Final Report

SOLAR WATER HEATERS IN INDIA: MARKET ASSESSMENT STUDIES AND SURVEYS FOR DIFFERENT SECTORS AND DEMAND SEGMENTS

Submitted to

Project Management Unit
Global Solar Water Heating Project
Ministry of New and Renewable Energy

20th January 2010

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ACKNOWLEDGEMNETS

The project team would like to sincerely thank Dr Bibek Bandyopadhyay, Advisor and Head, MNRE and Mr Ajit Gupta, National Project Manager, UNDP/GEF Global Solar Water Heating Project for their guidance during the entire duration of the project. Periodic review meetings organized by the Project Management Unit helped immensely in shaping the study. We are also grateful to the members of the Project Executive Committee as well as participants of the stakeholders consultation workshop for their suggestions and inputs.

During the course of the study, we had the opportunity to interact with a large number of solar water heater manufacturers/dealers, as well as office bearers of SWH manufacturers Associations in Karnataka and Maharashtra, the project team would like to thank them for sharing their knowledge and insights about the SWH market. The study relied heavily on interactions with a wide range of stakeholders, such as, SWH users, potential SWH users, state level renewable energy development agencies, architects and builders, banks, municipal corporations, electricity distribution companies, pollution control boards. Our special thanks go to all of them for sparing their valuable time to interact with us and for sharing their experiences, perceptions and thoughts on the subject.

Executive Summary

Solar Water Heater Market Assessment Studies and Surveys for Different Sectors and Demand Segments

1.0 Introduction

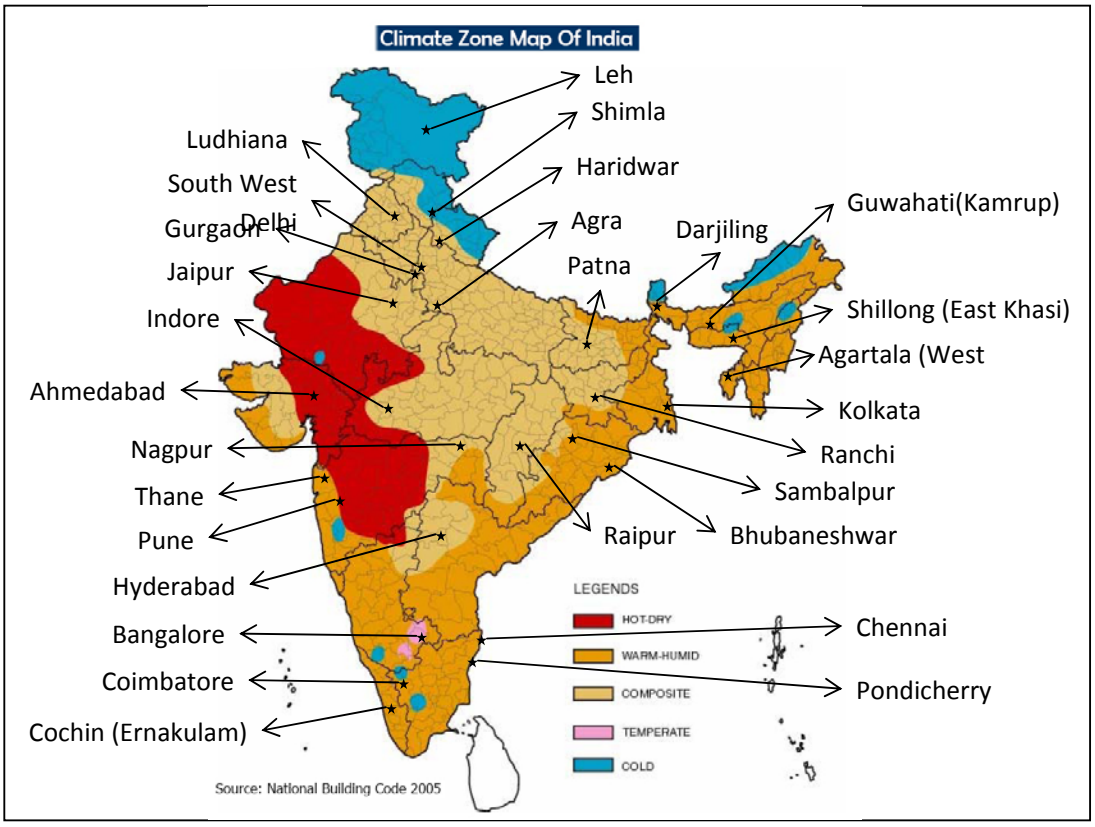
The present report addresses the following objectives.

- Understanding SWH market
- Projecting realizable demand for SWH till 2022
- Generating policy inputs (specific, separate studies on policy and regulation are underway)

The report is an outcome of work done by Greentech Knowledge Solutions Pvt. Ltd (GKS), New Delhi led consortium of consultants. The other members of the consortium are located at Pondicherry, Ahmedabad, Bhubaneshwar and Kolkata.

In addition to literature survey focused on global and Indian SWH market, we carried out a primary survey among 1000 users and non-users of SWH in household, commercial/institutional and industrial segments in 29 districts of India; selected in consultation with MNRE. We also held semi-structured interviews of 200 stakeholders- SWH manufacturers, dealers, SNA'S, banks, municipal corporations, electricity distribution companies, architects and builders. This was followed by analysis leading to demand projection and delineation of key areas for action to realize projected demand. The primary survey was followed by realizable demand projections.

Figure 1. Primary Survey – 29 Selected Districts



2.0 SWH Global Market

In 2008, the cumulative SWH capacity was 15 GWth. Growth in recent years has been 15% per year. There are estimated 40 million households (2.5% of the total) which were using SWH worldwide in 2004.

China is the leader; 10% of Chinese households use SWH; the target for 2020 being 30%. In 2008, 65.6% of existing global SWH capacity was in China; followed by European Union (12.3%), Turkey (5.8%), Japan (4.1%) and Israel (2.8%). The Indian share was 1.2%.

The residential sector is the mainstay of SWH in the two largest SWH markets; 98% of annual sale in China and 90% of installed capacity in Europe is in the residential sector. The market is urban-centric; 90% of installations in China are in urban areas.

While households-level SWH in Europe are installed predominantly in independent houses, it is both-independent houses and multi-storied buildings-in China.

3.0 Indian Market

The segment-wise statistics on Indian market are not available. Based on our work, we have pieced together the following picture.

Table 1. Estimated Breakup: Functional SWH Installations Till 2009

Sector	**million m^2**
Residential (80%)	2.108
Hotels (6%)	0.158
Hospitals (3%)	0.079
Industry (6%)	0.158
Other (Railway + Defence + Hostel + Religious places, other) (5%)	0.132
Total	**2.635**

***** It is assumed that 85% of the installed SWH are functional

The sale during 2009 is estimated at 0.55 million m^2. The CAGR of cumulative installation during 1995-2000 was 8.23%. It spurted to 20.6% during 2000-04 and further to 24.6% during 2004-08, denoting overall CAGR of 16.8% over 1995-2008. The following explains demand upsurge in recent years.

- Growth in new urban housing; rising disposable income; increased propensity for consumer durables
- Arrival of ETC & improvements in supply chain
- Energy price hike
- Policy initiatives

4.0 Primary Survey: Key Findings

In the residential sector, there are 0.7 million SWH user households; 65% of which are concentrated in Karnataka and Maharasthra. There is overall satisfaction with product- experience; some concern being voiced over after-sale support. The use of SWH-water is mainly for bathing. The average size of the domestic installations that were surveyed is around 150 lpd. Among non-users, in states other than Karnataka/Maharashtra, there is sketchy awareness of the bare concept of SWH. The customers perceive it as a product suited for independent houses and not so much for apartment buildings. Hot water demand expressed though months/year and supply chains are important demand drivers. The high demand regions report hot water demand for ≥ 9 months/year, while the lower end is 4 months/year.

In the hotel sector, SWH experience exists across regions and hotel/guest-house standards. The provisioning recognizes year-round demand for hot water. The use of expensive petroleum fuels and electricity support the case for SWH. Roof availability, for 15 room upward capacity hotels, is not a significant barrier. However, capital cost is a major consideration. Among hospitals and hostels, awareness/exposure levels are low; compared to hotels. Supply hour management/regulation is a key advantage for both. Roof availability is not a noticeable constraint.

The SWH experience among industries is limited and scattered. Heating of boiler feed water is the major application. Some of the candidate industries –rice-mills, pulp and paper, tea-gardens, leather, textile processing-utilize biomass and coal; lengthening the payback period. It is industries utilizing oil-fired boilers-mainly dairy, fertilizer and sub-set of textile which are the prime markets for SWH. In addition, there are industrial canteens. The report enumerates geographical clusters, where SWH-relevant industries are concentrated.

In the rural sector, the households, *dhabas*, primary health-centers, hostels and village- industries (silk-reeling, textile-dyeing, puffed rice-making) are the main segments. The capital cost, recourse to biomass, lack of piped water supply, roof design/strength and virtual absence of supply chain are the roadblocks. The report highlights a low-cost innovative product introduced in Ladakh and a community-level

positive experience in Himachal Pradesh. The development of rural market warrants large, fresh work in terms of product-development, demonstration, policy and promotion of supply chain.

5.0 Industry Structure, Supply Conditions And Value Proposition

There are two technologies in vogue; flat plate collector and evacuated tube collector; the later has flourished on the strength of import of glass tubes from China. There are 113 approved Indian producers. The largest player market share is under 15%. The producers do not have nation-wide, SWH- specific brand equity. The dealer network is limited. The manufacturing is concentrated in southern India and Maharashtra. Barring ETC, there have not been any major product/technology breakthrough in last two decades. The system cost for a household varies from Rs. 20000 to Rs. 60000, depending on size and standard. It is positioned as an electricity-saving consumer durable. ESCO or pay-per-use models have not been attempted in a significant way.

6.0 Approach To Estimating Realizable Potential

The empirical data, over a period of time, in terms of SWH sale, its region-wise and segment-wise breakup and behaviour of relevant variations is not available. The present installations are concentrated in Karnataka and Maharashtra; compounding the inadequacy of data required for all-India model-building.

We were required to devote considerable effort to the task of estimating present and future stock of housing, hotel-rooms, hospital-beds, hostel-beds, etc. The establishment of hot water- consumption norms involved a probe into the applications and working out weighted average since norms vary across hotel/hospital categories.

We have identified the parameters driving demand and built three scenarios for demand projection-realistic or most likely; optimistic and pessimistic which are, both, considered less likely.

Our estimates in terms of SWH penetration and CAGR, for a given segment under the concerned scenario, recognizes the following.

- Historical trends and best-case (Karnataka) performance
- Assessment of potential based estimated growth for a given segment and its response to SWH; considering payback period prospect,
- Variations in SWH penetration vis-à-vis new and old buildings

7.0 SWH Potential Projection

Under realistic scenario, we estimate demand as follows [1].

Table 2. SWH potential under realistic scenario (cumulative million m^2)

	2010	**2013**	**2017**	**2022**
Residential	2.58	4.25	7.68	15.74
Commercial/Institutional				
• Hotels	0.19	0.35	0.61	0.97
• Hospitals	0.10	0.17	0.27	0.43
• Others	0.18	0.27	0.39	0.52
Industry	0.19	0.33	0.57	1.05
Total	**3.24**	**5.37**	**9.52**	**18.70**

Residential sector would remain the largest sector and would contribute to 84% of the cumulative installations.

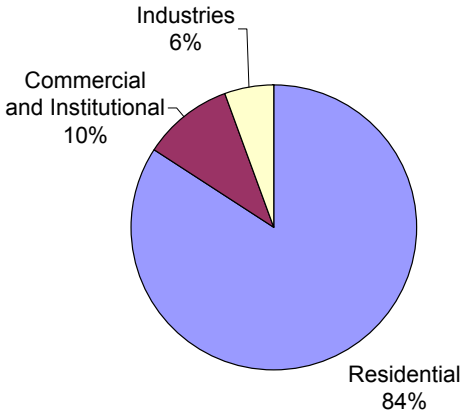


Figure 2 : Percentage-share of sectors in SWH installations 2022

[1] 1 m^2 = 50 lpd

Under optimistic and pessimistic scenario, total demand is projected as follows.

Table 3. Demand projections under optimistic and pessimistic scenario (cumulative million m^2)

	Optimistic	Pessimistic
2010	3.41	3.22
2013	6.15	5.11
2017	11.63	8.16
2022	24.08	13.13

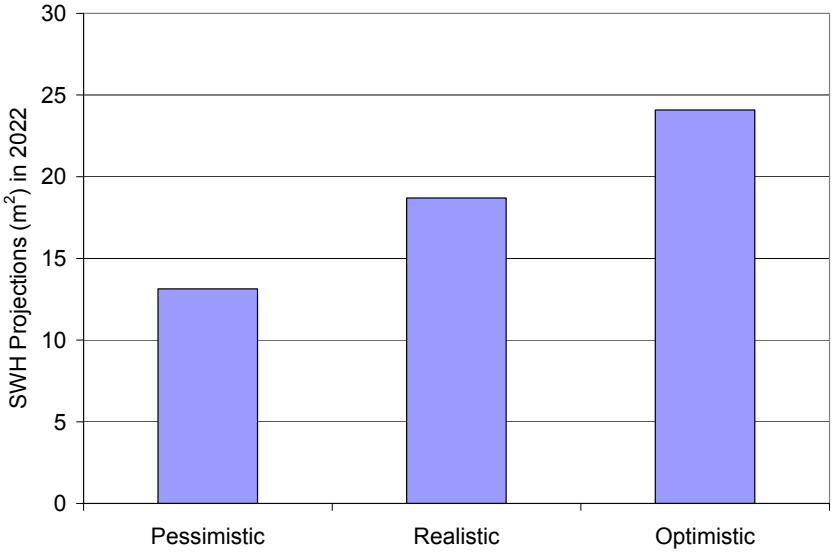


Figure 3: Comparison of projected SWH potential in 2022 for the 3 scenarios

The demand projection, under realistic scenario, implies SWH penetration in 1.78% of Indian households by 2022. In absolute terms, this is 5.25 million SWH-using households in 2022; for comparison there were 5.22 million water-purifier using households in India is 2008.

In the hotel and hospital segments, SWH penetration will reach 53% and 29% by 2022.

The demand projections under the realistic scenario are compared with the targets set for solar water heating in the recently announced Jawaharlal Nehru National Solar Mission (JNNSM) in the following table. The comparison shows a considerable gap between the targets set for the year 2017 and the projected potential. This indicates a need for having a much closer scrutiny of the JNNSM targets and the strategies to achieve the targets.

Table 4 Comparison of JNNSM targets and projected potential under realistic scenario

	JNNSM target (million m^2)	Projected potential (million m^2)
2013	7.0	5.4
2017	15	9.5
2022	20	18.7

8.0 Spatial Distribution of Projected Demand

Five states will lead demand-expansion, as is evident from the following table.

Table 5. Five top states
(cumulative SWH potential in million m^2 for 2022 under the realistic scenario)

State	**Residential million m^2**	**Commercial/ Institutional million m^2**	**Total (Excluding Industrial) million m^2**
Karnataka	3.72	0.16	3.88
Maharashtra	3.5	0.31	3.80
Tamil Nadu	1.53	0.14	1.67
Andhra Pradesh	1.08	0.09	1.17
Gujarat	0.90	0.06	0.96
%age of 5 states			**67.10%**

Further analysis of demand at the district level shows that a large part of the demand would come from selected urbanized districts. Some of the key districts (out of the 29 surveyed districts) which have large potential are listed in the table below.

Table 6: Selected districts with large SWH potential
(Cumulative SWH potential in million m^2 for 2022 under the realistic scenario)

District/Region	SWH potential (excluding industry) million m^2
Bangalore	1.94
Pune	1.11
National Capital Region	0.77
Thane	0.68
Hyderabad	0.58
Nagpur	0.38
Kolkata	0.36
Chennai	0.35
Coimbatore	0.33
Ahmedabad	0.29
Jaipur	0.27

9.0 Recommendations for Key Areas for Action

We have identified 10 key action points for MNRE and UNDP/GEF project. In our view these actions are important for relizing the potential of SWH in the country and achiving targets set under JNNSM. Please note that these do not follow any specific order of priority.

9.1 Select high-potential districts for implementation

The analysis presented in the report shows that the adoption of SWH depends primarily on the demand for hot water, regulations, SWH supply chain and paying capacity of the users. As presented in the previous section, a large part of the demand is concentrated in urban centers. Given this reality, MNRE should identify 10-20 districts and focus its attention on implementing SWH programme during the first phase of JNNSM (2010-2013) in these districts.

9.2 Implementation through Electricity Distribution Companies

There is a need to provide soft-term loan and, depending on the region and building vintage, a financial incentive to promote the market over next 5 to 8 years. Electricity distribution companies are the most appropriate vehicle to operate the package. The customer will appreciate readily the proposition of electricity-saving, rebate on electricity bill and outgo on account of SWH- purchase for a specified period because the company will make a single, consolidated proposal; smoothening all transactions. The distribution companies are also best equipped to operate compulsory installation policy for new buildings as well as old ones requiring extra power. They will build a clear database of installations, loan/rebate provided, SWH- performance and electricity saving. MNRE should set-up a working group to initiate a dialogue with Ministry of Power, Electricity Sector Regulators and Electricity Distribution Companies to develop a SWH programme for implementation through Electricity Distribution Companies by 2011.

9.3 Implementation-Oriented Mandatory Regulations

Mandatory regulations would remain a very important tool for developing market for SWH. Thus, it is imperative that the SWH mandatory regulations addresses the essential legal, administrative and technical issues and outlines the implementation mechanism. Prioritization and phasing might help, e.g., the policy may focus on new buildings above a cut-off point and limit itself to selected cities initially; extending the target-constituency and city-list over time. MNRE should initiate work with selected (3-5) municipal corporations and state governments having prior experience in implementing SWH mandatory regulations to update the regulations and develop a fool-proof strategy for implementation.

9.4 Strategy for Multi-storied Buildings

Given the shift towards multi-storey residential buildings, addressing water heating in multi-storey residential buildings through solar water heaters would be the key to realize potential in residential sector. A package of mandatory regulations, techno-managerial solutions, working models and best practices and incentives is essential for multi-storied buildings. Existing buildings will warrant special incentive. MNRE

may set-up a task force to study the issues and for developing a comprehensive strategy for multi-storey residential buildings.

9.5 Targeted and Variable Incentives Package

The payback period in respect of SWH varies across regions. It is not practical to stipulate compulsory SWH-installation for old buildings. The incentive package needs to address regional and vintage differences. MNRE should develop targeted and variable incentive packages that takes into account the specific requirements of different regions, sectors and vintage of builings.

9.6 Rural Market Development

Rural market particularly in the cold region may offer large potential. In the report we have indicated the barriers and successful experiences. MNRE should work out a blue print for the development of appropriate products, supply chains and a policy package focused on developing rural market for SWH.

9.7 Strategy to strengthen SWH Supply Chain

We have already elucidated the problem-areas. MNRE needs to work on a package of fiscal/monetary/subsidy policy to promote industry- consolidation, product/technology development appropriate to low/middle-income group market, visible and extensive distribution network, quality-standards and rating. It will help if the industry, on its part, works out a collective vision and strategy for realizing market-volume projected under the report. For example the industry and government can work together to constitute a fund of the order of around 5% of the annual turnover of the industry to be used for advertising and promotion.

9.8 Developing a database of SWH installations

Presently, there is no system for collecting information of SWH market and installations. Unavailability of this data was one of the main hurdles faced by the project team. MNRE should consider giving this responsibility to an independent

organisation to develop and maintain a data-base of SWH manufacturing, sales and installations.

9.9 Sector and Region Specific Market Assessment Studies

The present study should be seen as the first attempt to gain an understanding of the Solar Water Heating market. As indicated in the report there are several sectors which require more in-depth market assessment studies, two such sectors are industry and rural sectors. Amongst regions, cold region requires a detailed study. There is also a need to continue updating market assessment every alternate year.

9.10 Promoting Energy Service Company (ESCO) based models

For setting-up large SWH installations in commercial buildings, industries and large residential developments , ESCO approach has the potential to become the most preferred implementation arrangement. MNRE should develop an action plan to develop feasible ESCO models and create conducive environment for development of sustainable SWH ESCO businesses.

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Chapter 1. Introduction

1.1 Global Status of Solar Water Heaters

Use of solar energy for heating water is one of the oldest and most mature renewable energy technologies. The two predominant technologies that are used are Flat Plate Collectors (FPC) and Evacuated Tube Collectors (ETC)[2]. Solar Water Heater installations are witnessing a rapid growth throughout the world (table1.1). Globally, the industry has been growing at 15% annually. China and European Union are the two largest markets of solar water heaters. India accounts for around 1.5% of the total installed capacity (fig 1.1) and 1% of the sales during 2008[3](fig 1.2).

Table 1.1: Solar Water Heaters- Global Growth

Year	Installed Capacity (GWth)
2006	105
2007	126
2008	145

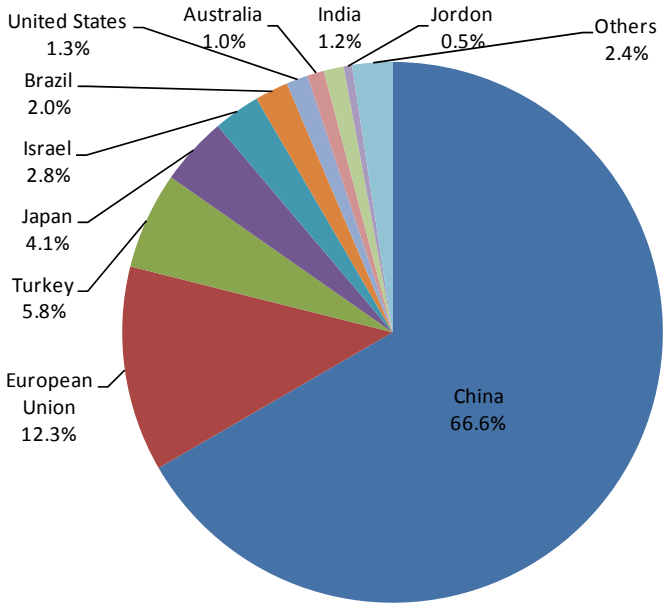


Figure 1.1: Share of Solar Hot Water (Top 10 countries, 2007)

[2] A FPC consists of a weatherproofed, insulated box covered with glass sheet, containing a black metal absorber sheet with built in pipes. An ETC has multiple evacuated glass tubes. The working fluid flows in the inner tube; the vacuum within the evacuated tubes reduces convection and conduction heat losses.

[3] REN 21. Renewables Global Status Report 2009 update

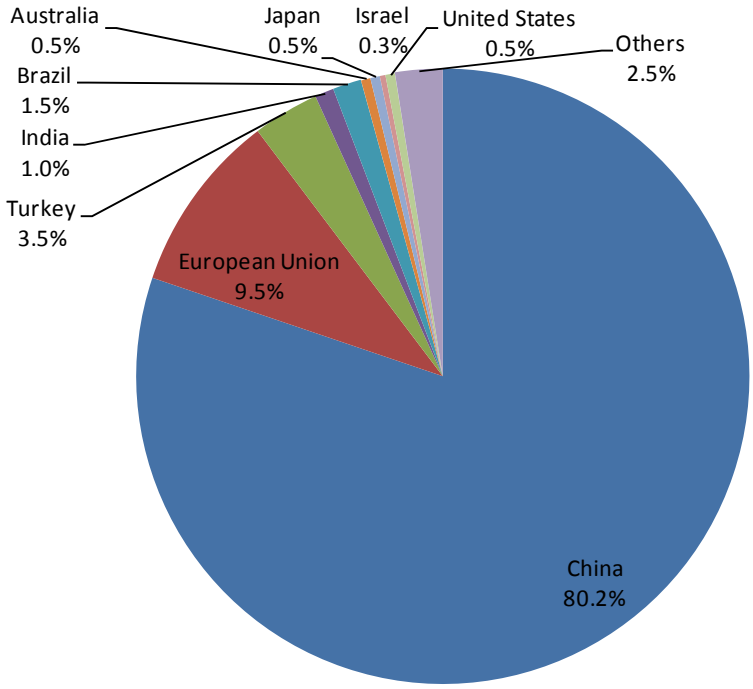


Figure 1.2: Share of Solar Water Heater Capacity added (Top 10 countries, 2007)

World-over, the residential sector has the largest market share in solar water heater market. In 2004, around 40 million households worldwide i.e. 2.5% of the total 1.6 billion households globally, were estimated to be using solar water heaters[4]. In China, it is estimated that 98% of the annual SWH sales are contributed by the residential sector[5]. Overall 10% Chinese households are estimated to be using solar water heaters, this percentage is expected to go up to 30% by 2020[6]. In Europe, 90% of the installed SWH capacity is in the residential sector[7]. In Europe majority of the residential systems are single-family homes, while in China a large number of residential solar water heaters are installed on multi-storey buildings. In China, almost 90% of the SWH are installed in the urban areas.

World-over residential sector has the largest market share in the solar water heater market. Majority of the SWH systems are installed in urban areas.

[4] REN21, Renewables Global Status Report 2005
[5] Han Jiangong, Experience and Future of Solar Energy in China, Presentation made at Copenhagen on 18th September 2008.
[6] Wallace WL, Liu S J and ZY Wang, Development of Standards, Testing and Certification Program to support the domestic solar water heating market in China, NDRC/UNDP/GEF Project Management Office.
[7] Centre for Renewable Energy Sources, Report on market situation and trends about relevant solar thermal applications, Solarcombi+ Project of European Union. 2008

1.2 Solar Water Heaters in India

The first serious attempts to deploy the technology were made with the formation of Department of Non-Conventional Energy Sources (DNES) in 1982, though the history of research and pilot-demonstration go back to 1960's. The total installed collector area increased from 119000 m^2 in 1989 to 525000 m^2 in 2001 [8]; and to estimated 3.1 million m^2 by December 2009[9]. The growth in installed solar water heater area is shown in figure 1.3. The annual average growth rate in SWH installations during 1995-2008 was 16.8%. Further, this period (1995-2008) can be divided into three phases:

- 1995-2000: The average annual growth during this period was 8.2%. A study reported that in 2001, almost 80% of the SWH installations were in the commercial and industrial sectors[10].
- 2001-2004: The average annual growth rate during this period was 20.6%. The market for residential systems became pre-dominant.
- 2004-2008: The average annual growth rate during this period was 24.6%

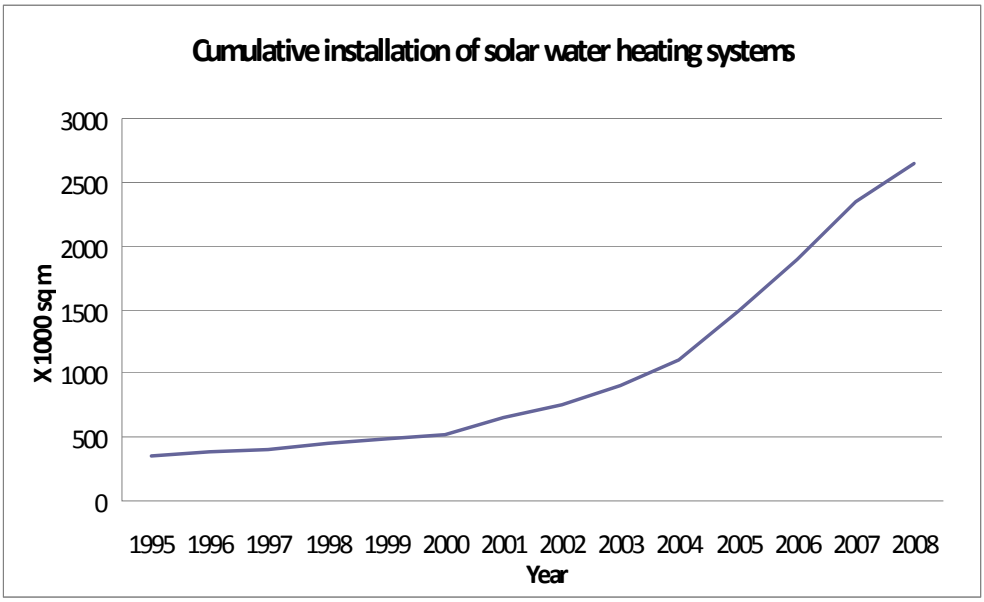


Figure 1.3: Cumulative Installation of Solar Water Heaters in India (1995-2008)

[8] OPET-TERI & HECOPET: Status of Solar Thermal Technologies and Markets in India and Europe. 2002

[9] The data presented is MNRE data. MNRE data is based on voluntary disclosures by SWH manufacturers on sales. There is no third-party inspection system in place to cross-check and verify these claims. In absence of any other data source, this study is based on MNRE data.

[10] same as 6

UNDP-GEF global solar water heater project is aimed at further accelerating the market development of solar water heating and facilitating the installation of 5 million m^2 of installed collector area by 2012. Solar water heaters are also an integral part of the recently announced Jawaharlal Nehru National Solar Mission (JNNSM) of Government of India. The Mission targets to have 20 million m^2 of Solar Water Heater collectors by the year 2022 (Table 1.2)

Table 1.2: Capacity addition target under JNNSM

	Cumulative Target	Addition during the Phase
Phase I (2010-13)	7 million m^2	3.45 million m^2
Phase II (2013- 17)	15 million m^2	8 million m^2
Phase III (2017-22)	20 million m^2	5 million m^2

Source: JNNSM document, MNRE

The overarching objective of the UNDP-GEF Solar Water Heating project is to leverage the MNRE National Programme and create markets and widespread demand for solar water heating in different sectors especially in the thus far untapped potential areas.

One of the pre-requisite is to gain a better understanding of the current Solar Water Heater market in the country and identify sectors and geographical areas having high potential for SWH. The present study is aimed at this objective and is titled "**Market Assessment Studies and Surveys for different Sectors and Demand Segments**".

1.3 Objective of the study

The objective 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 and, to project realizable market potential in each sector and segment till the year 2022.

Following sectors and demand segments were identified for the study:

- Residential buildings
- Institutional and commercial sector
- Industrial sector
- Rural/ small-town sector

1.4 Methodology

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: Secondary Information Collection & Planning of Survey

In this phase, secondary information on solar water heating sector in India was collected. This information consisted of information on manufacturers, products, policies, barriers and markets. This information was collected through literature survey as well as selected interviews with stakeholders and field visits. The collected information was used for planning of survey (phase II) of the study.

In consultation with MNRE during project inception meeting held on 28 July 2009, 29 districts were selected for conducting the primary survey. It was planned to conduct 1000-1200 interviews with various stakeholders. Data collection formats, structured interview formats were drafted and pilot-tested and sample size for different categories of stakeholders was finalized.

Phase II: Survey (primary data collection)

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

- Hot water demand (present as well as growth trends)
- Fuel/energy source/technology used
- Current status of solar water heater markets
- 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, 5 regional teams were deployed.

Phase III: Assessment of market potential

The work under this phase consisted of:

- An appreciation of sector-level issues concerning installation of SWH and implications of these in terms of SWH market prospects. This is based on the primary survey and stakeholder interviews done.
- Development of hot water requirement norms based on literature survey, primary survey and stakeholder consultations.
- Putting together a full picture of existing stock for different sectors in India and expected growth until 2020

- Clarifying the present base of SWH installations in the sector and outlining the alternative scenarios for demand buildup
- SWH installation projection under alternative scenarios till 2020

1.5 Literature Survey on SWH Potential in India

In India, very little published information exists on the SWH markets. In recent years, two research studies have presented methodologies for the assessment of SWH potential.

Chandrasekar and Kandpal[11] have presented a methodology to estimate the potential number of households that can use SWH systems. The methodology establishes a relationship between the seasonal and diurnal variations in ambient temperature at a place and the need of hot water for bathing. This has been used to estimate the expected capacity utilization of SWH for different locations in the country. The income levels of the households directly affect their capacity to purchase SWH. Using the income distribution of households in the country, the capital cost of typical SWH, and the rate of interest on the loans provided to the users to purchase SWH, the potential number of households who can use SWH have been estimated. In one of the examples presented in the paper, it is estimated that 45 million households in India can use SWH. This translates into a potential of 90 million m^2 of SWH in the residential sector.

Pillai and Banerjee[12] have presented a methodology for potential estimation of SWH in an area taking into consideration the factors affecting adoption at the end use level (micro-level factors) and factors that affect the aggregate market (macro-level factors). The methodology can be used to estimate the potential for the individual sectors and also for the target area as a whole. In the paper, the methodology is illustrated for a synthetic area at Pune with an area of 2 sq. km and population of 10,000. The end use sectors considered are residential, hospitals, nursing homes and hotels. The estimated technical potential and market potential are 1700 m^2 and 350 m^2 of collector area, respectively.

The two studies were considered while designing the primary survey.

[11] Chandrasekar, B., Kandpal, T.C., 2004. Techno-economic evaluation of domestic solar water heating systems in India. Renewable Energy 29,319–332.

[12] Pillai I.R., Banerjee, R., 2007. Methodology for estimation of potential for solar water heating in a target area. Solar Energy 81 , 162-172.

1.6 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.

1.7 Outline of the Report

The report has nine chapters. Chapter 2 explains the methodology used for the survey, chapter 3 presents the key findings of the primary survey. Chapter 4 deals with the methodology for projecting potential; chapter 5 to 8 presents the assumptions and the results for projection of SWH demand in residential, commercial and institutional buildings, industries and rural sector respectively. Conclusions are presented in Chapter 9. Brief survey reports of 29 districts are presented in Annexure –I, while projections at a glance are provided in Annexure-II. Annexure III gives the summary of LBNL report on "Residential and Transport Energy Use in India: Past Trend and Future Outlook", which is used as reference for few data inputs while doing projections.

Chapter 2. Primary Survey Design

2.1 Background

In addition to desk research, primary survey among owners of solar water heaters (SWH) as well as among non-owners and interviews of stakeholders formed the main component of work during phase II of the project. For survey, 29 districts were selected, the names of these districts are provided later in the chapter.

2.2 Primary Survey

The SWH installations in India 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 18 households were interviewed per district. We tried to follow the principle of interviewing 2 non-SWH owners per every SWH owner because we needed a larger (than owner) sample of non-owners to derive meaningful indications. We did not interview any family consuming under 100 kWh of electricity per month. It was considered a non-candidate for SWH on the economic means ground. We have tried to cover some households, apparently possessing the economic means, in the rural areas and such households are largely non-SWH owners.

For SWH owners as well as 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 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.

In respect of non-owners, the focus was on deciphering levels of perception, awareness and exposure to SWH. While we have collected information on the basic profile- economic status, family size- of the respondents, we have not drawn any conclusions from it.

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 5 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 non-SWH owner hospitals/ nursing homes per district. For hostels and other establishment, the number of interviews per district is two.

2.6 Industry

In the industrial sector, the objective was to cover six industries per district- a mix of SWH-owners and non- owners. The industries prioritized were-dairy, textile, drugs and pharmaceuticals, food processing. During the course of the study we were able to identify some other relevant industries also.

2.7 Sampling Frame

The sample size per district flowed from budget and time limitation. The objective was to cover a large number of districts (but few interviews per district) rather than do few districts.

Given the extremely small size of the sample per district and absence of knowledge regarding the universe – there do not exist any overall state-level statistics on SWH installations, leave alone segment-wise installations or installation-listing, it was not possible to develop a statistically significant sample and hence (statistically significant) conclusions. Nevertheless, it should be borne in mind that this a maiden and most extensive effort across climate zones in India to reach out to SWH owners and non-owners and it did throw up recurring or common messages. District-wise salient observations are provided in chapter 3.

2.8 Stakeholder Interviews

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

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

The SNA's 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.

2.9 Geographical Coverage

The approach has been to select districts from each climatic zone:

- Hot – dry
- Composite
- Warm and humid
- Cold
- Temperate

We have chosen 29 districts in consultation with MNRE and PMU (Figure 2.1). A gamut of variables underline district-selection-existing hub of SWH manufacturing, new policy initiative, emerging market, tourist character, solar city status.

We had put together a demographic-cum- economic profile of individual districts in India. However, our primary survey, as we saw, is not built on the edifice of statistical significance and so it was considered appropriate to follow practical considerations rather than a statistical approach. The district coverage, it may be seen from the map, is quite dispersed.

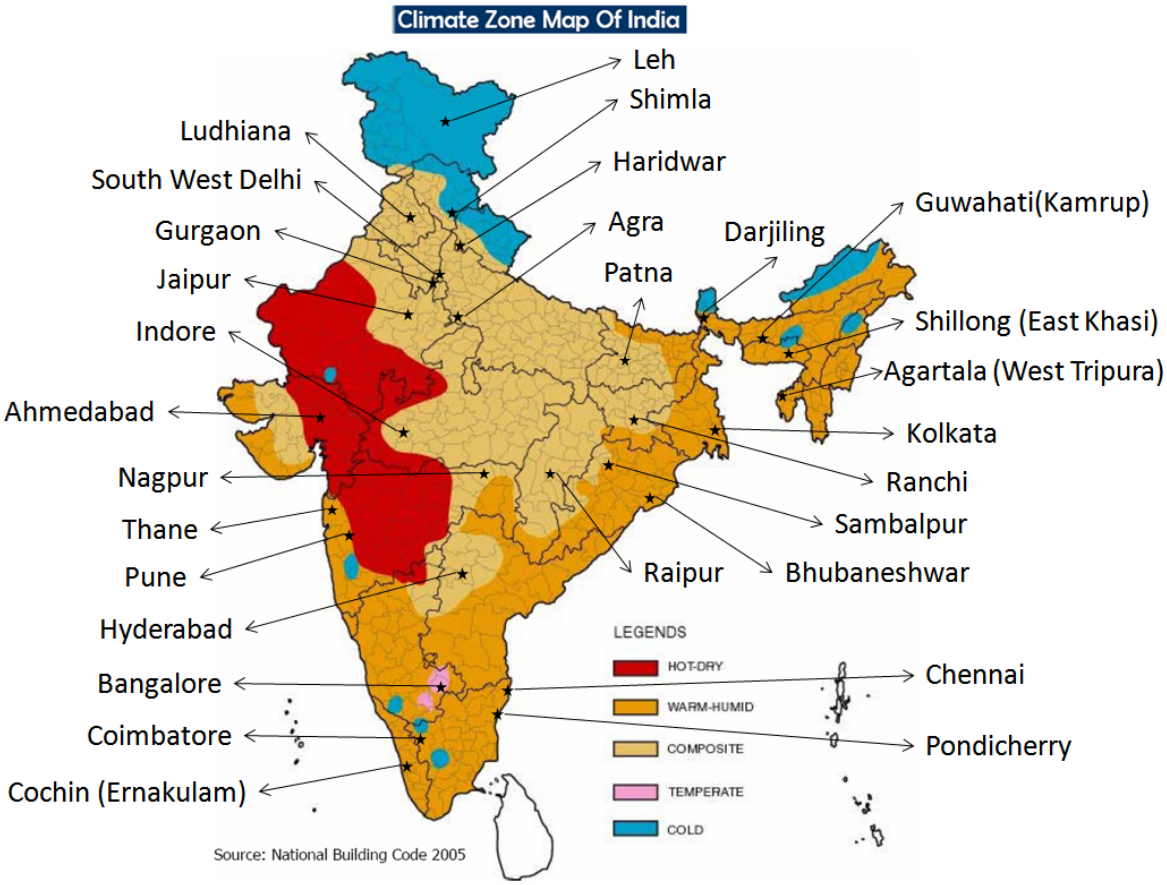


Figure 2.1: Selected Districts for Primary survey

2.10 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	Ludhiana, South Delhi, Gurgaon, Leh, Shimla, Haridwar, Agra
FVC	Ahmedabad	Ahmedabad, Jaipur, Nagpur, Pune, Thane, Indore
NBIRT	Guwahati, Kolkata and Agartala	Gauwahati (Kamrup), Shilong (East Khasi Hills), Agartala (West Tripura), Darjeeling
Varun Techno Infrastructure (P) Ltd., Bhubaneswar	Bhubaneswar	Kolkata, Ranchi, Sambalpur, Raipur, Bhubaneshwar, Patna
AURORE	Auroville	Hyderabad, Bangalore, Coimbatore, Cochin (Ernakulam), Chennai, Pondicherry

Chapter 3. Primary Survey Results

During the primary survey, approximately 1000 interviews were conducted in 28 districts. Summary district reports have been prepared for all the surveyed districts and are presented in Annexure I. Sector-wise main findings are presented in this chapter.

3.1 Residential Sector

Residential sector is the largest sector both in terms of installations as well as sales. As per industry estimates, currently, almost 70-80% of the SWH sales occur in the residential sector. As mentioned in chapter 1, in the year 2001, almost 80% of the SWH installations in India were in the commercial and industrial sectors, since then, residential sector has overtaken commercial and industrial sectors and has become the main driver of growth of SWH in India. It is estimated that in 2009 around 7 lakh households (around 0.4% of the total households) in the country were using SWH systems[13]. Almost 60% of these households are located in two states - Karnataka and Maharashtra. More than 95% of these households are located in the urban areas.

3.1.1 Growth of SWH in Residential Sector

The main reasons for growth in SWH in residential sector in recent years are:

- **Growth in new housing**: During 1991-2001 period, 54 million new housing units were added. In recent years, the demand for new housing has shown rapid increase. This is attributed to: increase in disposable incomes, easy availability of credit, trend towards smaller household size, and urbanization. A recent study predicts the demand for new housing units to range between 6.9 million to 9.7 million per year for the period 2005-2030[14].

- **Rising income and increased propensity for consumer durables**:
  India has been experiencing consistent economic growth since early 1990's, this is reflected also in the household incomes. The number of households having an annual income > Rs 5 lakh/ year has been estimated to grow 10 times -- from around 1 million households in 1995-96 to 10 million

[13] Assuming a) 70% of the total installed 3 million m^2 is in the residential sector b) average size of a SWH systems is taken as 3 m^2

[14] Deutsche Bank Research. Building up India – Outlook for India's real estate markets, May 8, 2006

households in 2009-10 [15] (figure 3.1). Increase in household incomes has resulted in increased penetration of consumer durables in households (Table 3.1) e.g. the penetration rate of cars has been estimated to triple from 3% in 2001-02 to over 9% in 2009-10. It is fair to assume that the demand for SWH in the residential sector has been fuelled by rising incomes.

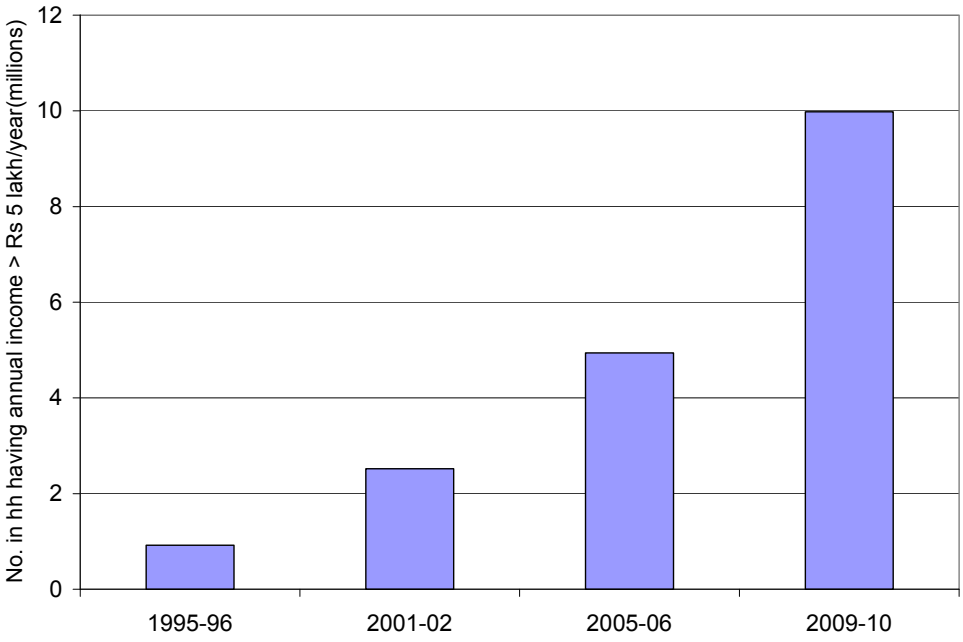


Figure 3.1: No of households having annual income > Rs 5 lakh (2001-02 prices)

Table 3.1: Penetration (%) in households of consumer durables

	1995-96	2001-02	2005-06	2009-10
Cars	1.6	3	5	9.14
Motorcycle	2.9	7.1	14.8	28.3
Refrigerators	8.6	13.4	16.1	22.5
White Goods	14.9	24.7	31.9	45.2

Source: NCAER (2005): The Great Indian Market

- **Arrival of Evacuated Tube Collector (ETC) & improvements in SWH supply chain**: Since 2000, the arrival of ETC has had a significant impact on the SWH market. As per MNRE data, in the year 2008-09, ETC constituted more than 30% of the total sales. On July 1, 2009, there were 61 MNRE approved ETC suppliers and manufacturers. The arrival of ETC has resulted in expanding the SWH supply chain significantly. It has also resulted in reduction in costs of the domestic SWH systems.

[15] NCAER (2005). The Great Indian Market.

3.1.2 Factors Influencing SWH Market in Residential Sector

One of the main objectives of the primary survey was to gain a better understanding of the factors influencing market for SWHs. The main findings are summarized below:

Demand for hot water: Demand for hot water for bathing shows significant variations across regions. The survey tried to capture this by collecting information from households on the number of months in a year when they use hot water for bathing. The results are shown in table 3.2. Some of the earlier studies have tried to link hot water demand with climatic factors. The primary survey results show that the demand for hot water not only depends on climatic factors but also depends on human behaviour (which is influenced by culture and traditional practices). The survey found that apart from cold and moderate climatic regions, which show a high demand for hot water (> 8 months/year) for bathing. There are certain areas in the country which do not fall under cold and moderate climate regions but exhibit high use of hot water e.g. parts of Maharashtra, Kerala, Tamil Nadu where surveyed households responded that hot water is used for more than 8 months in a year. Higher demand for hot water results in better capacity utilization and hence has a positive effect on SWH market. So it does not come as a surprise that the two largest urban residential markets are Bangalore and Pune.

Type of house: Low-rise independent houses with clear ownership of the roof offer most favourable conditions for installation of SWH. A majority of existing SWH installations fall under this category. In recent years, SWH have been installed on multi-storey apartment buildings. Some of the prominent multi-story systems are located at Pune, Thane, Bangalore and Gurgaon. Despite some well-functioning SWH systems in multi-storey apartment buildings, the general perception amongst stakeholders is that SWH are more suitable for independent house. Some of the apprehensions about the feasibility of a centralized solar water heating system in multi-story buildings are related with:

- Inadequate area on the roof for installation of SWH.
- Non-availability of technical solutions to ensure equitable distribution, metering of hot water
- Problems associated with the management of a community system.

SWH supply chain: Leaving out some of the more evolved SWH markets in Karnataka and Maharashtra, the number of active dealers of SWH in surveyed districts was small (ranging from one to four per district). Most of these dealers were found to be small and part-timers, pursing SWH business along with other businesses. Weakness in supply chain is a significant barrier in increasing penetration of SWH. Several of the SWH owners (particularly in low-density SWH areas) reported dissatisfaction by the service provided during installation, commissioning and maintenance.

Electricity supply situation: Electric geysers were found to be the most common water-heating device in the surveyed households. As a result, electricity shortages particularly power-cuts during morning hours influences the demand for SWH. During survey, it was found that in some states e.g. Karnataka, UP, Bihar and Punjab, the SWH market is influenced by poor electricity supply situation.

Awareness about SWH : Leaving out states like Karnataka and parts of Maharashtra which have relatively high penetration of SWH, general awareness about SWH was found to be low in rest of the country. Though people are familiar with the concept, the awareness on technologies and products was found to be very low.

Household income: SWH is a product owned by affluent households. 76 % of the surveyed SWH owner households owned a car and thus it can be concluded that a majority of the households owning SWH fall under the 'rich' and 'striver' categories as per affluence layers distribution based on household income by NCAER[16].

New v/s existing Houses: The interviews with SWH manufacturers and dealers indicate that around 80% of the SWH sales are for new housing and only 20% can be attributed to existing/old housing. The urban centres showing large growth in upper and middle class housing are potentially large market for SWH.

Policy: The highlights of the present policy environment are as follows:

- Several of the municipal corporations have issued orders making SWH use compulsory for new multi-story housing and houses constructed on plots having area more than 500 sq. yards.
- A few of the municipal corporations are offering rebate in property tax
- A few of electricity distribution companies offer rebate in monthly electricity bills.
- Several states offer upfront subsidy for residential systems
- IREDA through banks is operating an interest subsidy scheme to offer concessional finance for installation of SWH.

The impact of policy measures is mixed. Implementation of mandatory regulations is weak across cities, if implemented rigorously it has the potential to become an important driver in market development. Upfront subsidies by states do assist in development of market in the initial stages but the process of availing subsidy is generally long and cumbersome and in the states where it is offered only a fraction of the SWH owner households are availing subsidies. Rebate on property tax is being offered by only few cities, the amount of rebate available is small; the effectiveness of this instrument is yet to be tested. Rebate in electricity bills is a useful instrument to

[16] 'Rich' households have annual household income> Rs 1 million; 'Strivers' have annual household income between Rs 0.5 – 1 million.

promote SWH, however, it is being offered in very limited number of cities. Only a few banks and financial intermediaries are putting effort in implementing IREDA interest subsidy scheme. The scheme is being implemented successfully in some pockets; however, there is a scope to improve implementation of this scheme.

3.1.3 SWH Size

Generally the size of a domestic SWH installation is taken as 100 lpd. However, the average size of solar water heating system in surveyed SWH owner household was found to be 164 lpd (by dividing the cumulative capacity (lpd) by number of households). Thus for calculating number of SWH household and for projecting demand for SWH, the average collector area of a domestic SWH system is taken as 3 m^2 collector area.

3.1.4 Satisfaction with SWH

One of the heartening features of the survey was that more than 80% of the SWH owner households exhibited satisfaction with the performance of the SWH. However, the degree of satisfaction with the after-sales service was much lower, and this was an aspect on which the respondents wanted improvement. The degree of satisfaction was lower in some of the multi-storey residential buildings where SWH has been installed by the builder under the Municipal Corporation mandate. Some of the occupants of Government housing also showed dissatisfaction. Thus it can be concluded that in cases where the user households have not been directly involved in the buying decision of SWH, special efforts are required to educate and train them in the use of SWH.

Table 3.2: Data presented for surveyed districts on some of the key parameters that affect SWH market in the Residential Sector

District	Hot water demand in middle & high income hh (Months/year)	State electricity shortage % (2008-09)	SWH Supply chain
Shimla	≥9	0.2	Poor
Gurgaon	4-5	8.5	Poor
Agra	4-5	20.9	Poor
Ludhiana	4-5	10.6	Fair
Delhi	4-5	0.6	Fair
Haridwar	4-5	1.2	Poor
Coimbatore	8	7.9	Good
Bangalore	≥9	6	Good
Chennai	8	7.9	Fair
Pondicherry	9	12.3	Fair
Hyderabad	9	6.8	Good
Kochi	8	11.8	Fair
Thane	≥9	21.4	Good
Ahmedabad	4-5	9.8	Fair
Indore	5-6	17.2	Fair
Jaipur	4-5	1.1	Fair
Nagpur	5-6	21.4	Good
Pune	8	21.4	Good
Patna	4-5	17.6	Poor
Ranchi	5-6	4.7	Poor
Bhubaneswar	5-6	1.5	Poor
Sambalpur	5-6	1.5	Poor
Raipur	4-5	2.6	Fair
Guwahati	9	10.6	Poor
Darjeeling	7	3.2	Poor
Kolkata	6	3.2	Fair
Shillong	≥9	19.1	Poor
Agartala	4-5	9	Poor

Source: Primary survey and Central Electricity Commission.

3.2 Commercial and Institutional Buildings

3.2.1 Hotels

The major observations are as follows.

SWH Awareness and Exposure

The awareness on SWH, among hotel owners/managers, is good across hotel-standards. The owner of a budget hotel, in terms of SWH-concept and to some extent exposure, is nearly as aware as that of a General Manager of a luxury hotel in south, west, north and, to some extent, in the eastern region. Likewise, SWH installations exist across hotel standards. Thus, hotel-standard, other things being equal, is not a deterrent to readiness for SWH.

Poor Radiation Days in a Year

Unlike households, hotel/guesthouses are not discouraged by cloud cover or low radiation for a few days or weeks in the year. Thus, monsoon or fog in winter in itself is not the reason for hotel/guesthouses to stay away from SWH.

Roof Availability

The roof-availability for SWH is an issue mainly for hotels/guesthouses which do not own the roof. The roof-ownership, in turn, is linked to the hotel-size. Based on consultation with hotel managers/civil engineers, we have utilized a premise that hotels/guesthouses having 15 room upward capacity own the roof.

There is the trend, among centrally air-conditioned hotels, of setting up cooling towers, hydro equipment, satellite dish antennas on the roof. Despite this trend, there remains adequate space to install SWH to meet the hot water requirement in most of such hotels. A six-storied, 200 room five-star hotel commissioned recently at Ahmedabad, has utilized 75% of its roof for the installation of other equipment, 20% of its roof space is enough to meet 100% of its hot water requirement through SWH installation. Though it should be mentioned that roof availability could be an issue in some of the high-rise (tower) hotels.

Present Fuel Use

The hotels having a room capacity upward of 30 rooms largely utilize liquid fuel (or gaseous fuels in cities having piped natural gas supply) for water-heating. The small hotels- room capacity up to 30 rooms-rely on electricity or wood. It is attractive, from a payback period perspective, for electricity and liquid fuel dependent hotels/guest-

houses to adopt SWH. It is, only small wood-using hotels/guest-houses, existing on a limited scale, for which SWH is less attractive. Hotels located in areas facing severe power shortage and long hours of power cut often opt for SWH. During field survey a hotel owner in Begusarai in Bihar has opted for a 2000 m^2 SWH system primarily due to non-availability of electricity.

Policy Environment: SWH for Hotels/Guesthouses

The highlights of the present policy environment are as follows.

- A municipal corporation order making it compulsory for new hotels to install SWH is in force in many cities. Norms, under the order, for SWH sizing, are lax in most cities. Implementation of mandatory use is weak across cities
- A scheme of loans at the concessional interest rate of 5% pa for SWH is being implemented by IREDA but its delivery and utilization are low-key.
- There is accelerated depreciation provision for commercial hotels/guesthouses. The awareness of the accelerated depreciation provision among owners of modest hotels/guesthouses is low and when informed, the appeal seems unexciting.

Other Issues

The hotel/guesthouse industry expressed the following wish-list

- Lowering of SWH capital cost
- Technical solution of the problem of somewhat-staggered-through-the-day demand for hot water
- SWH delivering hot water round the year

3.2.2 Hospitals

The major observations are as follows:

SWH Awareness and Exposure

The awareness on SWH, among private hospital owners, is mixed across hospital standards/size. The knowledge of owners of small private hospitals is less-favourable-for-SWH climatic zones, in most instances, the knowledge is limited to existence of SWH product.

Poor Radiation Days in a Year

Unlike households, hospitals are not discouraged by cloud cover or low radiation for a few days or weeks in the year. Thus, monsoon or fog in winter in itself is not the reason for private hospitals to stay away from SWH.

Roof Availability

For government hospitals, roof is clearly available for SWH installation. The roof in respect of private hospitals appears substantially available but the precise position is not clear. Most private hospitals having 15 patient bed upward are assumed to possess roof for SWH installation. In respect of up to 15 bed hospitals, roof availability is mixed because many of these hospitals are independent buildings with own roof. We estimate that 10% to 15% of private hospital beds cannot be serviced by SWH because of roof availability. The new private hospitals, regardless of size and ownership of roof, can be mandated to install SWH through working out access to the common roof, since a policy of compulsory SWH for hospital is already in vogue in principle.

Present Fuel Use

The hospitals, barring large private hospitals- use electricity for water-heating. The cost of water-heating, therefore, is high. The large hospitals generally have liquid or gaseous fuel (Furnace oil/LPG/LDO/Gas) based boilers and hot water generation systems.

Policy Environment: SWH for Hospital

This is identical to one for hotels- compulsory SWH for new hospitals, concessional interest loan and accelerated depreciation.

Other Issues

Unlike hotels, it is not too difficult, barring luxury hospitals, to regulate hot water timing, a positive for SWH installation. We came across an SWH- dependent hospital where the system is turned off in summer.

Many owners of small/medium hospitals analyze the techno-economics of SWH at great length; the SWH suppliers find it difficult to cope with the demands they raise in terms of time and effort.

In several of the large hospitals which are spread over a large area, extensive piping is required for supplying hot water from a central facility and hence the cost involved in piping through a centarlised SWH emerges as a major issue.

3.2.3 Hostels

The demand for hot water from hostels emanates largely for bathing purpose. There is hot water required for kitchen-cleaning but this is small compared to the bathing demand.

The interviews of SWH owners and non-owners, among hostels, highlighted the following.

- Roof availability is almost a non-issue, it is available. However, security and upkeep of SWH installations may demand care in the light of potential student -activity on the terrace.
- It is possible to maximize SWH performance because regulating hot water supply to morning hours is easy.
- It is in summer that hostels have low occupancy. The vacations, thus, do not hurt, demand for hot water.
- From the pay-back period perspective, the business case should assume 150 days of hot water demand per year.
- The common method of water-heating is electricity. SWH, therefore, offers significant scope for cost-saving. The recourse to individual electric heating rods, inefficient and electricity-intensive, is considerable, enhancing further scope for saving.
- The decision-making, in case of hostels, managed by registered societies/ trusts, rests with key managing trustees. They are generally far removed from everyday management of hostels and will have to be educated.
- Many hostel-owners are sensitive to capital expenditure proposals, notwithstanding recurring saving. This, combined with 150 days/year hot water demand business case, makes a strong financial incentive, necessary to convert potential into actual demand.
- The promotional effort should target both- hostel owners and students.

3.3 Industries

3.3.1 Dairy

- In the organized dairy industry, the milk collection and processing is generally three stage process. The milk is collected at the milk collection centre. It is then transported to the chilling centre and then to the dairy processing plant. In some cases, milk is directly transported from the collection centre to the dairy processing plant.
- Most of the hot water requirements occur at the dairy processing plant. There may be some requirement of hot water at collection and chilling centre for

cleaning of vessels. At the dairy processing plant the practice is to have a central boiler to produce steam and then use steam to produce hot water.

- It is a common practice in the dairy industry to use petroleum fuels for steam generation in boilers.
- SWH can meet only a small part of the total thermal heating requirement. Four cases of use of SWH in dairy processing plants were studied. The SWH installation varied from 1500 lpd to 70000 lpd. The petroleum fuel replacement due to use of SWH in these four cases is estimated to vary between 1-5%.
- Space for SWHs is not a very big constraint for dairies as compared to several other industries. As water treatment facilities already exist for supplying boiler feed water, water quality is also not an important issue. Rapid growth in organized dairy opens a significant opportunity for SWHs.
- Dairy is one of the industrial sectors that has seen the largest number of SWH installations. Apart from major players in the cooperative dairy e.g. Amul, Mother Dairy, Mahanada, etc., large private players like Nestle also has fairly good exposure to SWH applications. While the application of SWH at dairy processing plants is fairly widespread, we were informed the presence of several hundred small (200 lpd) SWH installations in milk collection centres in Punjab.

3.3.2 Textile Industry

- Textile industry is one of the largest industrial consumers of process steam.
- The number of SWH installations in textile industry is very low. Most of the existing installations are for boiler feed water heating.
- During the field survey, some textile units located at Ludhiana, Ahmedabad, Gurgaon were visited. The main barriers in deployment of solar water heaters in textile industry are:
  - Use of low-cost solid fuels like biomass and coal which results in longer pay-back periods for SWH. Relatively smaller number of textile mills use petroleum fuels.
  - A large number of textile dying units come under unorganized and small-scale sector, for them both space and ability to organise funds for SWH systems is a big issue. Moreover, textile dying industry in India is currently faced with the issue of setting-up treatment plants for effluent water, so SWH is not a priority for them.

3.4 Rural Areas

- Hot water requirement in rural areas is mainly for following applications:
    - Households, particularly those in cold and moderate climate region. Based on the primary survey data and data available in some earlier studies, average hot water requirement range from 15 to 110 litres per day.
    - Primary health centers
    - *Dhabas*
    - Rural industries (silk reeling, textile/yarn dyeing, milk collection centers, puffed rice making, rice mills, etc.)

- At present, use of SWH in rural areas is very limited. During the primary survey, some instances of use of conventional SWH was found in high-income rural households in parts of Karnataka, Kearala, Punjab, Himachal Pradesh and Uttarakhand. The main barriers in use of conventional SWH systems in rural areas are:
    - High initial cost of the system
    - Longer pay-back period as the fuel replaced is low-cost biomass fuel
    - Lack of piped water supply
    - Lack of SWH supply chain

3.5 Interviews with Stakeholders

SNAs

For SNA's, SWH is one of the products, presumably less important than other ones in the basket. Hence, we received somewhat low-key insights and less specific suggestions on SWH. Some of the SNA's were very vocal about the need for a comprehensive quality control mechanism for the SWH systems.

SWH Manufacturers and Dealers

The SWH production industry in India is fragmented and so respondents articulated their observations and ideas based on a localized/regional perspective. We did come across few bold initiatives in terms of business model and technology-adoption but sensed an overall tendency on the part of manufacturing fraternity, understanding, to view the sector in incremental gain rather than quantum jump terms.

Other stakeholders

The architects and builders have been quite forthcoming, particularly on the subject of practical difficulties in implementation of mandatory SWH regulations and SWH suitability for multi-storied buildings.

The bank response was sharply divided. Active SWH-financing bank managers articulated their views clearly; most of the others almost pleaded ignorance.

The agenda vis-à-vis municipal corporations somewhat overlapped with that for SNA's. We inquired into the status of compulsory SWH policy and its implementation.

Our effort to hold discussion with officials of electricity distribution companies and pollution control boards did not yield significant results.

Chapter 4. Approach to Demand Projection

4.1 Approach

SWH, introduced in India in 1980's, is at the beginning of the growth phase in terms of product life-cycle.

The radiation availability and demand for hot water are the primary drivers of demand for SWH. In real life, there is a range of variables- affordability, growth in urban housing, energy price-hike, improvement in supply chain, industrial demand for energy-saving devices, a policy mix of compulsion and incentives for SWH installation- which have shaped the demand for SWH from time to time. The empirical data, over a period of time, in terms of SWH sale, its region-wise and segment-wise break-up, and influence of relevant variables does not exist. The present installations are concentrated (65%) in Karnataka and Maharashtra; compounding the inadequacy of data required for all-India model-building.

In view of this, 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 (2009)
- 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 establishing hot water consumption norms.

A scenario is envisaged to be a composite, encompassing demographic, economic, demand-condition, supply-condition, product/technology, industry-structure, policy and promotion parameters.

The objective of scenario building is two-fold. First, to project demand corresponding to conditions described under a scenario. Secondly, to highlight action which the major stakeholders need to organize to accomplish demand under a given scenario.

Three alternative scenarios are **realistic (most likely)** and two less likely -- **optimistic** and **pessimistic** scenarios. The demand projection, thus, needs to be viewed in conjunction with a scenario because it is linked to developments summarized under the scenario.

We have utilized the following concepts for estimation.

- SWH penetration: This denotes % of total hot water demand which will be met through SWH for a given segment (e.g. hotel, hospitals) in a concerned year. In case of households, it is the % of households owning a SWH.
- CAGR: This is annual growth percentage; treating the immediate previous year as the base.

Our estimates in terms of SWH penetration and CAGR, for a given segment under the concerned scenario, recognizes the following.

- Historical trends and best-case (Karnataka) performance
- Assessment of potential based on growth of a given segment and its response to SWH; considering payback period prospect, roof- availability, etc.
- Variations in SWH penetration vis-à-vis new and old buildings because new buildings are an easier proposition than old ones.

In addition to above work, we have used benchmarks. Electric geyser for the residential segment is a somewhat comparable product. We have used the electric geyser demand and its projection as a broad benchmark to put our projection in proper perspective.

We have incorporated a box on water purifier market to illustrate how technology/product/value proposition conditions can accelerate demand build-up.

We have elucidated the learning from primary survey and stakeholder interviews for a given segment under the concerned chapter on demand projection for the segment. Likewise, projection regarding growth of housing, hotel-rooms, hospital-beds and other segments and water-consumption norms for these segments are given under the concerned chapters.

4.2 Present Configuration of SWH Market

This has been discussed briefly in both chapter 1 and 3. To recap, SWH market in India has grown as follows.

- 1995-00 : 8.23%
- 2000-04 : 20.6%
- 2004-08 : 24.6%
- 1995-2008 : 16.8%

The growth since 2000 has come largely from the residential and commercial sectors. In the absence of any available information on the break-up of the market, we have used the information gathered during stakeholder interviews to build-up an estimated segment-wise breakup of existing installations. This is presented in Table 4.1.

Table 4.1: Estimated Breakup: Functional SWH Installation Till 31st December 2009-3.1 million m^2

Sector	**million m^2**
Residential (80%)	2.108
Hotels (6%)	0.158
Hospitals (3%)	0.079
Industry (6%)	0.158
Other (Railway + Defence + Hostel + Religious places, other) (5%)	0.132
Total	**2.635**

* It is assumed that out of the installed base of 3.1 million m^2, 85% of the installed SWH are functional

Similarly for our projection model, we needed a segment wise break-up of sales during 2009. The estimated break-up of sales in 2009 is given below.

Table 4.2: Estimated Breakup: SWH Sales during 2009- 0.55 million m^2

Sector	**million m^2**
Residential (77%)	0.425
Hotels (5%)	0.027
Hospitals (3%)	0.016
Industry + Others (15%)	0.082
Total	**0.55**

We would like to stress that these are rough estimates based on information gathered during the primary survey. To get a clear picture on the segment wise installation and sales network, there is a strong case for conducting a census of the existing SWH systems and also to put in place an information gathering system to collect and compile information on new systems being installed from all manufacturers and installers.

4.3 Alternative Scenarios

Radiation or resource availability and demand for hot water are the main determinants of pay-back period for SWH. The value of these parameters, across regions, will remain largely unchanged over the projection period. We, therefore, do not need to assume alternative values. The existing base of SWH in a given region already captures the impact of these parameters and we are building projection from the base. It is the other variables in terms of economic growth, industry-structure, supply chain, policy and promotion in respect of which alternative conditions are possible and hence the scenarios are built in terms of these.

The scenario encompasses the following variables.

- Growth in GDP
- Product/technology/value proposition
- Industry structure and distribution
- Solution package for multi-storey buildings
- Policy
- Promotion

An elucidation of present position with reference to above-cited variables is essential to understanding of alternative scenarios. This is done below.

4.3.1 Growth in GDP

This has multiplier effect and impacts disposable income, income-distribution and growth of various SWH market segments. Indian GDP, growth over 1999-2009 has averaged 7.1% (CAGR), according to Central Statistical Organization. We expect 7% CAGR in GDP growth under realistic or most likely scenario over 2010-2022 period.

4.3.2 Product Technology and Value Proposition

On the product/technology side, the following is pertinent.

During last decade, there have not been any major product/technology breakthroughs in the Indian SWH market, in terms of heat-collection under low radiation conditions, overnight temperature-loss, distribution piping, available standard sizes, space-intensity relative to capacity, capital cost per unit of output. ETC has been the most significant technological development; leading to marginal lowering of capital cost and significant market-expansion. Most of the ETC tubes are being imported from China.

Enamel-coating of tank; intended to plug leakage, facilitate use of pressure- pumps and enable recourse to mild steel is in the incipient stage in India, with one manufacturer setting-up a manufacturing facility. It will upscale the product and to some extent the capital cost.

The unit-price, depending on whether it is ETC and FPC, is in Rs. 8000 to 10000 and Rs. 12000 to 15000 per m^2 price-band. It has moved up in line with spurt in commodity prices in general and copper and steel in particular.

In terms of value proposition, the manufacturers have positioned it as an electricity or recurring cost-saving (water-heating) consumer durable for the residential sector- mostly owners of independent house. There is a mild sub-text of environmental concern and status symbol. The cost of typical household system, depending on size and specifications, is in Rs. 20000 to Rs. 60000 range, for 100 to 300 lpd systems. However, unlike durables, it is not available on hire purchase basis. A recent effort by a producer to sell it on pay-per-use appears to be a promotional effort rather than an enduring value proposition.

Under most likely scenario, we expect incremental improvements in above condition.

Under optimistic scenario, we anticipate a quantum-improvement in terms of product-feature, technology, pricing value proposition. It is difficult to outline the contours of such improvement. However, case study on water purifier (please refer chapter 8) market amplifies how innovative product-features, pricing, distribution and value proposition can lead to market expansion. A deepening of the market through offer of product-categories and price-points and fresh value proposition is the crux of caselet in the water purifier case study**,** denoting optimistic scenario.

Under pessimistic scenario, we expect continuance of present condition impact-making market-expansion.

4.3.3 Industry-Structure and Distribution

The manufacturing remains concentrated in Southern India and Maharashtra. It remains a fragmented industry-113 reporting producers/ suppliers (excluding a significant number of non-reporting ones). No manufacturer seems to have reached 15% market share. All manufacturers, consequently, suffer from limitation in terms of capacity to invest in product development, geographical outreach, dealer-network, advertisement and promotion spend and intensity of after-sale support.

The manufacturer brand-equity is limited to few players and this, too, in regions where SWH market is concentrated. A few well-known companies are engaged in SWH-manufacturing but they have not built strong SWH- specific brand equity.

In parts other than Karnataka and Maharasthra where we carried out the survey the number of active dealers per district does not exceed four and most- SWH- owners are not aware of all dealers; reducing scope for choice of dealers to one or two. The customers in areas other than Karnataka and Maharashtra pay 15% to 30% extra on account of freight, intermediaries and overall imperfect market. The incidence of entry/exit among dealers is high. For several dealers, SWH is one of the product-lines; reducing its significance in their own business mix.

Under realistic scenario, we expect significant improvement in supply chain e.g., a few players exceeding 20% individual market-share; establishing multi-location assembly facility and select brands commanding large scale recognition and customer- confidence.

Under optimistic scenario, we expect still better conditions e.g., large network of well- advertised dealers, easily accessible demonstartion points, exchange offers (against malfunctioning electric geysers).

Under pessimistic scenario, we anticipate marginal improvement in present condition.

4.3.4 A Solution for Multi-Storey Buildings

The residential construction in urban India is more and more shifting towards multi-storey apartments. Though we could not find present break-up and future trends in multi-storey housing v/s independent housing, we could get information on growth of elevator market in India, which supports the shift towards multi-storey apartments. The elevator market has grown by 15-25% since 2001. The current market size of elevator market is around 30000 units per year. It is estimated that 70% of the sales is for residential buildings[17]. As briefly mentioned in chapter 3, there are challenges associated with SWH solution for multi-storey residential buildings. We presume the policy of mandatory provision of SWH as being pursued by several municipal corporations would continue but this will not be adequate. A product/proposition which addresses the issues of terrace-availability, floor space index (FSI), collective ownership, fair distribution of hot-water among building occupants, maintenance, and such other matters through a process of development, piloting, scaling up and stakeholder involvement is the main priority. Under realistic scenario, we presume this will be addressed effectively.

Under optimistic scenario, we expect stringent compulsion backed by an additional and exclusive financial incentive for multi-storey building.

[17] http://www.constructionweekonline.in/article-5315-destination_upward__in_focus_july_2009/ accessed on 29 December 2009.

Under pessimistic scenario, we anticipate marginal improvement to the present policy/product package for multi-storied building.

4.3.5 Policy

The present policy consists of following ingredients.

- Loan @ 2%, 3% and 5% respectively to residential, institutional and industrial/commercial customers. Interest free loans to residential customers in selected regions of India.
- Capital subsidy equivalent to upfront interest subsidy to institutional and industrial/commercial customers who do not avail of concessional interest loan
- Capital subsidy @ Rs.6000 per 100 lpd, in addition to concessional interest loans, to residential customers in few states, e.g., Delhi
- Accelerated depreciation @ 80% to profit-making industrial/commercial customers
- Rebate in electricity bill, @ Rs. 50 to 150 per month, to residential customers in some cities
- Rebate in municipal property tax @ 6% to 10%, to SWH- owners in few Indian cities
- BIS standards established for FPC producers and a system of MNRE approval for ETC producers.
- Incorporation of SWH among building components covered under Energy Conservation Building Code (ECBC)
- Soft loans to SWH manufacturers for improvement in technology and expansion of production facilities
- Municipal Corporation regulations in several cities, making installation of SWH compulsory for
  - Housing units above a cut-off size
  - hospitals & nursing homes,
  - hotels, lodges and guest houses,
  - hostel, school, colleges, training centers and other institutes,
  - barracks of armed forces, paramilitary forces and police

The present policy, at the ground-level, has been implemented on a low key. While it has created an atmosphere favourable to SWH growth, the incidence of SWH-installation as a consequence of legal compulsion has remained limited to Banglore, Thane and Kalyan. The interest/capital subsidy entailing installations form a small percentage of total installations or annual installations.

Under realistic scenario, our key premises for policy action are as follows.

a) Mix of Mandatory Regulations, Guidelines, Best Practices and Incentives:
MNRE, city governments, builders, architects, BEE will work together to formulate and implement a mix of SWH- favouring legal/administrative mandatory regulations, guidelines and best practices for residential and non-residential buildings at least in high-potential cities. A large-number of the cities covered under the primary survey fall under the category of high-potential cities.

We presume the mix of mandatory regulations and best practices will be accompanied by a financial incentive for new residential buildings. The new non-residential buildings under hotel/hospital/hostel segments will require lesser financial incentive. It is imperative that the incentive reaches most customers. Likewise, it is important that multiple incentives are largely merged into a single, powerful incentive. The quantum of incentive will depend on the price-points which industry follows. UNDP-GEF project has commissioned separate studies on policy and regulatory issues and hence we are not proposing a specific quantum of incentive but the other contours of incentive policy are explained below.

b) Regional Variation in Incentive Quantum
We expect regional variations in the quantum of incentive because pay-back period varies across regions.

c) Incentive Linked to Building Vintage
For old buildings, we assume, under realistic scenario, that the financial incentive would be, significantly higher than for new buildings.

Under optimistic scenario, the incentive quantum will be larger and more importantly, it will be delivered through electricity distribution companies. We assume electric distribution companies will become, under this scenario, the main vehicle for promotion of SWH.

Under pessimistic scenario, we expect marginal fine-tuning of present compulsion-cum-incentive policy.

4.3.6 Promotion

The advertising and promotional effort by SWH producers, dealers, MNRE, SNA's and others is now negligible in terms of spend, outreach and impact. MNRE has already commissioned a study on communication strategy. Under realistic scenario, we expect all stakeholders to spend, over 2010-15 period, 3.5% to 5% of the projected turnover for advertising and promotion. Under optimistic scenario, this would be in 7% to 8% range.

4.4 Conclusion

The details of the three scenarios are presented in the table below (table 4.3). Sector-wise assumptions made for projection and projection results are presented in the following chapters.

Table 4.3: Summary table on Scenarios for Potential Projection

1.0	**Basic Parameter: Radiation Resource and Present Demand for Hot Water** ***Key Premise*:** Present level of SWH installation in a state captures these. The present level is the base for growth projection till 2020. Radiation and demand for hot water are stable parameters; unlikely to change significantly over the projection period.
2.0	**Other Parameters**
2.1	**GDP Growth 2010- 22 (CAGR)** Realistic: 7%, Optimistic: 8.5%, Pessimistic: 5.5%
2.2	**Product, Technology, Value Proposition** ***Present*:** Two technologies; one considered less suitable for non-residential buildings. No major breakthrough- except advent of ETC- during last two decades in terms of product features, sizing, space- requirement, unit-costing. ***Realistic*:** Incremental improvements ***Optimistic*:** A deepening of the market through development of product categories, multiple price points and innovative value propositions, e.g, pay-per use ***Pessimistic*:** Continuance of present conditions
2.3	**Industry-Structure And Distribution** ***Present*:** Fragmented character. Manufacturing concentrated in southern India/Maharashtra. Low brand-equity. Sub-optimal dealer network. ***Realistic*:** Significant improvement in present conditions, viz., • Industry-consolidation, emergence of few large players • Manufacturing/assembling spreading to several regions and consequential relative price parity across regions

	• A choice of brands and dealers in major Indian cities/ towns ***Optimistic*:** Still better conditions, e.g., large network of visible dealers, demo points, switch over from customer call to outlet based selling. ***Pessimistic***: Marginal improvement in present condition
2.4	**Multi-Storied Building** ***Present* :** Mandatory SWH installation policy implemented in a few cities on low key. Dearth of success models. ***Realistic*:** Clear enunciation and effective implementation of mandatory installation policy and institutionalization of guidelines, best practices, product features, hot water distribution mechanism, ownership and management model suitable for multi-storied buildings. ***Optimistic*:** In addition to above, stringent implementation of mandatory installation policy backed by a financial incentive exclusively for multi-storied buildings **Pessimistic:** Marginal improvement to present policy/ product package
2.5	**Policy** ***Present*:** A range of instruments- compulsion (substantially theoretical), soft interest loan, capital subsidy, accelerated depreciation, municipal property rebate tax, electricity bill rebate, BIS standards for SWH producers, SWH- coverage under ECBC, etc in vogue. The incentives reach a small proportion of installers; given the availment mechanism. ***Realistic:*** • **Mandatory installation Policy**: To cover residential and non- residential buildings, supported by useful guidelines and best practices in major Indian cities. Te be driven by stakeholder involvement • **Balancing compulsion**: A financial incentive to all installers; higher quantum for residential buildings than non-residential ones. A single, strong incentive rather than diffused, multiple ones. Incentive to reach most installers. • **A larger financial incentive for old buildings:** Relative to new ones • **Regional variation in incentive quantum**: SWH pay-back period varies

	across regions • **Fiscal/monetary/other policy support**: To encourage product-development, industry- consolidation, distribution network and product-pricing favourable to SWH market growth ***Optimistic*:** In addition to above • Larger quantum of financial incentives • Incentive being delivered mainly through electricity distribution companies- prime vehicle for SWH market- promotion ***Pessimistic*:** Marginal fine-tuning of present low-key compulsion-cum-multiple-incentive basket
2.6	**Promotion** ***Present* :** Negligible direct spend on advertising and promotion by SWH producers, dealers, MNRE, SNA's and others ***Realistic*:** The industry-government to spend 3.5% to 5% of projected turnover during 2010-15 period. To work in tandem. ***Optimistic*:** Spend @ 7% to 8% of projected turnover. Other action, e.g., exchange offers against malfunctioning electric geysers. ***Pessimistic*:** Marginal improvement to present position

Chapter 5. SWH Potential in Residential Sector

5.1 Water heating in Indian Households

Hot water is required in households for bathing, cleaning of utensils, washing of clothes, cooking, preparation of cattle feed, etc. In majority of the households in the country, water heating is carried out using the device (stove) used for cooking. While in rural areas, biomass is the main fuel that is used for water heating, in urban households, LPG stove, electrical immersion rod, electric geyser, LPG/PNG geyser are the main appliances that are used for water heating. Penetration of electric geysers is still low in the country and is mostly restricted to urban areas. Studies on ownership of appliances conducted by NSSO indicate that while the ownership of basic appliances like fans and TV are distributed across different income categories. Appliances like electric geysers, washing machines and air-conditioners which can be considered as more luxurious goods are owned by households with the highest level of income. As per the estimates of electric geyser industry, the current sale of electric geysers (mostly 15 and 25 liter capacity) in the country is 1.5-1.8 million pieces/ year and the annual growth in sale is around 20%[18]. A study on energy use in residential sector carried out by Ernest Orlando Lawrence Berkley Laboratory , USA estimates that in the year 2010, around 17 million households in India (6.5% of the total households) would be using electric geysers[19]. This number is estimated to increase sharply to 56 million households (17.6% of the total households) by the year 2020 (figure 5.1). The sharp increase is mainly attributed to increase in household incomes, with greater percentage of population being able to afford an electric geyser.

1. Hot water demand varies significantly across different regions in the country.
2. Biomass fuels, LPG and electricity are the three main fuels used for heating water.
3. The percentage of households using electric geysers for water heating is still low and mainly concentrated in urban areas. The demand is rising sharply and 56 million households are expected to use electric geysers by the year 2020.

[18] Personal communication. Meeting with Electric Geyser Manufacturers held with Secretary, MNRE on 30th September 2009 at Delhi

[19] Stephane de la Rue du Can, V Letschert, M McNeil, N Zhou & J Sathaye. Residential and Transport Energy Use in India: Past Trends and Future Outlook. Ernest Orlando Lawrence Berkley Laboratory. January 2009 . For details of the study refer Annexure III.

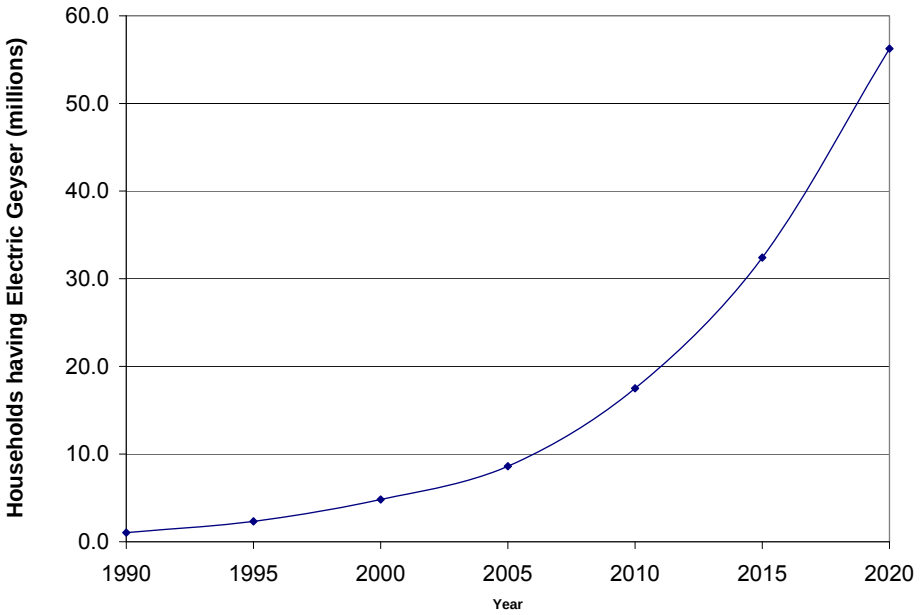


Figure 5.1: Projected growth in number of electric geyser households

5.2 Estimation of SWH Penetration Rate in States

Data collected during primary survey was used to calculate:

a) Penetration rate of SWH in urban households in a state, which is the percentage of urban households owning SWH in the year 2009 and is obtained by dividing the estimated number of SWH owner households in 2009 by the total number of urban households in the state in 2009.
b) Penetration rate in new-urban households, which is obtained by dividing estimated number of new urban households who have installed SWH in 2009 by the total number of new urban households added during 2009 in a state.

Based on the average penetration rates, the states have been classified into 5 categories (Table 5.1).

Table 5.1: Classification of states as per penetration rate of SWH in households

Category	Average SWH Penetration rate (% of urban household owning SWH)	SWH penetration rate in new-urban households	States
I	6 %	24%	Karnataka
II	1 %	6 %	Maharashtra
III	0.3%	2.4 %	HP, Punjab, Haryana, UK, Rajasthan, Goa, Tamil Nadu, Kerala, AP,
IV	0.1 %	1.2 %	Delhi, UP, Bihar, MP, Chhatisgarh, Orissa, WB, Jharkhand
V	0.01 %	0.6 %	N-E states, Sikkim

5.3 Projection of Number of Households

A bottom-up model was developed to project growth of SWH in the residential sector.

- State-wise number of urban and rural households for 2001 were computed using district-wise household data from census report of 2001.
- State-wise number of households falling under 4 categories -- urban-existing, urban-new, rural-existing and rural-new were calculated for every year from 2009 to 2022. The size of rural and urban households and the urbanization rate were taken from the LBNL study (table 5.2) [19].

Table 5.2: Household size and urbanization rate used for projecting number of households in 2020[20]

Year	Urban household size (persons/hh)	Rural household size (persons/hh)	Urbanization rate (%)
2000	4.60	5.19	27.7
2005	4.31	4.91	28.7
2010	4.05	4.80	30.1
2015	3.85	4.77	31.9
2020	3.70	4.75	34.3

[20] Stephane de la Rue du Can, V Letschert, M McNeil, N Zhou & J Sathaye. Residential and Transport Energy Use in India: Past Trends and Future Outlook. Ernest Orlando Lawrence Berkley Laboratory. January 2009

5.4 Alternate Scenarios

Pessimistic Scenario

The main assumptions have already been defined in the previous chapter. Specific assumptions made for the residential sector under pessimistic scenario are as follows:

i. State-wise penetration rate of SWH in urban-new households given in table 5.1 are used. An annual growth of 5% in the penetration rate is assumed.

ii. The ratio of deployment in new housing: existing houses is assumed to remain same as that in 2009 i.e. 4:1.

iii. SWH deployment in rural areas are calculated by taking penetration rates in rural areas as 12% that of urban areas. This percentage has been taken from the electric geyser study by LBNL in which the ratio of penetration of electric geysers in rural areas is 12% of that in urban areas in 2009.

iv. State-wise projection of annual number of SWH households is made separately for four categories of households:
   - Urban-new
   - Urban-existing i.e. existing number of urban households at the end of the previous year
   - Rural –new
   - Rural-existing

Realistic scenario

One of the major assumptions is a gradual stronger enforcement of the mandatory provisions for installation of SWH in new housing. It assumes that due to enforcement of mandatory provisions, the penetration rate of SWH in new housing, in the year 2022, in all the states would gradually increase and would reach levels of 10% (for category IV and V states) , 15 % (for category III states), 20% for category II. For Karnataka (category I) it is assumed that the penetration level in new housing would remain constant at 24%.

Optimistic scenario

One of the major assumptions here is policy and awareness initiative to increase penetration in existing housing. It is assumed that due to these initiatives the ratio of sales to new housing: existing housing would become 3:2 , resulting in increase in installation in existing housing.

5.5 Results

Pessimistic scenario: The cumulative installation of SWH in residential sector is expected to grow from 2.56 million m^2 in 2010 to 10.23 million m^2 in 2022. The deployment of SWH during 2010-2022 in residential sector would be 7.67 million m^2. Please refer to figure 5.2 for cumulative SWH deployment in residential sector for years 2010, 2013, 2017 & 2022 for pessimistic scenario. Table 5.3 provides state-wise SWH deployment in residential sector for pessimistic scenario.

Realistic scenario: The cumulative installation of SWH in residential sector is expected to grow from 2.58 million m^2 in 2010 to 15.74 million m^2 in 2022. The deployment of SWH during 2010-2022 in residential sector would be 13.16 million m^2. Please refer to figure 5.3 for cumulative SWH deployment in residential sector for years 2010, 2013, 2017 & 2022 for realistic scenario. Table 5.4 provides state-wise SWH deployment in residential sector for realistic scenario. Five states – Karnataka, Maharashtra, Tamil Nadu, Andhra Pradesh and Gujarat are expected to contribute to 68.1% of the installations under this scenario.

A comparison of cumulative electric geyser sales [19] v/s SWH sales is shown figure 5.4. The projection show that the SWH market would grow at a faster rate than electric geysers. The ratio of total electric geyser to SWH for the year 2009 is 20.5 and under this scenario, the ratio would decrease to 13.3 by 2022.

Optimistic scenario: The cumulative installation of SWH in residential sector is expected to grow from 2.74 million m^2 in 2010 to 20.28 million m^2 in 2022. The deployment of SWH during 2010-2022 in residential sector would be 17.54 million m^2. Please refer to figure 5.5 for cumulative SWH deployment in residential sector for years 2010, 2013, 2017 & 2022 for optimistic scenario. Table 5.5 provides state-wise SWH deployment in residential sector for optimistic scenario. Five states – Karnataka, Maharashtra, Tamil Nadu, Andhra Pradesh and Gujarat are expected to contribute to 67.5% of the installations under this scenario.

A comparison of above three scenarios is done and the cumulative SWH deployment for the years 2010, 2013, 2017 & 2022 is shown in figure 5.6.

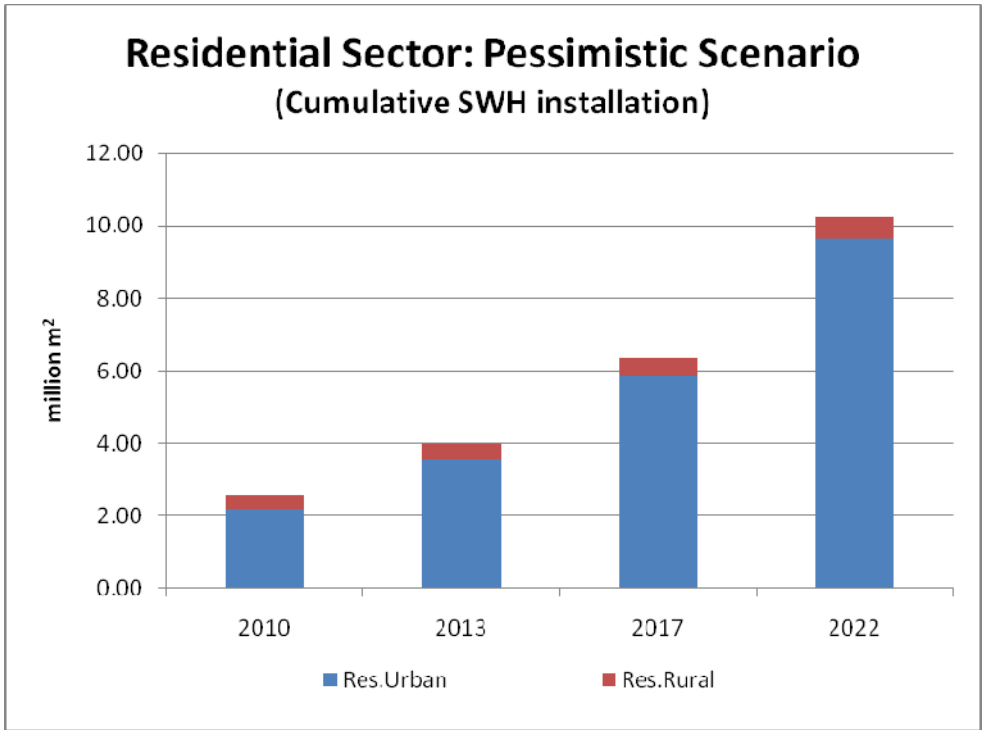


Figure 5.2: Year-wise cumulative SWH deployment in residential sector for pessimistic scenario

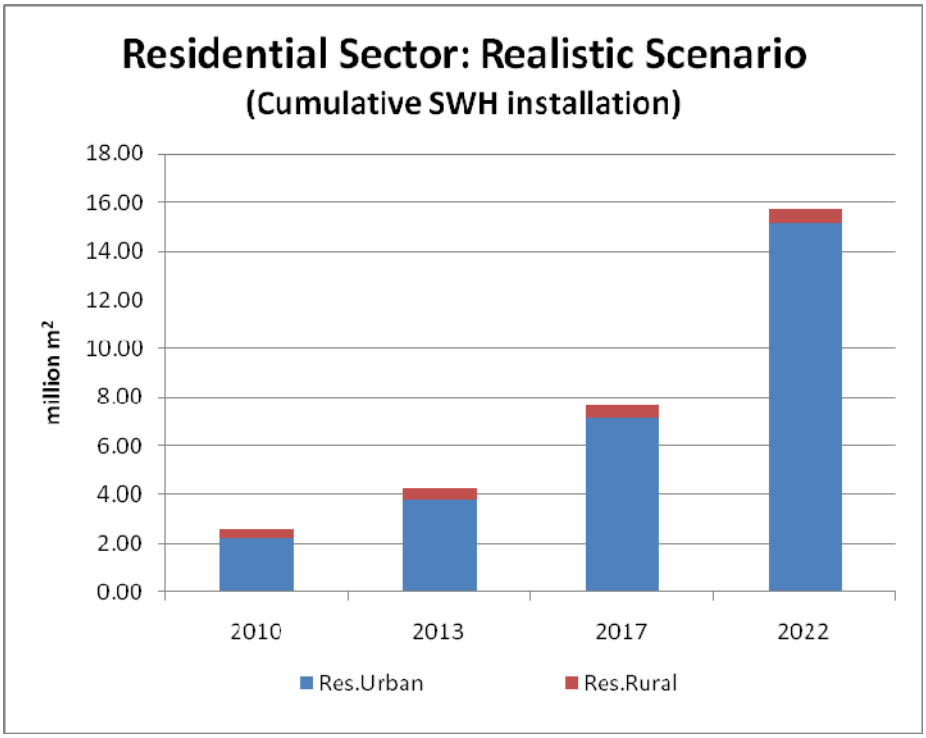


Figure 5.3: Year-wise cumulative SWH deployment in residential sector for realistic scenario

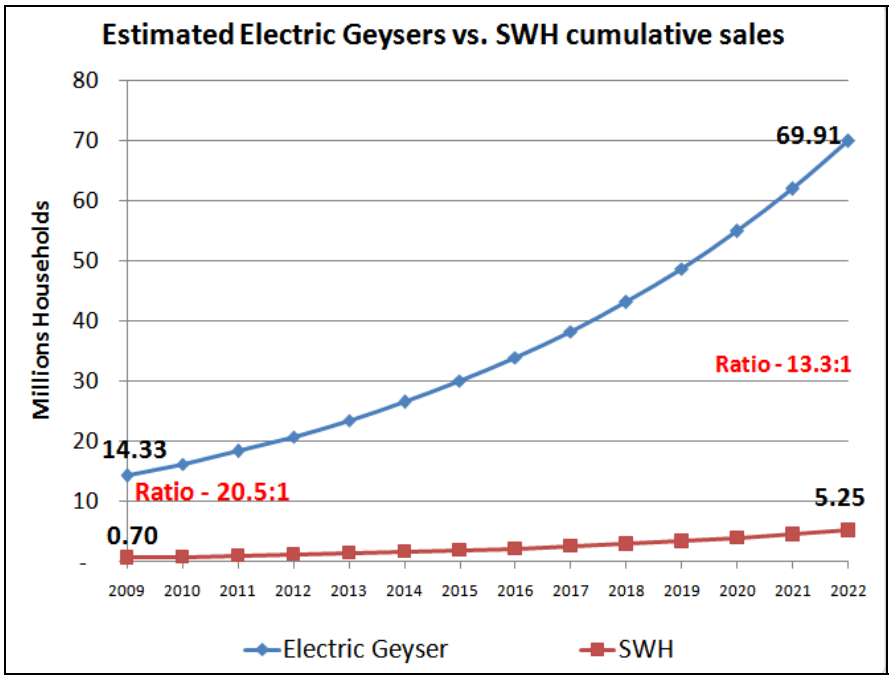


Figure 5.4: Electric geysers sales v/s SWH sales

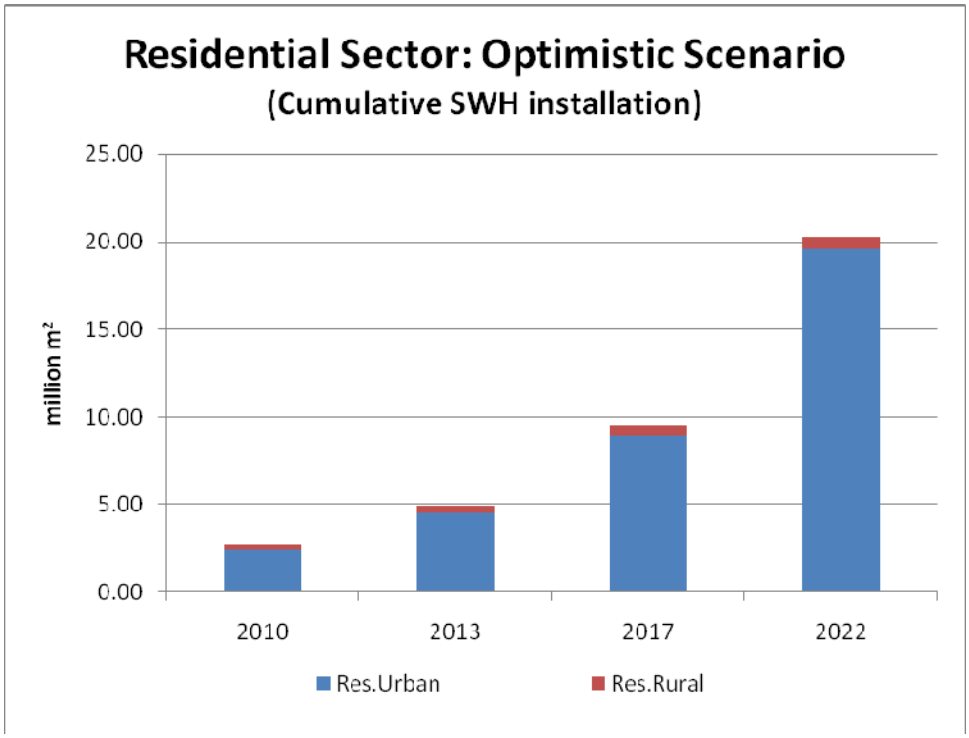


Figure 5.5: Year-wise cumulative SWH deployment in residential sector for optimistic scenario

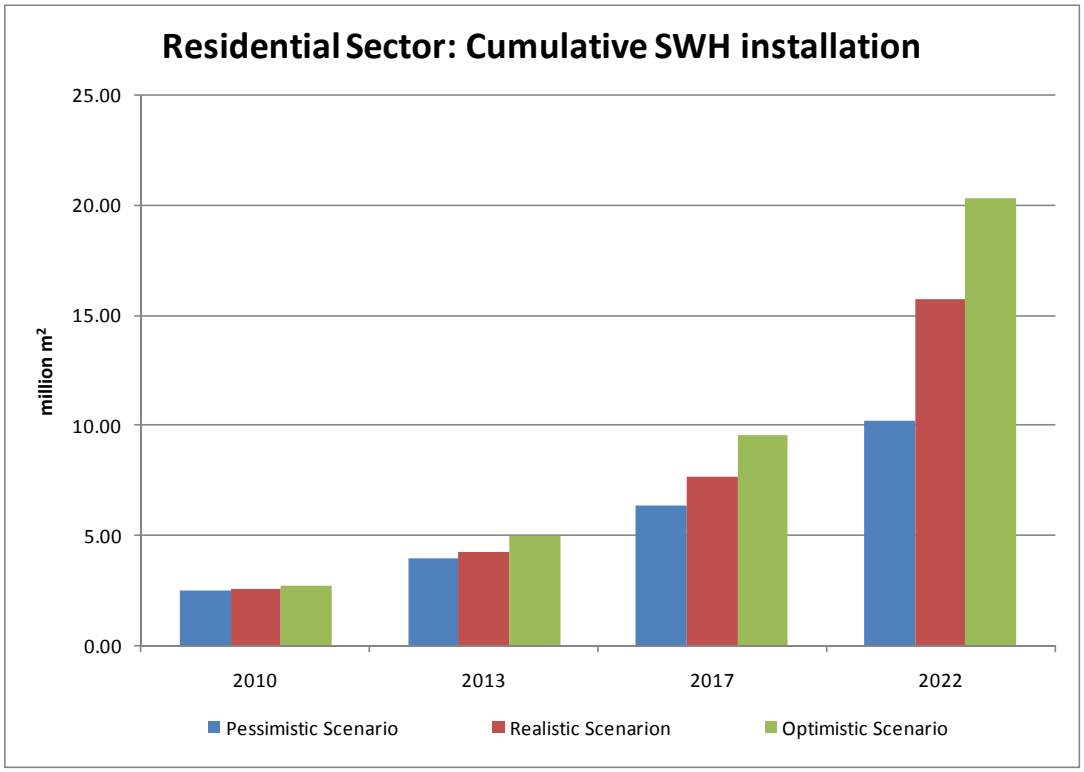


Figure 5.6: Year-wise cumulative SWH deployment in residential sector for all scenarios

Table 5.3: State-wise, Year-wise cumulative SWH deployment in residential sector in m^2 for Pessimistic Scenario

State	2010		2013		2017		2022	
	Rural	Urban	Rural	Urban	Rural	Urban	Rural	Urban
Karnataka	186,289	1,122,203	210,203	1,627,688	235,788	2,378,559	259,399	3,458,692
Maharashtra	55,064	487,872	66,574	822,928	80,993	1,413,912	97,812	2,475,684
Tamil Nadu	12,983	124,178	16,396	225,958	20,672	405,481	25,661	728,015
Andhra Pradesh	19,758	85,563	24,952	155,693	31,460	279,390	39,050	501,626
Gujarat	9,312	72,961	11,760	132,761	14,828	238,239	18,406	427,743
Uttar Pradesh	11,848	42,254	16,045	85,193	21,303	160,930	27,437	297,001
Rajasthan	11,179	46,612	14,119	84,815	17,801	152,201	22,096	273,267
West Bengal	6,554	36,107	8,877	72,800	11,786	137,520	15,179	253,796
Kerala	7,852	33,393	9,916	60,763	12,502	109,039	15,519	195,772
Punjab	4,382	30,205	5,534	54,963	6,978	98,631	8,661	177,086
Madhya Pradesh	4,650	22,881	6,298	46,132	8,361	87,144	10,768	160,825
Haryana	3,984	22,773	5,031	41,439	6,343	74,362	7,873	133,513
Delhi	105	20,039	142	40,402	188	76,320	242	140,850
Bihar	7,215	10,492	9,772	21,154	12,974	39,959	16,708	73,746
Orissa	3,849	8,785	5,213	17,712	6,921	33,459	8,913	61,751
Jharkhand	2,173	8,338	2,943	16,812	3,907	31,757	5,031	58,609
Uttranchal	1,858	8,124	2,347	14,783	2,959	26,528	3,673	47,629
Chhatisgarh	1,904	6,418	2,578	12,940	3,423	24,445	4,409	45,113
Jammu &Kashmir	679	3,150	919	6,351	1,220	11,997	1,572	22,141
Chandigarh	35	3,578	44	6,511	56	11,684	70	20,977
Assam	543	1,719	975	4,553	1,518	9,553	2,151	18,535
Himachal Pradesh	1,692	2,759	2,137	5,020	2,695	9,009	3,345	16,175
Goa	228	2,911	288	5,297	363	9,505	450	17,065
Pondicherry	114	2,774	144	5,048	182	9,059	226	16,264
Tripura	70	301	125	798	195	1,674	276	3,249
Manipur	35	247	64	653	99	1,370	140	2,659
Meghalaya	43	207	77	549	120	1,152	170	2,235
Mizoram	11	216	20	571	32	1,199	45	2,325
Nagaland	34	157	61	416	95	872	135	1,693
Arunachal Pradesh	22	119	38	315	60	660	85	1,281
Andaman & Nicobar	7	64	12	169	19	354	27	688
Sikkim	13	31	24	83	37	174	52	338
Daman & Diu	3	30	5	80	8	168	12	326
Dadra & Nagar Haveli	5	29	8	75	12	157	17	305
Lakshadweep	1	10	2	28	2	58	3	113
TOTAL	**354,493**	**2,207,499**	**423,642**	**3,571,453**	**505,899**	**5,836,520**	**595,614**	**9,637,088**

Table 5.4: State-wise, Year-wise cumulative SWH deployment in residential sector in m^2 for Realistic Scenario

State	2010		2013		2017		2022	
	Rural	Urban	Rural	Urban	Rural	Urban	Rural	Urban
Karnataka	186,289	1,122,203	210,203	1,627,688	235,788	2,378,559	259,399	3,458,692
Maharashtra	55,064	492,302	66,574	875,613	80,993	1,665,426	97,812	3,400,615
Tamil Nadu	12,983	127,079	16,396	262,352	20,672	593,663	25,661	1,503,906
Andhra Pradesh	19,758	87,562	24,952	180,769	31,460	409,053	39,050	1,036,241
Gujarat	9,312	74,665	11,760	154,144	14,828	348,806	18,406	883,618
Uttar Pradesh	11,848	43,789	16,045	104,942	21,303	267,119	27,437	760,960
West Bengal	6,554	37,418	8,877	89,676	11,786	228,260	15,179	650,261
Rajasthan	11,179	47,700	14,119	98,476	17,801	222,837	22,096	564,505
Madhya Pradesh	4,650	23,712	6,298	56,826	8,361	144,645	10,768	412,058
Kerala	7,852	34,173	9,916	70,549	12,502	159,644	15,519	404,420
Punjab	4,382	30,911	5,534	63,816	6,978	144,406	8,661	365,818
Delhi	105	20,767	142	49,769	188	126,680	242	360,879
Haryana	3,984	23,305	5,031	48,113	6,343	108,873	7,873	275,805
Bihar	7,215	10,873	9,772	26,058	12,974	66,326	16,708	188,948
Orissa	3,849	9,104	5,213	21,819	6,921	55,538	8,913	158,213
Jharkhand	2,173	8,641	2,943	20,708	3,907	52,712	5,031	150,163
Chhatisgarh	1,904	6,652	2,578	15,941	3,423	40,575	4,409	115,589
Uttranchal	1,858	8,314	2,347	17,163	2,959	38,839	3,673	98,390
Assam	543	1,871	975	6,646	1,518	21,999	2,151	81,984
Jammu &Kashmir	679	3,265	919	7,824	1,220	19,914	1,572	56,728
Chandigarh	35	3,662	44	7,559	56	17,106	70	43,334
Himachal Pradesh	1,692	2,823	2,137	5,829	2,695	13,190	3,345	33,415
Goa	228	2,979	288	6,150	363	13,916	450	35,252
Pondicherry	114	2,839	144	5,861	182	13,263	226	33,599
Tripura	70	328	125	1,165	195	3,857	276	14,373
Manipur	35	269	64	954	99	3,157	140	11,764
Mizoram	11	235	20	834	32	2,760	45	10,286
Meghalaya	43	226	77	801	120	2,653	170	9,888
Nagaland	34	171	61	607	95	2,009	135	7,488
Arunachal Pradesh	22	129	38	459	60	1,520	85	5,663
Andaman & Nicobar	7	69	12	246	19	816	27	3,042
Sikkim	13	34	24	121	37	402	52	1,499
Daman & Diu	3	33	5	117	8	386	12	1,439
Dadra & Nagar Haveli	5	31	8	109	12	361	17	1,344
Lakshadweep	1	11	2	40	2	134	3	499
TOTAL	**354,493**	**2,228,144**	**423,642**	**3,829,743**	**505,899**	**7,169,404**	**595,614**	**15,140,678**

Table 5.5: State-wise, Year-wise cumulative SWH deployment in residential sector in m^2 for Optimistic Scenario

State	2010		2013		2017		2022	
	Rural	Urban	Rural	Urban	Rural	Urban	Rural	Urban
Karnataka	190,619	1,177,142	222,503	1,851,121	256,618	2,852,284	288,098	4,292,460
Maharashtra	56,952	526,746	72,298	1,037,826	91,524	2,090,911	113,950	4,404,496
Tamil Nadu	13,543	138,061	18,094	318,424	23,796	760,172	30,448	1,973,830
Andhra Pradesh	20,610	95,128	27,536	219,404	36,212	523,783	46,333	1,360,034
Gujarat	9,714	81,117	12,978	187,089	17,068	446,638	21,839	1,159,721
Uttar Pradesh	12,536	48,525	18,133	130,063	25,143	346,299	33,321	1,004,753
West Bengal	6,935	41,466	10,032	111,142	13,911	295,922	18,435	858,590
Rajasthan	11,661	51,822	15,580	119,523	20,490	285,338	26,217	740,896
Madhya Pradesh	4,920	26,276	7,117	70,429	9,868	187,521	13,078	544,072
Kerala	8,190	37,126	10,943	85,628	14,391	204,420	18,413	530,788
Punjab	4,571	33,582	6,107	77,455	8,032	184,908	10,277	480,125
Delhi	111	23,013	160	61,682	222	164,230	294	476,496
Haryana	4,155	25,319	5,552	58,396	7,301	139,410	9,342	361,986
Bihar	7,634	12,049	11,043	32,296	15,312	85,987	20,292	249,482
Orissa	4,073	10,089	5,891	27,042	8,168	72,000	10,825	208,901
Jharkhand	2,299	9,576	3,325	25,666	4,611	68,337	6,110	198,272
Chhatisgarh	2,014	7,371	2,914	19,757	4,040	52,603	5,354	152,621
Uttranchal	1,938	9,032	2,590	20,832	3,406	49,732	4,358	129,134
Assam	614	2,201	1,191	8,567	1,914	29,039	2,758	109,018
Jammu &Kashmir	718	3,618	1,038	9,696	1,440	25,816	1,909	74,903
Chandigarh	37	3,978	49	9,175	65	21,904	83	56,875
Himachal Pradesh	1,765	3,067	2,359	7,074	3,102	16,889	3,969	43,856
Goa	238	3,236	317	7,464	417	17,819	534	46,267
Pondicherry	119	3,085	159	7,114	210	16,983	268	44,097
Tripura	79	386	153	1,502	246	5,091	354	19,112
Manipur	40	316	78	1,230	125	4,167	180	15,643
Mizoram	13	276	25	1,075	40	3,643	57	13,678
Meghalaya	49	266	94	1,033	151	3,502	218	13,149
Nagaland	38	201	75	782	120	2,652	173	9,957
Arunachal Pradesh	24	152	47	592	75	2,006	109	7,530
Andaman & Nicobar	8	82	15	318	24	1,078	34	4,045
Sikkim	15	40	29	156	47	531	67	1,993
Daman & Diu	3	39	6	151	10	510	15	1,914
Dadra & Nagar Haveli	5	36	10	141	15	477	22	1,788
Lakshadweep	1	13	2	52	3	177	4	664
TOTAL	**366,243**	**2,374,431**	**458,442**	**4,509,896**	**568,117**	**8,962,777**	**687,738**	**19,591,143**

Chapter 6. SWH Potential in Commercial and Institutional Buildings

This section covers three important types of commercial and institutional buildings. These are:

- Hotels
- Hospitals
- Hostels

The main observations of primary survey for hotels, hospitals and hostels has been described in chapter 3 and the general methodology used for projecting realistic potential along with description of the three scenarios has been described in chapter 4. This chapter now describes the details of the methodology for each segment and the results in the form of projected realistic potential for each segment.

6.1 SWH Potential in Hotels

6.1.1 Existing Stock of Hotel/Guesthouse Rooms in India

There do not exist, officials or otherwise, statistics on existing stock of hotel/guesthouse rooms in India. The official statistics are limited to the hotels which are approved and/or classified into star-rating or heritage-rating by the Government of India.

The GOI approves a hotel at the planning stage and classifies it after it operates for some time. The approval/classification is not required for building plan or use approval from the local body or for loan assistance from a bank or for electricity connection or for a wide range of permits which a hotel requires. The possession of GOI approval/classification, for hotels other than the upscale ones, does not generate tangible, significant advantage. The approval/classification process does not seem designed to attract modest hotels, e.g., the owner of a one star hotel in a small town needs to apply to the Regional District of Tourism at Mumbai or Delhi at the hotel planning stage. As a consequence of these ground-realities concerning GOI approval/classification of hotels/guest-houses, the official statistics on the stock of hotel/guest-house rooms capture the “tip of an iceberg”.

The various studies on hotel-sector focus on demand, and if supply is touched upon, it is essentially the supply of upscale hotels because the studies are meant to address the needs of clients of large consulting firms or credit rating organizations.

The state governments do not operate any hotel approval mechanism; they administer luxury tax applicable to hotels/guesthouses charging room-tariff above a cut-off point stipulated by respective state governments.

However, a system of compiling monthly tourist flow operated by Government of Gujarat helped us to overcome the problem of estimating the present stock of rooms. This is explained below.

There were 1425 GOI approved/classified hotels having 83781 rooms in India in 2007 **(Table-6.1)**. In Gujarat, there were 3097 GOI approved/classified rooms. However, the total hotel/guesthouse/dharamshala rooms in Gujarat were 56685 **(Table-6.2)**. Excluding *dharamshalas* and hotels/guesthouses having up to 15 rooms, there were 28583 rooms in Gujarat; yielding a ratio of 1 to 8.22 in terms of GOI approved/classified rooms to other rooms.

Table 6.1: GoI Classified/Approved Hotel Rooms in India: 1996-2007

(No of Rooms)

	No. of Rooms											
Apartment Hotel	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
One Star	4286	4912	5115	5419	6169	6296	6343	6606	6765	1629	1435	1774
Two Star	10326	11136	11366	12938	15078	16153	15999	17629	18449	5673	5823	6637
Three Star	14074	14776	15725	17531	19271	20542	22783	26071	28783	19985	20342	24496
Four Star	5172	5450	5990	7014	7588	7958	8551	8655	8831	5483	7354	7584
Five Star	0	0	0	0	0	9845	10107	10416	10982	7367	8470	9792
Five Star Deluxe	18502	18610	18647	21608	23598	25086	16240	16885	17885	15739	20943	20110
Apartment Hotel	0	0	0	0	0	0	0	0	0	0	334	461
Time Share Resort	0	0	0	0	0	0	0	0	0	0	0	62
Heritage Hotel	1176	1292	1372	1655	1758	2530	2124	2124	2173	1970	2211	2450
Unclassified	8438	8397	8307	5949	3731	3616	3334	3334	3902	9767	8924	10415
Total	**61974**	**64573**	**66522**	**72114**	**77193**	**92026**	**85481**	**91720**	**97770**	**67613**	**75836**	**83781**
CAGR % (**3.68**)		4.19	3.02	8.41	7.04	19.22	-7.11	7.30	6.60	-30.84	12.16	10.48

Source: Ministry of Tourism, Govt of India

Table 6.2: Hotels/Guesthouses Rooms In Gujarat (2007): An Overview

(GOI Classified/Approved Rooms: 3097)

Location	Total Rooms	Rooms Excluding Dharamshalas	Rooms Excluding Up to 15 room Properties and Dharamshalals
Ahmedabad	7409	6651	5561
Surat	3513	3474	3156
Vadodara	2760	2760	2493
Rajkot	1933	1870	1693
Vapi	1360	1360	1069
Dwarka	2024	1205	1027
Gandhidham	1203	1141	933
Bharuch	961	933	746
Jamnagar	902	902	740
Bhuj	786	729	603
Ambaji	2974	940	583
Junagadh	872	757	583
Bhavnagar	795	691	570
Saputara	531	531	502
Bechraji	731	450	450
Veraval	611	585	449
Gandhinagar	1391	714	430
Porbandar	572	515	422
Mehsana	506	506	370
Somnath	657	438	364
Ankleshwar	566	554	353
Sardar Sarovar	320	320	320
Valsad	500	500	318
Mundra	302	279	223
Tithal	191	191	179
Sasan	187	179	170
Anand	288	228	158
Virpur	814	710	153
Palitana	4465	161	150
Morbi	205	205	118
Chotila	405	239	116
Pavagadh	278	146	95
Patan	227	227	66
Dakor	515	219	52
Ubharat	61	61	45
Other	14843	6676	3323
Total	**56658**	**38047**	**28583**

Source: Tourism Corporation of Gujarat Ltd

We do not have comparable ratio in respect of other states. However, the states which are relatively developed in an overall sense and/or developed from a tourism perspective, can be expected to have a Gujarat comparable ratio of GOI approved/classified rooms to other rooms. Such states are: Sikkim, Delhi, Haryana, Himachal Pradesh, Punjab, Rajasthan, Uttarakhand, Chandigarh, Andhra Pradesh, Karnataka, Kerala, Tamilnadu, Goa and Maharashtra.

These states account for 86% of GOI approved/classified rooms in India. Hence, we have considered it appropriate to apply Gujarat ratio to all states.

From a hot-water requirement angle, excessively layered classification of establishments is not helpful. We have, therefore, merged the GOI classified rooms as follows.

- Low-End= 1 Star and 2 Star
- Mid-End= 3 Star
- High-End = 4 Star + 4 Star Apartment + 5 Star + 5 Star Apartment + 5 Star Deluxe+ Heritage+ Heritage Grand

The rooms which are approved by GOI but are awaiting classification are merged into low-end, mid-end and high-end categories, on a pro-rata basis for the respective state. A full estimate of GOI approved/classified and other SWH relevant rooms (non-GOI approved/classified establishments having upward of 15 rooms each) is presented under **Table –6.3**.

Table 6.3: Consolidated Position of Hotel/Guesthouse Rooms for 2007 (no of rooms)

	GOI Classified			GOI Approved /Awaiting Classification	GOI Classified /Approved	Other SWH Relevant Room	Total SWH Relevant Room	State Share %
	Low-End	Mid-End	High-end					
Arunachal Pradesh	0	0	0	10	10	82	92	0.01
Assam	86	257	148	0	491	4036	4527	0.58
Bihar	0	173	121	0	294	2417	2711	0.35
Chhattisgarh	13	78	0	69	160	1315	1475	0.19
Jharkhand	36	148	65	0	249	2047	2296	0.30
Manipur	0	0	0	0	0	0	0	0.00
Meghalaya	0	69	50	0	119	978	1097	0.14
Mizoram	0	0	0	0	0	0	0	0.00
Nagaland	0	0	0	0	0	0	0	0.00
Orissa	32	386	184	166	768	6313	7081	0.91
Sikkim	0	0	28	0	28	230	258	0.03
Tripura	0	101	0	0	101	830	931	0.12
West Bengal	186	339	1814	417	2756	22654	25410	3.27
Sub Total: East	**353**	**1551**	**2410**	**662**	**4976**	**40903**	**45879**	**5.91**
Delhi	78	161	7285	1331	8855	72788	81643	10.51
Haryana	26	395	895	204	1520	12494	14014	1.80
Himachal Pradesh	48	108	534	162	852	7003	7855	1.01
Jammu & Kashmir	0	70	169	47	286	2351	2637	0.34
Punjab	451	831	291	708	2281	18750	21031	2.71
Rajasthan	446	828	3569	611	5454	44832	50286	6.47
Uttar Pradesh	78	796	2587	405	3866	31779	35645	4.59
Uttrakhand	60	354	89	194	697	5729	6426	0.83
Chandigarh	172	46	155	230	603	4957	5560	0.72
Sub Total: North	**1359**	**3589**	**15574**	**3892**	**24414**	**200683**	**225097**	**28.98**
Andhra Pradesh	282	3354	1991	349	5976	49123	55099	7.09
Karnataka	152	616	1870	1369	4007	32938	36945	4.76
Kerala	1259	4287	2182	759	8487	69763	78250	10.07
Tamil Nadu	2427	3922	2887	740	9976	82003	91979	11.84
Andaman & Nicobar	0	48	90	13	151	1241	1392	0.18
Lakshadweep	30	0	0	0	30	247	277	0.04
Puducherry	84	220	0	55	359	2951	3310	0.43
Sub Total: South	**4234**	**12447**	**9020**	**3285**	**28986**	**238265**	**267251**	**34.41**
Goa	603	887	2686	65	4241	34861	39102	5.03
Madhya Pradesh	19	1064	529	236	1848	15191	17039	2.19
Maharashtra	1838	3041	9692	1747	16318	134134	150452	19.37
Daman & Diu	0	90	0	0	90	740	830	0.11
Dadra & Nagar Haveli	0	175	97	0	272	2236	2508	0.32
Gujarat	68	1753	748	528	3097	**25486**	28583	3.68
Sub Total: West/	**2528**	**7010**	**13752**	**2576**	**25866**	**212647**	**238513**	**30.71**
India	**8474**	**24597**	**40756**	**10415**	**84242**	**692498**	**776740**	**100.0**
Categorywise %	**1.1**	**3.2**	**5.2**	**1.3**	**10.8**	**89.2**	**100.0**	

6.1.2 Development of Hot Water Requirement Norms

The hot water purpose and position with reference to hotel standard is explained in table 6.4. Our consultation has led to the development of following norms of hot water consumption (table 6.5).

Table 6.4: Hotel areas for hot water consumption and industry practice

	Heritage	5 Star And Deluxe	4 Star	3 Star	2 Star	1 Star	Approved	Other
Guest room								
• Tub-bath	✔	✔	✔	✔	×	×	■	■
• Shower	✔	✔	✔	✔	✔	✔	✔	✔
• Bucket bath alone	×	×	×	×	×	×	×	✔
Kitchen	✔	✔	✔	✔	✔	✔	■	■
Locker-room showers	■	✔	✔	■	×	×	■	■
Swimming pool	×	×	×	×	×	×	×	×
Common restroom	×	✔	✔	×	×	×	×	×
Janitorial Work	×	■	×	×	×	×	×	×
Laundry	✔	✔	✔	✔	×	×	■	■
Gym/Spa	■	✔	✔	■	×	×	■	■

■ = Depends

Table 6.5: Hot water consumption norm for hotels/guesthouses (lpd/room)

Hotel Category / Purpose	Govt of India Approved/Classified High And Mid-end		Low-end	Other SWH relevant hotels/guesthouse
	Business Destination	Tourist		
Guestroom	50	75	30	25
Laundry*	50	50	X	x
Kitchen	40	20	20	5
Locker showers	5	10	X	x
Common rest room/gym/spa	5	10	X	X
Total	**150**	**165**	**50**	**30**

The heating of feed water for boiler which runs the laundry is included under laundry.

The other SWH relevant establishments are dominated by budget hotels and guesthouses, though they include 3-star equivalent establishments also. We have, given the general character of these establishments considered, them lower than the low-end under GOI scheme and estimate the hot water provisioning in these establishments at 30 lpd/room.

We have taken, all things considered, the following hot water provisioning norm.

High-end : 150 lpd/room
Mid-end : 125 lpd/room
Low-end : 50 lpd/room
Other : 30 lpd/room

6.1.3 Projection of Hotel Rooms

There is the question of projected growth of hotel/guesthouse rooms in India. The evidence in terms of actual growth over a period in the number of establishments/rooms covered under GOI approval/classification is partial; it highlights a CAGR of 3.68% **(Table 6.1)**. The record, on the demand side, in terms of growth in domestic tourist visits and foreign tourist visits over 1996-2007 is also available; the respective CAGR is 11.6% and 9.55 **(Table 6.6 & 6.7)**.

Table 6.6: Domestic Tourist Visits: 1996 to 2007

Year	Tourist Visits (in million)	CAGR (%)
1996	140.12	2.5
1997	159.88	14.1
1998	168.2	5.2
1999	190.67	13.4
2000	220.11	15.4
2001	236.47	7.4
2002	269.6	14
2003	309.04	14.6
2004	366.27	18.5
2005	391.95	7
2006	462.31	18
2007	526.56	13.9
2008 (P)	562.92	6.9
	Average	**11.6**

Source: Ministry of Tourism, Govt of India

Table 6.7: Foreign Tourist Visits: 1996 to 2007

Year	Tourist Visits (in million)	CAGR (%)
1996	5.03	8.4
1997	5.5	9.3
1998	5.54	0.7
1999	5.83	5.3
2000	5.89	1.1
2001	5.44	-7.8
2002	5.16	-5.1
2003	6.71	30.1
2004	8.36	24.6
2005	9.95	19
2006	11.75	18.1
2007	13.27	12.9
2008 (P)	14.11	6.4
	Average	**9.5**

Source: Ministry of Tourism, Govt of India

Based on our consultation with the hotel industry owners and historic demand growth record, we have adopted the following CAGR in respect of rooms across hotel standards/regions.

2008 to 2013 : 10% pa
2014 to 2017 : 7.5% pa
2018 to 2022 : 5% pa

There are numerous commenced/planned hotel projects, many of which will get delayed but completed in next four years, an extension of the surge which commenced in 2007. The sizeable growth in supply and hence enlarged base will push down CAGR subsequently, though there are analysts who expect 10% CAGR till 2015.

A C Neilson estimate, under a study carried out for Government of India in 2006, for alternative scenarios, of average hotel room requirement for 2015 is 1.384 million rooms. However, the hotel room providers factor in occupancy (60% to 65%) and thus plan a supply @ 1.5 times the average requirement. In other words, A C Neilson study leads to the need for 2 million rooms in 2015. Our projection of room supply in 2015 is 1.716 million.

The hotel room projection until 2020 is given under **Table 6.8.** It will grow from 1.01 million in 2009 to 2.24 million in 2020

Table 6.8: Hotel Room Projection

State	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Arunachal Pradesh	92	101	112	123	135	148	163	176	189	203	213	224	235	247
Assam	4527	4980	5478	6025	6628	7291	8020	8621	9268	9963	10461	10984	11534	12110
Bihar	2711	2982	3280	3608	3969	4366	4802	5162	5549	5966	6264	6577	6906	7251
Chhattisgarh	1475	1623	1785	1963	2160	2376	2613	2809	3020	3247	3409	3579	3758	3946
Jharkhand	2296	2525	2778	3056	3361	3697	4067	4372	4700	5053	5305	5570	5849	6141
Manipur	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Meghalaya	1097	1207	1328	1460	1606	1767	1944	2090	2246	2415	2535	2662	2795	2935
Mizoram	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nagaland	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Orissa	7081	7789	8568	9425	10367	11404	12544	13485	14497	15584	16363	17181	18040	18942
Sikkim	258	284	312	344	378	416	457	492	529	568	597	626	658	691
Tripura	931	1024	1127	1239	1363	1500	1650	1773	1906	2049	2152	2260	2372	2491
West Bengal	25410	27951	30746	33821	37203	40924	45016	48392	52022	55923	58719	61655	64738	67975
Sub Total:East	**45879**	**50467**	**55513**	**61065**	**67171**	**73888**	**81277**	**87373**	**93926**	**100970**	**106019**	**111320**	**116886**	**122730**
Delhi	81643	89807	98788	108667	119534	131487	144636	155483	167145	179681	188665	198098	208003	218403
Haryana	14014	15416	16957	18653	20518	22570	24827	26689	28691	30843	32385	34004	35705	37490
Himachal Pradesh	7855	8641	9505	10456	11501	12651	13916	14960	16082	17288	18153	19060	20013	21014
Jammu & Kashmir	2637	2901	3191	3510	3861	4247	4671	5022	5398	5803	6094	6398	6718	7054
Punjab	21031	23134	25447	27992	30791	33870	37257	40052	43056	46285	48599	51029	53580	56259
Rajasthan	50286	55314	60846	66931	73624	80986	89085	95766	102948	110669	116203	122013	128114	134519
Uttar Pradesh	35645	39209	43130	47443	52187	57406	63146	67882	72974	78447	82369	86487	90812	95352
Uttrakhand	6426	7069	7776	8553	9409	10350	11385	12239	13156	14143	14850	15593	16372	17191

Chandigarh	5560	6116	6727	7400	8140	8954	9849	10588	11382	12236	12848	13490	14164	14873
Sub Total: North	**225097**	**247607**	**272367**	**299604**	**329565**	**362521**	**398773**	**428681**	**460832**	**495395**	**520164**	**546173**	**573481**	**602155**
Andhra Pradesh	55099	60609	66669	73336	80670	88737	97611	104932	112801	121262	127325	133691	140375	147394
Karnataka	36945	40639	44703	49173	54091	59500	65450	70358	75635	81308	85373	89642	94124	98830
Kerala	78250	86075	94683	104151	114566	126023	138625	149022	160198	172213	180824	189865	199358	209326
Tamil Nadu	91979	101177	111294	122424	134666	148133	162946	175167	188304	202427	212549	223176	234335	246052
Andaman & Nicobar Islands	1392	1531	1685	1853	2038	2242	2466	2651	2850	3064	3217	3378	3547	3724
Lakshadweep	277	304	335	368	405	445	490	527	566	609	639	671	705	740
Puducherry	3310	3641	4005	4406	4846	5331	5864	6304	6776	7285	7649	8031	8433	8855
Sub Total: South	**267251**	**293976**	**323374**	**355711**	**391282**	**430410**	**473451**	**508960**	**547132**	**588167**	**617575**	**648454**	**680877**	**714921**
Goa	39102	43012	47313	52045	57249	62974	69272	74467	80052	86056	90359	94877	99620	104601
Madhya Pradesh	17039	18742	20617	22678	24946	27441	30185	32449	34882	37499	39373	41342	43409	45580
Maharashtra	150452	165497	182047	200252	220277	242304	266535	286525	308014	331115	347671	365055	383307	402473
Daman & Diu	830	913	1004	1104	1215	1336	1470	1580	1699	1826	1918	2013	2114	2220
Dadra & Nagar Haveli	2508	2759	3034	3338	3672	4039	4443	4776	5134	5519	5795	6085	6389	6709
Gujarat	28583	31441	34585	38044	41848	46033	50637	54434	58517	62906	66051	69353	72821	76462
Sub Total: West	**238513**	**262364**	**288601**	**317461**	**349207**	**384128**	**422541**	**454231**	**488299**	**524921**	**551167**	**578725**	**607662**	**638045**
India	**776740**	**854414**	**939855**	**1033841**	**1137225**	**1250947**	**1376042**	**1479245**	**1590189**	**1709453**	**1794925**	**1884672**	**1978905**	**2077851**

Table 6.9: Present and Future Hot Water Requirement: An Estimate

('000 lpd)

State	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Arunachal Pradesh	3.8	4.2	4.6	5.1	5.6	6.2	6.8	7.3	7.8	8.4	9.0	9.5	10.0	10.5
Assam	179.7	197.7	217.4	239.2	263.1	289.4	318.4	342.2	367.9	395.5	425.2	446.4	468.7	492.2
Bihar	112.3	123.5	135.9	149.4	164.4	180.8	198.9	213.8	229.9	247.1	265.6	278.9	292.9	307.5
Chhattisgarh	57.7	63.5	69.9	76.9	84.5	93.0	102.3	110.0	118.2	127.1	136.6	143.4	150.6	158.1
Jharkhand	91.5	100.6	110.7	121.7	133.9	147.3	162.0	174.2	187.2	201.3	216.4	227.2	238.5	250.5
Manipur	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Meghalaya	45.5	50.0	55.0	60.5	66.6	73.2	80.6	86.6	93.1	100.1	107.6	113.0	118.6	124.5
Mizoram	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nagaland	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Orissa	288.2	317.0	348.7	383.6	421.9	464.1	510.6	548.8	590.0	634.3	681.8	715.9	751.7	789.3
Sikkim	11.1	12.2	13.4	14.8	16.3	17.9	19.7	21.1	22.7	24.4	26.3	27.6	29.0	30.4
Tripura	37.5	41.3	45.4	50.0	55.0	60.4	66.5	71.5	76.8	82.6	88.8	93.2	97.9	102.8
West Bengal	1061.1	1167.2	1284.0	1412.4	1553.6	1709.0	1879.9	2020.8	2172.4	2335.3	2510.5	2636.0	2767.8	2906.2
Sub Total: East	**1888.4**	**2077.3**	**2285.0**	**2513.5**	**2764.8**	**3041.3**	**3345.5**	**3596.4**	**3866.1**	**4156.1**	**4467.8**	**4691.2**	**4925.7**	**5172.0**
Delhi	3498.0	3847.8	4232.6	4655.8	5121.4	5633.5	6196.9	6661.6	7161.3	7698.4	8275.7	8689.5	9124.0	9580.2
Haryana	588.4	647.3	712.0	783.2	861.5	947.7	1042.4	1120.6	1204.7	1295.0	1392.1	1461.7	1534.8	1611.6
Himachal Pradesh	328.6	361.5	397.7	437.4	481.2	529.3	582.2	625.9	672.8	723.3	777.5	816.4	857.2	900.1
Jammu & Kashmir	111.3	122.5	134.7	148.2	163.0	179.3	197.2	212.0	227.9	245.0	263.4	276.6	290.4	304.9
Punjab	809.1	890.0	979.0	1076.9	1184.6	1303.1	1433.4	1540.9	1656.5	1780.7	1914.3	2010.0	2110.5	2216.0
Rajasthan	2089.5	2298.5	2528.3	2781.1	3059.3	3365.2	3701.7	3979.3	4277.8	4598.6	4943.5	5190.7	5450.2	5722.7
Uttar Pradesh	1502.3	1652.5	1817.8	1999.6	2199.5	2419.5	2661.4	2861.0	3075.6	3306.3	3554.3	3732.0	3918.6	4114.5

Uttrakhand	255.9	281.4	309.6	340.5	374.6	412.1	453.3	487.3	523.8	563.1	605.3	635.6	667.4	700.7
Chandigarh	209.5	230.4	253.5	278.8	306.7	337.4	371.1	398.9	428.9	461.0	495.6	520.4	546.4	573.7
Sub Total: North	**9392.7**	**10331.9**	**11365.1**	**12501.6**	**13751.8**	**15127.0**	**16639.7**	**17887.7**	**19229.2**	**20671.4**	**22221.8**	**23332.9**	**24499.5**	**25724.5**
Andhra Pradesh	2251.1	2476.2	2723.8	2996.2	3295.8	3625.4	3987.9	4287.0	4608.6	4954.2	5325.8	5592.0	5871.6	6165.2
Karnataka	1542.7	1697.0	1866.7	2053.3	2258.7	2484.5	2733.0	2938.0	3158.3	3395.2	3649.8	3832.3	4023.9	4225.1
Kerala	3110.0	3421.0	3763.1	4139.4	4553.3	5008.7	5509.5	5922.7	6366.9	6844.5	7357.8	7725.7	8112.0	8517.6
Tamil Nadu	3588.4	3947.3	4342.0	4776.2	5253.8	5779.2	6357.1	6833.9	7346.5	7897.4	8489.7	8914.2	9359.9	9827.9
Andaman & Nicobar Islands	58.6	64.4	70.9	78.0	85.8	94.3	103.8	111.5	119.9	128.9	138.6	145.5	152.8	160.4
Lakshadweep	8.9	9.8	10.8	11.8	13.0	14.3	15.8	16.9	18.2	19.6	21.1	22.1	23.2	24.4
Puducherry	126.0	138.6	152.4	167.7	184.4	202.9	223.2	239.9	257.9	277.2	298.0	312.9	328.6	345.0
Sub Total: South	**10685.6**	**11754.2**	**12929.6**	**14222.6**	**15644.8**	**17209.3**	**18930.2**	**20350.0**	**21876.2**	**23517.0**	**25280.7**	**26544.8**	**27872.0**	**29265.6**
Goa	1598.2	1758.0	1933.8	2127.2	2340.0	2574.0	2831.3	3043.7	3272.0	3517.4	3781.2	3970.2	4168.7	4377.2
Madhya Pradesh	700.2	770.3	847.3	932.0	1025.2	1127.8	1240.5	1333.6	1433.6	1541.1	1656.7	1739.5	1826.5	1917.8
Maharashtra	6180.7	6798.8	7478.7	8226.6	9049.2	9954.1	10949.6	11770.8	12653.6	13602.6	14622.8	15353.9	16121.6	16927.7
Daman & Diu	33.4	36.8	40.5	44.5	49.0	53.9	59.2	63.7	68.5	73.6	79.1	83.1	87.2	91.6
Dadra & Nagar Haveli	103.5	113.9	125.2	137.8	151.5	166.7	183.4	197.1	211.9	227.8	244.9	257.1	270.0	283.5
Sub Total: West	1168.1	1284.9	1413.4	1554.7	1710.2	1881.2	2069.4	2224.6	2391.4	2570.8	2763.6	2901.7	3046.8	3199.2
Sub Total	**9784.3**	**10762.7**	**11838.9**	**13022.8**	**14325.1**	**15757.6**	**17333.4**	**18633.4**	**20030.9**	**21533.2**	**23148.2**	**24305.6**	**25520.9**	**26797.0**
India	**31751.0**	**34926.1**	**38418.7**	**42260.5**	**46486.6**	**51135.2**	**56248.8**	**60467.4**	**65002.5**	**69877.7**	**75118.5**	**78874.4**	**82818.1**	**86959.1**

6.1.4 Hot Water Requirement

Based on the norms set out and hotel room projection in previous sections, we have worked out the hot water requirement for hotel rooms till 2020 **(Table 6.9)**. It will grow from 38.41 million lpd in 2009 to 86.96 million lpd in 2020. The large requirement states are Maharashtra, Delhi, Rajasthan, Uttar Pradesh, Andhra Pradesh, Tamilnadu, Karnataka, Goa and Gujarat.

6.1.5 Present Penetration Rate of SWH in Hotels

The stakeholders, including SNA's, in the course of our interviews, found it difficult to throw light on the existing base of hotel SWH capacity in a given state. However, they could hazard an estimate in terms of percentage-range share of hotel sector in the state total of SWH installations. The percentage-range share of hotel sector in a state has enabled us to build a picture as shown under **Table 6.10** of state-wise penetration of SWH in hotels.

6.1.6 Alternative Scenarios

Pessimistic Scenario

State-wise penetration rate of SWH in existing and new hotels for 2009 are taken from table 6.10. An annual growth of 5% in the penetration rate is assumed, except for Karnataka

Table 6.10: Classification of states as per penetration rate of SWH in hotels

Category	*SWH Penetration rate in hotels (% of the total hotel hot water demand met through SWH) -2009*	*SWH penetration rate in new-hotels*	*States*
I	50 %	50%	Karnataka
II	25 %	25 %	Maharashtra
III	15%	20 %	HP, Punjab, Haryana, UK, Rajasthan, Goa, Tamil Nadu, Kerala, AP,
IV	10 %	20 %	Delhi, UP, Bihar, MP, Chhatisgarh, Orissa, WB, Jharkhand
V	5 %	20 %	N-E states, Sikkim

Realistic Scenario

Under this scenario, the penetration rate of SWH in new hotels, in the year 2022, in all the states would become 50% (current level of penetration of SWH in new hotels in Karnataka). For Karnataka it is assumed that the penetration level in new hotels would remain constant at 50%.

Optimistic Scenario

This scenario assumes greater penetration in existing hotels as well, with this the overall penetration rate of SWH in hotels would rise to 68% by 2022.

6.1.7 Results

Pessimistic: The cumulative installation of SWH in hotel sector is expected to grow from 193,660 m^2 /year in 2010 to 920,340 m^2/year in 2022 (figure 6.1). The deployment of SWH during 2010-2022 in hotel sector would be 0.727 million m^2. Table 6.11 provides state-wise SWH deployment in hotel sector for the scenario.

Realistic: The cumulative installation of SWH in hotel sector is expected to grow from 193,920 m^2 /year in 2010 to 966,180 m^2/year in 2022 (figure 6.1). The deployment of SWH during 2010-2022 in hotel sector would be 0.772 million m^2. Table 6.12 provides state-wise SWH deployment in hotel sector for the scenario. Five states – Maharashtra, Tamil Nadu , Kerala, Delhi and Karnataka are expected to contribute to 61.7% of the installations under this scenario.

Optimistic: The cumulative installation of SWH in hotel sector is expected to grow from 198,520 m^2 /year in 2010 to 1,273,200 m^2/year in 2022. The deployment of SWH during 2010-2022 in hotel sector would be 1.075 million m^2 (figure 6.1). Table 6.13 provides state-wise SWH deployment in hotel sector for this scenario.

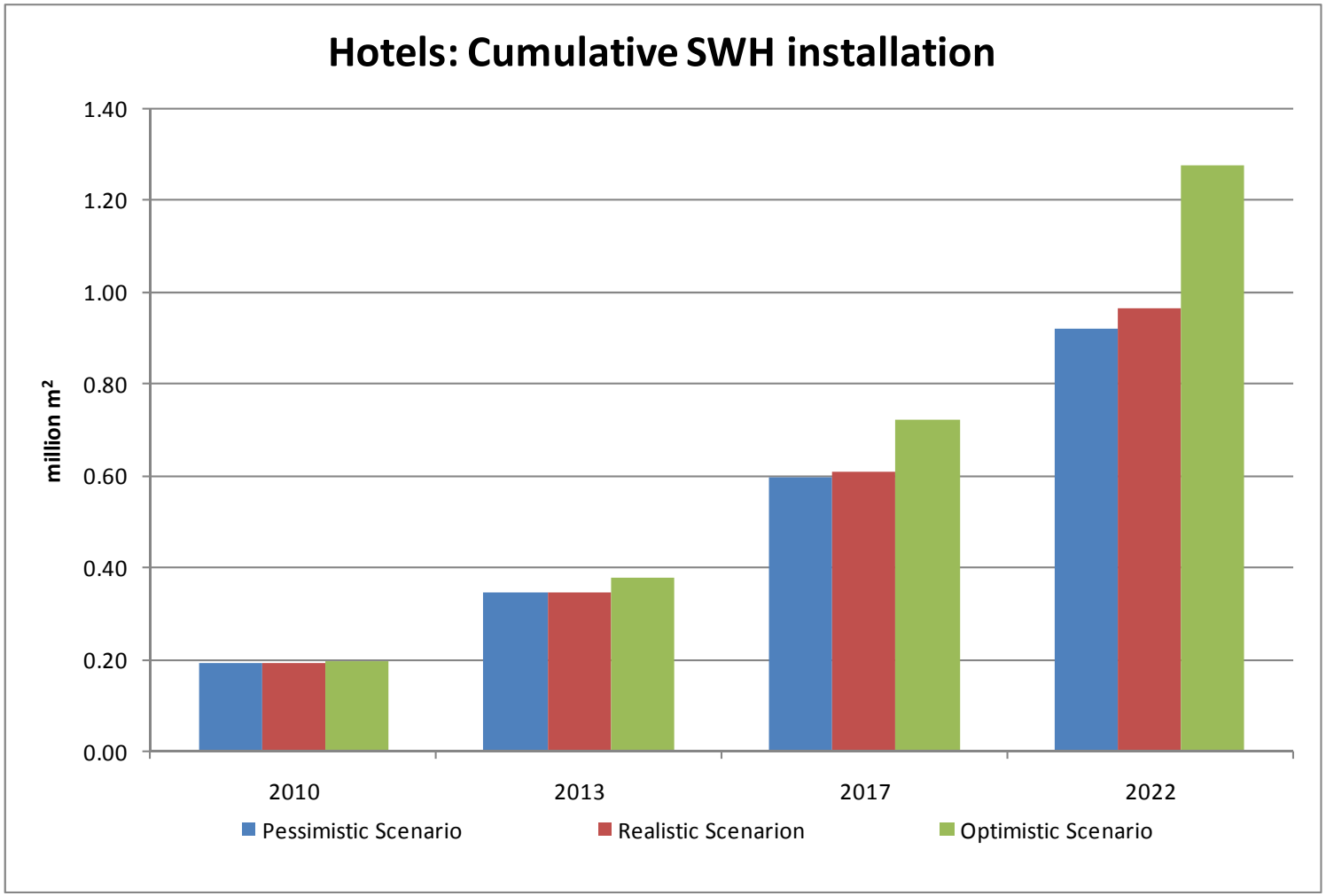


Figure 6.1: Cumulative SWH installation in million m^2 under 3 scenarios for Hotels

Table 6.11: State-wise cumulative SWH installation in m^2 for Pessimistic Scenario - Hotels

State	2010	2013	2017	2022
Maharashtra	52,380	91,840	159,020	247,540
Tamil Nadu	19,240	34,880	61,220	96,200
Kerala	16,680	30,220	53,020	83,360
Delhi	13,740	26,260	47,080	75,180
Karnataka	24,500	38,120	56,620	73,200
Andhra Pradesh	12,080	21,880	38,420	60,380
Rajasthan	11,200	20,300	35,620	56,020
Goa	8,580	15,580	27,300	42,920
Uttar Pradesh	5,880	11,300	20,260	32,320
Gujarat	6,260	11,380	19,960	31,340
West Bengal	4,180	7,980	14,300	22,820
Punjab	4,360	7,880	13,820	21,700
Haryana	3,140	5,700	10,020	15,760
Madhya Pradesh	2,760	5,280	9,460	15,080
Himachal Pradesh	1,760	3,200	5,600	8,820
Uttranchal	1,360	2,480	4,360	6,860
Orissa	1,140	2,160	3,880	6,200
Chandigarh	1,120	2,060	3,600	5,640
Pondicherry	680	1,240	2,160	3,380
Assam	440	960	1,760	2,900
Bihar	440	860	1,520	2,420
Jammu &Kashmir	440	860	1,520	2,400
Jharkhand	360	680	1,220	1,980
Dadra & Nagar Haveli	260	540	1,040	1,680
Chhatisgarh	220	440	780	1,240
Andaman & Nicobar	140	300	580	940
Meghalaya	100	220	440	720
Tripura	100	180	360	600
Daman & Diu	80	180	320	540
Sikkim	20	20	60	140
Lakshadweep	20	20	40	40
Arunachal Pradesh	-	-	20	20
Manipur	-	-	-	-
Mizoram	-	-	-	-
Nagaland	-	-	-	-
TOTAL	**193,660**	**345,000**	**595,380**	**920,340**

Table 6.12: State-wise cumulative SWH installation in m^2 for Realistic Scenario - Hotels

State	2010	2013	2017	2022
Maharashtra	52,400	92,060	159,900	250,080
Tamil Nadu	19,280	35,380	63,320	102,640
Kerala	16,720	30,680	54,900	88,980
Delhi	13,780	26,760	49,200	81,560
Karnataka	24,500	38,120	56,620	73,200
Andhra Pradesh	12,100	22,180	39,740	64,400
Rajasthan	11,240	20,620	36,900	59,780
Goa	8,600	15,780	28,220	45,720
Uttar Pradesh	5,900	11,500	21,120	35,000
Gujarat	6,260	11,500	20,600	33,420
West Bengal	4,180	8,120	14,920	24,740
Punjab	4,360	7,980	14,300	23,180
Haryana	3,160	5,800	10,380	16,840
Madhya Pradesh	2,760	5,380	9,860	16,360
Himachal Pradesh	1,760	3,240	5,800	9,400
Uttranchal	1,360	2,520	4,520	7,300
Orissa	1,140	2,200	4,060	6,740
Chandigarh	1,120	2,060	3,700	5,980
Pondicherry	680	1,240	2,220	3,600
Assam	440	960	1,840	3,220
Bihar	440	860	1,580	2,620
Jammu &Kashmir	440	860	1,580	2,620
Jharkhand	360	700	1,300	2,120
Dadra & Nagar Haveli	260	580	1,120	1,880
Chhatisgarh	220	440	800	1,340
Andaman & Nicobar	140	300	600	1,020
Meghalaya	100	260	480	820
Tripura	100	200	420	700
Daman & Diu	80	180	340	600
Sikkim	20	20	80	200
Lakshadweep	20	20	40	100
Arunachal Pradesh	-	-	20	20
Manipur	-	-	-	-
Mizoram	-	-	-	-
Nagaland	-	-	-	-
TOTAL	**193,920**	**348,500**	**610,480**	**966,180**

Table 6.13: State-wise cumulative SWH installation in m^2 for Optimistic Scenario - Hotels

State	2010	2013	2017	2022
Maharashtra	52,440	92,260	160,580	251,740
Tamil Nadu	19,920	39,500	77,920	141,600
Delhi	14,520	31,860	68,460	138,080
Kerala	17,280	34,260	67,540	122,760
Andhra Pradesh	12,480	24,780	48,900	88,860
Rajasthan	11,620	23,020	45,400	82,480
Karnataka	24,500	38,120	56,620	73,200
Goa	8,880	17,620	34,720	63,080
Uttar Pradesh	6,220	13,700	29,400	59,260
Gujarat	6,480	12,840	25,360	46,100
West Bengal	4,400	9,660	20,760	41,880
Punjab	4,500	8,920	17,600	31,960
Madhya Pradesh	2,900	6,400	13,720	27,660
Haryana	3,260	6,480	12,780	23,240
Himachal Pradesh	1,820	3,620	7,140	12,980
Orissa	1,200	2,620	5,660	11,400
Uttranchal	1,420	2,820	5,560	10,080
Chandigarh	1,160	2,300	4,540	8,240
Assam	480	1,220	2,940	7,060
Pondicherry	700	1,380	2,720	4,980
Bihar	460	1,020	2,200	4,440
Jammu &Kashmir	460	1,020	2,200	4,420
Dadra & Nagar Haveli	280	740	1,740	4,100
Jharkhand	380	840	1,800	3,600
Andaman & Nicobar	160	400	940	2,280
Chhatisgarh	240	520	1,120	2,260
Meghalaya	120	320	760	1,800
Tripura	100	260	640	1,500
Daman & Diu	100	220	540	1,320
Sikkim	20	40	140	440
Lakshadweep	20	40	80	300
Arunachal Pradesh	-	20	40	100
Manipur	-	-	-	-
Mizoram	-	-	-	-
Nagaland	-	-	-	-
TOTAL	**198,520**	**378,820**	**720,520**	**1,273,200**

6.2 SWH Potential in Hospitals

6.2.1 Hospital Beds in India

A state-wise estimate of government hospital beds in 2007 is given under **Table 6.14**. There are estimated 482522 beds.

There do not exist any statistics on the existence of private hospital beds in India. The Government of India, healthcare industry organization or healthcare specialist organizations have not put together, in public domain, either all-India or state-level information on private hospital beds. However, a recent report by Bureau of Energy Efficiency[21], estimates number of all-India private beds as 500000 for 2008, which is almost equal to the number of beds available in the government hospitals (482522). Thus we have assumed similar state-wise distribution for private hospitals as Government hospitals for 2009.

[21] BEE and ECO-III: Energy Efficiency in Hospitals – Best Practice Guide, March 2009

Table 6.14: State-wise distribution of government hospitals and hospital beds

S. No.	State/UT	Rural Hospitals		Urban Hospitals		Total Hospitals		Reference Period
		No.	Beds	No.	Beds	No.	Beds	
	India	6,955	154,031	3,021	328,491	9,976	482,522	01.01.2007
1	Andhra Pradesh	167	6220	192	28113	359	34333	01.01.2007
2	Arunachal Pradesh	36	379	30	1674	66	2053	01.01.2005
3	Assam	100	3000	-	-	100	3000	01.09.2004
4	Bihar	101	3030	-	-	101	3030	01.09.2004
5	Chattisgarh	116	3514	22	2051	138	5565	01.01.2004
6	Goa	9	452	11	2127	20	2579	01.01.2007
7	Gujarat	1483	18832	229	22200	1712	41032	01.01.2008
8	Haryana	56	1178	93	6484	149	7662	01.01.2008
9	Himachal Pradesh	94	2146	55	5963	149	8109	01.01.2008
10	(a) Jammu Division	28	830	8	870	36	1700	01.01.2000
	(b) Kashmir Division	33	990	23	1255	56	2245	01.01.2008
11	Jharkhand	47	1410	-	-	47	1410	01.09.2004
12	Karnataka	444	7290	424	35301	868	42591	01.01.2007
13	Kerala	173	12450	77	15945	250	28395	01.01.2008
14	Madhya Pradesh	275	8179	102	11739	377	19918	01.01.2008
15	Maharashtra	424	15380	242	30593	666	45973	01.01.2007
16	Manipur	24	669	4	1251	28	1920	01.01.2008
17	Meghalaya	26	780	8	1839	34	2619	01.01.2007
18	Mizoram	10	320	10	904	20	1224	01.01.2008
19	Nagaland	123	1962	12	790	135	2752	01.01.2006
20	Orissa	1623	5882	84	8668	1707	14550	01.01.2008
21	Punjab	77	2100	172	8927	249	11027	01.01.2007
22	Rajasthan	347	11850	128	20217	475	32067	01.01.2008
23	Sikkim	29	700	3	820	32	1520	01.01.2008
24	Tamil Nadu	533	25078	48	22120	581	47198	01.01.2008
25	Tripura	16	500	15	1762	31	2262	01.01.2008
26	Uttar Pradesh	397	11910	528	20550	925	32460	01.01.2007
27	Uttarakhand	24	100	94	5413	118	5513	01.01.2007
28	West Bengal	99	5171	284	44510	383	49681	01.01.2008
29	A&N Island	6	355	1	450	7	805	01.01.2007
30	Chandigarh	2	50	5	2150	7	2200	01.01.2004
31	D&N Haveli	1	30	1	130	2	160	01.01.2008
32	Daman & Diu	2	52	2	140	4	192	01.01.2004
33	Delhi	21	972	102	20220	123	21192	01.01.2008
34	Lakshadweep	5	160	-	-	5	160	01.01.2005
35	Puducherry	4	110	12	3315	16	3425	01.01.2008

(Source**:** BEE and ECO-III: Energy Efficiency in Hospitals – Best Practice Guide, March 2009)

6.2.2 Development of Hot Water Requirement Norms

In hospitals, heat stream is used in the form of steam and hot water. Steam is used in the kitchens and for humidification in HVAC and sterilization process. In addition steam is used to transport heat over longer distances. In many cases heat is transported from the heat generating station in the form of steam and then converted locally into central heating or hot tap water. Oil/Gas-fired boilers are used to generate steam and hot water.

The hot water requirement in hospitals, theoretically, stems from three purposes

- Patient room
- Laundry
- Kitchen

The position is as follows.

	Bathroom		**Kitchen**		**Laundry**	
	Govt	**Pvt**	**Govt**	**Pvt**	**Govt**	**Pvt**
Hospital up to 15 beds	√	√	×	×	×	×
Hospital from to 16 to 50 beds	√	√	limited	limited	×	×
Hospital with over 50 beds	√	√	√	√	limited	√

The laundry and kitchen are features of large corporate or public hospitals and these hospitals contribute a tiny percentage of total hospital beds in India. The kitchen requirement is for cleaning and works out under 5 litres per bed. For practical purpose, patient room or bathing constitutes the hot water requirement of hospitals. The arrangement, typically, is shower and/or bucket bath. There are patients who, for medical reasons, are required to abstain from bathing. The care-takers accompanying the patient, in many instances, do not bathe in the hospitals. These practices bring down the hot water consumption in a hospital.

The hospital owners/managers interviewed by us estimated hot water consumption per bed around 25 lpd/bed for patients who are permitted to bathe. The hospital covered under the survey reported SWH provisioning at rates varying from 15 to 60 lpd/bed, the popular provisioning norm, though, is in the vicinity of 30 lpd/bed. We have, therefore, followed the norm of SWH provisioning @ 30 lpd/bed for government and private hospitals, except for modern multi-specialty private hospitals. For multi-specialty private hospitals a norm of 190 lpd/bed has been taken based on discussions with some prominent services consultants involved in the design of new multi-specialty private hospitals.

6.2.3 Projected Hospital Beds and Hot Water Requirement

Not-withstanding the shortfall in beds/1000 population, the growth of beds in government hospitals is expected to be tardy- 2% pa till 2022. We expect private hospital growth @7% pa till 2013 and to taper to 5% over 2014-17 period and 3% pa thereafter. The gross number of hospital beds, estimated at 1.004 million in 2009 will grow to 1.58 million by 2022.

6.2.4 Hot Water Requirement

The total hot water requirement will escalate from 45.18 million lpd in 2009 to 75.11 million lpd in 2022. It is assumed that 20% of the private hospital beds are in multi-specialty private hospitals having a higher requirement of 190 lpd/bed, while for all other government and private hospitals hot water demand has been calculated @ 30 lpd/day.

6.2.5 Current Penetration Rate of SWH in Hospitals

Based on stakeholders consultations and assumptions made by the project team, the estimated current state-wise penetration rate of SWH in hospitals is shown in **Table-6.15**.

6.2.6 Alternative Scenarios

Pessimistic Scenario: The state-wise penetration rate of SWH in existing and new hospitals for 2009 are taken from table 6.15. An annual growth of 5% in the penetration rate is assumed.

Table 6.15: Classification of states as per penetration rate of SWH in hospitals

Category	SWH Penetration rate in hospitals (% of the total hospital hot water demand met through SWH) -2009	SWH penetration rate in new-hospitals	States
I	20 %	50%	Karnataka
II	10 %	25 %	Maharashtra
III	5%	20 %	HP, Punjab, Haryana, UK, Rajasthan, Goa, Tamil Nadu, Kerala, AP,

IV	2.5 %	20 %	Delhi, UP, Bihar, MP, Chhatisgarh, Orissa, WB, Jharkhand
V	1 %	20 %	N-E states, Sikkim

Realistic Scenario:

It assumes that the penetration rate of SWH in new hospitals, in the year 2022, in all the states would reach a level of 50%. For Karnataka it is assumed that the penetration level in new hospitals would remain constant at 50%.

Optimistic Scenario:

It assumes strong enforcement of mandatory provision in new hospitals along with a policy and awareness initiative to increase penetration in existing hospitals.

6.2.7 Results

Pessimistic: The cumulative installation of SWH in hospital sector is expected to grow from 97,418 m^2 /year in 2010 to 402,625 m^2/year in 2022. The deployment of SWH during 2010-2022 in hospital sector would be 0.3052 million m^2 (figure 6.2). Table 6.16 provides state-wise SWH deployment in hospital sector for the scenario.

Realistic: The cumulative installation of SWH in hospital sector is expected to grow from 97,615 m^2 /year in 2010 to 426,446 m^2/year in 2022. The deployment of SWH during 2010-2022 in hospital sector would be 0.3288 million m^2 (figure 6.2). Table 6.17 provides state-wise SWH deployment in hospital sector for the scenario. Five states – Karnataka, Maharashtra, Tamil Nadu, Gujarat and West Bengal are expected to contribute to 58.0% of the installations under the scenario.

Optimistic: The cumulative installation of SWH in hospital sector is expected to grow from 103,643 m^2 /year in 2010 to 958,118 m^2/year in 2022. The deployment of SWH during 2010-2022 in hospital sector would be 0.8545 million m^2 (figure 6.2). Table 6.18 provides state-wise SWH deployment in hospital sector for the scenario.

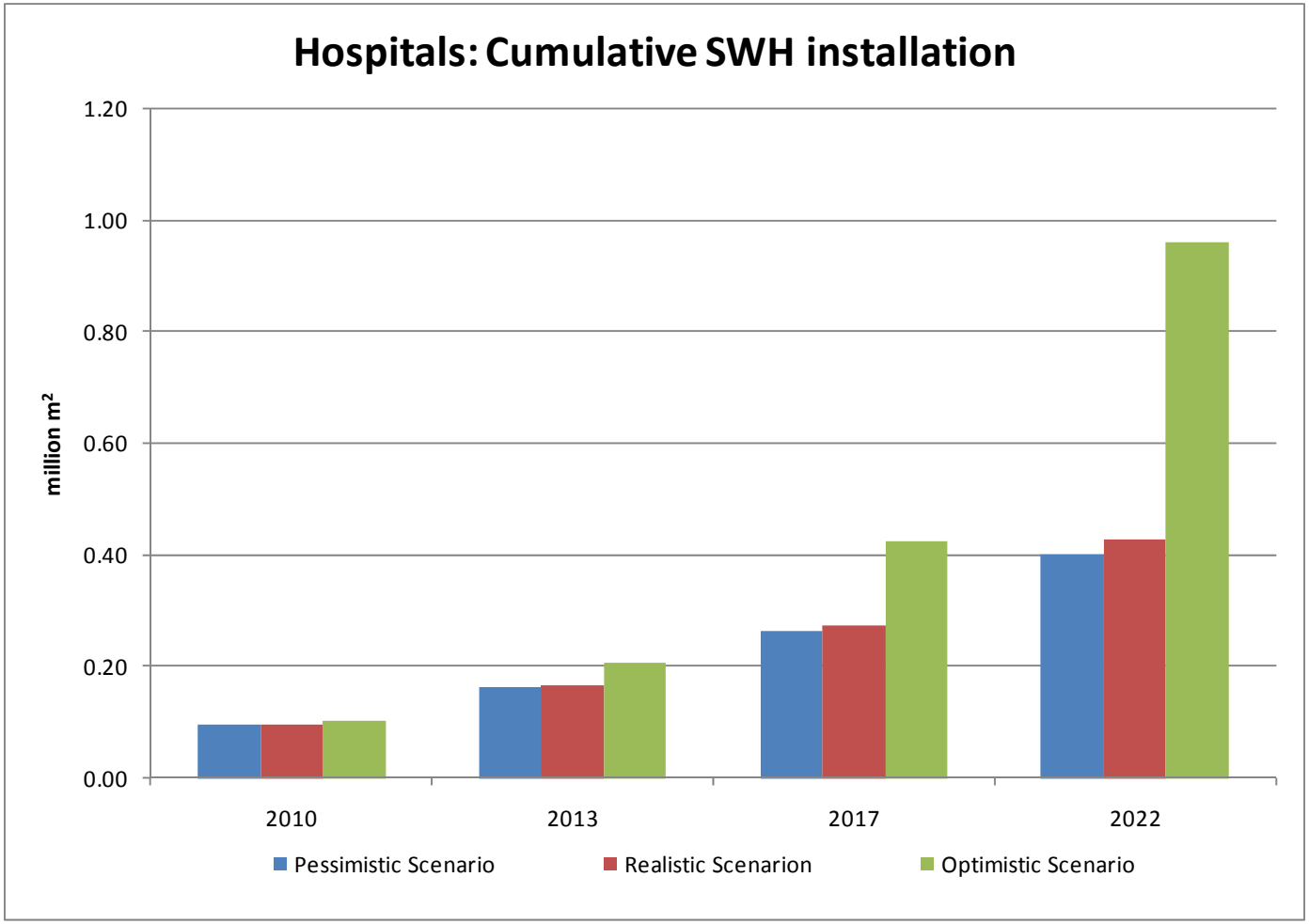


Figure 6.2: Cumulative SWH installation in million m^2 under 3 scenarios for Hospitals

Table 6.16: State-wise cumulative SWH installation in m^2 for Pessimistic Scenario - Hospitals

State	2010	2013	2017	2022
Karnataka	26,435	41,282	62,653	91,501
Maharashtra	14,482	23,111	36,245	55,058
Tamil Nadu	8,197	13,979	22,607	34,730
Gujarat	7,127	12,155	19,657	30,197
West Bengal	5,366	10,295	17,471	27,302
Andhra Pradesh	5,965	10,171	16,448	25,266
Rajasthan	5,570	9,500	15,362	23,599
Kerala	4,934	8,413	13,604	20,897
Uttar Pradesh	3,506	6,727	11,414	17,838
Delhi	2,290	4,393	7,452	11,647
Madhya Pradesh	2,151	4,127	7,003	10,944
Punjab	1,915	3,267	5,283	8,116
Orissa	1,572	3,016	5,117	7,996
Himachal Pradesh	1,409	2,402	3,884	5,967
Haryana	1,331	2,270	3,671	5,639
Uttranchal	958	1,632	2,639	4,057
Chhatisgarh	601	1,152	1,957	3,058
Pondicherry	595	1,015	1,641	2,520
Jammu &Kashmir	426	817	1,386	2,167
Goa	448	763	1,234	1,897
Bihar	328	629	1,067	1,666
Chandigarh	383	650	1,052	1,617
Assam	205	461	826	1,313
Nagaland	188	424	756	1,204
Meghalaya	180	403	719	1,147
Tripura	154	348	622	988
Arunachal Pradesh	141	316	566	899
Manipur	131	296	529	842
Jharkhand	152	293	495	773
Sikkim	104	233	418	665
Mizoram	83	188	337	536
Andaman & Nicobar	55	124	222	354
Daman & Diu	14	30	53	85
Dadra & Nagar Haveli	11	25	45	70
Lakshadweep	11	25	45	70
TOTAL	**97,418**	**164,932**	**264,479**	**402,625**

Table 6.17: State-wise cumulative SWH installation in m^2 for Realistic Scenario (Hospitals)

State	2010	2013	2017	2022
Karnataka	26,435	41,282	62,653	91,501
Maharashtra	14,488	23,171	36,481	55,696
Tamil Nadu	8,221	14,235	23,602	37,495
Gujarat	7,148	12,379	20,524	32,602
West Bengal	5,390	10,570	18,531	30,240
Andhra Pradesh	5,981	10,356	17,170	27,275
Rajasthan	5,585	9,673	16,038	25,477
Kerala	4,947	8,565	14,200	22,559
Uttar Pradesh	3,522	6,907	12,107	19,758
Delhi	2,300	4,509	7,904	12,900
Madhya Pradesh	2,161	4,237	7,428	12,122
Orissa	1,579	3,095	5,425	8,854
Punjab	1,921	3,326	5,515	8,759
Himachal Pradesh	1,414	2,447	4,056	6,443
Haryana	1,336	2,312	3,833	6,089
Uttranchal	960	1,663	2,757	4,382
Chhatisgarh	604	1,184	2,076	3,388
Pondicherry	596	1,034	1,715	2,723
Jammu &Kashmir	427	839	1,472	2,401
Goa	450	780	1,292	2,051
Bihar	329	645	1,132	1,847
Chandigarh	384	663	1,099	1,747
Assam	207	478	890	1,490
Nagaland	190	440	817	1,369
Meghalaya	181	418	777	1,301
Tripura	155	360	671	1,123
Arunachal Pradesh	141	326	607	1,019
Manipur	132	306	570	955
Jharkhand	154	301	526	858
Sikkim	104	242	451	755
Mizoram	84	196	364	608
Andaman & Nicobar	55	128	238	400
Daman & Diu	14	30	56	96
Dadra & Nagar Haveli	11	26	49	80
Lakshadweep	11	26	49	80
TOTAL	**97,615**	**167,148**	**273,073**	**426,446**

Table 6.18: State-wise cumulative SWH installation in m^2 for Optimistic Scenario - Hospitals

State	2010	2013	2017	2022
West Bengal	5,966	14,615	35,398	97,389
Karnataka	26,492	41,593	63,552	93,662
Tamil Nadu	8,936	18,833	40,354	92,517
Maharashtra	15,182	27,258	49,646	92,195
Gujarat	7,770	16,376	35,088	80,436
Andhra Pradesh	6,501	13,700	29,356	67,301
Uttar Pradesh	3,898	9,550	23,127	63,630
Rajasthan	6,072	12,797	27,419	62,860
Kerala	5,377	11,333	24,280	55,660
Delhi	2,545	6,235	15,100	41,543
Madhya Pradesh	2,392	5,859	14,191	39,043
Orissa	1,747	4,280	10,366	28,520
Punjab	2,087	4,400	9,429	21,614
Himachal Pradesh	1,536	3,237	6,934	15,896
Haryana	1,451	3,059	6,553	15,022
Chhatisgarh	668	1,637	3,965	10,910
Uttranchal	1,043	2,200	4,714	10,808
Jammu &Kashmir	473	1,160	2,811	7,733
Pondicherry	648	1,367	2,930	6,715
Bihar	365	892	2,161	5,942
Assam	228	642	1,721	5,881
Nagaland	208	590	1,580	5,395
Meghalaya	199	560	1,503	5,133
Goa	490	1,031	2,207	5,056
Tripura	172	484	1,298	4,432
Chandigarh	416	877	1,880	4,312
Arunachal Pradesh	155	438	1,177	4,024
Manipur	146	411	1,103	3,764
Sikkim	114	325	872	2,978
Jharkhand	170	415	1,004	2,762
Mizoram	93	262	703	2,399
Andaman & Nicobar	61	173	460	1,577
Daman & Diu	15	41	109	377
Dadra & Nagar Haveli	13	35	93	316
Lakshadweep	13	35	93	316
TOTAL	**103,643**	**206,701**	**423,176**	**958,118**

6.3 SWH Potential in Hostel Sector

6.3.1 Hostel rooms in India

There does not exist any estimate of hostel rooms in India. Under the circumstances, we have been required to develop it on the basis of available evidence. We have utilized the following assumptions.

- The hostel bed capacity in India is linked largely to professional higher education. It is assumed that "general" higher education does not entail any worthwhile demand for hostels.
- It is not possible to estimate precisely niche streams of hostel demand- school children, working women, vocational course students, general higher education programmes. These together are taken at 20% of the demand from professional higher education students. The estimate is made after considering the absolute number of professional higher education hostel-staying students.
- Within the professional higher education stream, there are the following typologies.
    - Students who stay at home
    - Students who rent out apartments or make similar other arrangements
    - Private house owners who house say 10 to 15 students in a hostel-like arrangement
    - Students who live in organized on-campus or off-campus hostel having capacity to house over 15 students.
- We have considered the last category as SWH- relevant and assumed that it forms 25% of the students pursuing higher professional education.
- There were 15.55 million higher education students in 2006-07 (Table 6.19). 15% of these were enrolled in technical and professional streams- 2.33 million[22].
- There are 16890 higher education institutes in India (Table 6.20) in 2006;.31.6% of which are professional/deemed universities/national institutes.
- The students are divided among states based on the number of professional/ deemed universities and national institutes in the respective states (Table 6.21).
- The students staying in organized hostels are estimated at 25% of all students, enrolled for higher professional education (Table 6.22); 0.58 million in 2006.

[22] Indian Education Services- A Hot Opportunity

- In addition there are 0.12 million other students– schools, vocational courses, general higher education, etc. who stay in organized hostels and need hot water
- We have followed SWH provisioning norm of 30 lpd/student.

Table 6.19: Actual Number of Higher Education Students

		2004	2005	2006
East	Arunachal Pradesh	6745	8839	10550
East	Assam	214342	217652	215761
East	Bihar	553693	524856	539738
East	Chhattisgarh	163254	195604	199670
East	Jharkhand	209176	260625	262088
East	Manipur	38679	38177	40457
East	Meghalaya	30716	38658	40540
East	Mizoram	12180	14575	13844
East	Nagaland	13644	28965	28242
East	Orissa	367187	413269	438550
East	Sikkim	6596	8985	10171
East	Tripura	22447	24845	26102
East	West Bengal	746509	787228	835825
	Sub-Total	**2385168**	**2562278**	**2661538**
North	Delhi	709169	867400	1183892
North	Haryana	264331	298146	353484
North	Himachal Pradesh	103628	108982	121865
North	Jammu & Kashmir	80405	158667	132812
North	Punjab	279707	347641	373461
North	Rajasthan	394478	488530	524381
North	Uttar Pradesh	1507991	1760595	1903489
North	Uttrakhand	131742	163961	175153
North	Chandigarh	51309	55077	57193
	Sub-Total	**3522760**	**4248999**	**4825730**
South	Andhra Pradesh	1056719	1411103	1520724
South	Karnataka	706241	951786	1061456
South	Kerala	313155	450577	451367
South	Tamil Nadu	809366	1324359	1587532
South	Andaman & Nicobar Islands	2706	3438	3641
South	Lakshadweep	0	0	259
South	Puducherry	20199	31154	32454
	Sub-Total	**2908386**	**4172417**	**4657433**
West	Goa	21643	23748	23919
West	Madhya Pradesh	758418	968760	995362
West	Maharashtra	1534613	1681789	1806825
West	Dadra & Nagar Haveli	0	0	0
West	Gujarat	645689	664347	580770
	Sub-Total	**2960982**	**3339872**	**3408155**
	India	**11777296**	**14323566**	**15552856**

Source: Indiastat.com

Table 6.20: Number of Higher Education Institutes In 2006

		College for General Education	College for Professional Education	Deemed Universities/national institutes	Total
East	Arunachal Pradesh	10	5	2	17
East	Assam	348	28	7	383
East	Bihar	743	57	13	813
East	Chhattisgarh	213	29	8	250
East	Jharkhand	113	26	7	146
East	Manipur	58	9	2	69
East	Meghalaya	54	4	1	59
East	Mizoram	26	4	1	31
East	Nagaland	37	4	1	42
East	Orissa	700	144	11	855
East	Sikkim	3	6	1	10
East	Tripura	14	6	1	21
East	West Bengal	374	179	20	573
	Sub-Total	2693	**501**	**75**	**3269**
North	Delhi	68	66	17	151
North	Haryana	168	146	8	322
North	Himachal Pradesh	95	48	5	148
North	Jammu & Kashmir	65	149	6	220
North	Punjab	232	152	8	392
North	Rajasthan	751	200	20	971
North	Uttar Pradesh	1637	331	33	2001
North	Uttrakhand	86	28	9	123
North	Chandigarh	12	10	3	25
	Sub-Total	3114	**1130**	**109**	**4353**
South	Andhra Pradesh	**1603**	810	21	2434
South	Karnataka	930	539	23	1492
South	Kerala	189	183	10	382
South	Tamil Nadu	490	699	35	1224
South	Andaman & Nicobar	3	3	0	6
South	Lakshadweep	0	0	0	0
South	Puducherry	17	38	1	56
	Sub-Total	3232	**2272**	**90**	**5594**
West	Goa	23	18	1	42
West	Madhya Pradesh	760	159	17	936
West	Maharashtra	1208	613	41	1862
West	Daman & Diu	1	2	0	3
West	Dadra & Nagar Haveli	0	1	0	1
West	Gujarat	518	295	17	830
	Sub-Total	2510	**1088**	**76**	**3674**
	India	**11549**	**4991**	**350**	**16890**

Source: www.education.nic.in annual report 2007-08

Table 6.21: Estimated No of Technical and Professional Higher Education Students

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Arunachal Pradesh	1729	1781	1835	1890	1946	2005	2065	2127	2191	2256	2324	2394
Assam	35365	36426	37519	38644	39804	40998	42228	43495	44800	46144	47528	48954
Bihar	88468	91122	93856	96671	99571	102559	105635	108804	112069	115431	118894	122460
Chhattisgarh	32728	33710	34721	35762	36835	37940	39079	40251	41458	42702	43983	45303
Jharkhand	42959	44247	45575	46942	48350	49801	51295	52834	54419	56051	57733	59465
Manipur	6631	6830	7035	7246	7464	7687	7918	8156	8400	8652	8912	9179
Meghalaya	6645	6844	7050	7261	7479	7703	7934	8172	8418	8670	8930	9198
Mizoram	2269	2337	2407	2480	2554	2631	2709	2791	2875	2961	3050	3141
Nagaland	4629	4768	4911	5058	5210	5366	5527	5693	5864	6040	6221	6408
Orissa	71882	74039	76260	78548	80904	83331	85831	88406	91058	93790	96604	99502
Sikkim	1667	1717	1769	1822	1876	1933	1991	2050	2112	2175	2240	2308
Tripura	4278	4407	4539	4675	4815	4960	5109	5262	5420	5582	5750	5922
West Bengal	136999	141109	145343	149703	154194	158820	163584	168492	173547	178753	184116	189639
Sub-Total	**436250**	**449338**	**462818**	**476702**	**491003**	**505734**	**520906**	**536533**	**552629**	**569208**	**586284**	**603872**
Delhi	194051	199872	205868	212044	218406	224958	231707	238658	245818	253192	260788	268611
Haryana	57939	59677	61468	63312	65211	67167	69182	71258	73396	75598	77865	80201
Himachal Pradesh	19975	20574	21191	21827	22482	23156	23851	24566	25303	26063	26844	27650
Jammu & Kashmir	21769	22422	23095	23788	24501	25236	25993	26773	27576	28404	29256	30134
Punjab	61214	63050	64942	66890	68896	70963	73092	75285	77544	79870	82266	84734
Rajasthan	85951	88529	91185	93921	96738	99641	102630	105709	108880	112146	115511	118976
Uttar Pradesh	311999	321359	331000	340930	351158	361692	372543	383720	395231	407088	419301	431880
Uttrakhand	28709	29570	30458	31371	32312	33282	34280	35309	36368	37459	38583	39740
Chandigarh	9374	9656	9945	10244	10551	10868	11194	11529	11875	12232	12598	12976
Sub-Total	**790981**	**814710**	**839152**	**864326**	**890256**	**916964**	**944472**	**972807**	**1001991**	**1032051**	**1063012**	**1094902**
Andhra Pradesh	249260	256738	264440	272374	280545	288961	297630	306559	315756	325228	334985	345035
Karnataka	173982	179202	184578	190115	195819	201693	207744	213976	220396	227007	233818	240832
Kerala	73983	76203	78489	80843	83269	85767	88340	90990	93720	96531	99427	102410
Tamil Nadu	260211	268017	276058	284339	292870	301656	310705	320027	329627	339516	349702	360193
Andaman & Nicobar	597	615	633	652	672	692	713	734	756	779	802	826
Lakshadweep	42	44	45	46	48	49	51	52	54	55	57	59
Puducherry	5320	5479	5643	5813	5987	6167	6352	6542	6739	6941	7149	7363
Sub-Total	**763395**	**786297**	**809886**	**834183**	**859208**	**884985**	**911534**	**938880**	**967046**	**996058**	**1025940**	**1056718**
Goa	3921	4038	4159	4284	4413	4545	4681	4822	4966	5115	5269	5427
Madhya Pradesh	163149	168043	173085	178277	183625	189134	194808	200652	206672	212872	219258	225836
Maharashtra	296155	305040	314191	323617	333325	343325	353625	364233	375160	386415	398008	409948
Daman & Diu	210	216	222	229	236	243	250	258	266	274	282	290
Gujarat	95193	98049	100991	104020	107141	110355	113666	117076	120588	124206	127932	131770
Sub-Total	**558627**	**575386**	**592648**	**610427**	**628740**	**647602**	**667030**	**687041**	**707653**	**728882**	**750749**	**773271**
India	**2549254**	**2625731**	**2704503**	**2785639**	**2869208**	**2955284**	**3043942**	**3135261**	**3229319**	**3326198**	**3425984**	**3528764**

Table 6.22: Estimated No of Technical and Professional Higher Education Hostel Students

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Arunachal Pradesh	432	445	459	472	487	501	516	532	548	564	581	598
Assam	8841	9107	9380	9661	9951	10249	10557	10874	11200	11536	11882	12238
Bihar	22117	22780	23464	24168	24893	25640	26409	27201	28017	28858	29723	30615
Chhattisgarh	8182	8427	8680	8941	9209	9485	9770	10063	10365	10676	10996	11326
Jharkhand	10740	11062	11394	11736	12088	12450	12824	13208	13605	14013	14433	14866
Manipur	1658	1708	1759	1812	1866	1922	1980	2039	2100	2163	2228	2295
Meghalaya	1661	1711	1762	1815	1870	1926	1984	2043	2104	2168	2233	2300
Mizoram	567	584	602	620	638	658	677	698	719	740	762	785
Nagaland	1157	1192	1228	1265	1303	1342	1382	1423	1466	1510	1555	1602
Orissa	17971	18510	19065	19637	20226	20833	21458	22102	22765	23448	24151	24875
Sikkim	417	429	442	455	469	483	498	513	528	544	560	577
Tripura	1070	1102	1135	1169	1204	1240	1277	1315	1355	1396	1437	1481
West Bengal	34250	35277	36336	37426	38548	39705	40896	42123	43387	44688	46029	47410
Sub-Total	**109063**	**112334**	**115704**	**119176**	**122751**	**126433**	**130226**	**134133**	**138157**	**142302**	**146571**	**150968**
Delhi	48513	49968	51467	53011	54601	56239	57927	59664	61454	63298	65197	67153
Haryana	14485	14919	15367	15828	16303	16792	17296	17814	18349	18899	19466	20050
Himachal Pradesh	4994	5144	5298	5457	5620	5789	5963	6142	6326	6516	6711	6912
Jammu & Kashmir	5442	5606	5774	5947	6125	6309	6498	6693	6894	7101	7314	7533
Punjab	15303	15763	16235	16722	17224	17741	18273	18821	19386	19967	20567	21183
Rajasthan	21488	22132	22796	23480	24185	24910	25657	26427	27220	28037	28878	29744
Uttar Pradesh	78000	80340	82750	85232	87789	90423	93136	95930	98808	101772	104825	107970
Uttrakhand	7177	7393	7614	7843	8078	8320	8570	8827	9092	9365	9646	9935
Chandigarh	2344	2414	2486	2561	2638	2717	2798	2882	2969	3058	3150	3244
Sub-Total	**197745**	**203678**	**209788**	**216082**	**222564**	**229241**	**236118**	**243202**	**250498**	**258013**	**265753**	**273726**
Andhra Pradesh	62315	64185	66110	68093	70136	72240	74407	76640	78939	81307	83746	86259
Karnataka	43496	44800	46144	47529	48955	50423	51936	53494	55099	56752	58454	60208
Kerala	18496	19051	19622	20211	20817	21442	22085	22747	23430	24133	24857	25602
Tamil Nadu	65053	67004	69014	71085	73217	75414	77676	80007	82407	84879	87425	90048
Andaman & Nicobar	149	154	158	163	168	173	178	183	189	195	201	207
Lakshadweep	11	11	11	12	12	12	13	13	13	14	14	15
Puducherry	1330	1370	1411	1453	1497	1542	1588	1636	1685	1735	1787	1841
Sub-Total	**190849**	**196574**	**202472**	**208546**	**214802**	**221246**	**227884**	**234720**	**241762**	**249014**	**256485**	**264179**
Goa	980	1010	1040	1071	1103	1136	1170	1205	1242	1279	1317	1357
Madhya Pradesh	40787	42011	43271	44569	45906	47284	48702	50163	51668	53218	54815	56459
Maharashtra	74039	76260	78548	80904	83331	85831	88406	91058	93790	96604	99502	102487
Daman & Diu	52	54	56	57	59	61	63	64	66	68	70	73
Gujarat	23798	24512	25248	26005	26785	27589	28416	29269	30147	31051	31983	32943
Sub-Total	**139657**	**143847**	**148162**	**152607**	**157185**	**161901**	**166758**	**171760**	**176913**	**182221**	**187687**	**193318**
India	**637313**	**656433**	**676126**	**696410**	**717302**	**738821**	**760986**	**783815**	**807330**	**831550**	**856496**	**882191**

6.3.2 SWH Projection

The hot water demand of higher professional education students staying in organized hostels and that of all students staying hostels is given under **Table 6.23** and **Table 6.24** respectively.

Realistic Scenario: We expect varied penetration of SWH vis-à-vis the zones. Our estimate is as follows.

Zone	Beginning penetration 2010	Penetration in 2020
South	5	25
North	2	15
West	3	20
East	1	10

The SWH potential will grow from 0.696 million lpd in 2010 to 6.89 million lpd in 2022 **(Table 6.25)**. This translates to 0.124 million m^2 of SWH installation during 2010- 2022. The overall SWH penetration in the hostel sector will touch 20.5% in 2022.

Table 6.23: Estimated Hot Water Demand of Professional Higher Education Hostel Students ('000 lpd)

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Arunachal Pradesh	13	13	14	14	15	15	15	16	16	17	17	18
Assam	265	273	281	290	299	307	317	326	336	346	356	367
Bihar	664	683	704	725	747	769	792	816	841	866	892	918
Chhattisgarh	245	253	260	268	276	285	293	302	311	320	330	340
Jharkhand	322	332	342	352	363	374	385	396	408	420	433	446
Manipur	50	51	53	54	56	58	59	61	63	65	67	69
Meghalaya	50	51	53	54	56	58	60	61	63	65	67	69
Mizoram	17	18	18	19	19	20	20	21	22	22	23	24
Nagaland	35	36	37	38	39	40	41	43	44	45	47	48
Orissa	539	555	572	589	607	625	644	663	683	703	725	746
Sikkim	13	13	13	14	14	14	15	15	16	16	17	17
Tripura	32	33	34	35	36	37	38	39	41	42	43	44
West Bengal	1027	1058	1090	1123	1156	1191	1227	1264	1302	1341	1381	1422
Sub-Total	**3272**	**3370**	**3471**	**3575**	**3683**	**3793**	**3907**	**4024**	**4145**	**4269**	**4397**	**4529**
Delhi	1455	1499	1544	1590	1638	1687	1738	1790	1844	1899	1956	2015
Haryana	435	448	461	475	489	504	519	534	550	567	584	602
Himachal Pradesh	150	154	159	164	169	174	179	184	190	195	201	207
Jammu & Kashmir	163	168	173	178	184	189	195	201	207	213	219	226
Punjab	459	473	487	502	517	532	548	565	582	599	617	636
Rajasthan	645	664	684	704	726	747	770	793	817	841	866	892
Uttar Pradesh	2340	2410	2482	2557	2634	2713	2794	2878	2964	3053	3145	3239
Uttrakhand	215	222	228	235	242	250	257	265	273	281	289	298
Chandigarh	70	72	75	77	79	82	84	86	89	92	94	97
Sub-Total	**5932**	**6110**	**6294**	**6482**	**6677**	**6877**	**7084**	**7296**	**7515**	**7740**	**7973**	**8212**
Andhra Pradesh	1869	1926	1983	2043	2104	2167	2232	2299	2368	2439	2512	2588
Karnataka	1305	1344	1384	1426	1469	1513	1558	1605	1653	1703	1754	1806
Kerala	555	572	589	606	625	643	663	682	703	724	746	768
Tamil Nadu	1952	2010	2070	2133	2197	2262	2330	2400	2472	2546	2623	2701
Andaman & Nicobar Islands	4	5	5	5	5	5	5	6	6	6	6	6
Lakshadweep	0	0	0	0	0	0	0	0	0	0	0	0
Puducherry	40	41	42	44	45	46	48	49	51	52	54	55
Sub-Total	**5725**	**5897**	**6074**	**6256**	**6444**	**6637**	**6837**	**7042**	**7253**	**7470**	**7695**	**7925**
Goa	29	30	31	32	33	34	35	36	37	38	40	41
Madhya Pradesh	1224	1260	1298	1337	1377	1419	1461	1505	1550	1597	1644	1694
Maharashtra	2221	2288	2356	2427	2500	2575	2652	2732	2814	2898	2985	3075
Daman & Diu	2	2	2	2	2	2	2	2	2	2	2	2
Gujarat	714	735	757	780	804	828	852	878	904	932	959	988
Sub-Total	**4190**	**4315**	**4445**	**4578**	**4716**	**4857**	**5003**	**5153**	**5307**	**5467**	**5631**	**5800**
India	**19119**	**19693**	**20284**	**20892**	**21519**	**22165**	**22830**	**23514**	**24220**	**24946**	**25695**	**26466**

Table 6.24: Estimated Hot Water Demand of All Hostel Students (' 000 lpd)

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Arunachal Pradesh	16	16	17	17	18	18	19	19	20	20	21	22
Assam	318	328	338	348	358	369	380	391	403	415	428	441
Bihar	796	820	845	870	896	923	951	979	1009	1039	1070	1102
Chhattisgarh	295	303	312	322	332	341	352	362	373	384	396	408
Jharkhand	387	398	410	422	435	448	462	476	490	504	520	535
Manipur	60	61	63	65	67	69	71	73	76	78	80	83
Meghalaya	60	62	63	65	67	69	71	74	76	78	80	83
Mizoram	20	21	22	22	23	24	24	25	26	27	27	28
Nagaland	42	43	44	46	47	48	50	51	53	54	56	58
Orissa	647	666	686	707	728	750	772	796	820	844	869	896
Sikkim	15	15	16	16	17	17	18	18	19	20	20	21
Tripura	39	40	41	42	43	45	46	47	49	50	52	53
West Bengal	1233	1270	1308	1347	1388	1429	1472	1516	1562	1609	1657	1707
Sub-Total	**3926**	**4044**	**4165**	**4290**	**4419**	**4552**	**4688**	**4829**	**4974**	**5123**	**5277**	**5435**
Delhi	1746	1799	1853	1908	1966	2025	2085	2148	2212	2279	2347	2418
Haryana	521	537	553	570	587	605	623	641	661	680	701	722
Himachal Pradesh	180	185	191	196	202	208	215	221	228	235	242	249
Jammu & Kashmir	196	202	208	214	221	227	234	241	248	256	263	271
Punjab	551	567	584	602	620	639	658	678	698	719	740	763
Rajasthan	774	797	821	845	871	897	924	951	980	1009	1040	1071
Uttar Pradesh	2808	2892	2979	3068	3160	3255	3353	3453	3557	3664	3774	3887
Uttrakhand	258	266	274	282	291	300	309	318	327	337	347	358
Chandigarh	84	87	90	92	95	98	101	104	107	110	113	117
Sub-Total	**7119**	**7332**	**7552**	**7779**	**8012**	**8253**	**8500**	**8755**	**9018**	**9288**	**9567**	**9854**
Andhra Pradesh	2243	2311	2380	2451	2525	2601	2679	2759	2842	2927	3015	3105
Karnataka	1566	1613	1661	1711	1762	1815	1870	1926	1984	2043	2104	2167
Kerala	666	686	706	728	749	772	795	819	843	869	895	922
Tamil Nadu	2342	2412	2485	2559	2636	2715	2796	2880	2967	3056	3147	3242
Andaman & Nicobar Islands	5	6	6	6	6	6	6	7	7	7	7	7
Lakshadweep	0	0	0	0	0	0	0	0	0	0	1	1
Puducherry	48	49	51	52	54	56	57	59	61	62	64	66
Sub-Total	**6871**	**7077**	**7289**	**7508**	**7733**	**7965**	**8204**	**8450**	**8703**	**8965**	**9233**	**9510**
Goa	35	36	37	39	40	41	42	43	45	46	47	49
Madhya Pradesh	1468	1512	1558	1604	1653	1702	1753	1806	1860	1916	1973	2033
Maharashtra	2665	2745	2828	2913	3000	3090	3183	3278	3376	3478	3582	3690
Daman & Diu	2	2	2	2	2	2	2	2	2	2	3	3
Gujarat	857	882	909	936	964	993	1023	1054	1085	1118	1151	1186
Sub-Total	**5028**	**5178**	**5334**	**5494**	**5659**	**5828**	**6003**	**6183**	**6369**	**6560**	**6757**	**6959**
India	**22943**	**23632**	**24341**	**25071**	**25823**	**26598**	**27395**	**28217**	**29064**	**29936**	**30834**	**31759**

Table 6.25: Projected SWH Installation ('000 ltrs) –Realistic Scenario

	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**
South	5	7	9	11	13	15	17	19	21	23	25	27	29
North	2	4	6	8	10	10	12	14	15	15	15	15	15
West	3	5	7	9	11	13	15	15	17	19	20	21	22
East	1	2	3	4	5	6	7	8	9	9	10	11	12
	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**
South	354	510	676	851	1035	1231	1436	1654	1883	2124	2378	2662	2981
North	147	302	467	641	825	850	1051	1263	1393	1435	1478	1522	1568
West	155	267	385	509	641	780	928	955	1115	1284	1392	1509	1636
East	40	83	129	177	228	281	338	398	461	475	543	621	710
Total	**696**	**1162**	**1656**	**2178**	**2729**	**3142**	**3753**	**4269**	**4852**	**5317**	**5791**	**6314**	**6894**
Penetration %	2.95	4.78	6.6	8.43	10.3	11.5	13.3	14.7	16.2	17.2	18.23	19.32	20.48

Chapter 7. Industries

7.1 Introduction

Hot water and steam are used in a variety of industries. Some of the important segments are:

- Textile
- Dairy
- Drug and pharmaceuticals
- Pulp and paper
- Food processing
- Electroplating
- Fertilizer
- Leather

In addition, most of the organized small, medium and large industries have canteens, which also require hot water.

The potential applications of SWH in the industries are:

- Pre-heating of boiler feed water: In this application, either full or part of the boiler feed water is heated in solar water heaters to a temperature of 60-80^{o}C before being supplied to the boiler. This replaces part of the fuel used in the boiler. In general, maximum fuel savings possible are of the order of 5%. From the point of integration with the existing process, this is simple to implement. The economics of this option becomes favourable when petroleum fuels are being used. The pay-back period after considering depreciation and subsidy benefits for a furnace oil based industry is reported to be around 3 years, while for a coal using industry, the pay-back period is around 5-6 years.[23]

- Heating of process hot water: There are several industrial processes e.g. electroplating, textile dyeing, cleaning/degreasing, drying, etc. which require hot water below 100^{o}C. In these applications, solar water heater in conjunction with a conventional water heating system can be used. In such cases, the fuel savings are much larger, but the system integration generally is more complex. The economics of this option becomes favourable when petroleum fuel or electricity is being used.

[23] CII. Case-study booklet on Renewable Energy. 2009

- Canteen applications: Industrial canteens exist in most of the organized small, medium and large industries. Hot water is required for both cooking as well as washing of utensils, hands etc.

7.2 Textile Industry

Textile is one of the largest industries in the country. The total production of cloth in the country was 49871 million m^2 in 2007-08 [24]. The industry is growing at a rate of around 5% annually. Major part of the steam requirement in a textile industry is in the chemical processing department. In chemical processing, the grey cloth is given various chemical treatments to make it acceptable for the ultimate end use. Some of the chemical processes are scouring, bleaching, dyeing, mercerizing, printing, curing etc. The steam consumption depends on a large number of factors – main being – choice of process and machines and type of cloth. In this study we have taken typical steam requirement as 20 kg of steam/kg of cloth.

A list of important textile clusters in India is provided in Table 7.1

Table 7.1: List of important textile clusters for exploring potential of SWH

Textile Cluster	**Products**
Panipat	Bed covers, towels, shawls, durries, blankets,etc.
Coimbatore	Textiles
Tiruppur	Knitted garments
Salem	Garments
Ludhiana	Knitted garments
Ahmedabad	Woven garments
Surat	Textiles
Bhilwara	Textiles
Sanganer (Jaipur)	Dying and Printing
Okhala (Delhi)	Woven garments
Noida (UP)	Woven garments
Bangalore	Woven garments
Mumbai	Woven garments
Jabalpur (MP)	Woven garments
Kanpur	Knitted garmenst

During the field survey, some textile units located at Ludhiana, Ahmedabad, Gurgaon were visited. One of the most important barriers in deployment of solar water heaters in textile industry is use of low-cost solid fuels like biomass and coal which results in

[24] NCAER. Assessing the prospects for India's Textile and Clothing Sector. July 2009.

longer pay-back periods for SWH. A large number of textile dyeing units come under unorganized and small-scale sector and availability of adequate space is also an issue for installing SWH systems. Interaction with dyeing industry revealed that at this point of time their main concern is in meeting water pollution norms and in setting-up of common effluent treatment plants; also several of the industries have already gone for energy conservation measures such as condensate recovery, which has reduced the scope for pre-heating of boiler feed water using SWH.

7.3 Dairy Industry

India is the largest producer of milk in the world. The milk production in the country was estimated at around 94.5 million MT in 2005[25], the milk production is expected to grow to 120 million MT by 2012. The milk production in the country is growing at a rate of around 4% per year. In 1995, only 17% of the total milk produced is processed in the formal dairy sector, this is expected to go up to 36% in 2012. There are around 700 milk processing plants in the formal dairy sector. Cooperative dairy federations account for almost 60% of the milk processing in the formal dairy sector, processing around 10 million MT of milk per year in 2005. Among private players, Nestle India, Hindustan Lever Ltd. and Britannia are some of the important players. Table 7.2 provides the details of state-wise milk processing capacity in the cooperative sector. Thermal energy is used for various processes e.g. pasteurization, washing etc. Typical thermal energy consumption in dairies is given in Table 7.3. Specific thermal energy depends on the product-mix as well as the process and machinery used. SWH are used for pre-heating boiler feed water or for generating hot water that is directly used for cleaning and other process applications. A case study on SWH use in a dairy is provided in box 7.1.

[25] The Babcock Institute. Dairy Industry in India. 2007

Box 7.1 SWH System at Panchmahal Dairy, Godhara

A Solar Water Heating System of capacity 20000 Lits/Day has been installed and commissioned at Panchmahal Dairy Godhara .

This system produces 20000 liters of hot water at 80-degree centi. Temperature.

Hot water produced by Solar System is used as pre heated boiler feed water and helps to save about 110 lit of furnace oil per day.

The system consist of 236 Nos. of Solar Flat Plate Collectors, and insulated tank of 20000 lit capacity for storage of hot water. Controls are provided for automatic functioning of the system. Necessary instruments are provided for regular monitoring of the system.

Source: Gujarat Energy Development Agency

Table 7.2: State-wise milk processing capacity in the cooperative sector

State	No.of Plants	Milk processing capacity
		LPD
Gujarat	19	6595000
Maharashtra	29	3820000
Andhra Pradesh	12	2437000
Bihar	10	720000
Haryana	5	470000
Karnataka	15	2130000
Kerala	9	900000
Punjab	9	1525000
MP	5	1030000
Orissa	5	135000
UP	16	1680000
Rajasthan	15	1425000
West Bengal	5	1510000
Tamil Nadu	15	2700000
Himachal Pradesh	3	30000
Total	**172**	**27107000**

Source: The Babcock Institute. Dairy Industry in India. 2007

Table 7.3: Typical Specific Thermal Energy Consumption

Dairy	Specific thermal energy (kcal/Ton)
Dairy A, Surat	40000
Dairy B, Nagpur	83000
Dairy C, Maharashtra	57000
Average	**60000**

Source: Information on energy conservation award winning dairies, available on Bureau of Energy Efficiency web-site www.bee-india.nic.in

7.4 Pharmaceutical and Drugs

During the primary survey, some pharmaceutical and drug companies located at Hyderabad were visited. Some of them were using SWH for pre-heating boiler feed water. One such case-study is given in box 7.2. A list of important pharmaceutical and drug clusters is provided in table 7.4.

Table 7.4: Pharmaceutical and Drug Clusters in India

Cluster	Product
Delhi	Pharmaceuticals
Ahmedabad	Pharmaceuticals
Mumbai, Thane and Belapur	Basic drugs
Hyderabad	Drugs

Box 7.2: Synthokem Labs Pvt. Ltd., Hyderabad

This is one of the few examples where an Industrial user has chosen solar water heaters for economical reasons and successfully implemented it in their production process. Their factory which used to be in an industrial estate is now part of a residential area as Hyderabad city has expanded. Being in a residential zone there are restrictions on fuels with high particle content. So they use furnace oil for boilers, which they found to be too expensive and highly volatile. As the price of furnace oil rose in mid 2000, the company started to look at ways to cut on fuel costs. With the help of consultants they concluded it was worth trying solar water heaters to pre heat the water fed into the boiler to reduce the furnace oil consumption in the boiler. With a 10,000 litre system they found they could raise the water temperature by 30 ^{o}C thereby reducing the energy cost by 16%. They believe the payback is around 2 years if the solar water heaters are reducing furnace oil consumption. Now they have become passionate advocates of solar water heaters and offer advice and support to other factories.

7.5 Electroplating

Electroplating is one of the varieties of several techniques of metal finishing. It is a technique of deposition of a fine layer of one metal on another through electrolytic process to impart various properties and attributes, such as corrosion protection, enhanced surface hardness, luster, colour, aesthetics, value addition etc. Electroplating operations are either performed as a part of manufacturing process by large scale manufacturing plants (e.g. automobile, cycle, engineering and numerous other industries) or performed as job-work for a wide variety of components by small and tiny units. These are spread across the entire country. However certain states have large number of units concentrated in some towns / cities. The list of clusters is given in table 7.5.

Table 7.5: List of Important Electroplating Clusters

Maharashtra	Mumba, Pune, Nashik
Karnataka	Bangalore
Tamil Nadu	Chennai, Madurai
Andhra Pradesh	Hyderabad
Punjab	Ludhiana
Delhi & NCR	Faridabad, Haryana, Okhla, Manesar
Gujarat	Ahmedabad and Rajkot

During the field survey, Kangaroo Industries, Ludhiana was visited. The company is the market leader in office equipments and products and has more that 100000 LPD of solar water heater installations at its factories at Ludhiana and Nalagarh (HP). Over last few years, the company has progressively added more capacity of SWH. It was interesting to note that none of the other electroplating industries in Ludhiana, which happens to be a large cluster of electroplating industry, is using SWH. The experience indicates that in several industries, integration of SWH with the existing process is a major issue. In general, this knowledge does not exist with the SWH manufacturers/suppliers and they have to rely completely on the knowledge of the sector experts or technical manpower in the industry to design and implement a SWH system.

7.6 Food Processing Industries

The food processing sector is highly fragmented industry, it widely comprises of the following sub-segments: fruits and vegetables, beer and alcoholic beverages, meat and poultry, marine products, grain processing, packaged or convenience food and packaged drinks. A huge number of entrepreneurs in this industry are small in terms of their production and operations, and are largely concentrated in the unorganized segment. Several of the food processing units require hot water or steam for

processing. One of the strategies for targeting SWH growth in food processing industry could be to focus on food parks which are being set-up at various locations in the country. A food park provides common infrastructure to food processing industries and has a large concentration of such industries. A list of food parks approved by Ministry of Food Processing Industries is provided in table 7.6

Table 7.6: List of Food Parks

Ministry of Food Processing Industries				
STATEMENT OF FOOD PARKS APROVED FOR FINANCIAL ASSISTANCE				
S.No	**State**	**Location of the Project**	**Implementing Agency**	**Year Approval**
1	**2**	**3**	**4**	**5**
1	Andhra Pradesh	Kuppam, Dist - Chittor	Andhra Pradesh Industrial Infrastructure corporation Ltd	2000-01
2	Assam	Chaygaon, Distt, Kamrup	Assam small Industries Development Corporation Ltd.	2000-01
3	Bihar	Hajipur, District Vaishali	North Bihar Ind Area Dev, Authority, C/o Department of Industries	2002-03
4	Chhatisgarh	Vill-Teadesara, Dist-Rajnandgaon	Chhatisgarh State Industrial Development Corporation	2001-02
5	Haryana	Saha, Dist. Ambala	Haryana State Ind. Dev. Corporation Ltd.	2001-02
6	Haryana	Raj, Dist-Sonipat	Haryana State Ind. Dev. Corporation Ltd.	2001-02
7	Jammu & Kashmir	Khumoh, Distt-Srinagar	J&K State Industrial Development Corporation Ltd.	2000-01
8	Jammu & Kashmir	Sopore, Baramulia	J&K State Industrial Development Corporation Ltd. (J&K SIDCO)	2002-03
9	Jammu & Kashmir	Jammu	Jammu Agro Industrial food Park,	2001-02
10	Karnataka	Malur, Distt-Kolar,	M/S Innova Agri-Bio Park Ltd.	2000-01
11	Karnataka	bagalkot	M/S Green Food Park Limited	2000-01
12	Karnataka	Jevargi	M/S Jewargi Agro Food Park	2002-03
13	Karnataka	Hirriyur	M/S Akshya Food park Limited	2006-07

14	Kerala	Distt. Mallapuram	Kerala industrial Infrastructure Development Corporation	1996-97
15	Kerala	Aroor, Distt-Alappuzha,	Marine Products infrastructure Development Corporation P. Ltd. 9MIDCON)/Seafood Park India Ltd.	2001-02
16	Kerala	Mazhuvannur, Ernakulam	Kerala industrial Infrastructure Development Corporation (KINFRA)	2002-03
17	Kerala	Adoor	Kerala industrial Infrastructure Development Corporation (KINFRA)	2005-06
18	Madhya Pradesh	Jaggakhedi, Distt-Mandsaur,	Madhya Pradesh Audyogic Kendrra Vikas Nigam (Indore) Ltd.	2000-01
19	Madhya Pradesh	Nimrani, Dist, Khargone,	Madhya Pradesh Audyogic Kendrra Vikas Nigam (Indore) Ltd.	2001-02
20	Madhya Pradesh	Piparia Babai, Distt Hoshangabad	Madhya Pradesh Audyogic Kendrra Vikas Nigam (Indore) Ltd.	2001-02
21	Madhya Pradesh	Borgaon, Distt. Chhindwara	M.P.Audyogik Kendra, Vikas Nigam (Jabalpur) Ltd.	2001-02
22	Madhya Pradesh	Malan[pur, Ghirongi, Distict Bhind (M.P)	M.P.Audyogik Kendra, Vikas Nigam (Gwalior) Ltd.	2002-03
23	Madhya Pradesh	Maneri, Distt. Mandla	M.P.Audyogik Kendra, Vikas Nigam (Jabalpur) Ltd.	2002-03
24	Maharashtra	Butibori, Distt. Nagpur,	Maharashtra Agro Industries Development Corporation Ltd.	200-01
25	Maharashtra	Vinchur, Distt, Nashik	Maharashtra Industrial Development Corporation	2001-02
26	Maharashtra	Mouza Gumthala, Bhandara Road, Dist. Nagpur.	M/S Haldiram Krishi Udyog Pvt. Ltd. Dist. Nagpur.	2002-03
27	Maharashtra	Village Sangvi, Distt. Satara	M/S Agrifood Informatics (India) Ltd, Pune- 411013	2002-03
28	Maharashtra	Palus, Distt-Sangli	Maharashtra Industrial Development Corporation	2003-04
29	Maharashtra	Kapsi, Taluka Kamtee, Distt. Nagpur	M/S Maa Umiya Audyogic Sahakari Vasahat Maryadit	2005-06

30	Maharashtra	MIDC Industrial Area, Shendra, Aurangbad	M/S Laxmi Nirmal Pratisthan	2006-07
31	Manipur	Lamphelpat, Imphal	Manipur Food industries Corporation Ltd.	2001-01
32	Manipur	Distt-Ukhrul	Rishang Keishing Foundation for Management of tribal Areas	20014-02
33	Mizoram	Chhingchip,	Mizoram Food and Allied Industries	2001-02
34	Nagaland	Bamunpukri, Dimapur	Progressive Rural Development Society	2006-07
35	Orissa	Khurda	Orissa indl. Infrastructure Development Corporation	2001-02
36	Punjab	Sirhind, Distt, Fatehgarh Sahib	Punjab Agri Export Corporation	2000-01
37	Rajasthan	Ranpur, Distt. Kota.	Rajasthan state Industrial Development & Investment Corporation ltd. (RIICO)	2002-03
38	Rajasthan	Boranada, District-Jodhpur	Rajastha State Industrial Development & Investment Corporation Ltd. (RIICO),	2002-03
39	Rajasthan	Sri Ganganagar	Rajastha State Industrial Development & Investment Corporation Ltd. (RIICO),	2003-04
40	Rajasthan	Alwar	Rajastha State Industrial Development & Investment Corporation Ltd. (RIICO),	2006-07
41	Tamilnadu	Virudhunagar, Distt. Madurai	V.P.S. Ayyemperumal Nadar & sons.	2000-01
42	Tamilnadu	Dindigul District	Nilakottai Food Park Ltd.	2004-05
43	Tripura	Bodhjungnagar, west Tripura	Tripura Industrial Development Corporation Ltd.	2000-01
44	Uttar Pradesh	Ghaziabad	Wise Industrial Park Ltd.	1999-00
45	Uttar Pradesh	Kharkion, Distt.-Varanasi	U.P State Industrial Development Corporation Ltd.	2000-01
46	Uttar Pradesh	Shahajanwa, gorakhpur	Gorakhpur Industrial Dev. Authority.	2004-05
47	Uttar Pradesh	Village Kushalipur, District Saharanpur	M/S Kushal International Limited.	2002-03

48	Uttar Pradesh	Kursi Road, Distt.-Barabanki	U.P State Industrial Development Corporation Ltd.	2000-01
49	West Bengal	Chakgaria, 24 Parganas (South)	State Fishermen's Cooperative Ltd. (BENFISH), Kolkata	1998-99
50	West Bengal	Dankuni, Distt. Hooghly	Modular Consultants Pvt. Ltd.	1996-97
51	West Bengal	Haldia District Midnapore.	Haldia Development Authority, Haldia,	2002-03
52	West Bengal	Sultanpur, South 24 Parganas	State Fishermen's Cooperative Ltd. (BENFISH), Kolkata	2003-04
53	West Bengal	Malda	Deptt. Of Food Processing Industries and Horticulture, Govt. of West Bengal.	2003-04
54	West Bengal	Shankarapur, Dist. Purba Medinipur	Department of Fisheries, Aquaculture, Aquatic Resources, Govt. of West Bengal,	2004-05
55	West Bengal	Sankhrail, Howrah	West Bengal Industrial Development Corporation (WBIDC)	2004-05
56	West Bengal	Murshidabad	M/S Pataka Industries Limited	2005-06

Source: http://mofpi.nic.in accessed on 22 December 2009

7.7 Projection of Demand of SWH in Industries

The projection of demand of SWH in industries has been done industry sector wise using the following methodology:

a. Estimating the total production for 2009 and subsequently till 2022.
b. Taking a norm for specific thermal energy consumption or steam consumption based on information collected from the industry.
c. Calculation of steam consumption per year.
d. Calculation of maximum SWH potential by assuming that SWH can provide 5% of the heating requirement for producing steam. Considering the fact the industries using coal and biomass the pay-back period for SWH is long (5-8 years) and hence the potential for acceptance is very low (please refer to pay-back acceptance schedule in figure 7.1)[26], these have not been considered and the potential has been calculated only for industries using petroleum fuels.

[26] Pillai I.R., Banerjee, R., 2007. Methodology for estimation of potential for solar water heating in a target area. Solar Energy 81 , 162-172.

e. Using progressively increasing penetration rate of SWH to calculate the cumulative SWH installations

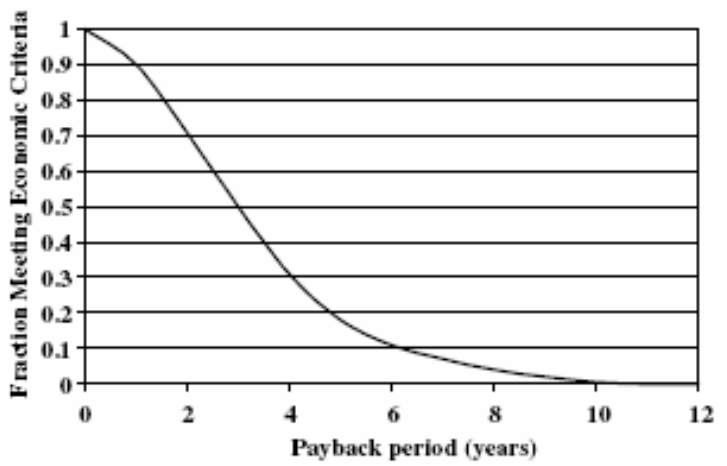


Figure 7.1: Payback acceptance schedule[25]

The projected demand for SWH in industries is shown in figure 7.2 and table 7.7. The cumulative SWH area for industrial applications is expected to grow to 1.05 million m^2 by 2022. It is expected that dairy and textile would provide around 70 % of the new demand; the rest of the demand would be by other industries and industrial canteens.

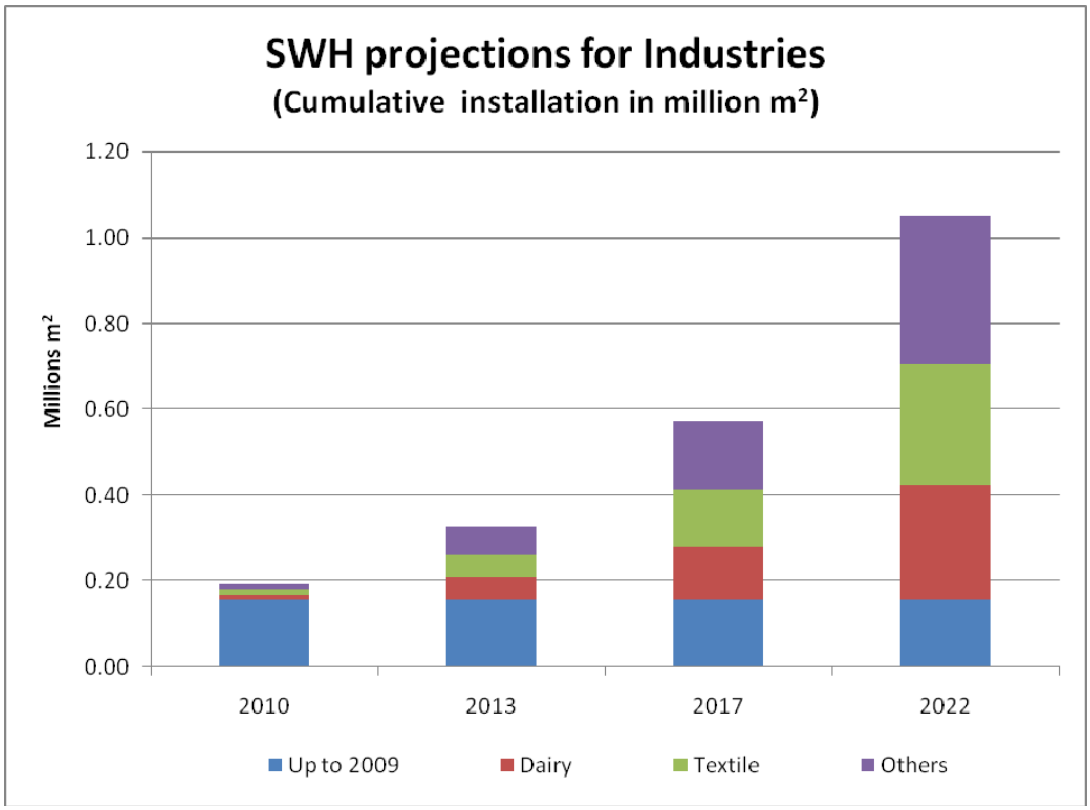


Figure 7.2: Year wise cumulative SWH projection for Industries

Table 7.7: Year wise cumulative SWH projection for Industries in m^2

Year	Up to 2009	Dairy	Textile	Others	TOTAL
2010	158,000	10,806	11,519	13,975	194,300
2013	158,000	50,150	53,462	64,856	326,468
2017	158,000	123,575	131,735	159,812	573,123
2022	158,000	264,991	282,489	342,695	1,048,174

7.8 Conclusions

The projections done for industries should be seen as preliminary assessment. Given the complexity of issues involved and no mandatory provisions for the sector, it is necessary to conduct detailed studies of individual sectors (even clusters) and have interactions with industry bodies and concerned government departments e.g. agencies running the industrial energy efficiency programme (BEE) and Industry Departments/Ministries to come up with sector specific strategies. Advent of ESCOs has the potential to open-up this sector. If we consider the Low Pressure Steam requirements, industries offer a huge potential, and from that point of view MNRE should take a combined view of solar thermal applications in industries taking all solar thermal technologies i.e. FPC, ETC and solar concentrators together.

Chapter 8. Rural Sector

Hot water requirement in rural areas is mainly for following sectors/segments:

- Households
- Primary health centers
- Hostels
- *Dhabas*
- Rural industries: micro, small and informal industries located in rural areas e.g. silk reeling, puffed-rice, rice mills, textile dyeing, dairy, fruit and vegetable processing, etc.

8.1 Hot water consuming segments

Residential Sector

Biomass is the main fuel for heating water in rural areas of the country. Very little information is available on hot water use and energy used for heating water in rural areas of India. Most of the studies on household energy in rural areas do not provide break-up of energy use for cooking and water heating separately, the main reason being that the same device i.e. cook stove is used for both the end-uses.

The highest requirement of hot water in rural households is in the cold region of the country, which essentially consists of the Himalayan states.

- A study in Ladakh has found actual hot water consumption in rural household to vary between 15 litres to 110 litres per day[27]. The large variation in the amount of hot water consumed depends on the fuel availability and economic status of the family.

- Another study in Kandaghat block of Shimla district[28], found that on an average a household, consumed about 50 liters of hot water per day during winter months. Hot water is mainly required for bathing, washing of clothes and for cleaning of utensils. The study further estimated that a household

[27] TERI. Renewable Energy Master Plan for Ladakh. 1998

[28] R Prasad , S Maithel and A Mirza. Solar Water Heaters for Rural Communities in Indian Himalayas – Experiences from a Pilot Project in Himachal Pradesh. Eds.R L Sawhney , D Buddhi and R P Gautam . Renewable Energies and Energy Efficiency for Sustainable Development, Proceedings of the 23rd National Energy Convention ' 99, Indore, December 20-22, 1999.

consumed about 720 kg of firewood per year for water heating, which is about 15 % of the total annual firewood consumption.

- The use of hot water is also high in the hilly areas of Western Ghats. A study on fuel use in rural households in Uttar Kannada district of Karnataka reported a high consumption of 1.7 kg/capita/day of biomass for water heating [29].

Primary Health Centres

Primary health centres and their sub-centres meet the health care needs of rural population. Each PHC covers a population of 1,00,000 and is spread over about 100 villages. It has 4 - 6 beds for patients. The activities of Primary Health Centres involve curative, preventive, primitive and Family Welfare Services. There are 23236 PHCs functioning as on September 2005 in the country[30]. Each PHC is estimated to have hot water requirement in the range of 100 – 200 lpd.

Hostels

A large number of hostels attached to schools run by Government e.g. Ministry of Tribal Affairs as well as by a variety of NGOs exists. Hot water requirement is for cooking as well as bathing.

Dhabas

A large number of *dhabas* (mostly in rural areas) exist on the highways. Hot water is required for cooking as well as for cleaning of utensils.

Rural Industries

There are several rural industries that require hot water. Some of these are:

a. Silk reeling: Hot water is required for reeling operation. There are estimated to be around 60,000 silk reeling ovens in the country[31].

b. Textile dyeing: Hot water is required for dyeing operation. There are several rural clusters engaged in textile/ yarn dyeing and fabric printing.

[29] T. V. Ramachandra, D. K. Subramanian, N. V. Joshi, S. V. Gunaga and R. B. Harikantra. Domestic energy consumption patterns in Uttara Kannada District, Karnataka State, India. Energy Conversion and Management Volume 41, Issue 8, May 2000, Pages 775-831.

[30] http://india.gov.in/citizen/health/primary_health.php

[31] Mande S and Kishore VVN. Towards Cleaner Technologies: A process Story on Biomass Gasifier for Heat applications in small and micro enterprises. TERI. 2007

c. Puffed rice making and rice flake making: Hot water is required for soaking paddy during puffed rice and rice flake making operations. There are estimated to be 50,000 puffed-rice making units[32] and around 500 rice flake making units, most of them are located in villages or small towns.

d. Rice mills: Hot water is required for soaking paddy.

e. Dairy – milk collection centers: Hot water is required for cleaning of drums and vessels. It estimated that around 80,000 villages are engaged in production of milk for the organized dairy sector.

8.2 Barriers in Use of SWH

At present, use of SWH in rural areas is very limited. During the primary survey, some instances of use of conventional SWH was found in high-income rural households in parts of Karnataka, Kerala, Punjab, Himachal Pradesh and Uttarakhand. The main barriers in use of conventional SWH systems in rural areas are:

- High initial cost of the system
- Longer pay-back period as the fuel replaced is low-cost biomass fuel
- Lack of piped water supply
- Absence of SWH supply chain
- Difficulty in installing conventional SWH systems on sloping roofs made of metal sheets, thatch, etc.

During the literature survey and primary survey some instances of innovations were observed. These include:

- Collector and storage type SWH in Ladakh
- Community solar water heaters in Himachal Pradesh

Box 8.1 Collector and Storage Type SWH in Ladakh

One of the potential technologies which should have a good potential in rural areas is a low cost collector cum storage SWH. This type of systems have been found to be very useful in Ladakh. These solar water heaters consist 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 has a capacity of 30 liters and has 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. One of the local NGO was involved in manufacturing and installations of these systems.

(Source: Renewable Energy Master Plan for Ladakh. TERI /MNRE. 1998)

[32] Srinivas S N . Design and Development of 25 kW Integrated Wood Gasifier System for Production of Puffed Rice. Ph D Thesis. B.V. Bhoomaraddi College of Engineering and Technology Hubli. 2009

Box 8.2 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)

8.3 SWH strategy for rural areas

A two-pronged strategy is suggested for rural areas:

- Technology innovation to develop low-cost appropriate products to meet requirements of different rural applications is a must for opening up this potentially large market for solar water heaters. Here an example of water purifier industry is useful, where product innovation has resulted in opening-up of a large market for water purifiers in rural and small town segment (Box 8.3)

The UNDP/GEF project may initiate work to understand in much greater detail:

- The demand for hot water in rural areas (quantity, time of the day, application)
- The issues in installation of SWH in rural houses.
- The economics of the present water heating practices.

Such a study would then lead the way for suitable SWH product identification /development.

- In parallel, a demonstration programme can be launched to install more SWH systems in *dhabas*, PHCs, hostels and community SWHs. Monitoring should be an integral part of the programme so that necessary data can be collected to establish feasibility of SWH technology.

Box 8.3: Water Purification Market

Product, Technology, Pricing and Distribution Innovations

Introduction in 1980's: Zero B meant to derive clean tap water. No electricity required.

Game-changer: UV-based purifiers in late 1980's. market dominated by two large players. UV held sway over the market for a decade.

Upscaled Product: RO purifiers. Several consumer durable companies entered business.

Problem-Solution Product: RO price averages Rs. 16000. UV price-band is Rs. 7000 to 8000. 80% of Indian households cannot afford either. So, chemical purifiers priced in Rs. 1000 – 2000 band entered the market. Neither electricity nor continuous water- supply required for chemical purifiers. 20% of water purifiers in use are now low- priced chemical purifiers, whose sale is driven by two large Indian companies.

Bottom of The Pyramid Product

To be launched soon by a top Indian company. A rice-husk based bulb, to be priced at Rs. 299 and to be sold through grocery-shops. No after-sale support. Can purify 3000 ltrs (annual requirement). The value proposition moves away from consumer durable to Rs. 1 per day for water-purification and outgo of Rs. 299 per year. customer risk vastly cut.

Market Growth

In 2008, 5.2 million or 2.6% of households in India used water purifiers; thanks to product- innovation. The chemical purifiers, in physical terms, are expected, to outpace UV/Ro market growth. The overall market is growing @ 25% in rupee terms. If Rs. 299 product works out, industry expects exponential growth. There is intense competition among six large players.

Chapter 9. Conclusions

9.1 SWH Global Market

In 2008, the cumulative SWH capacity was 15 GWth. Growth in recent years has been 15% per year. There are estimated 40 million households (2.5% of the total) which were using SWH worldwide in 2004.

China is the leader; 10% of Chinese households use SWH; the target for 2020 being 30%. In 2008, 65.6% of existing global SWH capacity was in China; followed by European Union (12.3%), Turkey (5.8%), Japan (4.1%) and Israel (2.8%). The Indian share was 1.2%.

The residential sector is the mainstay of SWH in the two largest SWH markets; 98% of annual sale in China and 90% of installed capacity in Europe is in the residential sector. The market is urban-centric; 90% of installations in China are in urban areas. While households-level SWH in Europe are installed predominantly in independent houses, it is both-independent houses and multi-storied buildings-in China.

9.2 Indian Market

The segment-wise statistics on Indian market are not available. Based on our work, we have pieced together the following picture.

Estimated Breakup: Functional SWH Installations Till 2009

Sector	**million m^2**
Residential (80%)	2.108
Hotels (6%)	0.158
Hospitals (3%)	0.079
Industry (6%)	0.158
Other (Railway + Defence + Hostel + Religious places, other) (5%)	0.132
Total	**2.635**

* It is assumed that 85% of the installed SWH are functional

The sale during 2009 is estimated at 0.55 million m^2. The CAGR of cumulative installation during 1995-2000 was 8.23%. It spurted to 20.6% during 2000-04 and further to 24.6% during 2004-08, denoting overall CAGR of 16.8% over 1995-2008. The following explains demand upsurge in recent years.

- Growth in new urban housing; rising disposable income; increased propensity for consumer durables
- Arrival of ETC & improvements in supply chain
- Energy price hike
- Policy initiatives

9.3 Primary Survey: Key Findings

In the residential sector, there are 0.7 million SWH user households; 65% of which are concentrated in Karnataka and Maharasthra. There is overall satisfaction with product- experience; some concern being voiced over after-sale support. The use of SWH-water is mainly for bathing. The average size of the domestic installations that were surveyed is around 150 lpd. Among non-users, in states other than Karnataka/Maharashtra, there is sketchy awareness of the bare concept of SWH. The customers perceive it as a product suited for independent houses and not so much for apartment buildings. Hot water demand expressed though months/year and supply chains are important demand drivers. The high demand regions report hot water demand for ≥ 9 months/year, while the lower end is 4 months/year.

In the hotel sector, SWH experience exists across regions and hotel/guest-house standards. The provisioning recognizes year-round demand for hot water. The use of expensive petroleum fuels and electricity support the case for SWH. Roof availability, for 15 room upward capacity hotels, is not a significant barrier. However, capital cost is a major consideration. Among hospitals and hostels, awareness/exposure levels are low; compared to hotels. Supply hour management/regulation is a key advantage for both. Roof availability is not a noticeable constraint.

The SWH experience among industries is limited and scattered. Heating of boiler feed water is the major application. Some of the candidate industries –rice-mills, pulp and paper, tea-gardens, leather, textile processing-utilize biomass and coal; lengthening the payback period. It is industries utilizing oil-fired boilers-mainly dairy, fertilizer and sub-set of textile which are the prime markets for SWH. In addition, there are industrial canteens. The report enumerates geographical clusters, where SWH-relevant industries are concentrated.

In the rural sector, the households, dhabas, primary health-centers, hostels and village- industries (silk-reeling, textile-dyeing, puffed rice-making) are the main segments. The capital cost, recourse to biomass, lack of piped water supply, roof

design/strength and virtual absence of supply chain are the roadblocks. The report highlights a low-cost innovative product introduced in Ladakh and a community-level positive experience in Himachal Pradesh. The development of rural market warrants large, fresh work in terms of product-development, demonstration, policy and promotion of supply chain.

9.4 Industry Structure, Supply Conditions And Value Proposition

There are two technologies in vogue; flat plate collector and evacuated tube collector; the later has flourished on the strength of import of glass tubes from China. There are 113 approved Indian producers. The largest player market share is under 15%. The producers do not have nation-wide, SWH- specific brand equity. The dealer network is limited. The manufacturing is concentrated in southern India and Maharashtra. Barring ETC, there have not been any major product/technology breakthrough in last two decades. The system cost for a household varies from Rs. 20000 to Rs. 60000, depending on size and standard. It is positioned as an electricity-saving consumer durable. ESCO or pay-per-use models have not been attempted in a significant way.

9.5 Approach To Estimating Realizable Potential

The empirical data, over a period of time, in terms of SWH sale, its region-wise and segment-wise breakup and behaviour of relevant variations is not available. The present installations are concentrated in Karnataka and Maharashtra; compounding the inadequacy of data required for all-India model-building.

We were required to devote considerable effort to the task of estimating present and future stock of housing, hotel-rooms, hospital-beds, hostel-beds, etc. The establishment of hot water- consumption norms involved a probe into the applications and working out weighted average since norms vary across hotel/hospital categories.

We have identified the parameters driving demand and built three scenarios for demand projection-realistic or most likely; optimistic and pessimistic which are, both, considered less likely.

Our estimates in terms of SWH penetration and CAGR, for a given segment under the concerned scenario, recognizes the following.

- Historical trends and best-case (Karnataka) performance
- Assessment of potential based estimated growth for a given segment and its response to SWH; considering payback period prospect,
- Variations in SWH penetration vis-à-vis new and old buildings

9.6 SWH Potential Projection

Under realistic scenario, we estimate demand as follows (cumulative million m^2)[33].

	2010	**2013**	**2017**	**2022**
Residential	2.58	4.25	7.68	15.74
Commercial/Institutional				
• Hotels	0.19	0.35	0.61	0.97
• Hospitals	0.10	0.17	0.27	0.43
• Others	0.18	0.27	0.39	0.52
Industry	0.19	0.33	0.57	1.05
Total	**3.24**	**5.37**	**9.52**	**18.70**

Residential sector would remain the largest sector and would contribute to 84% of the cumulative installations.

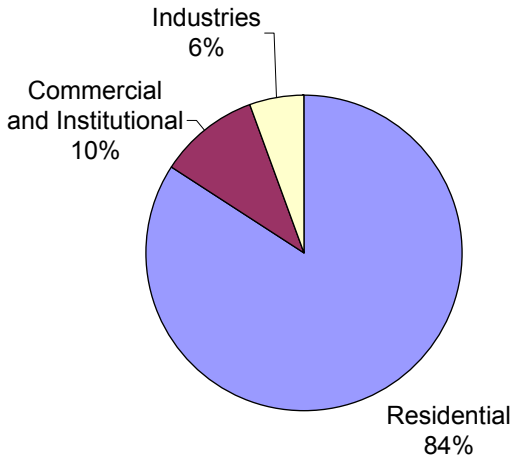


Figure 9.1: Percentage-share of sectors in SWH installations 2022

[33] 1 m^2 = 50 lpd

Under optimistic and pessimistic scenario, total demand is projected as follow (million m^2).

	Optimistic	**Pessimistic**
2010	3.41	3.22
2013	6.15	5.11
2017	11.63	8.16
2022	24.08	13.13

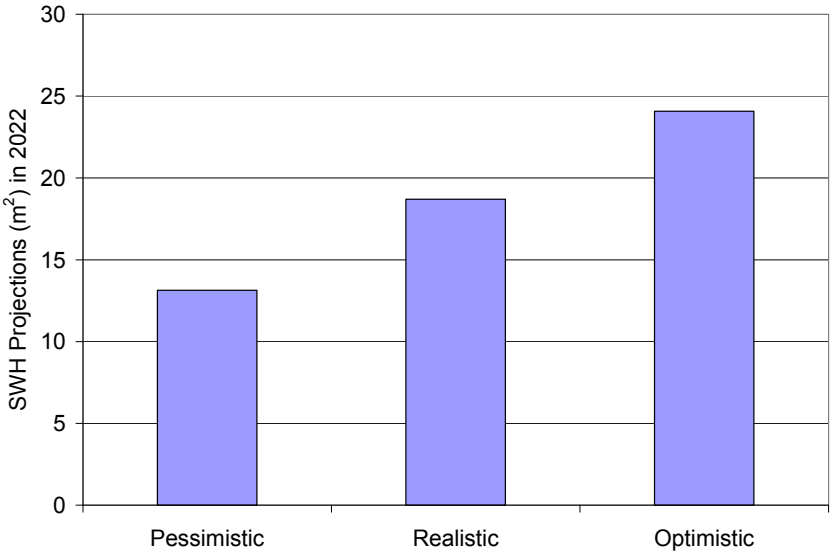


Figure 9.2: Comparison of projected SWH potential in 2022 for the 3 scenarios

The demand projection, under realistic scenario, implies SWH penetration in 1.78% of Indian households by 2022. In absolute terms, this is 5.25 million SWH-using households in 2022; for comparison there were 5.22 million water-purifier using households in India is 2008.

In the hotel and hospital segments, SWH penetration will reach 53% and 29% by 2022.

9.7 Spatial Distribution of Projected Demand

Five states will lead demand-expansion, as is evident from the following table.

Table.9.1: Five top states (cumulative SWH potential in million m^2 for 2022 under the realistic scenario)

State	Residential million m^2	Commercial/ Institutional million m^2	Total (Excluding Industrial) million m^2
Karnataka	3.72	0.16	3.88
Maharashtra	3.5	0.31	3.80
Tamil Nadu	1.53	0.14	1.67
Andhra Pradesh	1.08	0.09	1.17
Gujarat	0.90	0.06	0.96
%age of 5 states			**67.10%**

Further analysis of demand at the district level shows that a large part of the demand would come from selected urbanized districts. Some of the key districts (out of the 29 surveyed districts) which have large potential are listed in the table below:

Table.9.2: Selected districts with large SWH potential (cumulative SWH potential in million m^2 for 2022 under the realistic scenario)

District/Region	SWH potential (excluding industry) million m^2
Bangalore	1.94
Pune	1.11
National Capital Region	0.77
Thane	0.68
Hyderabad	0.58
Nagpur	0.38
Kolkata	0.36
Chennai	0.35
Coimbatore	0.33
Ahmedabad	0.29
Jaipur	0.27

9.8 Recommendations for Key Areas for Action

We have identified 10 key action points for MNRE and UNDP/GEF project. In our view these actions are important for realizing the potential of SWH in the country and achieving targets set under JNNSM. Please note that these do not follow any specific order of priority.

1. Select high-potential districts for implementation

The analysis presented in the report shows that the adoption of SWH depends primarily on the demand for hot water, regulations, SWH supply chain and paying capacity of the users. As presented in the previous section, a large part of the demand is concentrated in urban centres. Given this reality, MNRE should identify 10-20 districts and focus its attention on implementing SWH programme during the first phase of JNNSM (2010-2013) in these districts.

2. Implementation through Electricity Distribution Companies

There is a need to provide soft-term loan and, depending on the region and building vintage, a financial incentive to promote the market over next 5 to 8 years. Electricity distribution companies are the most appropriate vehicle to operate the package. The customer will appreciate readily the proposition of electricity-saving, rebate on electricity bill and outgo on account of SWH- purchase for a specified period because the company will make a single, consolidated proposal; smoothening all transactions. The distribution companies are also best equipped to operate compulsory installation policy for new buildings as well as old ones requiring extra power. They will build a clear database of installations, loan/rebate provided, SWH- performance and electricity saving. MNRE should set-up a working group to initiate a dialogue with Ministry of Power, Electricity Sector Regulators and Electricity Distribution Companies to develop a SWH programme of implementation through Electricity Distribution Companies by 2011.

3. Implementation-Oriented Mandatory Regulations

Mandatory regulations would remain a very important tool for developing market for SWH. Thus, it is imperative that the SWH mandatory regulations addresses the essential legal, administrative and technical issues and outlines the implementation mechanism. Prioritization and phasing might help, e.g., the policy may focus on new buildings above a cut-off point and limit itself to selected cities initially; extending the target-constituency and city-list over time. MNRE should initiate work with selected (3-5) municipal corporations and state governments having prior experience in implementing SWH mandatory regulations to update the regulations and develop a fool-proof strategy for its implementation.

4. Strategy for Multi-storied Buildings

Given the shift towards multi-storey residential buildings, addressing water heating in multi-storey residential buildings through solar water heaters would be the key to realize potential in residential sector. A package of mandatory regulations, techno-managerial solutions, working models and best practices and incentives is essential for multi-storied buildings. Existing buildings will warrant special incentive. MNRE may set-up a task force to study the issues and for developing a comprehensive strategy for multi-storey residential buildings.

5. Targeted and Variable Incentives Package

The payback period in respect of SWH varies across regions. It is not practical to stipulate compulsory SWH-installation for old buildings. The incentive package needs to address regional and vintage differences. MNRE should develop targeted and variable incentive packages that takes into account the specific requirements of different regions, sectors and vintage of builings.

6. Rural Market Development

Rural market particularly in the cold region may offer large potential. In the report we have indicated the barriers and successful experiences. MNRE should work out a blue print for the development of appropriate products, supply chains and a policy package focused on developing rural market for SWH.

7. Strategy to strengthen SWH Supply Chain

We have already elucidated the problem-areas. MNRE needs to work on a package of fiscal/monetary/subsidy policy to promote industry- consolidation, product/technology development appropriate to low/middle-income group market, visible and extensive distribution network, quality-standards and rating. It will help if the industry, on its part, works out a collective vision and strategy for realizing market-volume projected under the report. For example the industry and government can work together to constitute a fund of the order of around 5% of the annual turnover of the industry to be used for advertising and promotion.

8. Developing a database of SWH installations

Presently, there is no system for collecting information of SWH market and installations. Unavailability of this data was one of the main hurdles faced by the project team. MNRE should consider giving this responsibility to an independent organisation to develop and maintain a data-base of SWH manufacturing, sales and installations.

9. Sector and Region Specific Market Assessment Studies

The present study should be seen as the first attempt to gain an understanding of the Solar Water Heating market. As indicated in the report there are several sectors which require more in-depth market assessment studies, two such sectors are industry and rural sector. Amongst regions, cold region perhaps requires a detailed study. There is also a need to continue updating market assessment every alternate year.

10. Promoting Energy Service Company (ESCO) based models

For setting-up large SWH installations in commercial buildings, industries and large residential developments , ESCO approach has the potential to become the most preferred implementation arrangement. MNRE should develop an action plan to develop feasible ESCO models and create conducive environment for development of sustainable SWH ESCO businesses.

Annexure I: District Reports

1. Agra

Profile: Agra is one of the major districts of Uttar Pradesh spreading over 4027 km^2 of land. As per census of 2001, the population of the district was 3,620,436 with an urban share of 43.3%. Average annual growth in population for 1991-2001 was 3.5%. As per census 2001, total numbers of households were 544,463 with an average household size of 7. Primarily the economy of the Agra district is agriculture based while the economy of Agra city depends on tourism, small scale industries, commerce and trade. Agra city is famous for the leather goods, handicrafts, zari zardozi, marble and stone carving & inlay work, sweets and snacks.

SWH Scenario: Agra falls under composite climate and receives good solar radiation (5.6 kWh/m^2/day). Almost, 85.5% of the households are of permanent construction. Agra Municipal Corporation has adopted the SWH regulations as per the MNRE guidelines.

- ***Residential***: Hot water is required for 4-5 months in a year, out of which around 15-20 days remains cloudy/rainy when the backup is needed. The current market penetration of SWH in the district is very low (<0.1%). There are only 2 dealers in the district for SWH. A 100 lpd system with electric backup costs around Rs.20,000. Recently one of the private developer has provided SWH in a project (independent houses).

- ***Hotels*:** Agra being a tourist town has a large number of hotels. Hotel could be the biggest potential users of SWH as the hot water is required round the year and many hotels use diesel or furnace oil based boilers to get hot water. Less than 10 hotels have installed SWH. As a lot of hotels are old, there is an issue of retrofitting them with SWH.

- ***Hospitals and Hostels:*** No major installation in hospitals and hostels. Agra has a large number of educational institutes which can potentially be targeted for SWH. In one the hospitals, SWH system is installed but not working due to improper installation. This suggests that services need to be improved.

- ***Industries***: There are 4-5 dairies in the city but none has installed SWH. There is no SWH installation in the food processing and leather industry.

Summary of stakeholder interviews:

- **SNA**: State Govt. provides subsidy of Rs. 5000/6000 per domestic system. Also processes IREDA subsidy. Recently organized a solar expo which was visited by 50,000 visitors. Target for Agra for year 2009-10 is 40,000 lpd (200 systems x

200 lpd). SWH is made mandatory in Agra as done in other places but implementation is low key. Target for UP for year 2008-09 was 2,50,000 lpd.

- **Dealers**: Banks are not cooperative in processing soft loans. Gas geysers are available at a price of Rs.2,000-2,500 and hot water demand for 2-3 months can be met by spending ~Rs.300 in a year. This makes SWH economically not viable (payback >10 years). Very difficult to convince existing building owner for SWH installations due to retrofit and piping requirements. High capital cost is one of the major barriers for SWH installation. Lowering the initial cost by Rs.4,000-5,000 (for 100 LPD system) can significantly increase the sales.

- **Architects/Builders**: No subsidy is available to the builder, so they are not interested in SWH. There is an issue of electricity theft which de-motivates people to for energy saving appliance such as SWH. SNA is not cooperative in providing knowledge or subsidy for SWH. Piping costs for SWH are also significant, especially for a family which requires hot water at 4-5 bathrooms. In multi-storey apartments there could be control issues and individual may not be interested in sharing the facilities. Problems with monkeys who can damage the costly SWH system.

Agra

Very low-penetration rates for SWH, even the hotel sector has not been exploited. Weak supply chain. Target sectors: New residential construction, hotels, hospitals and hostels. Electricity shortage, low-rise construction favours SWH. Regulation on mandatory use of SWH in place, yet to be implemented efficiently.

Caselet: Mr. Anurag Jain, Dealer

Mr. Jain is a dealer of Kotak Urja for SWH and SHARP for PV based products. His main business is with Canon for photo copier and audio-visual products. He has a sales network in 13 districts in UP which he is utilizing for the sales of solar products. He started work 6 months back and has installed 1,500 LPD. Around 1,800 LPD SWH system installations are under process. Overall, he has done 20 installations and targeting for 100 during the year. At present, more demand is there in the Aligarh district.

1. Marketing approach:
   Meeting with NEDA, builders, architects
   Advertisement in newspapers and distributing leaflets
2. There is a lot of curiosity about the SWH but the conversion ratio is very low e.g. out of 500-600 enquiries only 1-2 go for installation.
3. There are few systems installed in the Govt. building which are not working due to inadequate maintenance.
4. SWH performance may not be adequate in the cloudy days of December month.

Getting loans from the banks is not easy. Also, the Govt. subsidy part is not clear.
5. Very difficult to convince existing building owner for SWH installations due to retrofit and piping requirements
6. High capital cost is one of the major barriers for SWH installation. Lowering the initial cost by Rs.4,000-5,000 (for 100 LPD system) can significantly increase the sales.

2. Ludhiana

Profile: Ludhiana is one of the major districts of Punjab spreading over 3767 km^2 of land. As per census of 2001, the population of the district was 3,032,831 with an urban share of 55.84%. Average annual growth in population for 1991-2001 was 3.26%. As per census 2001, total numbers of households were 558,650 with an average household size of 5. Ludhiana is one of the richest cities in India. The main industries are bicycle parts and hosiery.

SWH Scenario: Ludhiana falls under composite climate and receives good solar radiation (5.5 $kWh/m^2/day$). Almost, 93.1% of the households are of permanent construction. SWH installation is going to be mandatory as per MNRE guidelines. There is no state Govt. subsidy or rebate in electricity tariff for SWH.

- ***Residential*:** Hot water is required for 4-6 months in a year, out of which around 20-25 days remains cloudy/rainy when the backup is needed. Market penetration of SWH in the district is very low (<0.1%). There are 2 national brand dealers, 1 assembler and 4-5 other brand dealers in the district. The typical installation in the residential sector is 300 lpd system with electric backup, which costs Rs.50,000-75,000 depending on configuration (pressurized, indirect heating, etc). SWH are becoming popular in large independent houses. SWH dealers are trying to systematically target new large independent houses through architects, plumbers as well as direct promotion. There are 20-30 systems in nearby villages, most of these are installed by NRI families.

- ***Hotels:*** Total of around 75000 -100000 lpd installation in hotels. Most of the prominent hotels are having SWH installation.

- ***Hospitals:*** There are two large installations in hospitals, some other hospitals are seriously considering SWH option. Small private hospitals and nursing home segment is yet to be exploited.

- ***Hostels:*** Recently some systems have been put in both government as well as private institutions. In one of the installation, the respondent was not satisfied with the quality of the system. This segment has good potential.

- ***Religious buildings:*** Gurudwara require hot water for cooking and cleaning of utensils throughout the year. This segment is yet to be exploited.

- ***Industries***: Electroplating, textile dying and dairy are three industrial segments which offer large opportunity for SWH. There is only one large SWH installation for electroplating.

Summary of stakeholder interviews:

- **SNA**: There no subsidy given by the state government; central subsidy is processed through PEDA. The ***quality*** of SWH and after sales service is the major issue. There should be some quality control mechanism to allow only quality products to be sold in the market. Industry may potentially be a large user.

- **Dealers**: The banks are not cooperative in providing finance for SWH especially for industrial user. Gurudwaras are not willing to pay for SWH system and expects that the system would be donated. Moreover, the electricity tariff for Gurudwaras is very low. Dying industry has use of hot water and steam, but most of them have recently invested in heat recovery system. Plumber association is also a key stakeholder in SWH industry. Electricity situation in Ludhiana is not good and could be a key driver for SWH. There is trend to show-off and copy, which can be exploited for marketing SWH systems. Price is not a barrier for SWH installation as many installations are done without subsidy and/or bank finance.

- **Architects/Builders**: Capital cost is a concern for the consumer as the gas geysers are available at cheaper rate. Moreover, the hot water is required only for 3-4 months in year. Capital cost reduction can help in SWH penetration. SWH penetration & potential is quite good in hotel and residential sector and these sectors could be targeted first. SWH penetration has increased due to frequent electricity outages.

Ludhiana

Except hotel segment, all other segments are under-exploited. Regulation on mandatory use of SWH yet to be implemented efficiently. Good potential for SWH in all segments i.e. residential, hotels, hospitals, hostels, *gurudwaras* and industries (electroplating, textile dying and dairy). Electricity shortage, low-rise construction favours SWH.

3. Haridwar

Profile: Haridwar is located in Uttarakhand spreading over 2360 km^2 of land. As per census of 2001, the population of the district was 1,447,187 with an urban share of 30.8%. Average annual growth in population for 1991-2001 was 2.36%. As per census 2001, total numbers of households were 240,702 with an average household size of 6. Agriculture is the mainstay of this well irrigated district. Industrialization had commenced with industrial giants like Hindustan Lever, Dabur, Mahendra & Mahendra and Havells having moved in. It is one of the holiest places for Hindus and a large number of pilgrims visit the city. Hotel industry has developed a lot due to tourism.

SWH Scenario: Haridwar falls under composite climate and receives good solar radiation (5.4 kWh/m^2/day). Almost, 77.4% of the households are of permanent construction.

- ***Residential***: Hot water is required for 3-5 months in a year, out of which around few days remains foggy/cloudy/rainy when the backup is needed. There is limited apartment culture; more individual houses. Hence, good scope for SWH. Power situation in quite good and outages are very few. Hot water is required mostly for bathing.
- ***Hotels***: Despite a large number of hotels, guest houses, dharamshalas, only a few hotels have installed SWH. SWH users have installed systems with a capacity of 40-100 lpd per room. SWH meets almost 90% of their hot water demand. There are leakage problem in few installation.
- ***Hospital/Hostel***: There is a demand for hot water in these sectors but the level of awareness is low, most of the respondents say that they have not been approached by manufacturer or dealers.
- ***Industry***: There are few textile and pharmaceutical industries in the district who could be the potential users of SWH.

Haridwar

Very low penetration rates and weak supply chain. Limited potential in the residential sector with the present product range. Affordable product required to increase penetration in the residential sector. Ashrams, hotels and *dharamshalas*, *ayurvedic* medicine industry offer potential. Focus on awareness, Technical support and strengthening of the supply chain.

4. Shimla

Profile: Shimla is one of the major districts of Himachal Pradesh spreading over 5131 km^2 of land. As per census of 2001, the population of the district was 722,502 with an urban share of 23.15%. Average annual growth in population for 1991-2001 was 1.57%. As per census 2001, total numbers of households were 154,693 with an average household size of 5. Agriculture is the major source of income. The place is famous for its natural beauty, architectural buildings, wooden crafts and apples. Shimla is one of the favorite tourist places in India. Hotel industry has developed a lot due to tourism.

SWH Scenario: Shimla falls under cold climate and receives good solar radiation (5.4 $kWh/m^2/day$). Almost, 83.2% of the households are of permanent construction. Hot water is required for atleast 9 months/year, out of which around 20-25 days remains foggy/cloudy/rainy when the backup is needed. SWH installation processed through SNA is about 1,00,000 lpd.

- ***Residential***: Most of the construction is independent houses with sloping roof. Most of the household use electric geyser for getting hot water. Power situation is quite good as there are very few outages in the winter mornings. Other than bathing, hot water is required for utensil scrubbing, hand washing, shaving, etc.
- ***Hotels***: Several hotel users. On an average the hot water requirement is around 30-100 liters per room. Most of the installations are done after the construction. Most of the installations are done without any subsidy. The experience of users is good is there is no issue of leakage, scaling, etc. SWH system meets the 100% of hot water requirement.
- ***Hospital***: The hot water demand in hospitals is found very less. Surveyed hospitals were approached by the SWH dealers but they didn't go for SWH installation.

Shimla

High hot water demand but low penetration rate, except hotels. Weak supply chain. Affordable product required to increase penetration in the residential sector. Hotels, hospitals and hostels offer potential. Focus on awareness, Technical support and strengthening of the supply chain.

5. Gurgaon

Profile: Gurgaon is one of the fastest growing districts of Haryana spreading over 1253 km^2 of land. As per census of 2001, the population of the district was 1,660,289 with an urban share of 22.22%. Average annual growth in population for 1991-2001 was 3.76%. As per census 2001, total numbers of households were 273,881 with an average household size of 6. The commercial and industrial sector has grown at a very fast pace in Gurgaon. There are many prominent and prestigious units involved in the manufacturing of Cars, Motors-Cycles, Automobile parts, Telecommunication equipments, electrical goods, software development, hardware, sports goods, rubber products, readymade garments, light engineering goods, pharmaceuticals, terry towels, food items, air conditioners, shoes, pesticides, insecticides etc.

SWH Scenario: Gurgaon falls under composite climate and receives good solar radiation (5.5 kWh/m^2/day). Almost, 86.0% of the households are of permanent construction. SWH installation in the Haryana is around 7,00,000 lpd and the sales for the year 2008-09 was around 2,00,000 lpd (Haryana). The Government has very favorable policies for SWH installation.

- ***Residential***: Hot water is required for 4-5 months in a year. Construction is a mix independent bungalow and apartments. Most of the household use electric geyser for getting hot water. Power situation is poor as there are very frequent outages in the winter mornings. Other than bathing, hot water is required for utensil scrubbing. Awareness about SWH is quite low. Power situation and affordability could be the key driver for SWH. Some of the new multi-storey apartments by one of the private builders and Haryana Housing Board have made provision of SWH.

- ***Hotels***: Year-round hot water requirement but very few hotels have SWH installations. The total number of hotel rooms is expected to be around 5000 (2000 in star category + 3000 in lower categories) by 2010. Surveyed hotels showed interest in SWH.

- ***Hospital***: Only a few hospital users. Many of the surveyed hospitals are neither aware about the technology nor approached by the SWH dealers. Total number of beds in existing private hospitals are estimated to be 2000, another 1500 hospital beds would be added at the upcoming medi-city.

- ***Hostels***: The hot water requirement is found to be 10-25 liters per room. There are some installations in government supported institutions done with the support of HAREDA. Some of the private residential schools have opted for SWH. SWH installed are working fine without any scaling, leakage or deterioration problem.

- ***Industries***: The number of installations are few given the large base of the industry in the district. There is one large installation in a textile factory and some for industrial canteens.

Stakeholder interview: State Nodal Agency (HAREDA)

- State has a proactive SWH policy which consists of subsidy on domestic systems and monthly rebate in electricity bill of Rs. 100 to 300 per month for first 3 years. In addition, subsidy is available for non-commercial institutions.
- HAREDA has actively pursued amendment in municipal by-laws for SWH and SWH provisioning has now been included in the municipal bye-laws, but the implementation is not effective.

Gurgaon

Regulation on mandatory use of SWH yet to be implemented efficiently. Good potential for SWH in all segments i.e. residential, hotels, hospitals, hostels and industries (electroplating, textile, dairy and industrial canteens). Electricity shortage favours SWH.

6. South-West Delhi

Profile: South west Delhi densely populated district of Delhi spreading over 420 km^2 of land. As per census of 2001, the population of the district was 1,755,041 with an urban share of 87.15%. Average annual growth in population for 1991-2001 was 4.9%. As per census 2001, total numbers of households were 364,511 with an average household size of 5. Being the capital of the country, the commercial and residential sector has grown at a very fast pace in the district.

SWH Scenario: South West Delhi falls under composite climate and receives good solar radiation (5.5 kWh/m^2/day). Almost, 91.7% of the households are of permanent construction. Most of the national SWH players are present. The policies are quite favorable for SWH installation; still the SWH penetration is very low in the district.

- ***Residential***: Hot water is required for 4-5 months in a year. Construction in the district is mostly apartment buildings. Most of the household use electric geyser for getting hot water. Power situation is not very bad but still there are few outages in the winter mornings. Other than bathing, hot water is required for utensil scrubbing, washing machine, hand washing, etc. People are some-what aware about SWH but have limited knowledge about manufacture, subsidy, costs, etc.
- ***Hotels***: Delhi has only a small number of SWH installations in hotels. Some of the hotels having SWH were interviewed and were found to be satisfied with the SWH performance and it meets most of their hot water requirement. There is still no awareness in small hotels about the SWH.

- ***Hospital***: The hot water demand in hospitals is found 10-20 liters per bed. Due to mandatory provisions several of the hospitals (both small and large) are in the process of installing SWH. SWH owner has no problems with the SWH system.
- ***Industry***: We could not locate relevant industries for SWH.

Stakeholder interview: State Nodal Agency

- State Govt. provides a subsidy of Rs.6000 per domestic system.
- For non-commercial institutions, Rs.6000 per 100 lpd, maximum for 1000 lpd i.e. Rs.60,000. (Subsidy is directly given to the supplier)
- Govt. of Delhi has a climate change action plan. The target is to have 5 lacs lpd capacity by 2012.
- The Govt. has made SWH mandatory for all hospitals, hotels, hostels and nursing homes. The Govt. has collected information on institutions that have not complied and is in the process of enforcing penalty for non-compliance.

South-West Delhi

Regulation on mandatory use of SWH is yet to be implemented efficiently. Good potential for SWH in hotels, hospitals and hostels. Group housing, DDA flats and new apartment buildings can have large potential but lack of demonstrated alternatives is a big barrier. Thus focus on demonstration of practical application of SWH should be a priority.

7. Bangalore

Profile: Bangalore is the largest district of Karnataka spreading over 2191 km^2 of land. As per census of 2001, the population of the district was 6,537,124 with an urban share of 75.48%. Average annual growth in population for 1991-2001 was 3.03%. As per census 2001, total numbers of households were 1,460,697 with an average household size of 4.5. Bangalore is home to some of the most well-recognized colleges and research institutions in India. Numerous public sector heavy industries, software companies, aerospace, telecommunications, and defense organizations are located in the city. Bangalore is known as the *Silicon Valley of India* because of its position as the nation's leading IT exporter.

SWH Scenario: Bangalore falls under temperate climate and receives good solar radiation (5.5 $kWh/m^2/day$). Almost, 89.7% of the households are of permanent construction. Bangalore is the largest market for SWH and has the maximum penetration of SWH in the country. Most of the national players are present along with large number of local players.

***Summary of primary survey & stakeholder interviews*:**

- A good reason for the SWH to have taken off here is the weather and conditions, as it is cold (hence the need for hot water is all year round) at the same time the city like the rest of South India has good solar radiation enabling efficient usage of the SWH all year round.

- As there was demand for a product a very healthy eco-system of manufacturers and suppliers has grown here. As was pointed out by a senior manufacturer, though there are many manufacturers (which increases competition) it doesn't affect negatively as there is more than enough demand, also it boosts cluster growth so that raw materials and labour becomes easier to find. However not all the consumers are happy with the after-sales service and quality of the installations which requires immediate attention.

- With a stable market, architects and builders want the industry to go a step further in quality, innovation of the product and the services. This statement, points towards the need for standardization of the product, the quality, the service and the training.

- SWH's is being sold predominantly to a middle and high income population. The product needs to be sold through a different scope, e.g. as an appliance.

- Not many banks are interested in offering loans under the IREDA scheme. Many have stopped giving out subsidies due to bad experiences with the dealers who bring costumers.

- Hospitals and institutions, in general, have a great potential, but there seems to be a lack of incentive. Government orders making the use of SWH mandatory isn't working. Builders and architects might not even know them. Suggestions are to promote official policies that offer incentives to these sectors.

- The stability of the market in Bangalore district is clear. Some key stakeholders convey the idea of pushing SWH into rural and semi-urban areas.

Bangalore

Year-round demand of hot water; best manufacturing and dealership base in the country and best penetration rate of SWH in the country. Product innovation and intensification of marketing require to increase the customer-base (e.g lower-income households, existing housing). Still untapped potential in commercial and institutional buildings as well as industries. Regulation on mandatory use of SWH yet to be implemented efficiently. It has the potential to drive growth in new-housing.

Caselet 1: R. Prassana Venkatesh (Chief Engineer), Bhagwan Mahavir Jain Hospital

The Bhagwan Mahavir Jain Hospital is situated in a residential area of Bangalore and caters for the poorest section of the society, without excluding patients who decide to be in better wards. In 2003 they installed a 9000 lpd SWH. Chief Engineer R. Prassana Venkatesh wasn't there when it was installed but he knows everything about it. He is of the opinion that the issue of deployment of SWH and energy-efficiency in hospitals, can best be solved through official policies that offer incentives to the hospital sectors, encouraging the use of solar energy, and on the other hand making mandatory provisions for their use.

Caselet.2: Thomas P. , Selco Solar Light Private Ltd, Bangalore

Selco started as a Solar Lighting systems provider for rural Karnataka back in 1994. Solar water heaters entered their portfolio some time after and they have since been selling and servicing them for about 10 years now. Today they have their own plant producing flat plate solar water heaters. Their main customer base are the middle and upper classes of rural Karnataka, concentrated in the Western Ghats. They are mostly farmers with land holdings of 5 acres and more. Their annual SWH sales is 3.5 to 4 crores; 75% of this is accounted for by domestic (households) sales while the remainder 25% comes from the commercial/Industrial sector. Most of the demand (almost 75%) are for 100 and 200 lpd systems.

Their non household clientele includes hostels, hotels, orphanages, silk, wax and biscuit manufacturers. Their annual sales volumes show an increase of upto 30% SELCO have an active client base of about 100,000 individuals . But, according to them, only about 30% of this customer bank are interested in SWH. The reason for this lack of interest is the easy and cheap (almost free) availability of firewood and biomass that grow naturally in the rural parts of Karnataka that SELCO is active in. It is the semi-urban market who tend to exercise options (like SWH) as they have less access to firewood or biomass as fuel. In the years to come the biggest driver of transition is likely to be the shrinking availability, rising costs and supply of firewood.

Note: This same phenomenon is actually underway in the Nilgiris district of Tamilnadu,forcing many to turn to options for water heating. SWH is gaining in priority in these parts. For details refer our notes on Coimbatore.

The question of subsidy is a vexing one as experienced by SELCO. The paperwork and time involved is in inverse proportion to the benefit :2% subsidy. There is a critical lack of awareness about renewable energy amongst bank personnel. They will have to be trained intensely; but for that to happen, there should be official policies that give due priority to renewable energy initiatives starting with SWH and going on successively to include other technologies and applications over time.

SELCO is successful in promoting SWH and other renewable energy products only because of their big rural market base, which they have built up over time. As a result of this close connection with their market they are able to offer the whole package – product, finance and after sales service – that keeps their customers happy and adds to their growing number.
They have now started to apply for voluntary CER verification for their various projects with a carbon credits trader in the UK.

Caselet.3: Manjunath D. V., Managing Director, EMMVEE Solar Systems Private Ltd, Bangalore

Emmvee,a pioneer in solar technology, has set up one of the largest solar water heater manufacturing plants in the country. When completed, the total production capacity of the plant is expected to be 200 Flat plate collectors and upto 400 tanks/day. They have 6 distributors, 175 dealers and 22 sales staff that keep operations going.

Lining the inner tank with ceramic is a technological feature they are adding to their systems, which can set a new industry benchmark. Their association with Solar Cap of Denmark has helped them incorporate this feature in the tanks of their solar water heaters with only a marginal price increment for this valuable add-on. When we visited, they were running trial runs with ceramic coating in tanks and were getting ready to commence volume production. We believe that this innovation will help SWH gain greater traction upon the Indian market, which is being plagued by the problem of hard-water in many geographical areas across the country leading to gradual deterioration of the tanks due to corrosion.

Their current annual sales is in the range of Rs 50 crores and they aspire to be a Rs 200 crore company with full plant capacity. About one half of their production is planned for exports while the rest is meant for the home market. Of this about 60% will be consumed by the Karnataka market alone and the rest will retail in the states of Delhi, Punjab, MP, HP, TN and Kerala. Kalyan outside Mumbai and, recently Delhi, are starting to show interest in SWH. Govt clients account for 25-30% of net sales and the whole SWH market is poised to grow by about 20% each year. Power cuts, rising power tariffs and a new ecological consciousness will be the drivers of SWH and other renewable energy applications in the years to come.

As for market dampeners, the following were cited by the management as potential hurdles needing to be transcended
1. Policy: The market and industry can benefit from clear official policies originating from the government and capable of being executed on the ground with ease.

2. Mass awareness can stimulate the sector .Media can help with meaningful campaigns that highlight benefits to the environment and economy due to renewable energy.
3. Architects and builders should be made to believe in the inherent necessity and benefits of SWH
4. Cost to the end user have to come down.
5. Service and maintenance have to develop significantly if this industry is to mature and bear fruit.

Caselet.4: T. J. Joseph, Managing Director, Anu Solar Private Ltd, Bangalore

ANU SOLAR is an example of an innovative ESCO in the area of Solar Water Heaters; perhaps the only one in the country. Started a novel initiative (Pay per litre,pay as per use) in January 2009. Under this, the company offers to set up 200 lpd system against a refundable security deposit Rs. 1,900 + minimal non-refundable installation costs from customers. Hot water supply is metered; minimum monthly charges for hot water use is Rs. 80 The company claims to have spent about Rs. 5 crore in publicity and has 500 people in the field for sales, installation and service to promote this scheme. Focus is on Bangalore but hopes to be able to use this model for replication elsewhere.

ANU SOLAR commenced manufacturing/assembling SWH systems since 1990.While their biggest market is Karnataka other emerging markets for SWH include Vizag, Vijaywada, Nellore, Hyderabad, Pune, Nasik, and the states of Maharashtra, Tamil Nadu, Haryana, Punjab, and Gujarat

Issues :
Lack of awareness both amongst customers and the banking sector. The Govt. should create a long term and far sighted policy to promote SWH, as it is in national interests. The market is big and ever growing. Bangalore alone (the solar capital of the country) has currently about 14 lakh houses in Bangalore, growing by about 343 houses per day (estimated).This scenario has relevance for every major city and town across India making SWH a very viable addition to a house. Industry and the commercial sector too can reap big dividends with SWH. The company is considering a CDM project as a natural extension of their work in the field of renewable energy. Their clients include Apollo hospitals, Infosys, Ginger hotels and Wockhart Hospitals.

8. Coimbatore

Profile: Coimbatore, a district of Tamil Nadu, spreads over 7469 km^2 of land. As per census of 2001, the population of the district was 4,271,856 with an urban share of 66.01%. Average annual growth in population for 1991-2001 was 1.87%. As per census 2001, total numbers of households were 1,095,354 with an average household size of 4. Almost, 73.4% of the households are of permanent construction. Coimbatore is known chiefly for its numerous textile mills, factories, engineering firms, automobile parts manufacturers, health care facilities & educational institutions. The hill stations of Ooty, Coonnor and Valparai are close to the city making it a good tourist attraction all over the year.

SWH Scenario: Coimbatore falls under warm humid climate and receives good solar radiation (5.6 kWh/m^2/day).

***Summary of primary survey & stakeholder interviews*:**

- Home to a very dynamic SWH industry and market, accounting for about 25% of the net SWH market in the state of Tamil Nadu.
- Has about 6-10 successful SWH manufacturers, three of whom are big and have a national presence.
- Industry and the commercial sector (hotels/educational-religious institutions/hospitals) feature big on the client list of these manufacturers. Significant savings on power along with a bonus 'green image' are the chief incentives for this sector to embrace SWH. The domestic sector is slower but gaining in importance in the eyes of the industry. The wide prevalence of hard water in many parts of Coimbatore seems to be a market dampener. However, increasing power cuts is forcing householders to look for other options. A year round cool climate is a market driver.
- The constant “media noise” (advertisements, schemes and offers) made by Coimbatore's resident SWH manufacturers and distributors ensures that SWH – as a viable product and technology – is always kept in the public domain. This accounts for the unusually high awareness about SWH amongst the general public.
- Absence of trained maintenance staff for installations and post sale service is an industry/market 'speed-breaker' acknowledged by all. The industry is still in its infancy and the market is yet to attain maturity. This makes it difficult to create a 'job market' aimed at SWH technicians successfully. Production, sales and service feed off one another in a systemic loop. They will all have to come of age at the same time for market health to be achieved. It has been suggested that concerted and focussed training programs for solar technologies aimed at youth and others can meet this need in the long run.

- Absence of quality controls in product manufacture is a problem. It tends to cast SWH in a poor light in the eyes of uninformed customers. It also permits for poor quality products to enter the market and compete on the same platform with its higher quality cousins. While these reap the profits, the 'bad name' is shared equally by the entire industry. Govt. branding/certification of products and components will do much to elevate the standing of SWH in the eyes of the public and the market in general.

- Participation of banks can be enhanced through establishing a 'green policy' and creating special training modules for bank personnel, who currently lack much awareness about RE themselves. Loan/subsidy schemes have to be simplified to make it appealing to all.

- Enlightened official policies and proactive legislation is felt by all to be able to help the industry and market develop more rapidly than it can otherwise.

Coimbatore

Year-round demand of hot water; strong manufacturing and dealership base. Residential sector is yet to be exploited fully. SWH industry should focus on delivering a quality product. Product innovation and intensification of marketing require to increase the customer-base. Industrial segment (mainly textile) may offer potential. Regulation on mandatory use of SWH yet to be implemented efficiently. It has the potential to drive growth in new construction.

Caselet: R.Venkatesh (MD), VESAT Solar Energy Systems, Coimbatore

VESAT solar energy systems was started in 2004. It is a mid-league player manufacturing/assembling solar water heaters and distributing solar lights and solar cookers. Venkatesh, its founder and MD, is an instrumentation engineer by training who was drawn to renewable energy since the 90s. He went to work for a well known maker of electric geysers and helped set up their SWH division.
In 2004 he left to begin his own enterprise based on his understanding of the potential of this market. VESAT's subtle agenda is the popularization of renewable energy applications amongst the public so that a viable alternative is developed to replace our dependency on fossil fuel based energy generation. Being an ardent spokesman for renewable energy, Venkatesh gives lectures on how RE can make for positive changes in the environment. He tells his young audiences about the current technologies in RE and how these could provide career openings for them soon. He also uses social platforms (Lions and Rotary clubs) to talk about RE in its wider relation to man, his environment and its future. He is contemplating developing a course (in RE technologies with emphasis on solar energy products maintenance) for one or two of Coimbatore's premier technical institutions. He believes that it is time for renewable energy – technologies and applications – to go mainstream. Part of the public's current

indifference is due to a lack of mass awareness. Education can help people take more readily to alternatives. The Govt. can play a big role here.
Venkatesh maintains that the SWH market is a promising and growing one in need of committed players with long term visions and strategies. Being an astute technologist and entrepreneur, he realised that if he were to be successful in the business then he would have to address some of the industry's (and market) most glaring lacuna – quality and post marketing service.
Product quality and maintenance were the two biggest hurdles that kept new customers out, according to Venkatesh. And so his business philosophy began to revolve around these two aspects. Today these are the two pillars upon which his success rests. He is building a network of trained local plumbers who carry out installations and maintenance of solar water heaters under his team's supervision. Some of them are a part of his team. They also serve as sales agents for his products, further closing the gap between supplier and user , creating a bond that is hard to break and inevitably leading to new business.
VESAT services customers big and small. Their clients are varied and include textile mills, hospitals, schools, hotels and homes. Recommendations from satisfied clients have served to expand VESAT's customer base considerably over the years. A lot of these are individuals and organisations who are aware of the benefits of RE in helping reduce costs as well as minimising environmental footprints. However, this is a small group accounting for a very small fraction of the SWH market. Enlightened Govt. policies can help the RE market grow considerably. Favourable policies and practical financial mechanisms can be a winning combination that can provide RE and its attendant markets with the boost it needs to go mainstream.

9. Hyderabad

Profile: Hyderabad, a district of Andhra Pradesh, spreads over 650 km^2 of land. As per census of 2001, the population of the district was 3,829,753 with an urban share of 100%. Average annual growth in population for 1991-2001 was 1.60%. As per census 2001, total numbers of households were 695,906 with an average household size of 5.5. Almost, 86% of the households are of permanent construction. Hyderabad has developed into a major hub for the information technology industry in India.

SWH Scenario: Hyderabad falls under composite climate and receives a solar radiation of about 5.6 $kWh/m^2/day$. Andhra Pradesh is one of the emerging markets for solar water heaters particularly, the cities of Hyderabad, Vijaywada and Vishakapatnam, of which Hyderabad is the biggest.

***Summary of primary survey & stakeholder interviews*:**

- One of the large national brands of solar water heaters is based in Hyderabad. They have created a lot of awareness in the market and now are moving towards

institutional and industrial segments. They have installed systems in a number of hotels. They have also done a few industry installations for pharmaceuticals and dairy clients. However, the installed base is still limited compared to the potential.

- The Andhra Government has enacted law (GOM) for usage of renewable energy particularly solar water heater in new hotels, lodges, guest houses, hospitals, nursing homes and multi-storeyed buildings. The municipal corporations are supposed to enforce it with the support of the nodal agency. The agency has an approved list of 20 supplier/installers. However, our research revealed that the law is toothless and is not enforced. The nodal agency indicated that some municipal corporations are more active in enforcing it then others. In fact some of the builders and architects even in Hyderabad are not even aware that such a law exists.

- With increased awareness among users of different segments, hotels and industry users are switching to solar water heaters for economical reasons. However, the awareness level is still very poor and the installed base is relatively small

- Technical expertise of suppliers and installers is poor. Customers have complained of inadequate advise on very simple issues such as cold water at the furthest user point without wasting water, solar water heater installation location etc. Training for installers is still non-existent.

Hyderabad

Year-round demand of hot water. Manufacturing and dealership base is developing. The penetration rate is still low compared to potential in all the segments. SWH industry should focus on increasing its reach and delivery of quality product and services. Industrial segment (e.g pharmaceutical) may offer potential. Regulation on mandatory use of SWH yet to be implemented efficiently. It has the potential to drive growth in new construction.

Caselet.1: Joseph Pentony (Manager), Fernandez Hospital Pvt. Ltd., Hyderabad

Fernandez Hospital in Hyderabad is managed by a missionary trust. It endeavours to provide high quality service particularly to the poor and deprived sections of society. The manager, Joseph Pentony, is also responsible for the building and its maintenance.

Joesph and the management got interested in solar water heaters early on for both economical and environmental reasons. They caught on to solar water heaters back in 1997 when they installed a flat plate system of 2,000 litre capacity. Encouraged by the power savings and low maintenance, they installed the second system of 2,000 litre capacity in 2003. This time they installed an ETC system. They decided on ETC as

they perceive it to be more efficient with less maintenance because of glass tubes. Now they are also hoping to have a solar water heater system in an upcoming building. One of the challenges they had with putting up their first system was with laying out the hot water plumbing over the hospital. The installer did not make them aware of the cold water discharge for the first few litres, if the end user is located far away from the solar water heater. They found no one in Hyderabad to suggest a solution for this problem despite the fact that a circulatory system with a thermostat has been around for along time, which could easily solve this problem. He felt there was a critical lack of training and expertise in marketing solar water heaters in the city of Hyderabad, considered to be an emerging market in India, and certainly the biggest in the state of Andhra Pradesh.

Caselet.2: K. Laxma Reddy (General Manager), Synthokem Labs Pvt. Ltd., Hyderabad

This is one of the few examples where an Industrial user has chosen solar water heaters for economical reasons and successfully implemented it in their production process. Their factory which used to be in an industrial estate is now part of a residential area as Hyderabad city has expanded. Being in a residential zone there are restrictions on fuels with high particle content. So they use furnace oil for boilers, which they found to be too expensive and highly volatile. As the price of furnace oil rose in mid 2000, the company started to look at ways to cut on fuel costs. With the help of consultants they concluded it was worth trying solar water heaters to pre heat the water fed into the boiler to reduce the furnace oil consumption in the boiler. With a 10,000 litre system they found they could raise the water temperature by 30 degree C thereby reducing the energy cost by 16%. They believe the payback could be under 2 years if the solar water heaters are reducing furnace oil consumption. Now they have become passionate advocates of solar water heaters and offer advice and support to other factories.

10. Ernakulam

Profile: Ernakulam, a district of Kerala state, spreads over 2407 km^2 of land. As per census of 2001, the population of the district was 3,105,798 with an urban share of 47.6%. Average annual growth in population for 1991-2001 was 0.87%. As per census 2001, total numbers of households were 693,161 with an average household size of 4.5. Almost, 92.3% of the households are of permanent construction. Ernakulam is the commercial capital of the state of Kerala.

SWH Scenario: Ernakulam falls under warm-humid climate and receives a solar radiation of about 5.6 $kWh/m^2/day$. The SWH market is significant and relatively untapped in the twin cities of Kochi (formerly Cochin) and Ernakulam. These two are

the principal metros of Ernakulam district, considered by many to be the biggest SWH market in the state of Kerala, accounting for up to 30% of net SWH sales.

Summary of primary survey & stakeholder interviews:

- The commercial sector - hospitality and health in particular – is a big and growing market for SWH and accounts for up to 60% of sale. The domestic sector is sluggish in comparison. Old habits, availability of cheap electric geysers and concern over losing roof space have been cited as some possible reasons for this resistance. However, steeply rising power tariffs and frequent power cuts can be leveraged successfully to the advantage of SWH and RE in the long run.

- After sales service has been cited by many – manufacturers, distributors and customers alike - as a very real gap in the system impacting negatively upon the industry and market at large. Finding, training and retaining trained technicians for SWH is a problem in Kerala due to multiple socio-economic reasons. Currently, plumbers are being sought and enlisted for this job, sometimes successfully and many times not. A dependable, respectable and profitable job economy (based on RE technologies and applications) is still to emerge. To catalyze this, efforts are underway by some proactive organizations to develop a training curriculum (for SWH and other RE technologies) to be included in ITI training programs. Its intent is to produce certified SWH technicians who can be employed by manufacturers and distributors, leading to a balanced market equation through fulfilling the needs of the demand - supply chain in this sector.

- Product quality and pricing were mentioned by a few as potential market deterrents.

- Banks are not proactive enough. Manpower shortages, diffused signals from their HOs and complex loan/subsidy procedures have been cited by many as the reason for restricted bank participation. Making RE a priority issue amongst banks could reverse this trend.

- The role of positive legislation cannot be overstated and may be needed to provide the stimulus this industry needs. Making mandatory the use of renewable energy in new buildings and offering meaningful incentives for others to embrace RE applications can be a big step in this direction.

Ernakulam

Good demand of hot water in households. Dealership base is still developing, no significant local manufacturing. The penetration rate is low compared to potential. Main immediate market is in the hospitality sector. SWH industry should focus on increasing its reach and delivery of quality product and services. Regulation on mandatory use of SWH yet to be implemented, it has the potential to drive growth in new construction.

Caselet: Mr. Aji Augustin - Chief co-ordinator, Aditya Solar Shop - Distributors of SWH and Solar lighting products, Kerala

The Aditya Solar shop is unlike your regular SWH distributor. Though it is a profit-making RE products retailer located in the commercial heart of Ernakulam, Kochi, it is run like an NGO. It is a part of the Aditya Charitable Trust (itself a part of the larger Rajagiri Educational Foundation that runs a great number of schools and colleges under it).

The Aditya Solar shop was started in 1999. It is one of the earliest MNRE approved solar product outlets in Kerala and is still featured on the MNRE web site. From the very beginning the shop's only intention was to enable the non-electrified and backward regions of the state of Kerala with RE lighting, heating and cooking interventions. Their product portfolio is large and includes SWH, solar based lights and solar cookers. They have in the past also promoted bio-gas systems and still continue to be open to distributing new RE applications that are useful and needed.

SWH sales account for roughly half the Aditya Solar shop's total sales. They service household, industrial and governmental customers. Being part of a reputed trust, they get a lot of recommendations from well wishers and supporters. They are open to distributing any brand of product so long as it comes with some degree of reliability. They are not dependent upon manufacturers to provide after sales support, preferring to rely upon their own trained staff for installations and troubleshooting. They service the whole state and get enquiries from its remotest parts. However, limited human resources prevent them from attending to all enquiries. Priority is given to the requests of NGOs and charitable institutions.

Being deeply committed to the cause of renewable energy, the Aditya Trust are designing a 6 month diploma course in RE technologies that will be on offer in their technical training centres from the next academic year. These courses are meant to popularise renewable energy, while at the same time providing new employment avenues for rural youth. In the process, it is felt, a pool of qualified RE technicians will be created who can be employed by the industry and the market and thus help it develop. This far reaching vision of the Trust is very likely to impact upon the cause of RE in very positive ways in the long run. The Aditya solar shop, backed by the values and vision of the Aditya Trust, can be seen as a frontrunner in generating new models for RE, which are born out of conviction, not market analysis. But the two dovetail to the great benefit of all.

11. Chennai

Profile: Chennai, the capital Tamil Nadu state, spreads over 178 km^2 of land. As per census of 2001, the population of the district was 4,343,645 with an urban share of 100%. Average annual growth in population for 1991-2001 was 0.94%. As per census 2001, total numbers of households were 962,213 with an average household size of 4.5. Almost, 87.2% of the households are of permanent construction. Chennai's economy has a broad industrial base in the automobile, technology, hardware manufacturing, and healthcare industries. The city is India's second largest exporter of software, information technology (IT) and information-technology-enabled services (ITES).

SWH Scenario: Chennai falls under warm-humid climate and receives a solar radiation of about 5.6 kWh/m^2/day.

***Summary of primary survey & stakeholder interviews*:**

There is a potential here based on numbers but there are various other issues

- Very low penetration despite being one of the districts with more electric geyser sales. Despite, culturally, there seems to be a need of hot showers now and then, pricing and weather play unfavorably for its success. The weather plays a role in low penetration as when the consumer is about to buy the product the logic given is that it is hot throughout the year except in the monsoon when the SWH is not very effective anyways.

- Industry can play an important role in a SWH boom in cities like Chennai. However, the market is still immature, where dealers and manufacturers don't have the training and sales capacity to import this product in this segment. The agencies selling SWH are not working out solutions for industries that work with pre-heating etc. as there isn't a focus on pre-assessment.

- The Nodal agency has awareness programmes but they do not seem to be effective.

Chennai

Strong sales of electric geysers indicate good demand of hot water in households. The penetration rate is low compared to potential. SWH industry should focus on establishing SWH as a viable product in Chennai. Regulation on mandatory use of SWH yet to be implemented, it has the potential to drive growth in new construction.

12. Pondicherry

Profile: Pondicherry is the main district of Union Territory Pondicherry, spreading over 479 km^2 of land. As per census of 2001, the population of the district was 974,345 with an urban share of 51.93%. Average annual growth in population for 1991-2001 was 1.91%. As per census 2001, total numbers of households were 163,864 with an average household size of 6. Almost, 77% of the households are of permanent construction. Pondicherry is also considered an educational hub of southern India.

SWH Scenario: Pondicherry falls under warm-humid climate and receives a solar radiation of about 5.7 $kWh/m^2/day$.

***Summary of primary survey & stakeholder interviews*:**

There is a potential here based on numbers but there are various other issues

- Need of SWH's is very low for two main reasons. First of all, electricity rate is very cheap. Economically is not worth it, not even considering the effort of going through months of paperwork for a subsidy.
- Secondly, there is a need of hot water, but the market can do with not more than 50 lpd of it. Electric geysers are no more than 30 lpd, according to the Nodal Agency in Pondicherry and an architect interviewed. Why would they pay so much for a 100 lpd SWH, when they could pay less for a system that fits more their necessities?

Pondicherry

There is a demand of hot water in households. More affordable product required for a break-through in the household sector. Growing hospitality sector offers growth prospects. Regulation on mandatory use of SWH yet to be implemented, it has the potential to drive growth in new construction.

13. Ahmedabad

Profile: Ahmedabad is has a area of 8,707 km^2 . As per census of 2001, the population of the district was 5,816,519 with an urban share of 80.2%. Total numbers of households were 1,150,588 with an average household size of 5. Household have grown by 1.27 & 3.65% in rural and urban area, respectively. Almost, 85.5% of the households are of permanent construction. Ahmadabad city established itself as the home of a booming textile industry and witnessing a major construction boom and population increase.

SWH Scenario: Ahmadabad falls under hot-dry climate and receives a solar radiation of about 5.8 kWh/m^2/day.

***Summary of primary survey & stakeholder interviews*:**

- ***Non-Owners*** Household: Hot water is required 4-5 months in a year. There is less interest for SWH and people have mild exposures to SWH.
- ***Non-Owners*** Hospital: Two small hospitals were interviewed. Both depend on electricity for water heating. Low interest in SWH, mild exposure to SWH.
- ***Non-Owners*** Hotels: Three hotels were interviewed. The average hot water demand is 40 to 50 ltrs/ room per day. Use fire wood for heating water. Less inclined to go for SWH. Mild exposure to SWH. Roof availability is an issues
- ***Non-Owners*** Industry: Three dairy and two pharmaceutical industries were interviewed. All of them need steam. Use liquid fuel or PNG. Not convinced about the viability of SWH. Some exposure to SWH
- ***SWH Owner*** households : All six households were independent houses. Four of them have electric geysers. The hot water requirement is estimated at 180 days/year for bathing. Average capacity of SWH works out to be135 lpd. No loan, electricity/property tax benefit. Some problems reported but on the whole, happy with the product
- ***SWH Owner*** Hotels: Two hotels having 34 and 24 rooms respectively. Hot water requirement @ 20 to 30 ltrs/room/day. Wood was used earlier. SWH meets 35% and 75% of hot water requirement. Mixed feedback on product and performance.
- ***SWH Owner*** Hospital: Interviewed one hospital having 19 rooms. It has installed a 400 lpd during renovation of the hospital. No loan or benefits. Use SWH fully and round the year. Good product but some problems and sub-standard after sale support.
- ***Stakeholders Manufacture/dealers*** : Largely FPC sale. Annual sale is 4000 sq.mtrs. Ahmedabad account for 25% to 35% of Gujarat market. Hotels and hostel considered other promising categories. Cost/payback and product quality are the main barriers. Market expected to decline because of PNG.
- ***SNA*** : The state Govt. SWH policy has operated, since 1979, in an on-off manner. Capital subsidy is the main vehicle. The governmrnt. took a view that SWH is an established product and discontinued the subsidy this year. There is a move to make SWH for 200 sq.mtr (terrace or plot not clear) housing mandatory. There is no proposal on property tax or electricity rebate. They feel that they should have targeted industries/institutions rather than households.

Ahmedabad

Hot water demand in households limited to winter months though significant percentage of population can afford SWH. Innovative marketing, enforcement of regulation and strengthening of supply chain is required to develop SWH market. Commercial buildings and industries (textile, pharma, dairy) needs to be targeted.

14. Indore

Profile: Indore, a district of state Madhya Pradesh, spreads over 3,898 km^2 of land. As per census of 2001, the population of the district was 2,923,770 with an urban share of 71.21%. Growth in population for rural & urban sector for the period 1991-2001 was 2.7 & 3.7% respectively. Total numbers of households were 419,904 with an average household size of 7. Almost, 66.6% of the households are of permanent construction. Household with two wheeler ownership is around 36%. Indore is also called as 'Mini Mumbai', due to the similar lifestyles of people residing here. The market size of the district is Rs.8920 crore. Per capita income for urban & rural sector is Rs. 49089 & 24922.

SWH Scenario: Indore falls under composite climate and receives a solar radiation of about 5.7 $kWh/m^2/day$. SWH installation in the city is estimated to be around 5,00,000 lpd with an annual sales of 1,00,000 lpd. Almost 30% installation is in residential sector. FPC and ETC sales ratio is 80:20 while installations have ratio of 95:5. The city shares around 30% of SWH market of the state. There are 4 national brand SWH dealers and 7 other dealers in the city.

***Summary of primary survey & stakeholder interviews*:**

- The demand from hotels, hospitals and hostels are encouraging. Being an educational hub, the hostels could be large users of SWH
- Bank-credit and policy support is weak.
- The apartments are growing very fast and the power situation seems to be good in the city.
- FPC dominates the market as there is demand for FPC in commercial and industrial sectors.
- At present, people give very less preference to SWH while building a house. Also, the dealers have not paid much attention to promote SWH in residential sector.

- The announcement has been done to make SWH mandatory as per MNRE guidelines. There is no property tax rebate, nor any electricity rebate. Banks are also not active in providing loans for SWH.

Indore

Fair to good potential for SWH in all segments i.e. residential, hotels, hospitals, hostels. Regulation on mandatory use of SWH yet to be implemented, it has the potential to drive growth in new construction.

15. Jaipur

Profile: Jaipur, a district of state Rajasthan, spreads over 11,143 km^2 of land. As per census of 2001, the population of the district was 6,117,522 with an urban share of 51.24%. Growth in population for rural & urban sector for the period 1991-2001 was 2.3 & 3.8%, respectively. Total numbers of households were 785,030 with an average household size of 8. Almost, 83.2% of the households are of permanent construction. Household with two wheeler ownership is around 36.3%. The market size of the district is Rs.16218 crore. Per capita income for Urban & rural sector is Rs.60282 & 26170.

SWH Scenario: Jaipur falls under composite climate and receives a solar radiation of about 5.8 $kWh/m^2/day$. SWH installation in the city is estimated to be around 4,00,000 lpd with an annual sales of 50,000 lpd. Almost 35% installation is in residential sector. FPC and ETC sales ratio is 90:10 while installations have ration of 95:5. The city shares around 40-50% of SWH market of the state. There are only 2 national brand SWH dealers in the city. The market is expected to grow by 40% per annum for next few years.

***Summary of primary survey & stakeholder interviews*:**

- Demand-enhancers: A large population of hotels and hospitals. Households tend to choose larger than 100 lpd system
- Demand-Dampeners: Short winter, slender base of local production of SWH, weak bank-credit and policy support
- Low level of competition dealer of two national brands, one producer focused on all-India defence market, another is a recent entrant
- Brisk demand from hostel because it is possible to regulate bathing hours and optimize use. 35% to 40% of existing installation are hostels

- The demand from hotels is good. However, it is large hotels, say, 60 room upward which go in for SWH. They use it to heat feed water for boiler. The small hotels have roof availability problem- cable dish, water tank, diesel tank, etc

- We could not locate a single industrial installation. The pharma reported temperature requirement depending on the batch- whether it is syrup or non-syrup and need to control temperature precisely. The textile printing reports recurring cost of 5 or 10 paise/ltr; depending on whether it uses wood or LPD

- *Policy*: SWH is mandatory for all residential building located on 500 sq.mtr or larger plot. An order making SWH compulsory for commercial and relevant industrial establishments is expected soon. No rebate on municipal property tax. No state- govt. subsidy. 5 paise/unit rebate on electricity tariff. SWH producers/dealers stay away from banks because effort to help customer get bank-credit proves counter productive

16. Nagpur

Profile: Nagpur, a district of state Maharashtra, spreads over 9802 km^2 of land. As per census of 2001, the population of the district was 4,521,073 with an urban share of 65.61%. Growth in population for rural & urban sector for the period 1991-2001 was 1.4 & 3.1%, respectively. Total numbers of households were 790,524 with an average household size of 6. Almost, 53.7% of the households are of permanent construction. Household with two wheeler ownership is around 37.8%. The market size of the district is Rs. 13860 crore. Per capita income for Urban & rural sector is Rs. 49161 & 2304.

SWH Scenario: Nagpur falls under composite climate and receives a solar radiation of about 5.6 kWh/m^2/day. SWH installation in the city is estimated to be around 1000000 lpd with an annual sales of 2,00,000 lpd. Almost 90% installation is in residential sector. FPC and ETC sales ratio is 20:80 while installations have ration of 65:35. The city shares around 8-10% of SWH market of the state. There are 2 national brand SWH dealers, 1 assembler and one other dealer in the city. The market is expected to grow by 25-30% per annum for next few years.

***Summary of primary survey & stakeholder interviews*:**

- Demand-enhancers: Limited apartment culture. Hence, good scope for SWH. Daily 4 hour power-cut. 2 hours in the morning; 2 hours in the evening. High radiation 300 days/year

- Demand-Dampeners: Dissatisfied customers spread negative publicity far more actively than satisfied ones. Dealer churn- 20 dealers have entered/existed in last seven years.

- Co-operative banks active on SWH-financing. Nationalized banks passive and this is a demand dampener
- Brisk demand from hospitals/nursing homes. The owner-doctor stays on the top floor; feels mentally assured of SWH water-supply for his family. Hostel demand is strong
- Hotel demand is affected by capex requirement and recourse to wood. A 30-room hotel spends Rs. 50000 per annum on wood.
- Weak industrial demand. Capex requirement and recourse to agro waste prevent build up of industrial demand. Dairy utilizes SWH to meet cleaning water requirement; not pasteurization because pasteurization demand 80^{o}C temperature. Pharma industry has stayed away from SWH because of 100^{o}C temperature requirement.
- Nagpur Municipal Corporation has issued an order dt. 3-1-2008, making SWH compulsory in the context of issuing building use permission. The details are as follows.

Sr. No	Type of buildings	Per capita capacity recommended (ltrs) per day
1	Hospitals	100
2	Hotels	150
3	Hostels and other such buildings	25
4	Canteen	As required
5	Laboratory and research institutions	As required
6	Residence (for 100 sq.mtr and above except LIG/EWS and slum)	25

The order is not implemented at the ground-level

- Nagpur Municipal Corporation has passed a resolution to provide 10% rebate on property tax but this is not implemented.
- There is no electricity tariff rebate.
- Non-household establishments report complete lack of awareness of capital subsidy for SWH.
- International Council for Local Environmental Initiatives (ICLEI)- GTZ has a resource center in Nagpur Municipal Corporation premises where SWH sample and info displayed; including dealer list.

Caselet: MM Solar Nagpur

This is owned by Yogesh Ranade who is into SWH business since 1999. His brother used to work for an SWH manufacturer and, together, they graduated to becoming a dealer. He is also engaged in institutional marketing of streetlight, LED and CFL products. He was a dealer for a large manufacturer until 2008. The growing popularity of ETC and own experience prompted Yogesh to enter the business of producing ETC SWH in 2008. He produces the tank and sources imported tubes. He is supported in the ETC marketing business by a dealer each at Gondia, Bhandara, Vardha, Yavatmal and Gadhchiroli. The dealer remains responsible for marketing, installation and after-sale support in these cities. Encouraged by initial success, Yogesh is preparing to manufacturer FPC SWH in a year. There are commercial/industrial customers who do not accept ETC, are keen on FPC. This explains Yogesh's desire to produce FPC SWH.

17. Pune

Profile: Pune, a district of state Maharashtra, spreads over 15,642 km^2 of land. As per census of 2001, the population of the district was 7,232,555 with an urban share of 58.08%. The current population of Pune urban agglomerate is over 4 million. Total numbers of households were 1,517,041 with an average household size of 5. Almost, 61% of the households are urban and the growth rates in household for urban and rural sector during 1991-2001 was 4% & 1.1%, respectively. Household with two wheeler ownership is around 47.37%. The market size of the district is Rs.31415 crore. Almost, 74.94% of the household are of permanent construction. Today, Pune is known for its educational facilities, having more than a hundred educational institutes and nine universities. Pune has well-established Manufacturing, Glass, Sugar and Metal Forging industries. Being the eighth largest city of India, the commercial sector has also developed rapidly.

SWH Scenario: Pune falls under warm-humid climate and receives a solar radiation of about 5.6 kWh/m^2/day.

***Summary of primary survey & stakeholder interviews*:**

- ***Non-Owners*** Household: Households- hot water bath almost round the year; 13 out of 16 have geysers; mixed reaction on power-cuts in winter but cannot depend on power in winter; reaction to SWH somewhat unfavorable but exposure is considerable.

- ***Non-Owners*** Hospital: 40 to 80 lit/day of hot water requirement per day per room, Depends on electricity and LPG. Mixed reaction to SWH but exposure is considerable.

- ***Non-Owners*** Hotel: Room capacity in 20 to 50 range, hot water requirement is 20 to 25 litre/room, Electricity for water heating, mixed reaction to SWH but good exposure.

- ***Non-Owners*** Industry: Interviewed three pharmaceutical industries. All three need steam- 500 to 2000 kg range. None needs hot water. Use liquid fuel. Low interest in SWH but good exposure

- ***Owner*** Household: Interviewed 6 bunglows and 2 apartments. Power- cuts in winters, Average capacity per HH: 175 lpd largely no electric backup. All use FPC syetems. 50% of them availed of loan and 25% availed of subsidy. Electricity/property tax rebate not availed, most use it for over 300 days. Over-all happy experience

- ***Owner*** Hotels: Three hotels having 51 , 87 and 228 rooms respectively. Hotel reports hot water requirement @150 ltrs/room/day, hostel reports 50 ltrs/room/day. All systems are FPC. SWH provision @ 80% to 90% of hot water requirement. Over-all satisfied with SWH.

- ***Owner*** Hospital: 88 rooms. Water requirement @ 20 ltrs/room. Power cut problem. SWH @ 30% of hot water requirement. Over-all satisfied with SWH.

- ***Owner*** Industry: Alfa Laval and Finolex, SWH used for hot water in canteen. System size, 2000 ltrs/day and 1500 ltrs/day respectively. One of them availed of subsidy. No loan, no other benefit. Used for 250 to 300 days/year. Back up is electricity. Over-all satisfied with SWH.

- ***Manufacture/dealers*** : 90% to 95% of the market is for households. Flat plate dominates but relatively new entrants pushing ETC. Existing base estimated at 50 lacs lpd. Annual sale in Pune estimated at 25 lacs lpd. Pune expected to account for 30% to 50% of Maharashtra.

- ***SNA:*** Has computed 9.5 million m^2 potential for Maharashtra: New HH-0.51, Existing building-8.50, Hotel/hostel etc.-0.27, Hospital-0.18, Govt.-0.02.

- ***Municipal Corporation***): 5% rebate on property tax, PMC has installed SWH at three crematoria, two hostels, and three hospitals. It believes that it is appropriate mainly for individual houses.

- ***Bank***: Bank of Maharashtra and Bank of India. BOM has financed 7500 systems in last three years; 80% individual, 10% institutional, 10% commercial. Manufacturers/dealers bring cases. Repayment is good, but hurt by supposed Govt. ownership of the scheme. People think they need not pay, if it is Govt. scheme. BOM suggested reduced margin. BOI has not financed but aware. Too much paperwork for too small amount.

- ***Architect***: Good for independent houses. Not for apartment because distribution policy not easy to work out. There is permission problem. Supports mandatory regulation. Never invited to any SWH event. Households and hotels most potential categories.

- ***Builder***: Positive feedback. Supports compulsion. Cost and customer acceptance are not issues. FPC more suitable. Another builder, however, considers it unsuitable for apartments. Both have used it in their projects. One of them advocates subsidy and electricity tariff rebate.

18. Thane

Profile: Thane, a district of state Maharashtra, spreads over 9558 km^2 of land. As per census of 2001, the population of the district was 81,31,849 with an urban share of 72.58%. Total numbers of households were 1,755,124 with an average household size of 5. Almost, 74.6% of the households are urban and the growth rates in household for urban and rural sector during 1991-2001 was 5.5% & 1.8%, respectively. Household with two wheeler ownership is around 15%. The market size of the district is Rs.34678 crore. Almost, 77% of the household are of permanent construction. Thane is the third-most industrialized district in Maharashtra.

SWH Scenario: Thane falls under warm-humid climate and receives a solar radiation of about 5.6 $kWh/m^2/day$.

***Summary of primary survey & stakeholder interviews*:**

- ***Manufacture/dealers***: Existing Base of SWH in the district is estimated as 10 to 12 lacs lpd. Household have 90% share of the total SWH installation, and 95% of it is in apartments, mainly due to compulsion. FPC share 90% of installations. Thane district share in Maharahstra is estimated to be 6 % to 10%. The competition is intense and price-based; quality overlooked.

- ***Municipal Corporation*** : TMC was the first city in India to make SWH compulsory. Compulsory SWH since 2005- new hospitals, hotels, guest-houses, barracks, canteens, labs, research institutions, hostels, and Govt./public sector buildings plus residential building. Compulsory for existing buildings, if they seek change of use other than residential and Govt./public sector use. Intention to make it compulsory for all existing buildings, except residential. 10% property tax rebate for residential buildings. Capacity norm prescribed @ 25 lpd/person for most buildings. 100 lpd and 125 lpd for hospitals and hotels respectively. No fixed norm for canteens and research institutions. FPC of IS no 12933 mandatory. Implicitly, no scope for ETC. TMC could furnish a list of 58 buildings, totaling over 3 lac lpd where SWH is installed from Sept 2005 to June 2008. Not sure if this is an exhaustive list. TMC estimates that 3000 SWH systems (presumably of

150 lpd, on average are coming up annually. This ties in with trade estimate of 5 lac lpd/year. The suggestions received by TMC pertain to additional space to be allowed for SWH installation. TMC highlights need for a separate authority to check and monitor SWH installations.

- ***Architect*** : Two architects who have designed provision for SWH are enthusiastic about SWH in independent houses but not so enthusiastic for apartments. Terrace space is a problem in apartments; they advocate extra terrace being allowed. They give an impression that in apartment buildings, hot water timings are regulated and occupants grudge this.

- ***Builder*** : Two builders interviewed have installed. Both support the product. However, one of them reports problems in a multi-storied building where early bathers exhaust the quota and late bathers do not get hot water.

- ***Bank*** : A line of credit for builders can change credit position. Most SWH enquires are turned down. A mechanism to track these and offer to them an alternative credit product. It may not help to make all banks/all branches credit distributors; the functionaries will not build knowledge/experience. Let there be a select but focused SWH credit outlets in the city. A mechanism to respond to product/scheme queries of bank officials.

- ***Non-Owners*** Household Presently, most of them use electric geyser for heating water. Hot water requirement is round the year. People are well aware of the technology.

- ***Non-Owners*** Hospital: 20-30 lit/day of hot water requirement per day per room, Depends mainly on electricity, Mixed reaction to SWH but exposure is considerable.

- ***Non-Owners*** Hotel: Terrace availability is a major problem. Aware that such a product exists but not aware of types or cost. Not approached by manufacturer/dealer. Not aware of Govt. support schemes. All are strongly interested in learning.

- ***Non-Owners*** Industry : Interviewed three food processing and three pharma. Except one, all others need steam- 200 to 1000 kg range. Use liquid fuel and one uses firewood. Low interest in SWH but good exposure.

- ***Owner*** Household: Interviewed 3 bunglows and 4 apartments. Only one has the electric geyser. Power- cuts in winters. No one has taken loan or availed subsidy. Most use it for over 300 days. Happy experience.

- ***Owner*** Hospital: Total 21 rooms. Water requirement @100 lit/room. Power cut problem.

- ***Other observations:*** In Thane, many builders put up a system which will meet, say, 10% (1000 lpd for 100 families) of hot water demand. Some builders shift the system to another building, once cleared. Many builders want a cheap system; good enough for 3 to 4 years. Some builders connect only the top floor to SWH. The hot water hours in apartment buildings are regulated typically 5 to 11 a.m; the valve is turned off. The terrace availability does not pose a problem till 12 floors. Beyond that, provisioning reduces. There is a system in 24 storied building designed to cater to 35% of the requirement.

19. Bhubaneswar

Profile: Bhubaneswar, a district of Orissa, spreads over 2888 km^2 of land. As per census of 2001, the population of the district was 18.77 lacs with an urban share of 42.9%. Average annual growth in population for 1991-2001 in rural and urban sector was 1.66 & 2.19%, respectively. As per census 2001, total numbers of households were 268,950 with an average household size of 7. Almost, 73.4% of the households are of permanent construction. Almost, 49% of the households own a two wheeler. Market size of the district is around Rs.8600 crores and the per capita income for urban and rural sector is Rs.25,500 & Rs.1700, respectively. Bhubaneswar is the largest city in central Orissa, 2nd largest city in east India. With its large number of Hindu temples, Bhubaneswar is often referred to as a Temple City of India.

SWH Scenario: Bhubaneswar falls under warm-humid climate and receives a solar radiation of about 5.4 $kWh/m^2/day$. The city has 1 SWH assembler, 6 national brand dealers and one local dealer. FPC-ETC split up of existing installation is 80:20 while the split up for annual sale is 20:80. The district has 7-10% of the SWH market share for state. The SWH market is expected to grow by 25-30% in next few years. According to dealer a sales of 10,000 LPD has been recorded in the upcoming institutions during the year 2008-09. Nearby markets are Angul, Bherhampur, Koraput, Sunabeda, Baripada, Baleswar, Bhadhrak, Rourkela, Sambalpur.

***Summary of primary survey & stakeholder interviews*:**

- There are several unsatisfied customers because of non-functioning of SWH due to various reasons. They spread negative publicity far more actively than satisfied ones.

- No banks are active on SWH-financing. Nationalized banks passive and this is a demand dampener. Bank of India & Union Bank has financed 3 and 4 nos.100 LPD systems respectively).

- The demand for hospitals/ nursing homes is significant. The hospital management feels that providing hot water through SWH reduce their cost and contribute to environment but are worried about after sales services. Hostel demand is also strong.

- Hotel demand is affected by initial capital requirement they want that SWHS of 500 LPD should be considered as commercial unit and 100% depreciation benefit would encourage them to go for it.

- Weak industrial demand. They also feel same as hotelier, Dairy never tried to utilize the system. The rice mill owners and fly ash brick manufacture are keen to utilize as pre-boiling equipment.

- Bhubaneswar Municipal Corporation does not have any policy for SWH.

- Non-Owner Households: Households- hot water use almost round the year; 25 out of 50 have geysers. The use of hot water is almost 275-280 days of the year; mixed reaction on future power-cuts but; reaction to SWH somewhat unfavorable because of no awareness, how it functions & cost of system.

- Non-Owners Hospital: 20 lit/day of hot water requirement per day per room and 200 lit/day for sanitation entirely depends on electricity & LPG. Mixed reaction to SWH, not clear how it will help sanitation activity. Very much hopeful on long term cost factor

- ***Non-Owners*** Hotel: Room capacity in 20 to 50 range, hot water requirement is 20 to 25 litre/room, Electricity, LPG & mini wood boiler for water heating, mixed reaction to SWH, because no good exposure.

- ***Non-Owners*** Industry: Interviewed one dairy industries (Orissa Milk Federation co-op Ltd.). They require steam- 2000 kg range. During 1985 used 10000lits/day, lack of support and service discouraged them, which forced the management to dismantle the unit.

- ***Owner*** Household: Interviewed 6 bungalows, most use it for over 300 days. All of them face after sales service problem. Developed their own technician; over-all happy experience.

- ***Owner*** Hotels: Three hotels having 150, 100, & 60 room. Most of them converted to electric heater. It presumed that, to acquire the system with subsidy was the intention. Not aware about current technological development like ETC.

- ***Owner*** Hospital: 30 rooms. Water requirement @ 25 ltrs/room. Power cut problem. SWH meets 60% of hot water requirement. Over-all satisfied with SWH.

- ***Manufacture/dealers*** : 90% market is for households and 10 for institution and service industry .New ETC technology. Existing base estimated at one lacs lpd. Several national level brand dealers are present.

Caselet: Gayatri Solar Bhubaneswar
A young engineer in the year 1994 began his mission "Solar Energy System on each rooftop of Orissa" inspired by new technology on visualizing the future energy demand with market development and guided by his father Er.G.H.Panigrahi without any support from any Govt. body. He traveled and surveyed entire state with his bike and found interesting facts and defects on Solar Water Heating System installed an approximate capacity of 20000LPD spread over different locations/district by OREDA . Repaired free of cost the minor defects and made the system functional with smile on customers face and building the confidence that solar systems can be operational for longtime if minor maintenance is carried on time. In due course the survey, contacts, effort, timely service & dedication helped his business of solar water heating system.

20. Sambalpur

Profile: Sambalpur, a district of Orissa, spreads over 6702 km^2 of land. As per census of 2001, the population of the district was 935,613 with an urban share of 27.12%. As per census 2001, total numbers of households were 202,247 with an average household size of 5. Almost, 33% of the households are of permanent construction. Average annual growth in household construction for rural and urban sector is 1.2 & 2.1%, respectively. Almost, 19% of the households own a two wheeler. Market size of the district is around Rs.1200 crores. The place is famous for its globally renowned textile bounded patterns and fabrics. Apart from textiles, Sambalpur is also famous for rice production and rice mill hub.

SWH Scenario: Sambalpur falls under warm- dry climate and receives a solar radiation of about 5.4 $kWh/m^2/day$.

***Summary of primary survey & stakeholder interviews*:**

- Demand-enhancers: Limited apartment culture. Hence, good scope for SWH. Daily unscheduled power cut, High radiation 300 days/year, Nov- Mid February experienced sharp fall in temp to 3-4 degree.

- No banks are active on SWH-financing. Nationalized banks passive and this is a demand dampener.

- Sector specific scenarios in Sumbalpur is very much encouraging; particularly large number of rice mills currently use boilers . During interview it is learnt that,

considering environmental factor and saving of resources SWH could be good option as primary feeder to boiler cannot be ruled out. This alone could be 2lac lpd capacity.

- Sambalpur Municipal Corporation does not have any policy for SWH.

In the city of Sambalpur the rice mill could be a potential user of the SHW in coming years.

21. Patna

Profile: Patna, the capital of Bihar state, spreads over 3202 km^2 of land. As per census of 2001, the population of the district was 3,618,210 with an urban share of 44%. As per census 2001, total numbers of households were 726,364 with an average household size of 5. Almost, 68% of the households are of permanent construction. Average annual growth in household construction for rural and urban sector is 2.1 & 3.6%, respectively. Almost, 17% of the households own a two wheeler. Market size of the district is around Rs.11210 crores. Major industries in the district include Leather, Handicrafts, Agro processing. There are a lot of educational institutes in the Patna city.

SWH Scenario: Patna falls under composite climate and receives a solar radiation of about 5.5 kWh/m^2/day. Last year Sales recorded 10,000 lpd.

***Summary of primary survey & stakeholder interviews*:**

- ***Residential***: Almost half of the non SWH users have electric geyser and other use LPG stove for heating water. There are frequent power cuts in the winter morning. Hot water demand in a year ranges from 4-5 months/year. People have mild exposure and interest in SWH. All 4 SWH owners have independent bungalow. Hot water is used for bathing and utensil washing. Hot water usage in a year is up to 250 days. Two of them have done retrofit for SWH installation. Two of them have used subsidy.

- ***Hospitals***: 2 non users with 72 & 24 room capacity. Using electric geyser for heating water. Hot water demand per room ~20 lpd. Not aware of the technology but shown interest. For them cost is the major barrier. One user with 2000 lpd SWH installation. Installation done without loan or subsidy. Overall happy with the product and the after sales service.

- ***Hotels***: 2 non users with 60 & 35 room capacity. Using electric geyser for heating water. Hot water demand per room ~20 lpd. Not aware of the technology and not shown any interest. Feels that the cost is high and requires efforts in maintaining.

Two users 21 & 42 rooms. Both availed the subsidy. One of them has some issues with scaling and leakage. SWH meets 100 & 50% of their hot water demand.

- ***Industries***: 2 non users, one has the hot water demand of 500 lpd. Presently use diesel for heating water. Aware of the technology but interest is low. One dairy is using SWH system of 25,000 lpd. Satisfied with the product.

22. Ranchi

Profile: Ranchi, the capital of Jharkhand state, spreads over 7574 km^2 of land. As per census of 2001, the population of the district was 2,785,064 with an urban share of 35%. As per census 2001, total numbers of households were 505,508 with an average household size of 5.5. Almost, 33% of the households are of permanent construction. Average annual growth in household construction for rural and urban sector is 2 & 3%, respectively. Almost, 19% of the households own a two wheeler. Market size of the district is around Rs.33609 crores. Ranchi is a prominent political, commercial, industrial, and educational hub of eastern India. Ranchi accounts for 50% mineral production of the state, nearing about 18% of nation's mineral production.

SWH Scenario: Ranchi falls under composite climate and receives a solar radiation of about 5.4 kWh/m^2/day. Here 1 lac lpd in residential sector and 2 lacs lpd in institutional/ industry is possible in next 2-3 yrs.

***Summary of primary survey & stakeholder interviews*:**

- ***Residential***: Almost half of the non SWH users have electric geyser and other use LPG stove for heating water. There are frequent power cuts in the winter morning. Hot water demand in a year ranges from 76 to 225 days. People have mild exposure and interest in SWH. Except one, all 5 SWH owners have independent bungalow. Hot water is used for bathing and utensil washing. Hot water usage in a year ranges from 76 to 250 days. Three of them have done retrofit for SWH installation. SWH meets most of their hot water demand.

- ***Hospitals***: 2 non users with 10 & 20 room capacity. Using electric geyser for heating water. Hot water demand per room ~5 lpd. Not aware of the technology and shown some interest. One user with 500 lpd SWH installation. Installation done without loan or subsidy. Usage is round the year. Overall happy with the product performance and the after sales service.

- ***Hotels***: 2 non users with 50 & 75 room capacity. Hot water requirement is very low. Cost seems to be high for them. Two users 20 & 25 rooms having 2000 & 3000 lpd SWH system. Both availed the subsidy.

- ***Industries***: One Pharma industry is using SWH system of 18,000 lpd. Round the year usage. Availed subsidy. Two dairy units use 2000 lpd.

- ***Non-Owners*** Industry: Interviewed one dairy industries one fly ash brick unit . They required steam- 1000 kg range. The fly ash brick unit looking to change technology where hot water will be used the approximate requirement will be 10,000 lts, for him SHW could be a good option.

- ***Manufacture/dealers***: 70% market is for households and 30% for institution and service industry .New ETC technology. Existing base estimated at 2 to 2.5 lacs lpd. Annual sale in and around of Ranchi.

Ranchi is one of most potential city for SWH System among the eastern state due to its climate and industrial demand.

23. Raipur

Profile: Raipur, the capital of Chhattisgarh state, spreads over 2517 km^2 of land. As per census of 2001, the population of the district was 3,016,930 with an urban share of 30%. As per census 2001, total numbers of households were 5 81,582 with an average household size of 5. Almost, 40.7% of the households are of permanent construction. Almost, 22% of the households own a two wheeler. Market size of the district is around Rs.5157 crores. The district is rich in mineral resources.

SWH Scenario: Raipur falls under composite climate and receives a solar radiation of about 5.4 kWh/m^2/day. Last year sales recorded 25,000 lpd (by Govt. Guest house & govt. quarters). The current estimate shows 2lac LPD could be achievable in next 2-3 years

***Summary of primary survey & stakeholder interviews*:**

- ***Residential***: Majority of the non SWH users have electric geyser while others use LPG stove for heating water. Among the geysers small on line are mostly used. There are power cuts in the winter morning. Hot water demand in a year is for 4-5 months. Awareness is low but shown some interest in SWH. All 3 SWH owners have independent bungalow. Hot water is used for bathing and utensil washing. Hot water usage in a year ranges from 76 to 175 days. One of them have done retrofit for SWH installation. Two of them have availed subsidy.

- ***Hospitals***: 3 non users, presently using electric geyser for heating water. Hot water demand per room ~20 lpd. Not aware of the technology but shown interest.

- ***Hotels***: 2 non users with 60 & 40 room capacity. Using electric geyser for heating water. Hot water demand per room is around 20-25 lpd. Not aware of the technology but showed high interest. Feels that the cost is high. Two users 52 &

35 rooms, having 2000 & 500 lpd system. Both availed the subsidy. Overall experience is good.

- ***Non-Owners*** Household: Households- hot water use almost round the year; 60 out of 100 have geysers. The use of hot water is almost 100-150 days of the year; mixed reaction on future power-cuts but; reaction to SWH somewhat unfavorable because of no awareness, how it functions & cost of system.

- ***Non-Owners*** Industry: Interviewed one dairy and one rice mill unit both use boiler for steam and hot water. Did not show much interest in SWH.

- ***Owner*** Household: Interviewed 6 independent, most use it for over 270-300 days. All of them have FTC model face after sales service problem. Over-all happy experience.

For the city of Raipur in coming years both residential sector and institutional sector will be potential user for SWH system.

24. Kamrup (Guwahati)

Profile: Kamrup, A district of Assam state, spreads over 2740 km^2 of land. As per census of 2001, the population of the district was 2,522,324 with an urban share of 36%. As per census 2001, total numbers of households were 490,740 with an average household size of 5. Almost, 33% of the households are of permanent construction. Almost, 17% of the households own a two wheeler. Market size of the district is around Rs.8396 crores.

SWH Scenario: Kamrup falls under warm-humid climate and receives a solar radiation of about 4.9 $kWh/m^2/day$. There are around 19 installations in the city, out of which 3 are not functioning.

***Summary of primary survey & stakeholder interviews*:**

- From the experiences of the solar hot water users of Guwahati, it is found that most of the users are satisfied with the performance of the systems and are using such systems almost all the year round except, for a few days of continuous cloudy days.

- During recent years a number of SWH systems have been installed within Guwahati city without any Government subsidy or bank loan and the users are fully satisfied.

- It is found from the primary survey of non owner households that, out of 11 non owner (of SHW) households of Guwahati city as many as 9 households have electric Geysers (standard size, 2 kW). Most of these users would opt for Solar

system if such systems are dependable and economically viable. Further, a large numbers of multistoried residential complexes are coming up in Guwahati and in such complexes there are electric geysers in 90% of apartments. Present population of geyser in such residential complex is estimated to be around 6,000.

- From the feedback received from primary surveys of guest houses and hospitals, even without any subsidy or support solar hot water systems are considered economically viable for hotels, guesthouses, hospitals and hostels, particularly when combined with preheating of water for cooking purpose.

- WEAKNESS: Lack of awareness, system cost is high (Rs.28,500 for 100 lpd FPC system), no regulation binding the hotels , hospitals and residential complexes to use solar hot water system, very poor after sale service and low marketing effort by the solar hot water companies/ dealers.

- The potential industries are

    - Milk pasteurization plants- preheating boiler water. 9 plants in Govt. sector and 8 plants in private sector with average requirement of 500 LPD.

    - Tea factories steam /boiling where water is used for sterilizing the floor. The average requirement of factories is 1000 LPD and there are around 1000 factories in Assam.

- ***Policy***: In the electricity tariff taxed by the State Regulatory Commission for the electrical distribution companies there is a provision of rebate of Rs. 40.00 per month per 100 LPD SHW installed. There is no other regulatory / mandatory provision for use of SHW system in Assam. There is a Govt. of India scheme of bank loan at 'nil' interest for SHW system for NE States. Higher level of subsidy is available from MNRE. Govt. of India for Solar Water Heating System.

Caselets:

i) Guwahati Neurological Research Centre (Hospital) invested Rs. 3,10,000.00 in a 2500 LPD SHW system during the year 2005 . Yearly saving is estimated by the Engineer in-charged at Rs.11,250.00. Thus the payback period was about 3 years only.

ii) Similarly, the St. John's Hospital who invested Rs. 2,50,000 for a 1000 LPD system, is saving about Rs. 4320.00 in electricity per month. As such, the payback period is about 5.years.

iii) Sisters' of Superior Auxiliary is using a 1000 LPD SWH for last 4 years and meeting over 80% of hot water requirement from the SHW.

iv) The Indian Institute of Entrepreneurship, Guwahati is fully depending on hot water supply in the 42 rooms (single bed) trainees' guesthouse for last nine years on the 2500 LPD hot water system installed in their guest house.

v) The Purabi Dairy saved around 30% of cost of fuel (diesel) when their 2500 LPD solar hot water system, when the system was in use for 10 years from1991.

25. Darjeeling

Profile: 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. Almost, 11% of the households own a two wheeler. Market size of the district is around Rs.3242 crores.

SWH Scenario: Darjeeling District falls under warm-humid climate and receives a solar radiation of about 5.2 kWh/m^2/day. The hills of Darjeeling gets less than 4 kwh/m^2 / day solar radiation. The existing installation in the city is around 5000 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. Siliguri city share in West Bengal market is around 5-7%. There are 3 assembler, 3 national brand dealers and 1 other dealer in the city. Market is expected to grow by 50% for next few years.

*Summary of primary survey & stakeholder interviews***:**

- *Demand-enhancers*: Daily uses of hot water almost throughout the year. High radiation is available in the Siliguri and Kalimpong area almost 200 days in a year. High cost of electricity in WBSEDCL area. Average Temperature is low in comparison to other part of West Bengal.
- *Demand-Dampeners*: After sales service is very poor from the supplier's side. Low radiation in the hill areas is the main barrier for growth in demand.
- Some systems was found non functional due to low radiation and poor after sales service of the suppliers.
- Bank loan is not available till now.
- Siliguri Corporation has not issued any policy regarding use of the SWH system.
- Easy bank finance for installing the SWH system is needed.
- Hostels, institutions & hotel industry have good potential r in Darjeeling town and also in the sub divisions particularly. Kalimpong has better potential because of high number of sunny days with low ambient temperature.

Caselet: North Bengal Alternative Energy & Rural Development Association
Mr. Ashok Barari Secretary of this organization has worked a lot in various sectors like old-age home, orphanage home, institutions, hostels, households etc. for installing the solar energy systems like solar hot water, home lighting, street light, lantern etc. for the past 30 years in remote areas of North Bengal such as Panighata, Mirik, Matigara (situated in Darjeeling dist.), Sikkim North, East, South, West (situated in Sikkim).
In last year Mr Barari took initiative to install Solar Water Heater system in a orphanage home called "Ashagram" situated at Rani danga , Darjeeling district. They have installed 1600 LPD system and now they are very much satisfied with their experience. They are using hot water for residential children bathing, cooking, clothes cleaning etc.
Last year they have installed 200 LPD SWH system in "Apna Ghar" an old-age home situated at Calom Jote, Matigara, Darjeeling District, they are also satisfied with the system.There are more such examples. He works silently to improve the market and generating the awareness of the people.

26.Kolkata

Profile: Kolkata, the capital of state West Bengal, spreads over 187 km^2 of land. As per census of 2001, the population of the district was 4,580,544 with an urban share of 45%. Annual growth rate in population during 1991-2001 was 0.4%. As per census 2001, total numbers of households were 929,586 with an average household size of 5. Almost, 91.3% of the households are of permanent construction. Almost, 19% of the households own a two wheeler. Market size of the district is around Rs.13980 crores.

SWH Scenario: Kolkata falls under warm-humid climate and receives a solar radiation of about 5.4 kWh/m^2/day. The existing installation in the city is around 100,000 lpd. Annual sale is around 45,000 lpd in the city. Households share 70% of the existing installation. FPC-ETC split up of existing installation is 75:25 while the split up for annual sale is 60:40. Kolkata city share in West Bengal market is around 50-60%. There are 1 manufacturer, 5 assemblers, 2 national brand dealers and 3 other dealer in the city. Market is expected to grow by 50% for next few years.

***Summary of primary survey & stakeholder interviews*:**

- *Demand-enhancers*: Frequent Power cut in Kolkata. High radiation in almost 265 days in a year. High cost of electricity in CESC / WBSEDCL area. Availability of soft loan.

- *Demand-Dampeners*: Leakage problems. Initial high cost. Poor service provided by the supplier. Non availability of water with full pressure at the Roof. (In case of old houses)

- Competition exists only in dealers of SWH system. Practically no manufacturers exist in Kolkata, except one of inferior quality. After sale service is very poor from the supplier side.
- Bank loan is not available easily.
- Awareness of general people is low.
- Kolkata Corporation has not issued any policy regarding use of the SWH system.
- Annual Maintenance Contract from Supplier is required for the growth of the market.
- Low industrial demand. Household sector & hotels industry and Hospitals are very much potential sector in Kolkata
- In West Bengal most of the system installed in Govt. sector are non functional.
- Old aged homes run by NGOs are also prospective customers

Caselet 1:Ramakrishna Mission Residential College, Narendrapur,
The College, set up in 1960 and affiliated to the University of Calcutta, has 6 science departments. Since the college is dedicated to the ideal of man-making and character building education as propounded by Swami Vivekananda, the college lays much emphasis on values both moral and spiritual and on games and sports. The College has well-equipped prayer halls at the hostels; cricket, football and table-tennis teams which perform quite creditably in different sports meets

Ram Krishna Mission Residential College, Narendrapur

Swami Suparananda Maharaj Principal, College is so much satisfied with this system. 2800 LPD installed in this college. There are three 3- storied hostel building (Brahmananda Bhavan, Gauranga Bhavan, Ramkrishna Bhavan) where the system has been installed. Mainly cooking and bathing purposes they use the hot water and they are quite satisfied with the system because of getting instant hot water in any time of the day.

27. Shillong (East Khasi Hills)

Profile: Shillong, the capital of state Meghalaya, spreads over 2752 km^2 of land. As per census of 2001, the population of the district was 660,923 with an urban share of 42%. Annual growth rate in population during 1991-2001 was 2.1%. As per census 2001, total numbers of households were 125,567 with an average household size of 5. Almost, 43.7% of the households are of permanent construction. Almost, 5% of the households own a two wheeler. Market size of the district is around Rs.1484 crores.

SWH Scenario: Shillong falls under warm-humid climate and receives a solar radiation of about 4.8 kWh/m^2/day. There are around 27 installations in the city, out of which 24 are domestic.

***Summary of primary survey & stakeholder interviews*:**

- There is hot water demand round the year. From the radiation availability point of view, SWH can fully meet hot water demand for 8 months, 50% for 2 months and 2 months electric backup is required. From the experiences of the solar hot water users, it is found that all the users are satisfied with the performance of the systems and are using such systems almost all the year round, except during continuous cloudy days.
- Cost is not a major barrier as SWH systems have been installed in hotels/hostels within the city without any Government subsidy or bank loan.
- As most of the residential houses in Meghalaya are with sloping roofs there are problem /extra cost in installation of SWH system.
- Awareness is quite low. System cost is high (Rs.28,500 for 100 lpd system).
- Very poor after sale service and low marketing effort by the solar hot water companies/ dealers.
- ***Policy:*** The state Govt. provides Rs 3000.00 per domestic system for targeted numbers of beneficiaries every year. There are no other regulatory/Tariff incentive. There is a Govt. of India scheme of bank loan at 'nil' interest for SWH system for NE States.

28. West Tripura (Agartala)

Profile: West Tripura, a district of state Tripura, spreads over 2997 km^2 of land. As per census of 2001, the population of the district was 1,532,982 with an urban share of 27%. Annual growth rate in population during 1991-2001 was 1.7%. As per census 2001, total numbers of households were 321,777 with an average household size of 5. Only, 13.7% of the households are of permanent construction. Almost, 8% of the households own a two wheeler. Market size of the district is around Rs.3415 crores.
SWH Scenario: Agartala falls under warm-humid climate and receives a solar radiation of about 5.2 kWh/m^2/day. The existing installation in the city is around 6300

lpd. Annual sale is around 200 lpd in the city. Households share 20% of the existing installation. FPC-ETC split up of existing installation is 75:25 while the split up for annual sale is 70:30. Agartala city share in Tripura market is around 25-30%. There are 2 national brand dealers and 1 other dealer in the city. Market is expected to grow by 50% for next few years. Nearby markets: Bishalgarh, Sekerkut, Teliamura, Khowai, Ranirbazar, Jirania.

*Summary of primary survey & stakeholder interviews***:**

- ***Demand-enhancers***: Limited apartment culture, good scope for SWH. Daily average 2 hour power-cut. Almost 250 clear days in a year. Winter is of 5 months.
- ***Demand-Dampeners***: Leakage problems. High initial cost. Absence of marketing network of SWH manufactures.
- Awareness of general people is low.
- There is only growth in Govt. sector.
- Annual Maintenance Contract from Supplier is required for the growth of the market.
- ***Policy***: A local assembler has tied up with two co-operative banks for providing of low interest loan to SWH users. Agartala Municipal Corporation has not issued any policy regarding the use of the SWH System. There is no electricity tariff rebate on use of SWH. Agartala Municipal Corporation has not passed any resolution to provide any rebate on property tax to encourage SWH user.

Caselet: Sagarmahal Guest House under ICAT Dept. Govt. of Tripura.

There is a tourist place named Nirmahal under Melaghar block in West Tripura district. The Nirmahal is constructed in the middle of the big water body with an attractive design before 100 years by the kingdom of Tripura. Hence it has become an attractive tourist spot in the state. The Sagarmahal has been constructed for accommodation of the tourist who stay there for one or two days. The authorities approached TREDA for installing of SWH system in the Sagarmahal for hot water uses. Accordingly TREDA has installed the SWH in the following manner.

Year of installation: 2006.
Capacity: 1000 lpd.
Supplier: Rashmi Solar.
Cost: Rs. 200000.
Subsidy from TREDA: Rs. 160000.
Contribution from Sagarmahal: Rs. 40000.

The side of installation is shadow free and sunshine is available for whole day. Beneficiary is fully satisfied about the functioning of the SWH.

It does not work for 40 to 50 days in a year due to rainy days and cloudy sky. In other days they are getting full quantity of water at a temperature of 55°C to 65°C. They are using this hot water for bathing and cooking regularly. Previously they were using geysers' for bathing in 16 rooms of the guest house but now they have stopped using geysers' as they have the solar hot water. They are saving 2400 kwh electricity per year and 500 to 700 kg biomass per year. Net savings Rs.25000/year (approx.).
No major problem has been faced by them. Only some minor problem in piping & tape including the insulation of the piping. These have been repaired and servicing was done by TREDA with an cost of Rs. 6000 (approx.) from 2006. Tourist and visitors become inspired by seeing the SWH system.This is a very good technology because it runs without any fuel and operators. Tourism dept. are now very much interested to install such type of SWH system in their other guest houses in Tripura.

29.LehLadakh

Profile: LehLadakh, a district of state Jammu & Kashmir, spreads over 45, 110 km^2 of land (largest in India). As per census of 2001, the population of the district was 117,232 with an urban share of 24%. Annual growth rate in population during 1991-2001 was 2.7%. As per census 2001, total numbers of households were 24,147 with an average household size of 5. Only, 3.5% of the households are of permanent construction. Almost, 9% of the households own a two wheeler. Market size of the district is around Rs.359 crores.

SWH Scenario: Leh falls under cold climate and receives a solar radiation of about 5.4 kWh/m^2/day. At present, SWH deployment in the district is less but the potential is quite good for the district. As per the recent study, the SWH potential for the Leh district is estimated around 9.4 lacs lpd (~18,800 m^2 of collector area). Almost 40% of the total potential falls under residential sector. Hotels & guest houses have 35% share in the overall potential. As per census 2001, total number of hospital beds in the district was 310.

Residential: Having the very cold climate conditions, hot water is required throughout the year. Based on the studies done in 90's it was found that, on an average, 100 lpd system is required per household to meet their demand. Recent studies show that around 4000 households can be targeted for SWH deployment.

Drain-down type solar water heaters have been found to be very useful in Ladakh. In this design, a rectangular tank with a large area/volume ratio is contained in an insulated box with a double-glazed cover. This collector is then mounted on the roof (roofs in Ladakh are flat), and inclined at a 45 degree angle to the horizontal, as a compromise between optimum summer and winter tilts. Cold water is piped into the top of the tank, and hot water drawn from the bottom. The collector tank is constructed of 2mm welded GI sheet metal with internal support to prevent buckling.

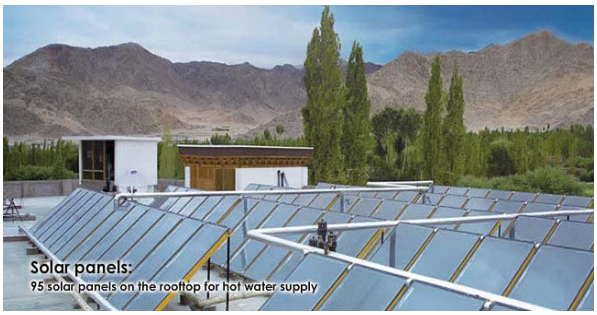
The tank is generally about 10mm deep, with a surface of the tank is painted matte black.

Hotels/Guest House: Being one of the favorite tourist spots in India, Leh has a large number of tourists visiting every year (~38,000). The tourist season here begins from June, reaching the peak in July-August, and then slackens from September. By October end, activities associated with tourism come to a halt. To cater to the boarding and lodging requirements of the tourists, a number of hotels and guest houses (approximately 500 in number) are available. Average SWH system size for hotels and guest house can be taken as 1000 lpd and 500 lpd, respectively. Hotels and guest houses are not operational throughout the year. On an average, they are open for five months (June to October) out of which August and September are the peak months (almost 100% occupancy). During the rest of the operating months, the average occupancy is about 25%. Almost all the hotels have a central wood fired boiler for heating water. Hot water is supplied to individual rooms through pipelines. Pipelines are not insulated resulting in heavy energy losses. The average hot water requirement per occupant per day is 30 lpd in hotels. In the guest houses, kerosene stoves are used for heating water and hot water is supplied in buckets. The average hot water requirement per occupant per day is 15 lpd.

Govt. buildings: Apart from residential sector & hotels/guest houses, there are a large number of Govt. buildings which can be targeted for SWH deployment. The estimated potential for Govt. buildings is ~1.3 lac lpd.

Caselet: The Grand Dragon Hotel, Ladakh

The hotel has around 53 rooms. It blends traditional architecture with "green" philosophy as they have 95 solar panels (total 9500 lpd, 190 m^2 of collector area) to help heat the water for central heating, and bathroom. The windows are double glazed and the hotel including the water supply, are well insulated to conserve energy.



Annexure II: Projections at a glance

Table A3: SWH projections for India (Sector-wise cumulative installations in million m^2 of collector area)

	Pessimistic Scenario							Realistic Scenario							Optimistic Scenario						
Year	Res.Urban	Res.Rural	Hotel	Hospital	Industry	Others	Total	Res.Urban	Res.Rural	Hotel	Hospital	Industry	Others	Total	Res.Urban	Res.Rural	Hotel	Hospital	Industry	Others	Total
2010	2.21	0.35	0.19	0.10	0.19	0.18	3.22	2.23	0.35	0.19	0.10	0.19	0.18	3.24	2.37	0.37	0.20	0.10	0.19	0.18	3.41
2013	3.57	0.42	0.35	0.16	0.33	0.27	5.11	3.83	0.42	0.35	0.17	0.33	0.27	5.37	4.51	0.46	0.38	0.21	0.33	0.27	6.15
2017	5.84	0.51	0.60	0.26	0.57	0.39	8.16	7.17	0.51	0.61	0.27	0.57	0.39	9.52	8.96	0.57	0.72	0.42	0.57	0.39	11.63
2022	9.64	0.60	0.92	0.40	1.05	0.52	13.13	15.14	0.60	0.97	0.43	1.05	0.52	18.70	19.59	0.69	1.27	0.96	1.05	0.52	24.08

Table A2: SWH projections for States for 2010 (Cumulative installations in m^2 of collector area)

2010	Pessimistic Scenario					Realistic Scenario					Optimistic Scenario				
State	Res.Urban	Res.Rural	Hotel	Hospital	Total	Res.Urban	Res.Rural	Hotel	Hospital	Total	Res.Urban	Res.Rural	Hotel	Hospital	Total
Karnataka	1,122,203	186,289	24,500	26,435	1,359,427	1,122,203	186,289	24,500	26,435	1,359,427	1,177,142	190,619	24,500	26,492	1,418,752
Maharashtra	487,872	55,064	52,380	14,482	609,797	492,302	55,064	52,400	14,488	614,255	526,746	56,952	52,440	15,182	651,320
Tamil Nadu	124,178	12,983	19,240	8,197	164,598	127,079	12,983	19,280	8,221	167,563	138,061	13,543	19,920	8,936	180,460
Andhra Pradesh	85,563	19,758	12,080	5,965	123,365	87,562	19,758	12,100	5,981	125,400	95,128	20,610	12,480	6,501	134,719
Gujarat	72,961	9,312	6,260	7,127	95,660	74,665	9,312	6,260	7,148	97,385	81,117	9,714	6,480	7,770	105,081
Rajasthan	46,612	11,179	11,200	5,570	74,561	47,700	11,179	11,240	5,585	75,704	51,822	11,661	11,620	6,072	81,176
Uttar Pradesh	42,254	11,848	5,880	3,506	63,488	43,789	11,848	5,900	3,522	65,059	48,525	12,536	6,220	3,898	71,180
Kerala	33,393	7,852	16,680	4,934	62,858	34,173	7,852	16,720	4,947	63,692	37,126	8,190	17,280	5,377	67,974
West Bengal	36,107	6,554	4,180	5,366	52,207	37,418	6,554	4,180	5,390	53,543	41,466	6,935	4,400	5,966	58,767
Punjab	30,205	4,382	4,360	1,915	40,863	30,911	4,382	4,360	1,921	41,574	33,582	4,571	4,500	2,087	44,741
Delhi	20,039	105	13,740	2,290	36,173	20,767	105	13,780	2,300	36,951	23,013	111	14,520	2,545	40,189
Madhya Pradesh	22,881	4,650	2,760	2,151	32,442	23,712	4,650	2,760	2,161	33,282	26,276	4,920	2,900	2,392	36,488
Haryana	22,773	3,984	3,140	1,331	31,228	23,305	3,984	3,160	1,336	31,785	25,319	4,155	3,260	1,451	34,186
Bihar	10,492	7,215	440	328	18,475	10,873	7,215	440	329	18,858	12,049	7,634	460	365	20,508
Orissa	8,785	3,849	1,140	1,572	15,346	9,104	3,849	1,140	1,579	15,672	10,089	4,073	1,200	1,747	17,109
Uttranchal	8,124	1,858	1,360	958	12,300	8,314	1,858	1,360	960	12,492	9,032	1,938	1,420	1,043	13,434
Goa	2,911	228	8,580	448	12,167	2,979	228	8,600	450	12,257	3,236	238	8,880	490	12,843
Jharkhand	8,338	2,173	360	152	11,024	8,641	2,173	360	154	11,328	9,576	2,299	380	170	12,425
Chhatisgarh	6,418	1,904	220	601	9,143	6,652	1,904	220	604	9,379	7,371	2,014	240	668	10,293
Himachal Pradesh	2,759	1,692	1,760	1,409	7,621	2,823	1,692	1,760	1,414	7,689	3,067	1,765	1,820	1,536	8,189
Chandigarh	3,578	35	1,120	383	5,116	3,662	35	1,120	384	5,201	3,978	37	1,160	416	5,591
Jammu &Kashmir	3,150	679	440	426	4,695	3,265	679	440	427	4,811	3,618	718	460	473	5,270
Pondicherry	2,774	114	680	595	4,163	2,839	114	680	596	4,230	3,085	119	700	648	4,552
Assam	1,719	543	440	205	2,907	1,871	543	440	207	3,061	2,201	614	480	228	3,523
Tripura	301	70	100	154	625	328	70	100	155	653	386	79	100	172	736
Meghalaya	207	43	100	180	530	226	43	100	181	550	266	49	120	199	633
Manipur	247	35	-	131	413	269	35	-	132	436	316	40	-	146	502
Nagaland	157	34	-	188	379	171	34	-	190	395	201	38	-	208	448
Mizoram	216	11	-	83	311	235	11	-	84	330	276	13	-	93	382
Dadra & Nagar Haveli	29	5	260	11	304	31	5	260	11	306	36	5	280	13	334
Arunachal Pradesh	119	22	-	141	281	129	22	-	141	292	152	24	-	155	332
Andaman & Nicobar	64	7	140	55	266	69	7	140	55	271	82	8	160	61	310
Sikkim	31	13	20	104	168	34	13	20	104	171	40	15	20	114	189
Daman & Diu	30	3	80	14	127	33	3	80	14	130	39	3	100	15	157
Lakshadweep	10	1	20	11	42	11	1	20	11	43	13	1	20	13	47
TOTAL	2,207,499	354,493	193,660	97,418	2,853,070	2,228,144	354,493	193,920	97,615	2,874,172	2,374,431	366,243	198,520	103,643	3,042,837

Note: The above table excludes the SWH projections for Industrial and other sectors.

Table A3: SWH projections for States for 2013 (Cumulative installations in m^2 of collector area)

2013	Pessimistic Scenario					Realistic Scenario					Optimistic Scenario				
State	Res.Urban	Res.Rural	Hotel	Hospital	Total	Res.Urban	Res.Rural	Hotel	Hospital	Total	Res.Urban	Res.Rural	Hotel	Hospital	Total
Karnataka	1,627,688	210,203	38,120	41,282	1,917,293	1,627,688	210,203	38,120	41,282	1,917,293	1,851,121	222,503	38,120	41,593	2,153,338
Maharashtra	822,928	66,574	91,840	23,111	1,004,452	875,613	66,574	92,060	23,171	1,057,417	1,037,826	72,298	92,260	27,258	1,229,643
Tamil Nadu	225,958	16,396	34,880	13,979	291,213	262,352	16,396	35,380	14,235	328,362	318,424	18,094	39,500	18,833	394,851
Andhra Pradesh	155,693	24,952	21,880	10,171	212,696	180,769	24,952	22,180	10,356	238,257	219,404	27,536	24,780	13,700	285,420
Gujarat	132,761	11,760	11,380	12,155	168,057	154,144	11,760	11,500	12,379	189,783	187,089	12,978	12,840	16,376	229,284
Rajasthan	84,815	14,119	20,300	9,500	128,734	98,476	14,119	20,620	9,673	142,887	119,523	15,580	23,020	12,797	170,921
Uttar Pradesh	85,193	16,045	11,300	6,727	119,265	104,942	16,045	11,500	6,907	139,394	130,063	18,133	13,700	9,550	171,447
Kerala	60,763	9,916	30,220	8,413	109,312	70,549	9,916	30,680	8,565	119,710	85,628	10,943	34,260	11,333	142,163
West Bengal	72,800	8,877	7,980	10,295	99,952	89,676	8,877	8,120	10,570	117,242	111,142	10,032	9,660	14,615	145,449
Delhi	40,402	142	26,260	4,393	71,197	49,769	142	26,760	4,509	81,179	61,682	160	31,860	6,235	99,937
Punjab	54,963	5,534	7,880	3,267	71,644	63,816	5,534	7,980	3,326	80,656	77,455	6,107	8,920	4,400	96,882
Madhya Pradesh	46,132	6,298	5,280	4,127	61,836	56,826	6,298	5,380	4,237	72,740	70,429	7,117	6,400	5,859	89,805
Haryana	41,439	5,031	5,700	2,270	54,440	48,113	5,031	5,800	2,312	61,257	58,396	5,552	6,480	3,059	73,488
Bihar	21,154	9,772	860	629	32,415	26,058	9,772	860	645	37,334	32,296	11,043	1,020	892	45,250
Orissa	17,712	5,213	2,160	3,016	28,101	21,819	5,213	2,200	3,095	32,327	27,042	5,891	2,620	4,280	39,833
Jharkhand	16,812	2,943	680	293	20,727	20,708	2,943	700	301	24,652	25,666	3,325	840	415	30,246
Uttranchal	14,783	2,347	2,480	1,632	21,242	17,163	2,347	2,520	1,663	23,693	20,832	2,590	2,820	2,200	28,442
Goa	5,297	288	15,580	763	21,927	6,150	288	15,780	780	22,997	7,464	317	17,620	1,031	26,432
Chhatisgarh	12,940	2,578	440	1,152	17,111	15,941	2,578	440	1,184	20,143	19,757	2,914	520	1,637	24,828
Himachal Pradesh	5,020	2,137	3,200	2,402	12,760	5,829	2,137	3,240	2,447	13,653	7,074	2,359	3,620	3,237	16,290
Jammu &Kashmir	6,351	919	860	817	8,947	7,824	919	860	839	10,441	9,696	1,038	1,020	1,160	12,915
Chandigarh	6,511	44	2,060	650	9,265	7,559	44	2,060	663	10,327	9,175	49	2,300	877	12,401
Assam	4,553	975	960	461	6,950	6,646	975	960	478	9,059	8,567	1,191	1,220	642	11,620
Pondicherry	5,048	144	1,240	1,015	7,447	5,861	144	1,240	1,034	8,279	7,114	159	1,380	1,367	10,021
Tripura	798	125	180	348	1,451	1,165	125	200	360	1,850	1,502	153	260	484	2,398
Meghalaya	549	77	220	403	1,249	801	77	260	418	1,556	1,033	94	320	560	2,008
Manipur	653	64	-	296	1,013	954	64	-	306	1,323	1,230	78	-	411	1,718
Nagaland	416	61	-	424	902	607	61	-	440	1,108	782	75	-	590	1,447
Mizoram	571	20	-	188	780	834	20	-	196	1,050	1,075	25	-	262	1,362
Arunachal Pradesh	315	38	-	316	670	459	38	-	326	823	592	47	20	438	1,097
Dadra & Nagar Haveli	75	8	540	25	648	109	8	580	26	724	141	10	740	35	925
Andaman & Nicobar	169	12	300	124	605	246	12	300	128	687	318	15	400	173	905
Sikkim	83	24	20	233	360	121	24	20	242	407	156	29	40	325	550
Daman & Diu	80	5	180	30	295	117	5	180	30	332	151	6	220	41	418
Lakshadweep	28	2	20	25	75	40	2	20	26	88	52	2	40	35	129
TOTAL	3,571,453	423,642	345,000	164,932	4,505,027	3,829,743	423,642	348,500	167,148	4,769,033	4,509,896	458,442	378,820	206,701	5,553,859

Note: The above table excludes the SWH projections for Industrial and other sectors.

Table A4: SWH projections for States for 2017 (Cumulative installations in m^2 of collector area)

2017	Pessimistic Scenario					Realistic Scenario					Optimistic Scenario				
State	Res.Urban	Res.Rural	Hotel	Hospital	Total	Res.Urban	Res.Rural	Hotel	Hospital	Total	Res.Urban	Res.Rural	Hotel	Hospital	Total
Karnataka	2,378,559	235,788	56,620	62,653	2,733,621	2,378,559	235,788	56,620	62,653	2,733,621	2,852,284	256,618	56,620	63,552	3,229,073
Maharashtra	1,413,912	80,993	159,020	36,245	1,690,169	1,665,426	80,993	159,900	36,481	1,942,800	2,090,911	91,524	160,580	49,646	2,392,661
Tamil Nadu	405,481	20,672	61,220	22,607	509,981	593,663	20,672	63,320	23,602	701,257	760,172	23,796	77,920	40,354	902,242
Andhra Pradesh	279,390	31,460	38,420	16,448	365,717	409,053	31,460	39,740	17,170	497,423	523,783	36,212	48,900	29,356	638,251
Gujarat	238,239	14,828	19,960	19,657	292,684	348,806	14,828	20,600	20,524	404,758	446,638	17,068	25,360	35,088	524,154
Uttar Pradesh	160,930	21,303	20,260	11,414	213,907	267,119	21,303	21,120	12,107	321,649	346,299	25,143	29,400	23,127	423,970
Rajasthan	152,201	17,801	35,620	15,362	220,984	222,837	17,801	36,900	16,038	293,576	285,338	20,490	45,400	27,419	378,647
West Bengal	137,520	11,786	14,300	17,471	181,076	228,260	11,786	14,920	18,531	273,497	295,922	13,911	20,760	35,398	365,990
Kerala	109,039	12,502	53,020	13,604	188,166	159,644	12,502	54,900	14,200	241,246	204,420	14,391	67,540	24,280	310,631
Delhi	76,320	188	47,080	7,452	131,040	126,680	188	49,200	7,904	183,972	164,230	222	68,460	15,100	248,012
Punjab	98,631	6,978	13,820	5,283	124,712	144,406	6,978	14,300	5,515	171,198	184,908	8,032	17,600	9,429	219,969
Madhya Pradesh	87,144	8,361	9,460	7,003	111,968	144,645	8,361	9,860	7,428	170,294	187,521	9,868	13,720	14,191	225,300
Haryana	74,362	6,343	10,020	3,671	94,396	108,873	6,343	10,380	3,833	129,429	139,410	7,301	12,780	6,553	166,044
Bihar	39,959	12,974	1,520	1,067	55,520	66,326	12,974	1,580	1,132	82,012	85,987	15,312	2,200	2,161	105,660
Orissa	33,459	6,921	3,880	5,117	49,377	55,538	6,921	4,060	5,425	71,943	72,000	8,168	5,660	10,366	96,195
Jharkhand	31,757	3,907	1,220	495	37,379	52,712	3,907	1,300	526	58,444	68,337	4,611	1,800	1,004	75,752
Uttranchal	26,528	2,959	4,360	2,639	36,486	38,839	2,959	4,520	2,757	49,074	49,732	3,406	5,560	4,714	63,411
Chhatisgarh	24,445	3,423	780	1,957	30,604	40,575	3,423	800	2,076	46,874	52,603	4,040	1,120	3,965	61,727
Goa	9,505	363	27,300	1,234	38,401	13,916	363	28,220	1,292	43,791	17,819	417	34,720	2,207	55,164
Assam	9,553	1,518	1,760	826	13,656	21,999	1,518	1,840	890	26,247	29,039	1,914	2,940	1,721	35,614
Himachal Pradesh	9,009	2,695	5,600	3,884	21,187	13,190	2,695	5,800	4,056	25,741	16,889	3,102	7,140	6,934	34,066
Jammu &Kashmir	11,997	1,220	1,520	1,386	16,124	19,914	1,220	1,580	1,472	24,186	25,816	1,440	2,200	2,811	32,268
Chandigarh	11,684	56	3,600	1,052	16,392	17,106	56	3,700	1,099	21,961	21,904	65	4,540	1,880	28,389
Pondicherry	9,059	182	2,160	1,641	13,042	13,263	182	2,220	1,715	17,380	16,983	210	2,720	2,930	22,843
Tripura	1,674	195	360	622	2,851	3,857	195	420	671	5,142	5,091	246	640	1,298	7,274
Meghalaya	1,152	120	440	719	2,432	2,653	120	480	777	4,030	3,502	151	760	1,503	5,916
Manipur	1,370	99	-	529	1,998	3,157	99	-	570	3,826	4,167	125	-	1,103	5,395
Mizoram	1,199	32	-	337	1,567	2,760	32	-	364	3,155	3,643	40	-	703	4,386
Nagaland	872	95	-	756	1,724	2,009	95	-	817	2,922	2,652	120	-	1,580	4,353
Arunachal Pradesh	660	60	20	566	1,306	1,520	60	20	607	2,207	2,006	75	40	1,177	3,298
Andaman & Nicobar	354	19	580	222	1,175	816	19	600	238	1,673	1,078	24	940	460	2,502
Dadra & Nagar Haveli	157	12	1,040	45	1,254	361	12	1,120	49	1,542	477	15	1,740	93	2,325
Sikkim	174	37	60	418	689	402	37	80	451	970	531	47	140	872	1,589
Daman & Diu	168	8	320	53	549	386	8	340	56	790	510	10	540	109	1,169
Lakshadweep	58	2	40	45	146	134	2	40	49	225	177	3	80	93	353
TOTAL	5,836,520	505,899	595,380	264,479	7,202,279	7,169,404	505,899	610,480	273,073	8,558,855	8,962,777	568,117	720,520	423,176	10,674,590

Note: The above table excludes the SWH projections for Industrial and other sectors.

Table A5: SWH projections for States for 2022 (Cumulative installations in m^2 of collector area)

2022	Pessimistic Scenario					Realistic Scenario					Optimistic Scenario				
State	Res.Urban	Res.Rural	Hotel	Hospital	Total	Res.Urban	Res.Rural	Hotel	Hospital	Total	Res.Urban	Res.Rural	Hotel	Hospital	Total
Karnataka	3,458,692	259,399	73,200	91,501	3,882,792	3,458,692	259,399	73,200	91,501	3,882,792	4,292,460	288,098	73,200	93,662	4,747,421
Maharashtra	2,475,684	97,812	247,540	55,058	2,876,095	3,400,615	97,812	250,080	55,696	3,804,204	4,404,496	113,950	251,740	92,195	4,862,381
Tamil Nadu	728,015	25,661	96,200	34,730	884,607	1,503,906	25,661	102,640	37,495	1,669,703	1,973,830	30,448	141,600	92,517	2,238,394
Andhra Pradesh	501,626	39,050	60,380	25,266	626,323	1,036,241	39,050	64,400	27,275	1,166,967	1,360,034	46,333	88,860	67,301	1,562,529
Gujarat	427,743	18,406	31,340	30,197	507,687	883,618	18,406	33,420	32,602	968,046	1,159,721	21,839	46,100	80,436	1,308,096
Uttar Pradesh	297,001	27,437	32,320	17,838	374,595	760,960	27,437	35,000	19,758	843,155	1,004,753	33,321	59,260	63,630	1,160,965
West Bengal	253,796	15,179	22,820	27,302	319,096	650,261	15,179	24,740	30,240	720,420	858,590	18,435	41,880	97,389	1,016,293
Rajasthan	273,267	22,096	56,020	23,599	374,982	564,505	22,096	59,780	25,477	671,858	740,896	26,217	82,480	62,860	912,452
Kerala	195,772	15,519	83,360	20,897	315,548	404,420	15,519	88,980	22,559	531,477	530,788	18,413	122,760	55,660	727,621
Delhi	140,850	242	75,180	11,647	227,919	360,879	242	81,560	12,900	455,581	476,496	294	138,080	41,543	656,413
Madhya Pradesh	160,825	10,768	15,080	10,944	197,618	412,058	10,768	16,360	12,122	451,308	544,072	13,078	27,660	39,043	623,852
Punjab	177,086	8,661	21,700	8,116	215,563	365,818	8,661	23,180	8,759	406,419	480,125	10,277	31,960	21,614	543,976
Haryana	133,513	7,873	15,760	5,639	162,786	275,805	7,873	16,840	6,089	306,608	361,986	9,342	23,240	15,022	409,590
Bihar	73,746	16,708	2,420	1,666	94,540	188,948	16,708	2,620	1,847	210,123	249,482	20,292	4,440	5,942	280,156
Orissa	61,751	8,913	6,200	7,996	84,859	158,213	8,913	6,740	8,854	182,720	208,901	10,825	11,400	28,520	259,645
Jharkhand	58,609	5,031	1,980	773	66,393	150,163	5,031	2,120	858	158,172	198,272	6,110	3,600	2,762	210,744
Chhatisgarh	45,113	4,409	1,240	3,058	53,820	115,589	4,409	1,340	3,388	124,726	152,621	5,354	2,260	10,910	171,145
Uttranchal	47,629	3,673	6,860	4,057	62,218	98,390	3,673	7,300	4,382	113,745	129,134	4,358	10,080	10,808	154,380
Assam	18,535	2,151	2,900	1,313	24,899	81,984	2,151	3,220	1,490	88,845	109,018	2,758	7,060	5,881	124,716
Goa	17,065	450	42,920	1,897	62,332	35,252	450	45,720	2,051	83,473	46,267	534	63,080	5,056	114,938
Jammu &Kashmir	22,141	1,572	2,400	2,167	28,280	56,728	1,572	2,620	2,401	63,321	74,903	1,909	4,420	7,733	88,965
Himachal Pradesh	16,175	3,345	8,820	5,967	34,307	33,415	3,345	9,400	6,443	52,603	43,856	3,969	12,980	15,896	76,702
Chandigarh	20,977	70	5,640	1,617	28,304	43,334	70	5,980	1,747	51,131	56,875	83	8,240	4,312	69,509
Pondicherry	16,264	226	3,380	2,520	22,390	33,599	226	3,600	2,723	40,147	44,097	268	4,980	6,715	56,060
Tripura	3,249	276	600	988	5,114	14,373	276	700	1,123	16,472	19,112	354	1,500	4,432	25,399
Manipur	2,659	140	-	842	3,642	11,764	140	-	955	12,859	15,643	180	-	3,764	19,587
Meghalaya	2,235	170	720	1,147	4,272	9,888	170	820	1,301	12,180	13,149	218	1,800	5,133	20,300
Mizoram	2,325	45	-	536	2,906	10,286	45	-	608	10,939	13,678	57	-	2,399	16,135
Nagaland	1,693	135	-	1,204	3,031	7,488	135	-	1,369	8,992	9,957	173	-	5,395	15,526
Arunachal Pradesh	1,281	85	20	899	2,285	5,663	85	20	1,019	6,787	7,530	109	100	4,024	11,763
Andaman & Nicobar	688	27	940	354	2,009	3,042	27	1,020	400	4,488	4,045	34	2,280	1,577	7,937
Dadra & Nagar Haveli	305	17	1,680	70	2,072	1,344	17	1,880	80	3,322	1,788	22	4,100	316	6,226
Sikkim	338	52	140	665	1,196	1,499	52	200	755	2,506	1,993	67	440	2,978	5,478
Daman & Diu	326	12	540	85	963	1,439	12	600	96	2,147	1,914	15	1,320	377	3,626
Lakshadweep	113	3	40	70	226	499	3	100	80	682	664	4	300	316	1,283
TOTAL	9,637,088	595,614	920,340	402,625	11,555,667	15,140,678	595,614	966,180	426,446	17,128,919	19,591,143	687,738	1,273,200	958,118	22,510,199

Note: The above table excludes the SWH projections for Industrial and other sectors.

Table A6: SWH projections for Districts for 2010 (Cumulative installations in m^2 of collector area)

2010		Pessimistic Scenario				Realistic Scenario				Optimistic Scenario			
District	State	Residential	Hotel	Hospital	Total	Residential	Hotel	Hospital	Total	Residential	Hotel	Hospital	Total
Agra	Uttar Pradesh	5,410	1,764	351	7,525	5,564	1,770	352	7,686	6,106	1,866	390	8,362
Ahmadabad	Gujarat	24,682	1,878	2,138	28,698	25,193	1,878	2,144	29,216	27,249	1,944	2,331	31,524
Bangalore	Karnataka	654,246	12,250	13,217	679,713	654,246	12,250	13,217	679,713	683,880	12,250	13,246	709,376
Chennai	Tamilnadu	27,432	5,772	2,459	35,663	28,012	5,784	2,466	36,263	30,321	5,976	2,681	38,978
Coimbatore	Tamilnadu	27,432	3,848	1,639	32,920	28,012	3,856	1,644	33,513	30,321	3,984	1,787	36,092
Darjiling	West Bengal	6,399	836	805	8,040	6,596	836	809	8,240	7,260	880	895	9,035
East Khasi hills (Shillong)	Meghalaya	175	70	126	371	188	70	127	385	220	84	139	443
Ernakulam (Kochi)	Kerala	10,311	4,170	1,233	15,715	10,506	4,180	1,237	15,923	11,329	4,320	1,344	16,993
Gurgaon	Haryana	13,378	1,570	666	15,614	13,644	1,580	668	15,892	14,737	1,630	726	17,093
Hardwar	Uttarakhand	1,996	272	192	2,460	2,034	272	192	2,498	2,194	284	209	2,687
Hyderabad	Andhra Pradesh	52,660	6,040	2,982	61,683	53,660	6,050	2,990	62,700	57,869	6,240	3,251	67,359
Indore	Madhya Pradesh	8,259	828	645	9,733	8,509	828	648	9,985	9,359	870	717	10,946
Jaipur	Rajasthan	23,116	4,480	2,228	29,824	23,552	4,496	2,234	30,282	25,393	4,648	2,429	32,470
Kamrup (Guwahati)	Assam	1,131	220	103	1,453	1,207	220	104	1,530	1,407	240	114	1,761
Khordha (Bhubaneswar)	Orissa	3,790	342	472	4,604	3,886	342	474	4,701	4,248	360	524	5,133
Kolkata	West Bengal	21,331	2,090	2,683	26,104	21,986	2,090	2,695	26,772	24,200	2,200	2,983	29,384
LehLadakh	Jammu & Kashmir	766	132	85	983	789	132	85	1,006	867	138	95	1,100
Ludhiana	Punjab	12,106	1,526	670	14,302	12,353	1,526	672	14,551	13,354	1,575	731	15,659
Nagpur	Maharashtra	54,294	5,238	1,448	60,980	54,737	5,240	1,449	61,425	58,370	5,244	1,518	65,132
Patna	Bihar	8,853	220	164	9,237	9,044	220	165	9,429	9,842	230	182	10,254
Pondicherry	Pondicherry	2,166	510	446	3,122	2,215	510	447	3,172	2,403	525	486	3,414
Pune	Maharashtra	162,881	10,476	2,896	176,253	164,210	10,480	2,898	177,588	175,109	10,488	3,036	188,634
Raipur	Chhattisgarh	3,329	88	240	3,657	3,422	88	241	3,752	3,754	96	267	4,117
Ranchi	Jharkhand	4,205	144	61	4,410	4,326	144	61	4,531	4,750	152	68	4,970
Sambalpur	Orissa	1,895	171	236	2,302	1,943	171	237	2,351	2,124	180	262	2,566
Shimla	Himachal Pradesh	2,226	880	705	3,810	2,258	880	707	3,845	2,416	910	768	4,094
Delhi	Delhi	20,144	13,740	2,290	36,173	20,872	13,780	2,300	36,951	23,124	14,520	2,545	40,189
Thane	Maharashtra	81,440	4,190	1,159	86,789	82,105	4,192	1,159	87,456	87,555	4,195	1,215	92,964
West Tripura (Agartala)	Tripura	222	60	93	375	238	60	93	392	279	60	103	442
TOTAL		1,236,276	83,805	42,432	1,362,513	1,245,306	83,925	42,516	1,371,747	1,320,041	86,089	45,042	1,451,173
NCR		45,835	16,929	3,784	66,548	47,117	16,986	3,799	67,902	51,563	17,842	4,182	73,587

Note: The above table excludes the SWH projections for Industrial and other sectors.

Table A7: SWH projections for Districts for 2013 (Cumulative installations in m^2 of collector area)

2013		Pessimistic Scenario				Realistic Scenario				Optimistic Scenario			
District	State	Residential	Hotel	Hospital	Total	Residential	Hotel	Hospital	Total	Residential	Hotel	Hospital	Total
Agra	Uttar Pradesh	10,124	3,390	673	14,186	12,099	3,450	691	16,239	14,820	4,110	955	19,885
Ahmadabad	Gujarat	43,356	3,414	3,647	50,417	49,771	3,450	3,714	56,935	60,020	3,852	4,913	68,785
Bangalore	Karnataka	918,945	19,060	20,641	958,646	918,945	19,060	20,641	958,646	1,036,812	19,060	20,797	1,076,669
Chennai	Tamilnadu	48,471	10,464	4,194	63,129	55,749	10,614	4,271	70,634	67,303	11,850	5,650	84,803
Coimbatore	Tamilnadu	48,471	6,976	2,796	58,243	55,749	7,076	2,847	65,672	67,303	7,900	3,767	78,970
Darjiling	West Bengal	12,251	1,596	1,544	15,392	14,783	1,624	1,585	17,992	18,176	1,932	2,192	22,300
East Khasi hills (Shillong)	Meghalaya	439	154	282	874	615	182	292	1,089	789	224	392	1,405
Ernakulam (Kochi)	Kerala	17,670	7,555	2,103	27,328	20,116	7,670	2,141	29,928	24,143	8,565	2,833	35,541
Gurgaon	Haryana	23,235	2,850	1,135	27,220	26,572	2,900	1,156	30,628	31,974	3,240	1,530	36,744
Hardwar	Uttarakhand	3,426	496	326	4,248	3,902	504	333	4,739	4,684	564	440	5,688
Hyderabad	Andhra Pradesh	90,322	10,940	5,085	106,348	102,860	11,090	5,178	119,128	123,470	12,390	6,850	142,710
Indore	Madhya Pradesh	15,729	1,584	1,238	18,551	18,937	1,614	1,271	21,822	23,264	1,920	1,758	26,942
Jaipur	Rajasthan	39,574	8,120	3,800	51,494	45,038	8,248	3,869	57,155	54,041	9,208	5,119	68,368
Kamrup (Guwahati)	Assam	2,764	480	230	3,475	3,811	480	239	4,530	4,879	610	321	5,810
Khordha (Bhubaneswar)	Orissa	6,878	648	905	8,430	8,109	660	929	9,698	9,880	786	1,284	11,950
Kolkata	West Bengal	40,838	3,990	5,148	49,976	49,276	4,060	5,285	58,621	60,587	4,830	7,308	72,725
LehLadakh	Jammu & Kashmir	1,454	258	163	1,875	1,748	258	168	2,174	2,147	306	232	2,685
Ludhiana	Punjab	21,174	2,758	1,143	25,075	24,272	2,793	1,164	28,230	29,247	3,122	1,540	33,909
Nagpur	Maharashtra	88,950	9,184	2,311	100,445	94,219	9,206	2,317	105,742	111,012	9,226	2,726	122,964
Patna	Bihar	15,463	430	315	16,207	17,915	430	323	18,667	21,669	510	446	22,625
Pondicherry	Pondicherry	3,894	930	761	5,585	4,504	930	775	6,209	5,455	1,035	1,026	7,515
Pune	Maharashtra	266,850	18,368	4,622	289,841	282,656	18,412	4,634	305,702	333,037	18,452	5,452	356,941
Raipur	Chhattisgarh	6,207	176	461	6,844	7,408	176	474	8,057	9,068	208	655	9,931
Ranchi	Jharkhand	7,902	272	117	8,291	9,460	280	120	9,861	11,596	336	166	12,098
Sambalpur	Orissa	3,439	324	452	4,215	4,055	330	464	4,849	4,940	393	642	5,975
Shimla	Himachal Pradesh	3,579	1,600	1,201	6,380	3,983	1,620	1,224	6,827	4,717	1,810	1,619	8,145
Delhi	Delhi	40,544	26,260	4,393	71,197	49,910	26,760	4,509	81,179	61,842	31,860	6,235	99,937
Thane	Maharashtra	133,425	7,347	1,849	142,621	141,328	7,365	1,854	150,546	166,519	7,381	2,181	176,080
West Tripura (Agartala)	Tripura	554	108	209	871	774	120	216	1,110	993	156	290	1,439
TOTAL		1,915,928	149,732	71,744	2,137,404	2,028,566	151,362	72,683	2,252,611	2,364,388	165,836	89,316	2,619,540
NCR		85,820	32,110	7,016	124,946	102,183	32,711	7,186	142,080	124,983	38,593	9,818	173,395

Note: The above table excludes the SWH projections for Industrial and other sectors.

Table A8: SWH projections for Districts for 2017 (Cumulative installations in m^2 of collector area)

2017		Pessimistic Scenario				Realistic Scenario				Optimistic Scenario			
District	State	Residential	Hotel	Hospital	Total	Residential	Hotel	Hospital	Total	Residential	Hotel	Hospital	Total
Agra	Uttar Pradesh	18,223	6,078	1,141	25,443	28,842	6,336	1,211	36,389	37,144	8,820	2,313	48,277
Ahmadabad	Gujarat	75,920	5,988	5,897	87,805	109,090	6,180	6,157	121,427	139,112	7,608	10,526	157,246
Bangalore	Karnataka	1,307,174	28,310	31,326	1,366,810	1,307,174	28,310	31,326	1,366,810	1,554,451	28,310	31,776	1,614,537
Chennai	Tamilnadu	85,231	18,366	6,782	110,379	122,867	18,996	7,080	148,944	156,794	23,376	12,106	192,276
Coimbatore	Tamilnadu	85,231	12,244	4,521	101,996	122,867	12,664	4,720	140,251	156,794	15,584	8,071	180,448
Darjiling	West Bengal	22,396	2,860	2,621	27,876	36,007	2,984	2,780	41,771	46,475	4,152	5,310	55,937
East Khasi hills (Shillong)	Meghalaya	891	308	504	1,702	1,941	336	544	2,821	2,557	532	1,052	4,141
Ernakulam (Kochi)	Kerala	30,385	13,255	3,401	47,041	43,036	13,725	3,550	60,312	54,703	16,885	6,070	77,658
Gurgaon	Haryana	40,352	5,010	1,835	47,198	57,608	5,190	1,917	64,715	73,355	6,390	3,277	83,022
Hardwar	Uttarakhand	5,897	872	528	7,297	8,359	904	551	9,815	10,628	1,112	943	12,682
Hyderabad	Andhra Pradesh	155,425	19,210	8,224	182,859	220,256	19,870	8,585	248,712	279,998	24,450	14,678	319,126
Indore	Madhya Pradesh	28,651	2,838	2,101	33,590	45,902	2,958	2,228	51,088	59,217	4,116	4,257	67,590
Jaipur	Rajasthan	68,001	14,248	6,145	88,393	96,255	14,760	6,415	117,430	122,331	18,160	10,968	151,459
Kamrup (Guwahati)	Assam	5,535	880	413	6,828	11,759	920	445	13,124	15,476	1,470	861	17,807
Khordha (Bhubaneswar)	Orissa	12,114	1,164	1,535	14,813	18,737	1,218	1,628	21,583	24,051	1,698	3,110	28,858
Kolkata	West Bengal	74,653	7,150	8,735	90,538	120,023	7,460	9,266	136,749	154,916	10,380	17,699	182,995
LehLadakh	Jammu & Kashmir	2,644	456	277	3,377	4,227	474	294	4,995	5,451	660	562	6,674
Ludhiana	Punjab	36,963	4,837	1,849	43,649	52,984	5,005	1,930	59,919	67,529	6,160	3,300	76,989
Nagpur	Maharashtra	149,490	15,902	3,624	169,017	174,642	15,990	3,648	194,280	218,243	16,058	4,965	239,266
Patna	Bihar	26,466	760	533	27,760	39,650	790	566	41,006	50,650	1,100	1,080	52,830
Pondicherry	Pondicherry	6,930	1,620	1,231	9,781	10,084	1,665	1,286	13,035	12,894	2,040	2,198	17,132
Pune	Maharashtra	448,471	31,804	7,249	487,524	523,926	31,980	7,296	563,202	654,730	32,116	9,929	696,776
Raipur	Chhattisgarh	11,147	312	783	12,242	17,599	320	830	18,750	22,657	448	1,586	24,691
Ranchi	Jharkhand	14,266	488	198	14,952	22,647	520	210	23,378	29,179	720	402	30,301
Sambalpur	Orissa	6,057	582	768	7,407	9,369	609	814	10,792	12,025	849	1,555	14,429
Shimla	Himachal Pradesh	5,852	2,800	1,942	10,594	7,942	2,900	2,028	12,870	9,996	3,570	3,467	17,033
Delhi	Delhi	76,508	47,080	7,452	131,040	126,868	49,200	7,904	183,972	164,452	68,460	15,100	248,012
Thane	Maharashtra	224,236	12,722	2,900	239,857	261,963	12,792	2,918	277,673	327,365	12,846	3,972	344,183
West Tripura (Agartala)	Tripura	1,122	216	373	1,711	2,431	252	402	3,085	3,202	384	779	4,364
TOTAL		3,026,230	258,360	114,889	3,399,479	3,605,056	265,308	118,532	3,988,897	4,466,374	318,454	181,909	4,966,738
NCR		155,689	57,400	11,748	224,837	242,632	59,904	12,409	314,945	312,249	81,977	23,043	417,269

Note: The above table excludes the SWH projections for Industrial and other sectors.

Table A9: SWH projections for Districts for 2022 (Cumulative installations in m^2 of collector area)

2022		Pessimistic Scenario				Realistic Scenario				Optimistic Scenario			
District	State	Residential	Hotel	Hospital	Total	Residential	Hotel	Hospital	Total	Residential	Hotel	Hospital	Total
Agra	Uttar Pradesh	32,444	9,696	1,784	43,924	78,840	10,500	1,976	91,315	103,807	17,778	6,363	127,948
Ahmadabad	Gujarat	133,845	9,402	9,059	152,306	270,607	10,026	9,781	290,414	354,468	13,830	24,131	392,429
Bangalore	Karnataka	1,859,045	36,600	45,751	1,941,396	1,859,045	36,600	45,751	1,941,396	2,290,279	36,600	46,831	2,373,710
Chennai	Tamilnadu	150,735	28,860	10,419	190,014	305,913	30,792	11,249	347,954	400,855	42,480	27,755	471,091
Coimbatore	Tamilnadu	150,735	19,240	6,946	176,921	305,913	20,528	7,499	333,941	400,855	28,320	18,503	447,679
Darjiling	West Bengal	40,346	4,564	4,095	49,005	99,816	4,948	4,536	109,300	131,554	8,376	14,608	154,538
East Khasi hills (Shillong)	Meghalaya	1,684	504	803	2,990	7,041	574	911	8,526	9,357	1,260	3,593	14,210
Ernakulam (Kochi)	Kerala	52,823	20,840	5,224	78,887	104,985	22,245	5,640	132,869	137,300	30,690	13,915	181,905
Gurgaon	Haryana	70,693	7,880	2,820	81,393	141,839	8,420	3,045	153,304	185,664	11,620	7,511	204,795
Hardwar	Uttarakhand	10,260	1,372	811	12,444	20,413	1,460	876	22,749	26,698	2,016	2,162	30,876
Hyderabad	Andhra Pradesh	270,338	30,190	12,633	313,161	537,646	32,200	13,638	583,484	703,184	44,430	33,650	781,264
Indore	Madhya Pradesh	51,478	4,524	3,283	59,285	126,848	4,908	3,637	135,392	167,145	8,298	11,713	187,156
Jaipur	Rajasthan	118,145	22,408	9,439	149,993	234,641	23,912	10,191	268,743	306,845	32,992	25,144	364,981
Kamrup (Guwahati)	Assam	10,343	1,450	657	12,449	42,067	1,610	745	44,422	55,888	3,530	2,940	62,358
Khordha (Bhubaneswar)	Orissa	21,199	1,860	2,399	25,458	50,138	2,022	2,656	54,816	65,918	3,420	8,556	77,894
Kolkata	West Bengal	134,487	11,410	13,651	159,548	332,720	12,370	15,120	360,210	438,512	20,940	48,695	508,147
LehLadakh	Jammu & Kashmir	4,743	720	433	5,896	11,660	786	480	12,926	15,362	1,326	1,547	18,235
Ludhiana	Punjab	65,011	7,595	2,841	75,447	131,068	8,113	3,066	142,247	171,641	11,186	7,565	190,392
Nagpur	Maharashtra	257,350	24,754	5,506	287,609	349,843	25,008	5,570	380,420	451,845	25,174	9,219	486,238
Patna	Bihar	45,227	1,210	833	47,270	102,828	1,310	923	105,061	134,887	2,220	2,971	140,078
Pondicherry	Pondicherry	12,368	2,535	1,890	16,793	25,368	2,700	2,042	30,110	33,274	3,735	5,036	42,045
Pune	Maharashtra	772,049	49,508	11,012	832,569	1,049,528	50,016	11,139	1,110,683	1,355,534	50,348	18,439	1,424,321
Raipur	Chhattisgarh	19,809	496	1,223	21,528	47,999	536	1,355	49,890	63,190	904	4,364	68,458
Ranchi	Jharkhand	25,456	792	309	26,557	62,078	848	343	63,269	81,753	1,440	1,105	84,298
Sambalpur	Orissa	10,600	930	1,199	12,729	25,069	1,011	1,328	27,408	32,959	1,710	4,278	38,947
Shimla	Himachal Pradesh	9,760	4,410	2,984	17,154	18,380	4,700	3,221	26,301	23,913	6,490	7,948	38,351
Delhi	Delhi	141,092	75,180	11,647	227,919	361,121	81,560	12,900	455,581	476,790	138,080	41,543	656,413
Thane	Maharashtra	386,024	19,803	4,405	410,232	524,764	20,006	4,456	549,226	677,767	20,139	7,376	705,282
West Tripura (Agartala)	Tripura	2,115	360	593	3,068	8,789	420	674	9,883	11,680	900	2,659	15,239
TOTAL		4,860,205	399,093	174,648	5,433,945	7,236,967	420,129	184,746	7,841,843	9,308,922	570,232	410,121	10,289,275
NCR		280,205	91,457	18,276	389,938	653,682	98,995	20,108	772,785	860,316	163,236	60,813	1,084,365

Note: The above table excludes the SWH projections for Industrial and other sectors.

Annexure III: Summary of LBNL Report

Report Title: Residential and Transport Energy Use in India: Past Trend and Future Outlook[34]

This report characterizes the underlying residential and transport sector end use energy consumption in India. Each sector was analyzed in detail. End-use sector-level information regarding adoption of particular technologies was used as a key input in a bottom-up modeling approach. The report looks at energy used over the period 1990 to 2005 and develops a baseline scenario to 2020. Moreover, the intent of this report is also to highlight available sources of data in India for the residential and transport sectors.

1. Macro Activity and Structure Change

1.1 Activity:

Population and GDP are two fundamental activity drivers that influence energy demand from all the sectors. Between 1990 and 2005, India's population increased at an annual average growth rate of 1.9% and GDP grew at an average rate of 6.0% (WB, 2005). Urbanization rate remained low at 29% (2004) but is expected to increase rapidly. Population and urbanization rate forecast were based on the United Nations projections for India (UN, 2007a) which estimate a population growth rate of 1.3% and an urbanization level of 35% by 2020 (UN, 2007b). We assume a 7% increase in GDP with continuous increase of service and industry share at the expense of the agriculture sector (Table 1).

Table 1: GDP Projection Assumptions

	1990	2005	2020	AAGR 1990-2005	AAGR 2005-2020
Total	**244**	**585**	**1618**	6.0%	**7.0%**
Agriculture, value added (constant 2000 US$)	78	112	151	2.5%	2.0%
Industry, value added (constant 2000 US$)	64	156	461	6.1%	7.5%
Services, etc., value added (constant 2000 US$)	101	317	1006	7.9%	8.0%
Share					
Agriculture		19%	9%		
Industry		27%	28%		
Services		54%	62%		

1.2 Primary Electricity Factor

The factor that converts final electricity consumption to primary energy was equal to 4.2 in 2005 for India. Two reasons explain this large primary energy conversion factor: first electricity distribution and transmission (T&D) losses are substantial, representing 31% of electricity production in 2004 (CEA, 2006) and second electricity is generated for a large part (82%) with the use of fuel combustion with low efficiency (26% for coal, 28% for oil and 41% for gas).

[34] Source: http://ies.lbl.gov/drupal.files/ies.lbl.gov.sandbox/LBNL-1753E.pdf (last assessed 19 January 2010)

Primary electricity factor was forecast to decline at an annual rate of 0.9% during the period 2005 to 2020 to account for the new policy in place and also in conjunction with recent trend that showed an annual rate of decline of -2.3% over the period 2000 to 2005 (Table 2).

Table 2: Primary Electricity Factor Forecast

	1990	2005	2020	AAGR 00-05	AAGR 05-20
Fuel input	**2,709**	**6,969**	**19,842**	**6.5%**	**7.2%**
coal	*2,191*	*5,919*	*15,947*	*6.8%*	*6.8%*
gas	*126*	*412*	*1,400*	*8.2%*	*8.5%*
oil	*112*	*210*	*703*	*4.3%*	*8.4%*
nuclear	*22*	*63*	*697*	*7.3%*	*17.4%*
Hydro	*258*	*365*	*1,094*	*2.3%*	*7.6%*
Energy output	**952**	**2,249**	**7,159**	**5.9%**	**8.0%**
Own Uses	81	157	501	4.5%	8.0%
Transmission and distribution loses	204	439	1,289	5.2%	7.4%
Electricity delivered	**682**	**1,652**	**5,369**	**6.1%**	**8.2%**
Primary factor	3.97	4.22	3.72	0.4%	-0.9%

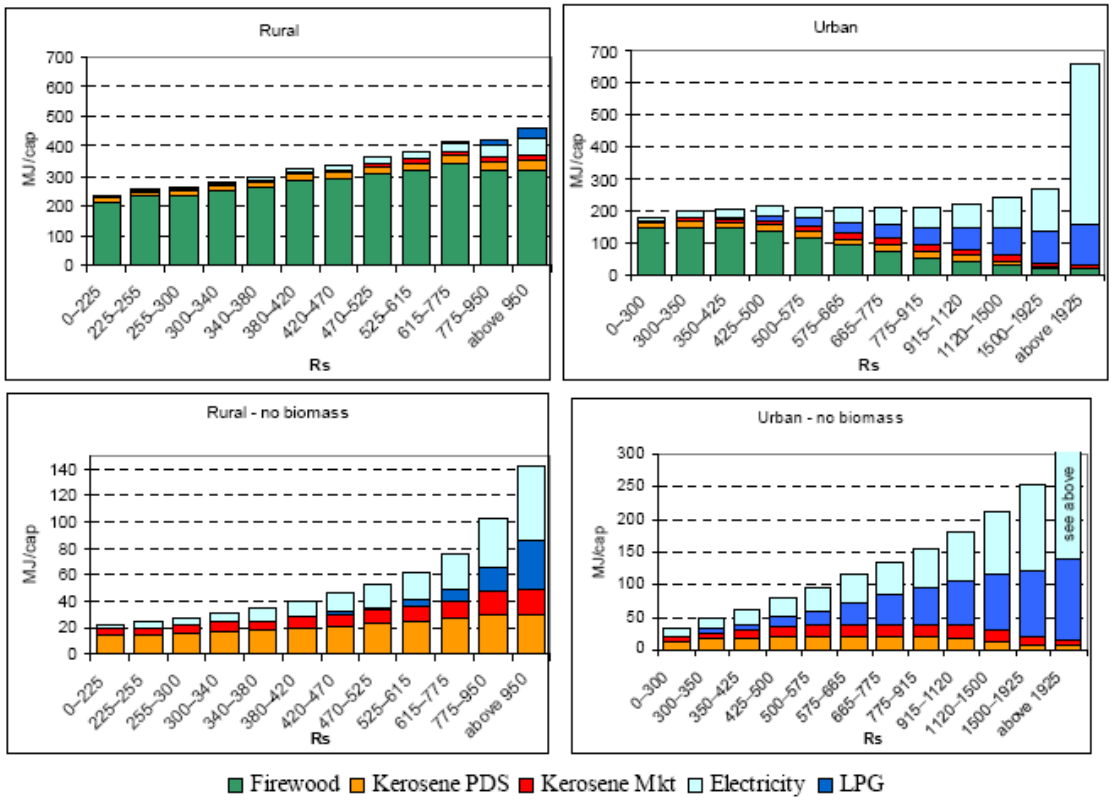
2. The Residential Sector

Residential energy consumption represents 39% of final energy consumed and slightly less (37%) in terms of primary energy consumption. However, energy consumption in the residential sector in India is still largely dominated by the use of firewood.

A large quantity of incremental electricity demand will come from the residential sector in India. Energy services examined in the residential sector include cooking, water heating, lighting, and appliance usage. Urban and rural homes are distinguished due to their difference in energy requirement. The number of urban and rural households is used as drivers for residential energy consumption. Figure 1 shows the result of the National Sample Survey Organization's survey on Consumption of Some Important Commodities in India (NSSO, 2001a) conducted in 2000. It shows the average quantity of fuel consumed per capita by monthly per capita expenditure (MPCE) in rural and urban areas. In rural areas, firewood remains the predominant fuel used irrespective of expenditure.

The two figures shown at the bottom exclude biomass in order to better represent trends in other fuel use. All fuel consumption tends to increase with income. However, the quantity of kerosene consumed remains fairly constant across income categories in urban areas and regardless of its price. The demand for LPG and electricity are income elastic and increase considerably with higher expenditure level. These observations are even more pronounced in urban areas, where consumption of firewood phases out almost completely, while LPG consumption increases progressively and electricity use escalates with households that have the highest level of expenditure.

Figure 1. Final Energy Consumption per Capita per MPCE per Month



Source: NSSO, 2001a

2.1 Methodology

Residential energy provides numerous services associated with household living, including space cooling, water heating, cooking, refrigeration, lighting, and the powering of a wide variety of other appliances. The end uses were further broken out by technologies. Each end use was assigned appropriate devices and fuel types, with diffusion rates and energy efficiencies based on survey data and literature research. Changes in energy demand in the model are in part a function of driver variables, e.g., GDP, population, household size and urbanization rate, which were determined exogenously and included in the model and in part a function of energy intensities.

Annual average appliance Unit Energy Consumption (UEC) are calculated based on a stock turnover modeling, which includes information on initial stocks by vintage, energy efficiencies by vintage (allowing explicit modeling of the impacts of standards), efficiency degradation profiles, and lifetime or survival profiles.

2.2 End Use Analysis

Residential energy is typically used for cooking, water heating, space conditioning, lighting and appliances. Cooking and lighting are the most essential activities requiring energy, while the importance of other functions varies.

Figure 2. Final Energy Consumption by End Uses in 2005

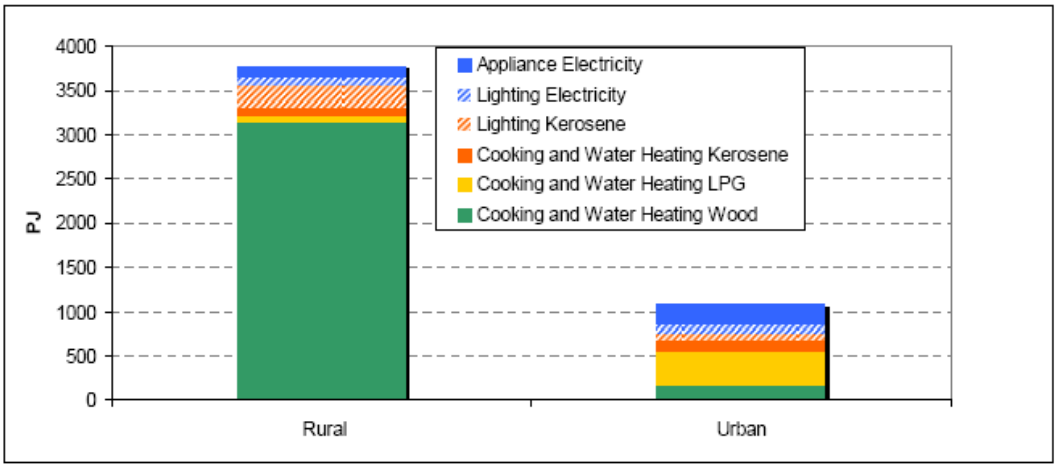


Figure 2 shows the decomposition of energy consumption in the residential sector by end uses. The predominant energy requirement serves the basic need of cooking and water heating. In rural areas, cooking and water heating represent up to 90% of household energy needs. The vast majority of energy use relies on traditional wood fuel. Lighting and services from basic appliances such as TVs, fans and refrigerators constitute the major remaining energy use. The substantial difference of final energy use between urban and rural areas arises from the fact that rural households use much more inefficient fuels, such as fuelwood for cooking and kerosene for lighting. Hence, their requirement to provide equivalent energy services than urban households is much higher.

Cooking and Water heating

Data from NSSO (2001a) as shown in Figure 1 were used to estimate the energy use for cooking and water heating. The quantities reported in the NSSO survey for LPG and wood were entirely assigned to cooking and water heating energy use. Electricity use for cooking is very small and was entirely allocated to the appliance energy use. Kerosene was the most challenging fuel to disaggregate as it is used both for cooking and lighting. A survey from NCAER (2005) shows that in rural areas, 34% of kerosene consumption is used for cooking and water heating while the remaining quantity is used for lighting. In urban areas, the share of kerosene used for cooking and water heating is much larger, representing 61.2% and 3.9% respectively, while 34% is used for lighting.

Average useful energy was calculated to assess how much energy households require according to their living area (urban/rural) and income level. Useful energy consumption was derived by multiplying each quantity of fuel with its efficiency rate (Table 3).

Table 3: Efficiency of Fuel Use

Wood	LPG	Kerosene (Heat)
13%	60%	40%

The data show that useful energy consumption is correlated with income as well as with fuel choice. For instance, households using wood, use it more when their income rises but less than households with similar income that use commercial fuels. The main reason is that commercial fuels are more convenient to use and therefore people tend to use them more. Cooking and water heating useful energy for urban households is about 4,500 MJ/year whereas rural households use only 3,000 MJ/year. However, due to the preponderance of wood in rural areas, the final energy consumed by a household living in rural areas represents more than twice the energy consumed by an urban household (22,500 MJ vs 13,000 MJ).

Appliances

Most of the electricity consumed in the residential sector is used to power appliances. The diffusion of appliances ownership is particularly elastic to income. With increasing electricity access and raising income level, the number of households owning appliances is increasing very rapidly in India. NSSO surveys (1997, 2001a, 2005b) provide appliance saturation by MPCE for rural and urban areas. Appliances such as water heaters, washing machines and air conditioners, which can be considered as more luxurious goods, are owned only by households with the highest level of income. According to MNRE (2008), a total of about 2.15 million square meters of collector area has been installed.

2.3 Drivers of Energy Use in the Residential Sector

Energy consumption in the residential sector is closely linked to the urbanization rate. Urban households tend to have higher levels of energy needs and hence, the migration of rural population towards urban centers increases the level of energy use. In addition, other factors, such as the diminution in household size and increase in housing floorspace represent major drivers of energy demand (Schipper, 1997, 2001). Table 4 shows some activity variables for the residential sector and their trends over the period 1990 to 2005.

Table 4: Residential Activity Variables

Population		1990	2005	AAGR 90-05
Population	Million	850	1,095	1.70%
Share of urban	Percent	26%	29%	0.79%
Urban Population	Million	217	314	2.51%
Rural Population	Million	633	780	1.41%
Number of Households	Million	154	232	2.76%
Number of Households (Urban)	Million	41	73	3.98%
Number of Households (Rural)	Million	114	159	2.26%
Household size urban	persons	5.34	4.31	-1.42%
Household size rural	persons	5.57	4.91	-0.84%

Source: WB, 2008; NSSO, 2001a; NSSO, 2008.

2.4 Residential Future Outlook

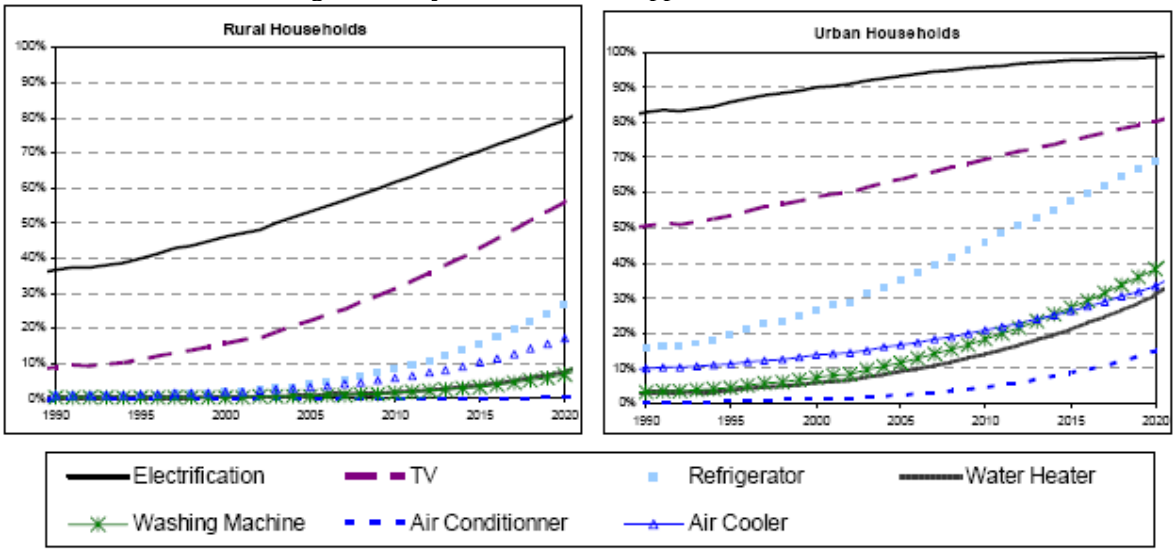
Driver Forecast

The main drivers of energy consumption in the residential sector are the number of households and the penetration of appliance ownership by household.

In 2005, average household size in India was estimated at 4.91 persons in rural areas and 4.31 in urban areas (NSSO, 2008). The average size in rural areas has decreased slightly from 5.57 to 4.91, while it has declined in urban areas from 5.34 to 4.31 (MOSPI, 2006; NSSO, 2008). Size of household is a key driver as it determines the number of household units that require energy. We assumed that household size will decrease slightly less rapidly than historically with increasing income to reach 4.75 in 2020 and that urban household average size will reach 3.70.

Appliance ownership was forecast using a regression on income on electrified households. NSSO (2001a) provides appliance saturation by MPCE for rural and urban areas while the diffusion level is available only by urban and rural areas but not per MPCE class. When the diffusion was a lot more important than the average saturation (in the case of fans), the saturation levels by MPCE class were converted in diffusion level assuming a linear relation with income. Appliance diffusion was then projected using Gompertz equations. Figure 3 shows the projection's results from 1990 and 2020, assuming a 7% economic growth from 2005 and historical growth rate in earlier years.

Figure 3: Projections of Rate of Appliance Diffusion



Residential End Use Intensities: Cooking and Water heating

Cooking and water heating energy consumption per household was projected using an income regression. The relation between each individual fuel consumption and MPCE was analyzed with data provided by the NSSO Survey (2001a).

Figure 4: Average Energy Consumption per Capita per Month

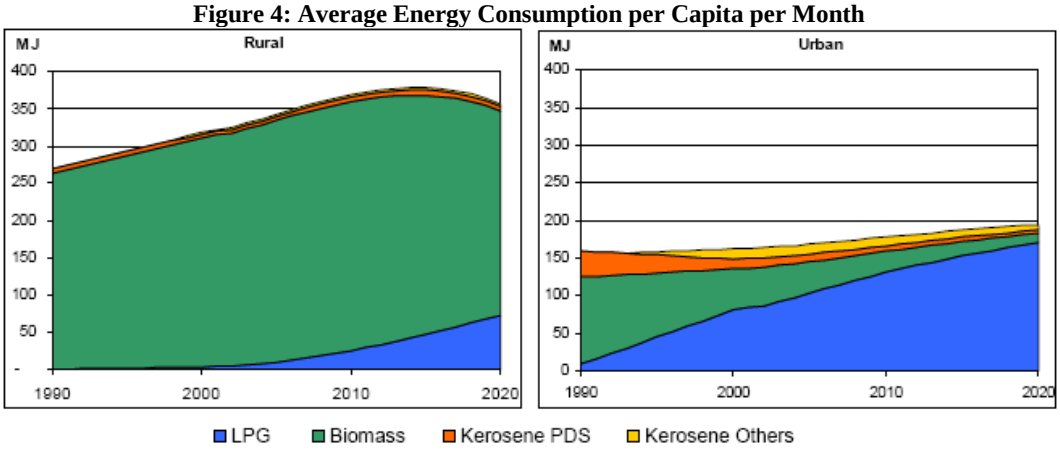


Figure 7 shows projections of final energy consumption for cooking and water heating per capita per month living in urban and rural areas. With increasing level of income, households augment their demand for energy. In urban and rural areas, this additional demand will be mostly met with LPG.

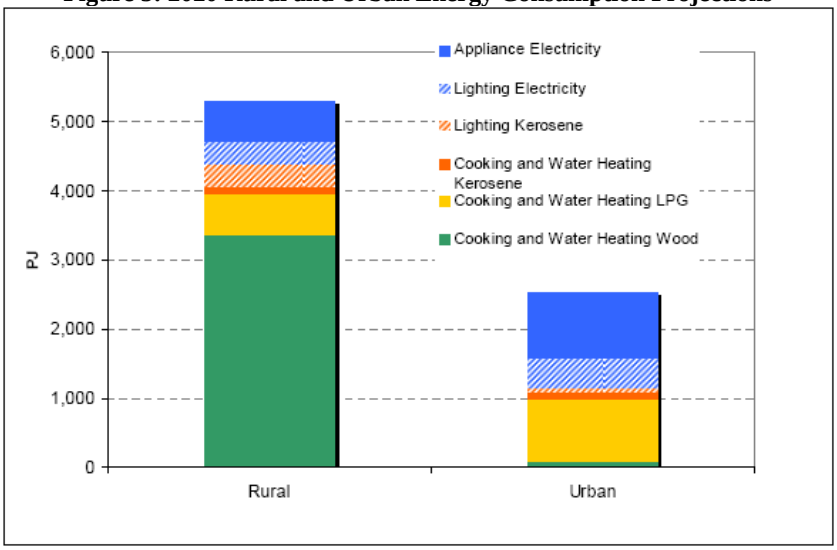
Residential End Use Intensities: Appliances

Appliance Unit Energy Consumption (UEC) is assumed to stay constant over time with three exceptions: refrigerators, air conditioners and water heaters. Water heater UEC is expected to decrease slightly (598 kWh for year 2020) during the forecast period due to the projected decrease of the number of persons per household.

Baseline Energy Projection in the Residential Sector

According to the projections, the average household will consume five times more electricity in 2020 than in 2000. Urban household consumption rises from 908 kWh in 2000 to 2972 kWh in 2020, while rural rises from 224 to 1311 kWh. Per household rural consumption grows twice as fast as urban. Figure 5 gives the urban and rural energy consumption projections for 2020.

Figure 5: 2020 Rural and Urban Energy Consumption Projections



SUMMARY OF KEY PROJECTIONS AND DERIVED INPUTS FOR PRESENT STUDY

	1990	1995	2000	2005	2010	2015	2020	AAGR 90-05	AAGR 05-20
Population Total	860,195,000	954,282,000	1,046,235,000	1,134,403,000	1,220,182,000	1,302,535,000	1,379,198,000	1.90%	1.30%
Urbanization rate	25.50%	26.60%	27.70%	28.70%	30.10%	31.90%	34.30%	0.80%	1.20%
Rural Population	640,845,275	700,442,988	756,427,905	808,829,339	852,907,218	887,026,335	906,133,086	1.70%	0.80%
Urban population	219,349,725	253,839,012	289,807,095	325,573,661	367,274,782	415,508,665	473,064,914	2.70%	2.50%
Persons/hh (Rural)	5.57	5.38	5.19	4.91	4.8	4.77	4.75	-0.80%	-0.20%
Persons/hh (urban)	5.3	4.94	4.6	4.31	4.05	3.85	3.7	-1.40%	-1.00%
Households (rural)	115,053,012	130,193,864	145,747,188	164,731,026	177,689,004	185,959,399	190,764,860	-1.40%	-1.00%
Households (urban)	41,386,741	51,384,415	63,001,542	75,539,132	90,685,131	107,924,329	127,855,382	-1.40%	-1.00%
Households CAGR (rural)	-	-	2.28%	2.48%	1.53%	0.91%	0.51%	-	-
Households CAGR (urban)	-	-	4.16%	3.70%	3.72%	3.54%	3.45%	-	-
Geyser penetration (rural hh)	0%	0%	1%	1%	2%	4%	8%	10.3%	14.5%
Geyser penetration (urban hh)	3%	4%	6%	9%	14%	21%	31%	7.6%	8.4%
Geyser penetration CAGR for 2010-2020 (rural hh): 14.87%									
Geyser penetration CAGR for 2010-2020 (urban hh): 8.27%									