 LPD SWH system for boiler preheat application and is saving 30% of the cost of the fuel. More details about the hot water requirement can be found in Appendix-V

9.2.5 Other Observations

1. Lack of awareness about economics and economic viability of solar hot water system.
2. High cost particularly of the FPC system. High carriage cost is one of the causes. A dealer has indicated the price of a 100 LPD system to be Rs. 28,550.00 at Guwahati.
3. Doubts about suitability of using ETC type SHW system in the NE Region, due to hail storms that occur in the region occasionally.
4. There is no regulation binding the hotels, hospitals and residential complexes to use solar hot water system.
5. Very poor after sale service.
6. Low marketing effort by the solar hot water companies/ dealers. It is found that one company–Rashmi industries sold quite a number of solar hot water systems in few years and users are satisfied with the system performance.
7. Low awareness creation and publicity activities from the side of the Government and the State agencies. None of the existing solar hot water user have availed the benefit of having SHW rebate in their electricity bill as provided the Electricity Regulatory Commission.
8. Most of the SHW systems installed in the Govt. Buildings (fully on Govt. grants) during late eighties and nineties became non functional (primarily due to negligence

of the users) within short time of installation. This had discouraged the concerned Govt. agencies and dealer to propagate such systems in Assam .

9. Though there is a Government of India scheme of bank loan at low interest rate for SHW system for NE States, household owners in general and Architect&Builders in particular are not aware of the scheme. The Nationalized bank, who are expected to motivate the potential users, are yet to play an active role. In fact when project team visited three Nationalized banks (State Bank of India, Canara Bank and Punjab & Sind Bank) the response was 'negative' and no bank official were willing to discuss about the scheme.

9.3 Future Projections

As explained in Chapter 2, SWH demand projections are done under three scenarios. The projections are summarized in Table9.7 & 9.8 for Assam (Hilly Part) and Tinsukhia & Dibrugarh.

Table 9.7: SWH Demand Projection for Assam (Cumulative installation in m^2 of collector area)

Scenario	Category	2010	2013	2017	2022
BAU	*Residential*	6	11	12	33
	Hotels	20	20	40	80
	Hospitals	20	30	60	120
	Hostel+ Others	20	30	60	120
	Total	**66**	**91**	**172**	**353**
Optimistic-I	*Residential*	6	11	23	100
	Hotels	20	20	70	240
	Hospitals	20	30	100	360
	Hostel+ Others	20	30	100	360
	Total	**66**	**91**	**293**	**1,060**
Optimistic-II	*Residential*	6	11	15,140	37,400
	Hotels	20	20	960	2,920
	Hospitals	20	30	310	810
	Hostel+ Others	20	30	960	2,890
	Total	**66**	**91**	**17,370**	**44,020**

Table 9.8: SWH Demand Projection for Tinsukhia & Dibrugarh(Cumulative installation in m^2 of collector area)

Scenario	Category	2010	2013	2017	2022
BAU	*Residential*	10	10	20	40
	Hotels	3	5	10	20
	Hospitals	3	5	10	20
	Hostel+ Others	4	10	10	20
	Total	**20**	**30**	**50**	**100**
Optimistic-I	*Residential*	10	10	30	130
	Hotels	3	5	10	50
	Hospitals	3	5	10	50
	Hostel+ Others	4	10	20	60
	Total	**20**	**30**	**70**	**290**
Optimistic-II	*Residential*	10	10	1,510	3,980
	Hotels	3	5	80	240
	Hospitals	3	5	350	980
	Hostel+ Others	4	10	90	230
	Total	**20**	**30**	**2,030**	**5,430**

Chapter 10 Meghalaya

10.1 Introduction

Meghalaya is situated in the north-eastern region of India, between the Brahmaputra valley in the north and the Bangladesh in the south. Meghalaya Plateau's elevation varies between 150 meters to 1961 meters above sea level. The highest point of the entire state is the Shillong peak whose elevation is about 1965m above sea level.

The Meghalayan sky seldom remains free of clouds. The average annual rainfall is about 2600 mm over western Meghalaya, between 2500 to 3000 mm over northern Meghalaya and about 4000 mm over south-eastern Meghalaya. There is a great variation of rainfall over central and southern Meghalaya. At Sohra (Cherrapunji), the average annual rainfall is as high as 12000 mm but in Shillong the average annual rainfall is around 2500 mm. The temperature in summer months varies from 18 to 25^{o}C and in winters it's between -6 to 16^{o}C. The solar insolation in the state ranges from 4.8-5.2 kWh/m2/day. Shillong and Cheerapunji are two major tourist destinations.

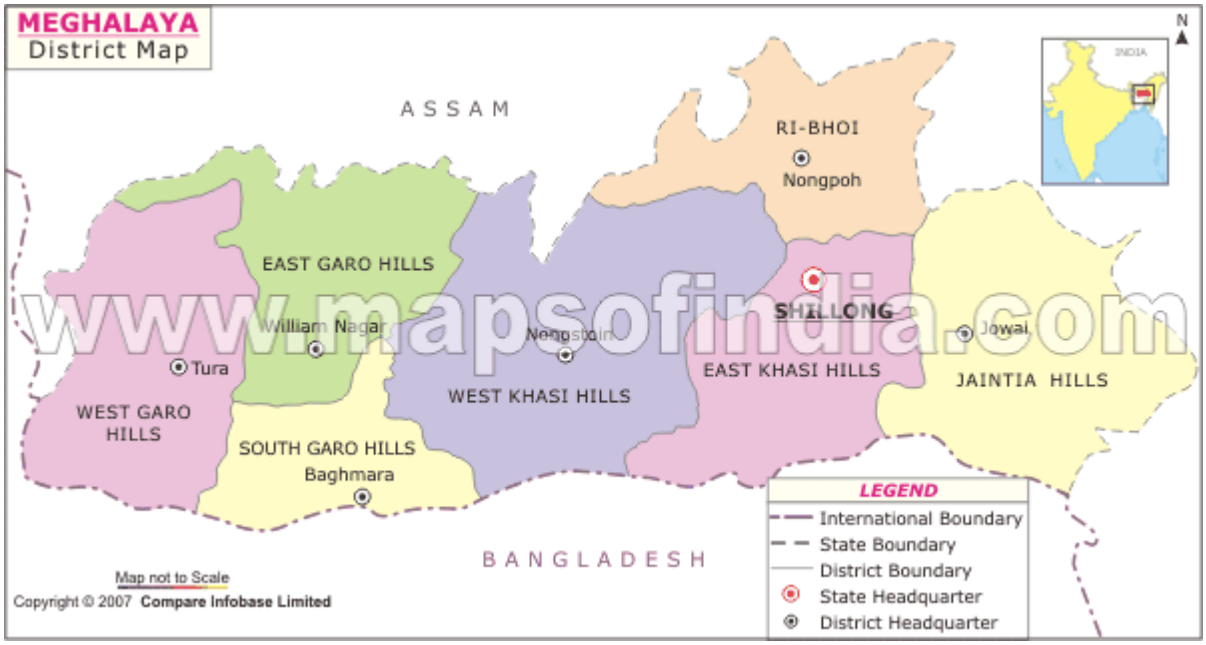


Figure 10-1: Map of Meghalaya, Source: www.mapsofindia.com

Table 10-1: General information about Meghalaya

State	Meghalaya
Area	22,720
Population	23,18,822
Capital	Shillong
Districts	7

10.2 Present Scenario of SWH

The total Installed capacity in Meghalaya is around 16500 LPD. For the sake of primary survey, East Khasi Hills district which contains the capital city of Shillong was selected as the representative cluster for the state of Meghalaya.

Table 10-2: Hot Water Demand Months

Districts	Residential	Hotel	Hospital	Hostels
East Khasi Hills	10 Months	12 Months	12 Months	12 Months

Source: Primary data collected by project team

10.2.1 Residential

The total number of households in Meghalaya as per the Census 2001 is given in the table below

Table 10-3: Household data from Census 2001

Total No. of Households	Urban Households	Rural Households
406,357	86,639	319,718

The hot water requirement for residential purposes is for 10-12 months in a year because of general cold weather and mild summers. The predominant ways of meeting the hot water requirement in residential sector is through, electric storage geysers and LPG (stoves and geysers). Mostly the hot water is required for bathing and kitchen (cooking & cleaning) purposes. Most of the users of SWH were partially satisfied with the performance for the two basic reasons; firstly the SWH could only provide hot water to them independently for 190-240 days (due to high non-sunny days in an year), and secondly, the after sales services and

maintenance support by the dealers is poor. The project team also found some poor installations in which the outer pipes were left uninsulated and hence the performance of the system was abysmal. Flat plate systems are enjoying the majority share in the market and 60% government subsidy helped dealers to sell a 100 LPD flat plate system at Rs. 9000-10000. The power supply scenario in the urban areas is unsatisfactory and cost of electricity is as high as Rs 3.15 per unit to the domestic users.

10.2.2 Commercial

Hotels:

There are more than 2380 hotel + guest house rooms in Meghalaya.

Table 10-4: Total hot water demand in Hotels

Total No. of Hotel Rooms	Hot Water Requirement (LPD)	Total Hot Water Requirement (LPD)
2383	100	238300

The penetration of SWH in the hotel segment in Meghalaya is calculated in the table below

Table 10-5: Penetration of SWH in Hotels

Total Hot water demand (LPD)	Installed capacity of SWH in Hotels (LPD)	Penetration
238300	4000	1.68%

The demand for hot water is for almost round the year in Meghalaya. The predominant way of heating is through individual electric storage geysers, LPG stoves, LPG geysers. Major consumptions of hot water in hotels are for bathing, kitchen and boiled water for drinking purposes.

10.2.3 Institutional

Hospitals:

The total hospital beds including primary health centers are around 3614. To estimate hot water requirement in hospitals, per bed requirement of 30 LPD is assumed. The total requirement is estimated at 1.08 lakh LPD.

Table 10-6: Total hot water demand in Hospitals

Total No. of Hospital beds	Hot Water Requirement (LPD)	Total Hot Water Requirement (LPD)
3614	30	108420

The penetration of SWH in Hospitals in Meghalaya is calculated in the table below:

Table 10-7: Penetration of SWH in Hospitals

Total Hot water demand (LPD)	Installed capacity of SWH in Hospitals (LPD)	Penetration
108420	5000	4.61%

The demand for hot water is for almost round the year in Meghalaya. The predominant way of heating is individual geysers in operation theaters, Wards etc. Major consumption of hot water in hospitals is for bathing of patients and their attendants in wards, hand washing and sterilization of equipments in operation theatre and kitchen purposes.

Residential Schools & Hostels :

The approximate number students living in hostels or resident schools in Meghalaya are more than 8000. The per student hot water demand is estimated to be around 15-20 lt/student for bathing and 6-10 lts/student for cooking purposes. The total hot water demand in residential schools and hostels is estimated in the table below

Table 10-8: Total hot water demand in Hostels

Total No. of boarding students	Hot Water Requirement (LPD)	Total Hot Water Requirement (Million LPD)
8000	25	0.2

The penetration of SWH in Hostels and Residential schools is calculated in the table below

Table 10-9: Penetration of SWH in Hostels

Total Hot water demand (LPD)	Installed capacity of SWH in Hostels (LPD)	Penetration
200000	500	0.25%

The hot water demand months is almost round the year. The predominant way of heating water is by using individual electric geysers in bathrooms and kitchen while some of the large hostels also use wood/diesel boiler to generate hot water.

10.3 Future Projection

As explained in Chapter 2, SWH demand projections are done under three scenarios. The projections are summarized in Table10.10 & 10.11 for Meghalaya & East Khasi Hills.

Table 10.10: SWH Demand Projection for Meghalaya (Cumulative installation in m^2 of collector area)

Scenario	Category	2010	2013	2017	2022
BAU	*Residential*	140	210	370	750
	Hotels	80	120	210	430
	Hospitals	100	150	270	540
	Hostel+ Others	10	20	30	50
	Total	**330**	**500**	**880**	**1,770**
Optimistic-I	*Residential*	140	210	610	2,260
	Hotels	80	120	350	1,290
	Hospitals	100	150	430	970
	Hostel+ Others	10	20	40	160
	Total	**330**	**500**	**1,430**	**4,680**
Optimistic-II	*Residential*	140	210	9,980	24,700
	Hotels	80	120	980	2,730
	Hospitals	100	150	460	970
	Hostel+ Others	10	20	760	2,320
	Total	**330**	**500**	**12,180**	**30,720**

Table 10.11: SWH Demand Projection for East Khasi Hills (Cumulative installation in m^2 of collector area)

Scenario	Category	2010	2013	2017	2022
BAU	*Residential*	10	20	30	50
	Hotels	70	110	190	390
	Hospitals	50	80	130	270
	Hostel+ Others	140	210	370	750
	Total	**270**	**420**	**720**	**1460**
Optimistic-I	*Residential*	10	20	40	160
	Hotels	70	110	310	1160
	Hospitals	50	80	220	810
	Hostel+ Others	140	210	610	2260
	Total	**270**	**420**	**1180**	**4390**
Optimistic-II	*Residential*	10	20	150	380
	Hotels	70	110	600	1410
	Hospitals	50	80	1100	3210
	Hostel+ Others	140	210	1780	4380
	Total	**270**	**420**	**3630**	**9380**

Chapter 11 Manipur

11.1 Introduction

Manipur is a state in northeastern India, with the city of Imphal as its capital. Manipur is bounded by the Indian states of Nagaland to the north, Mizoram to the south and Assam to the west; it also borders Myanmar to the east. It covers an area of 22,347 km^2.

The climate of Manipur is largely influenced by the topography of this hilly region which defines the geography of Manipur. Lying 790 meters above sea level, Manipur is wedged between hills on all sides. This northeastern corner of India enjoys a generally amiable climate, though the winters can be a little chilly. The maximum temperature in the summer months is 32 ^oC. In winter the temperature often falls below zero, bringing frost. Snow sometimes falls in some hilly regions due to the Western Disturbance. The coldest month is January, and the warmest July. The ideal time for tourism in the state, in terms of climate, is from October to February, when the weather remains bright and sunny without the sun being too hot.

The state is drenched in rains from May until mid-October. It receives an average annual rainfall of 1467.5 mm. However, the rain distribution varies from 933 mm in Imphal to 2593 mm in Tamenglong. The downpour ranges from light drizzles to heavy showers. The normal rainfall of Manipur enriches the soil and helps in agricultural processes and irrigation. The South Westerly Monsoon picks up moisture from the Bay of Bengal and heads toward Manipur, hits the eastern Himalaya ranges and produces a massive amount of rain in the state.

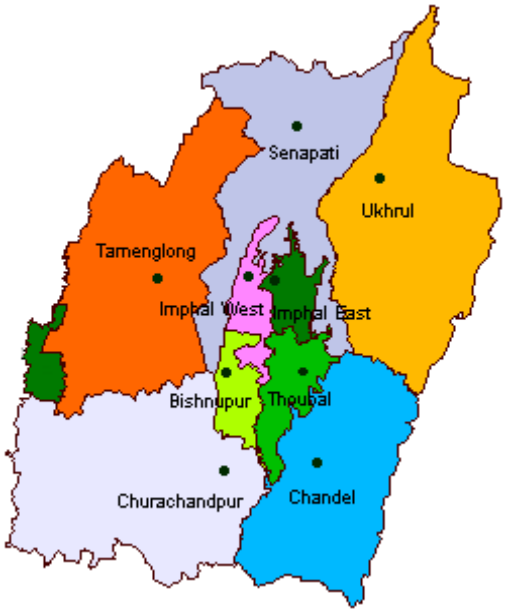


Figure 11-1: Map of Manipur, Source: Wikipedia

11.2 Present Status of SWH

The total Installed capacity in Manipur is around 12500 LPD.

11.2.1 Residential

The total number of households in Manipur as per the Census 2001 is given in the table below

Table 11- 1: Household Data from Census 2001

Total No. of Households	Urban Households	Rural Households
384,199	96,230	287,969

The hot water demand is almost round the year. The predominant ways of meeting the hot water requirement in residential sector is through, electric storage geysers and LPG (stoves and geysers). Mostly the hot water is required for bathing and kitchen (cooking & cleaning) purposes. The power supply scenario in the urban areas is unsatisfactory and cost of electricity is as high as Rs 3.20 per unit to the domestic users.

11.2.2 Commercial

Hotels:

There are around 730 hotel + guest house rooms in Manipur.

Table 11- 2: Total hot water demand in Hotels

Total No. of Hotel Rooms	Hot Water Requirement (LPD)	Total Hot Water Requirement (LPD)
733	100	73300

The penetration of SWH in the hotel segment in Manipur is calculated in the table below

Table 11- 3: Penetration of SWHs in Hotels

Total Hot water demand (LPD)	Installed capacity of SWH in Hotels (LPD)	Penetration
73300	1000	1.36%

The demand for hot water is for almost round the year in Manipur. The predominant way of heating is through individual electric storage geysers, LPG stoves, LPG geysers and natural gas geyser. Major consumption of hot water in hotels is for bathing, kitchen and boiled water for drinking purposes.

11.2.3 Institutional

Hospitals:

This segment is also a major hot water consumer; the total hospital beds including primary health centers are more than 3350. To estimate hot water requirement in hospitals, per bed requirement of 30 lpd is assumed. The total requirement is estimated to be around 1 Lakh LPD.

Table 11- 4: Total hot water demand in Hospitals

Total No. of Hospital beds	Hot Water Requirement (LPD)	Total Hot Water Requirement (LPD)
3361	30	100830

The penetration of SWH in Hospitals in Manipur is calculated in the table below:

Table 11- 5: Penetration of SWHs in Hospitals

Total Hot water demand (LPD)	Installed capacity of SWH in Hospitals (LPD)	Penetration
100830	5000	4.96%

The demand for hot water is for almost round the year in Manipur. The predominant way of heating is individual geysers in operation theaters, wards etc. Major consumption of hot water in hospitals is for bathing of patients and their attendants in wards, hand washing and sterilization of equipments in operation theatre and kitchen purposes.

Residential Schools & Hostels :

The approximate number of boarding students in Manipur is more than 10500. The per student hot water demand is estimated to be around 15-20 lt/student for bathing and 6-10 lts/student for cooking purposes. The total hot water demand in residential schools and hostels is estimated in the table below

Table 11- 6: Total hot water demand in Hostels

Total No. of boarding students	Hot Water Requirement (LPD)	Total Hot Water Requirement (Million LPD)
10760	25	0.269

The penetration of SWH in Hostels and Residential schools is calculated in the table below

Table 11- 7: Penetration of SWHs in Hostels

Total Hot water demand (LPD)	Installed capacity of SWH in Hostels (LPD)	Penetration
269000	500	0.19%

The hot water demand is almost round the year. The predominant way of heating water is by using individual electric geysers in bathrooms and kitchen while some of the large hostels also use wood/diesel boiler to generate hot water.

11.3 Future Projections

As explained in Chapter 2, SWH demand projections are done under three scenarios. The projections are summarized in Table11.8 for Manipur.

Table 11.8: SWH Demand Projection for Manipur (Cumulative installation in m^2 of collector area)

Scenario	Category	2010	2013	2017	2022
BAU	*Residential*	120	190	320	640
	Hotels	20	30	50	110
	Hospitals	100	150	270	540
	Hostel+ Others	10	20	30	50
	Total	**250**	**390**	**670**	**1,340**
Optimistic-I	*Residential*	120	190	520	1,940
	Hotels	20	30	90	320
	Hospitals	100	150	430	900
	Hostel+ Others	10	20	40	160
	Total	**250**	**390**	**1,080**	**3,320**
Optimistic-II	*Residential*	120	190	10,060	25,110
	Hotels	20	30	300	840
	Hospitals	100	150	430	900
	Hostel+ Others	10	20	1,010	3,080
	Total	**250**	**390**	**11,800**	**29,930**

Chapter 12 Mizoram

12.1 Introduction

Mizoram is one of the Seven Sister States in North Eastern India, sharing borders with the states of Tripura, Assam, Manipur and with the neighbouring countries of Bangladesh and Myanmar. Mizoram became the 23rd state of India on 20 February 1987.The capital of Mizoram is Aizawl.

Mizoram has a mild climate, comfortable in summer 20°C to 29°C and never freezing during winter, with temperatures from 11°C to 21°C. The region is influenced by monsoons, raining heavily from May to September with little rain in the dry (cold) season. The average state rainfall is 254 cm per annum. In the capital, Aizawl rainfall is about 208 cm and in Lunglei another major center about 350 cm.

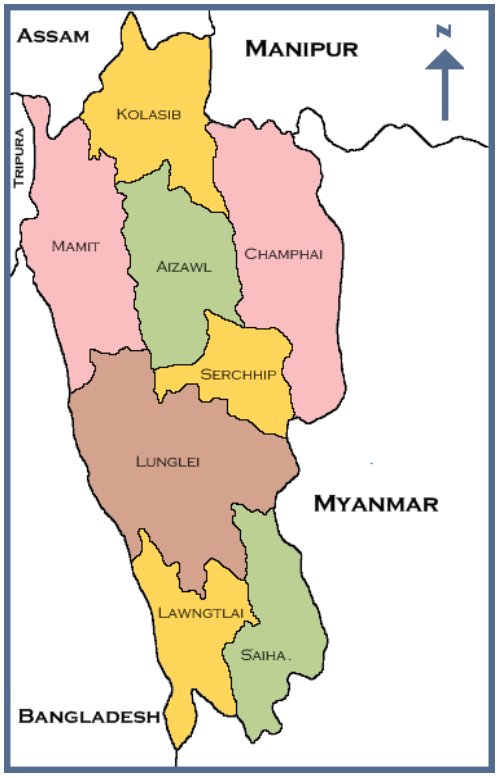


Figure 12-1: Map of Mizoram, Source: Wikipedia

12.2 Present Status of SWH

The total Installed capacity in Mizoram is around 10,850 LPD.

Table 12-1: SWH Capacity installed

Name of User	District	Capacity (LPD)	Use
Hospital	Aizawl	8000	Washing/Bathing
Institutes	Aizawl	3900	Washing/Bathing
Government	Aizawl	800	Washing
Hotel	Aizawl	500	Washing/Bathing

12.2.1 Residential

The total number of households in Mizoram as per the Census 2001 is given in the table below

Table 12- 2: Household Data from Census 2001

Total No. of Households	Urban Households	Rural Households
154,643	77,841	76,802

The hot water demand is almost round the year. The predominant ways of meeting the hot water requirement in residential sector is through, electric storage geysers and LPG (stoves and geysers). Mostly the hot water is required for bathing and kitchen (cooking & cleaning) purposes. The power supply scenario in the urban areas is unsatisfactory and cost of electricity is as high as Rs 3.20 per unit for the domestic users.

12.2.2 Commercial

Hotels:

There are around 280 hotel + guest house rooms in Mizoram.

Table 12- 3: Total hot water demand in Hotels

Total No. of Hotel Rooms	Hot Water Requirement (LPD)	Total Hot Water Requirement (LPD)
280	100	28000

The penetration of SWH in the hotel segment in Mizoram is calculated in the table below

Table 12- 4: Penetration of SWHs in Hotels

Total Hot water demand (LPD)	Installed capacity of SWH in Hotels (LPD)	Penetration
28000	500	1.8%

The demand for hot water is for almost round the year in Mizoram. The predominant way of heating is through individual electric storage geysers, LPG stoves, LPG geysers and natural gas geyser. Major consumption of hot water in hotels is for bathing, kitchen and boiled water for drinking purposes.

12.2.3 Institutional

Hospitals:

The total hospital beds including primary health centers are around 3000. To estimate hot water requirement in hospitals, per bed requirement of 30 lpd is assumed. The total requirement is estimated to be around 90000 LPD.

Table 12- 5: Total hot water demand in Hospitals

Total No. of Hospital beds	Hot Water Requirement (LPD)	Total Hot Water Requirement (LPD)
3000	30	90000

The penetration of SWH in Hospitals in Mizoram is calculated in the table below:

Table 12- 6: Penetration of SWHs in Hospitals

Total Hot water demand (LPD)	Installed capacity of SWH in Hospitals (LPD)	Penetration
90000	8000	8.9%

The demand for hot water is for almost round the year in Mizoram. The predominant way of heating is individual geysers in operation theaters, Wards etc. Major consumption of hot water in hospitals is for bathing of patients and their attendants in wards, hand washing and sterilization of equipments in operation theatre and kitchen purposes.

Hostels :

The approximate number of hostel residents in Mizoram is more than 6700. The per student hot water demand is estimated to be around 15-20 lt/student for bathing and 6-10 lts/student for cooking purposes. The total hot water demand in residential schools and hostels is estimated in the table below

Table 12- 7: Total hot water demand in Hostels

Total No. of hostel residents	Hot Water Requirement (LPD)	Total Hot Water Requirement (LPD)
6700	25	167500

The penetration of SWH in Hostels is calculated in the table below

Table 12- 8: Penetration of SWHs in Hostels

Total Hot water demand (LPD)	Installed capacity of SWH in Hostels (LPD)	Penetration
167500	4000	2.4%

The hot water demand is almost round the year. The predominant way of heating water is by using individual electric geysers in bathrooms and kitchen while some of the large hostels also use wood/diesel boiler to generate hot water.

12.3 Future Projections

As explained in Chapter 2, SWH demand projections are done under three scenarios. The projections are summarized in Table 12.9 for Mizoram.

Table 12.9: SWH Demand Projection for Mizoram (Cumulative installation in m^2 of collector area)

Scenario	Category	2010	2013	2017	2022
BAU	*Residential*	400	610	1,070	2,150
	Hotels	10	20	30	50
	Hospitals	160	240	430	810
	Hostel+ Others	80	120	210	430
	Total	**650**	**990**	**1,740**	**3,440**
Optimistic-I	*Residential*	400	610	1,730	6,450
	Hotels	10	20	40	160
	Hospitals	160	240	650	810
	Hostel+ Others	80	120	350	1,290
	Total	**650**	**990**	**2,770**	**8,710**
Optimistic-II	*Residential*	400	610	6,120	14,920
	Hotels	10	20	120	320
	Hospitals	160	240	650	810
	Hostel+ Others	80	120	720	1,920
	Total	**650**	**990**	**7,610**	**17,970**

Chapter 13 Nagaland

13.1 Introduction

Nagaland is a state located in the far north-eastern part of India. It borders the state of Assam to the west, Arunachal Pradesh and part of Assam to the north, Burma to the east and Manipur to the south. The state capital is Kohima, and the largest city is Dimapur. With a population of nearly two million people, it has a total area of 16,579 km² making it one of the smallest states of India. This farthest lying state in northeast, Nagaland, was born on 1 December 1963. The state is divided into eleven districts: Kohima, Phek, Mokokchung, Wokha, Zunheboto, Twensang, Mon, Dimapur, Kiphire, Longleng and Peren. It is a largely mountainous state. Agriculture is the most important economic activity in Nagaland. Principal crops include rice, corn, millets, pulses, tobacco, oilseeds, sugarcane, potatoes and fibres. Other economy boosters are Forestry, Cottage industries, Insurance, Real estate and Tourism

Nagaland is largely a mountainous state. The Naga Hills rise from the Brahmaputra Valley in Assam to about 2,000 feet (610 m) and rise further to the southeast, as high as 6,000 feet (1,800 m). Mount Saramati at an elevation of 12,552 feet (3,826 m) is the state's highest peak; this is where the Naga Hills merge with the Patkai Range in Burma. Rivers such as the Doyang and Diphu to the north, the Barak river in the southwest and the Chindwin river of Burma in the southeast, dissect the entire state. Nagaland has a largely monsoon climate with high humidity levels. Annual rainfall averages around 70–100 inches (1,800–2,500 mm), concentrated in the months of May to September. Temperatures range from 21 °C to 40 °C. In winter, temperatures do not generally drop below 4 °C, but frost is common at high elevations.

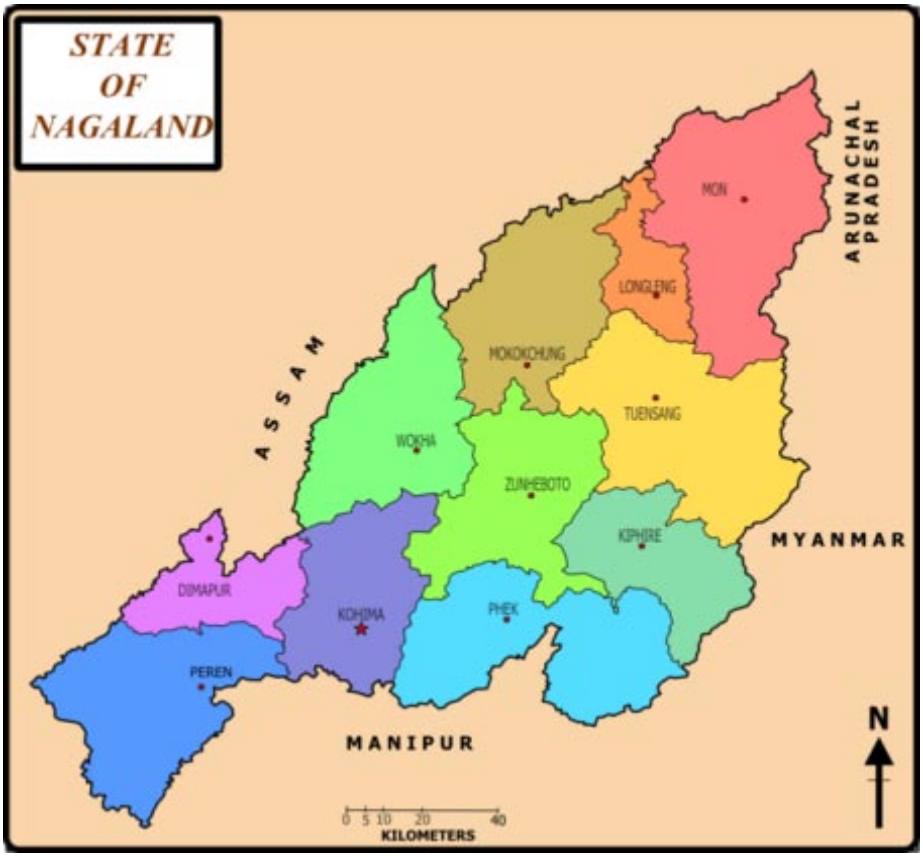


Figure 13-1: Map of Nagaland, Source: Wikipedia

13.2 Present Status of SWH

The total Installed capacity in Nagaland is around 17,650 LPD. In the entire state only 40 SWH installations has been done till now.

Table 13- 1: SWH Installations in Nagaland

City/Town	District	Total Nos.	Aggregate Capacity (LPD)
Kohima	Kohima	33	14,650
Khuzama	Kohima	1	100
Dimapur	Dimapur	3	300
Mokokchung	Mokokchung	1	100
Pfutsero	Phek	2	2,500
Total		**40**	**17,650**

13.2.1 Residential

The total number of households in Nagaland as per the Census 2001 is given in the table below

Table 13- 2: Household Data from Census 2001

Total No. of Households	Urban Households	Rural Households
320,810	62,633	258,177

The hot water demand is round the year. The predominant ways of meeting the hot water requirement in residential sector is through, electric storage geysers and LPG (stoves and geysers). Mostly the hot water is required for bathing and kitchen (cooking & cleaning) purposes. The power supply scenario in the urban areas is unsatisfactory and cost of electricity is as high as Rs 3.20 per unit for the domestic users.

13.2.2 Commercial

Hotels:

There are around 80 hotels and guest houses, in total there are around 1260 hotel + guest house rooms in Nagaland.

Table 13- 3: Total hot water demand in Hotels

Total No. of Hotel Rooms	Hot Water Requirement (LPD)	Total Hot Water Requirement (LPD)
1260	100	126000

The penetration of SWH in the hotel segment in Nagaland is calculated in the table below

Table 13- 4: Penetration of SWHs in Hotels

Total Hot water demand (LPD)	Installed capacity of SWH in Hotels (LPD)	Penetration
126000	1000	0.8%

The demand for hot water is round the year in Nagaland. The predominant way of heating is through individual electric storage geysers, LPG stoves, LPG geysers and natural gas geyser. Major consumption of hot water in hotels is for bathing, kitchen and boiled water for drinking purposes.

13.2.3 Institutional

Hospitals:

This segment is also a major hot water consumer; there are more than 40 hospitals in Nagaland, the total hospital beds including primary health centers are around 2850. To

estimate hot water requirement in hospitals, per bed requirement of 30 lpd is assumed. The total requirement is estimated to be more than 86000 LPD.

Table 13- 5: Total hot water demand in Hospitals

Total No. of Hospital beds	Hot Water Requirement (LPD)	Total Hot Water Requirement (LPD)
2882	30	86460

The penetration of SWH in Hospitals in Nagaland is calculated in the table below:

Table 13- 6: Penetration of SWHs in Hospitals

Total Hot water demand (LPD)	Installed capacity of SWH in Hospitals (LPD)	Penetration
86460	6000	6.9%

The demand for hot water is round the year in Nagaland. The predominant way of heating is individual geysers in operation theaters, Wards etc. Major consumption of hot water in hospitals is for bathing of patients and their attendants in wards, hand washing and sterilization of equipments in operation theatre and kitchen purposes.

Hostels :

The approximate number students in Nagaland are more than 5200. The per student hot water demand is estimated to be around 15-20 lt/student for bathing and 6-10 lts/student for cooking purposes. The total hot water demand in residential schools and hostels is estimated in the table below

Table 13- 7: Total hot water demand in Hostels

Total No. of boarding students	Hot Water Requirement (LPD)	Total Hot Water Requirement (Million LPD)
5260	25	131500

The penetration of SWH in Hostels and Residential schools is calculated in the table below

Table 13- 8: Penetration of SWHs in Hostels

Total Hot water demand (LPD)	Installed capacity of SWH in Hostels (LPD)	Penetration
131500	3600	2.75%

The hot water demand is almost round the year. The predominant way of heating water is by using individual electric geysers in bathrooms and kitchen while some of the large hostels also use wood/diesel boiler to generate hot water.

13.3 Future Projections and Key barriers:

As explained in Chapter 2, SWH demand projections are done under three scenarios. The projections are summarized in Table 13.9 for Nagaland.

Table 13-9: SWH Demand Projection for Nagaland (Cumulative installation in m^2 of collector area)

Scenario	Category	2010	2013	2017	2022
BAU	*Residential*	130	200	350	710
	Hotels	20	30	50	110
	Hospitals	120	180	320	640
	Hostel+ Others	70	110	190	390
	Total	**340**	**520**	**910**	**1,850**
Optimistic-I	*Residential*	130	200	560	2,110
	Hotels	20	30	90	320
	Hospitals	120	180	520	770
	Hostel+ Others	70	110	310	1,160
	Total	**340**	**520**	**1,480**	**4,360**
Optimistic-II	*Residential*	130	200	7,640	18,790
	Hotels	20	30	490	1,440
	Hospitals	120	180	520	770
	Hostel+ Others	70	110	570	1,510
	Total	**340**	**520**	**9,220**	**22,510**

Chapter 14 Tripura

14.1 Introduction

Tripura is a landlocked state in northeastern India with altitudes varying from 14 to 940m above sea level, though the majority of the population (27,57,205 – Census 2001)lives is plains. The 10491 km^2 area of the state is divided into 4 districts. Almost 50% of the population resides in West Tripura district. The state has a tropical climate with temperatures ranging between 20-36^oC in summers and 7-21^oC in winters. The state receives an average rainfall of 234.4 cm annually with around 90 rainy days occurring in a year. Most of the population is dependent on agriculture and allied services. The industrial sector of the state continues to be under developed.

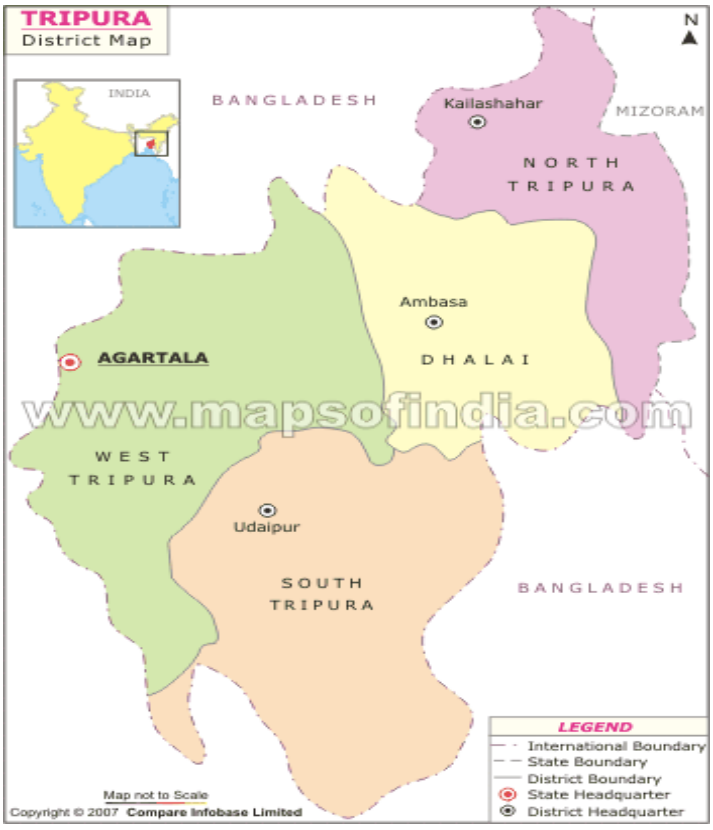


Figure 14-1: Map of Tripura, Source: www.mapsofindia.com

14.2 Present Status of SWH

The total Installed capacity in Tripura is around 10,000 LPD. Presently, there is no electricity bill rebate, property tax rebate being provided to the end user. There were no mandatory installation norms in place as well.

Table 14- 1: SWH installations in Tripura in the last two years

Year	System installed		Total
	No.	Capacity	
2007-08	2	500	6000
	5	1000	
2008-09	2	100	200

14.2.1 Residential

The total number of households in Tripura as per the Census 2001 is given in the table below

Table 14- 2: Household data from Census 2001

Total No. of Households	Urban Households	Rural Households
634,498	117,861	516,637

The survey findings revealed that hot water wasn't used for the summer months (April-September) but in the rest of the period there was use of hot water for bathing and washing clothes primarily. The predominant ways of meeting the hot water requirement in residential sector is through, electric storage geysers and LPG (stoves and geysers). Mostly the hot water is required for bathing and kitchen (cooking & cleaning) purposes. The power supply scenario in the urban areas is unsatisfactory and cost of electricity is as high as Rs 3.20 per unit for the domestic users.

14.2.2 Commercial

Hotels:

There are around 175 hotels of different categories in Tripura, most of which are concentrated in the South and West Tripura districts. The total no of hotel rooms in Tripura are more than 1350.

Table 14- 3: Total hot water demand in Hotels

Total No. of Hotel Rooms	Hot Water Requirement (LPD)	Total Hot Water Requirement (LPD)
1365	100	0.136

The penetration of SWH in the hotel segment in Tripura is calculated in the table below

Table 14- 4: Penetration of SWHs in Hotels

Total Hot water demand (LPD)	Installed capacity of SWH in Hotels (LPD)	Penetration
136000	3000	2.2%

The demand for hot water is almost round the year in Tripura. The predominant way of heating is through individual electric storage geysers, LPG stoves, LPG geysers. Major consumption of hot water in hotels is for bathing, kitchen and boiled water for drinking purposes.

14.2.3 Institutional

Hospitals:

There are more than 20 hospitals in Nagaland, the total hospital beds including primary health centers are more than 3450. To estimate hot water requirement in hospitals, per bed requirement of 30 lpd is assumed. The total requirement is estimated to be around 1 lakh LPD.

Table 14- 5: Total hot water demand in Hospitals

Total No. of Hospital beds	Hot Water Requirement (LPD)	Total Hot Water Requirement (LPD)
3455	30	103650

The penetration of SWH in Hospitals in Tripura is calculated in the table below:

Table 14- 6: Penetration of SWHs in Hotels

Total Hot water demand (LPD)	Installed capacity of SWH in Hospitals (LPD)	Penetration
103650	5000	4.82%

The demand for hot water is round the year in Tripura. The predominant way of heating is individual geysers in operation theaters, Wards etc. Major consumption of hot water in hospitals is for bathing of patients and their attendants in wards, hand washing and sterilization of equipments in operation theatre and kitchen purposes.

Hostels :

The approximate number students in Tripura are about 7000. The per student hot water demand is estimated to be around 15-20 lt/student for bathing and 6-10 lts/student for

cooking purposes. The total hot water demand in residential schools and hostels is estimated in the table below

Table 14- 7: Total hot water demand in Hostels

Total No. of boarding students	Hot Water Requirement (LPD)	Total Hot Water Requirement (LPD)
7060	25	176500

The penetration of SWH in Hostels is calculated in the table below

Table 14- 8: Penetration of SWHs in Hotels

Total Hot water demand (LPD)	Installed capacity of SWH in Hostels (LPD)	Penetration
176500	500	0.28%

The hot water demand in hostels is for 6-8 months in a year. The predominant way of heating water is by using individual electric geysers in bathrooms and kitchen.

14.2.4 Other Observation

The region on average receives 200 sunny, 75 partially cloudy and 90 rainy days in a year. The penetration of SWH in the state is poor. The few systems that have been installed are by the government agencies. Primary survey results revealed that the main deterrent was the initial costs associated with the product. People perceive it as an expensive product as there is not enough awareness about its benefits, not enough marketing and because they believe the product can't provide reliable services. This has happened as some have received a negative feedback of the systems that were installed.

14.3 Future Projections

As explained in Chapter 2, SWH demand projections are done under three scenarios. The projections are summarized in Table 14.9 for Tripura.

Table 14.9: SWH Demand Projection for Tripura (Cumulative installation in m^2 of collector area)

Scenario	Category	2010	2013	2017	2022
BAU	*Residential*	44	60	110	210
	Hotels	60	90	160	320
	Hospitals	100	150	270	540
	Hostel+ Others	10	20	30	50
	Total	**214**	**320**	**570**	**1,120**
Optimistic-I	*Residential*	44	60	180	640
	Hotels	60	90	260	970
	Hospitals	100	150	430	930
	Hostel+ Others	10	20	40	160
	Total	**214**	**320**	**910**	**2,700**
Optimistic-II	*Residential*	44	60	5,880	14,570
	Hotels	60	90	580	1,560
	Hospitals	100	150	440	930
	Hostel+ Others	10	20	670	2,020
	Total	**214**	**320**	**7,570**	**19,080**

Chapter 15 Jharkhand

15.1 Introduction

Jharkhand is a state in eastern India and is the nation's thirteenth most populous with a population of 26,909,428 and the Annual Growth of 2.3 % is recorded. It was carved out of the southern part of Bihar on 15 November 2000. The Urban population is about 22 % whereas rural population of the state is about 78 % (No. of Urban Households is 1,349,315 and no. of Rural Households is 4,489,207).

Jharkhand shares its border with the states of Bihar to the north, Uttar Pradesh and Chhattisgarh to the west, Orissa to the south, and West Bengal to the east. It has an area of 74,677 Square Kilometers. The industrial city of Ranchi is its capital while Jamshedpur is the largest city of the state. Some of the other major cities and industrial centers are Dhanbad, Bokaro and Hazaribagh.

Climate of the state in general is tropical with hot summers and cold winters. There are regional variations and some parts of the state like Ranchi, Netarhat, and Parasnath have a pleasant climate even during the summers. Maximum rainfall takes place during the months from July to September that accounts for more than 90% of total rainfall in the state. The Maximum and the Minimum Rainfall are 1900 mm and 600 mm respectively. Chhottanagpur consists of three smaller plateaus of Ranchi, Hazaribagh, and Koderma, and city of Ranchi is located at an altitude of 654 meters above sea level in the plateau of Ranchi. Ranchi was once the summer capital of Bihar. Ranchi has a salubrious climate. Temperature ranges from maximum 42 °C during summer and minimum 10 °C during winter.

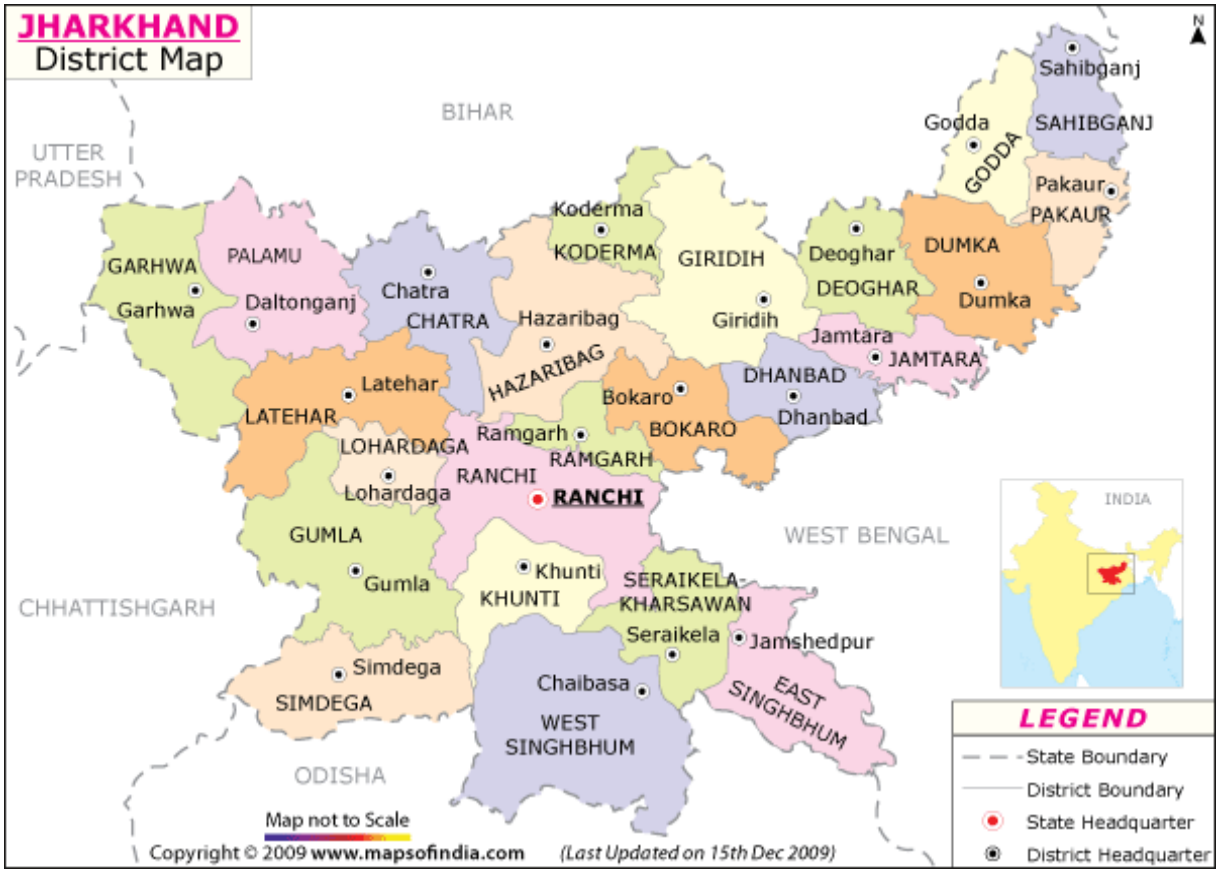


Figure 15-1: Map of Jharkhand, Source: Wikipedia

For the sake of primary survey, Ranchi was selected as a representative district for the state.

15.2 Present status of SWH

In the last five years, approximately 5.4 lakh LPD of SWH systems have been installed in Jharkhand. Most of the installations are in and around the capital Ranchi, which accounts for almost 65% of the total installation.

Table 15- 1: Hot water requirement in months[2]

Districts	Residential	Hotel	Hospital	Hostel
Ranchi (Urban)	6 Months (Oct to March)	12 Months	6-8 Months	6-8 Months (Oct to March)

15.2.1 Residential:

The total number of households in Jharkhand as per the Census 2001 is given in the table below

Table 15- 2: Household Data from Census 2001

Total No. of Households	Urban Households	Rural Households	Avg. Number of persons/ Household
4,461,360	1,006,395	3,454,965	5.2

In comparison to other districts, the concentration of domestic systems is higher in Ranchi, this perhaps can be attributed to better awareness and supply chain of SWH because of Ranchi being the state capital and the presence of JREDA as well as most of the manufacturers and installers having their base in Ranchi. This is a also a reflection of the fact the at the relatively affluent people who can afford a SWH system are based here and awareness level of the people are also higher as compared to other districts. The major hot water requirement in the residential sector is for bathing purposes. However some of the demand also exists for kitchen purposes during winters. The predominant way of heating water in the urban areas is either by using Electric Geysers or Immersion rods. The power supply scenario in the urban areas is satisfactory and the cost of electricity is Rs 3.00/kWh.

Most of the users are satisfied with the product, but few users' complained about the poor after sale support provided by the dealers.

Case Study: Mr. Rajesh Agarwal, Residence, Ranchi (500LPD)

In view of the high cost of heating water through electric geysers, due to high electricity tarrifs, Mr. Agarwal has installed a 500 LPD ETC based SWH system in 2009. The already installed electric geyser is now acting as a back-up system. The SWH has supply point in bathroom as well as in kitchen. The system is in a very good shape and its performance is up to the mark till now. The 500 LPD system costs around Rs. 90000 and Rs. 40000 was awarded as a subsidy to them. As per the owners view they are able to get hot water from SWH system for almost round the year. They are completely satisfied with the performance of the system. However the user feels that the awareness level of the technology in the residential sector is quite low.

15.2.2 Commercial

Hotels

This is one of the largest hot water consuming segments of the state, there are around 284 hotels and 220 guest houses, in total there are 6300 hotel + guest house rooms in Jharkhand.

Table 15- 3: Hotels in Jharkhand

No. of Star Hotel	20
No. of Non Star but Registered Hotel	114
No. of Unregistered Hotel	150
No. of Guest Houses & Circuit Houses	220
No. of Rooms in all Categories	6,300

The total hot water requirement in hotels is calculated in the table below:

Table 15- 4: Total hot water demand in Hotels

Total No. of Hotel Rooms	Hot Water Requirement (LPD)	Total Hot Water Requirement (Million LPD)
6300	100	0.63

The penetration of SWH in the hotel segment is calculated in the table below

Table 15- 5: Penetration of SWHs in Hotels

Total Hot water demand (LPD)	Installed capacity of SWH in Hotels (LPD)	Penetration
630000	55000	8.73%

The demand for hot water is for almost round the year irrespective of the altitude of the place. The predominant way of heating is through individual geysers in rooms. Major consumption of hot water in hotels is for bathing, kitchen and laundry purposes. However most of the hotels except most high end hotels are outsourcing the laundry. These are usually the traditional *dhobi* services.

Awareness level of SWH technology in hoteliers varies from place to place, in Ranchi awareness level is quite high as compared to other districts of the state.

Case Study: Chankya BNR Hotel, Ranchi (8000 LPD)

Chankya BNR Hotel is one of the most luxurious and main hotel in Ranchi. Established in the year 1985, it consists of 71 deluxe suites. To reduce the consumption and dependence on electricity in an environment friendly way, the hotel owners decided to install SWH for its bathroom, kitchen and laundry requirements. An 8000 LPD ETC based system was installed in the year 2010. The SWH system provides hot water to individual rooms, kitchen for cooking and washing purposes and in laundry area for washing. The user is partially satisfied with the performance of the system. Electric heating back-up in the tank acts as auxiliary support for the non sunny days. The hotel owner complained about the poor after sale support and maintenance service of the dealer.

The overall cost of the 8000 LPD installed SWH system was around Rs. 10.6 Lacs and the state nodal agency provided a capital subsidy of Rs. 6.4 Lacs.

15.2.3 Institutional

Hospitals

There are more than 22000 hospital beds in Jharkhand including the small clinics and primary health care centers. To estimate hot water requirement in hospitals, per bed requirement of 30 LPD is assumed. The total requirement is estimated at 0.66 million lpd.

Table 15- 6: Total hot water demand in Hospitals

Total No. of Hospital beds	Hot Water Requirement (LPD)	Total Hot Water Requirement (Million LPD)
22000	30	0.66

The penetration of SWH in hospital sector is calculated in the table below

Table 15- 7: Penetration of SWHs in Hotels

Total Hot water demand (LPD)	Installed capacity of SWH in Hospitals (LPD)	Penetration
660000	40000	6%

The demand for hot water is almost round the year. The predominant way of heating is individual geysers in operation theaters, Wards etc. Some large hospitals have boiler based on wood or diesel to meet their hot water demand. Major consumption of hot water in hospitals is for bathing of patients and their attendants in wards, hand washing and sterilization of equipments in operation theatre, kitchen and laundry purposes. Awareness level of SWH technology in hospitals is low.

Case Study: R.P. Hospital & Research center, Ranchi (3000 LPD)

R P Hospital and Research center is a newly constructed multi-specialty hospital containing 100 patient beds in Ranchi. The hot water is required for bathing by patients and their attendants in wards, hand washing and sterilization of equipments in operation theatre, kitchen and laundry purposes and the requirement is round the year. To reduce the consumption and dependence on electricity for heating water in an environmental friendly way, a 3000 LPD flat plate solar water heater system is installed to provide hot water in the wards, operation theater and kitchen since the inception of the building in 2009. Apart from electric back-up in the solar tank, the electric storage geysers in wards, OT and kitchen act as a auxiliary support for the non sunny days. The overall cost of the 3000 LPD flat plate SWH system was Rs. 4.92 lakhs. The state provided capital subsidy of Rs. 2.4 lakh.

Hostels & Residential Schools :

Jharkhand has a large number of residential schools and colleges. The approximate number students in Jharkhand are about 75000. The per student hot water demand is estimated to be around 15-20 lt/student for bathing and 6-10 lts/student for cooking purposes. The total hot water demand in residential schools and hostels is estimated in the table below

Table 15- 8: Total hot water demand in Hostels

Total No. of boarding students	Hot Water Requirement (LPD)	Total Hot Water Requirement (Million LPD)
75000	25	1.875

The penetration of SWH in hostels and residential schools is calculated in the table below

Table 15- 9: Penetration of SWHs in Hostels

Total Hot water demand (LPD)	Installed capacity of SWH in Hostels (LPD)	Penetration
1875000	270000	14.4%

The hot water demand in hostels is for 6-8 months in a year. The predominant way of heating water is by using individual electric geysers in bathrooms and kitchen

15.3 Future Projections

As explained in Chapter 2, SWH demand projections are done under three scenarios. The projections are summarized in Table 15.10 & 15.11 for Jharkhand & Ranchi.

Table15.10: SWH Demand Projection for Jharkhand (Cumulative installation in m^2 of collector area)

Scenario	Category	2010	2013	2017	2022
BAU	*Residential*	1,600	2,430	4,250	8,560
	Hotels	1,100	1,670	2,930	5,890
	Hospitals	800	1,220	2,130	4,280
	Hostel+ Others	5,400	8,210	14,360	21,470
	Total	**8,900**	**13,530**	**23,670**	**40,200**
Optimistic-I	*Residential*	1,600	2,430	5,480	15,110
	Hotels	1,100	1,670	3,770	7,210
	Hospitals	800	1,220	2,740	5,910
	Hostel+ Others	5,400	8,210	15,640	21,470
	Total	**8,900**	**13,530**	**27,630**	**49,700**
Optimistic-II	*Residential*	1,600	2,430	112,080	277,970
	Hotels	1,100	1,670	3,770	7,210
	Hospitals	800	1,220	2,980	5,910
	Hostel+ Others	5,400	8,210	15,640	21,470
	Total	**8,900**	**13,530**	**134,470**	**312,560**

Table 15.11: SWH Demand Projection for Ranchi (Cumulative installation in m^2 of collector area)

Scenario	Category	2010	2013	2017	2022
BAU	*Residential*	2,400	3,650	6,380	12,840
	Hotels	1,800	2,310	3,210	4,410
	Hospitals	600	910	1,600	2,150
	Hostel+ Others	1,000	1,040	1,130	1,320
	Total	**5,800**	**7,910**	**12,320**	**20,720**
Optimistic-I	*Residential*	2,400	3,650	8,220	22,670
	Hotels	1,800	2,740	4,500	6,170
	Hospitals	600	910	2,050	3,010
	Hostel+ Others	1,000	1,460	1,590	1,850
	Total	**5,800**	**8,760**	**16,360**	**33,700**
Optimistic-II	*Residential*	2,400	3,650	34,470	85,480
	Hotels	1,800	2,740	4,500	6,170
	Hospitals	600	910	2,050	3,010
	Hostel+ Others	1,000	1,460	1,590	1,850
	Total	**5,800**	**8,760**	**42,610**	**96,510**

Chapter 16 SWH in the Rural Areas

16.1 Introduction

Around 80% of the population of the Himalayan region lives in villages. One of the previous studies on energy use in households in Himachal Pradesh had reported that around 15% of the energy consumption in a typical rural household is for heating water[8]. Hot water is required for cooking, tea preparation, preparation of animal feed, as well as for bathing, cleaning and washing of clothes and utensils. The same study reported that on an average a rural household is using 3-5 kg of firewood/day for heating water. With a large part of the Himalayan region facing firewood shortage due to wide-spread deforestation, women and children have to spend long hours and walk long distances to collect firewood. Another study in the high-altitude Himalayan region in Nepal has linked the high incidence of disease like scabies to the poor hygiene arising due to non-availability of hot water. Thus it seems that utilization of solar energy for heating water in the rural areas of the Himalayan region can have significant environmental, social and economic benefits.

16.2 Experience of Using SWH in rural areas of the Himalayan Region

Despite the large potential of solar water heating, there are not many examples of application of solar water heaters in the rural areas of the Himalayan region. In terms of technology and ownership, two distinct types of experience exist:

1. A low-cost batch-type Solar Water Heater owned by individual household

2. A conventional Solar Water Heater managed by the community.

Low-cost SWH owned by individual households

The use of collector cum storage (batch) type water heaters is an example. There is some experience on this technology in Ladakh, where a local NGO – LeDEG has been involved in fabrication and dissemination of these water heaters. As mentioned in chapter 1, different

[8] Prasad Rakesh, Maithel S and Mirza Asim. Renewable energy technologies for fuelwood conservation in the Indian Himalayan region. Sustainable Development.

types of batch type solar water heaters have been popular in China (refer to figures in chapter 1), with almost 6 million such solar water heaters were estimated to be in use in the year 2000.

Collector cum storage type solar water heaters is particularly useful for meeting the hot water requirements during afternoon and evening. In these water heaters the cold water is filled in the morning and by afternoon the water is heated up and is available for use. The solar water heaters promoted by LeDEG consisted of a thin metal tank (painted black); has insulation at the back, and has a glass glazing on the front side. The systems in Ladkah have a capacity of 30 liters and have been found to provide at least 30 liters of water at a temperature of 50^{o}C for a minimum of 250 days in a year. It was estimated that a typical system would save 150 liter of kerosene per year. A study done in 1997-98 reported that LeDEG had installed 100 such systems[9]. In villages, particularly for persons engaged in agriculture, it is quite common to take bath in the evening and thus there is a good match between the hot water supply and demand. It is possible to make arrangements for insulating the storage tank to store hot water during night and making it available in the morning, however, such arrangement results in increasing the cost of the device.

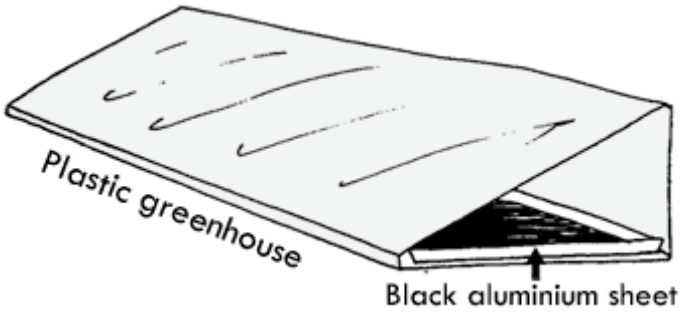
In recent years another NGO in Ladakh -- SECMOL has been using simple collector cum storage SWH at its campus near Leh. The description of the system is given in box below. These examples show the relevance of simple low cost SWH for meeting hot water demand in rural as well as small towns in the Himalayan region.

[9] Renewable Energy Master Plan for Ladakh. TERI /MNRE. 1998

Low-Cost Collector and Storage Type SWH by SECMOL, Leh

(Based on information provided at SECMOL website http://www.secmol.org)

SECMOL has designed a very low cost solar water heater from basic materials easily available. The cost of one 100 litre solar heater is Rs 3,500, whereas commercial ones cost Rs 25,000 per 100 litre. One of the advantages of this design over expensive commercial models is that it has no pipes inside that can freeze and break, so it can be used all winter without draining. Since it is basically a large shallow tray, if it freezes overnight, nothing breaks, and in the sunny morning it simply melts and starts warming up again.



Materials for construction are:

a. Aluminium sheet painted black, or black plastic.

b. Greenhouse plastic to cover it.

c. Frame made of mud bricks or wood.

d. A common toilet-tank valve if desired

The bottom is a black tray that can hold two inches (5 cm) of water. It must be black to absorb the solar radiation and convert it to heat, and can be made either of sheet metal bent up at the sides to form a tray, or commercial black pond-liner plastic (tough and UV resistant) and formed around a frame of bricks. SECMOL has also made one of cement and black tiles to preheat cooking water in the kitchen (because of the concern about consuming water heated on black paint or plastic.)

SECMOL experience shows that 3 feet (1 m) is a good maximum width to allow maintenance without walking on the base, and the tray can be as long based on space available. In case of SECMOL it is about 18 feet (5 m) long. The SWH is filled with water in the morning, and by 12 noon it makes 100 liter of 45°C water. Shallower will get hotter faster. A common toilet tank valve on the inlet pipe prevents overflow by automatically letting cold water in when warm water is drawn out, and cutting the supply when the water level reaches the desired height.

Conventional SWH owned by the community

Community owned SWH systems consists of a centrally located relatively large conventional SWH system. Generally these systems are either connected to a common bathroom and/or to a common hot water tap. The villagers can either take bath or can carry hot water in bucket to their houses. Most of such systems have been installed with 80-100 % subsidy. The systems are either managed by a community organistaion or by a local NGO. It is reported that in some cases these systems are managed by an entrepreneur though the details of this arrangement are not available.

We found examples of such projects in Himachal Pradesh, Sikkim, Jammu region and Nepal. In Himachal Pradesh, the concept has been used since 1990s. Initially a few such systems were supported by HIMURJA, later three projects were set-up by TERI under a research project (box 16.2). In recent years, some such SWH systems operated by an entrepreneur have been installed in Himachal Pradesh under a DST sponsored project (figure 16.1). It is also reported that the World Wildlife Fund (WWF) has recently supported community systems at Sikkim. We also visited a project put by JAKEDA in Jammu region.

Pilot Project On Use of Community Solar Water Heaters in Villages of Himachal Pradesh

The concept of community solar water heaters of about 750 lpd for small rural hill communities of about 15 households was successfully demonstrated at three sites in Himachal Pradesh. Involvement of villagers, particularly women and local NGOs was the highlight of the implementation approach. No major technical problem was faced during first two years of the operation. A simplified monitoring approach involving users in data collection was adopted for monitoring the performance of the installed SWHs. The data collected for the first year of operation showed that a 750 lpd community SWH resulted in fuel savings of about 18000 kg of fire wood per annum. During the monitoring, seasonal variation in hot water withdrawn from SWH as well as daily load profile for hot water use were also recorded. Economic analysis showed that the life-cycle cost per liter of hot water supplied from SWH was Rs 0.12/liter. On life cycle cost basis, the community solar water heater matches the present method of water heating using traditional chulha with firewood as fuel.

Source: R Prasad , S Maithel and A Mirza. Solar Water Heaters for Rural Communities in Indian Himalayas – Experiences from a Pilot Project in Himachal Pradesh. Proceedings of the 23rd National Energy Convention ' 99, Indore, December 20-22, 1999

The project team visited a new community Solar Water Heater System which was under installation by JAKEDA at hamlet, Hiranagar (Kathua District, J&K). The details of the system are as follows:

- Capacity of the system 1500 LPD
- FPC with Cu Absorber and Selective coating
- Year of installation – Aug 2010

- Purpose – to demonstrate and prov*id*e hot water for the 500 HHs of the hamlet
- Installed on the roof of the Community Center ; A village society has been formed to see to its regular maintenance

Figure16.1 Recently installed community system at Hiranagar, Dist Kathua, J&K

16.2 Primary Survey and Results

During the study, information was collected on hot water use in 15 villages spread across different states and varying altitudes (Table 16.1). Some of the villages were visited by the project team, in others information was collected through local NGOs or through the state nodal agencies. The purpose of these surveys was to gain understanding of hot water requirement in rural areas of the Himalayan region and also to make a list of villages for selecting model villages for demonstration projects under the UNDP/GEF Global Solar Water Heating Programme. The objective of the demonstration projects would be to disseminate SWH technology in rural areas of the Himalayan region that may lead up to a larger initiative focused on rural areas of the Himalayan region.

With the help of NGO - Himalayan Environmental Studies and Conservation Organization, HESCO, Dehradun, detailed primary survey in residential households was conducted in 5 villages of Uttarakhand. The project team also conducted primary survey in villages of J&K, HP and other North Eastern States. Primary survey questionnaires were used to get feedback and information from the households in the selected villages. It included questions about the construction of households, quantity/time/use of hot water, present method of heating water and on general characteristics of the village. The data has been summarized in Table 16.1.

Table 16.1: General characteristics and hot water demand in surveyed villagess

State	District	Village	No. of Households	Altitude (m)	No. of Hot water usage months/Year	Average Hot water requirement per household LPD	Primary fuel	Secondary fuel	Household survey status
J&K	Jammu	Gaink	500	350	2	60	Biomass	LPG	5
J&K	Kathua	Barotta	200	900	10	NA	NA	NA	None
J&K	Udhampur	Dhiari	300	850	8	NA	NA	NA	None
Himachal Pradesh	Kangra	Bandla	NA	1400	10	120	Biomass	LPG	15
Uttarakhand	Rudraprayag	Budhna	NA	800	6	70	Biomass	LPG	49
Uttarakhand	Uttarkashi	Barethi	145	1000	8	65	Electricity	Biomass	37
Uttarakhand	Uttarkashi	Basunga	NA	1000	8	80	LPG	Electricity/ Biomass	13
Uttarakhand	Dehradun	Jatowala	83	600	4	110	LPG	LPG/Biomass	50
Uttarakhand	Pithoragarh	Shatsilling	52	1800	12	30	LPG	Biomass	50
West Bengal	Darjeeling	7^{th} Mile	50-60	1200	8	100	Biomass	LPG	None
Sikkim	East Sikkim	Rumtek	90-100	1500	10	100	Biomass	LPG	None
Arunachal Pradesh	Tawang	Shyo Village	100	1500	12	100	Biomass	LPG	None
Assam	Dibrugarh	Tamuly Khat	250	300	5	50	Biomass		None
Assam	Dibrugarh	Tapar Gaon	400	300	5	50	LPG	Electricity/ Biomass	None
Meghalaya	East Khasi Hills	Mawphlong	1500	1800	12	50	Biomass	Charcoal	None

Number of months of hot water demand

Primary survey confirmed that while the demand for hot water for cooking and tea-making is present throughout the year (around 10-15 liter/ household), the number of months for which hot water is required for bathing and washing varies significantly with the climate and altitude (table 16.2)

Table 16.2 Number of months of hot water demand v/s altitude of the surveyed village

Altitude	Number of months of hot water demand
Low (0-600 m)	2-5 months
Medium (600-1500 m)	6-10 months
High (>1500 m)	12 months

Average hot water requirement per household

The average hot water requirement ranged from 50-120 litres/household/day (figure 16.3). The hot water usage was found to depend also on factors like income of the households and availability of piped water supply.

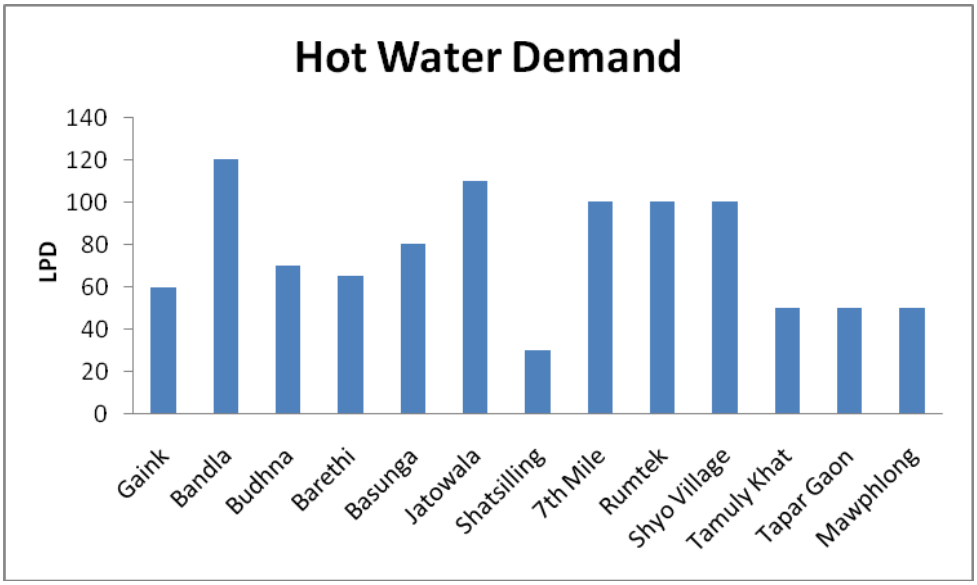


Figure 16.2: Hot water demand in the surveyed villages

Fuel/Device used for Heating Water

In most of the cases the cooking device i.e. a biomass stove or the LPG stove was the primary device for heating water and biomass and LPG the preferred fuels for heating water. In villages having better electricity supply, the use of immersion rods was observed. The use of storage type electric geysers was limited to relatively affluent villages situated near towns.

Awareness about SWH

In Himachal and Uttarakhand it was found that the villagers had some awareness about the product. This could be attributed to the fact that the villages were in close proximity of the towns and that there have been some installations done by comparatively educated and affluent people of the village in the past. This was however not the case in Jammu's Gaink village.

Fig 16.3: A 15 yr old Residential SWH installation in village Guggar (Dharamsala – Palampur Road)

Some more information on the villages is provided below:

Jatowala (UK) comprises of 486 residents housed in 83 households. The main occupation of the people is farming and contract labor work.

Altitude – 600m

Orientation – South-West Facing

Temperature Variation – 15 to 44^{o}C (Summer), 5 to 25^{o}C (Winter)

Climate – Subtropical

Other information – Good availability of piped water supply; willingness to spend some money on SWH; proximity to Dehradun town which has an established SWH supply chain; presence of NGO - HESCO

Barethi (UK) compromises of 700 people residing in 145 households. Prime occupation of the people is agriculture and some are engaged in government jobs.

Altitude – 1000m

Orientation – South-West Facing

Temperature Variation – 11 to 38^{o}C (Summer), 4 to 20^{o}C (Winter)

Climate – Temperate with occasional light snowfall in winters

Other information – Good availability of piped water supply; willingness to spend some money on SWH; hot water requirement for 8 months; fair awareness about SWHs; presence of NGO - HESCO

Shatsilling (UK) comprises of around 300 people residing in 52 households. Prime occupation is agriculture. The village has electricity supply and piped water supply.
Altitude: 1800 m
Climate – Temperate with snowfall in winters, occasionally sub-zero temperature during winter
Reason for selection - Availability of piped water supply; hot water requirement for 12 months; fair awareness about SWHs; presence of NGO – Kumaon Agriculture and Greenery Advancement Society (KAGAS)

Rumtek (Sikkim) comprises of around 450 people residing in 90-100 households. It is also visited by tourists and trekkers. The village households provide accommodation to these. The famous Rumtek Monastery is also located here. The village has electricity supply and piped water supply.
Altitude : 1500 m
Climate – Temperate with occasional snowfall in winters.
Other information - Availability of piped water supply; hot water requirement for 10 months; fair awareness about SWHs; presence of NGO – Rumtek Monsatery (Dharma Chakra Center), WWF.

7th Mile (WB) comprises of around 280 people residing in 50-60 households. Prime occupation is agriculture. The village has electricity supply and piped water supply.
Altitude: 1800 m
Climate: Temperate through the year with temperatures ranging from 7-27^{o}C.
Other information: Availability of piped water supply; hot water requirement for 8 months; fair awareness about SWHs; presence of NGO – North Bengal Alternative Energy and Rural Development Association.

Shyo village (Arunachal Pradesh) is located at the periphery of Tawang town and comprises of around 100 households. There is also a Buddhist Monastery located here with 500 inhabitants. The village has electricity supply and piped water supply.

Altitude: 1500 m

Climate: Temperate through the year

Other information: Availability of piped water supply; hot water requirement for 12 months; presence of NGO – Highlander's Society, Tawang; presence of Arunachal Pradesh Renewable Energy Development Agency at Tawang.

Tamuly Khat (Assam) is located in district Dibrugarh and comprises of around 250 households. The village has electricity supply and piped water supply.

Altitude: 300 m

Climate: Sub-Tropical

Other information: Presence of NGO – ABITA Gramin Krishi Unnayan Prakalpa, a society sponsored by the Assam branch of Indian Tea Association. A livelihood development project which includes sericulture is under implementation in the village by the society.

Mawphlong (Meghalaya) is located in district East Kashi Hills. It is around 20 km from Shillong and comprises of around 1500 households. There is also an Orphan Boys' Hostel in the village with around 170 inmates. The village has electricity supply and piped water supply.

Altitude: 1800 m

Climate: Temperate

Other information: Year round hot water requirement and presence of the NGO – Khashi Jayanti Presbyterian Assembly.

Barotta (J&K) is located in the Billawar area (Kathua district) of the state. It comprises of 200 households.

Altitude: 900 m

Climate: Temperate

Other information: Good requirement of hot water. Presence of women self help groups.

Dhiari (J&K) is located in Udhampur district and is in close proximity to both Katra and Udhampur towns. There are around 300 households in the village.

Altitude: 850 m approximately

Other information: Proximity to Katra and Udhampur, Katra being a high potential area of SWH use.

16.3 Model Villages/Clusters

It was proposed that three model villages/clusters will be identified in the study for the purpose of demonstration projects by UNDP/GEF & MNRE. The three selected model Village/Cluster are shown in table 16.3.

Table 16.3: Selected Model Villages/Clusters in the Himalayan Region

Model Village/Cluster	State	District	Altitude (m)	Reasons for Selection
Katra*	J&K	Udhampur	900	➢ Large Number of Hotels & Guest houses ➢ Religious Destination
Jatowala	Uttarakhand	Dehradun	600	➢ Proximity to a Capital City having a good base of manufacturer and dealers of SWH ➢ Presence of NGO
Shyo Village	Arunachal Pradesh	Tawang	1500	➢ Presence of a Buddhist Monastery ➢ Very near to Tawang town

*For detailed information about Katra refer Appendix-II

16.4 Proposal for an Action Plan for dissemination of SWH in rural areas of the Himalayan region

The rural areas of Himalayan region have around 8 million households. The survey results show that the firewood is the main source of fuel for heating water. Based on the results of the survey and earlier studies, if we assume that each rural household consumes 4 kg of firewood/ day for heating 50 litres of water/ day for 8 months in the year, the total annual firewood consumption works out to be around 8 million tons of firewood/year. By undertaking a large dissemination programme on solar water heaters a substantial savings in firewood can be achieved, which would have significant positive environmental impact. A solar water heating programme would also have social and economic benefits resulting from reduction in drudgery, saving of time in fuel collection, reduction in smoke and better health. Thus it is strongly recommended that UNDP-GEF solar water heating project along with the

Ministry of New and Renewable Energy should launch a large initiative to disseminate Solar Water Heaters in the rural areas of the Himalayan region.

We have tried to develop an action plan for such an initiative and the main activities are shown in figure 16.4 and are described below:

Activity 1: Design competition to select appropriate designs for promotion in rural areas

To develop low-cost, small-sized (50 LPD) solar water heater for domestic applications (including preheating of water for cooking, drinking and making tea) keeping in view the requirement of households located in rural/small-towns of the Himalayan region. A detailed note on the design competition is enclosed as **Annexure-I**

Activity 2. Pilot testing of the prototypes: Five prototypes of each of the selected designs (5-10 in numbers) would be tested to check the performance. The testing would consist of both lab testing as well as field testing with actual users. The designs would be improved based on the feedback received.

Activity 3: Evaluation of the community SWH models and currently available SWH technology for residential applications:

- A short-term study would be commissioned to evaluate the viability of the community SWH models and gauge its potential.
- Three villages/clusters would be selected to disseminate the currently available SWH technology. The three suggested project locations are provided in section 16.3

Activity 4.Technology transfer, training and promotion of local manufacturing capacity: For the sustainability of the initiative, the emphasis would be to promote local manufacturing. This would not only ensure better after-sales service but would also create employment opportunities for the local population. Local manufacturers would be identified and trained. Facilitation for organizing bank loans may also be required. At the end of this activity up to 20 local manufacturers are expected to be available for manufacturing of low-cost SWHs in the Himalayan region.

Activity 5. Pilot projects in around 30 villages (around 3000 SWH systems) through local entrepreneurs/ NGOs: It is proposed to undertake pilot projects in around 30 villages

to test both the acceptability of the various SWH products, the subsidy requirement as well as the business models for large-scale dissemination. Local entrepreneurs as well as NGOs would be eligible to run the pilot projects.

Activity 6. Launching of a dissemination programme: A programme for large-scale dissemination would be launched. The dissemination programme may be launched in phases, starting with states which are ready for the launch of the initiative.

Activity 7. Implementation of the dissemination programme to reach atleast 5% of the rural population by 2022 (50000 systems/ year): The aim of the dissemination progarmme would be to reach atleast 5% of the rural households by 2022. It is estimated that around 50,000 SWHs would have to be disseminated every year.

Table 16.4 Proposed activities for the dissemination of SWH in the rural areas of the Himalayan Region

Year	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Activities												
1.Design competition to select appropriate designs for promotion in rural areas												
2. Pilot testing of the prototypes												
3. Evaluation of community SWH models & currently available SWH technologies for residential applications												
4.Technology transfer, training and promotion of local manufacturing capacity and NGOs												
5. Pilot projects in around 30 villages (around 3000 SWH systems)												
6. Launching of a dissemination programme												
7. Dissemination programme to reach atleast 5% of the rural population by 2022 (50000 systems/ year)												

Chapter 17 Conclusions and Action Plan

17.1 Present status of SWH in Himalayan Region

The total installed capacity of SWHs in the Himalayan region (including Jharkhand) is estimated at around 33000 sq. m, which is less than 1% of the total installed SWH capacity in the country. The state-wise break-up is provided in table 17.1.

17.1 State-wise:

The situation for SWH varies across the states.

- Around 90% of the installations are concentrated in three states – Himachal Pradesh, Uttarakhand and Jharkhand.
- Himachal Pradesh as a market is better developed primarily on account of well developed sales and service network of a few manufacturers and success achieved in the hotel sector. Manali, Dharmshala and Shimla account for most of the installations.
- In Uttarakhand and Jharkhand the market is showing signs of development but still needs to consolidate to become a sustainable business. The two capital cities of Dehradun and Ranchi have the maximum number of installations.
- In Jammu as well as in Kashmir valley, the situation is not-encouraging with very few working installations outside of the defence establishments. Ladakh has longer history and experience with a variety of SWH systems. Ladakh Renewable Energy Developmet Agency (LREDA) under Ladakh Autonomous Hill Development Council has set a target of installing SWH 15000 m^2 by the year 2012, i.e. 7500 m^2 collector area in 2011 and the rest 7500 m^2 in 2012.Tenders for procuring the 7500 m^2 for 2011 has already been floated. LREDA proposes to provide a subsidy of 50% of the cost of the system for residential, 90% for government buildings, educational institutions, hospitals etc and 40% for the hotels, lodges and other commercial establishments. Refer Annexure-III for details.
- The Solar Water Heating programme in the Eastern and North Eastern India is yet to pick up. This region receives less solar radiation and has lesser number of sunny days. In Darjeeling and Sikkim the market is at a very nascent stage and only few installations are present. In the other North-Eastern states like Arunachal Pradesh,

Assam, Manipur, Mizoram, Nagaland, Meghalaya and Tripura the SWH installations are very few. Most of the existing installations are in the government organizations or installed under government programmes.

Table 17.1: Estimated installed capacity of SWHs* in the Himalayan States (in m^2)

States	2010
Himachal Pradesh	14,460
Jharkhand	8,900
Uttarakhand	5,480
J&K	1,680
Mizoram	650
Sikkim	400
Nagaland	340
Meghalaya	330
Arunachal Pradesh	326
Manipur	250
Tripura	214
West Bengal (Hilly Region)	160
Assam (Hilly Region)	66
Grand Total	**33256**

* Does not include army installations

17.2 Sector-wise

The adoption of solar water heating has not been uniform across all market segments.
The commercial and institutional sector comprising of hotels and hostels have been more forthcoming in adopting this technology. There has been some success achieved in hotels in Himachal Pradesh (Manali, Shimla and Dharmshala), but in other large tourist destinations (Jammu, Leh, Srinagar, Mussoorie, Nainital, Haridwar, Rishikesh, Darjeeling, Shillong, Tawang, Gangtok etc) the penetration of SWH remains very low.

The spread in the residential sector has been very limited. This is on account of the low level of awareness coupled with the low/ subsidized electricity tariffs being given by most of the state electricity boards to domestic consumers which acts as a disincentive. Though the requirement of hot water is a necessity in most of the rural areas particularly those located in the higher altitudes, in the absence of an appropriate product, the SWH use is almost non-existent.

In the industrial segment the market is yet to develop. A few installations are reported in industries in Haridwar but most of them are used to provide hot water for industrial canteens. The integration of SWH to provide hot water for process heat is not yet reported in any industrial clusters falling under the scope of this project. However this market (Jammu, Haridwar, Rudrapur, Dibrugarh, Tinsukia, Parwanoo) seems to have significant potential for the SWH technology.

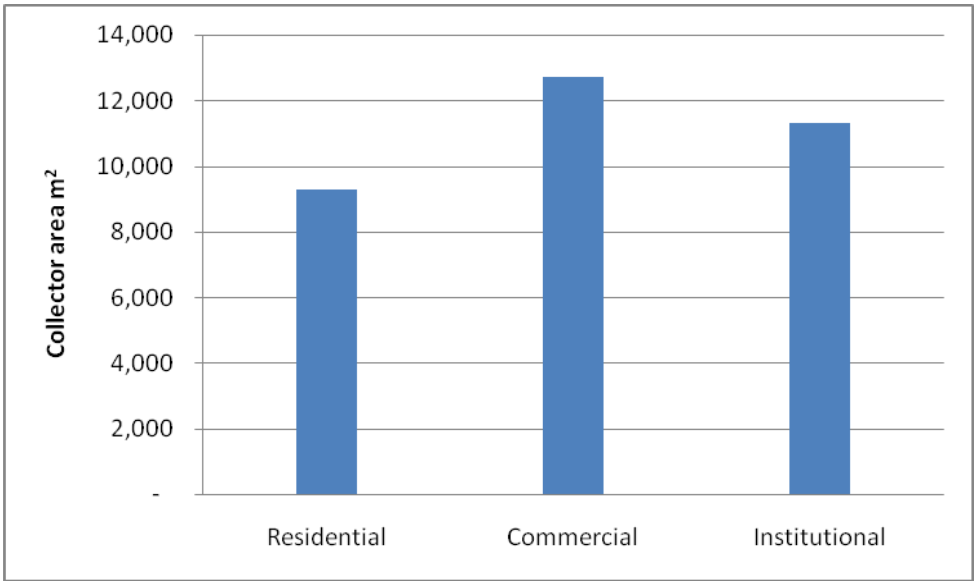


Figure 17.1: Category Wise Break-up of present installation

17.2 Main Barriers

The main barriers in use of SWH systems in Himalayan region are:

17.2.1 Technical

Lack of Appropriate Product to address issues such as:

- Low solar insolation in several parts (e.g. Kashmir valley, Sikkim, North-Eastern states)
- Small capacity requirements
- Low purchasing power of the people
- Technical problems associated with freezing in colder regions
- Difficulty in installing conventional SWH systems on sloping roofs made of metal sheets, stone tiles, etc.

- Lack of piped water supply, particularly in rural areas and quality of water, particularly presence of silt and hardness.

17.2.2 Financial

- High initial capital cost of the system, primarily due to high transportation, installation and marketing costs. Typically, capital cost of SWH system increases 2 fold than of the same system in plains due to the above factors.
- Low electricity tariff resulting in longer pay-back for SWH systems. Refer table 17.2
- Delays in disbursement of the subsidy and problems in accessing subsidy for the users living in remote areas.

17.2.3 SWH supply chain

- Lack of local manufacturing, with only one manufacturer located in the Himalayan region
- Weak SWH supply chain resulting in difficulty in procuring the systems as well as in poor after-sales service.
- Difficulty in transportation of the systems to remote areas

17.2.4 Awareness related barriers

- Poor awareness across states and segments, except perhaps hotel segment.
- Limited number of successfully operating SWH systems, thus the positive demonstration effect is low

17.3 Observations on the current SWH market

17.3.1 Solar Resource Availability

The solar resources vary across the Indian Himalayan Regions because of large variations in topography, altitude, climate etc. Leh-Ladakh regions are cold desert with radiation level in the range of 5.8-6.2 kWh/m^2/day and around 300 days of clear sunshine in a year providing ideal conditions for solar utilization. The Srinagar Valley receives a solar radiation of approximately 4.2-4.3 kWh/m^2/day with high number of overcast days. However the Jammu

region experiences a tropical climate and has an average radiation of 5.3-5.4 kWh/m^2/day. The solar radiation level in Himachal Pradesh and Uttarakhand varies across the state but as most these potential areas are tourist destinations having summer periods as a peak period and solar resource availability matches with the peak demand period.

The Himalayan belt of North Eastern and Eastern India gets more number of cloudy days. At several places the Solar Hot Water systems work for hardly 150 days in a year. The systems may work for 180 – 200 days provided larger collector areas are used for smaller quantity of hot water. Typically, a 200 LPD Solar Hot Water System in North Eastern Region and Sikkim provides same quantum of hot water like a 100 LPD hot water system installed in Ranchi. This means a 4 Sq. Mt. Collector area in North East is equivalent to 2 Sq. Mt. Collector area in plain. The Cost / Lt. of solar hot water is almost double in the North East. As such the Solar Hot Water system which is financially viable device in Ranchi is not viable in North East. Moreover, cheap fire wood is available in the North Eastern Hills making Solar Water Heating System less popular.

17.3.2 Electricity tarriff

Several of the states lying in Indian Himalayan regions have low domestic electricity tarrifs which hinders the growth of SWH industry. For details about the electricity tariffs in different states please refer to table 17.2.

17.3.3 Local industry and supply-chain

Another observation across the states was that the development of the industry in any region is contingent on the presence of strong local supply chain. In many regions having immense potential, due to the absence of technically qualified local dealers, the SWHS industry was not able to make a visible impact.

The spread of systems wherever it has occurred in the Hotel segment has been by positive user feedback and endorsement which has encouraged new users to try out the system. The primary motivation seems to be rising commercial electricity tariffs coupled with rising fossil fuel costs. No brand building or sustained publicity campaigns were carried out by any individual manufacturers. Some publicity campaigns have been carried out by SNA to publicize the subsidy schemes and this has helped create some level of awareness especially among domestic users.

The manufacturing base for SWHS is largely absent. At present there is no manufacturer and very few dealers of Solar Water Heating system in the North Eastern Region. The after sale support of the dealers operating in North Eastern states is also very poor.

17.3.4 Mandatory regulations & state policies

Mandatory regulations with common features have been notified in several states for SWH (refer table 17.2) but across all states there don't seem to have had any appreciable impact on the development of the industry. This is primarily on account of the lack of any sustained administrative effort to implement these notifications as well as lack of initial ground work to create a positive and healthy image of SWH, which needs to be done before implementing the mandatory provisions

17.3.5 Subsidy Administration

SNA's have had a major role in the administration of the subsidy schemes of the MNRE. In this study we found that the expected positive impacts of previous subsidy regimes have been largely diluted because of the poor administration of the scheme. Delays in subsidy disbursement have bred a lot of resentment in the manufacturers and dealers as capital gets blocked for months and sometimes years. Another recurring issue for SNA is the lack of a proper evaluation and monitoring of the SWH systems availing the subsidy. This issue can be partially addressed by providing installation norms and standards along with third party monitoring and verification.

17.3.6 Technology

Flat plate technology seems to be the technology of choice for most of the large establishments especially in the hotel segment. ETC technology has been used in a lot of domestic installations as well as in some commercial establishments. Sub-standard quality of tubes, poor service by local dealers has created a bad image for ETC systems in some locations.

Technology solutions like low-cost storage cum collector type SWH for rural areas, hybrid Solar Water Heaters (solar + biomass), etc are required.

17.3.7 Credit availability

Availability of easy and collateral free low interest finance can be a major factor in the development of the technology in the region. Case study of SWH in hotels of Manali shows how low interest rates and easy access of finance to the hotel owners for SWH technology has resulted in the development of the SWH market. Banks here have provided easy collateral free financing using various RBI credit guarantee schemes which have funds earmarked for SSI sector. The main instrument used for providing these loans has been the RBI's CGTMSE (Credit Guarantee trust for Medium and small enterprises). Loans have also been speedily sectioned at the branch level as the manager has used his knowledge of local conditions and the credit history of the customers to provide hassle free loans.

Table 17.2: Summary table on main barriers

States	Solar Resource Availability	Awareness	Mandatory provisions	Subsidy Disbursement	Supply chain	Electricity Tarriff	Access to credit
J&K	Ladakh (Excellent) Jammu (Good) Kashmir (Low)	Poor	No	Fair	Poor	Low	Poor
Uttarakhand	Good	Fair	Yes	Fair	Fair	Domestic (Low) Commercial (Medium)	Poor
Himachal Pradesh	Good	Good	Yes	Fair	Good	Commercial (High) Residential (Low)	Fair (Good example at Manali and Dharmshala)
West Bengal (Hilly part)	Low	Poor	No	Poor	Poor	High	Poor
Sikkim	Low	Poor	No	Poor	Poor	Medium	Poor
Assam	Low	Poor	No	Poor	Poor	High	Poor
Arunachal Pradesh	Low	Poor	No	Poor	Poor	Domestic (High) Commercial (Medium)	Poor
Tripura	Low	Poor	No	Poor	Poor	Low	Poor
Nagaland	Low	Poor	No	Poor	Poor	Medium	Poor
Manipur	Low	Poor	No	Poor	Poor	Domestic (Medium) Commercial (Low)	Poor
Mizoram	Low	Poor	No	Poor	Poor	Medium	Poor
Meghalaya	Low	Poor	No	Poor	Poor	Low	Poor
Jharkhand	Good	Fair	Yes	Fair	Poor	Medium	Poor

17.4 Demand Projections

For SWH projections, three scenarios were considered. Details for each scenario are given in the sub-sections below:

Business As Usual (BAU) Scenario

BAU scenario assumes that the SWH market in the Himalyan region would follow the last 15 years all-India trend . (SWH market has shown a CAGR of 16.8% in the cumulative SWH installations during 1995-2008). We have assumed that the **SWH cumulative installation would grow by 15% per annum under the BAU scenario** limited to 25% penetration in the non-residential segments.

Optimistic-I Scenario

Under this scenario, higher CAGR compared to BAU scenario are considered assuming improvement in:

- Economic Viability
- Policy & Enforcement (State/city regulation and enforcement)
- Supply Chain (Availability of SWH suppliers, installers and maintenance provider,)
- Access to Credit (Availability and availment culture of finances)

This scenario does not consider any significant improvement in SWH technology.

Optimistic-II Scenario

This scenario is built from the demand side and takes in to account launch of low cost batch type SWH systems. Under this scenario, we have assumed that due to the launch of a new appropriate product that matches the needs and demands of the Himalayan population, SWH penetration would reach to certain level in each state and sector by 2022. The states like Uttarakhand & Himachal Pradesh have a good SWH market base and it is assumed that the SWH penetration level would reach 5% in residential sector (i.e. 5% of the households in these states would own a SWH) and 25% in commercial and institutional sectors (i.e 25% of the hot water demand in these sectors would be met by SWH by 2022). The other states

except Tripura are assumed to reach penetration of 2.5% in residential sector and 25% in commercial and institutional sector. Tripura being an exceptional case because of its warm weather conditions is assumed to have 1% penetration in residential and 25% in commercial and institutional sectors. The projections of the representative districts in optimistic II scenario takes same penetration rate in residential sector as per their respective states and 35% penetration in the commercial and institutional sectors in all the states.

For the period 2010 to 2013, the projections are similar to BAU scenario as it is assumed that the new technology would be available for dissemination only in the year 2013. Based on the 2013 penetration and assigned 2022 penetration levels, penetration levels for in between years is estimated. Based on the projection of unit base (household, hotel and hospitals) and SWH penetration, forecasting of SWH installations has been done for each location and category.

Table17.3: Cumulative installed collector area under three scenarios in m^2

Scenario	2010	2013	2017	2022
BAU	33,256	74,374	115,537	200,493
Optimistic-I	33,256	74,374	145,123	303,600
Optimistic-II	33,256	74,374	497,350	1,149,970

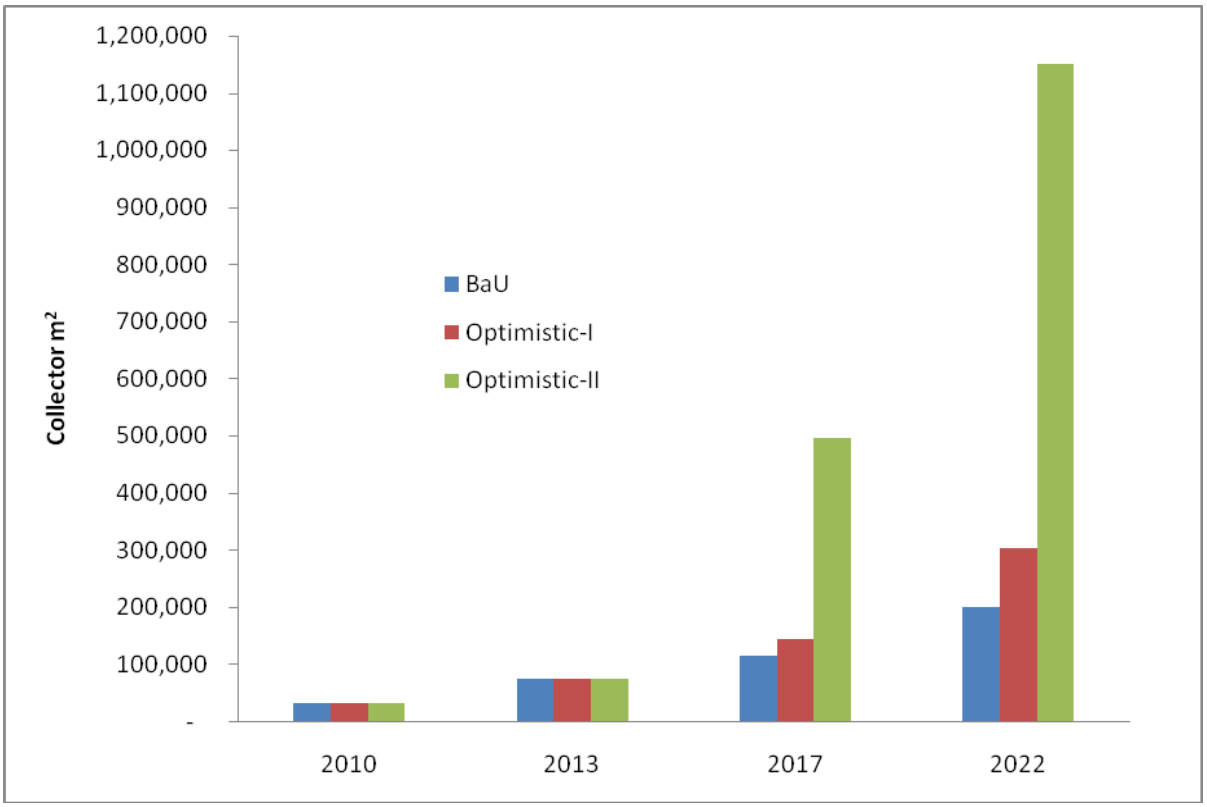


Figure 17.2: Total collector area in sqm under three scenarios in 2013, 2017 & 2022

17.5 Action Plan

An action plan is proposed for increasing the deployment of SWH in the Himalayan region. An activity chart for the action plan is provided in the table 17.6. The main programmes and activities are stated below

17.5.1 Programme for Commercial (Hotels), Institutional (Hostels, Hospitals) and Industry:

A three year (2011-2014) focused programme aiming to increase the deployment of SWH in 15 identified high potential districts, as shown in table 17.4, in commercial, institutional and industrial sectors is proposed. It would develop a base for long-term development of SWH in the Himalayan states.

Table 17.4: High potential districts in Himalayan Region

High Potential District	State
Jammu	J&K
Srinagar	J&K
Leh	J&K
Dehradun	Uttarakhand
Nainital	Uttarakhand
Udham Singh Ngr	Uttarakhand
Haridwar	Uttarakhand
Kullu	Himachal Pradesh
Kangra	Himachal Pradesh
Shimla	Himachal Pradesh
Darjeelling	West Bengal
East Sikkim (Gangtok)	Sikkim
East Khasi Hills (Shillong)	Meghalaya
Tawang	Arunachal Pradesh
Ranchi	Jharkhand

Table 17.4 shows the hot water requirement in hotels (totaling to around 53 Lakh LPD) for some of the major tourist/religious clusters in Himalayan Region.

Table 17.5: Hot Water Requirement in Hotels& Guest houses in major tourist destinations

City	State	Hot Water Requirement (lakhs LPD)
Katra	J&K	10.8
Leh	J&K	5.2
Manali	Himachal Pradesh	9.6
Nainital	Uttarakhand	5.7
Dehradun-Mussoorie	Uttarakhand	11
Haridwar-Rishikesh	Uttarakhand	6
Darjeelling	West Bengal	2.6
Shillong	Meghalaya	2

Source: Based on Primary Survey and key stake holders interview

The programme would aim at increasing awareness, improving access to credit and removing other technical and commercial barriers. The specific activities for this programme are described below

- **Creating awareness** among the Hotel, Hostel and Industry owners about the environmental and financial benefits of the technology and the subsidy regime of the government to promote the SWH technology by organizing focused seminars, campaigns and study tours in all the major potential districts**.**
- **Improving Access to Credit**: Creating awareness about the benefits of financing SWH technology among banks and other financial institutions and identifying and tying up with at least one key bank per cluster for facilitating easy delivery of bank credit.
- **Capacity Building**: Conducting training and capacity building programmes for local technicians, dealers and manufacturers for proper installation and maintenance of SWHs.
- **New Niche areas/sectors for SWH**: Investigation of new niche areas for application of SWHs and proposing new and innovative technical designs for integration of SWH in those new areas/sectors

This programme can be implemented through Cluster/State level Solar Water Heater Facilitation Cells. These cells should be responsible for running the campaign, providing technical support to existing and potential users, sample checking and third party monitoring and verification of the installed SWH systems.

17.5.2 Focused Programme for the Residential Sector

The residential sector is the largest potential market but its development would be slow and would require sustained efforts to improve technology (offer wider variety of product to residential end-user) and market development. This market would also depend on the electricity tariff and electricity supply situation in the states. The activities that can increase the deployment of SWH in residential sector are:

d) **Low-cost domestic solar water heaters**: it is strongly recommended that UNDP-GEF solar water heating project along with the Ministry of New and Renewable Energy should launch a large initiative to disseminate Solar Water Heaters in the rural areas of the Himalayan region. Main activities of the initiative have been summarized below (refer table 16.4)

   Activity 1: Design competition to select appropriate designs for promotion in rural areas

   Activity 2: Pilot testing of the prototypes:

   Activity 3: Evaluation of the community SWH models:

   Activity 4.Technology transfer, training and promotion of local manufacturing capacity:

   Activity 5. Pilot projects in around 30 villages (around 3000 SWH systems) through local entrepreneurs/ NGOs

   Activity 6. Launching of a dissemination programme

   Activity 7. Implementation of the dissemination programme to reach atleast 5% of the rural population by 2022 (50000 systems/ year)

e) **Bank credit**: Availability of easy and low interest loans by banks for small capacity systems

f) **A balanced and gradual approach to mandatory provisions**: Mandatory provisions for all government housing, public-sector housing, industrial housing, etc. to begin with and gradual expansion to housing in capital and large cities once the necessary capacities and awareness is well established.

17.5.3 Strengthening local manufacturing and SWH supply chain

UNDP/GEF Solar Water Heater project should focus on strengthening local manufacturing and supply chain.

c) **Programme for developing manufacturing base in the Himalayan region**: Provide technical support, training and devise an incentive programme for manufacturers for setting manufacturing base in the Himalayan region. MNRE/SNAs may partner with MSME (Ministry of medium, small and micro enterprise) or state industries departments for implementation and execution of this programme.

d) **Training and capacity building of local technicians for installation and maintenance of SWHs**: UNDP/GEF Solar Water Heater Project is already supporting development of training modules for technicians. It is suggested that UNDP/GEF Solar Water Heater Project can tie up with selected polytechnic/ITIs in each Himalayan state for delivery of the training modules.

17.5.4 Effective and Efficient delivery of capital subsidy

JNNSM has provision for higher subsidies in the Himalayan region. The previous experience with disbursement of subsidies across all states has been poor. Corruption, slow-processing, lack of inspection and verification, favouring certain suppliers, have been reported from most of the states. During stakeholder's consultations, a large number of participants reported confusions/absence of clarity about the provisions and modalities of the new capital subsidy scheme. It is suggested that **MNRE and SNAs should take immediate steps to look into the problems in disbursing capital subsidy and come-out with an effective, efficient and corruption free delivery mechanism**.

Table 17.6: Activity chart for the Action Plan for Himalayan States

Activities/Year	2011	2012	2013	2014	2015	2016	2017
Programme for Commercial, Institutional and Industrial Sector in 15 identified districts							
➢ Formation of Solar Water Heater Facilitation Cell in each of the identified high potential District/Cluster.							
➢ Awareness Creation through Seminars, Focused workshops and study tours							
➢ Improving Access to Credit by tying-up with at least one bank per cluster							
➢ Training & capacity building of local technicians, dealers and manufacturers							
➢ Technical Support to the existing and potential Users							
➢ Sample checking and verification of the installed SWH systems							
➢ Finding new niche areas/sectors for the use of SWH							
➢ SWH demand creation through innovative and new designs that can cater the needs new niche areas/sectors							
Focused programme for Residential Sector: Low cost domestic solar water heater							
➢ Design competition to select appropriate designs for promotion in rural areas							
➢ Pilot testing of the prototypes							
➢ Evaluation of community SWH models & currently available SWH technologies for residential applications							
➢ Technology transfer, training and promotion of local manufacturing capacity and NGOs							
➢ Pilot projects in around 30 villages (around 3000 SWH systems)							
➢ Launching of a dissemination programme							
➢ Dissemination programme to reach atleast 5% of the rural population by 2022 (50000 systems/ year)							

Annexure -I

Design Competition for developing Low Cost Solar Water Heater for Domestic Applications

Background: Under the market assessment study for Solar Water Heaters in Himalayan region, under the UNDP/GEF global solar water heating project, the potential assessment of rural area in Indian Himalayan Region, consisting of northern, eastern and north eastern Himalayan states, was conducted. It was found that most of the rural areas have very low penetration of SWH. The main findings for rural areas are stated below:

- The hot water demand is for bathing, kitchen and drinking purposes.
- The present SWH products are out of the affordable range of the rural population.
- The manufacturing and supply chain of SWH is very weak.
- Most of the places are not having piped water supply, which is a prerequisite for the conventional SWH system
- Presently most of the rural population is using biomass which is available almost free of cost but the process of collecting the biomass is quite tedious.
- There is a demand for a small size (around 50 LPD) type SWH system, which fits the needs and demands of rural population.

In order to develop a cost effective small size SWH, which can be locally manufactured, a competition for the most appropriate designs is proposed. The preliminary details of the design competition are given below.

Objective: To develop a cost effective design of a small size type solar water heater for domestic applications (including preheating of water for cooking, drinking and making tea) keeping in view the requirement of households located in rural/small-towns of the Himalayan region.

Eligibility: Any creative individual, institute, or organization having own workshop or tie up with a workshop is eligible to participate in the design competition

Specifications of the SWH system:

Product Specifications:

Functionality: Solar Water Heating-as good as possible

Capacity of SWH: 50 LPD

Maximum Product Cost: Rs. 4000

Material of Construction: Any. Local available material is preferred

The material of construction of storage tank and pipes should be such that the water is fit for human use and consumption.

Product Design:

The design should be fresh and innovative

It should be practical design which can be mass produced

Simple in construction and easy to manufacture at local level

Should be light in weight, easy to carry and install

Easy to maintain and use

Should have least packaging size to save on transportation

The product should have a minimum life expectancy of 5 years.

User:

Users in the rural area in Indian Himalayan Region, consisting of northern, eastern and north eastern Himalayan states

Submittals:

The participant has to submit their design along with the component stated below

1. A brief write up in 200 words
2. A hand sketch and a design drawing of the concept
3. Bill of materials
4. Cost of the system with break-up of its component.

Method of Evaluation:

The designs submitted by the participants will be evaluated on following criteria

- Concept Idea

- Practicality
- Thermal performance of the system: Will be calculated based on the theoretical model and sample calculations.
- Cost of the system.
- Durability and life of the product
- Ease of use

Evaluation committee: The evaluation team would consist of three members -- a Product Designer, a Solar Energy Specialist and a representative of a local NGO representing typical user (preferably a women)

Results

Total 6 designs would be selected (3 for northern Himalayan regions and 3 for eastern and north eastern Himalayan regions). The selected candidates will be issued certificate of appreciation and would be allotted Rs. 75000 (Rs. 25000 manufacturing cost and rest for human efforts) to manufacture and supply 5 systems of the design submitted by him.

The systems will be tested on their field performance and based on their results order for 1000 certified systems directly linked with MNRE subsidy would be placed to supply in the Himalayan region in India.

Time Schedule:

Day zero: Notice for the design competition would be released in selected national and local newspapers and would be sent to all NGOs', Engineering colleges, Industry associates, and all other organization working in the field of solar thermal.
Day 30: Registration for the competition closed.
Day 60: Last date for submitting the designs
Day 90: Results intimated to the selected candidates
Day 180: Last date to supply 5 systems at the selected locations
Day 240: Results for the field performance data and placing of the order for 1000 such units

Annexure-II

KATRA: Solar Water Heater Status

General Features:

Katra is a small town in J&K, situated in the foothills of the Trikuta Mountains, where the holy shrine of Vaishno devi is located. It is part of the Reasi district and is 42 km from the city of Jammu. The elevation varies from 2500 ft (Katra town) to 6619 ft (Bhairon Ghati). The temperature also varies with elevation and the average temperature in Katra town is 9^oC (winters), 30^oC (summers) and for the Bhawan area 5^oC (winter) and 22^oC (summer).

Katra is the base camp for the pilgrims who visit Vaishno Devi. Although it has a small population of 7569 (Census 2001), it has a thriving tourism industry that offers plenty of hotels, guest houses and restaurants. The number of pilgrims that visit the shrine every year has increased from 1.4 million in 1986 to 8.2 million in 2009. There is also the prestigious Sri Mata Vaishno Devi University (SMVDU) located in the vicinity of the town.

Tourism Sector and Hot Water Demand

The economy of the place thrives on tourism and its allied activities. Vaishno Devi has daily arrivals of between 15,000-30,000 pilgrims/day and the peak season is from March-August and during the Navratras. It is estimated that around 35% of the tourists visiting the pilgrimage stay in hotels as a large proportion of these comprise of local and day visitors.

Accommodation facilities include hotels/guest houses run by private owners, J&K Tourism Department, Shri Mata Vaishno Devi Shrine Board and few other institutions. These are located mostly in Katra town but there is a sizeable number in the Bhawan area as well. Table 1 provides information on the different types of hotels/guest houses in the region and the estimated hot water requirement. Table 2 provides information on the facilities provided by Mata Vaishno Devi Shrine Board. In Katra during peak season the average occupancy rate of hotels is 80% while in the lean season it's about 50%. The hotel industry is growing with the growth in tourist arrivals.

Table 1: Estimated Hot water demand in different Hotel Categories

	Hotels	**No. of Beds**	**Hotel Rooms**	**Estimated Requirement (LPD)**
Category A (@300 LPD/room)	16	1527	720	2,16,000
Category B (@200 LPD/room)	26	1721	750	1,50,000
Category C (@100 LPD/room)	163	11,234	4956	4,95,600
Total	**205**	**14,482**	**6426**	**8,61,600**

Source: Jammu and Kashmir Tourism Development Corporation, Katra (JKTDC)

Table 2: Accommodation Facilities Provided by Mata Vaishno Devi Shrine Board

Place	**Bed Capacity**
Katra (Shrine Board)	1004
Vaishno Devi Bhawan Area	3370
Total	**4374**
Hot Water Requirement (@50 LPD/bed)	**2,18,700 LPD**

Source: Jammu and Kashmir Tourism Development Corporation, Katra (JKTDC)

The total hot water requirement in katra region is hotels/guest houses and accommodation facilities provided by shrine board is estimated to be around **10.8 lakh LPD**

There is requirement of hot water throughout the year in these establishments. The more luxurious hotels were found to use diesel boilers for heating the water whereas the middle and lower segment hotels were predominantly using decentralized electric heaters. **There were only two recent SWH installations found in Katra**.

Caselet - Hotel K.C.,Katra which is a new hotel has installed a 2400 LPD system an year back with the help of subsidized finance from PNB Bank. It was preheating water for the connected diesel boiler system or at times taking care of the requirement itself. The daily peak hot water requirement of the hotel was around 5000 liters. The system had a 2000 LPD storage tank connected in series with a set of 2 auxiliary tanks (with electric backup) of capacities 500 and 300 liters. They had reported savings of Rs. 8000-9000/month even though they had to switch on the electric boiler for sometime in the mornings and evenings. The user experience was satisfactory.

Current Status

The SWH market is still at a very nascent stage in Katra. There is some product knowledge now after these initial installations but skepticism still exists in the minds of the hoteliers.

They were unsure whether the SWH would be able to provide quality hot water at all times. Some were apprehensive due to the high initial costs involved and didn't have knowledge of the finance options.

Analysis of Supply Chain

No presence of dealers in Katra town. There are dealers of Tata-BP, Suntechnics in Jammu (it seemed that they were concentrating their efforts on Solar P.V. and the institutional SWH market). Intersolar has also recently setup dealership in Jammu and are responsible for one of the hotel installations in Katra. Racold, although without a dealership base here has been forthcoming in marketing the technology amongst Katra hoteliers.

Key Barriers

- **Low commercial electricity tariff (Avg. tariff Rs. 2.69/unit). This feature specially makes SWHs seem not so attractive to hoteliers who employ electricity for water heating. Electricity theft by manipulating the meter reading (as told by some hoteliers).**
- Lack of well developed supply chain (only developing recently)
- Lack of product/finance information amongst potential users
- Reluctance to change existing system

Annexure-III

Leh: SWH Potential & Status Report

General Features

Mountains dominate the landscape around the Leh as it is at an altitude of 3,500m. The principal access roads include the 434 km Srinagar-Leh highway which connects Leh with Srinagar and the 473 km Leh-Manali Highway which connects Manali with Leh. Both roads are open only in summer season.

As of 2001 India census, Leh town had a population of 27,513. Males constitute 61% of the population and females 39%, due to a large presence of non-local labourers, traders and government employees. Leh District, which comprises the whole of Indian-administered eastern Ladakh (but not Kargil nor Zanskar) has a total population of 117,000 people according to the 2001 census.

Leh has a cold desert climate with long, harsh winters from October to early March, with minimum temperatures well below freezing for most of the winter. The city gets occasional snowfall during winter. The weather in the remaining months is generally fine and warm during the day. Average annual rainfall is only 90 mm. The temperature can range from −28 °C in winter to 33 °C in summer.

Table 10: Monthly temperature profile of Leh

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Average high °C	-2	1	6	12	16	21	25	25	21	14	7	2	12.3
Average low °C	-14	-11	-5	-1	3	7	10	10	5	-1	-6	-11	1.2
Rainfall mm	9	8	11	9	9	3	15	15	9	7	3	4	102

Source: TERI report on Solar Energy Master Plan for Ladakh Region, MNRE

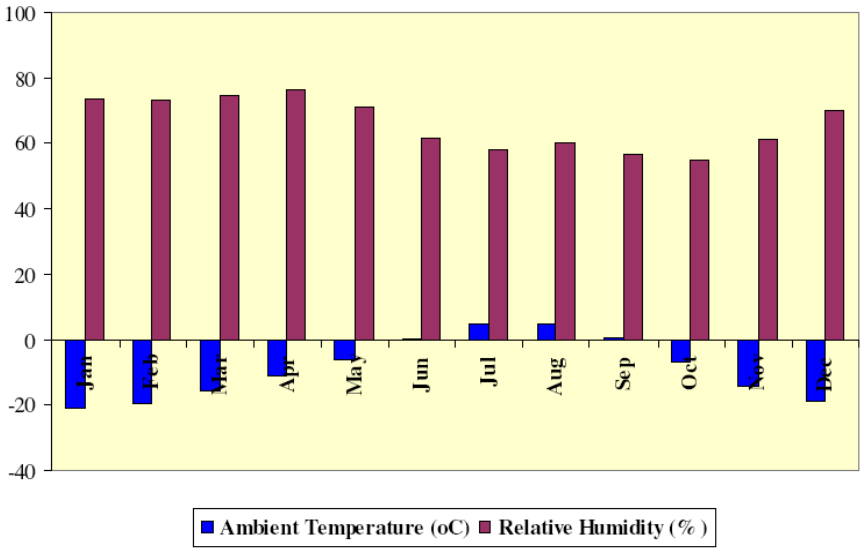


Figure 17: Ambient temperature and rainfall in Leh
Source: TERI report on Solar Energy Master Plan for Ladakh Region, MNRE

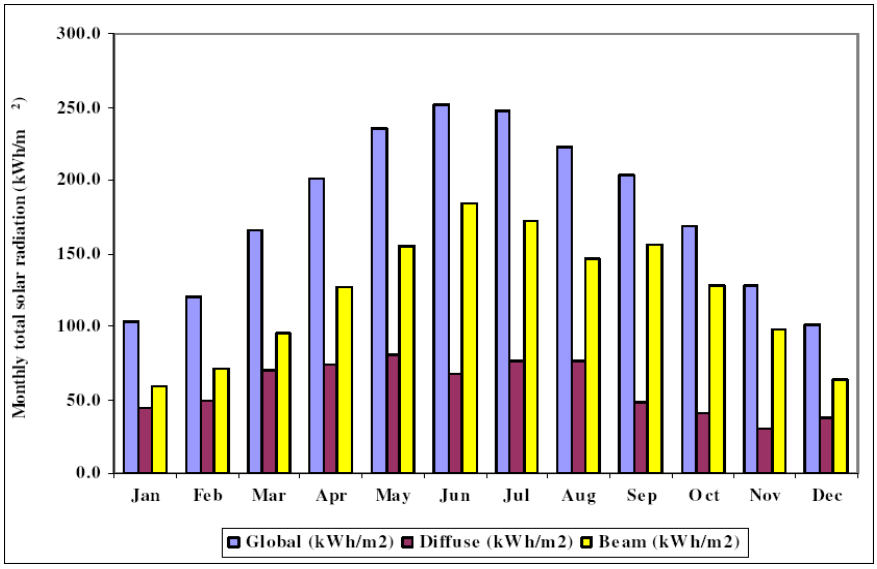


Figure 2: Global, Diffuse and Beam Solar Radiation in Leh
Source: TERI report on Solar Energy Master Plan for Ladakh Region, MNRE

Hot Water Demand & Present status of SWH

The hot water is required for bathing, washing, cooking and drinking purposes in residential segment. However, apart from the above mentioned areas, hotels and guest houses require hot water for space heating also. Presently around 40000 LPD of Solar water heating systems are installed in Leh. The table below shows the category wise installation in Leh.

Table 11: Present installation of SWH in Leh

Category	Installed Capacity m^2
Residential	240
Commercial	400
Institutional	160
Grand Total	**800**

Leh district has around 24000 residential households, 209 hotels, 25 hospitals and 544 religious places of worship. The table below provides the hot water requirement* and SWH penetration in each of the category.

Table 12: Hot water demand and penetration of SWH in Leh

Category	Hot Water Demand (LPD)	Installed Capacity m^2	Current Penetration
Residential	2,407,300	240	0.5%
Commercial	522,500	400	3.83%
Institutional	689,300	160	1.16%
Grand Total	**3,619,100**	**800**	**1.1%**

*Hot water requirement does not take in to account the hot water required for space heating

Note: The hot water demand is calculated using a norm of 150 lpd for urban household, 50 LPD for rural household, 100 LPD per hotel room, 30 LPD per hospital bed and 25 LPD per inhabitant of hostel or religious place.

Ladakh Renewable Energy Developmet Agency (LREDA) under Ladakh Autonomous Hill Development Council has set a target of installing SWH 15000 m^2 by the year 2012, i.e. 7500 m^2 collector area in 2011 and the rest 7500 m^2 in 2012.Subsidy of 50% of the cost of the system for residential, 90% for government buildings, educational institutions, hospitals etc and 40% for the hotels, lodges and other commercial establishments is being provided by LREDA[10]. The projection for the year 2013, 2017 and 2022 are made considering the plans of LREDA as well as assuming that most of the existing market will be saturated by 2013 and after that the SWH installation will be done in new construction. Table below provides the projections for the year 2013, 2017 and 2022.

[10] Tender No: NIT No. 28, Rate contract for design, manufacture, supply, installation & commissioning of ETC based solar water heater with insulated cold water tanks and piping insulation for sub zero temperature conditions at various sites in Leh district of J&K.

Table 13: SWH projections for the year 2013, 2017 & 2022

Category	Present (m^2)	2013 (m^2)	2017 (m^2)	2022 (m^2)
Residential	240	16629	18398	20621
Commercial	400	3609	5018	6887
Institutional	160	4761	6611	9064
Grand Total	**800**	**25000**	**30027**	**36573**

Tenders have already been floated by LREDA for procurement of the 7500 m^2 of SWH for the year 2011. All the systems are having anti freeze (Glycol) @ 3lts per 100 LPD

The specification of the SWH systems as per the tender document is given below:

Evacuated Tube Collector based systems

1. EVACUATED TUBE COLLECTOR (Overall Dimensions)	
Option 1	
Outer Diameter	47 mm
Inner Diameter	34mm
Length	1500mm
Numbers	Minimum **7** for each 50 LPD System
Option 2	
Outer Diameter	58mm
Inner Diameter	47mm
Length	1800mm
Numbers	Minimum **5** for each 50 LPD System
2. GASKET FOR FLANGES	3 mm thick gasket of Neoprene/synthetic rubber gasket shall be used for sealing the joints between flanges.
3. COLLECTOR SUPPORT FRAME	The structure should be in a position of withstand a wind velocity of 120 kms/hr. shall be made with angle iron of 35 mmx35mmx4mm; will have vertical support at top and bottom edge of the inclined plane of the collector at a distance of 1.5 M or less. The vertical support shall be firmly grouted with the roof.

4. PAINTING OF STANDS	Proper cleaning and degreasing of the surface should be done with the help of three in one solution before painting. Two coats of zinc chromate red oxide primer shall be applied followed by two coats of enamel paint of suitable colour as per NIT.	
5. STORAGE TANK(HOT WATER)		
a) Material	Stainless Steel (SS 304/ IS 1730 grade)	
b) Thickness	**Minimum thickness**	**Tank capacity**
	1mm	100 LPD
	1mm	200 LPD
	1mm	500 LPD
	1.6mm	1000 LPD
	2mm	2000 LPD
	2mm	3000 LPD

c) Insulation	Aluminium sheet of thickness 22 SWG shall be used for cladding the tank insulation. Solar water Heating System (SWHS) may be insulated with 100mm thermal grade PUF Insulation of 32kg/ meter cube or higher density or 150mm thermal grade rock wool Insulation of density 48kg/m^3. The storage tank shall be properly installed at site using enameled coated appropriate size angle iron stands, girder, cement concrete pedestals of 1:2:3 ratio or any other specific provision suitable to site to ensure the stability against heavy storm etc. but not less than 1'x1'x6" dimensions.
6. PIPING Material Insulation	1" to 2" diameter Medium class (B class) GI as per IS 1239 shall be used for piping. 25mm thick insulation of 48kg/cu.m. density and K value+0.03 W/MK R value+1.67 sq.m. C/W to withstand and temp. of 250 deg. C be used. Thin plastic sheet shall be used as covering between glass wool and aluminium cladding Besides other retaining material like chicken mesh etc. retaining material like chicken mesh etc. 26 SWG thick aluminium sheet shall be used for cladding the insulated pipe. The pipe line should be properly supported and fixed with clamp with the help of suitable size stand/civil structure (cement concrete ratio 1:4) ISI mark strainer of standard make should be fitted in the main cold water supply line before the system.

7. VALVES/NIPPLE/TEES /BENDS	Gun metal valve ISI marked shall be used. Nipple/tees and bends of ISI marked of medium class GI (B class) shall be used. Air vents in each row are to be provided.
8. INSTRUMENTATION (above 1000 LPD)	**Temperature gauge**: 1 No. dial type (for Hot Water Storage Tank/Outlet) **Gun metal strainer**: 1 No. (at Cold Water inlet) **Water meter** -1 at the inlet of cold water tank. Maximum 2 nos. of chrome plated brass taps for systems upto 200 lpd and thereafter 1 tap per 200 lpd of superior quality for distribution line.
9. INSULATED COLD WATER TANK suitable for sub-zero temperature conditions	HDPE/LDPE material with Gun metal float valve (ISI marked) equal to the capacity of Hot water storage tank. Cold Water Tank may be insulated with 100mm thermal grade PUF Insulation of 32kg/ meter cube or higher density or 150mm thermal grade rock wool Insulation of density 48kg/m³ or higher density. Aluminium sheet of thickness 22 SWG shall be used for cladding the tank insulation. The cold water tank shall be properly installed at site using enamelled coated appropriate size angle iron stands, girder, cement concrete pedestals of 1:2:3 ratio or any other specific provision suitable to site to ensure the stability against heavy storm etc. but not less than 1'x1'x6" dimensions. The tank insulation should be designed to withstand extreme low temperature upto -30 deg. C

10. MAKE UP TANK	The capacity of make up tank should be 5 litres up to 500 lpd and 10 litres for 1000 lpd and above made of SS304 minimum 0.8 mm thick
11. SYSTEM INTER CONNECTING PIPING:	ISI marked G.I. pipes, medium class of IS: 1239 duly insulated with 50mm thick rock wool of 48 Kg/m³ density and 26swg Al cladding. EPDM hose pipes can also be used for systems up to and including 500LPD.
12. STANDS & PEDESTALS FOR THE TANKS (hot water tank/ cold water tank)	The tanks will be mounted on stands made out of MS angle iron frame of 35x35x4mm up to 500liters, 50x50x6 mm up to 2000lpd and 65x65x6mm for capacity above 2000 liters with each leg duly grouted with PCC 1:2:4 of 1'x1'x1' size.The cold water tanks will be placed over angle iron frame having 4 cross members in 4 legs with 5mm thick MS sheet for full bottom support fixed of 4 horizontal members based on the size of the cold water Tanks.

13. SYSTEM LAYOUT & DESIGN	Air venting at appropriate places without hindrance of a spring leaded valve to prevent air locking in the system should be provided. For this purpose, the system shall have, at a suitable point, atmospheric pressure conditions preferably in the high temperature zone. System shall have a suitable expansion/make up tank at a high point in the system to ensure that collectors run full all the times. Capacity of this expansion/make up tank should be 1.5% of the system capacity for all systems.
14. HEAT EXCHANGER	For thermosyphen systems only. May be used by incorporating Cu/SS coils/retender inside the storage tank Copper/SS tube of %" dia Minimum 22 SWG. May be higher depending upon the pressure requirements. Shall be so designed to ensure the pressure drop less than 0.3 kg/cm. The surface area of the heat exchanger should not be less than 0.24 m^2 per sq.m of the absorber area of the system (for 100 lpd system, the copper tube length of 7 meter is required). All the elements of heat exchanger shall be as per relevant Indian Standard or as per TEMA Class C construction.

Flat plate collector based systems

1. ABSORBER MATERIAL	Absorber shall be of copper sheet and copper tube.
Thickness of sheet Riser	34 SWG (IS 191) Diameter : 12.7+0.5mm Thickness : 0.56 mm (IS 2501) Number : 10
Header	Diameter : Minimum 25.4+0.5 mm Thickness : 0.71 mm Number : 2 Projection out side: 40 mm+0.5 mm Including flanges of the collector box.
Space between Riser Tubes	120 mm maximum from centre to centre of the riser. The free edges at the sides not to exceed 60 mm from the centre of the extreme end riser tube. For independent fins or joints in the sheet an overlap of minimum 2 mm shall be provided.
Bonding between Riser & Sheet	Full length of all risers shall be welded with the absorber sheet. In case of brazing/soldering/tig welding of continuous nature, un-brazed/un-soldered portion should not exceed more than 10% of the length of the riser. For brazing/soldering, minimum 60% tin soldier or suitable brazing material shall be used. The flux used in soldering shall be mechanically removed and neutralized with the solution of sodium carbonate to avoid corrosion after installation. The flux used should be non greasy and non corrosive.
Coating	Selective coating with Absorbtivity >0.92 and emissivity<0.2
2. FLAT PLATE COLLECTOR Overall Dimensions(mm)	Size Length Width Height A 1860+10 1240+10 100+10

3. COLLECTOR BOX MATERIALS Aluminium	Aluminium extruded sections of size approximately 100 mmx25mm channel sections (within the tolerance given above) and of thickness 1.6 mm for the sides 0.71 mm aluminium sheet for the bottom (Tolerance 10%). 1.2 mm thick aluminium angle (dimensions 25mmx25mmx1.2mm) retainer for glass
Fabrication of the Box	Side channel shall be welded by inert arc or gas brazing to ensure leak proof continuity of the joints of the box.
Attachment of Bottom Sheet	Bottom sheet may be joined with spot welding or self threaded nickel plated screws .In case of screw joint wooden battens shall be provided to secure the screws. The screwed/riveted joint shall be made leak proof by sealing paste of Zinc Oxide based or rubber based or silicon rubber based or epoxy based sealing compounds.
4. TESTING OF RISER-HEADER ASSEMBLY	It should be tested for leakage and strength at a minimum hydraulic/pneumatic pressure of 5 kg/sq.cm.

5. COLLECTOR BOX INSULATION Back Insulation Material name Rock wool Glass wool Mineral wool Side insulation	Insulation shall be providing at back and sides. Thermal resistance (R) of insulation material shall be minimum **0.96 sq.m deg.C/W** for back insulation and minimum **0.48 sq.m deg. C/W** for side insulation. This shall be derived after determining thermal conductivity (K) value at 100 deg.C mean temperature in accordance with IS 3346. The thickness of the insulation material (L) may be derived by the equation R= *U* K or the insulation materials with following specifications may be used: K W/MK — R m^2C/W — Thickness (mm) — density (KG/Cum) 0.029 — 1.67 — 50 — 48 0.03 — 1.67 — 65 — 24 0.028 — 1.67 — 50 — 48 The insulation must with stand a temperature of 250 deg.C. Aluminium foil of thickness 0.015mm to 0.021 mm shall be used for covering the back insulation 25mm thick insulation of specification as mentioned above. Aluminium foil of thickness 0.015mm to 0.021mm shall be used of covering the side insulation. Glass wool Resin Bonded/ Rock wool/Rigid Polyurethane of Thickness 25mm, minimum shall be used so as to achieve R value=0.08 as per IS 3346:1980.

6. FRONT GLAZING Material thickness Transmittance General appearance of glass Aperture area Spacing between cover plate and Absorber surface	Single piece glass Toughened- 4.0+0.2 mm (IS 2553(Part-I) 82% (Minimum) Free from bubbles/rough surface 2.30sq.mt.(approx.)for size A collector 20 to 40 mm
7. HEADER FLANGES	Brass flanges of 62+3 mm diameter and minimum thickness of 4 mm with provision of four number of GI plated nuts bolts with diameter of 6mm-8mm shall be used. Flanges shall be brazed to the header and brazing tested for leakage at the test pressure of 10kg/sq.cm. In no case crude soldered flanges shall be used. The assembly of the flanges should be at right angle to the header area to ensure proper assembly at the site of installation.
8. GROMMET	Suitable sealing between the inlet and outlet of header and casing of the following materials shall be provided. Neoprene, EPDM, Silicon rubber or butyl rubber etc. The grommet shall be suitable for a temp. Upto 125 deg. C and mechanical loading during transportation of collectors. Typical size of grommet may be 40 mm outer diameter and 25mm inner diameter.
9. ASSEMBLY OF COLLECTORS	The load of the absorber should not be on the insulation. It should be taken by the collector box. The air gap between the glazing and the absorber should be 25mm (+5mm). Insulation should not be allowed to slide. Glazing shall be fixed on the collector box by using EPDM /Neoprene /Synthetic rubber channels. The glass should be firmly held, without strain taking into account the expansions of glass. A typical example is by retaining the glazing with the help of self tapping screws and aluminium angle retainer of dimensions 25 mm x25mmx1.5mm fixed on the top of the box it shall be ensured that the screws are not touching the glass edge. Top surface along the edge between the glass and the aluminium angle shall be caulked with suitable sealants such as zinc oxide based/rubber based/silicon rubber based or poly-sulphide rubber sealants

10. GASKET FOR FLANGES	3 mm thick gasket of Neoprene/synthetic rubber gasket shall be used for sealing the joints between flanges.
11. COLLECTOR SUPPORT FRAME	The structure should be in a position of withstand a wind velocity of 120 kms/hr. shall be made with angle iron of 35 mmx35mmx4mm; will have vertical support at top and bottom edge of the inclined plane of the collector at a distance of 1.5 M or less. The vertical support shall be firmly grouted with the roof.
12. PAINTING OF STANDS	Proper cleaning and degreasing of the surface should be done with the help of three in one solution before painting. Two coats of zinc chromate red oxide primer shall be applied followed by two coats of enamel paint of suitable colour as per NIT.
13. STORAGE TANK(HOT WATER)	
a) Material	Stainless Steel (SS 304/ IS 1730 grade)
b) Thickness	**Minimum thickness** / **Tank capacity**
	1mm / 100 LPD 1mm / 200 LPD 1mm / 500 LPD 1.6mm / 1000 LPD 2mm / 2000 LPD 2mm / 3000 LPD
c) Insulation	Aluminium sheet of thickness 22 SWG shall be used for cladding the tank insulation. Solar water Heating System (SWHS) may be insulated with 100mm thermal grade PUF Insulation of 32kg/ meter cube or higher density or 150mm thermal grade rock wool Insulation of density 48kg/m³. The storage tank shall be properly installed at site using enameled coated appropriate size angle iron stands, girder, cement concrete pedestals of 1:2:3 ratio or any other specific provision suitable to site to ensure the stability against heavy storm etc. but not less than 1'x1'x6" dimensions.

14. PIPING Material Insulation	1" to 2" diameter Medium class (B class) GI as per IS 1239 shall be used for piping. 25mm thick insulation of 48kg/cu.m. density and K value+0.03 W/MK R value+1.67 sq.m. C/W to withstand and temp. of 250 deg. C be used. Thin plastic sheet shall be used as covering between glass wool and aluminium cladding Besides other retaining material like chicken mesh etc. retaining material like chicken mesh etc. 26 SWG thick aluminium sheet shall be used for cladding the insulated pipe. The pipe line should be properly supported and fixed with clamp with the help of suitable size stand/civil structure (cement concrete ratio 1:4) ISI mark strainer of standard make should be fitted in the main cold water supply line before the system.
15. VALVES/NIPPLE/TEES /BENDS	Gun metal valve ISI marked shall be used. Nipple/tees and bends of ISI marked of medium class GI (B class) shall be used. Air vents in each row are to be provided.
16. INSTRUMENTATION (above 1000 LPD)	**Temperature gauge**: 1 No. dial type (for Hot Water Storage Tank/Outlet) **Gun metal strainer**: 1 No. (at Cold Water inlet) **Water meter -**1 at the inlet of cold water tank. Maximum 2 nos. of chrome plated brass taps for systems upto 200 lpd and thereafter 1 tap per 200 lpd of superior quality for distribution line.
17. INSULATED COLD WATER TANK suitable for sub-zero temperature conditions	HDPE/LDPE material with Gun metal float valve (ISI marked) equal to the capacity of Hot water storage tank. Cold Water Tank may be insulated with 100mm thermal grade PUF Insulation of 32kg/ meter cube or higher density or 150mm thermal grade rock wool Insulation of density 48kg/m³ or higher density. Aluminium sheet of thickness 22 SWG shall be used for cladding the tank insulation. The cold water tank shall be properly installed at site using enamelled coated appropriate size angle iron stands, girder, cement concrete pedestals of 1:2:3 ratio or any other specific provision suitable to site to ensure the stability against heavy storm etc. but not less than 1'x1'x6" dimensions. The tank insulation should be designed to withstand extreme low temperature upto -30 deg. C
18. MAKE UP TANK	The capacity of make up tank should be 5 litres up to 500 lpd and 10 litres for 1000 lpd and above made of SS304 minimum 0.8 mm thick

19. SYSTEM INTER CONNECTING PIPING:	ISI marked G.I. pipes, medium class of IS: 1239 duly insulated with 50mm thick rock wool of 48 Kg/m³ density and 26swg Al cladding. EPDM hose pipes can also be used for systems up to and including 500LPD.
20. STANDS & PEDESTALS FOR THE TANKS (hot water tank/ cold water tank)	The tanks will be mounted on stands made out of MS angle iron frame of 35x35x4mm up to 500liters, 50x50x6 mm up to 2000lpd and 65x65x6mm for capacity above 2000 liters with each leg duly grouted with PCC 1:2:4 of 1'x1'x1' size.The cold water tanks will be placed over angle iron frame having 4 cross members in 4 legs with 5mm thick MS sheet for full bottom support fixed of 4 horizontal members based on the size of the cold water Tanks.
21. SYSTEM LAYOUT & DESIGN	Air venting at appropriate places without hindrance of a spring leaded valve to prevent air locking in the system should be provided. For this purpose, the system shall have, at a suitable point, atmospheric pressure conditions preferably in the high temperature zone. System shall have a suitable expansion/make up tank at a high point in the system to ensure that collectors run full all the times. Capacity of this expansion/make up tank should be 1.5% of the system capacity for all systems.
22. HEAT EXCHANGER	For thermosyphen systems only. May be used by incorporating Cu/SS coils/retender inside the storage tank Copper/SS tube of %" dia Minimum 22 SWG. May be higher depending upon the pressure requirements. Shall be so designed to ensure the pressure drop less than 0.3 kg/cm. The surface area of the heat exchanger should not be less than 0.24 m^2 per sq.m of the absorber area of the system (for 100 lpd system, the copper tube length of 7 meter is required). All the elements of heat exchanger shall be as per relevant Indian Standard or as per TEMA Class C construction.

Annexure-IV
Case Study: Manali Hotels
A Model For Success In The Tourism Sector

General Features

Manali is one of the largest tourist destinations in Himachal Pradesh and one of the biggest winter tourism destinations of North India. . There are various types of tourist flows. Manali's now turning into a base camp for trekkers and intrepid mountaineers. There are major Buddhist monasteries which also make it a major religious tourism destination.

Table 14: Tourist influx in Kullu

Year	Domestic in Lacs	Foreign in lacs	Total in Lacs
2007	19.62	1.02	20.64
2008	20.01	1.13	21.14
2009	22.24	1.20	23.44
2010 (estimates)	23.50	1.50	25.00

Source: Manali Hoteliers Association.

It can be seen that the tourist arrivals are growing steadily. This has lead to a rapid growth in all categories of hotels to cater to the tourist arrivals The No of hotels and rooms are given below.

Table 15: Hotels and Hotel Rooms in Manali

Category	Hotels	Total Rooms
3star and above	39	1350
1& 2 Star Luxury (Rooms with bathtubs)	150	600
1& 2 Star normal rooms		4950
Non Star Hotels	100	1000
Lodges /Guest Houses/Ashrams	160	800
TOTAL	**449**	**8700**

Source*: Manali Hoteliers Association*

The climate of Manali keeps changing during the year. The summers are cool and the winters are very harsh. During the winters the snow line comes down and there is snowfall in the region for around 3 months.

Table 16: Temperature Profile of Manali

Temperature:	Maximum	Minimum
Winter: Nov. to Mid - April	18 °C	-6 °C
Summer: Mid - April to Mid-July	28 °C	20 °C
Monsoon: Mid - July to September	25 °C	15 °C

The occupancy for most hotels crosses 90% during these peak seasons. At other times it varies from 10 to 40 %. Average occupancy is estimated at around 50% for all categories of hotels. The luxury star hotels have a higher occupancy at 65% as they offer conference and other adventure tourism facilities which extends their season.

Present Status of SWH in Hotels

Manali, a hill resort in the Kullu District of Himachal Pradesh state is a rare success for the solar water heating industry. Presently around 1.5 lakh LPD of SWH systems is installed in hotel segment in Manali.

The extent of proliferation can be seen by the following observations.

- Steady growth was experienced in the number of SWH installations in the last 5 years. The total installations in hotels have crossed 150000 LPD.

- Almost 20% of the hotels have installed SWHS in capacities of 1000-12000 LPD.
- The hotels using SWH systems are able to meet about 25-50% of the annual requirement for hot water by the SWH systems.
- Most of the owners are satisfied with the systems performance. Many have gone in for additional capacities. Most have calculated paybacks of less than 4 years.
- New areas of SWH application are being explored i.e. Kitchens, laundry, Space Heating and Swimming pool heating.

Success Model

There are some basic underlying factors which have contributed to the overall success of the solar water heating industry

- **Increase in Demand for Hot Water:** Around 570 hotels, more than 9000 hotel rooms, 10-15 % annual growth in the number of tourist arrivals and consequent increase in the hotel rooms especially in the luxury segment has led to a huge increase in the demand for hot water.
- **High Usage**: Year round cold weather makes hot water a necessity in hotels. Consumption varies from 300 LPD in luxury hotel room to 75 LPD per room in Lodges. Water heating energy costs is almost 40% of total energy cost.
- **Rising Tariffs of Electricity and Diesel:** High commercial electricity tariff (Rs. 4.50-5 / Unit) and increase in the prices of diesel has increased the cost of heating water and hence makes alternate/renewable energy sources attractive.
- **Compatibility:** SWH ensure availability of hot water when it is required the most. Peak usage season when the maximum tourist arrivals occur i.e. May and June and peak solar radiation months coincide.

- **Space:** Rooftop space requirement for SWH installation is not a constraint (unlike the plains the terraces are sloping so they cannot be put to other uses).

Given these favorable circumstances the industry too has responded pragmatically by

- **Supplying good quality and properly designed systems.** The two major National Players in the market Tata BP and Intersolar have installed all weather systems, with anti freeze protection, which can work even during the peak winters.
- **Proper Systems Integration to backups**. Backups either provided in the system i.e. Electric or supplied to boiler so systems are very reliable.
- **Prompt Service through dedicated local dealers** Availability of local dealers has ensured proper working of systems as problems are quickly resolved.

The Local Administration has issued Administrative orders making solar water heating mandatory in all new Hotels. This has further increased awareness about SWHS.

Role of Banks:

Another feature of this region is the prominent role played by nationalized banks in promoting solar water heating.

They have provided easy collateral free financing using various RBI credit guarantee schemes which have funds earmarked for SSI sector. Loans have also been speedily sectioned at the branch level as the manager has used his knowledge of local conditions and the credit history of the customers to provide hassle free loans.

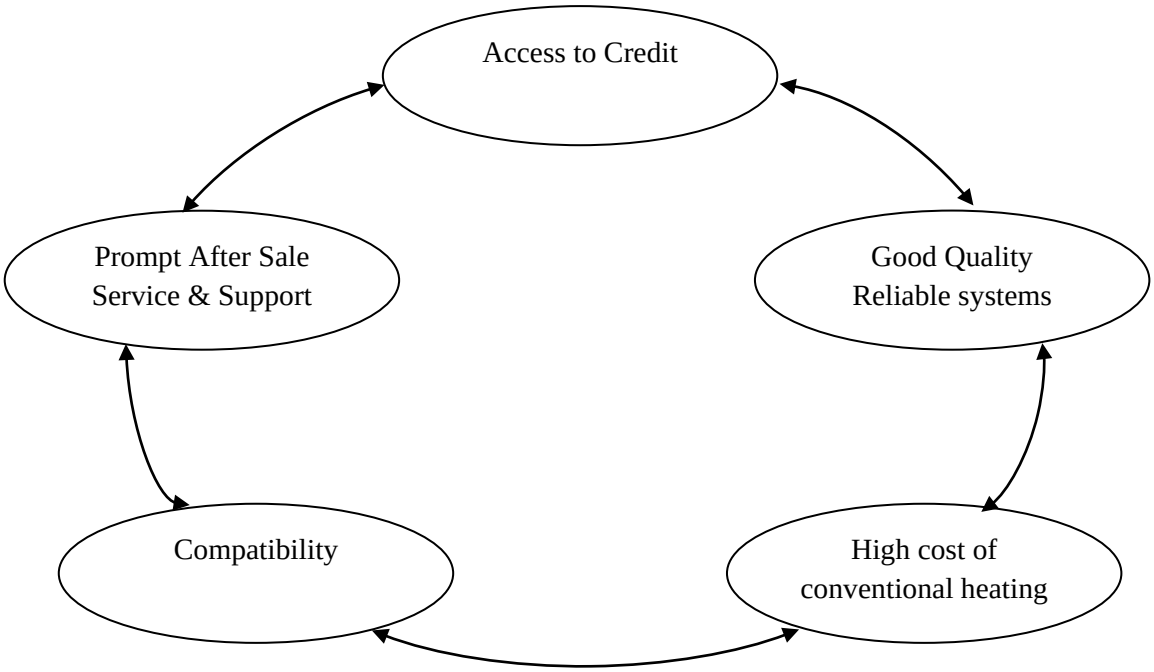
Meetings with the Local manager of the PNB bank reveal that they have provided loans over the last 3-4 years exceeding Rs 8000000 (8 million) approx 50000 liters systems Their repayment record has been very good and they are willing to finance solar proposals in the future.

The main instrument used for providing these loans has been the RBI's CGTMSE (Credit Guarantee Trust for Medium and Small Enterprises). Here the borrower pays an initial premium of 1.5 % on the loan sanctioned and a service fee of 0.5 %every year.

The credit guarantee fee is acceptable as then the borrower does not have to provide a collateral security to the bank and bank is insured against defaults so this encourages quick lending.

Conclusion

The success factors in Manali experience can be summarized by the following schematic. Each component is a part of the overall system and removal of any one will lead to collapse of the model.



In conclusion it needs to be noted that no one single factor can lead to the growth in SWH penetration alone. It calls for a comprehensive approach which addresses all the factors which are required for commercial success.

Appendix-V

Tinsukhia & Dibrugarh Industrial Estates: SWH Potential & Status

Tinsukhia and Dibrugarh are well known for their tea gardens and tea processing units. There are 182 tea gardens in Dibrugarh district and 75 in Tinsukia districts (excluding small tea gardens)

In the Tea Estates hot water is used for the following purposes

i) Cleaning of floors & machines
ii) In bungalows of Executives
iii) In Hospitals
iv) In canteens (preheating for cooking)
v) For preparing tea served to the field workers

The primary data was collected from 13 Tea Estates about the type and quantity of hot water used in their premises. It is estimated that there are more than 1350 executive bungalows, more than 250 hospitals and a canteen in each tea estate of the district. The total hot water requirement in tea estates in the districts is estimated to be more than 20 lakh LPD. Presently there are only two systems of 200 LPD each is installed on a trial basis in the bungalows in a tea estate. The basic barrier is lack of awareness about the SWH technology and incentives and policies of central and state government.

Other Industry and Institution:

There are substantial scope of using Solar Water Heating systems in the hospitals, Guest houses and residential colonies of the following industrial units/ institutions –

1) Digboi Refinery of Indian Oil Corporation Ltd. , Digboi
2) North Eastern Coal Field of Coal India , Margharita
3) Kathalguri Project of NEEPCO , Dulliajan , Dibrugarh district
4) Dibrugarh University , Dibrugarh
5) A big Gas Cracker cum Petro-chemical complex is coming up in Lapet Kata , Dibrugarh district

Annexure-VI

Minutes of Workshop on

"Solar Water Heaters in the Himalayan Region"

Organized by: Greentech Knowledge Solutions, New Delhi
Venue: Hotel KLG, Sco 121-124, Sector 43/B, Chandigarh. 160034

Date: 25 August, 2010

The workshop was attended by various stake holders from the Northern Himalayan region and the neighboring states. A number of Manufacturers, Dealers, SNA officials, Academics and End users were able to put forth their views and concerns. It was generally agreed that there was a vast scope for the use of SWHs in the Himalayan region however there were still certain hurdles which needed to be addressed by the different groups.

Inaugural Session

Dr. Sameer Maithel (Greentech Knowledge Solutions) welcomed the gathering and gave an introduction of the project and the workshop. He also highlighted the current status and an estimate of realizable potential of SWHs in India and the Himalayan belt in particular.

Dr. Bandhyopadhyay (Advisor, MNRE) discussed the need of the technology in the present scenario in Himalayan belt and highlighted the objective of the project. He commented on the failures of the implementation process during the first phase of SWH programme during 1990's, citing the reasons. He was optimistic that the implementation process would be more efficient and successful under the new policy and incentive schemes under JNNSM. He also emphasized the importance of having a strong manufacturing base with appropriate technical knowhow as it is very critical for the success of the scheme and urged the manufacturer and dealers to not to lack in this regard.

Mr. AJ Singh (UREDA) talked about the measures his organization had taken to increase the deployment of SWH in Uttarakhand. He also recognized that the problems which were being faced by the users were related to delays in obtaining electricity rebate, and subsidy from the respective departments. The problem of poor after sales services of the dealers and installers was also brought up him.

Mr. Romesh Verma (JAKEDA) spoke few words on the existing status in J&K. He stated that J&K had an accumulative installation of 1270 m^2 collector area. This figure however is not remarkable as the state has a high potential for SWH use.

Mr. Sood (Director, HIMURJA) spoke about the keen efforts his department was making to increase the deployment of SWH in HP. Mr. Sood stated that a cumulative installation of 14,700 m^2 collector area have been achieved by Himachal Pradesh. He expressed an urgency to finalize and clarify the implementation mechanism of the JNNSM so that the deployment could be accelerated.

Session 1: Project Overview and SWH Potential in Tourism Sector

Mr. Dheeraj Lalchandani (Greentech) described the scope of the project and the methodology adopted in brief. This was followed by the presentation by Mr. Gaurav Malhotra (Greentech) on the recent work concluded in the Jammu district. From its findings it was concluded that there is a high demand for hot water in the region especially in the hospitality sector (Jammu being a base for popular tourist destinations) but only few recent installations had taken place so far.

Mr. Richard Sequeira (Solenge India) presented a totally contrasting case of Manali district of Himachal Pradesh. The Hotel industry in Manali had experienced an annual compounded growth of SWH installations of 15-20% over the last 5 years and has a cumulative installed capacity of 3000 m^2 collector area. The success story has been possible due to a high demand pattern; aggressive marketing by the installers and an effective utilization of the Credit Guarantee Fund Trust for Micro and Small Enterprises (CGTMSE) by the local PSU banks there.

Thereafter, Mr. Yatinder Singh (Owner, Koti Resorts, Shimla) and Mr. Prabhat Thakur (Owner, Hotel Yak, Manali) gave a feedback on the use of SWHs in their facilities. Both were quiet satisfied with the performance and financial savings from SWH system but faced some inconvenience in claiming the capital subsidy

Session 2 : SWH in Household Sector with a Focus on Rural Households.

Dr. Sameer Maithel (Greentech), Prof SS Chandel and Dr. Anil Joshi (Himalayan Environmental Studies and Conservation Organization) were the key speakers in this session. Dr. Maithel presented the case of China & Nepal, where the use of SWHs had been widespread. Prof. Chandel and Dr. Joshi likewise stressed on the imperative need for village level manufacturing and training, innovation and appropriate system designs integrated with other energy systems in order to meet the demands of villages rural households in Himalayan regions. They also recognized the need of streamlining the implementation scheme of the government policies and incentives

Session 3: SWH Industry Perspective

Mr. Ashish Sharda (Channel Partner, TATA BP Solar, Shimla) briefed about the general installation problems encountered in the Himalayan region. He advocated the need of stream lining of government policies and creating more awareness about the SWH technology in the public.

Mr. Ramandeep Singh (Synergy Solar) made a presentation on the activities of his company. He presented a case of an industrial system providing preheated water to the boiler round the clock.

List of Attendees

Sl.No	Name of the participant	Organization
1	A.J. Singh	Uttrakhand Renewable Energy Development Agency (UREDA)
2	Anil Joshi	Himalayan Environmental studies & Conservation Organization
3	Ashish Sharda	Tata BP Solar, Shimla
4	B.M. Sood	Himachal Pradesh Energy Development Agency (HIMURJA),Shimla
5	Bhupinder Kumar	Inter Solar Systems (P) Ltd, Chandigarh
6	Bibek Bandyopadhyay	MNRE
7	Biharilal Bhardwaj	Nainika Enterprises, Sunder Nagar, Mandi
8	Dheeraj Lalchandani	Greentech Knowledge Solutions Pvt. Ltd., New Delhi
9	Gaurav Malhotra	Greentech Knowledge Solutions Pvt. Ltd., New Delhi
10	Sameer Maithel	Greentech Knowledge Solutions Pvt. Ltd., New Delhi
11	K. K. Singla	Solchrome Pvt Ltd, Parwanoo
12	Pravesh Soni	HIMURJA
13	Raman Deep Singh	Synergy Solar Pvt Ltd, Chandigarh
14	Richard Sequeria	Solenge, India
15	Rinchen Upashak	Great Himalayan Traders, Manali
16	Romesh Verma	JAKEDA
17	S. S. Chandel	NIT, Hamirpur
18	Sangeet Sharma	M/s S & N Merchandises, Dehradun
19	Suresh Sharma	M/s Akanksha Solar, Chandigargh
20	Yatinder Singh	M/s Saakar Foundation Chandigarh
21	Prabhat Thakrey	Hotel Yak, Manali
22	Omkar Singh	Akanksha Solar
23	Sidharth Samnotra	J K Machine, Jammu
24	Devinder Kaushal	Inter Solar Sysem
25	Ramesh Pandita	JAKEDA, Srinagar, Jammu
26	S S Kaushal	Synergy Solar Ltd., Chandigarh
27	Manoj	HESCO
28	Anil	Nainika Enterprises
29	R K Gupta	PEDA
30	Munish Sharma	Solchrome Pvt. Ltd., Chandigarh
31	Puneet K Gupta	Solchrome Pvt. Ltd., Chandigarh
32	Rajiv Goyal	Dept. of Science & Technology
33	Naresh Sharma	HIMURJA, Shimla
34	S C Sharma	XEM, Municipal Corporation, Amritsar
35	Umesh Garg	Soland Solar Systems, Ambala
36	Vipul Jain	Soland Solar Systems, Ambala
37	Jaspal Singh	PEDA, Chandigarh
38	Dr. A K Tripathi	MNRE
39	Mrs. Chandel	Gram Pradhan
40	Mr. Nagendra Singh	Koti Resort, Manali
41	Mr. Balbeer Singh	PEDA, Chandigarh

Minutes of Workshop on

"Solar Water Heaters in the Himalayan Region"

Organized by: N.B Institute of Rural Technology, Kolkata
Venue: Kolkata
Date: 28 August, 2010

Dr. S. P Gon Chaudhuri, President, NBIRT welcomed all the members and gave a brief outline of the UNDP/GEF Global Solar Water Heating Project. Dr. Bibek Bandopadhaya, Advisor, MNRE, Govt of India stressed the need to promote Solar Water Heating System in the Eastern and North eastern region in commercial mode. He mentioned though some subsidy is being provided to Solar Water Heating System under National Solar Mission our attempts should be always directed to commercialize the programme for its sustainability. He expressed his satisfaction with the participation of all Eastern and North Eastern States in the Workshop.

Dr. S.P Gon Chaudhuri raised the issue related to the solar insolation in the Eastern and North Eastern Region. He further mentioned that due to low solar insolation of the region and due to the small duration of the winter the use of SWH system is not getting a major boost in Eastern & North Eastern Region. Dr. Sameer Maithal along with Mr. Dheeraj Lalchandani made a technical representation on SWH System. They highlighted the national & international scenarios of different type of SWH Systems. There after the following State representatives made presentation.

- Assam
- Arunachal Pradesh
- Jharkhand
- Meghalaya
- Manipur
- Nagaland
- West Bengal

All the State Representatives highlighted about the existing SWH Program in the respective states. They also insisted on higher subsidy for SWH System in the region considering the low solar radiation and high transportation cost in the region. They mentioned categorically

that unless subsidy is increased significant quantity of SWH System may not be installed in the region. They also highlighted about other incentives required for the region.

Mr. Ananth, CEO, M/S Nuetech, Bangalore & also the secretary of Solar Water Heating System manufacturer Association of Karnataka made a presentation on various type of SWH System installed by his Company in the region. He also stressed the need to commercialize the SWH System keeping in view the future sustainability of the program.

Dr. B. Bandopadhaya in his concluding remarks stressed the need for developing manufacturing units of SWH Systems in the region and the service network. He opined that only through such initiative cost of Solar Water Heating System could be reduced. Dr. S.P. Gon Chaudhuri thanked all the participants for joining in the Workshop in a big way. He finally mentioned that a business model for marketing of SWH Syustem with full servicing facilities needs to be developed by the manufactures and the same may be propagated like other domestic appliances. Dr. Bandopadhaya requested Greentech & NBIRT to organize a similar Workshop at Guwahati some time in October, 2010.

The name of the Participants are given below

- Mr. B. Bandopadhyaya, Advisor, MNRE
- Dr. Sameer Maithal, Director, Greentech Knowledge Solutions
- Dr. S.P. Gon Cahudhuri, President, NBIRT
- Dr. Dheeraj Lalchandani, Programme Officer, Greentech Knowledge Solutions
- Dr. C. Koley, NIT, Durgapur
- Shri S.P Ghosh, FOSET
- Shri S.K Shahi, APEDA
- Shri Joy Chakraborty, WBREDA
- Shri Uttam Mukherjee, Sunshine Power
- Shri A.K Mitra, Victor Solar
- Shri Tamal Manna, Tata BP Solar India Ltd.
- S.K Ray Chaudhuri, G P Troniocs
- Kavito Chish, NRE, Nagaland
- T.S Angami, NRE, Nagaland
- L Manglem, MANIREDA
- John E Rodborne, MNREDA
- P.K Chandra, WBGEDCL

- K Gupta, Paramarth Sadhak Sangha
- M.K Chaudhury, AEDA, Guwahati
- Dr. H Bhaumik, VIB, Nimpith
- D. Sarkar, WBPCB
- R Nondee, WBPCB
- P.N Das Gupta, WBGEDCL
- S.R De, WBGEDCL
- Eltaf Hussain, NBIRT, Kolkata
- B.L Soni, Sinclairs
- Ashok Kumar, JREDA
- K.G Sinha, WBGEDCL
- Asis Ghosh, Rashmi Industries
- T Ananth, Nuetech Solar
- Dr. S Neogi, Regional Test Centre, Kolkata
- Mrinal Kanti Kundu, Superinendent, Governor's Estates
- Anupam Baral, Geetanjali Solar Enterprises
- P.C Sharma, NBIRT, Assam
- Abhijit Dutta, NBIRT, Kolkata
- Ms. Manikankana Majumder, NBIRT, Kolkata
- Mr. Amit Dhar, NBIRT, Kolkata
- Ms. Mallika Karmakar, NBIRT, Kolkata
- A Surya Sreenadh, Ambuja Reality

Annexure-VII

Projections at a Glance

Projections under the three scenarios of the States

2010	BAU Scenario					Optimistic-I Scenario					Optimistic-II Scenario				
Sector	**Residential**	**Hotel**	**Hospital**	**Hostel/Other**	**TOTAL**	**Residential**	**Hotel**	**Hospital**	**Hostel/Other**	**TOTAL**	**Residential**	**Hotel**	**Hospital**	**Hostel/Other**	**TOTAL**
J&K	710	740	40	190	1,680	710	740	40	190	1,680	710	740	40	190	1,680
Uttarakhand	1,300	1,250	310	2,620	5,480	1,300	1,250	310	2,620	5,480	1,300	1,250	310	2,620	5,480
Himachal Pradesh	4,660	9,000	500	300	14,460	4,660	9,000	500	300	14,460	4,660	9,000	500	300	14,460
West Bengal (Hilly region)	30	80	10	40	160	30	80	10	40	160	30	80	10	40	160
Sikkim	120	160	50	70	400	120	160	50	70	400	120	160	50	70	400
Arunachal Pradesh	6	160	70	90	326	6	160	70	90	326	6	160	70	90	326
Assam (Hilly region)	6	20	20	20	66	6	20	20	20	66	6	20	20	20	66
Meghalaya	140	80	100	10	330	140	80	100	10	330	140	80	100	10	330
Manipur	120	20	100	10	250	120	20	100	10	250	120	20	100	10	250
Mizoram	400	10	160	80	650	400	10	160	80	650	400	10	160	80	650
Nagaland	130	20	120	70	340	130	20	120	70	340	130	20	120	70	340
Tripura	44	60	100	10	214	44	60	100	10	214	44	60	100	10	214
Jharkhand	1,600	1,100	800	5,400	8,900	1,600	1,100	800	5,400	8,900	1,600	1,100	800	5,400	8,900

2013	BAU Scenario					Optimistic-I Scenario					Optimistic-II Scenario				
Sector	Residential	Hotel	Hospital	Hostel/Other	TOTAL	Residential	Hotel	Hospital	Hostel/Other	TOTAL	Residential	Hotel	Hospital	Hostel/Other	TOTAL
J&K	20,350	4,780	140	1,070	26,340	20,350	4,780	140	1,070	26,340	20,350	4,780	140	1,070	26,340
Uttarakhand	1,980	1,890	470	3,990	8,330	1,980	1,890	470	3,990	8,330	1,980	1,890	470	3,990	8,330
Himachal Pradesh	7,080	13,690	760	460	21,990	7,080	13,690	760	460	21,990	7,080	13,690	760	460	21,990
West Bengal (Hilly region)	50	120	20	60	250	50	120	20	60	250	50	120	20	60	250
Sikkim	190	240	80	110	620	190	240	80	110	620	190	240	80	110	620
Arunachal Pradesh	13	240	110	140	503	13	240	110	140	503	13	240	110	140	503
Assam (Hilly region)	11	20	30	30	91	11	20	30	30	91	11	20	30	30	91
Meghalaya	210	120	150	20	500	210	120	150	20	500	210	120	150	20	500
Manipur	190	30	150	20	390	190	30	150	20	390	190	30	150	20	390
Mizoram	610	20	240	120	990	610	20	240	120	990	610	20	240	120	990
Nagaland	200	30	180	110	520	200	30	180	110	520	200	30	180	110	520
Tripura	60	90	150	20	320	60	90	150	20	320	60	90	150	20	320
Jharkhand	2,430	1,670	1,220	8,210	13,530	2,430	1,670	1,220	8,210	13,530	2,430	1,670	1,220	8,210	13,530

2017	BAU Scenario					Optimistic-I Scenario					Optimistic-II Scenario				
Sector	Residential	Hotel	Hospital	Hostel/Other	TOTAL	Residential	Hotel	Hospital	Hostel/Other	TOTAL	Residential	Hotel	Hospital	Hostel/Other	TOTAL
J&K	22,980	6,830	200	1,500	31,510	23,770	7,400	270	1,550	32,990	57,140	12,820	490	2,520	72,970
Uttarakhand	3,470	3,310	820	6,980	14,580	5,110	4,880	1,210	10,290	21,490	82,740	20,000	1,210	10,290	114,240
Himachal Pradesh	12,390	23,940	1,330	800	38,460	16,500	31,870	1,770	1,060	51,200	53,220	31,870	1,770	2,670	89,530
West Bengal (Hilly region)	80	210	30	110	430	130	350	40	170	690	8,990	1,050	40	230	10,310
Sikkim	320	430	130	190	1,070	520	700	220	300	1,740	2,100	860	220	310	3,490
Arunachal Pradesh	15	430	190	240	875	30	700	300	390	1,420	4,930	780	350	530	6,590
Assam (Hilly region)	12	40	60	60	172	23	70	100	100	293	15,140	960	310	960	17,370
Meghalaya	370	210	270	30	880	610	350	430	40	1,430	9,980	980	460	760	12,180
Manipur	320	50	270	30	670	520	90	430	40	1,080	10,060	300	430	1,010	11,800
Mizoram	1,070	30	430	210	1,740	1,730	40	650	350	2,770	6,120	120	650	720	7,610
Nagaland	350	50	320	190	910	560	90	520	310	1,480	7,640	490	520	570	9,220
Tripura	110	160	270	30	570	180	260	430	40	910	5,880	580	440	670	7,570
Jharkhand	4,250	2,930	2,130	14,360	23,670	5,480	3,770	2,740	15,640	27,630	112,080	3,770	2,980	15,640	134,470

2022	BAU Scenario					Optimistic-I Scenario					Optimistic-II Scenario				
Sector	Residential	Hotel	Hospital	Hostel/Other	TOTAL	Residential	Hotel	Hospital	Hostel/Other	TOTAL	Residential	Hotel	Hospital	Hostel/Other	TOTAL
J&K	26,870	9,950	330	2,110	39,260	31,940	13,620	760	2,430	48,750	112,970	28,200	1,100	4,760	147,030
Uttarakhand	6,980	6,660	1,650	14,030	29,320	16,710	15,950	2,280	21,470	56,410	205,630	57,250	2,280	21,470	286,630
Himachal Pradesh	24,930	48,150	2,420	1,610	77,110	47,440	59,450	2,420	3,050	112,360	119,750	59,450	2,420	7,160	188,780
West Bengal (Hilly region)	160	430	50	210	850	480	1,290	70	570	2,410	22,770	2,950	70	570	26,360
Sikkim	640	860	270	370	2,140	1,930	2,060	420	720	5,130	4,870	2,060	420	720	8,070
Arunachal Pradesh	30	860	370	480	1,740	90	1,830	770	1,320	4,010	12,390	1,830	770	1,320	16,310
Assam (Hilly region)	33	80	120	120	353	100	240	360	360	1,060	37,400	2,920	810	2,890	44,020
Meghalaya	750	430	540	50	1,770	2,260	1,290	970	160	4,680	24,700	2,730	970	2,320	30,720
Manipur	640	110	540	50	1,340	1,940	320	900	160	3,320	25,110	840	900	3,080	29,930
Mizoram	2,150	50	810	430	3,440	6,450	160	810	1,290	8,710	14,920	320	810	1,920	17,970
Nagaland	710	110	640	390	1,850	2,110	320	770	1,160	4,360	18,790	1,440	770	1,510	22,510
Tripura	210	320	540	50	1,120	640	970	930	160	2,700	14,570	1,560	930	2,020	19,080
Jharkhand	8,560	5,890	4,280	21,470	40,200	15,110	7,210	5,910	21,470	49,700	277,970	7,210	5,910	21,470	312,560

Projection of all the three scenarios for Representative Clusters

2010	BAU Scenario					Optimistic-I Scenario					Optimistic-II Scenario				
Sector	**Residential**	**Hotel**	**Hospital**	**Hostel/Other**	**TOTAL**	**Residential**	**Hotel**	**Hospital**	**Hostel/Other**	**TOTAL**	**Residential**	**Hotel**	**Hospital**	**Hostel/Other**	**TOTAL**
Jammu	140	300	4	60	504	140	300	4	60	504	140	300	4	60	504
Srinagar	10	10	4	4	28	10	10	4	4	28	10	10	4	4	28
Dehradun	1080	1270	180	1790	4320	1080	1270	180	1790	4320	1080	1270	180	1790	4320
Nainital	90	270	20	380	760	90	270	20	380	760	90	270	20	380	760
Udham S Ngr	20	50	10	100	180	20	50	10	100	180	20	50	10	100	180
Kullu	700	3500	200	400	4800	700	3500	200	400	4800	700	3500	200	400	4800
Kangra	800	1900	200	600	3500	800	1900	200	600	3500	800	1900	200	600	3500
Darjeeling	30	80	10	40	160	30	80	10	40	160	30	80	10	40	160
East Sikkim	120	140	50	50	360	120	140	50	50	360	120	140	50	50	360
Tinsukhia & Dibrugarh	10	3	3	4	20	10	3	3	4	20	10	3	3	4	20
Tawang	2	10	4	40	56	2	10	4	40	56	2	10	4	40	56
Papumpare	30	60	20	60	170	30	60	20	60	170	30	60	20	60	170
East Khasi Hills	140	50	10	70	270	140	50	10	70	270	140	50	10	70	270
Ranchi	2400	1800	600	1000	5800	2400	1800	600	1000	5800	2400	1800	600	1000	5800

2013	BAU Scenario					Optimistic-I Scenario					Optimistic-II Scenario				
Sector	Residential	Hotel	Hospital	Hostel/Other	TOTAL	Residential	Hotel	Hospital	Hostel/Other	TOTAL	Residential	Hotel	Hospital	Hostel/Other	TOTAL
Jammu	210	460	10	90	770	210	460	10	90	770	210	460	10	90	770
Srinagar	20	20	10	10	60	20	20	10	10	60	20	20	10	10	60
Dehradun	1640	1930	270	2710	6550	1640	1930	270	2710	6550	1640	1930	270	2710	6550
Nainital	130	420	30	580	1160	130	420	30	580	1160	130	420	30	580	1160
Udham S Ngr	30	80	20	160	290	30	80	20	160	290	30	80	20	160	290
Kullu	1060	5320	300	610	7290	1060	5320	300	610	7290	1060	5320	300	610	7290
Kangra	1220	2890	300	910	5320	1220	2890	300	910	5320	1220	2890	300	910	5320
Darjeeling	50	120	20	60	250	50	120	20	60	250	50	120	20	60	250
East Sikkim	180	210	80	80	550	180	210	80	80	550	180	210	80	80	550
Tinsukhia & Dibrugarh	10	5	5	10	30	10	5	5	10	30	10	5	5	10	30
Tawang	3	20	10	60	93	3	20	10	60	93	3	20	10	60	93
Papumpare	40	90	30	90	250	40	90	30	90	250	40	90	30	90	250
East Khasi Hills	210	80	20	110	420	210	80	20	110	420	210	80	20	110	420
Ranchi	3650	2310	910	1040	7910	3650	2740	910	1460	8760	3650	2740	910	1460	8760

2017	BAU Scenario					Optimistic-I Scenario					Optimistic-II Scenario				
Sector	Residential	Hotel	Hospital	Hostel/Other	TOTAL	Residential	Hotel	Hospital	Hostel/Other	TOTAL	Residential	Hotel	Hospital	Hostel/Other	TOTAL
Jammu	370	800	10	160	1340	610	1300	20	260	2190	9800	1910	250	940	12900
Srinagar	30	30	10	10	80	40	40	10	10	100	5360	2090	140	710	8300
Dehradun	2860	3380	480	4750	11470	3610	4250	600	5980	14440	16300	9280	730	6060	32370
Nainital	230	730	60	1020	2040	290	930	70	1300	2590	9120	2660	130	1300	13210
Udham S Ngr	50	130	30	280	490	60	160	30	340	590	13250	1360	110	450	15170
Kullu	1860	8010	430	710	11010	2180	10890	610	990	14670	5570	10890	610	990	18060
Kangra	2130	4170	390	990	7680	2490	5840	550	1390	10270	18100	5840	550	1390	25880
Darjeeling	80	210	30	110	430	130	350	40	170	690	8,990	1,050	40	230	10,310
East Sikkim	320	370	130	130	950	410	480	170	170	1230	1850	820	200	200	3070
Tinsukhia & Dibrugarh	20	10	10	10	50	30	10	10	20	70	1510	80	350	90	2030
Tawang	5	30	10	110	155	10	40	20	170	240	270	130	20	170	590
Papumpare	70	160	50	160	440	120	260	80	260	720	810	260	80	260	1410
East Khasi Hills	370	130	30	190	720	610	220	40	310	1180	1780	1100	150	600	3630
Ranchi	6380	3210	1600	1130	12320	8220	4500	2050	1590	16360	34470	4500	2050	1590	42610

2022	BAU Scenario					Optimistic-I Scenario					Optimistic-II Scenario				
Sector	Residential	Hotel	Hospital	Hostel/Other	TOTAL	Residential	Hotel	Hospital	Hostel/Other	TOTAL	Residential	Hotel	Hospital	Hostel/Other	TOTAL
Jammu	750	1610	20	320	2700	2260	4810	60	970	8100	25710	4810	680	2310	33510
Srinagar	50	50	20	20	140	110	110	40	40	300	14220	6410	380	1850	22860
Dehradun	5760	6790	960	8270	21780	9680	11410	1500	11570	34160	40580	24040	1500	11570	77690
Nainital	460	1470	120	1650	3700	800	2540	200	2310	5850	24030	7210	300	2310	33850
Udham S Ngr	110	270	50	560	990	170	410	80	860	1520	35180	4010	260	930	40380
Kullu	3750	10990	540	830	16110	5330	15390	750	1160	22630	13000	15390	750	1160	30300
Kangra	4280	5720	480	1160	11640	6090	8010	680	1620	16400	46080	8010	680	1620	56390
Darjeeling	160	430	50	210	850	480	1,290	70	570	2,410	22,770	2,950	70	570	26,360
East Sikkim	640	750	270	270	1930	1110	1300	410	410	3230	4610	2020	410	410	7450
Tinsukhia & Dibrugarh	40	20	20	20	100	130	50	50	60	290	3980	240	980	230	5430
Tawang	10	50	20	170	250	30	160	40	230	460	700	350	40	230	1320
Papumpare	150	320	70	250	790	450	560	90	350	1450	2080	560	90	350	3080
East Khasi Hills	750	270	50	390	1460	2260	810	160	1160	4390	4380	3210	380	1410	9380
Ranchi	12840	4410	2150	1320	20720	22670	6170	3010	1850	33700	85480	6170	3010	1850	96510