Survey/Audit and Assessment of Potential of Solar Water Heating and Rooftop SPV Systems in Gurgaon-Manesar area of Haryana

Final Report

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Project Management Unit
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Submitted by

Bhagwat Technologies and Energy Conservation Pvt Ltd
in collaboration with
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During the course of the study, we had the opportunity to interact with a wide range of stakeholders, such as, SWH/SPV users, potential SWH/SPV users, SWH/SPV manufacturers' and suppliers, HAREDA, Gurgaon Municipal Corporation, HUDA (Haryana Urban Development Authority), Electricity distribution company (DHBVN), Haryana Pollution control board, Gurgaon Industrial Association, Gurgaon Guest house Association, Indian Medical Association-Gurgaon Chapter, office-bearers of various Group Housing Societies and Automotive Component Manufacturing Association. We sincerely thank all of them for sparing their valuable time to interact with us and for sharing information, experiences, perceptions and thoughts on the subject.

EXECUTIVE SUMMARY

Survey/Audit and Assessment of Potential of Solar Water Heating and Rooftop SPV Systems in Gurgaon-Manesar area of Haryana

1.0 Gurgaon-Manesar Urban Complex

The Gurgaon-Manesar Urban Complex has emerged as one of the fastest growing urban areas in the country. The total area of the complex is 37069 Hectares. The current population is estimated at 25 lakhs, which as per the development master plan is expected to reach 37 lakhs by 2021.

Gurgaon-Manesar has two large industrial areas – Udyog Vihar and Industrial Model Township (IMT), Manesar. It is known for its Automobile and IT/ITES industry in the country. The total number of industrial units in 2003-04 was 944. The growth of real estate has been spectacular in the region. The region has been adding 20,000 -30,000 flats/houses (having 2 or more bedrooms) every year for the past few years. The region is expected to continue to grow at a fast pace in coming years. The Gurgaon district has 25 notified SEZs in the country having a total area of 1120 Hectares. This makes it one of the leading districts in the country for SEZ development.

The rapid development of Gurgaon-Manesar has put enormous pressure on natural resources and environment. The region is facing severe shortage of both power and water. A large part of the resources needed for the infrastructure development and its operation are being sourced from outside the region. There is a good potential to integrate solar energy utilization in the new infrastructure which would help to some extent in reducing dependence of the region on resources sourced from outside the district.

2.0 Objective of the Study

The study is titled "**Survey/Audit and Assessment of Potential of Solar Water Heating and Rooftop SPV Systems in Gurgaon-Manesar area of Haryana**". The main objectives of the study are:

i. Audit of the present requirement of hot water and backup power and the present means of meeting those requirements in existing institutions, establishments, complexes and industrial units; and,

ii. Assessment of the requirement of new institutions, establishments, complexes and industrial units being planned or under construction/ implementation

iii. Provide and overall assessment of the demand for both types of systems in the Gurgaon-Manesar area

iv. Evaluate the role of implementation in the ESCO mode

v. Provide at least three case studies for each demand segment covering both types of installations (in all 12 case-studies)

vi. Develop model preliminary project reports for each demand segment for different implementation modalities (in all 4 model project reports)

3.0 Methodology

The first phase of the study involved stakeholder's interactions and conducting primary survey to build the inventory of the residential & commercial buildings and industries. During this phase Solar Water Heating and Solar PV installations for case studies were identified. The project team met various stakeholders as listed below and collected relevant information for the study:

- HAREDA (Haryana Renewable Energy Development Agency)
- HUDA (Haryana Urban Development Authority)
- SWH manufacturers/dealers
- Municipal Corporation
- Electricity distribution companies (DHBVN)
- Haryana Pollution Control Board

- Gurgaon Industrial Association
- Gurgaon Guest house Association
- Indian Medical Association-Gurgaon Chapter
- Automotive Component Manufacturing Association
- Telecom Industries
- Solar PV Experts
- Experts from Textile, Auto component Manufacturing, Dairy, Catering& laundry Industry

The second phase of the study was focused on case-studies and for carrying out technological and financial assessment. During this phase detailed information on 12 case-studies on SWH and SPV applications was collected. This data was then analysed and case-studies were prepared in a standard format.

The third phase of the study was devoted to carrying out projections of the demand, assessing realistic market potential, collecting and analyzing data for preparing 4 model project reports and report preparation.

4.0 Assessment of Hot Water Demand

4.1 Residential

A previous report on Solar Water Heater market[1] indicates that Solar Water Heaters are generally owned by middle and affluent urban households. Hence, for estimating the hot water demand, residential units falling under the old Gurgaon town, village *abadies*, slums have note been considered. Based on the property tax data of the Municipal Corporation and data collected from the survey, it is estimated that Gurgaon has 85000 flats (having 2 or more bedrooms) in multi-storey housing and 32000 houses constructed on individual plots. The norms used for calculating hot water requirement in the residential sector are presented in table 1.

[1] Greentech Knowledge Solutions. Solar Water Heaters in India: Market Assessment Studies and Surveys for Different Sectors and Demand Segments. Report prepared for UNDP/GEF Global Solar Water Heating Project. January 2010

Table 1. Hot water demand norms for residential sector

Type	**Hot Water Requirement (lpd/unit)**	**Usage Pattern (Days/Year)**
Residential Apartments		
3 bed-room and above	200*	150
2 bed room	100*	150
Individual Houses		
Above 250 sq yards	300	150
Below 250 sq yards	150	150

** As per HAREDA order on SWH.*

The other data is based on stakeholders' interaction and primary survey.

Using these norms for the year 2010, the total daily hot water requirement is estimated at 21 million lpd during winter months. The total annual demand taking 150 days of use is calculated as 3292 million litres.

Electric geysers are the most common technology used for heating water and the total number of electric geysers in the residential sector is estimated to be around 3 lakhs. The life-cycle cost of heating water through electric geysers is calculated as Rs 0.42/ litre.

4.2 Commercial and Institutional Sector

From the view point of hot water use, the commercial and institutional sector comprised of:

- Hotels and guest houses
- Hospitals and nursing homes
- Hostels

Based on the data collected through both primary and secondary sources, the present inventory of the commercial and institutional sector is estimated and is presented in table 2. The hot water norms for each category based on primary survey and stakeholders' interaction are also presented in table 2.

Table 2. Inventory of Commercial and Institutional Sector (2010) and hot water norms

	No. of units	Hot water norm (lpd)
Luxury Hotels	5200 rooms	150
Budget Hotels	2800 rooms	100
Guest Houses, Service apartments, paying guest accommodation	30000 rooms	70
Hospital (Large, Multi-specialty > 100 beds)	2800 beds	50
Hospital (< 100 beds)	1200 beds	30

The total daily hot water requirement from the commercial and institutional sector is estimated to be 3.4 million lpd, out of which almost 2.2 million lpd are contributed by the guest houses. The predominant mode of heating water in guest houses, small hotels and hospitals is electric geysers. Large hotels and hospitals rely on petroleum furls based boilers and hot water generators.

4.3 Industrial Sector

The industrial segments in Gurgaon- Manesar that are of interest from a hot water point of view are:

- Automobile (hot water use in electroplating, degreasing and phosphating)
- Textile (hot water use for washing and dyeing)
- Dairy (hot water use for pasteurization, cleaning)
- Catering (hot water use for cooking, cleaning and keeping food hot)
- Laundry (washing of clothes)

Apart from these there are other industries that use boilers or have canteens and hence have solar water heater potential. The total estimated hot water demand for industries is calculated as 5.6 million lpd.

4.4 Hot Water Demand in 2010 and 2014

The daily hot water demand for 2010 is estimated at 30 million lpd. The percentage wise distribution of this demand is given in figure 1. The residential sector is responsible for 70% of the daily hot water demand.

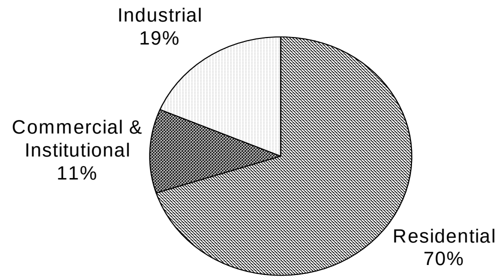
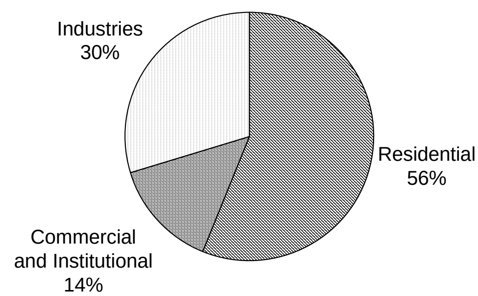


Figure 1 Daily Hot Water Requirement (2010) - Sector wise distribution

The annual hot water requirement is estimated at 5866 million liters. The distribution of this demand is given in figure 2, which shows that while the residential sector accounts for 56% of the annual requirement, industries account for 30% and are an important sector from a view point of reducing fossil fuel use for water heating.



The hot water demand for 2014 was calculated based on estimation of new addition in the building stock. The growth rates for different types of building for the 2011-2014 period is given in table 3.

Table 3. Growth in Building Stock (2011-2014)

Flats in multi-storey housing	15000 per year
Houses constructed on individual plots	5000 per year
Hotel rooms	10% per year
Guest house rooms	20% per year
Hospital beds	7.5% per year

Taking these growth rates into account it is expected that the total daily hot water requirement would increase from 30.0 million lpd in 2010 to 46.92 million lpd by 2014.

Table 4. Daily Hot Water Demand (in million lpd)

	Predominant means for heating water	**2010**	**2014**
Residential (Flats/houses having 2 or more than 2 bedrooms)	Electric Geysers	21.0	34.0
Hotels and Guesthouses	Electric Geysers/ Petroleum fuel based boilers and hot water generators	3.2	4.6
Hospitals	Electric Geysers/ Petroleum fuel based boilers and hot water generators	0.2	0.22
Industry	Petroleum fuel based boilers and hot water generators		
o Auto		2.3	2.3
o Textile		1.0	1.0
o Dairy		1.0	1.0
o Catering		1.2	1.2
o Laundry		0.1	0.4
SEZ (IT/ITES)		NA	2.2*
SEZ (Others)		NA	NA
Total		**30.0**	**46.92**

4.5 Current Solar Water Heater Market

The total installed capacity of solar water heaters is estimated at 0.33 million lpd. This is around 1.5% of the total daily requirement of hot water. A list of prominent SWH installations in Gurgaon is given in table 6.

Table 6. Large Solar Water Heater Systems in Gurgaon

Industrial		Capacity (lpd)
1	Chelsea Mills, Sector 5, IMT, Manesar	50,000
2	Anant Raj Industries, Sector 8, Manesar	5,000
3	Maruti Udyog Ltd	4,000
Hospitals		
1	Columbia Asia Hospital	5,000
2	Healers Hospital Pvt Ltd	1,500
3	Medicity Hospital	8,000
Multi-storey Housing		
1	Unitech Group Housing	4,000 (8 x 500)
2	Omex Group Housing	5,000 (10 x 500)
3	Haryana Housing Board, Sec 43	32,000 (32 x 1000)
4	BPTP, Freedom Park Life, Sector 57	15,700
5	Central Park	
6	IVY Complex	12, 800
Institutional		
1	Om Shanti Retreat Centre, Bhoran Kalan – Bilaspur, Gurgaon	21,000
2	Working Women Hostel, Civil Line, Gurgaon	2,000
3	Shanti Gram Niketan, Vill Mandawar, Sohna	2,600
4	Dronacharya College of Engineering	2,000
5	HIPA	3,000
Hotels		
1	Crowne Plaza	20,000
2	Galaxy	16,000

The SWH market has benefited from the state government order making the use of solar water heater mandatory in a variety of buildings. The annual installation of SWH at Gurgaon-Manesar for the year 2010-11 is estimated at around 0.1 to 0.15 million lpd.

4.5 Solar Water Heater Policy

Haryana is the first State in the country to issue a comprehensive notification dated 29.07.2005 on Energy Conservation Measures. It makes Solar Water Heating Systems mandatory for water heating application in all functional buildings where hot water is required. The Haryana Urban Development Authority has adopted the mandatory provisions of HAREDA vide their letter dated 28.11.05. The Department of Urban Local Bodies, Haryana has also amended the Haryana Municipal Building Bye-laws vide Notification dated 16.11.07. Solar Water Heating has been made mandatory in:

- Industries,
- Hospitals and Nursing Homes, Govt. Hospitals
- Hotels, Motels and Banquet Halls,
- Jail barracks,
- Canteens, Housing Complexes set up by Group Housing Societies/Housing Board,
- All Residential buildings built on a plot of size 500 sq. yards and above falling within the limits of Municipal Committees/Corporations and HUDA Sectors, and
- all Govt. buildings, Residential Schools, Educational Colleges, Hostels, Technical/Educational Institutes, District Institute of Education and Training, Tourism Complexes and Universities etc.

The regulation is yet to be enforced in an effective manner; however, it has definitely helped in opening new segments for the solar water heater industry e.g. the multi-storey residential buildings.

5.0 Assessment of Back-up Power (2010 and 2014)

Gurgaon-Manesar urban complex is facing an acute power crisis and has a very large back-up power generation capacity in the form of diesel based generators (approx 2000 MW). On an average there is a power shortage of 20% which during peak demand periods goes up to 35%. The average duration of daily power cut ranges from 4-8 hours.

Table 5. Back-up Power (DG sets)

	2010	**2014**
Residential	400	600
Commercial and Industrial	1600	2100
SEZ	NA	NA
Total	**2000**	**2700**

6.0 Solar Water Heater Market Potential

To carry out realizable market potential of SWH in the area till the year 2022, following three cases has been assumed

1. Business as usual scenario
2. Growth Scenario -I
3. Growth Scenario -II

The projections have been carried out by:

a) Projecting future demand for hot water for each category assuming growth rates for different time periods i.e. 2010-2014, 2014-2018 and 2018-2022.

b) Assuming gradual increase in penetration levels to assumed terminal penetration rates in 2022 for each category.

c) For projections, new and existing buildings have been treated separately, given the fact that several of the mandatory provisions are applicable to new buildings and incorporation of SWH is much easier and economically viable in new buildings.

6.1 Business as Usual Scenrio

This scenario corresponds to the business as usual condition, where:

- The government does not take any specific steps for promotion of SWH in high potential categories as well as for implementing mandatory provisions.
- The growth of the market is left primarily to marketing efforts of the SWH suppliers and growing awareness amongst potential users.

The projections under this scenario are presented in table 6. The BAU scenario results show a healthy annual growth of 21.3% in SWH deployment till the year 2022. It shows that even if the government focuses its attention on awareness generation and ensuring quality and leaves the marketing efforts to SWH industry, substantial increase in SWH deployment are possible. Deployment in new residential construction (both flats and plotted housing) is estimated to account for more than 50% of the cumulative SWH deployment.

Table 6. Realizable Potential for SWH under BAU Scenario (cumulative SWH deployment in sq. m)

		BAU Scenario		
	2009-10	**2013-14**	**2017-18**	**2021-22**
Residential	3,688	19,421	30,315	37,068
Commercial	774	4,295	7,573	10,160
Institutional	306	502	676	878
Industrial	1,000	3,214	6,444	10,449
Total	**5,767**	**27,432**	**45,007**	**58,555**

6.2 Growth Scenario -I

The growth scenario-I assumes:

a) A more pro-active policy on mandatory provisioning of SWH which has elements of stricter enforcement as well as periodic revision of the provisions taking ground-realities into account.

b) A focused and targeted approach for awareness generation and technical training.

c) Promotion of ESCOs for segments such as industries and commercial buildings.

All these steps would result in much higher penetration across all categories and almost 100% increase over 2022 BAU projections (table 7). The annual growth rate in SWH deployment under this scenario would be 28.35%.

Table 7. Realizable Potential for SWH under Growth Scenario -I (cumulative SWH deployment in sq. m)

		Growth Scenario –I		
	2009-10	**2013-14**	**2017-18**	**2021-22**
Residential	3,688	24,063	47,942	70,508
Commercial	774	5,793	14,254	24,284
Institutional	306	521	760	1,084
Industrial	1,000	5,213	11,521	19,418
Total	**5,767**	**35,590**	**74,477**	**115,294**

6.3 Growth Scenario -II

Growth Scenario –II builds on Growth Scenario –I and assumes that Energy Conservation Building Codes (ECBC) would become mandatory and would have a better implementation compared with the mandatory provisioning of SWH.

The projections for the scenario are given in table 8. The annual growth rate in SWH deployment is 32.3 %.

Table 8. Realizable Potential for SWH under Growth Scenario -II (cumulative SWH deployment in m^2)

		Growth Scenario-II		
	2009-10	**2013-14**	**2017-18**	**2021-22**
Residential	3,688	27,750	62,069	97,248
Commercial	774	7,291	20,936	38,408
Institutional	306	540	844	1,291
Industrial	1,000	7,456	17,144	29,275
Total	**5,767**	**43,037**	**100,993**	**166,222**

6.4 Strategy to achieve SWH Potential

The priority sectors for the realizable SWH potential are stated below (in the descending order of their potential)

1. New Multi-storey housing
2. Industries (Hybrid systems of SWH and Waste heat recovery units)
3. Guest houses and Hotels
4. Existing and New Plotted housing
5. SEZs

Actions required to realize the SWH potential for each subcategory is described below:

New Housing: New housing should be the focus in the residential sector. In 2010, despite the mandatory order from the government in plot sizes above 500 Sq yds and in Group Housing/ Apartments etc , SWH were provided in less than 5% of the new housing.

Following steps should be taken:

- Awareness creating measures through media and events.
- In case of plotted housing, mandatory provision need to apply to plot sizes above 250 sq yds.
- There is a need to re-look into the mandatory provisions for multi-storey housing, to make them more realistic. For buildings above a certain height, enough space is not available on the roof for putting-up adequately sized SWH. Literature on Chinese experience (Zhejang Province) show that SWH are strongly recommended for multi-storey housing up to 12 storey high.
- Stricter enforcement of the mandatory provision *(making them non compoundable*)
- Capacity building measures amongst the developers and architects and plumbing consultants about the mandatory provision.

- A technical solar cell to be established which should be responsible for the independent monitoring of the large residential SWH systems, providing technical support for designing of SWH systems, and look into genuine problems of the developers and users (e.g. lack of space at roof-tops/ rooftop orientation in high-rise buildings) and provide solutions.
- As shown in the report, fee for service ESCO model seems viable for the new multi-storey housing. There is a need to take-up demonstration projects to demonstrate this model and attract ESCOs in this field.

A sharp focus on this area is likely to a substantial increase in uptake of solar water heating systems.

<u>Existing Housing</u>:

- Plotted Housing: This segment has been showing growth across all major cities. The space on roof is not a problem in plotted housing, similarly affordability is also not a major issue. There is good potential to increase the penetration in existing plotted housing through awareness and increasing the marketing efforts.

  Multi-storey Housing: On the other hand, in existing multi-storey housing which is a big segment the solution is technical complex and financially unattractive. The decision making process in Resident Welfare Associations and Cooperative Housing Societies is slow which makes the task of retrofitting existing multi-storey housing with SWH very difficult. Under the present policy and incentive frame-work, the fee for service ESCO model does not seem to be workable. Demonstration projects are required to test different incentives and innovative financing models. This segment is unlikely to see any radical changes in solar water heating deployment

<u>Commercial and Institutional Buildings:</u>

As shown in the case studies, SWH have attractive pay-back period (less than 2-3 years) for hotels and guest-houses.

- Creating awareness and stricter enforcement of mandatory regulations should be the focus, as this segment does not require any new incentives.
- The guest houses should be the focus, as these have emerged as the largest sub-segment. A demonstration project on ESCO for guest houses may be undertaken.

As most of the Guest houses exist outside the Guest house byelaws the ***mandatory provisions need to be creatively formulated.*** Guest Houses potential for SWHS can only be realized by reducing the current ceiling from 500 sq yds to plot sizes of 250 sq yds and above or apply to any residential building which has more than 6 sanctioned bathrooms in the building plan. This is a segment which shows great promise for the immediate future

Industries:

Industries offer a large untapped potential. Most of the solar water heater projects in industries have an attractive pay-back period. Automobile, catering and laundry offer the greatest potential.

- As a follow up on the work done during the study to identify potential industries and in establishing preliminary feasibility, there is a need to take-up quickly demonstration projects in the automobile and dairy industry.
- Capacity building, through seminars with PAN India industry associations like ACMA and Indian Dairy Federation and publications in industry journals.
- There is a case to demonstrate guaranteed saving ESCO model for industries.
- Industrial solar water heater systems are generally more complex. Hybrid systems incorporating waste heat recovery and solar water heating seem to be the most attractive options. A technical solar cell to be established to act as single window information source and technical resource for the industry.

This is an area with a huge untapped potential and successful demonstration projects in this area can have a pan India impact on the spread of solar water heating in Industrial application.

6.5 Immediate Suggestions

1. Formation of realistic norms for the mandatory regulations, on the basis of primary and secondary survey with the end users and SWH installers following actions are suggested
    a. Mandatory regulations for the residential plotted housing greater than 250 sq yard are needs to be formulated
    b. Norms for the mandatory regulations for multi storey building should be revised and different norms should be formulated for more than 12 storey buildings.

   c. Mandatory regulation of at least 75 lpd per room for star rated hotels & 50 lpd per room for budget hotels/Guest houses and 30 lpd per bed for star rated hospitals.
2. Formation of a technical solar facilitation cell that can provide technical support required for the complex installations. Details of the technical solar facilitation cell are provided in Appendix III.
3. Capacity building measures for Architects and Builders: Organization of at least 3 awareness cum technical training programme with site visits and case studies.
4. Awareness programme for potential industries with the help of industrial associations like ACMA/ SIAM/ Indian Dairy federations
   a. Organization of at least 3 awareness cum technical training programme on hybrid Solar Water Heating systems (SWH+ Waste heat recovery Units) with site visits and case studies.
   b. Awards and recognition for installation of large innovative and complex solar water heating systems.
5. Facilitation and monitoring of 2-4 model ESCo projects in industrial and commercial sector.

7.0 Rooftop Solar PV Market Development

The primary aim of rooftop solar PV in Gurgaon would be diesel saving. Our analysis show that given the large installed DG capacity (2000 MW) and present economics of solar PV (even after considering incentives offered under JNNSM), the contribution of solar PV on Gurgaon power situation would be only marginal in immediate future.

The two options which look attractive for Gurgaon-Manesar are:

- Off-grid day time use PV systems: In this configuration solar power generated through PV system is directly used to provide power to the day-loads. The system has a minimal battery bank to compensate for the fluctuations in the power generated through PV system during the day-time as well as to fill the gap between the peak power and the generated power, whenever required during the day time. In this configuration solar power can be used only during the day time and will not be stored for use in the night time or during the periods when there is no sun hence this type of solar PV system can substitute DG power only in the day time. This mode is suitable when stable day-time loads are available and there are frequent and long power cuts during the day time. Given the large investment required and simple pay-back period of 8 years and more one can expect only a few projects materializing in immediate future. The three most attractive segments based on the availability of day-time loads as well as space availability are:

  - Large multi-storey housing complexes
  - Guest houses
  - Industries

  Existing telecom towers in Gurgaon-Manesar does not seem to be an attractive segment.

- <u>Grid-connected rooftop systems</u>: In this configuration solar power generated can be directly fed into the grid. These systems work on net metering system, which meters both the electricity supplied from the PV system to the grid as well as the electricity used by the facility from the grid. This mode helps the local utility in getting supply of additional electricity during peak demand period during the day and also helps in utilizing the un-utilised roof area of the buildings. The two attractive segments seems to be:

  - Industries
  - Housing complexes

  School is another segment which may be interesting due to large rooftop area which is available.

8.0 Model Preliminary Project Reports

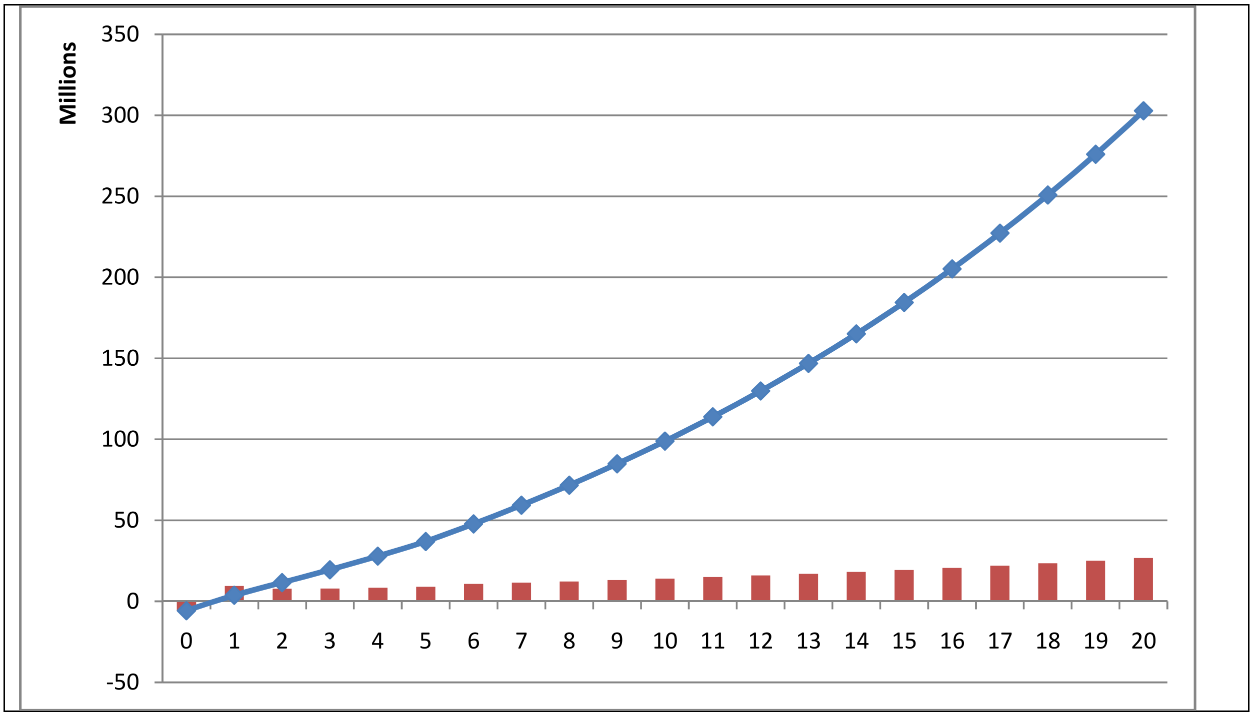
As per the ToR of the study, four model preliminary project reports have been prepared for the projects which can be pursued further for immediate implementation. A brief description is as follows:

8.1 Solar Water Heating at Dudhmansagar Dairy (capacity 1300 m^2 SWH integrated with Heat Recovery)

Dudhmansagar dairy, the wholly owned subsidiary of Amul, is the only large dairy operating in the Gurgaon-Manesar industrial area. Main operations carried out in the dairy are processing of milk, manufacturing of ice-cream & *dahi*. Daily production capacity in terms of milk, *dahi* & ice-cream are 1 million liter, 25 thousand kg & 25 thousand liter respectively.

The financial analysis of the proposed 1300 sq. m SWH system is presented in the table below:

Financial Data	
Capacity of SWH (Sqm)	1300 sqm
Life	20 years
Capital Cost (SWH)	Rs. 1.1 Crores (approx)
O&M Cost	2% per annum
MNRE Subsidy	Yes
Type of Subsidy	Capital + Interest Subsidy on Balance of systems (Soft loan @5% for 5 years)
Amount of Subsidy	Rs. 39 lakhs (Capital)
Capacity of Waste Heat Recovery Unit (WHRU)	4 lakh kcal/hr
Life	15 years
WHRU usage	12 hrs/day
Capital Cost (WHRU)	Rs. 36 lakh (Approx)
O&M Cost (WHRU)	2% per annum
Net Equity (SWH+WHRU)	Rs. 58 lakhs (approx)
Soft Loan Amount @ 5%	Rs. 49 lakh (approx)
Depreciation Benefits	Accelerated depreciation @ 80% Rs. 34 lakhs (in 2 years)
Expected Savings	820 kg Furnace Oil/day (Average)
Savings	Rs. 80 lakhs/annum (As per current furnace oil price i.e. Rs. 27per kg
Loan Amortization	Rs. 11.32 Lakhs/annum
Simple Payback	7 Months (approx)
NPV	Rs. 14.8 Crores
IRR	150%
Saving to Investment ratio	41
Cash Flow Analysis:	



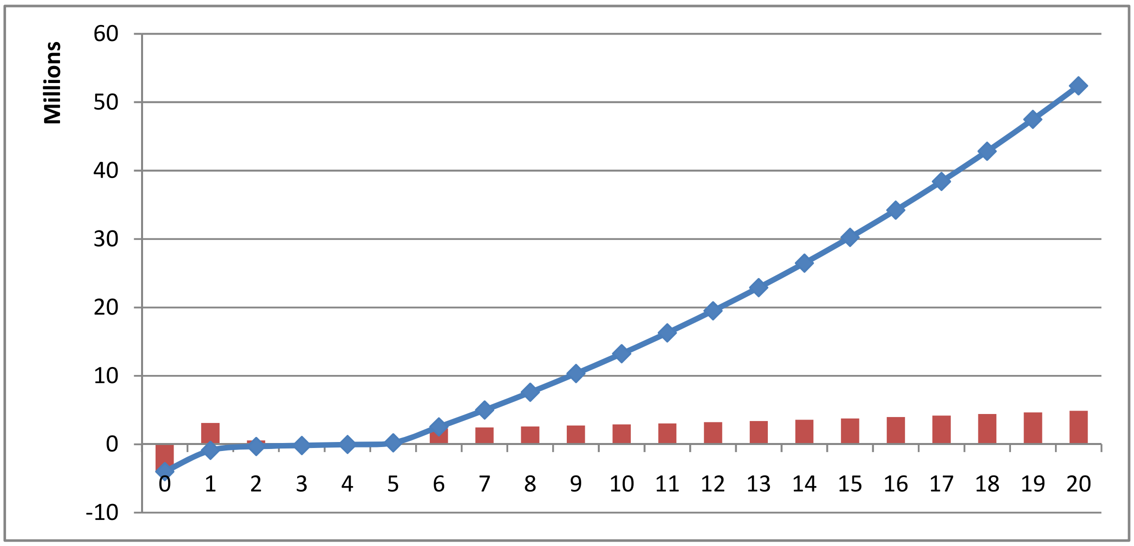
8.2 Solar Water Heating for Electroplating at Omax Auto (capacity 2500 sq.m)

Omax Autos Ltd is the wholly owned subsidiary of Omax Group. Omax is one of the biggest producers of auto components in the Gurgaon-Manesar industrial area and an OEM to all the major auto brands of India. They have two manufacturing units in the Gurgaon region. One of the main operations carried out in the Auto-component industries is electroplating. Sradhavalli village is the centre for Omax's electroplating operations. The daily electroplated area from the Sradhavalli unit is around 110000 dcm sq. Electroplating consumes a very large amount of energy in the form of heat and electricity. The proposed solar water heating system would supply hot water for electroplating.

Financial Data	
Capacity (Sqm)	2500 sqm
Life	20 years
Capital Cost	Rs. 2 Crores (approx)
O&M Cost	2% per annum
MNRE Subsidy	Yes
Type of Subsidy	Capital + Interest Subsidy on Balance of systems (Soft loan @5% for 5 years)
Amount of Subsidy	Rs. 75 Lakhs (Capital)

Expected Savings	220 kg furnace oil per day
Depreciation Income TAX Benefits	Accelerated depreciation @ 80% Rs. 40 lakhs (in 2 years)
Equity	Rs. 40 lakhs (approx)
Soft Loan Amount @ 5%	Rs. 85 lakhs (approx)
Savings	Rs. 22 lakhs/annum (As per current furnace oil price i.e. Rs. 27per kg)
Loan Amortization	Rs. 19.6 Lakhs/annum
Simple Payback	4 years
NPV	Rs. 2.6 Crores
IRR	39%
Saving to Investment ratio	5.5

Cash Flow Analysis:



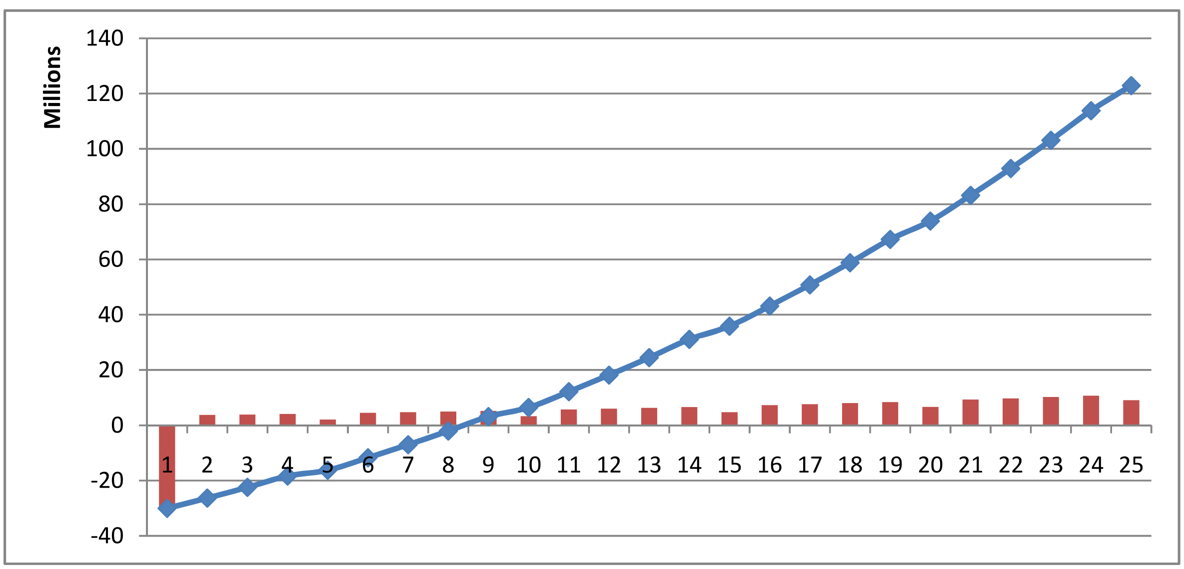
All the equity invested in the project in 2 years time, will be gained back through the savings and other benefits. After 2 years savings can take care of the rest of the annuity to be paid to the bank till the 5th year. After 5th year Savings can be realized in the balance sheet also.

8.3 200 kWp Solar PV Rooftop Power Plant at Garden Estate Housing Complex

Garden estate is a premium housing complex in Gurgaon having 373 apartments. A 200 kWp Solar PV power plant is being proposed to take care of part of the day-time laod and save diesel.

Financial Data (SPV)	
Capacity (PV System)	200 kWp
Life	25 years
Inverter Capacity	300 kVA
Battery bank	530 kWh
Capital Cost	Rs. 5.76 Crores (approx)
Recurring Cost	Rs. 21.88 lakhs per 5 years
MNRE Subsidy	Yes
Type of Subsidy	Capital
Amount of Subsidy	Rs. 2.4 Crores
Expected Savings	91000 lt diesel/yr + 100000 kWh/yr
Depreciation Benefits	No
Savings	Rs. 3.9 Crores/annum (As per current price diesel @ Rs. 37/lt & Electricity @ Rs. 4.5/unit)
Simple Payback	8.4 years
NPV	Rs. 3.37 Crores
IRR	15 %
Saving to Investment ratio	6.2

Cash Flow Analysis:

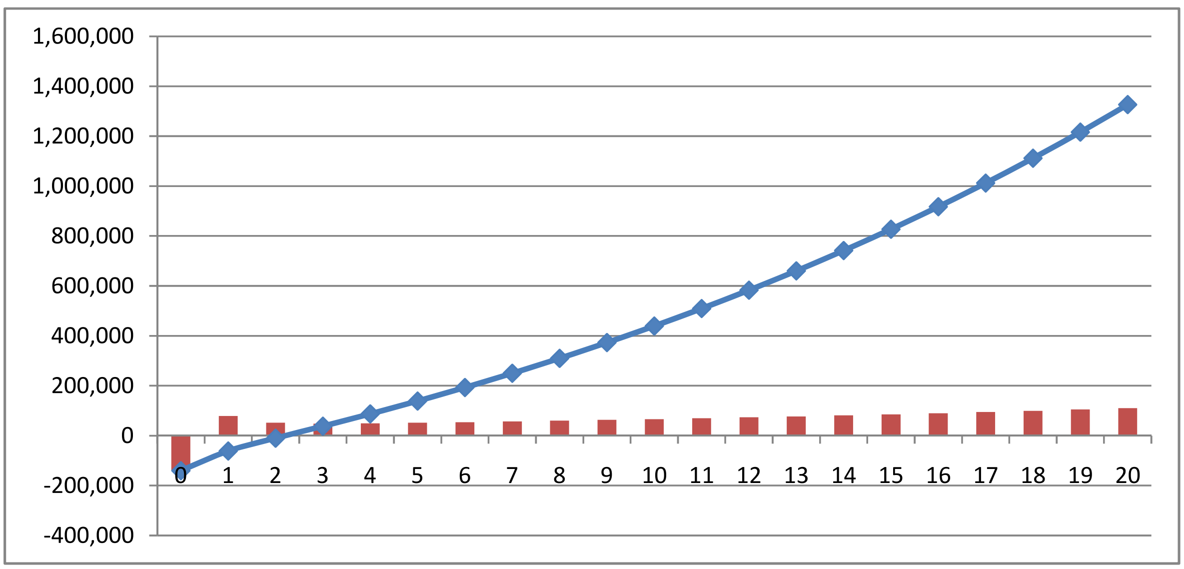


8.4 1000 lpd Solar Water Heating System and a 5 kWp Solar PV Rooftop system for a guest house

Gurgaon has around 2000 guest-houses. This model preliminary project report has been developed for a typical guest house.

Financial Data (SWH)	
Capacity (SWH)	1000 lpd
Life of SWH	20 years
Capital Cost	Rs. 2 lakhs (approx)
O&M Cost	2% per annum pressurized 4% pa
MNRE Subsidy	Yes
Type of Subsidy	Capital
Amount of Subsidy	Rs. 60000
Expected Savings	10200 kWh/yr
Depreciation Income tax Benefits	Accelerated depreciation @ 80% Rs. 45000 (in 2 years)
Savings	Rs. 46000/annum.
Simple Payback	2.2 Years
NPV	Rs. 7.5 Lakhs
IRR	43%
Saving to Investment ratio	7.8

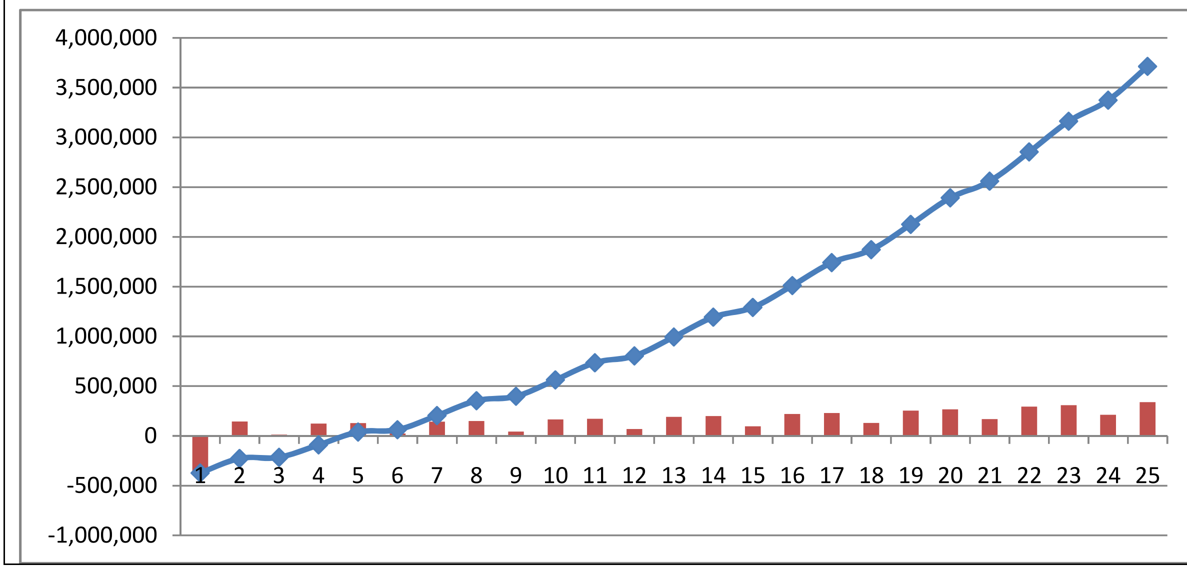
Cash Flow Analysis:



Financial Data (Solar PV System)	
Capacity (PV System)	5 kWp
Life	25 years
Inverter Capacity	12 kVA
Battery bank	28.8 kWh
Capital Cost	Rs. 11 lakhs (approx)
Recurring Cost	Rs. 1.12 lakhs per 3 years
MNRE Subsidy	Yes
Type of Subsidy	Capital
Amount of Subsidy	Rs. 4.5 lakhs
Expected Savings	3000 lt diesel/yr

Depreciation Benefits	Accelerated depreciation @ 80% Rs. 2 lakhs (in 2 years)
Savings	Rs. 1.14 lakhs/annum (As per current price i.e. Rs. 37 per litre for diesel)
Simple Payback	4.7 years
NPV	Rs. 9.67 Lakhs
IRR	28%
Saving to Investment ratio	9.4

Cash Flow Analysis:



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Chapter 1. Introduction

1.1 Gurgaon-Manesar Urban Complex

The Gurgaon-Manesar area in Haryana is fast emerging as a commercial, industrial and residential hub and is home to a large number of industrial, commercial and institutional establishments including office complexes, residential complexes, hotels, hospitals, nursing homes, hostels, educational institutions etc. Presently population of Gurgaon-Manesar area is around 2.5 million and it is expected to reach 3.7 million by 2021. As per the final development plan – 2021, for Gurgaon-Manesar complex, the total urbanizable area for the Gurgaon- Manesar is 37069 Hectares. Following is the proposed land use pattern in Hectares (table 1.1)

Table1.1: Master Plan Land Use Pattern[2]

Sr No	Land Use	Area (Hectares)	Distribution
1	Residential	14930	47.2 %
2	Commercial	1404	4.4%
3	Industrial	5441	17.2%
4	Transport and Communication	4231	13.4%
5	Public Utilities	564	1.8%
6	Public and Semi Public use	1630	5.2%
7	Open Spaces	2675	8.5%
8	Special Zone	106	0.3%
9	Defence Land	633	2%
	Total	**31614**	**100%**

Note: This area excludes 5455 Hectares for SEZ's, Existing town and Village Abadies

The existing developed area in Gurgaon is spread from sector 1 to sector 57, whereas sector 58 to sector 115 are still under development/construction phase and are estimated to be fully

[2] Source: Final development plan 2021 AD for the controlled area of Gurgaon-Manesar urban complex, Town & Country Planning Department, 5th Feb 2007

operational by 2021. It can be noticed that more than half of the total number of sectors are yet to be developed and residential segment is the largest segment in terms of the area.

The existing development pattern of Gurgaon (for sector 1 to 57) is given in table 1.2.

Table1.2.: Existing Development pattern of Gurgaon (Sector 1-57)

Type	No. of Sectors Dedicated
Only Residential	34
Only Commercial	4
Only Industrial	7
Residential & Commercial	9
Residential & Industrial	3

The Manesar area of the Gurgaon-Manesar urban complex, consists of 15 sectors. Sector 1 of Manesar is a residential area (under construction), while rest of the 14 sectors are part of Industrial Model Town (IMT).

A map of the master plan-2021 of Gurgaon-Manesar complex is presented in figure 1.1.

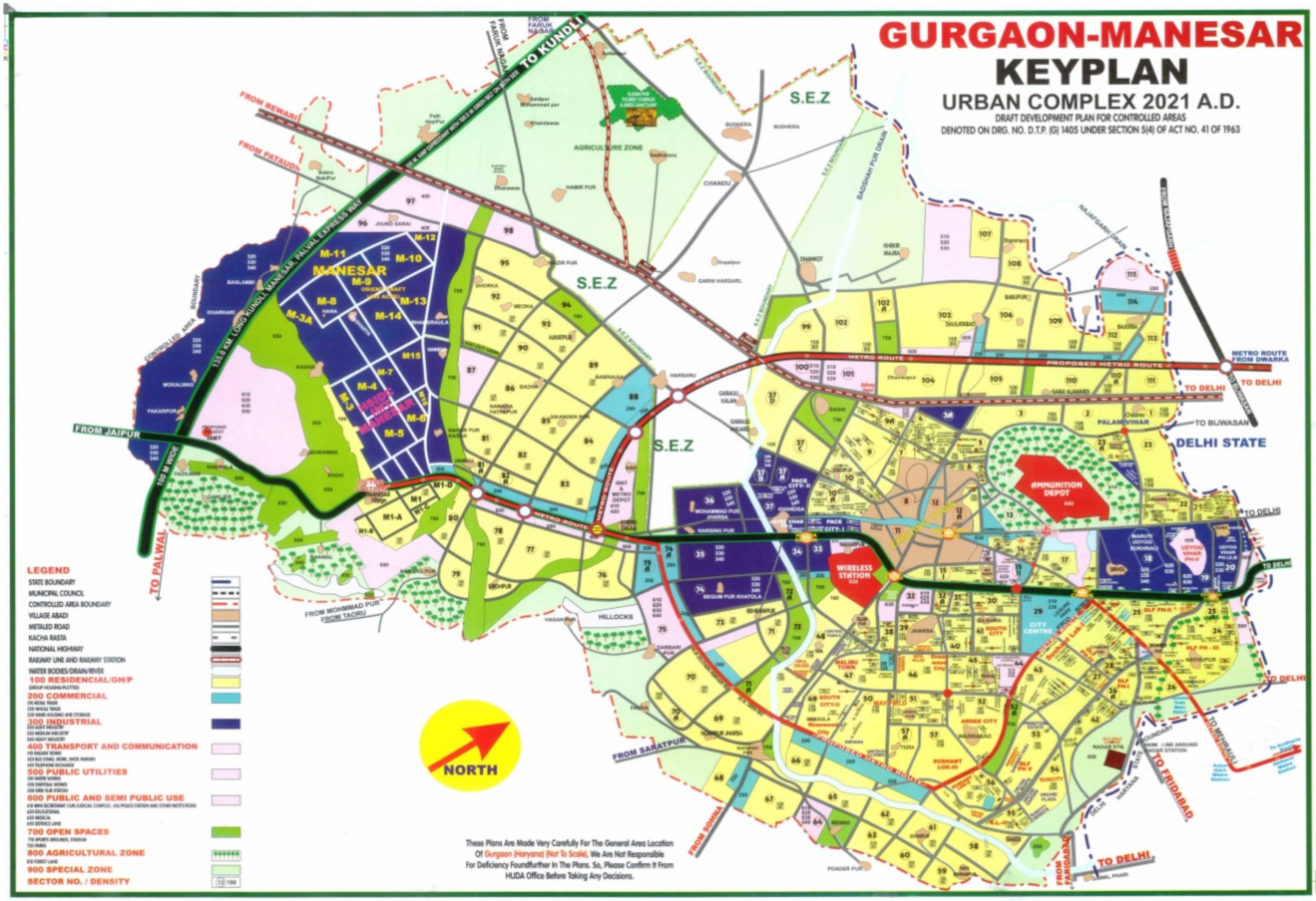


Fig 1.1: Map of the Master Plan 2021

1.2 Hot water and Back-up Power Scenario

Hot water is required for residential, commercial & institutional and industrial applications. Residential segment consists of both plotted housing as well as multi storey flats. The hot water requirement in the residential sector is primarily for bathing and is currently being met mainly using electric geysers. Commercial & Institutional segment consists of Hotels, Hospitals, Guest houses, Nursing homes, Hostels, etc. At present most of the demand in the commercial and institutional segment for hot water is met using electric geysers, petroleum fuel based steam boilers and pressurized hot water generator. The main hot water consuming industries in Gurgaon-Manesar complex are Automobile, Textile, Dairy, Catering and Laundry. In the industrial segment, petroleum fuel based steam boilers and pressurized hot water generators are most widely used.

Gurgaon-Manesar urban complex is facing an acute power crisis and has a very large back-up power generation capacity in the form of diesel based generators (approx 2000 MW). On an average there is a power shortage of 20%, which during peak demand periods goes up to 35%. On an average the duration of daily power cut ranges from 4-8 hours.

Gurgaon receives good annual mean daily global solar radiation of 5.5 $kWh/m^2/day$ as shown in figure 1.2. Given the large requirement for hot water and back-up power solar energy in the form of solar water heaters and solar Photovolatic electricity generation systems are potentially attractive options to reduce dependence on fossil fuels.

The history of SWH in Gurgaon dates back to the early 1990's, when SWH systems in some institutions were set-up. The Department of Urban Local Bodies, Haryana has amended the Haryana Municipal Building Bye-laws vide Notification dated 16.11.07, making the use of SWH mandatory in certain categories of residential, commercial and institutional segments. Though the regulation is still to be implemented strictly, this has resulted in some new installations in recent years particularly in multi-storey housing and commercial buildings. Haryana government also offers subsidy on SWH systems as well as a rebate in electricity bills. Still the overall penetration of SWH is low across all segments. The number of Solar PV installations are very few and are primarily in the institutional and industrial segments.

The present study is being undertaken as a part of the UNDP-GEF global solar water heating project, which 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.

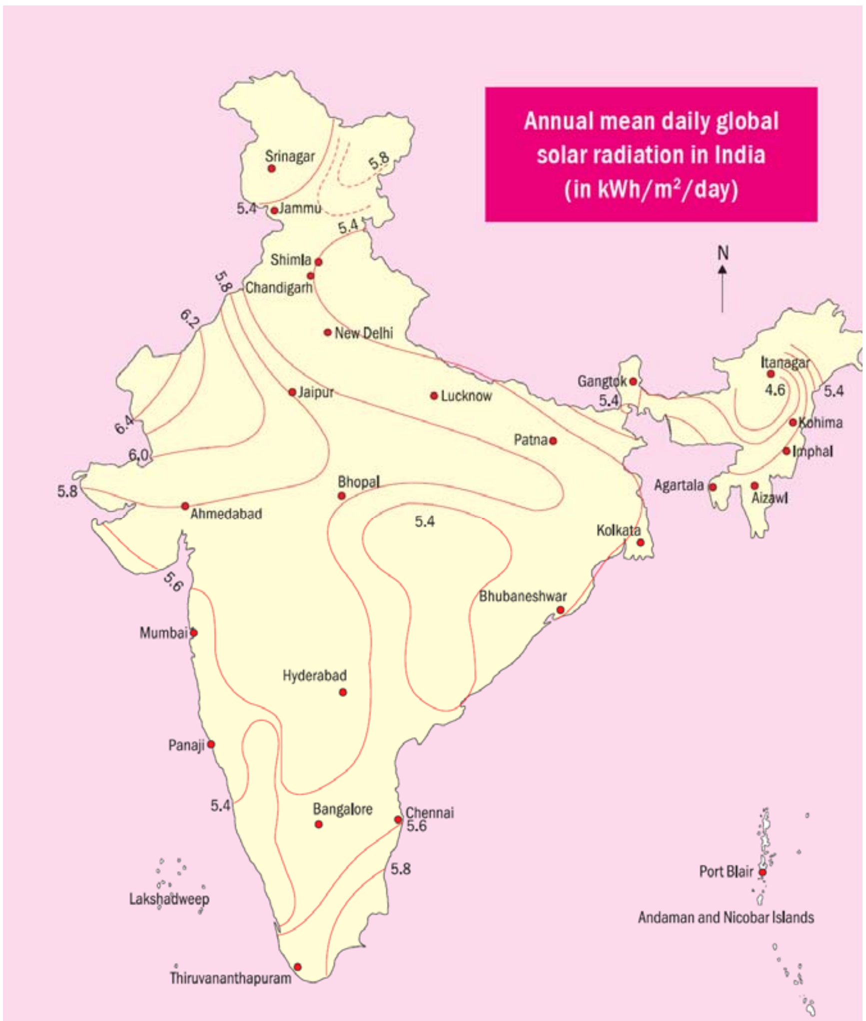


Figure 1.2: Annual mean daily global solar radiation in India

1.3 Objective of the study

The present study is titled "**Survey/Audit and Assessment of Potential of Solar Water Heating and Rooftop SPV Systems in Gurgaon-Manesar area of Haryana**". The objective of the study is to:

- Audit of the present requirement of hot water and backup power and the present means of meeting those requirements in existing institutions, establishments, complexes and industrial units; and,
- Assessment of the requirement of new institutions, establishments, complexes and industrial units being planned or under construction/ implementation
- Project realizable market potential for both types of systems till 2022 in the Gurgaon-Manesar area
- Evaluate the role of implementation in the ESCO mode
- Provide at least three case studies for each demand segment covering both types of installations
- Develop model preliminary project reports for each demand segment for different implementation modalities

Following sectors and demand segments are covered in the study:

- Residential buildings (Flats having 2 or more bed rooms and plotted housing)
- Institutional and commercial sector (Hotels, Guest houses, Hospitals, Nursing homes)
- Industrial sector (Automobile, Dairy, Textile, Catering & Laundry)

1.4 Limitations of the Study

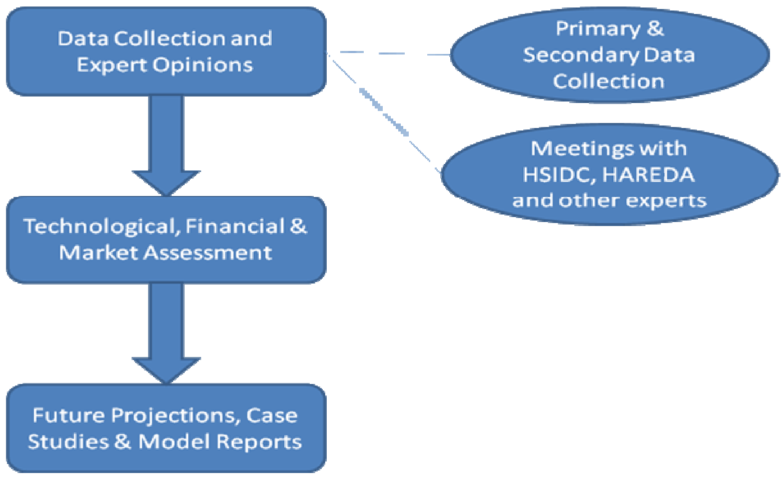
Due to lack of availability of published literature and data on solar water heater & Solar PV market as well as in some cases about the future growth trends of certain segments, the study team has made several assumptions while projecting the demand for solar water heaters. Most of these assumptions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

1.5 Outline of the Report

The report has eight chapters. Chapter 2 explains the methodology for the study. Chapter 3 to 5 cover water heating in residential, commercial & institutional and industrial sectors respectively. Chapter 6 deals with back-up power demand and rooftop Solar PV. The market potential for SWH under three different scenarios is provided in Chapter 7. Chapter 8 deals with feasibility of Energy Service Company (ESCO) approach. Conclusions are presented in Chapter 9. Annexure - I consists of 12 case studies pertaining to different demand segments and the 4 model preliminary project reports are presented in Annexure-II.

Chapter 2. Methodology and Approach Followed

2.1 Methodology



The assignment was divided into three phases: (i) Market Segmentation and Primary & Secondary information collection; (ii) Technological, financial & market assessment of SWH and rooftop PV; (iii) Future projections, case studies and model preliminary reports formation.

2.1.1 Phase I: Primary & Secondary Information Collection

In this phase, market segmentation was carried out and secondary information was collected for each sub-categories using maps, internet-search, DHBVN etc. The data collected through secondary sources was updated and validated by primary survey carried out by the auditing team on the field. Meeting with the key experts & stake holders of SWH and SPV market, conventional heating and back-up system manufacturers, industries, associations were also organized so as to gain insights about the current position of the SWH & SPV market as well as to identify the issues related to the implementation of the technology with the current processes in industries.

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

- Collect information on the inventory for various segments/ sub-segments.
- Hot water & back-up power 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)
- To identify installations which can be taken up for case-studies
- Awareness and users perception and feedback about SWH & SPV
- Identifying four model projects and making a preliminary report for the implementation of the technology.

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

- HAREDA (Haryana Renewable Energy Development Agency)
- HUDA (Haryana Urban Development Authority)
- SWH manufacturers/dealers
- Municipal corporations
- Electricity distribution companies (DHBVN)
- Haryana Pollution control board
- Gurgaon Industrial Association
- Gurgaon Guest house Association
- Indian Medical Association-Gurgaon Chapter
- Automotive Component Manufacturing Association
- Telecom Industries
- Solar PV Experts
- Experts from Textile, Auto component Manufacturing, Dairy, Catering& laundry Industry

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.

HAREDA:

- Statistics on SWH & SPV installations
- Addresses of SWH & SPV manufacturers and dealers

- SWH & SPV schemes/promotional programmes in vogue and details of utilization and achievement
- Perspective on SWH and SPV

SWH Manufacturers/Dealers

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

Other Stakeholders:

We restricted ourselves to specific issues, while holding discussions with municipal corporations, electricity distribution companies and other stake holders.

2.2.2 Phase II: Technological, Financial and Market Assessment

The work under this phase consisted of:

- An appreciation of sector-level issues concerning installation of SWH and rooftop PV systems and implications of these in terms of SWH & SPV 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.
- Clarifying the present base of SWH installations in each sector and outlining the alternative scenarios for demand buildup

2.2.3 Phase III: Future projections, Case studies & Model Preliminary Reports

Based on the data collected during primary & secondary survey

- Future projection about the hot water and back-up power demand was carried out till 2014.

- Twelve detailed case studies, three in each segment; residential, commercial, institutional & industrial, were formulated.
- Four model projects were identified and detailed preliminary reports were formed.

2.3 Work Organization

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

Table 2.0.1: Work distribution among the team

Organisation	Office Location	Responsibilities
GKS	New Delhi	Meeting with key experts and stake holders, Future projections, Case studies & Model preliminary reports
BTECON	New Delhi	Primary & Secondary data collection, Meetings with stake holders, data collection for case studies
Solenge India	Gurgaon	Meeting with key experts & stake holders, ESCo mode analysis, Model Preliminary reports and case studies

Chapter 3. Solar Water Heater: Residential

3.1 Hot Water Requirement (Present & Future)

Gurgaon is generally divided into two areas, old Gurgaon and new Gurgaon. The area lying to the west of the NH-8 is referred as old Gurgaon whereas area lying to the east of NH-8 is called new Gurgaon. In the old Gurgaon, sector 10, 15, 17, 21, 22 & 23 are having higher residential agglomerations, whereas in the new Gurgaon, sector 31,43, 45, 46, 47, 50, 51, 52, 55 ,56, 57, Sushant Lok I & III, DLF phase I, II, III, IV, V are having high density of residential units.

A previous report on Solar Water Heater market[3] indicates that Solar Water Heaters are generally owned by middle and affluent urban households. Hence, for estimating the hot water demand, residential units falling under the old Gurgaon town, village *abadies* and slums have not been considered. Based on the property tax data of the Municipal Corporation and data collected from the survey, it is estimated that there are around 85000[4] residential flats and around 32000[5] constructed individual plots in the Gurgaon-Manesar area, which are considered potential candidates for adopting SWH and hence have been used for calculating hot water requirements.

In order to estimate hot water demand, we have further sub-categorized the residential sector in four sub-categories.

1. Residential Apartments
    a. 3 bed room and above
    b. 2 bed room
2. Individual Plots
    a. Area > 250 sq yards
    b. Area < 250 sq yards

[3] Greentech Knowledge Solutions. Solar Water Heaters in India: Market Assessment Studies and Surveys for Different Sectors and Demand Segments. Report prepared for UNDP/GEF Global Solar Water Heating Project. January 2010

[4] Based on the data available with municipal corporation of Gurgaon, available on the property tax website www.mcg.gov.in

[5] Based on the data available with municipal corporation of Gurgaon, available on the property tax website www.mcg.gov.in

In the residential sector, the demand for hot water is primarily for bathing purposes. The hot water demand in each of the sub-categories with their typical usage pattern is stated in the table 3.1.

Table 3.1: Hot water demand pattern in Residential Sector

Type	Hot Water Requirement (lpd/unit)	Usage Pattern (Days/Year)
Residential Apartments		
3 bed-room and above	200*	150
2 bed room	100*	150
Individual Houses		
Above 250 sq yards	300	150
Below 250 sq yards	150	150

** As per HAREDA norms for sizing of SWH systems. The other data is based on stakeholders interactions, primary survey and assessment of the project team.*

Data collected from primary survey & meetings with key persons of the real estate industry, indicates that apartments having 3 or more bed-rooms constitutes approximately 65 % of the total residential flats. The data collected from the municipal corporation of Gurgaon[6] indicates that almost 65% of the plotted housing is above 250 sq yards. Table 3.2 shows the existing hot water demand in the residential sector in Gurgaon-Manesar area

[6] Source: The official website of municipal corporation of Gurgaon; www.mcg.gov.in

Table 3.2: Hot water demand in Residential Sector (2010)

Type	Total Number (Existing)	Total Daily Hot Water Requirement (Existing) Million liter per day	Yearly Hot Water Requirement (Million liter)	Typical SWH Size (sq m)	Equivalent SWH Capacity (Million sq m)
Residential Apartments					
3 or more bed room	55,250	11.05	1658	4	0.22
2 bed room	29,750	2.98	446	2	0.059
Constructed Individual Plots					
Above 250 sq yard	20,800	6.24	936	6	0.125
Below 250 sq yard	11,200	1.68	252	3	0.034
Total	**117,000**	**21.95**	**3292**		**0.438**

The Gurgaon-Manesar area is expected to see a robust growth in housing. Based on estimates by various agencies (refer table 3.3) we estimate that around 15,000 residential units having 2 to 5 bedrooms would be added every year till the end of financial year 2014. Based on the property tax data provided by Municipal Corporation of Gurgaon, it is estimated that construction has already taken place in around 32,000 individual plots. It is estimated that apart from the construction of multi-storey housing, construction of houses will also take place in about 3500 individual plots every year till 2014.

Table 3.3: No. of Residential Apartments added in recent years

Year	Residential flats added	Residential flats added per year
2008	5000[a]	5000
2009	14000[a]	14000
2010 & 2011	50000[a]	25000
Mid 2010 to 2014	40000[b]	11500

Source: [a] Based on Propequity report http://www.articlesbase.com/real-estate-articles/gurgaon-property-boosts-by-new-master-plan-1327465.html

[b] The mid and housing challenge, An article by DTZ research 10th anniversary issue of Hindustan times property

We are considering 2011-12, 2012-13 & 2013-14 as the immediate future years. Table below shows the projections of the immediate future for the hot water demand.

Table 3.4: Hot water demand for Immediate Future (up to 2013-14)

Year	2011-12			2012-13			2013-14		
Type	Cumulative number	Daily Hot Water Demand (Million litre per day)	Equivalent SWH Capacity (Million Sqm)	Cumulative number	Daily Hot Water Demand (Million litre per day)	Equivalent SWH Capacity (Million Sqm)	Cumulative number	Daily Hot Water Demand (Million litre per day)	Equivalent SWH Capacity (Million Sqm)
Residential Apartments									
3 bedrooms or more	65000	13	0.26	74750	14.95	0.3	84,500	16.9	0.34
2 bedrooms	35000	3.5	0.07	40250	4.02	0.08	45,500	4.55	0.091
Individual Houses									
Above 250 sq yard	28275	8.48	0.17	30550	9.16	0.18	32,825	9.85	0.196
Below 250 sq yard	15225	2.28	0.045	16450	2.47	0.05	17,675	2.65	0.053
Total	**143500**	**27.27**	**0.545**	**162,000**	**30.61**	**0.612**	**180,500**	**33.95**	**0.679**

3.2 Existing Solar Water Heater Installations

Haryana is the first State in the country to issue a comprehensive notification dated 29.07.2005 on Energy Conservation Measures. It makes Solar Water Heating Systems mandatory for water heating application in all functional buildings where hot water is required. The Haryana Urban Development Authority has adopted the mandatory provisions of HAREDA vide their letter dated 28.11.05. The Department of Urban Local Bodies, Haryana has also amended the Haryana Municipal Building Bye-laws vide Notification dated 16.11.07. Solar Water Heating has been made mandatory in:

- Industries,
- Hospitals and Nursing Homes, Govt. Hospitals
- Hotels, Motels and Banquet Halls,

- Jail barracks,
- Canteens, Housing Complexes set up by Group Housing Societies/Housing Board,
- All Residential buildings built on a plot of size 500 sq.yds. and above falling within the limits of Municipal Committees/Corporations and HUDA Sectors, and
- all Govt. buildings, Residential Schools, Educational Colleges, Hostels, Technical/Educational Institutes, District Institute of Education and Training, Tourism Complexes and Universities etc.

The regulation is yet to be enforced in an effective manner; however, it has definitely helped in opening new segments for the solar water heater industry particularly the multi-storey residential buildings. In recent years, atleast 6 housing complexes have installed Solar Water Heaters (table 3.5)

Table 3.5 SWH systems in multi-storey housing

Multi-storey Housing		
1	Unitech Group Housing	4,000 (8 x 500)
2	Omex Group Housing	5,000 (10 x 500)
3	Haryana Housing Board, Sec 43	32,000 (32 x 1000)
4	BPTP, Freedom Park Life, Sector 57	15,700
5	Central Park	44,000
6	IVY Complex	12, 800

Table 3.6 shows the current penetration of SWH in the Gurgaon-Manesar area.

Table 3.6 : Penetration level in Residential Sector

Type	No. of Installations	Total Installed Capacity (lpd)	Total Installed Capacity (Sq m)	Existing Potential (Sqm)	Penetration (%)
Residential Apartments	6	115000	2300	279000	0.82
Individual Houses	250	67160	1345	158400	0.85

The results from the table are clearly pointing to the fact that the efforts to promote SWH in the residential segment have resulted in limited success, though it should be noted that in the last 2 years the installations of SWH in the residential sector have gone-up significantly. The factors contributing to the limited success are:

- Low awareness level in the residential sector.
- Limited marketing effort and reach of the SWH suppliers
- Seasonal hot water demand (150-180 days per year)
- Apprehension about the effectiveness of the system especially in peak winters which in Gurgaon are accompanied by hazy weather due to fog and smog.

An analysis of the cost of heating water (presented in the box below) clearly indicates that the life-cycle cost of the hot water using a solar system are significantly lower to the cost of heating water using an electric geyser.

Box 3.1 Life-cycle cost of heating water (Electric vs Solar with electric back-up)

Calculations were carried out for calculating the cost of heating water (Rs/litre) using an electric geyser and a solar water heater (with electric back-up) for Gurgaon. Solar Advisory Model (NREL software) was used for modeling the SWH system. The hot water requirement was taken as100 lpd at a temperature of 60^{o}C for 180 days in a year (October –March). Following assumptions were made regarding the cost:

- Cost of electricity: Rs 6/ kWh
- Cost of electric geyser: Rs 6500
- Cost of SWH: Rs 25000 (good quality pressurized SWH system including both capital and installation cost)

The life of electric geyser was taken as 8 years, while that of SWH was taken as 15 years. No cost escalation in electricity tariff was taken. The anlaysis shows that the life-cycle cost of heating water using a electric geyser comes to about Rs 0.42/ litre, while the life-cycle cost of heating of water using a SWH with electric back-up comes to Rs 0.21/ litre and the SWH is able to supply around 85% of the hot water requirement.

Chapter 4. Solar Water Heater: Commercial & Institutional

4.1 Commercial

The commercial sector analysis covers:

1. Hotels
2. Guest houses

4.1.1 Hotels

Hotel sector was further sub-classified in to two categories on the basis of the type of the hotel; luxury hotels and budget hotels. The definition of the categories along with their hot water requirement is given in table 4.1.

Table 4.0.1: Classification of Hotels and their hot water requirement norm

Category	Consists of	Hot Water Requirement (lpd/room)[7]	Usage Pattern (Days/Year)*
Luxury Hotels	5,4& 3 star hotels	150	250
Budget Hotels	2 star and other budget hotels	100	250

*****taking 70% occupancy*

The luxury hotels here are considered to consists of hotels having 3 star or above star categories whereas budget hotels are considered consisting of 2 star and lower category hotels.

Primary demand for hot water in the hotels is for bathing, kitchen & laundry purposes; bathing purpose has a seasonal hot water demand whereas kitchen & laundry demand is round the year. Due to the in-house laundry and kitchen, luxury hotels have higher hot water as compared to budget hotels where laundry requirement is outsourced and kitchen capacity is limited.

At presently, there are around 8000 hotel rooms available in the Gurgaon-Manesar area. Based on the data collected during primary survey, around 65% of the total available rooms are in the luxury hotel category. Table 4.2 shows the present hot water requirement in the hotel category

[7] Based on the data from primary survey and stake holders' interviews

Table 4.2: Present hot water demand in hotels

Type	Total Rooms (Existing)	Total Daily Hot Water Requirement (Existing) Million liter/ day	Yearly Hot Water Requirement (Million liter)	Typical SWH Size (sqm/room)	Equivalent SWH Capacity (sqm)
Luxury Hotels	5200	0.78	195	3	15600
Budget Hotels	2800	0.28	70	2	5600
Total	**8000**	**1.06**	**265**		**21200**

Interviews with key resource persons in the hotel industry revealed that the hotel industry in Gurgaon is experiencing a robust growth and is expected to grow at a rate of 10% in both the categories of hotels in immediate future. The projected demand for hot water in hotels in Gurgaon for the year 2011-12, 2012-13 & 2013-14 is presented in table 4.3.

Table 4.3: Hot water demand for immediate future in Hotels

Year	2011-12			2012-13			2013-14		
Type	Total Number (Rooms)	Daily Hot Water Demand (Million lpd)	Equivalent SWH Capacity (Sqm)	Total No. of rooms	Daily Hot Water Demand (Million lpd)	Equivalent SWH Capacity (Sq m)	Total No. of Rooms	Daily Hot Water Demand (Million lpd)	Equivalent SWH Capacity (Sq m)
Luxury	5720	0.86	17,160	6292	0.94	18,876	6921	1.04	20,764
Budget	3080	0.31	6,160	3388	0.34	6,776	3727	0.37	7,454
Total	8800	1.17	23320	9680	1.28	25652	10648	1.41	28217

The notification by HAREDA dated 29/07/2005 clearly states the mandatory requirement but has not provided any kind of norm for the size of the SWH systems in the hotels. There are a few installations of solar water heaters in hotels but still the current penetration of SWH is very low (refer table 4.4).

Table 4.4 Current penetration of SWH in Hotels

Type	No. of Installations (till Mar 2010)	Total Installed Capacity (lpd)	Total Installed Capacity (Sq m)	Current Penetration (%)
Luxury Hotels	2	36000	720	4.6%
Budget Hotels	4	3000	60	1%

Hotels have a high year-round hot water requirement and installation of solar water heater is financially attractive. As most of the existing hotels have centralized hot water systems, integration of SWH is not a big issue as it can be directly connected to the existing system. However limitation on roof area availability (as most of the roof is already occupied with the air-conditioning systems, DG's, roof gardens, etc) does limit the realizable potential in the hotels sector.

4.1.2 Guest Houses

Gurgaon has witnessed very high growth of Guest houses/service apartments/paying guest accommodations in the recent years. These Guest houses are mostly rented by multinational companies, airlines, BPO's etc operating in Gurgaon or near-by areas, because of the lower rates and high class amenities (equivalent to a 3 star hotels). At present more than 2000[8] Guest houses of average 15 room capacities are operational in the Gurgaon-Manesar area; several of them are not registered as guest houses. Primarily the hot water requirement in Guest houses is for bathing. Based on the data from the primary survey and interviews with key resource person of the Guest house association of Gurgaon, the hot water requirement norm is established (refer table 4.5)

Table 4.5: Hot water requirement norm for Guest houses

Category	Hot Water Requirement (lpd/room)	Usage Pattern (Days/Year)
Guest Houses	70	250

Based on the above facts, the present requirement of hot water in the Guest houses is shown in table 4.6

Table 4.6: Present hot water requirement in Guest houses

Type	Total Rooms (Existing)	Total Hot Water Requirement (Million lpd)	Annual Hot Water Requirement (Million liter)	Typical SWH Size (sqm/room)	Equivalent SWH Capacity (sqm)
Guest houses	30000	2.1	525	1.5	42000

[8] Based on the interview with the key resource person of Guest house association of Gurgaon

Based on the interview with the Gurgaon guest house association resource person and some of the guest house owners , the growth scenario of the guest houses in Gurgaon is very positive. In recent past Guest houses have experienced more than 20% growth rate. Given the large demand of Guest houses in the area, the expected growth in the immediate future can be assumed to be atleast 20%. Table 4.7 shows the projections for the hot water requirements in the Gurgaon-Manesar area at a growth rate of 20%.

Table 4.7: Future projections for Hot water requirement and SWH potential

Year	2011			2012			2013		
	Total No. of Rooms	Hot Water Demand (Million lpd)	Equivalent SWH capacity (Sqm)	Total No. of Rooms	Hot Water Demand (Million lpd)	Equivalent SWH Capacity (Sqm)	Total No. of Rooms	Hot Water Demand (Million lpd)	Equivalent SWH Capacity (Sqm)
Guest Houses	36000	2.52	50400	43200	3.02	60480	51840	3.63	72576

It is estimated that atleast 5 guest houses have solar water heater installations. One of the users was interviewed and this is presented as a case study.

4.2 Institutional

The Institutional sector consists of

1. Hospitals
2. Nursing Homes

4.2.1 Hospitals

Hospital sector was further sub-classified in to two categories on the basis of the type of the hospital; large multi-specialty hospitals and small hospitals. The definition of the categories along with their hot water requirement is given in table 4.8.

Table 4.8: Classification of Hospitals with their hot water norm

Category	Consists of	Hot Water Requirement (lpd/bed)	Usage Pattern (Days/Year)
Large multi-speciality	Hospitals having 100 or more beds (excluding	50	250

Hospitals	Govt. hospitals)		
Small Hospitals	Hospitals having less than 100 beds	30	250

Primarily, hot water in large hospitals is required for bathing, laundry and the kitchen however, the bathing requirement in the small hospitals is limited as most of the patients are not in the position to take bath and the attendant usually avoid taking baths in the hospital The present hot water requirement in hospitals is shown in table 4.9.

Table 4.9: Present hot water requirement with SWH potential in Hospitals

Type	Total Beds	Hot Water Requirement Million lpd	Annual Hot Water Requirement (Million liter)	Typical SWH Size (sqm/bed)	Equivalent SWH Capacity (sqm)
Large multi-specialty Hospitals	2800	0.14	35	1	2800
Small Hospitals	1200	0.036	9	0.6	720
Total	**4000**	**0.176**	**44**		**3520**

For calculating the future hot water requirement a growth rate of 7.5% per annum[9] for the period of 2011-2014 is assumed. Table 4.10 shows the future hot water requirement on the above growth rate.

Table 4.10: Future hot water requirement for Hospitals

Year	2011-12			2012-13			2013-14		
Type	Total Number (Beds)	Daily Hot Water Demand (Million lpd)	Equivalent SWH Capacity (Sqm)	Total Number (Beds)	Daily Hot Water Demand (Million lpd)	Equivalent SWH Capacity (Sqm)	Total Number (Beds)	Daily Hot Water Demand (Million lpd)	Equivalent SWH Capacity (Sqm)
Large multi-specialty Hospital	3010	0.15	3,010	3236	0.16	3,236	3478	0.17	3,478

[9] Greentech Knowledge Solutions. Solar Water Heaters in India: Market Assessment Studies and Surveys for Different Sectors and Demand Segments. Report prepared for UNDP/GEF Global Solar Water Heating Project. January 2010

Medium/small Hospital	1290	0.04	774	1387	0.04	832	1491	0.04	894
Total	4300	0.19	3784	4623	0.20	4068	4969	0.22	4373

Just like hotels, hospitals are also covered under the SWH mandatory order of HAREDA. There are a few SWH installations in hospitals but the current penetration level is low (refer table 4.11)

Table 4.11: Current penetration of SWH in Hospitals

Type	No. of Installations (till Mar 2010)	Total Installed Capacity (lpd)	Total Installed Capacity (Sqm)	Equivalent SWH capacity corresponding to hot water demand (Sqm)	Current Penetration (%)
5 star hospitals	3	14500	290	2800	10.4%
Normal hospitals	2	700	14	720	2%
Total	**5**	**15200**	**304**	**3520**	**8.6%**

Although the penetration percentage seems good for the 5 star hospital category but most of the systems in the large hospitals are extremely undersized, this is because of the low roof-top area available for the SWH system. For example, Medanta Medicity hospital has a capacity of 1700 beds for which appropriate size of SWH should be around 80,000 lpd, whereas the installed capacity of the SWH system is 8,000 lpd

4.2.2 Nursing homes

Nursing homes are present in a quite large number in the Gurgaon-Manesar area, but the interaction with the president of Indian Medical Association (IMA), Gurgaon Chapter revealed that the hot water requirement in a typical nursing home in Gurgaon is very low because most of the nursing homes are maternity nursing homes where bathing requirements are minimal, also the kitchen and the laundry services are outsourced. Therefore there is no as such requirement of hot water in Nursing homes. Nursing homes can be regarded as a low potential segment for SWH.

Chapter 5. Solar Water Heaters: Industrial

The Gurgaon-Manesar area has two large industrial areas: Udyog Vihar (Phase I, II, III, IV & V) in Gurgaon and Industrial Model Town (IMT) at Manesar.

Major industries that requires hot water/steam or low temperature process heat operating in this region are

1. Auto- component manufacturing industry
2. Textile industry
3. Dairy industry
4. Ancillary support to commercial establishments
    a. Catering & food outlets
    b. Laundry industry

The application of SWH along with the potential in each of the category is described in detail.

5.1 Auto Component Manufacturing Industry

Most of the auto component industries operating in Gurgaon-manesar area are vendors to the large automobile manufacturers' like Hero-Honda & Maruti Suzuki. The processes which require hot water or low temperature heat are degreasing & electroplating and phosphating. All of these processes requires hot water or heat at a temperature of 55-85^{o}C. Conventionally, hot water or low temperature heat is produced with help of a petroleum fuel based boiler/hot water generator.

The potential applications of SWH in the auto component manufacturing industry 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 5-8%. 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 and it is not possible to meet all pre-heating requirements through energy conservation measures e.g waste heat recovery system. The pay-back period after considering depreciation and subsidy benefits for a furnace oil based industry is reported to be around 1-3 years, while for a coal using industry, the pay-back period is around 5-6 years

- Integration of SWH to provide process heat: In this application the SWH can be effectively integrated in the existing electroplating or degreasing baths to provide the process heat required during the day-time. One such model exercise is done on the Omax Auto electroplating unit located in Manesar. The detailed study can be found in the Annexure.

The total estimated electroplating production in the whole Gurgaon-Manesar area is around 5-10 decimeter square per day. Each decimeter square of the electroplated area requires around 50 kCal of process heat. Around 70% of the total heat required is below 70^{o}C and can be easily supplied by SWH system. Table 5.1 shows the equivalent SWH capacity to meet hot water demand in the electroplating industries in Gurgaon-Manesar area.

Table 5.1: Present SWH potential in Automobile manufacturing industry

Type	Production/day in the Area (million sq dcm)	Production during the day time in the Area (million sq dcm)*	Total heat required per unit area (kcal/sq dcm)	Heat that can be provided through SWH per unit area (kcal/sq dcm)	Equivalent SWH capacity per unit electroplated area (sq m/sq dcm)	Equivalent SWH Capacity (sq m)
Electro-plating	0.5-1	0.17-0.35	50	35	0.055	9000-19000

**Assuming one-third of the production takes place during the day-time*

Assumption: The above calculation of SWH potential is only for the day time production as the most efficient way to utilize solar energy is to use it as soon as it is available with minimum storage as storage is leads to higher cost and heat losses.

5.2 Textile Industry

Textile is one of the largest industries operating in the Gurgaon-Manesar area. The total production of cloth in this area is around 1 million m^2/day. 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 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. A visit to one of the major textile units revealed that most of the textile dyeing units are using furnace oil or diesel fired boiler to produce steam which is required for two purposes, one for maintaining the temperature of the dyeing baths at around 90-95^{o}C and second used directly for fastening of colors. Higher temperature of the baths restricts the use of SWH to preheating of the boiler feed water. Interaction with dyeing industry revealed that at this point of time their main concern is about the global recession and tough market conditions that are directly affecting their production capacity; 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.

While textile washing on the other hand requires hot water at around 50-60^{o}C, which can be easily supplied through SWH. One of the large textiles washing unit has already installed SWH system to produce hot water required (refer to case study) for the process but there are only few of the individual textile washing units. Most of the textile units provide washing with the dyeing and printing facility. In that case hot water requirement can be catered through the condensate recovery of the steam.

5.3 Dairy Industry

There is only one large dairy unit operating in the Gurgaon-Manesar area – Dudhmansagar dairy, a wholly owned subsidiary of Amul. The dairy supplies milk, ice cream & *dahi* to the Delhi NCR region. The daily processing capacity is around 1 million liter milk per day, 25000 liter ice-cream per day and 25000 kg *dahi* per day. Milk processing comprises of pasteurization, which is heating of milk to 78-80^{o}C followed by sudden cooling. Presently heating of milk is done by the help of hot water, produced by using steam generated through petroleum fuel based steam boilers. The potential applications of SWH in the dairy industry are

- Preheat the make-up water for the boiler: Due to the condensate recovery system the make-up water requirement for the boiler is about 36000 liter per day. Preheating of the make-up water up to 60-80^oC reduces the load on the boiler and increases the efficiency of the boiler.
- Integration of SWH to provide process heat: In the pasteurization process raw milk which to be heated from 4^oC to 78^oC is first pre-heated from the heat recovered from the cooling process to 55^oC. The rest of the heat is supplied with the help of hot water generated through steam. SWH can be integrated with the present process to provide a $\Delta T = 10^oC$ to the 55^oC milk. The rest of the heat can be provided with the help of conventional process. Table 5.2 shows the equivalent SWH capacity to meet hot water demand of the dairy unit in Manesar

Table 5.2: Hot water requirement and SWH potential in Dairy industry

Type	Milk Production (million lpd)	Production during the day time in the Area (million lpd)*	Total heat required per unit production (kcal/litre of milk)	Heat provided through SWH per unit production (kcal/litre of milk)	Equivalent SWH Capacity per unit production (sq m/litre of milk)	Equivalent SWH Capacity (sq m)
Milk Pasteurization	1	0.35	31	10	0.01	3500

**Assuming one-third of the production takes place during the day-time*

Assumption: The above calculation of SWH potential is only for the day time production as the most efficient way to utilize solar energy is to use it as soon as it is available with minimum storage as storage is leads to higher cost and heat losses.

The other benefits associated with using SWH system to provide a part of the process heat is the reduction of steam consumption which subsequently reduces the load of the boiler and hence increases its efficiency.

5.4 Ancillary to the Commercial Establishments

5.4.1 Catering and Food Outlets

Gurgaon-Manesar area is a hub of multinational, BPO's, other service sector companies, manufacturing industries etc, which creates a very high demand of catering services. Based on our interaction with key expert in catering industry, around 7 lakh meals are prepared and served in Gurgaon-Manesar area.

The hot water requirement in catering and food service establishments is primarily for

- Meal Preparation
- Meal service (Bain Maries)
- Dish washing.

The interaction also revealed that around 2-3 litre of hot water per meal at 70-80^{o}C is required for all the three purposes. The break-up of the meals prepared is given in table 5.3.

Table 5.3: Break up for the meals prepared

Type of Meal Prepared	Percentage
Break fast	5%
Lunch	70%
Dinner	25%

Around 30% of the meals are produced in the in-house kitchens of the clients, where mostly dishwashers are used to clean the dishes. These dishwashers are fitted with electric heaters and are having thermostatic controls to produce hot water for washing purpose. For the rest of the 70% of the meals, washing of the utensils is done manually. Table 5.4 shows the hot water requirement and equivalent SWH capacity to meet this hot water demand for the catering industry in the Gurgaon-Manesar area.

Table 5.0.4: Present hot water requirement and SWH potential in Catering Industry

Type	Production (Million Meals/day)	Production during the day time (million meals/day)*	Hot water required per meal inclusive of washing (l/meal)	Hot water required per meal exclusive of washing (l/meal)	Total hot water requirement for catering industry (million lpd)	Equivalent SWH Capacity (sqm)
Catering	0.7	0.525	2.5	1.5	1.155	23100

Assumptions:

a. SWH is only used for preparing Lunch and Breakfast

b. Only manual dish washing can be catered through SWH

5.4.2 Laundry

Specialized laundry services are required by most of the commercial establishments like hotels, hospitals, factories etc. Most of the laundry units based in South Delhi were providing services to the commercial establishments in Gurgaon but due to some changes described below it has now become unfeasible for them to provide services in Gurgaon.

- Delhi laundry units are forced to shift to Noida, due to pollution control regulations and other state government policies.
- Logistical problems due to increased traffic and congestion have increased their expenses.

Most of the laundry units are now in process to start their units in Manesar area, so as to provide services in Gurgaon and Manesar.

Interaction with one of the largest laundry unit in Gurgaon revealed that till now the laundry in Gurgaon has a market size of only 25000-45000 kg of cloth per day but due to the reasons stated above the market size is expected to grow at 40% per annum in the immediate future. Hence, till 2014 there will be around 1.2 lakh kg of cloth washed by the laundry units based in Gurgaon-Manesar area.

A typical laundry unit is based on three processes, washing, drying and finishing. The hot water requirement is only for the washing cycle, drying and finishing is done through steam. The hot water requirement in the washing cycle is about 1.67 l/kg at about 60-70^{o}C. Presently most of the laundry units are using petroleum fuel based boilers to produce steam, which in turns generates hot water and also provide the steam for the finishing and drying purposes. The potential applications of SWH in the laundry industry are

- Pre-heat the feed water for the boiler: The feed water can be pre heated to about 60-70^{o}C, so as to reduce the fuel consumption of the boiler.

- Integration of SWH in washing machines: The water heated with the help of solar water heating system can easily be integrated in the washing machines to directly provide hot water in the washing cycle.

Based on these facts, the equivalent SWH capacity in the laundry sector is presented in table 5.5.

Table 5.5: Hot water requirement and SWH potential in Laundry Industry

Type	Production (kg/day)	Hot water requirement per kg of cloth (l/kg)	Feed water for the boiler (l/kg cloth)	Total (l/kg)	Total Daily Requirement (million lpd)	Equivalent SWH Capacity (sqm)
Laundry	45000	1.67	1.5	3.17	0.14	2853

Given that the sector is growing at a very fast rate the potential in the near future will increase drastically. The table 5.6 shows the equivalent SWH capacity for the immediate future in the laundry sector for a growth rate of 40%.

Table 5.0.6: Future hot water requirement and SWH potential in laundry Industry

Year	2011			2012			2013		
Type	Production (kg/day)	Daily Hot Water Demand (Million lpd)	Equivalent SWH Capacity (Sqm)	Production/day (kg/day)	Daily Hot Water Demand (Million lpd)	Equivalent SWH Capacity (Sqm)	Production/day (kg/day)	Daily Hot Water Demand (Million lpd)	Equivalent SWH Capacity (Sqm)
Laundry	63000	0.2	3994	88200	0.28	5592	123,480	0.39	7828

According to our analysis, laundry units will consume around 0.39 million lpd of hot water by the year 2013, which would require 2500 liter of diesel per day. The extensive use of solar water heating technology in the laundry sector can abate almost the entire diesel required for the water heating purpose.

Chapter 6. Roof-top Solar PV: Gurgaon-Manesar Area

In order to assess the present and future back-up power requirement it is imperative to understand the power scenario of the area, conventional sources of back-up power and the fuel used for the purpose. In order to proceed in a step wise manner we have divided this chapter in to three sections.

1. Power Scenario of Gurgaon-Manesar
2. Back- up power Analysis
3. Roof top solar PV potential assessment

6.1 Power Scenario of Gurgaon-Manesar

The Gurgaon-Manesar area is suffering from acute power shortage condition. The table 6.1 shows the picture of power in the area.

Table 6.1: Power Scenario of Gurgaon-Manesar

Parameter	Peak Power (MW)	Units per day (kWh/day)
Average Demand	800	14 Million
Peak demand	1045	16.5 Million
Supply	650	13.5 Million
Average Deficit	18%	
Peak Deficit	35%	

*Source: DHBVN

The power scenario clearly shows that on an average there is an 18% power deficit which shoots up to 35% during the peak demand periods. This demand and supply situation is for the load allotted by DHBVN to the consumers, apart from that 15% of the total applied load is not yet allotted by DHBVN by the consumers. After taking this factor in consideration the actual demand is about 17.5% higher than the demand projected by DHBVN.

DHBVN has also predicted that the average demand of the Gurgaon region is growing at 14-15% per annum, whereas the demand in the Manesar area is expected to grow at around 20% per annum. Table 6.2 shows the future projections of the electricity demand taking an average of 18% growth rate for the whole Gurgaon-Manesar area

Table 6.2: Future projections of Power Scenario in Gurgaon-Manesar area

Parameters	2011-12	2012-13	2013-14
Average Demand (MW)	944	1114	1314
Peak Demand (MW)	1233	1455	1717

6.2 Back-up Power Analysis

The entire Gurgaon-Manesar area is crippled by the acute power shortage, this has boosted the market for the back-up power equipments like inverters, diesel generators & natural gas based generators. Inverters can provide limited back-up for a short period of time. Currently Gurgaon is facing an average power cut of 2-3 hrs/day with a peak cut of 7-8hrs/day during the peak electricity demand. Manesar being mainly an industrial area has a higher demand as compared to Gurgaon and is currently suffering from an average power cut of 7-8 hrs/day with peak cut ranging up to 16 hrs/day. The back- up requirement is met mostly with the help of Diesel Generators. Overall there is around 2000 MVA capacity DG installed in the total Gurgaon-Manesar area, almost 20% of the total capacity installed is in the residential group housing sector whereas commercial & industrial comprises of 80% of the total DG capacity installed. All the commercial complexes are having about 100 % Diesel Generator back-up while industrial sectors are having more than 100% DG back-up because the load which is not sanctioned by DHBVN is also supplied by DG's along with the back-up power.

The penetration of DG's in the area is increasing at a rapid rate. The state government has made announcements to add new power generation capacity to fulfill the demand, but still most of the new buildings and industrial projects have the provision for the 100% DG back in the designing phase itself. Almost all the newly built residential apartments planned housing, commercial complexes & industries have DG's, which can provide back-up power for almost all of their loads. According to the diesel generator dealers the DG market is growing at more than 15%. The table 6.3 shows the DG capacity installed in the immediate future for the growth rate of 15%.

Table 6.3: Future projections for the DG capacity installed in Gurgaon-Manesar area

	Existing	2011-12	2012-13	2013-14
Installed DG Capacity (MW)	2000	2300	2645	3041.75

The total installed DG capacity till 2013 will be almost 3000 MW.

6.3 Solar PV Potential Assessment

Solar PV is a new and expensive technology to produce power using solar energy. Under this study a detailed assessment for the viable option of using solar PV system for generating power was investigated. The idea was to identify the segments & applications where power from solar is practically and financially viable. The emphasis was also made to understand the designing of the current PV systems installed and to estimate the actual savings incurred through them. After the analysis of all type of segments, applications and designs for the solar PV systems, certain conclusions were reached which will be discussed in detail below but a common conclusion for all the sectors and application was that solar PV power should only become viable after all the DSM and energy efficiency measures are taken, consumption should be reduced first then only generating power from expensive technology like solar PV is recommended.

Rooftop solar PV can be used in three modes:

- Off-grid solar PV with battery back-up: Power generated through solar is first stored in batteries and then it is supplied to the load with the help of inverter. Batteries are used to provide uninterrupted power even when there is no sunlight available outside. In this configuration, battery back-up for 2-3 autonomous days is designed, so that even if there is no sunlight for 2-3 days, batteries will be able to provide uninterrupted power to the loads. As the battery back-up is large, the size of solar system, required to charge the batteries, is also very large, which make the whole system expensive. The main disadvantage of this type configuration is the recurring cost of the batteries, as in the entire life of 25 yrs of the solar systems, batteries have to replaced five times also the overall efficiency of the systems is reduced, because power is first stored in batteries which is accompanied by losses. This mode is usually used for remote areas which do not have access to grid electricity.

- Off-grid day time use: In this configuration solar power generated through PV system is directly used to provide power to the day-load e.g. pumping, day-time lighting in offices, etc. The system has a minimal battery bank to compensate for the fluctuations in the power generated through PV system during the day-time as well as to fill the gap between the peak power and the generated power, whenever required during the day time. In this configuration solar power can be used only during the day time and will not be stored for use in the night time or during the periods when there is no sun hence this type of solar PV system can substitute DG power only in the day time. This mode is suitable when stable day-time loads are available and there are frequent and long power cuts during the day time.
- Grid-connected systems: In this configuration solar power generated can be directly fed into the grid. These systems work on net metering system, which meters both the electricity supplied from the PV system to the grid as well as the electricity used by the facility from the grid. This mode helps the local utility in getting supply of additional electricity during peak demand period during the day and also helps in utilizing the un-utilised roof area of the buildings.

6.3.1 Solar PV as a Substitute to DG’s

In the areas facing extensive power shortages like Gurgaon, Solar PV power could be an attractive option when used to substitute power generated from diesel, particularly during daytime. Normal DG’s have efficiency of around 20%, the overall cost of power generated through DG’s (at the current diesel prices) range between Rs 12-16/kWh, which is quite comparable with the cost of power generated through solar PV system.

Large Luxurious Residential Apartments:

The day time load of the residential complexes is low as compared to the night loads. During day-time, when the loads are 15-20% of the peak load, in case of power cuts, DG's are used at part-loads. The roof area available can be used to cater to the entire or part of the day time load. A solar system can be designed so that the day time back-up requirement and certain exclusive loads like pumping etc can be taken care by the solar PV system. In this way day-time diesel consumption for generating back-up power can be reduced drastically. To reduce wastage, the system can be designed such that, if back-up is not required then also the energy from solar will be used first even before the grid electricity. Till now no such example exist where such kind of system is used to reduce the day time diesel consumption. During this study we tried to analyze the feasibility of such system in a large group housing society in Gurgaon named Garden Estate, the model preliminary report on Solar PV systems in group housing explains all the aspects of the feasibility. The feasibility report was also forwarded to the board members of the Resident welfare association of the Garden Estate. The members of the group housing have shown interest in taking this project forward hence an inception meeting with all the board members of the RWA with the solar PV expert was organized and the idea was discussed. The process of implementation is in pipeline and may take 6-8 months before the project starts. The market of solar PV systems for reducing diesel consumption in the day time in the luxurious group housing segment is quite large but the main problem is related with the large investment required for such a system.

Guest Houses:

In the day time occupancy of the guest house falls to 15-20 % hence the daytime load of a typical guest house falls to 10-12 kW as compared to 45-50 kW peak load, normally encountered during the night time. Even for the small 10-12 kW daytime loads, a 62 kVA DG, sized as per the peak load, is used to provide back-up power to the Guest house. Due to the low load the cost of power produced from the DG is about Rs. 16-18 per unit which is comparable to the cost of power generated through solar PV system. The feasibility of the solar PV system was analyzed with the help of a solar PV expert, to reduce the day time diesel consumption and a model preliminary report is formulated, attached in the annexure. The technique used for designing was same, solar will be used first, then grid electricity and at last the DG electricity will be used.

Telecom towers:

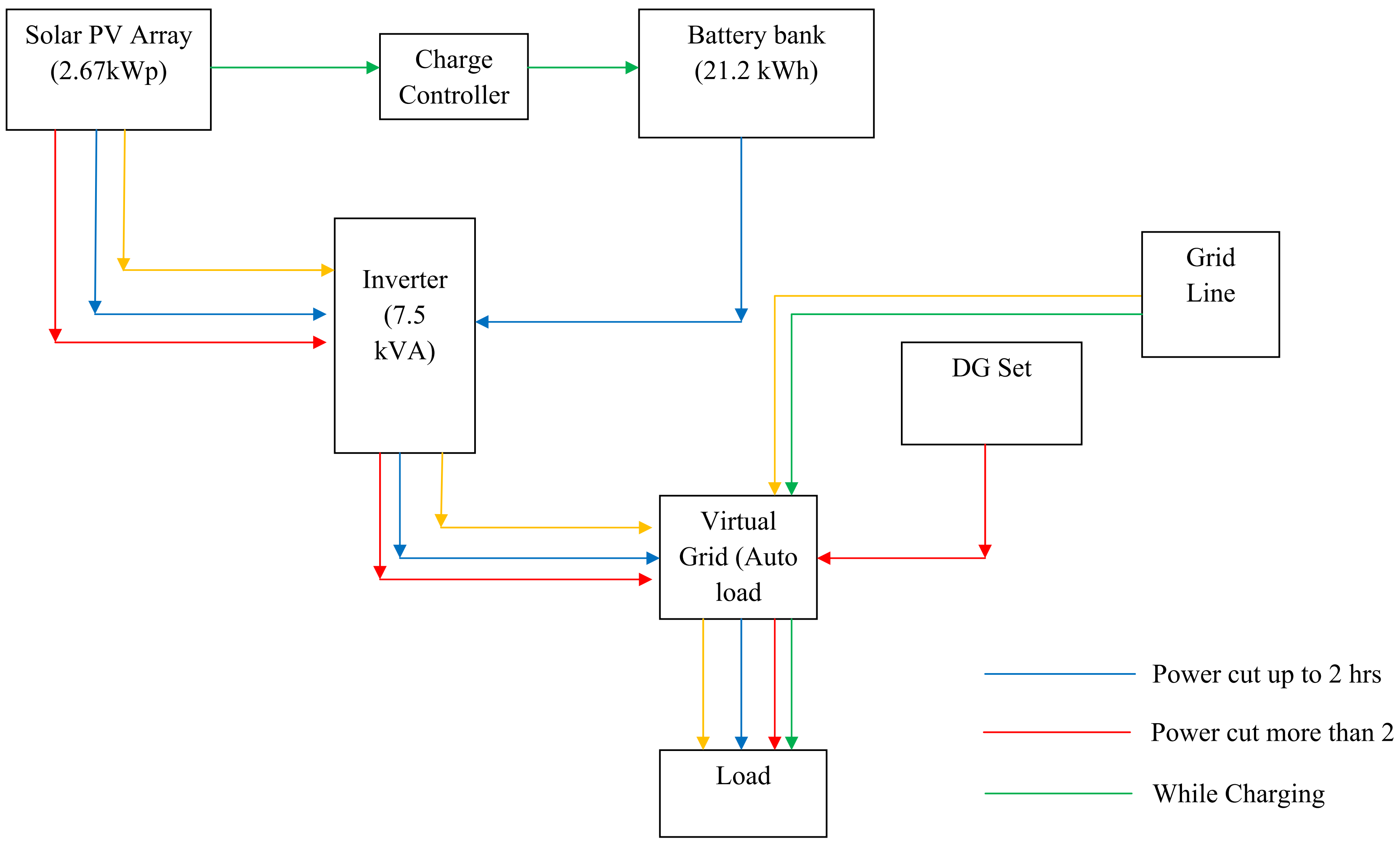
There are around 500 telecom towers located in Gurgaon-Manesar area with the load ranging from 3 kW to 10 kW with an average load of 6 kW. Due to the high loads of telecom towers in the area the solar model for the diesel abatement with very low battery bank is not a viable option as it would require a solar system of 6 kW which requires a shade free space of 90 sqm, which is quite difficult to achieve. However one other approach for designing the solar PV system was analyzed which may become a practically and financially viable for the telecom towers. Let us take an example of a 6 kW load tower in a city of Gurgaon where average day time power cut is around 2hrs. Our strategy to design the solar system is to provide a 6 kW load a back-up power for 2 hrs. The design for this is mentioned below:

Table 6.4: Design configuration of grid tied solar PV system for telecom towers

Design of Solar PV system for 2 hr back-up	
Total Units Required in 2 hrs	6 kW X 2h = 12 kWh
1 kW PV System generates	4.5 kWh/day (approx)
Capacity of the PV System for 12 units/ day	12 /4.5 = 2.67 kW
Battery Bank (50% Max Discharge)	21.6 kWh
Inverter	7.5 kVA
Shade free area required	40 sq m
System Cost (including batteries)	Rs. 6.5-7 lakhs
Recurring Cost	Rs. 1.2 lakh/5yr
Subsidy (Capital @Rs.90/watt)	Rs. 2.4 lakhs
Accelerated Depreciation Benefit	Rs. 1.3 lakhs (in 2 yrs)
Savings	Up to 1750 lt diesel/yr
Payback period	5.7 yrs

Such a solar system will generate 12 units per day which may be used in the way shown in the block diagram below.

Block Daigram for Solar + Grid +DG tied Telecom Tower



In such a configuration, battery bank is sized so that it can provide the required number of units in the 2 hrs. Rest of the time battery will be charged with the help of Solar system, if the battery is full then solar system will provide electricity directly to the load. During the power cut in daytime hybrid system of solar PV and batteries will be used, whereas in the night only batteries will be used up to a limit of 2 hrs/day (the limit will be little less if used during the night time) to provide a specific load of 6 kW. The cost of this system is around 6.5-7 lakhs and it may provide diesel savings up to 1750 lts/yr. The battery component is very less and the recurring cost of the batteries is around Rs. 1.2 lakhs per 5 yrs. This kind of system can be designed as per the given shade free area available, the back-up hours from solar will change accordingly but during the solar back-up hours the use of DG sets is eliminated which gives real diesel savings.

6.3.2 Solar PV system for constant loads during the day time

In most of the industries pumping loads forms a major part of the total load and also mostly these pumps are used for 24 hours a day therefore possibility of solar PV systems specifically designed to cater the pumping loads during the day time with the help of minimal battery bank to provide constant power can exist. In this way almost all the pumping load required during the day time can be catered through solar system, which will drastically reduce the electricity requirement during the day time. No such type of systems exists in the Gurgaon-Manesar area till date, however recently Omax autos has installed a 2X100 kW system at the rooftops of their industrial sites but the design of the system is to provide solar electricity to a central grid which is also tied with grid electricity and DG's and provides the electricity to the whole plant. It is estimated that solar system will provide almost 8% of the total requirement. More details about this system can be assessed in the case studies section in Annexure.

Chapter 7. Market Potential of SWH

To carry out market potential of SWH in the area till the year 2022, following three cases has been assumed

1. Business as usual scenario
2. Growth Scenario -I
3. Growth Scenario -II

Gurgaon-Manesar area is experiencing rapid growth and this growth is likely to continue for the next decade. Based on news-reports/articles, interactions with key resource persons and the study team assessment, typical growth rates for each of the category of hot water users are assumed for 2011-2014, 2014-2018 and 2018-2022 and are stated in table 7.1

Table 7.1: Assumptions for the growth rate

Category	2011-2014	2014-2018	2018-2022
Residential Flats	15000 flats per year	10000 flats per year	5000 flats per year
Residential individual plots	3500 units per year	2000 units per year	1200 units per year
Hotel- Luxury	10% per annum	7% per annum	5% per annum
Hotel- Budget	10% per annum	7% per annum	5% per annum
Guest House	20% per annum	10% per annum	5% per annum
Hospital- Large Corporate	7.5% per annum	5% per annum	5% per annum
Hospital- Normal	7.5% per annum	5% per annum	5% per annum
Auto Industry	5% per annum	3% per annum	2% per annum
Dairy Industry	5% per annum	3% per annum	2% per annum
Textile Industry	5% per annum	3% per annum	2% per annum
Catering Industry	10% per annum	7.5% per annum	5% per annum
Laundry Industry	40% per annum	20% per annum	10% per annum

7.1 Business as usual Scenario

7.1.1 Description of Business as Usual Scenario

This scenario corresponds to the business as usual condition. It assumes:

- No sector specific targeted approach under the government programme.
- No special steps taken for implementing mandatory provisions.

- Gradual improvement in general awareness on environmental issues and solar water heaters amongst the population.
- Gradual improvement in the Solar water heating supply chain and marketing efforts of the SWH suppliers.
- New mechanisms like ESCO would not come into being

Basic assumptions made for the penetration rate in each of the category are stated in table 7.2.

Table 7.2: Assumption for Business as Usual case

Category	Assumed Penetration Rate
Residential Flats	Existing: Due to the complex issues involved with financing and retrofitting, it is assumed that no SWH installations would take place in existing multi-storey residential flats. New: 5% penetration in new flats (As per the recent trend)
Residential individual plots	Existing: From the current penetration of 0.85%, it is assumed that in this scenario by 2022, 5% of the residential plots would have a SWH. This category does not have any major technical issues related with availability of roof area as well as shading. Affordability is also not a constraint, hence, good marketing effort and increasing awareness on environment issues can result in this gradual increase in penetration. New: 5% penetration in new individual plots.
Hotel- Luxury	Existing: Due to issues related with non-availability of roof space, it is assumed that the penetration of SWH in existing luxury hotel will not increase. New: It is assumed that in the absence of strict enforcement of the mandatory provisions, only 5% hot water requirement in new luxury hotels would be met through SWH.
Hotel- Budget	Existing: From the current penetration of 1%, it is assumed that this would gradually increase and reach up to 5% by 2022. New: 5% penetration in new budget hotels.
Guest House	Existing: From the current penetration of less than 1%, it is assumed that this would gradually increase and reach up to 5% by 2022. New: 5% penetration in new guest houses.
Hospital- corporate	Existing: From the current penetration of 10.4%, it is assumed that in this scenario it may reach up to 15% by 2022. New: 15% penetration in new hospitals.
Hospital- Normal	Existing: Due to the complications involved in retrofitting of SWH system and low demand of hot water, it is assumed that there would not be any new SWH installations in the existing hospitals. New: 5% penetration in new normal hospitals.

Auto Industry	The current penetration is nil. It is assumed that this would increase gradually and 5% of the average daily hot water demand to be met by 2022
Dairy Industry	The current penetration is nil. It is assumed that this would increase gradually and 5% of the average daily hot water demand to be met by 2022
Textile Industry	As the textile industry is badly impacted due to global economic crisis, it is assumed that the penetration level would not change.
Catering Industry	The current penetration is nil. It is assumed that this would increase gradually and 5% of the average daily hot water demand to be met by 2022
Laundry Industry	The current penetration is nil. It is assumed that this would increase gradually and 5% of the average daily hot water demand to be met by 2022

7.1.2 Projections for Business as Usual Scenario -I

Based on the above assumptions the projections for the business as usual scenario for the year 2013-14, 2017-18& 2021-22 is generated in table 7.3.

Table 7.3: Projections for Business as usual scenario (cumulative SWH sq m)

Type		2009-10 (sq m)	2013-14 (sq m)	2017-18 (sq m)	2021-22 (sq m)
Flats	Existing	2328	2328	2328	2328
	New		10020	16700	20040
Independent Housing	Existing	1360	3573	5787	8000
	New		3500	5500	6700
Hotels-Luxury	Existing	718	718	718	718
	New		362	717	1040
Hotels-Budget	Existing	56	131	205	280
	New		130	257	373
Guest House	Existing	0	700	1400	2100
	New		2255	4276	5649
Hospitals-Corporate	Existing	291	334	377	420
	New		141	262	409
Hospitals-Normal	Existing	14	14	14	14
	New		12	22	35

Industry-Auto		0	851	1915	3110
Industry-Dairy		0	405	912	1481
Industry-Catering		0	564	1506	2745
Industry-Laundry		0	179	743	1633
Industry-Textile		1000	1216	1368	1481
Total		**5,767**	**27,432**	**45,007**	**58,555**
CAGR	**21.31%**				

The business as usual scenario results indicates that the SWH deployment would show an annual growth of 21.3% till the year 2022. This growth rate is marginally below the growth rate of 25% being observed by the SWH industry in India for the last 5 years.

7.2 Growth Scenario-I

7.2.1 Description of Growth Scenario-I

In the growth scenario -I, it is assumed that government would take steps in removing key barriers in the deployment of SWH. It assumes the following:

- A more pro-active policy on mandatory provisions. This should include stricter enforcement as well as periodic review of the mandatory provisions to make them more realistic based on ground realities. Some of the revisions that can be considered:
    - Inclusion of Guest house category in the mandatory notifications and formation of norms for the size of SWH in the hotels, hospitals and guest houses category.
    - Making SWH mandatory on residential plots of 250 sq. yards and above (presently they are mandatory on plot sizes of 500 sq. yards and above)
    - Relaxing the SWH norms for high rise apartments (e.g. more than 12 storeys high) which have problems in accommodating systems due to limited roof area.
- Awareness and promotional activities e.g.
    - Special programmes for developers and architects about the mandatory provisions.
    - Formation of a technical solar cell for technical support, formulation of realistic mandatory provisions and independent monitoring of large systems.
    - Special awareness programs for electricity utility managers.

   - Awareness cum technical progarmmes for SWH for the hotels, guest houses & industries having low temperature process heat requirements.
- Special promotional schemes for ESCO for large SWH installations for the industrial use.

The penetration rate for each of the category in the growth scenario -I are given in table 7.4

Table 7.4: Assumptions for Growth Scenario -I

Category	Assumed Penetration Rate
Residential Flats	Existing: Due to the complex issues involved with financing and retrofitting, it is assumed that no SWH installations would take place in existing multi-storey residential flats. New: Starting with 5% penetration in new residential flats in 2011 to 10% penetration by 2022.
Residential individual plots	Existing: From the current penetration of 0.85%, it is assumed that in this scenario it would gradually rise and reach 5% by 2022. New: Starting with 5% penetration in new residential plots in 2011 to 15% penetration by 2022
Hotel- Luxury	Existing: Due to issues related with non-availability of roof space, it is assumed that the penetration of SWH in existing luxury hotel will not increase. New: Starting with 5% penetration in new luxury hotels in 2011 to 15% penetration by 2022.
Hotel- Budget	Existing: From the current penetration of 1%, it is assumed that in this scenario it may reach up to 5% by 2022. New: Starting with 5% penetration in new budget hotels in 2011 to 15% penetration by 2022.
Guest House	Existing: 5% penetration by 2022 New: Starting with 5% penetration in new guest houses in 2011 to 15% penetration by 2022.
Hospital- Corporate	Existing: From the current penetration of 10.4%, it is assumed that in this scenario it may reach up to 15% by 2022. New: Starting with 15% penetration in new corporate hospitals in 2011 to 20% penetration by 2022.
Hospital- Normal	Existing: Due to the complications involved in retrofitting of SWH system and low demand of hot water, the penetration of SWH in existing normal hospital will remain same. New: Starting with 5% penetration in new normal hospitals in 2011 to 20% penetration by 2022.
Auto Industry	The current penetration is nil. It is assumed that this would increase gradually and 10% of the average daily hot water demand to be met by 2022
Dairy Industry	The current penetration is nil. It is assumed that this would increase gradually and 5% of the average daily hot water demand to be met by 2022
Textile Industry	As the textile industry is badly impacted due to global

	economic crisis, it is assumed that the penetration level would not change.
Catering Industry	The current penetration is nil. It is assumed that this would increase gradually and 10% of the average daily hot water demand to be met by 2022
Laundry Industry	The current penetration is nil. It is assumed that this would increase gradually and 10% of the average daily hot water demand to be met by 2022

7.2.2 Projections for Growth Scenario -I

Based on the above assumptions, the projections for growth scenario -I are calculated in table 7.5

Table 7.5: Projections for Growth scenario -I (cumulative SWH sqm)

Type		2009-10 (sqm)	2013-14 (sqm)	2017-18 (sqm)	2021-22 (sqm)
Flats	Existing	2328	2328	2328	2328
	New		12753	27327	40080
Independent Housing	Existing	1360	3573	5787	8000
	New		5409	12500	20100
Hotels-Luxury	Existing	718	718	718	718
	New		559	1629	3119
Hotels-Budget	Existing	56	131	205	280
	New		201	585	1119
Guest House	Existing	0	700	1400	2100
	New		3484	9717	16948
Hospitals-Corporate	Existing	291	334	377	420
	New		154	317	545
Hospitals-Normal	Existing	14	14	14	14
	New		19	51	105
Industry-Auto		0	1702	3831	6220
Industry-Dairy		0	810	1824	2962
Industry-Catering		0	1127	3011	5490
Industry-Laundry		0	359	1487	3266

Industry-Textile		1000	1216	1368	1481
Total		**5,767**	**35,590**	**74,477**	**115,294**
CAGR	**28.35%**				

The Growth Scenario-I results indicate that the SWH deployment would show an annual growth of 28.35% till the year 2022. This growth rate is marginally above the growth rate of 25% being observed by the SWH industry in India for the last 5 years.

7.3 Growth Scenario -II

7.3.1 Description of Growth Scenario-II

In the Growth Scenario-II, apart from actions suggested in the Growth Scenario-I, it is assumed that the Energy Conservation Building Code (ECBC) becomes mandatory for all the commercial buildings and are strictly enforced.

The penetration rate for each of the category in the growth scenario -II are given in table 7.6

Table 7.6: Assumptions for Growth Scenario-II

Category	Assumed Penetration Rate
Residential Flats	Existing: Due to the complex issues involved with financing and retrofitting, it is assumed that no SWH installations would take place in existing multi-storey residential flats. New: Starting with 5% penetration in new residential flats in 2011 to 15% penetration by 2022.
Residential individual plots	Existing: From the current penetration of 0.85%, it is assumed that in this scenario it would gradually rise and reach 5% by 2022. New: Starting with 5% penetration in new residential plots in 2011 to 20% penetration by 2022
Hotel- Luxury	Existing: Due to issues related with non-availability of roof space, it is assumed that the penetration of SWH in existing luxury hotel will not increase. New: Starting with 5% penetration in new luxury hotels in 2011 to 25% penetration by 2022. (As per ECBC compliance)
Hotel- Budget	Existing: From the current penetration of 1%, it is assumed that in this scenario it may reach up to 5% by 2022. New: Starting with 5% penetration in new budget hotels in 2011 to 25% penetration by 2022. (As per ECBC compliance)
Guest House	Existing: 5% penetration by 2022 New: Starting with 5% penetration in new guest houses in 2011 to 25% penetration by 2022.
Hospital- Corporate	Existing: From the current penetration of 10.4%, it is assumed

	that in this scenario it would reach up to 15% by 2022. New: Starting with 15% penetration in new corporate hospitals in 2011 to 25% penetration by 2022.
Hospital- Normal	Existing: Due to the complications involved in retrofitting of SWH system and low demand of hot water, the penetration of SWH in existing normal hospital will remain same. New: Starting with 5% penetration in new hospitals in 2011 to 25% penetration by 2022.
Auto Industry	The current penetration is nil. It is assumed that this would increase gradually and 15% of the average daily hot water demand to be met by 2022
Dairy Industry	The current penetration is nil. It is assumed that this would increase gradually and 15% of the average daily hot water demand to be met by 2022
Textile Industry	3% increase in penetration by 2022
Catering Industry	The current penetration is nil. It is assumed that this would increase gradually and 15% of the average daily hot water demand to be met by 2022
Laundry Industry	The current penetration is nil. It is assumed that this would increase gradually and 10% of the average daily hot water demand to be met by 2022

7.3.2 Projections for Growth Scenario-II

Based on above assumption, projections for Growth Scenario-II are generated in table 7.7.

Table 7.7 Projections for Growth Scenario-II (Cumulative SWH sqm)

Type		2009-10 (sqm)	2013-14 (sqm)	2017-18 (sqm)	2021-22 (sqm)
Flats	Existing	2328	2328	2328	2328
	New		15485	37955	60120
Independent Housing	Existing	1360	3573	5787	8000
	New		6364	16000	26800
Hotels-Luxury	Existing	718	718	718	718
	New		757	2542	5198
Hotels-Budget	Existing	56	131	205	280
	New		272	912	1866
Guest House	Existing	0	700	1400	2100
	New		4714	15159	28247
Hospitals-5 Star	Existing	291	334	377	420

	New		167	373	681
Hospitals-Normal	Existing	14	14	14	14
	New		25	80	175
Industry-Auto		0	2553	5746	9329
Industry-Dairy		0	1216	2736	4443
Industry-Catering		0	1691	4517	8235
Industry-Laundry		0	538	2230	4898
Industry-Textile		1000	1459	1915	2369
Total		**5,767**	**43,037**	**100,993**	**166,222**
CAGR	**32.33%**				

The Growth Scenario-II results indicate that the SWH deployment would show an annual growth (CAGR) of 32.33% till the year 2022. This growth rate is significantly above the growth rate of 25% being observed by the SWH industry in India for the last 5 years.

7.4 Overall Picture

An overall analysis of all the three scenarios for the four broad categories i.e. residential, commercial, institutional and industrial is given in the table 7.8. The typical pattern for the three scenarios are provided in figure 7.1, 7.2 & 7.3

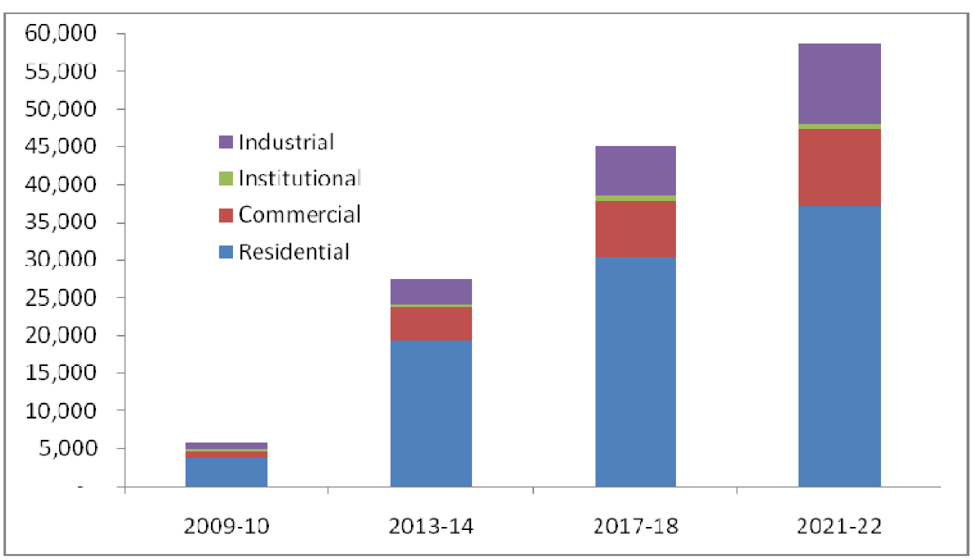


Figure 7.1: Business as usual scenario (Cumulative SWH deployment in sq. m of collector area)

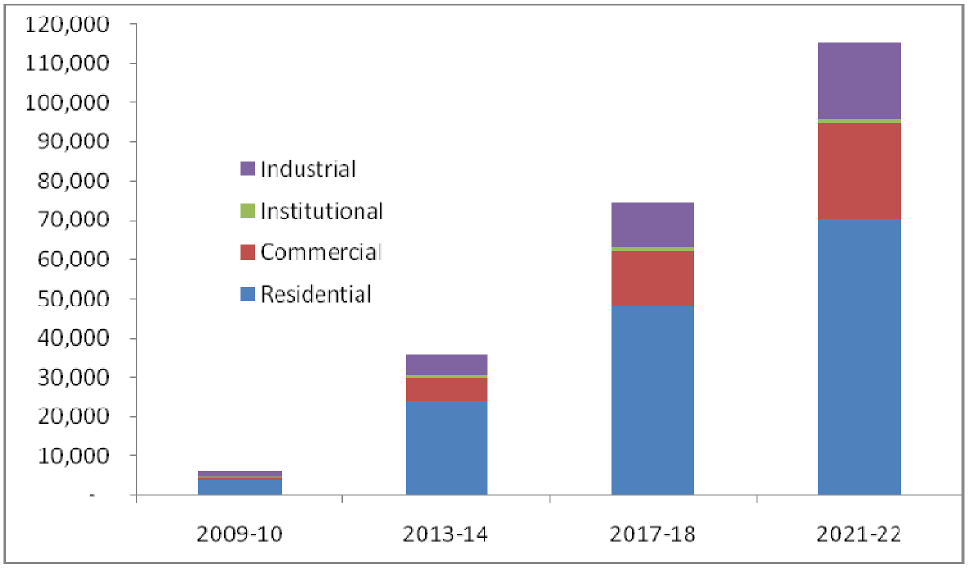


Figure 7.2: Typical pattern for Growth Scenario –I
(Cumulative SWH deployment in sq. m of collector area)

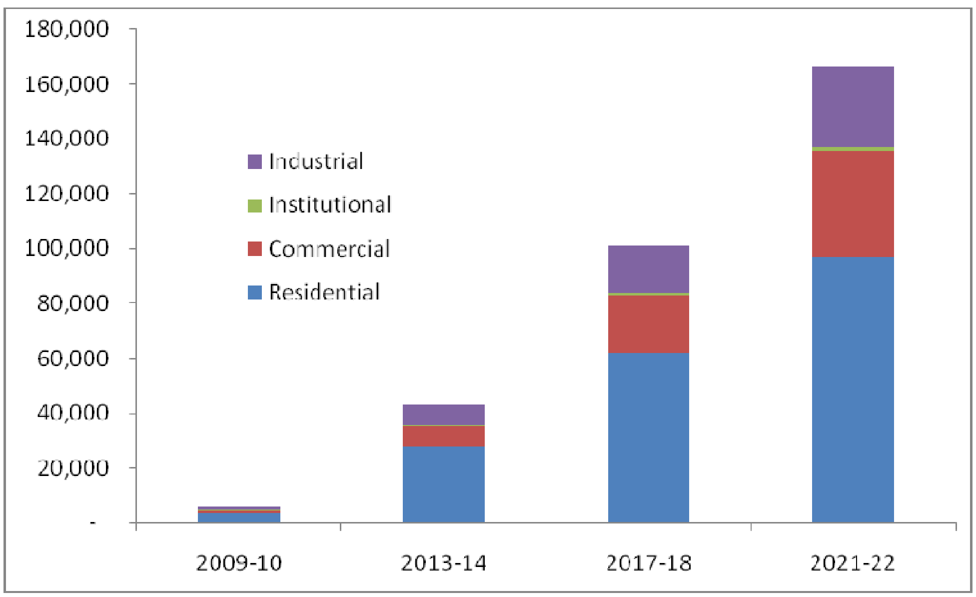


Figure 7.3: Typical pattern for Growth Scenario-II
(Cumulative SWH deployment in sq. m of collector area)

Table 7.8: Overall picture of all the three scenarios

		BAU Scenario			Growth scenario –I			Growth Scenario-II		
	2009-10	**2013-14**	**2017-18**	**2021-22**	**2013-14**	**2017-18**	**2021-22**	**2013-14**	**2017-18**	**2021-22**
Residential	3,688	19,421	30,315	37,068	24,063	47,942	70,508	27,750	62,069	97,248
Commercial	774	4,295	7,573	10,160	5,793	14,254	24,284	7,291	20,936	38,408
Institutional	306	502	676	878	521	760	1,084	540	844	1,291
Industrial	1,000	3,214	6,444	10,449	5,213	11,521	19,418	7,456	17,144	29,275
Total	**5,767**	**27,432**	**45,007**	**58,555**	**35,590**	**74,477**	**115,294**	**43,037**	**100,993**	**166,222**

Chapter 8. Scope for Energy Service Companies (ESCO)

8.1 Introduction

There are many known barriers to the large scale deployment of solar technologies viz low awareness, weak installation and service channels, inadequate access to finance and poor performance of previously installed systems.

Energy Performance contracting is a contractual arrangement between the beneficiary and the energy service provider company has the potential to become a means to overcome the barriers of large scale deployment of solar water heating or solar PV systems. Under some models of ESCO, the ESCo invests in the system installed in the users' facility and acts as a service provider company in exchange the payment for this service is based either on the metered energy or as a fixed monthly charge.

8.2 Gurgaon-Manesar SWH Context

Solar Water heating is not a widely understood technology and its deployment in various segments is primarily driven by mandatory requirements or attractive subsidy schemes. ESCo organizations can play an instrumental role in changing the mindset of the users from mandatory requirement and subsidies to saving incurred through SWH.

During the course of the study, not a single ESCo operating in the Gurgaon-Manesar area came in to picture. Also studies in other parts of the country showed that there exist no credible examples ESCo's operating in the solar water heating segment. ESCo concept is in its nascent stage in India and are virtually absent in solar water heating. It is also likely that most of the ESCo's for SWHS will emerge out of the existing manufactures or their distribution channels. Under this study the role of ESCo's in solar water heater industry is examined.

8.3 ESCo Business Model

The emerging ESCos would be fledgling firms and would require extensive policy and financial support in its initial phases before they can emerge as viable business entities.(This matter is the subject of another study being undertaken under the UNDP/GEF Solar Water Heating Project so we will not go into any details).

The ESCo's attractiveness and financial viability can be enhanced by building a business model which combines solar water heating with other energy efficiency measures. In the context to Gurgaon-Manesar integration of SWH system with waste heat recovery from DG's and Boilers emerged as one of the most attractive options.

In the context to address the industrial segments in Gurgaon-Manesar area for using SWHS in ESCo mode, a Guaranteed Savings ESCo model is proposed.

8.3.1 Guaranteed Savings Model

The key points of the model are stated below

- ESCo will design, install and maintain the system but does not finance it (although it may facilitate financing)
- ESCo guarantees a minimum output of the system and if the system does not perform to the standards set in the guarantee the client is compensated financially.
- BTU metering forms an integral part of this scheme and a contractual verification mechanism is evolved.
- The ESCo will be liable to complete the formalities relating to the subsidy scheme provided by MNRE or any other agency
- The ESCo will charge fees either based on the metered output of the system or as a fixed monthly bill.

This business model is expected to work in the following market segments.

1. For Profitable cash rich companies/ firms which want to avail of accelerated depreciation benefits
2. For Large Equipment Vendors who want to promote/ establish their brands or new technologies and are looking for demonstration projects.

3. In Industries where the solution deployed are technically complex and needs intense maintenance and supervision.

8.3.2 Fee for Service Model

The key points of this model are stated below

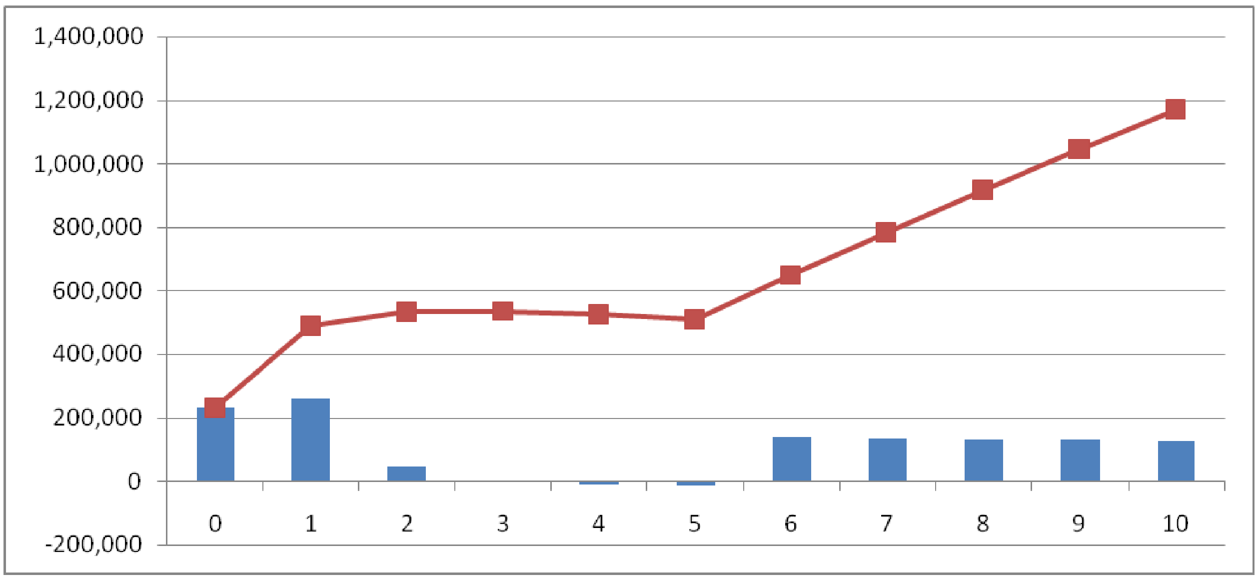
- ESCo invests, designs, installs & maintains the SWH system
- ESCo will collect a part of the capital investment from the client as a refundable security e.g 25% of project cost as a refundable security from the user.
- ESCo will charge a non refundable installation charge e.g @ Rs. 15 -25 per lpd.
- ESCo reserves the right to transfer the system to the user after 10 years after adjusting security deposit or may take back the system
- ESCo will be eligible for availing MNRE subsidy.
- ESCo may collect payments either on the metered energy or as a fixed monthly bill

With a charge of Rs 1.25 per kWh (on the electricity saved) this model in our analysis is found to be perfectly workable however it involves higher degree of risk as compared to the Guaranteed Saving model

The analysis of the fee for service model for a simple boiler feed application is given in table 8.1

Table 8.1: Financial Analysis of Fee for Service Model

Financial Analysis (Fee for Service Model)	
Capacity (SWH)	10,000 lpd
Life of SWH	20 years
Capital Cost	Rs. 16 lakhs (approx) @ 160 per liter
O&M Cost	3% per annum
MNRE Subsidy	Yes
Type of Subsidy	Capital & Interest subsidy
Amount of Subsidy	Rs. 6 lakhs @ Rs 60 per liter (approx)
Equity by ESCo	3.2 lakhs
Subsidized loan amount	6.8 lakhs (16 – 9.2 lacs)
Security Charge	4 lakhs
Installation Charge	1.5 lakhs @ Rs 15/ lpd
Expected Savings	1,60,000 kWh/yr

Depreciation Benefits	Accelerated depreciation @ 80% Rs. 3.17 lakhs in 2 years
Yearly Payment @Rs. 1.25/kWh	Rs. 2 lakhs
Saving to Investment ratio	3.3
Cash Flow Analysis of ESCo 	

8.4 *ESCo in Group Housing (Multi-storey Buildings)*

The analysis for the role of ESCo to provide solar water heating solutions to the group housing societies is divided in to two categories

1. New Construction
2. Retrofit in the existing construction

8.4.1 Role of ESCo in New Construction Group Housing

ESCo in group housing can only be a success if it provides turn-key solution for the hot water delivery during the whole year at the prescribed temperature, which requires auxiliary support to the SWH system. Presently electric back-up is used for the auxiliary heating however analysis shows that the most cost effective and environmental friendly way for the auxiliary heating is using Piped Natural gas (PNG).

For the sake of analysis we have considered an eight-storey tower having 4 flats on each floor, i.e. a total of 32 flats. An ETC based solar water heater system designed @ 125 litre/flat i.e. 4000 liter total capacity to provide hot water at 60^{o}C for 6 months in a year (October-March) can provide up to 85% of the total heating required. Life cycle cost analysis of the options for auxiliary heating is given in the table 8.2

Table 8.2: Life cycle cost analysis – comparison of cost of heating water

Type	**Solar Water Heater**	**Electric Back-up**	**Gas Back-up**
Number	1	1	1
Capacity	4000 lpd	1000 lt	100 lts
Capital Cost	Rs. 1,100,000	Rs. 80000	Rs. 100000
Maintenance Cost/Annum	Rs. 33000	Rs. 6400	Rs. 5000
Operation Cost/Annum	Nil	Rs. 39,600	Rs. 10,500
Life	16 years	8 years	10 years
Life Cycle Cost	Rs. 16.28 lakh	Rs. 2.55 lakh	Rs. 4.48 lakh
Cost/liter hot water	Rs. 0.14	Rs. 0.08	Rs. 0.04
Total cost/liter of hot water(Solar+Aux)		**Rs. 0.22**	**Rs. 0.18**

The ESCo scheme works as follows

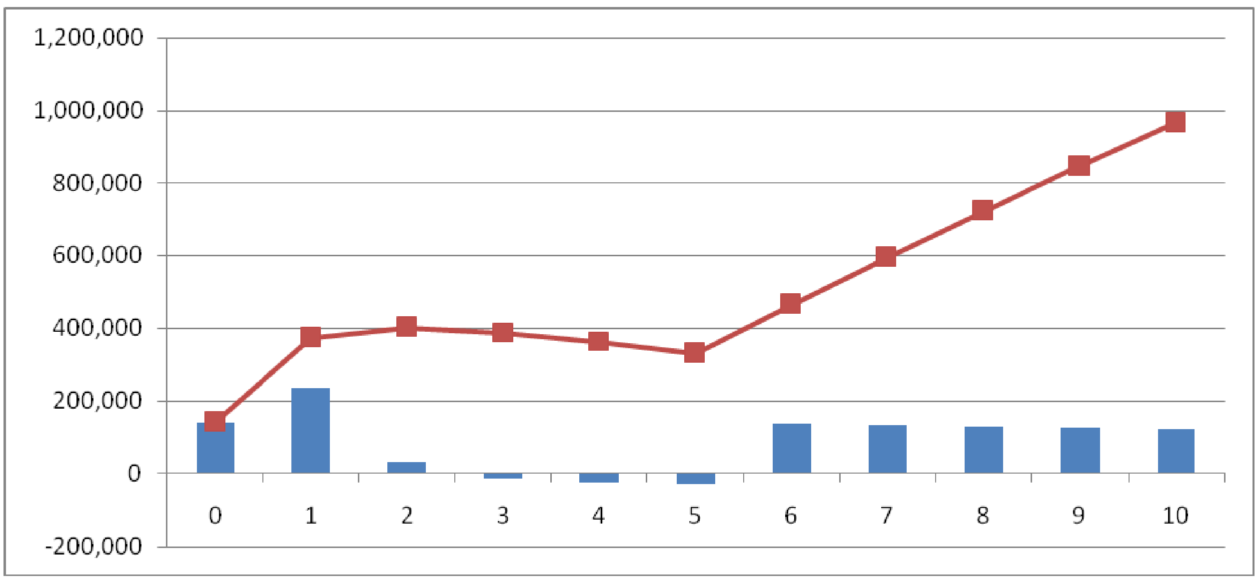
1. Each of the residents who wish to utilize the SWHS pays a connection fee of Rs 10,000 i.e. approx 20 % of system costs.
2. The resident agrees to pay a monthly subscription of Rs.500 per month towards charges of the hot water. (This is less than the average annual electricity consumption for producing hot water)

The financial analysis of ESCo operating with Gas back up is given in table 8.3

Table 8.3: Financial Analysis of ESCo in Group housing with Gas back-up

Financial Analysis for ESCo in Group housing	
Capacity (SWH)	4000 lpd
Life of SWH	16 years
Capital Cost	Rs. 12 lakhs (approx)
O&M Cost	3% per annum

MNRE Subsidy	Yes
Type of Subsidy	Capital & Interest subsidy
Amount of Capital Subsidy	Rs. 2.4 lakhs @ Rs 60 per liter (approx)
Equity by ESCo	Rs.2.4 lakhs
Subsidized loan amount	Rs. 7.2 lakhs (12 – 4.8 lakh)
Security Charge	Rs. 3.2 lakhs @ Rs. 10000/flat
Installation Charge	Rs. 60000 @ Rs. 15/lpd
Depreciation Benefits	Accelerated depreciation @ 80% Rs. 3 lakhs in 2 years
Yearly Payment	Rs. 1.92 lakhs @(Rs. 500/flat /month)
Saving to Investment ratio	3.0
Cash Flow Analysis of ESCo	



8.4.2 Retrofit in Existing Construction

This may be one segment where ESCo's can play a significant role especially in societies which are now feeling the pinch of high maintenance charges which are a direct consequence of high DG usage. The ESCO is necessary here because while the residents are keen on the savings but may be unwilling to pay upfront for a SWHS. An ESCo can invest in the system and charge a fixed monthly sum from all the connected households and the residents would not mind this charge if it is added to their monthly maintenance bill.

The ESCo's main role is to act as a facilitator for retrofitting solar water heating systems on common rooftops and providing all necessary insulated piping connections to the usage points. Retrofitting costs for the ESCo would be higher than the new construction installation and therefore it requires incentive/schemes from the government to make their business model viable. Apart from

- Capital Subsidy which is available @ 3000 per m^2 of collector area.
- Soft Loan for the project @ 5 % for the balance of systems costs.
- Accelerated Depreciation benefits for the system as it owned and operated by the ESCo Company.

If the ESCo company is also entitled to the rebate in electricity bill, as per the Haryana Govt Notification, @ 100/ 100 LPD installed to the group housing society for 36 months then also the model is not attractive for the ESCo company

Therefore, our analysis for this segment revealed that the scope for ESCO's in retrofitting SWHS in the existing group housing do not make an attractive business proposition under the current policy. Also the residents are reluctant to make an additional investment as they have already installed electric geysers.

Chapter 9. Conclusions

9.1 Hot Water Demand in 2010 and 2014

The daily hot water demand for 2010 is estimated at 30 million lpd. The percentage wise distribution of this demand is given in figure 9.1. The residential sector is responsible for 70% of the daily hot water demand.

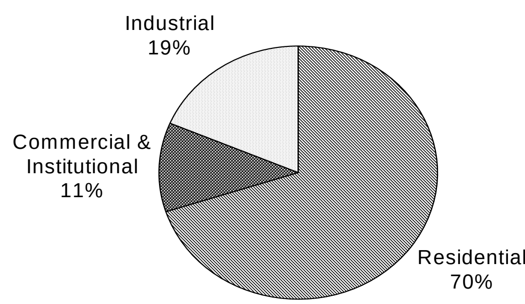


Figure 9.3 Daily Hot Water Requirement (2010) - Sector wise distribution

The annual hot water requirement is estimated at 5866 million liters. The distribution of this demand is given in figure 9.2, which shows that while the residential sector accounts for 56% of the annual requirement, industries account for 30% and are an important sector from a view point of reducing fossil fuel use for water heating.

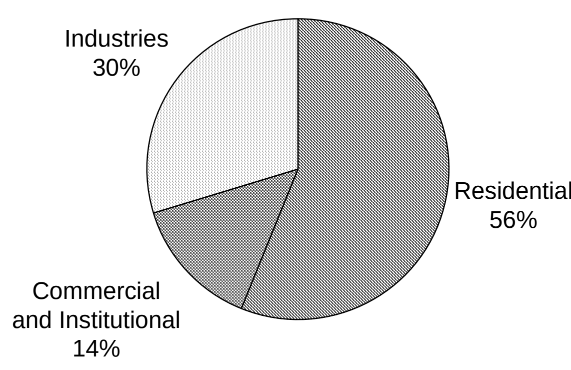


Figure 9.4: Annual Hot Water Requirement (2010)

Total Demand =5866 million litres

The hot water demand for 2014 was calculated based on estimation of new addition in the building stock. The growth rates for different types of building for the 2011-2014 period is given in table 9.1.

Table 9.1. Growth in Building Stock (2011-2014)

Flats in multi-storey housing	15000 per year
Houses constructed on individual plots	5000 per year
Hotel rooms	10% per year
Guest house rooms	20% per year
Hospital beds	7.5% per year

Taking these growth rates into account it is expected that the total daily hot water requirement would increase from 30.0 million lpd in 2010 to 46.92 million lpd by 2014.

Table 9.2. Daily Hot Water Demand (in million lpd)

	Predominant means for heating water	**2010**	**2014**
Residential (Flats/houses having 2 or more than 2 bedrooms)	Electric Geysers	21.0	34.0
Hotels and Guesthouses	Electric Geysers/ Petroleum fuel based boilers and hot water generators	3.2	4.6
Hospitals	Electric Geysers/ Petroleum fuel based boilers and hot water generators	0.2	0.22
Industry	Petroleum fuel based boilers and hot water generators		
o Auto		2.3	2.3
o Textile		1.0	1.0
o Dairy		1.0	1.0
o Catering		1.2	1.2
o Laundry		0.1	0.4
SEZ (IT/ITES)		NA	2.2*
SEZ (Others)		NA	NA
Total		**30.0**	**46.92**

9.2 Assessment of Back-up Power (2010 and 2014)

Gurgaon-Manesar urban complex is facing an acute power crisis and has a very large back-up power generation capacity in the form of diesel based generators (approx 2000 MW). On an average there is a power shortage of 20% which during peak demand periods goes up to 35%. The average duration of daily power cut ranges from 4-8 hours.

Table 9.3. Back-up Power (DG sets)

	2010	**2014**
Residential	400	600
Commercial and Industrial	1600	2100
SEZ	NA	NA
Total	**2000**	**2700**

9.3 Solar Water Heater Market Potential

To carry out realizable market potential of SWH in the area till the year 2022, following three cases has been assumed

1. Business as usual scenario
2. Growth Scenario -I
3. Growth Scenario -II

The projections have been carried out by:

a) Projecting future demand for hot water for each category assuming growth rates for different time periods i.e. 2010-2014, 2014-2018 and 2018-2022.

b) Assuming gradual increase in penetration levels to assumed terminal penetration rates in 2022 for each category.

c) For projections, new and existing buildings have been treated separately, given the fact that several of the mandatory provisions are applicable to new buildings and incorporation of SWH is much easier and economically viable in new buildings.

9.3.1 Business as Usual Scenrio

This scenario corresponds to the business as usual condition, where:

- The government does not take any specific steps for promotion of SWH in high potential categories as well as for implementing mandatory provisions.
- The growth of the market is left primarily to marketing efforts of the SWH suppliers and growing awareness amongst potential users.

The projections under this scenario are presented in table 9.4. The BAU scenario results show a healthy annual growth of 21.3% in SWH deployment till the year 2022. It shows that even if the government focuses its attention on awareness generation and ensuring quality and leaves the marketing efforts to SWH industry, substantial increase in SWH deployment are possible. Deployment in new residential construction (both flats and plotted housing) is estimated to account for more than 50% of the cumulative SWH deployment.

Table 9.4. Realizable Potential for SWH under BAU Scenario (cumulative SWH deployment in sq. m)

		BAU Scenario		
	2009-10	**2013-14**	**2017-18**	**2021-22**
Residential	3,688	19,421	30,315	37,068
Commercial	774	4,295	7,573	10,160
Institutional	306	502	676	878
Industrial	1,000	3,214	6,444	10,449
Total	**5,767**	**27,432**	**45,007**	**58,555**

9.3.2 Growth Scenario -I

The growth scenario-I assumes:

a) A more pro-active policy on mandatory provisioning of SWH which has elements of stricter enforcement as well as periodic revision of the provisions taking ground-realities into account.

b) A focused and targeted approach for awareness generation and technical training.

c) Promotion of ESCOs for segments such as industries and commercial buildings.

All these steps would result in much higher penetration across all categories and almost 100% increase over 2022 BAU projections (table 9.5). The annual growth rate in SWH deployment under this scenario would be 28.35%.

Table 9.5. Realizable Potential for SWH under Growth Scenario -I (cumulative SWH deployment in sq. m)

		Growth Scenario –I		
	2009-10	2013-14	2017-18	2021-22
Residential	3,688	24,063	47,942	70,508
Commercial	774	5,793	14,254	24,284
Institutional	306	521	760	1,084
Industrial	1,000	5,213	11,521	19,418
Total	**5,767**	**35,590**	**74,477**	**115,294**

9.3.3 Growth Scenario -II

Growth Scenario –II builds on Growth Scenario –I and assumes that Energy Conservation Building Codes (ECBC) would become mandatory and would have a better implementation compared with the mandatory provisioning of SWH.

The projections for the scenario are given in table 9.6. The annual growth rate in SWH deployment is 32.3 %.

Table 9.6. Realizable Potential for SWH under Growth Scenario -II (cumulative SWH deployment in m^2)

		Growth Scenario-II		
	2009-10	2013-14	2017-18	2021-22
Residential	3,688	27,750	62,069	97,248
Commercial	774	7,291	20,936	38,408
Institutional	306	540	844	1,291
Industrial	1,000	7,456	17,144	29,275
Total	**5,767**	**43,037**	**100,993**	**166,222**

9.3.4 Strategy to achieve SWH Potential

The priority sectors for the realizable SWH potential are stated below (in the descending order of their potential)

1. New Multi-storey housing

2. Industries (Hybrid systems of SWH and Waste heat recovery units)
3. Guest houses and Hotels
4. Existing and New Plotted housing
5. SEZs

Actions required to realize the SWH potential for each subcategory is described below

New Housing: New housing should be the focus in the residential sector. In 2010, despite the mandatory order from the government in plot sizes above 500 Sq yds and in Group Housing/ Apartments etc , SWH were provided in less than 5% of the new housing.

Following steps should be taken:

- Awareness creating measures through media and events.
- In case of plotted housing, mandatory provision need to apply to plot sizes above 250 sq yds.
- There is a need to re-look into the mandatory provisions for multi-storey housing, to make them more realistic. For buildings above a certain height, enough space is not available on the roof for putting-up adequately sized SWH. Literature on Chinese experience (Zhejang Province) shows that SWH are strongly recommended for multi-storey housing up to 12 storey high.
- Stricter enforcement of the mandatory provision *(making them non compoundable*)
- Capacity building measures amongst the developers and architects and plumbing consultants about the mandatory provision.
- A technical solar cell to be established which should be responsible for the independent monitoring of the large residential SWH systems, providing technical support for designing of SWH systems, and look into genuine problems of the developers and users (e.g. lack of space at roof-tops/ rooftop orientation in high-rise buildings) and provide solutions.
- As shown in the report, fee for service ESCO model seems viable for the new multi-storey housing. There is a need to take-up demonstration projects to demonstrate this model and attract ESCOs in this field.

A sharp focus on this area is likely to a substantial increase in uptake of solar water heating systems.

Existing Housing:

- *Plotted Housing*: This segment has been showing growth across all major cities. The space on roof is not a problem in plotted housing; similarly affordability is also not a major issue. There is good potential to increase the penetration in existing plotted housing through awareness and increasing the marketing efforts.
- *Multi-storey Housing*: On the other hand, in existing multi-storey housing which is a big segment the solution is technical complex and financially unattractive. The decision making process in Resident Welfare Associations and Cooperative Housing Societies is slow which makes the task of retrofitting existing multi-storey housing with SWH very difficult. Under the present policy and incentive frame-work, the fee for service ESCO model does not seem to be workable. Demonstration projects are required to test different incentives and innovative financing models. This segment is unlikely to see any radical changes in solar water heating deployment

Commercial and Institutional Buildings:

As shown in the case studies, SWH have attractive pay-back period (less than 2-3 years) for hotels and guest-houses.

- Creating awareness and stricter enforcement of mandatory regulations should be the focus, as this segment does not require any new incentives.
- Preparation of realistic norms for hotels, guest houses and hospitals for the mandatory regulations.
- The guest houses should be the focus, as these have emerged as the largest sub-segment. A demonstration project on ESCO for guest houses may be undertaken.

As most of the Guest houses exist outside the Guest house byelaws the mandatory provisions need to be creatively formulated. Guest Houses potential for SWHS can only be realized by reducing the current ceiling from 500 sq yds to plot sizes of 250 sq yds and above or apply to any residential building which has more than 6 sanctioned bathrooms in the building plan. This is a segment which shows great promise for the immediate future

Industries:

Industries offer a large untapped potential. Most of the solar water heater projects in industries have an attractive pay-back period. Automobile, catering and laundry offer the greatest potential.

- As a follow up on the work done during the study to identify potential industries and in establishing preliminary feasibility, there is a need to take-up quickly demonstration projects in the automobile and dairy industry.
- Capacity building through seminars with PAN India industry associations like ACMA and Indian Dairy Federation and publications in industry journals.
- There is a case to demonstrate guaranteed saving ESCO model for industries.
- Industrial solar water heater systems are generally more complex. Hybrid systems incorporating waste heat recovery and solar water heating seem to be the most attractive options. A technical solar cell to be established to act as single window information source and technical resource for the industry.

This is an area with a huge untapped potential and successful demonstration projects in this area can have a pan India impact on the spread of solar water heating in Industrial application.

9.3.5 Immediate Suggestions

1. Formation of realistic norms for the mandatory regulations, on the basis of primary and secondary survey with the end users and SWH installers following actions are suggested
    a. Mandatory regulations for the residential plotted housing greater than 250 sq yard are needs to be formulated
    b. Norms for the mandatory regulations for multi storey building should be revised and different norms should be formulated for more than 12 storey buildings.
    c. Mandatory regulation of at least 75 lpd per room for star rated hotels & 50 lpd per room for budget hotels/Guest houses and 30 lpd per bed for star rated hospitals.
2. Formation of a technical solar facilitation cell that can provide technical support required for the complex installations. Details of the technical solar facilitation cell are provided in Appendix III.
3. Capacity building measures for Architects and Builders: Organization of at least 3 awareness cum technical training programme with site visits and case studies.
4. Awareness programme for potential industries with the help of industrial associations like ACMA/ SIAM/ Indian Dairy federations

a. Organization of at least 3 awareness cum technical training programme on hybrid Solar Water Heating systems (SWH+ Waste heat recovery Units) with site visits and case studies.
b. Awards and recognition for installation of large innovative and complex solar water heating systems.

5. Facilitation and monitoring of 2-4 model ESCo projects in industrial and commercial sector.

9.4 Rooftop Solar PV Market Development

The primary aim of rooftop solar PV in Gurgaon would be diesel saving. Our analysis show that given the large installed DG capacity (2000 MW) and present economics of solar PV (even after considering incentives offered under JNNSM), the contribution of solar PV on Gurgaon power situation would be only marginal in immediate future.

The two options which look attractive for Gurgaon-Manesra are:

- Off-grid day time use PV systems: In this configuration solar power generated through PV system is directly used to provide power to the day-loads. The system has a minimal battery bank to compensate for the fluctuations in the power generated through PV system during the day-time as well as to fill the gap between the peak power and the generated power, whenever required during the day time. In this configuration solar power can be used only during the day time and will not be stored for use in the night time or during the periods when there is no sun hence this type of solar PV system can substitute DG power only in the day time. This mode is suitable when stable day-time loads are available and there are frequent and long power cuts during the day time. Given the large investment required and simple pay-back period of 8 years and more one can expect only a few projects materializing in immediate future. The three most attractive segments based on the availability of day-time loads as well as space availability are:
  - Large multi-storey housing complexes
  - Guest houses

- Industries

Existing telecom towers in Gurgaon-Manesar does not seem to be an attractive segment.

- Grid-connected rooftop systems: In this configuration solar power generated can be directly fed into the grid. These systems work on net metering system, which meters both the electricity supplied from the PV system to the grid as well as the electricity used by the facility from the grid. This mode helps the local utility in getting supply of additional electricity during peak demand period during the day and also helps in utilizing the un-utilized roof area of the buildings. The two attractive segments seems to be:
  - Industries
  - Housing complexes

  School is another segment which may be interesting due to large rooftop area which is available.

9.5 Model Preliminary Project Reports

As per the ToR of the study, four model preliminary project reports (refer Annexure –II) have been prepared for the projects which can be pursued further for immediate implementation. These are:

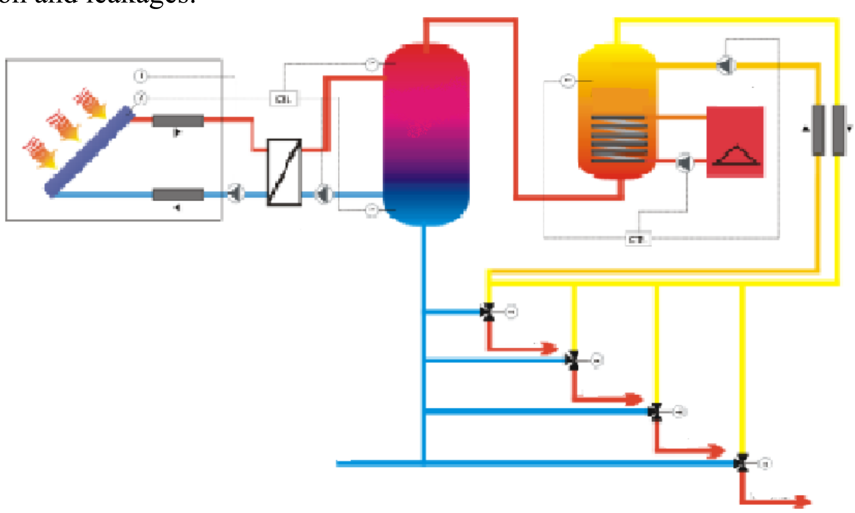
- Solar Water Heating at Dudhmansagar Dairy
- Solar Water Heating for Electroplating at Omax Auto
- 200 kWp Solar PV Rooftop Power Plant at Garden Estate Housing Complex
- 1000 lpd Solar Water Heating System and a 5 kWp Solar PV Rooftop system for a guest house.

ANNEXURE I: CASE STUDIES

Case Study 1: Hotel City Mark

Project Details	
Location	Mahavir Chowk, Gurgaon
Type	Hotel
Installation Year	2010
Technology	Solar Water Heater
Solar Manufacturer	Inter Solar

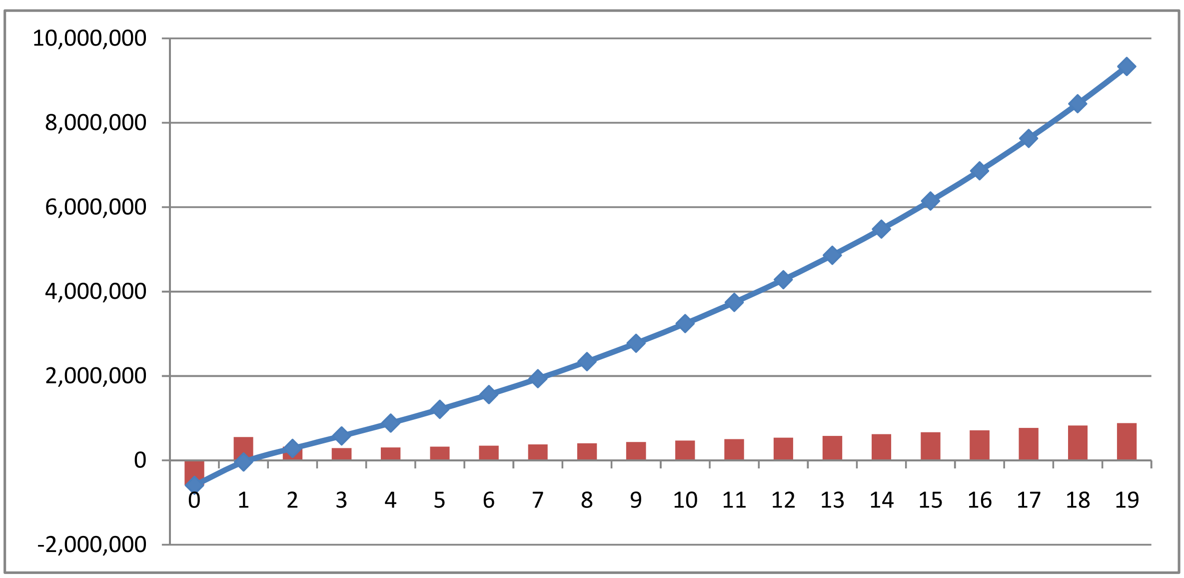
Technical Summary of Project
Project Objective: To save electricity and diesel with the help of SWH
Project Description: Hotel City Mark is a premium luxury hotel situated in the heart of the city. For the sake of reducing operational costs with environmental friendly measures they decided to go for Solar Water Heaters for providing hot water in the bathrooms and kitchen. A 6000 lpd system containing 56 flat plate collectors provides hot water to all of the 90 rooms as well as in the kitchen. The primary solar circuit is connected through the solar tank of 6000lt capacity, with the help of plate type heat exchanger. This solar tank is well insulated with glass wool and is connected to an auxiliary tank of 4000 lt capacity, having electrical heating elements of 54 kW with a thermostat designed to maintain the temperature of the auxiliary tank at 55^{o}C. The hot water supply to the rooms and kitchen is provided from this auxiliary tank. The programmable controls ensure that heat is withdrawn from the primary circuit as soon as the differential temperature between the primary circuit and the solar tank reaches 10^{o}C. The material of construction of both of the tanks is MS Steel with epoxy coating from inside to prevent from internal corrosion and leakages.



Financial Data	
Capacity	6000 lpd
Life	20 years

Capital Cost	Rs. 16 Lakhs
Avoided Capital Cost (business as usual case Electric Room Geysers or Centralized Diesel Water Boiler).	Rs. 6500 X 90 Rooms= Rs. 5.85 lakhs
Net Capital Cost	Rs. 10.15 Lakhs
O&M Cost	2%
Life Cycle Cost	Rs. 23.75 lakhs
NPV of Total Cost	Rs. 18.9 lakhs
MNRE Subsidy	Yes
Type of Subsidy	Capital
Amount of Subsidy	Rs. 4.25 Lakhs
Expected Usage (days per year)	250
Expected Savings	Rs. 2.75 Lakhs/annum
Depreciation Benefits	Yes
Life Cycle Savings	Rs. 1.16 Crores
NPV of Total Savings	Rs. 63.50 lakhs
Simple Payback	1.1 years
IRR	71%
Savings to Investment ratio	7.3

Cash Flow Analysis:



Remarks

- Hybrid system with very large electrical backup which is designed to take the total demand of peak winter demand. Hence no other water heating arrangement required.
- AMC Necessary. MS tank may not be able to stand the corrosive nature of the water.
- Investment in Hybrid systems will prove financially prudent an account of avoided capital expenditure.

Case Study 2: Hotel Park Premier

Project Details	
Location	Sec-29, Gurgaon
Type	Hotel
Installation Year	2010
Technology	Solar Water Heater
Solar Manufacturer	Emmvee Solar Systems Pvt Ltd

Technical Summary of Project

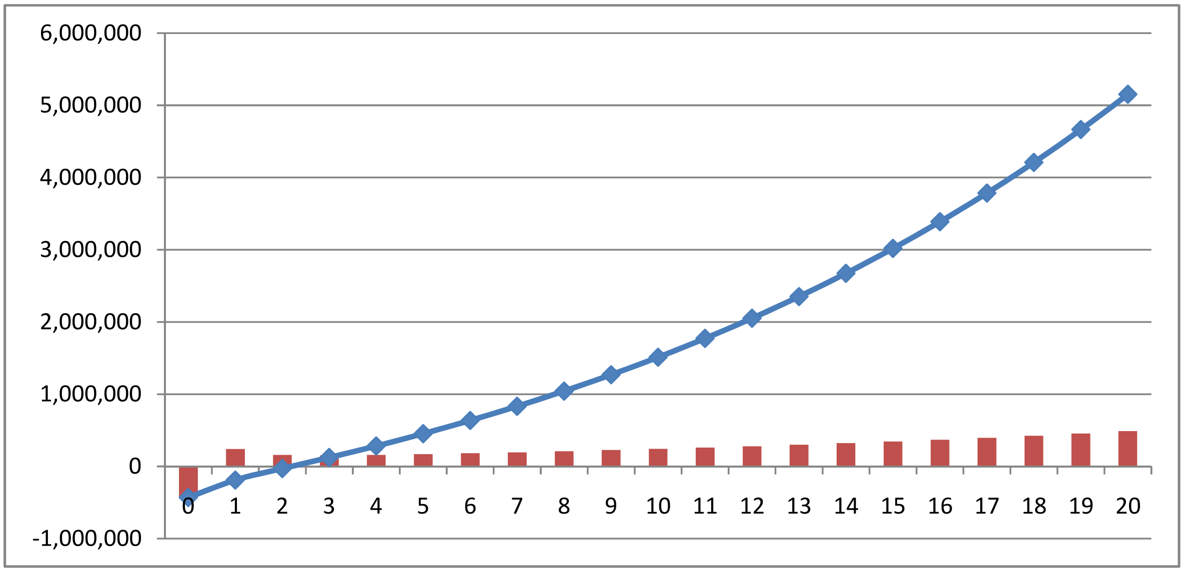
Project Objective: To save electricity and diesel with the help of SWH

Project Description:
Hotel City Mark is a luxury hotel situated in the heart of the city. To comply with mandatory provisions and reduce operational costs they decided to go for Solar Water Heaters for providing hot water in the bathrooms and kitchen. A 3000 lpd system containing 24 flat plate collectors provides hot water to all of the 94 rooms as well as in the kitchen. The collectors are connected through a solar tank which in turns provides hot water to a diesel based hot water generator, thermostatically controlled to provide hot water at 50^{o}C. All the hot water requirements pertaining to bathing and kitchen purposes are taken care from this system. They have not installed a single geyser in the hotel although they do have a steam boiler which is used for laundry purposes but they don't use solar water heater to pre-heat the make-up water for the boiler as SWH is undersized and could not cater to all the hot water demand.

Financial Data (Realistic Scenario)	
Capacity	3000 lpd
Life	20 years
Capital Cost	Rs. 6 Lakhs
Auxiliary Heating	Hot Water Generator
Fuel used in Auxiliary Heating	Diesel
O&M Cost	2%
Life Cycle Cost	Rs. 8.91 lakhs

NPV of Total Cost	Rs. 7.08 lakhs
MNRE Subsidy	Yes
Type of Subsidy	Capital
Amount of Subsidy	Rs. 1.7 lakhs (as per JNNSM guidelines)
Expected Usage (days per year)	250
Expected Savings	3780 lt diesel/annum
Depreciation Benefits	Yes
Life Cycle Savings	Rs. 58.75 lakhs
NPV of Total Savings	Rs. 28.62 lakhs
Simple Payback	2.2 years
IRR	45%
Savings to Investment ratio	9.8

Cash Flow Analysis:



Remarks

- **Centralized heating system ,No electric geysers are installed**, resulting in lower overall capital cost.
- **System is undersized**. Larger capacity could have been installed as year round requirements for the laundry/ kitchen etc exist and space was available on the rooftop.

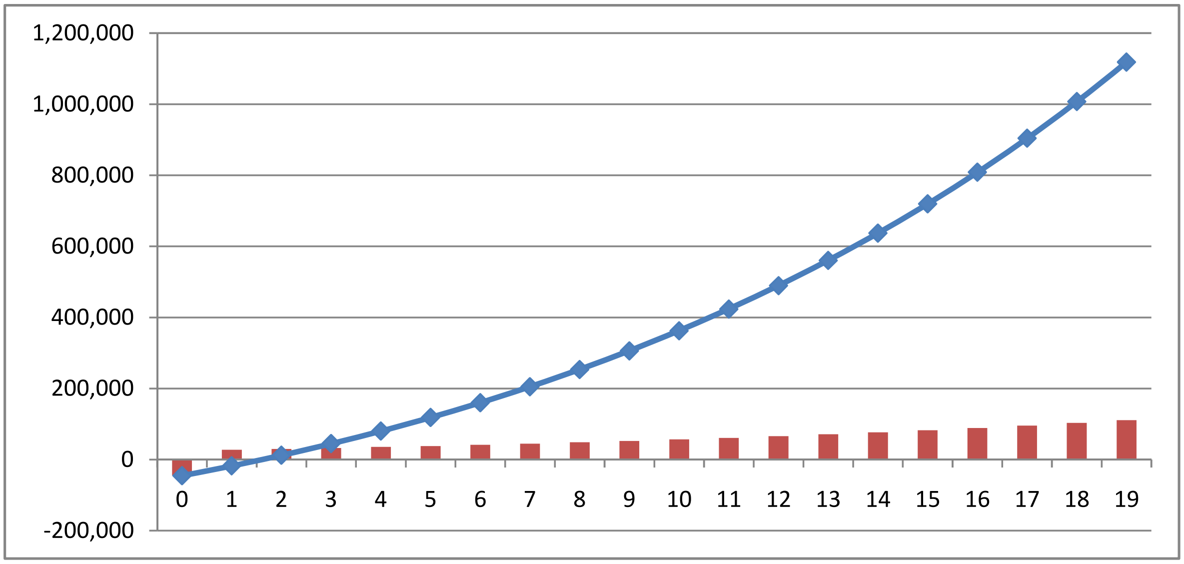
Case Study 3: Working Women Hostel

Project Details	
Location	Working Women Hostel, Near Nehru Stadium, Civil Lines ,Gurgaon
Type	Residential Hostel
Installation Year	2007
Technology	Solar Water Heater
Solar Contractor	Sun Glow Solar

Technical Summary of Project
Project Objective: For the cause of promoting deployment of Solar Water Heaters in institutions, HAREDA has installed SWH in Working Women Hostel.
Project Description: Under the social sector scheme, HAREDA has installed a 2000 lpd SWH system in the working women hostel situated in Gurgaon. Under this scheme, HAREDA provides 90% financial assistance for installing a solar water heating systems in social sector institutions. The hostel is a single storey building having 40 rooms. Each room has a bathroom and a kitchen attached and can accommodate two persons. A community type solar water heating system is designed to cater the hot water requirement for bathing and kitchen purposes. The system consists of 20 flat plate collectors, making the total capacity of the installed system to be 2000 lpd, with common distribution piping for hot water supply in each room and no auxiliary heating provisions. Piping system was designed so as to minimize the piping cost as well as its complexity. The SWH system is the only source of hot water in the hostel and as per the warden's opinion they are quite satisfied with the performance of the system. As per their estimate the use of SWH system is for around 90-100 days in the year. Regular maintenance of the system is ensured through an annual maintenance contract with the supplier. If such kind of installation happens under the new guidelines of JNNSM, it may not be a very financially attractive proposition. As per our analysis, under the current subsidy regime its pay back would be around 8 yrs. The requirement of hot water is for only 90-100 days in an year, therefore SWH is not utilized fully hence will not give attractive returns.

Financial Data	
Capacity	2000 lpd
Life	20 years
Capital Cost	Rs. 4.5 Lakhs
O&M Cost	2%
Life Cycle Cost	Rs. 6.68 Lakhs
NPV of Total Cost	Rs. 5.31 lakhs
MNRE Subsidy	Yes
Type of Subsidy	Capital
Amount of Subsidy	Rs. 4 lakhs (90% subsidy)
Expected Usage (days per year)	100
Expected Savings	Rs. 37000 /annum
Depreciation Benefits	NA
Life Cycle Savings	Rs. 15 Lakhs
NPV of Total Savings	Rs. 10.6 lakhs
Simple Payback	1.6 years

IRR	70%
Savings to Investment ratio	33.4
Cash Flow Analysis:	



Remarks

- A good example of a community based solar water heating system
- Common distribution pipeline reduces the cost of piping.
- AMC results in regular maintenance of the system.
- Hot water is required only for 90-100 days in a year and hence the plant utilization factor is low.

Case Study 4: Guest House, Sec-17

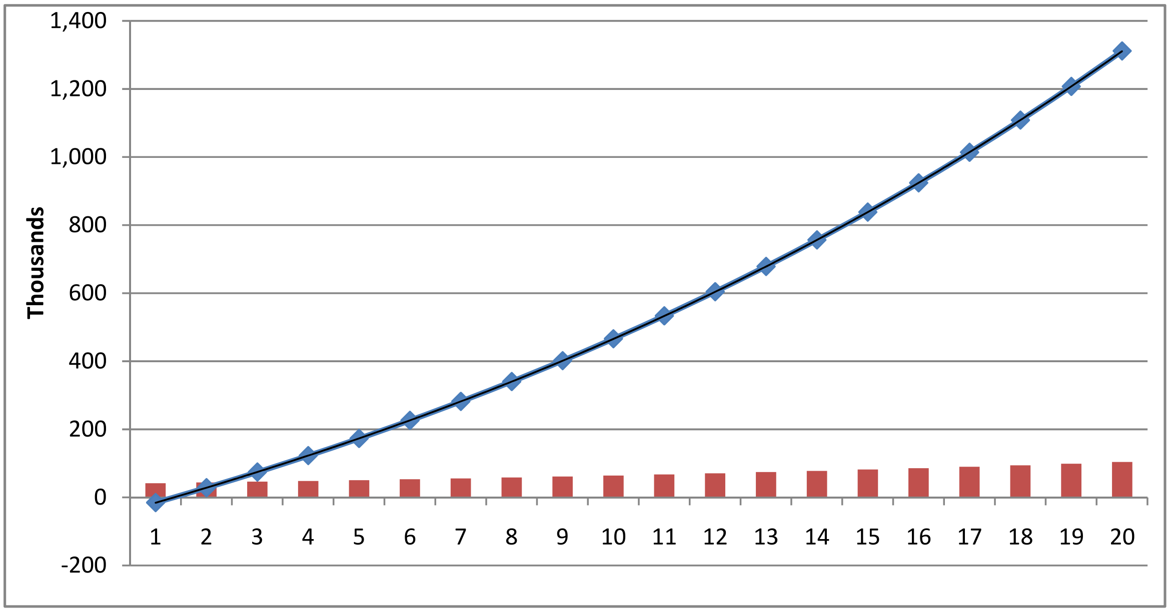
Project Details	
Location	Sector 17, Gurgaon
Type	Guest House
Installation Year	2008
Technology	Solar Water Heating System
Solar Manufacturer	BHEL

Technical Summary of Project
Project Objective: To save electricity and diesel with the help of SWHS
Project Description: Guest houses have a hot water requirement for around 9 – 10 months in the year. The conventional way is to install storage electrical geysers in individual toilets. The SWHS was designed to meet the hot water requirements for the entire Guest House . The system consists of 10 flat plate collectors with electrical back-up in the tank to cater the hot water requirements of all the twenty two rooms as well as kitchen. This is a simple thermo-siphon system in operation since 2000. The system is optimally designed and properly installed and all the pipe work is insulated. Performance of system is up to the mark, primarily because of the regular annual maintenance. The SWHS was integrated into the operations since the inception of the guest house hence they did not install any additional room/ toilet storage electric geysers. No subsidy or grant of any kind was availed as the owners were not aware of the subsidy. The primary motivation for the installation was that promoters were familiar with SWHS and its environmental and energy savings potential.

Financial Data (Realistic Scenario)	
Capacity	1000 lpd
Life	20 years
Capital Cost	Rs. 2 Lakhs
Avoided Capital Cost (business as usual case Electric Room Geysers)	Rs. 6500 X 22 Rooms= Rs. 1.43 lakhs
Net Capital Cost	Rs. 57000
O&M Cost	2%
Life Cycle Cost	Rs. 3.43 lakhs
NPV of Total Cost	Rs. 2.53 lakhs
MNRE Subsidy	No
Type of Subsidy	NA
Amount of Subsidy	NA
Expected Usage (days per year)	250
Expected Savings	Rs. 46000/annum
Actual Savings	Not computed
Depreciation Benefits	Accelerated Depreciation not taken

Life Cycle Savings	Rs. 15.12 lakhs
NPV of Total Savings	Rs. 8.41 lakhs
Simple Payback	1.35 years
IRR	78%
Savings to Investment ratio	7.6

Cash Flow Analysis:



Remarks/ Learnings

- Maximum Benefits derived as SWHs was planned at the design stage itself.
- Proper Installation hence no geysers are required, which results in lower capital cost and quicker paybacks.
- Annual Maintenance Contract (AMC) has ensured good performance of the system for last 10 years.
- Subsidies not the main driver in the decision making process. Awareness about the technology and its potential benefits were more important factors.

Case Study 5: HUDA Housing Society

Project Details	
Location	HUDA Housing Society, Sector 43, Gurgaon
Type	Residential Housing Society
Installation Year	2008
Technology	Solar Water Heater
Solar Contractor	Inter Solar

Technical Summary of Project

Project Objective: For the cause of promoting deployment of Solar Water Heaters in residential units, housing board of Haryana has installed SWH in the HUDA Housing society.

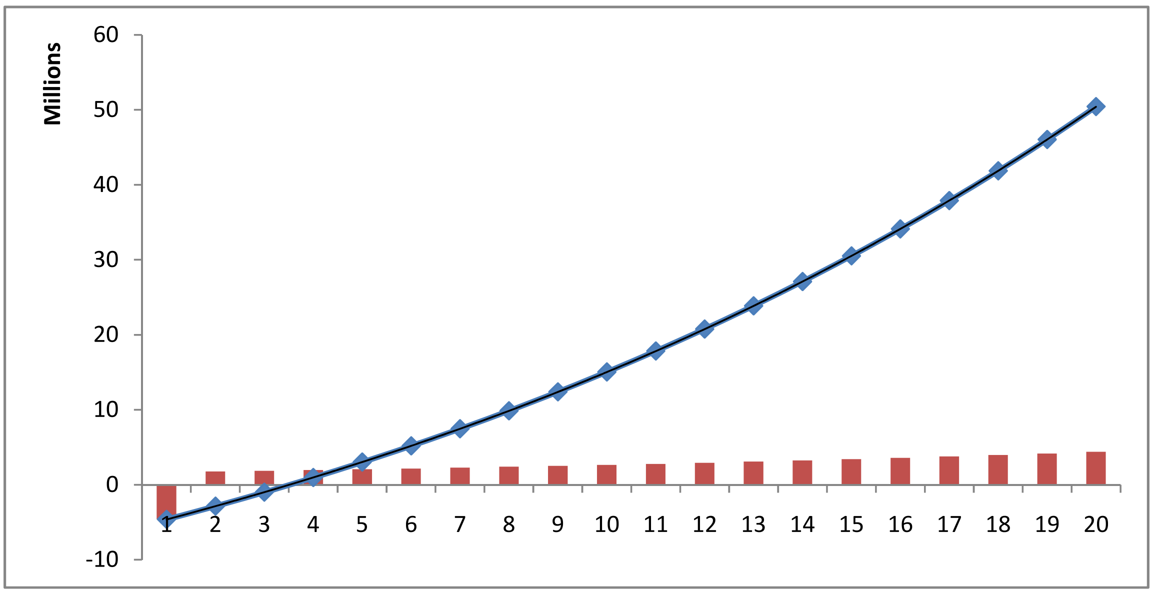
Project Description:

The Society has eight towers, each having eight floors with four flats in each floor. For each tower 4x 1000 lpd systems, each catering eight flats that lie in a straight column are installed. In this configuration piping cost as well as its complexity is minimized. The system has a common distribution pipe of hot water supply for all the eight floors. As common solar water heating system is provided for each tower, consisting of 32 flats, therefore no back up provisions are given instead of that electric geysers are installed in each flat and solar water heating system provides preheated water to the electric geysers. In terms of collectors, 40 flat plate collectors are installed on the roof of each tower having a shade free area of 135 sq meter. The total cost of the system was around 71 lakhs. As per the HUDA analysis, it can provide hot water for 365 days a year, hence its pay-back, without subsidy and depreciation benefits, is 3 years and 4 months, assuming that it's operational and maintenance cost is negligible. Whereas, if we assume a realistic scenario, Two hundred days of usage per year including yearly maintenance cost, capital subsidy & benefits of reducing diesel cost of DG under the current power scenario, its pay-back comes out to be 3.5yrs. The recent guidelines on capital subsidy have made such projects more financially attractive. Under the increased subsidy, payback of similar kind of system is less than 3 years.

Financial Data (Realistic Scenario)	
Capacity	32000 lpd
Life	15 years
Capital Cost	Rs. 71 Lakhs
O&M Cost	2%
Life Cycle Cost	Rs. 1.055 Crores
NPV of Total Cost	Rs. 85 lakhs

MNRE Subsidy	Yes
Type of Subsidy	Capital
Amount of Subsidy	Rs. 8 lakhs
Expected Usage (days per year)	200
Expected Savings	Rs. 18.2 lakhs/annum
Depreciation Benefits	NA
Life Cycle Savings	Rs. 6.1 Crores
NPV of Total Savings	Rs. 3.072 Crores
Simple Payback	3.5 years
IRR	43%
Savings to Investment ratio	9.7

Cash Flow Analysis:



Remarks
The building is yet to be occupied. It would be interesting to see how the system would be used and managed by the residents.

Case Study 6: Chelsea Textile Mills

Project Details	
Location	Chelsea Textile Mills, Sector-3, IMT Manesar, Gurgaon
Company Profile	Denim Washing
Installation Year	2006
Technology	Hybrid Solar Water Heater for Process Heating Application
Solar Contractor	Intersolar
Size of System	50,000 lpd

Technical Summary of Project

Project Objective: To save energy by harnessing solar energy.

Project Description:

The washing of the denim clothes, requires hot water at 55-90°C, for half of the cycle and most of the energy is required for heating the water . Conventionally the water heating requirement is met through a steam boiler running on Furnace oil or Diesel. In order to save energy and reduce operating cost as well as to protect the environment from harmful emissions, Chelsea Textile mills decided to use a hybrid solar water heating system coupled with waste heat recovery to generate hot water for their process application. The system consists of 480 flat plate collectors with soft water in the primary circuit. A 10,000 liters insulated tank with a plate heat exchanger is used to transfer heat from the primary circuit. This solar tank is connected to the main tank of 50,000lts where water heated from solar energy is mixed with water heated by waste recovery system installed on the DG's. This main tank is well insulated and behaves as a consumption tank. For auxiliary heating they use a boiler running on Furnace oil.

The Global recession and tough market conditions led to the plant operating below capacity hence the hot water consumption was not able to reach the earlier projected demand. The SWHS was heating more water than required in the process and hence the excess heat had to be dumped. Even after the wastage they manage to save around 8000 lts of furnace oil per month from the combined (solar + waste heat recovery) system. As per the designed data the payback of the system is around 1.6 years.

Poor Water quality was the major operational problem with the solar system. This led to scaling in the heat exchanger. They also report breaking of few glazing of the collector after sudden cooling and heating.

Design Parameters

- Hot water is required in the washing cycle at 55-90°C. 50% of the total water requirement is for hot water
- 50000 lpd system, flat plate collectors, covers total rooftop area available around 1500 sqm.
- Solar Storage tank: 10,000 lts
- Auxiliary tank: 50,000 lts
- Auxiliary heating: Waste heat recovery from DG, Boiler (FO as well as Diesel), and hot water generators
- Coupling of waste heat recovery with solar energy. The auxiliary tank has level indicator for solar and waste heat recovery water.

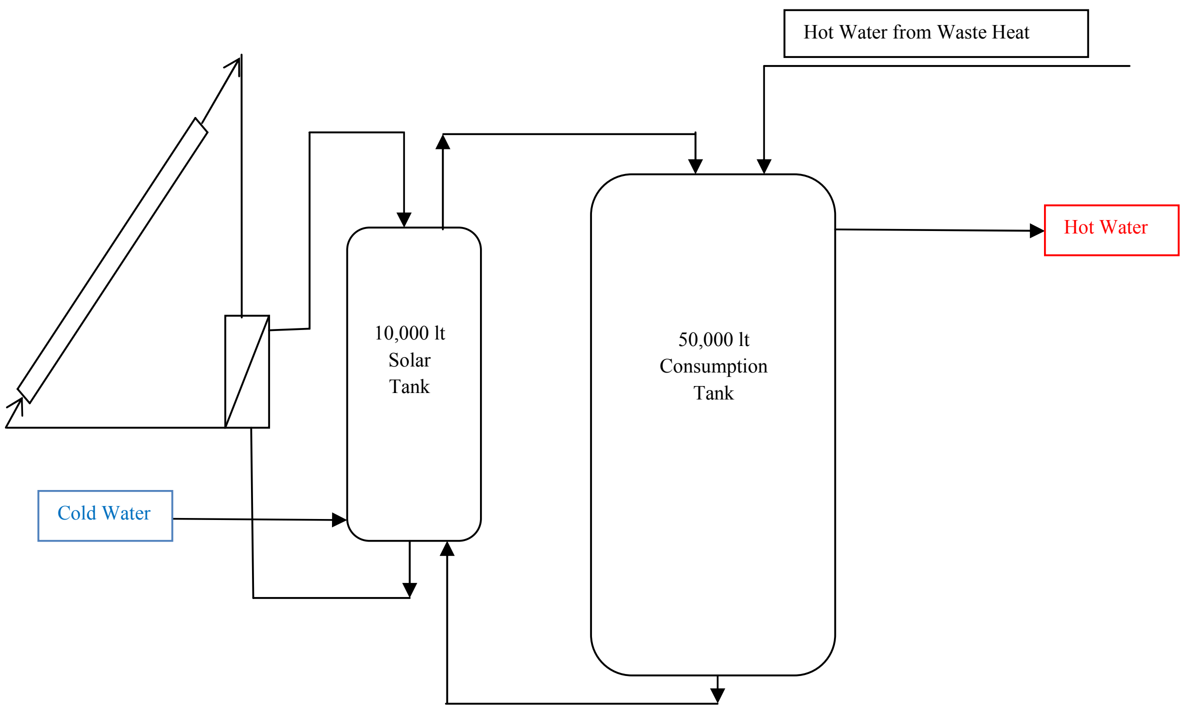
Operation Issues

- *Due to unforeseen circumstances (Global Recession) low processing hence hot water* *requirements are low.Current System hot water capacity is underutilized*

- *Requirements of hot water are lower by as much as 50 % of the estimated demand.*
- *Scaling due to water hardness is the major operational bottleneck. High maintenance cost have to be incurred due to regular de scaling of heat exchangers*
- *Collector Glass breakage is another operational issue. Sudden temperature variations during summer months caused breakages in collector glass which disrupt operations.*

Learning's

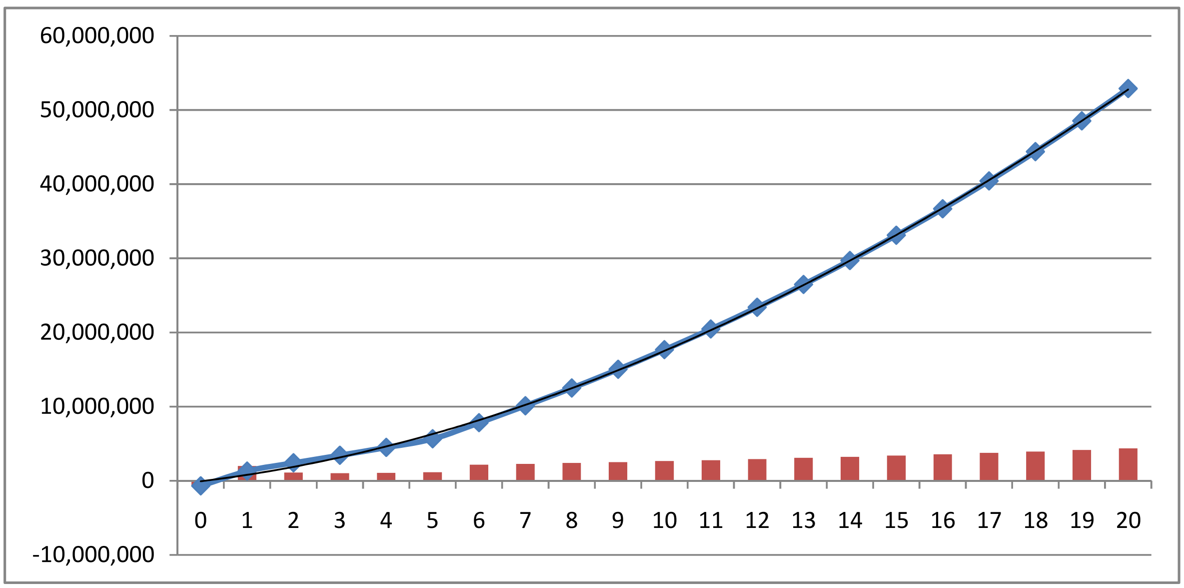
1. System Designers need to optimally size the system keeping in view other locally available low cost energy sources. Hybrid systems which use waste heat recovery from generators or furnaces will not only enhance the reliability of the system but also improve the financial viability.
2. Medium to long term AMC arrangements with Vendors/ Integrators need to be incorporated into all SWHS projects to ensure optimal operations and realization of potential savings.



Financial Data (As per design)	
Capacity	50,000 lpd
Life	20 years
Capital Cost	Rs. 46 lakhs
O&M Cost	Rs. 1 lakh/ annum
Life Cycle Cost	Rs. 74.3 lakhs
NPV of Total Cost	Rs. 59 lakhs

MNRE Subsidy	Yes
Type of Subsidy	Soft Loan @ 5%
Equity from Promoter	15%
Amount of Subsidy	Rs. 9 lakhs
Expected Savings	Rs. 18 lakhs per annum
Depreciation Benefits	Rs. 12 lakh/ Annum
Life Cycle Savings	Rs. 6 crores
NPV of Total Savings	Rs. 2.9 Crores
Simple Payback	5 months
IRR	250%
Savings to Investment ratio	13.1

Cash Flow Analysis:



Remarks
• Hybrid systems of solar can make killer applications. • Designing of hybrid system will play a key role for efficient working of the system. • Hardness of Water is the major problem.

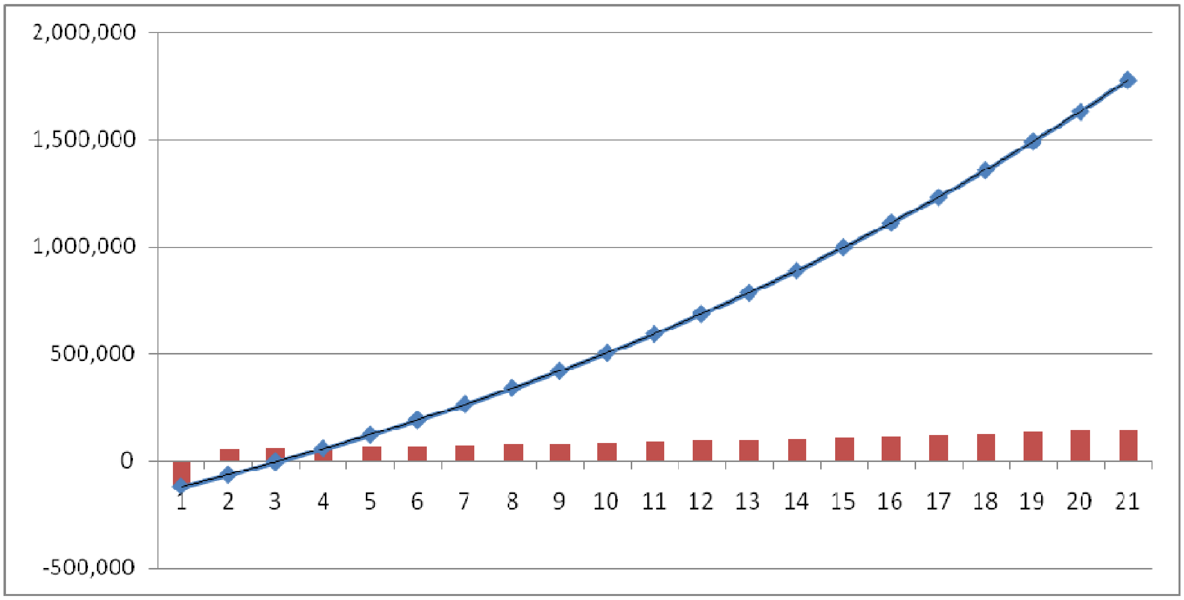
Case Study 7: Guest House, Sector 55

Project Details	
Location	Sector 55, Gurgaon
Type	Guest House
Installation Year	2006
Technology	Solar Water Heating System
Solar Manufacturer	TATA BP Solar

Technical Summary of Project
Project Objective: To save electricity and diesel with the help of SWHS
Project Description: The SWHS was designed to meet the hot water requirements for the entire Guest House. The system consists of 10 flat plate collectors of 2 sqm each with a separate electrical back-up tank to cater the hot water requirements of all the twenty rooms well as kitchen. A simple pressurized system working on thermo-siphon effect operating since 2006. The system is optimally designed and properly installed and all the pipe work is insulated. Performance of system is up to the mark, primarily because of the regular annual maintenance. The SWHS was integrated into the operations since the inception of the guest house hence they did not install any additional room toilet storage electric geysers. No subsidy or grant of any kind was availed by the owners. The primary motivation for the installation was that promoters were familiar with SWHS and its environmental and energy savings potential.

Financial Data	
Capacity	1000 lpd
Life	20 years
Capital Cost	Rs. 2.5 Lakhs
Avoided Capital Cost (business as usual case Electric Room Geysers)	Rs. 6500 X 20 Rooms= Rs. 1.3 lakhs
Net Capital Cost	Rs. 1.2 Lakh
O&M Cost	2%
Life Cycle Cost	Rs. 3.71 lakhs
NPV of Total Cost	Rs. 2.95 lakhs
MNRE Subsidy	No
Type of Subsidy	NA
Amount of Subsidy	NA
Expected Usage (days per year)	250
Expected Savings	Rs. 61000/annum @Rs. 6/kWh
Actual Savings	Not computed
Depreciation Benefits	Accelerated Depretiation not taken
Life Cycle Savings	Rs. 20.18 lakhs
NPV of Total Savings	Rs. 10.65 lakhs
Simple Payback	2 years
IRR	52%

Savings to Investment ratio	8.1
Cash Flow Analysis:	



Remarks/ Learnings
• Maximum Benefits derived in this agreement when projects planned SWHS from Inception. • Proper Installation hence no geysers are required, hence lower capital cost and quicker paybacks. • Pressurized systems have 30% higher costs than the non-pressurized system. • Optimal functioning requires regular maintenance hence AMC must be a part of every transaction. • Subsidies not the main driver in the decision making process. Awareness about the technology and its potential benefits are more important factors.

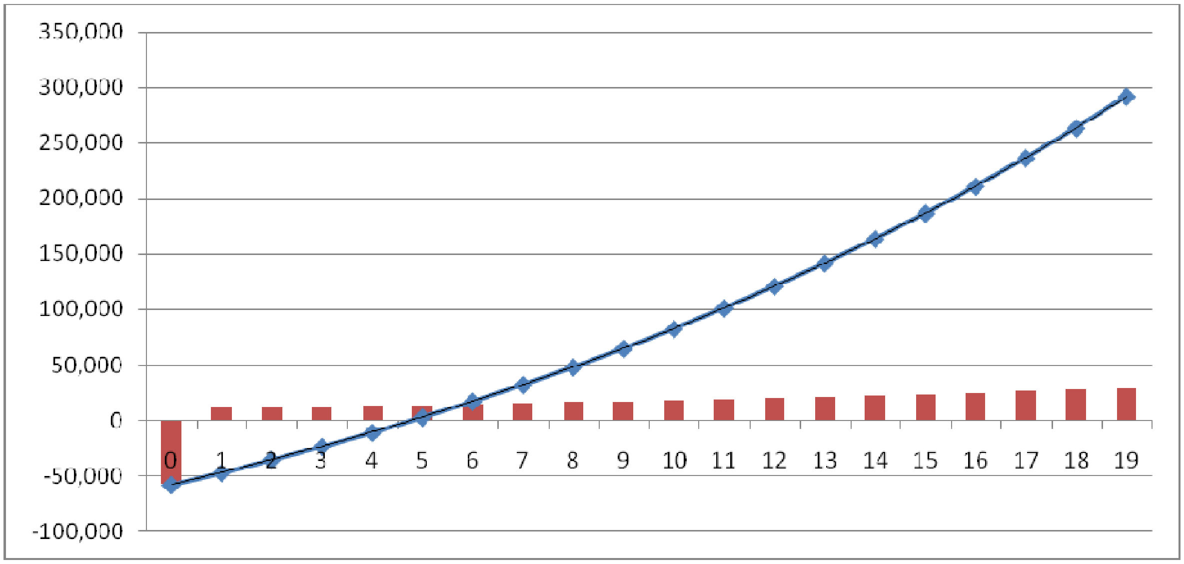
Case Study 8: Individual House, Sector 21

Project Details	
Location	Sector 21, Gurgaon
Type	Individual house
Installation Year	2010
Technology	Solar Water Heating System
Solar Manufacturer	Honeywell Solar solutions

Technical Summary of Project
Project Objective: To reduce the electricity and diesel consumption with the help of SWHS
Project Description: A pressurized ETC system having 6 sq meter aperture area and a solar tank of 300 lts, was installed in March 2010, to provide hot water in 6 bathrooms. Highly modernized system having circulation pump and insulated auxiliary tank of 100 liter having electrical back-up. The system is optimally designed and properly installed and all the pipe work is insulated. The SWHS was integrated into the design of the house hence they did not install any additional room toilet storage electric geysers. Have applied for the capital subsidy. The primary motivation for the installation was that promoters were familiar with SWHS and its environmental and energy savings potential.

Financial Data	
Capacity	300 lpd
Life	20 years
Capital Cost	Rs. 1.15 Lakhs
Avoided Capital Cost (business as usual case Electric Room Geysers)	Rs. 6500 X 6 = Rs. 39000
Net Capital Cost	Rs. 58000
O&M Cost	2%
Life Cycle Cost	Rs. 1.71 lakhs
NPV of Total Cost	Rs. 1.35 lakhs
MNRE Subsidy	Yes
Type of Subsidy	Capital
Amount of Subsidy	Rs. 18000
Expected Usage (days per year)	180
Expected Savings	Rs. 13000/annum @ Rs.6/kWh
Actual Savings	N/A
Depreciation Benefits	N/A
Life Cycle Savings	Rs. 4.36 lakhs
NPV of Total Savings	Rs. 2.57 lakhs
Simple Payback	4.8 years
IRR	24%
Savings to Investment ratio	3.8

Cash Flow Analysis:



Remarks/ Learnings
• Maximum Benefits derived in this agreement when projects planned SWHS from Inception. • Proper Installation hence no individual geysers are required, hence lower capital cost and quicker paybacks. • Pressurized systems have 30% higher costs than the non-pressurized system. • Optimal functioning requires regular maintenance hence AMC must be a part of every transaction. • Subsidies not the main driver in the decision making process. Awareness about the technology and its potential benefits are more important factors.

Case Study 9: Industrial Canteen

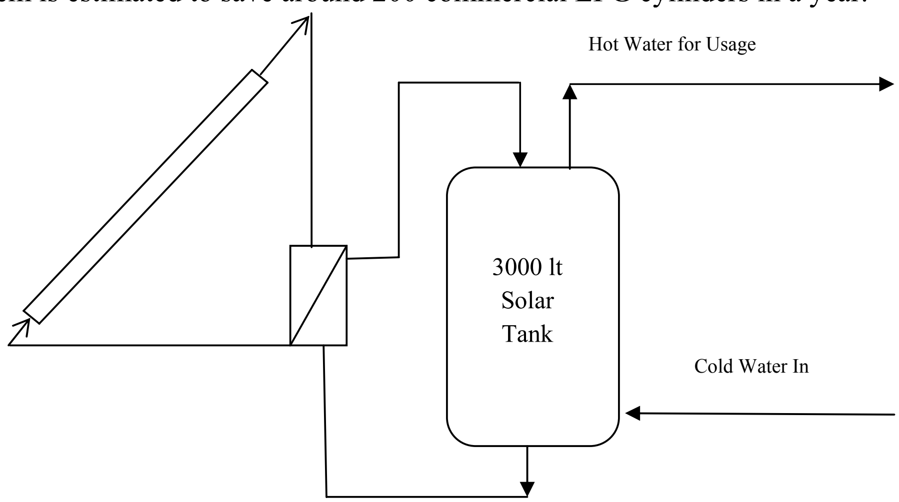
Project Details	
Location	Industrial Canteen, Manesar
Company Profile	Pharmaceutical
Installation Year	2009
Technology	SWH for industrial kitchen
Solar Contractor	Synergy Solar
Size of System	3000 lpd

Technical Summary of Project

Project Objective: To reduce LPG consumption by using solar water heater in canteen

Project Description:

A 3000 lpd ETC based pressurized system used for providing hot water for canteen purposes. The canteen has capacity of 1000 meals per day. A RO system provides soft water which with the help of Plate type heat exchanger gets heated to about 60-70^oC. Six 500 lpd ETC based modules acts as a solar collector and transfers heat to a solar tank at a minimum differential temperature of 5^oC. The solar tank provides hot water in the kitchen directly. No auxiliary heating device is installed. The canteen prepares lunch and dinner for approx 500 peoples. The system is estimated to save around 200 commercial LPG cylinders in a year.

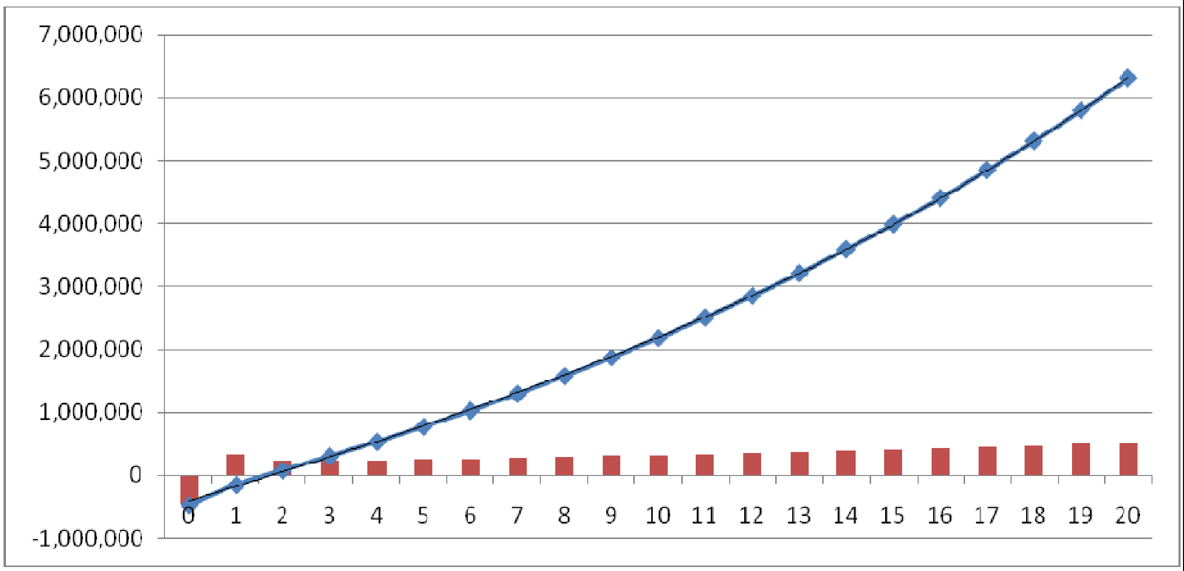


SWH design configuration

Financial Data (As per design)	
Capacity	3000 lpd
Life	20 years
Capital Cost	Rs. 6.5 lakhs
O&M Cost	Rs. 13000/ annum
Life Cycle Cost	Rs. 9.66 lakhs
NPV of Total Cost	Rs. 7.67 lakhs
MNRE Subsidy	Yes
Type of Subsidy	Capital

Amount of Subsidy	Rs. 1.8 lakhs
Expected Savings	3800 kg LPG/ year= Rs. 18 lakhs per annum @ Rs. 55/ kg
Depreciation Benefits	Accelerated depreciation @ 80% For 2 years Rs. 12 lakh
Life Cycle Savings	Rs. 6.94 Lakh
NPV of Total Savings	Rs. 35.5 Lakh
Simple Payback	1.65 years
IRR	57%
Savings to Investment ratio	15.1

Cash Flow Analysis:



Remarks
• One of the best examples for usage of SWH in catering purposes • Hot water is used both for cooking and dish washing purposes

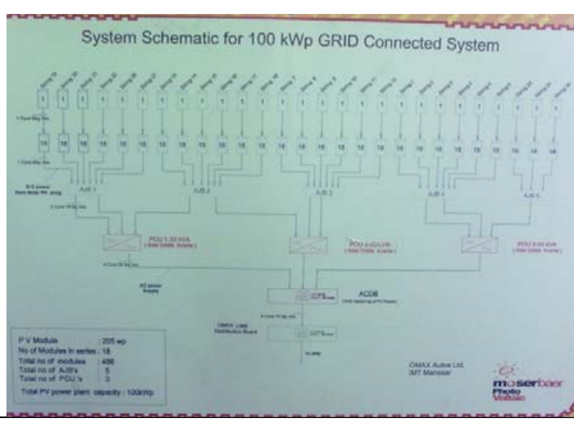
Case Study 10: Omax Autos Limited

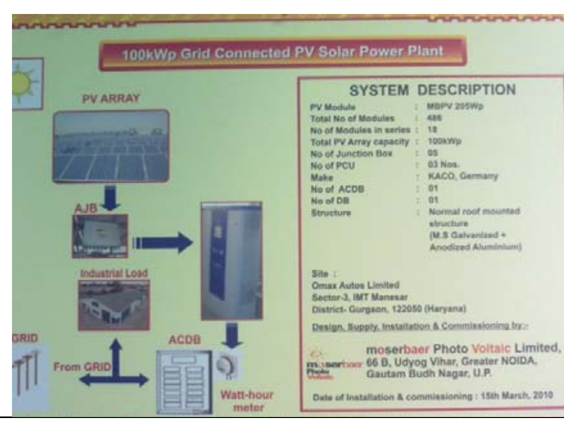
Project Details	
Location	Omax Autos Limited, Sector-3, IMT Manesar, Gurgaon
Company Profile	Omax Autos is one of the largest manufacturers of auto components in Gurgaon-Manesar area. The Manesar facility is equipped with latest range of machineries for metal pressing, welding, painting and sprockets manufacturing. Products manufactured are sheet metal component, frames, tubular welded components, sprockets etc.
Installation Date	20 May, 2010
Technology	Solar Photovoltaic
Solar Contractor	Moserbear PV

Technical Summary of Project

Project Objective:
To reduce the diesel consumption of DG's, used for back-up power, by utilizing the solar energy during day time as much as possible.

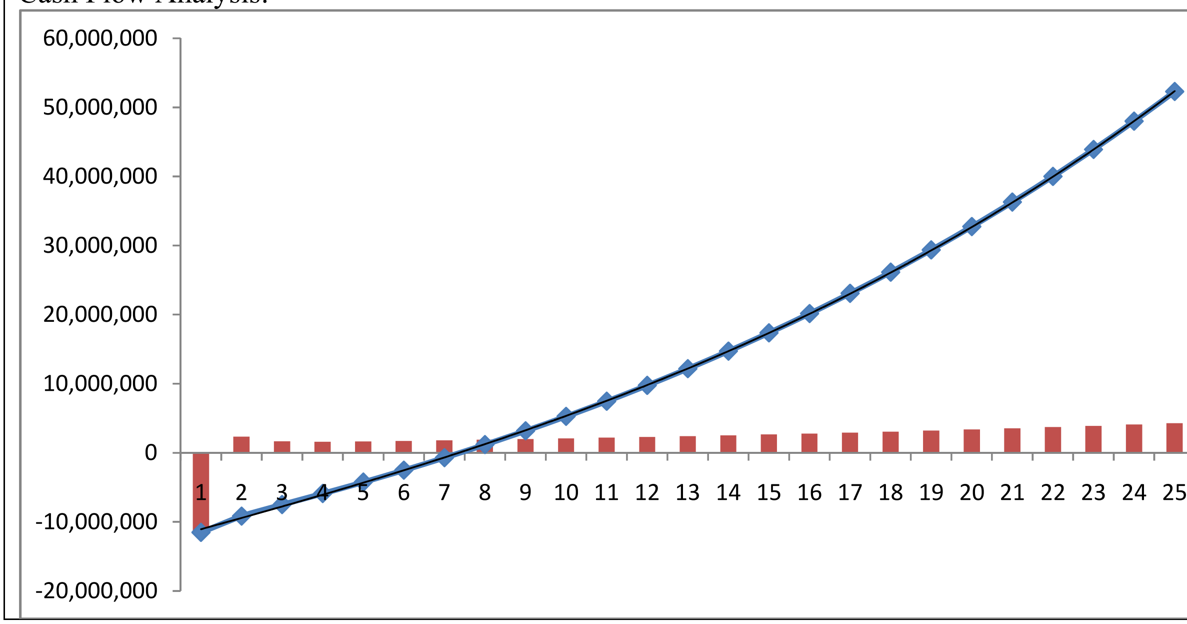
Project Description:
The Manesar facility operates 24 hour a day and has an average load of around 1700 kVA. Due to major power shortage in the Gurgaon-Manesar area, DG back-up of 2500 kVA is provided for the smooth operation of the unit. Average diesel consumption was around 4000 lts/day, creating a massive bill of around Rs. 4.4 lakh per month and emitting 3.5 million kg of CO_2 per annum, became a matter of concern to the management. The management took a decision to start switching to a cleaner power generating technology for reducing the diesel consumption. They chose solar PV technology, as it is the most cleaner way of producing electricity and it takes very less time install the plant. After the placement of order it took only 100 days to install the plant and start producing electricity from it.
As per the available rooftop area, a 100 kWp system consisting of 486 mono-crystalline modules of 205Wp each is installed on the roof which is connected through charge controllers and inverters to integrate with the grid power and DG's with the help of digital controllers to supply electricity to the plant. Controls are designed in a way that provides first priority to the solar energy then to the grid and last to the power from DG's. The estimated electricity production from the solar panels is around 1.5 lakh kWh/year, saving around forty thousand liters per year of diesel. Efforts are being made to integrate batteries with this PV plant, which can provide the peak load, so that one of the DG set of 250 kVA capacity can be eliminated. Total roof top area covered by PV modules is around 2000 m^2. A schematic description of the Solar PV plant is given below.





Financial Data	
Capacity	100kWp
Life	25 years
Capital Cost	Rs. 2.5 Crores
O&M Cost	Rs. 1.25 lakh/year, Escalating rate 5.75%
Total Cost	Rs. 3.16 Crores
NPV of Total Cost	Rs. 2.62 Crores
MNRE Subsidy	Yes
Type of Subsidy	Capital Subsidy
Amount of Subsidy	Rs. 75 lakhs (Rs. 75/Wp)
Expected Savings	Rs. 15 lakhs/annum (40,000 lts diesel/year @ Rs.37/liter, Escalation rate 7%)
Depreciation Benefits	Rs. 57.75 lakh
Total Savings	Rs. 8.39 Crores
NPV of Total Savings	Rs. 4.18 Crores
Simple Payback	7.5 years
IRR	17%
Savings to Investment ratio	4.8

Cash Flow Analysis:



Remarks
Although the power generated is quite expensive but if we take in to consideration the social and environmental benefits involved with the technology it is a sensible decision to switch to solar power.

Case Study 11: Institute of Rural Research & Development (IRRAD)

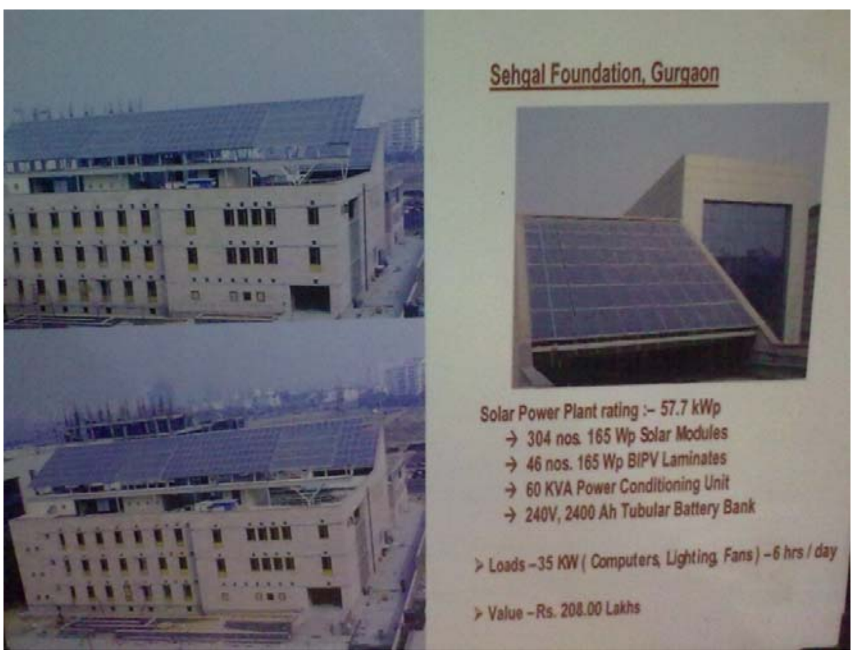
Project Details	
Location	Institute of Rural Research & Development (IRRAD), Gurgaon
Installation Date	2005
Technology	Solar Photovoltaic
Solar Contractor	TATA BP Solar

Technical Summary of Project

Project Objective: To self sufficient for essential electricity for computers, essential lighting and ceiling fans

Project Description:

To become self sufficient in power IRRAD has installed a 60.39 kWp solar PV system on the roof of the building. Modules are planted on roof as well as on the south facing wall inclined at 30 degree. IRRAD is an office building generally operated in the day time and has a certification of a green building by IGBC. Due to good design of the building the energy requirement is much less than the conventional office building. The system was designed to take the day time load lighting, fans and equipments estimated to be around 35 kW but due to the reasons stated above the load is much less and most of the energy generated is wasted. No subsidy or any other kind of benefit was availed hence the net cost of the system is very large. The design of the solar system is conventional, modules are connected to batteries with the help of charge controller and load is connected through batteries via inverter. The system has a huge battery bank (3 autonomous days) and an inverter of 60 kVA.

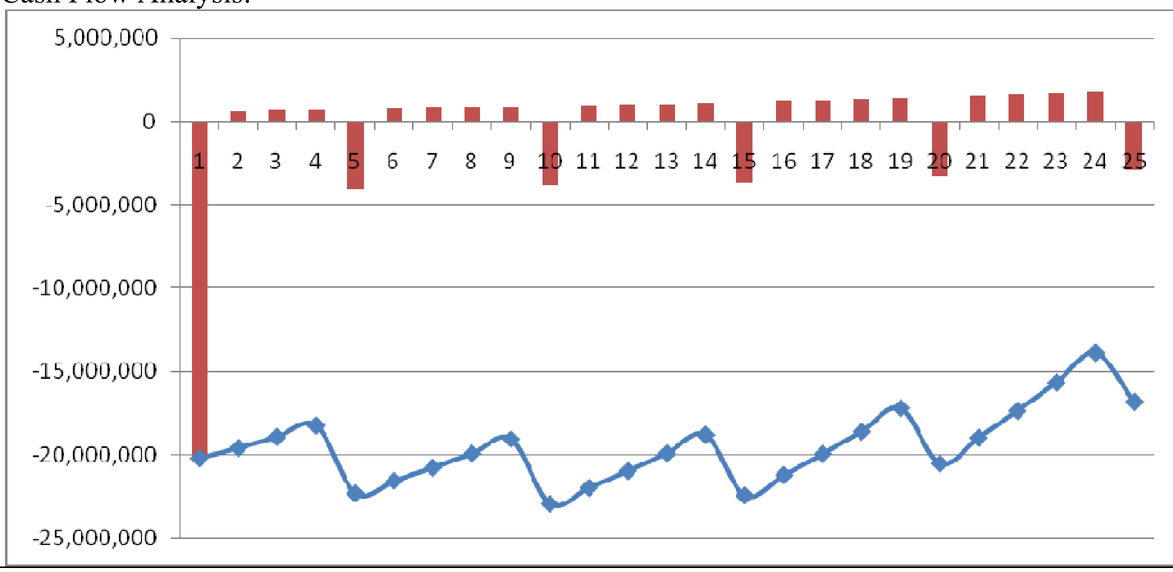


Solar system configuration of IRRAD

Financial Data	
Capacity	60.39kWp
Connected Load	35 kW

Life	25 years
Capital Cost	Rs. 2.08 Crores
O&M Cost	Rs. 1.0 lakh/year, Escalating rate 5.75%
Recurring Cost (Batteries)	Rs. 48 lakhs/5 yrs
Total Cost	Rs. 5.1 Crores
NPV of Total Cost	Rs. 3.23Crores
MNRE Subsidy	No
Expected Savings	Rs. 7.15 lakhs/annum
Depreciation Benefits	No
Total Savings	Rs. 3.14 Crores
NPV of Total Savings	Rs. 1.42 Crores
Simple Payback	Out of reach
IRR	-
Savings to Investment ratio	1.6

Cash Flow Analysis:



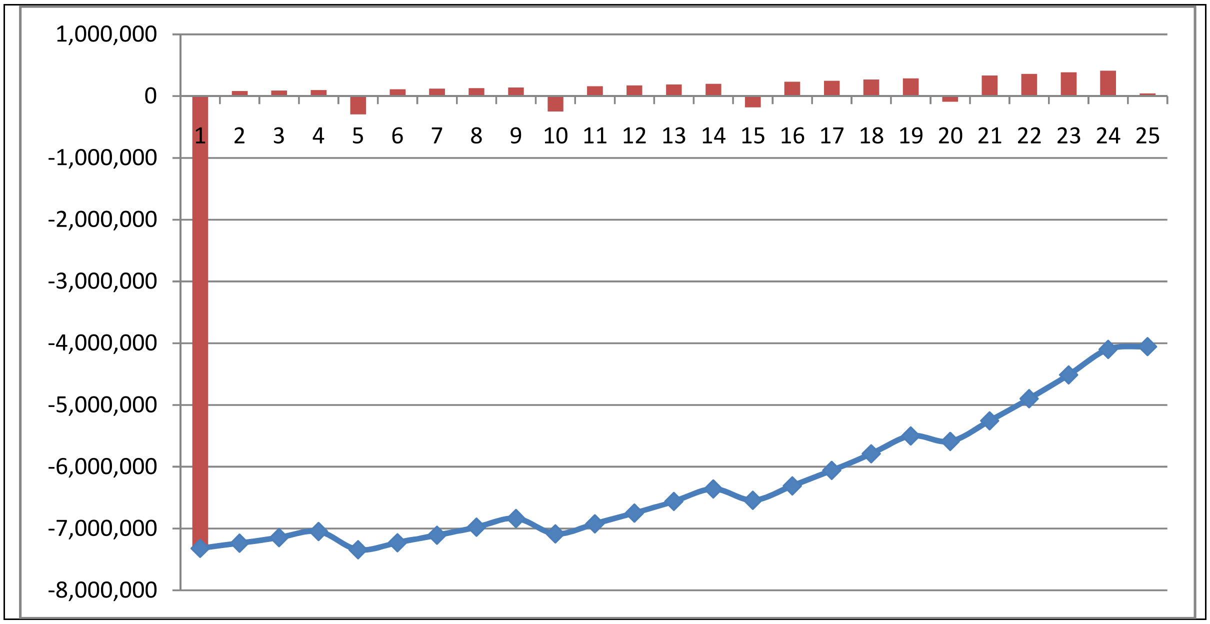
Remarks/Learnings
• Huge wastage due to over-designing of the system • 3 day autonomous battery bank capacity is not required as office building is operated only during the day time. • Key to design is to reduce battery bank as much as possible.

Case Study 12: TERI RETREAT, Gurgaon

Project Details	
Location	RETREAT: Resource Efficient TERI Retreat for Environmental Awareness and Training
Installation Date	1998
Technology	Solar Photovoltaic
Solar Contractor	TATA BP Solar

Technical Summary of Project
Project Objective: To use solar PV system in hybrid with biomass gasifier for generating essential electricity required for operating the complex
Project Description: To become self sufficient in power RETREAT has installed a 10.7 kWp solar PV system on the roof of the building. Modules are planted on roof as well as on the south facing wall inclined at 30 degree. RETREAT is a training complex having hostels for the trainees. Due to good design of the building the energy requirement is much less than the conventional. The system was designed to supplement the Gasifier during the day time load and provide electricity during the night time. Building management system is used to integrate the solar PV system with the Gasifier with a help of 36 kVA bidirectional inverter, which provides electricity to the building and the battery bank. The total battery bank is of 900 Ah and 240 V. The system can provide approx 55 kWh/ day on a usual sunny day. The power generated through solar replaces the gasifier electricity costing approx Rs. 7 per kWh

Financial Data	
Capacity	10.7kWp
Life	25 years
Capital Cost	Rs. 74 Lakh
O&M Cost	Rs. 40000/year, Escalating rate 5.75%
Recurring Cost (Batteries)	Rs. 4 lakhs/5 yrs
Total Cost	Rs. 1.14 Crores
NPV of Total Cost	Rs. 86 Lakh
MNRE Subsidy	No
Expected Savings	Rs. 1.15 lakhs/annum
Depreciation Benefits	No
Total Savings	Rs. 73 Lakh
NPV of Total Savings	Rs. 28.7 lakh
Simple Payback	Out of reach
IRR	-10%
Savings to Investment ratio	1.0
Cash Flow Analysis:	



Remarks/Learnings
• Solar PV system only becomes financially viable when it is used to substitute power from expensive sources like Diesel Generator.

ANNEXURE II: MODEL PRELIMINARY REPORT (MPR)

MPR 1: Dudhmansagar Dairy

Project Details	
Location	Dudhmansagar Dairy, Sector 3, Manesar
Company Profile	Amul's first venture in North India "Doodhmansagar Dairy' Manesar Gurgaon unit mainly carries out the activities of processing (pasteurization, clarification and homogenization), packing, cold storage and distribution of cow milk and toned milk in the NCR market. Recently some new value added milk products such as Ice Cream, curd, butter milk, flavored milk, ghee, etc. are added in manufacturing range and quite a sizeable quantities of these products are manufactured and marketed.
Technology	Solar Thermal & Waste Heat Recovery Application
Application	PASTEURIZATION.

Technical Summary of Project

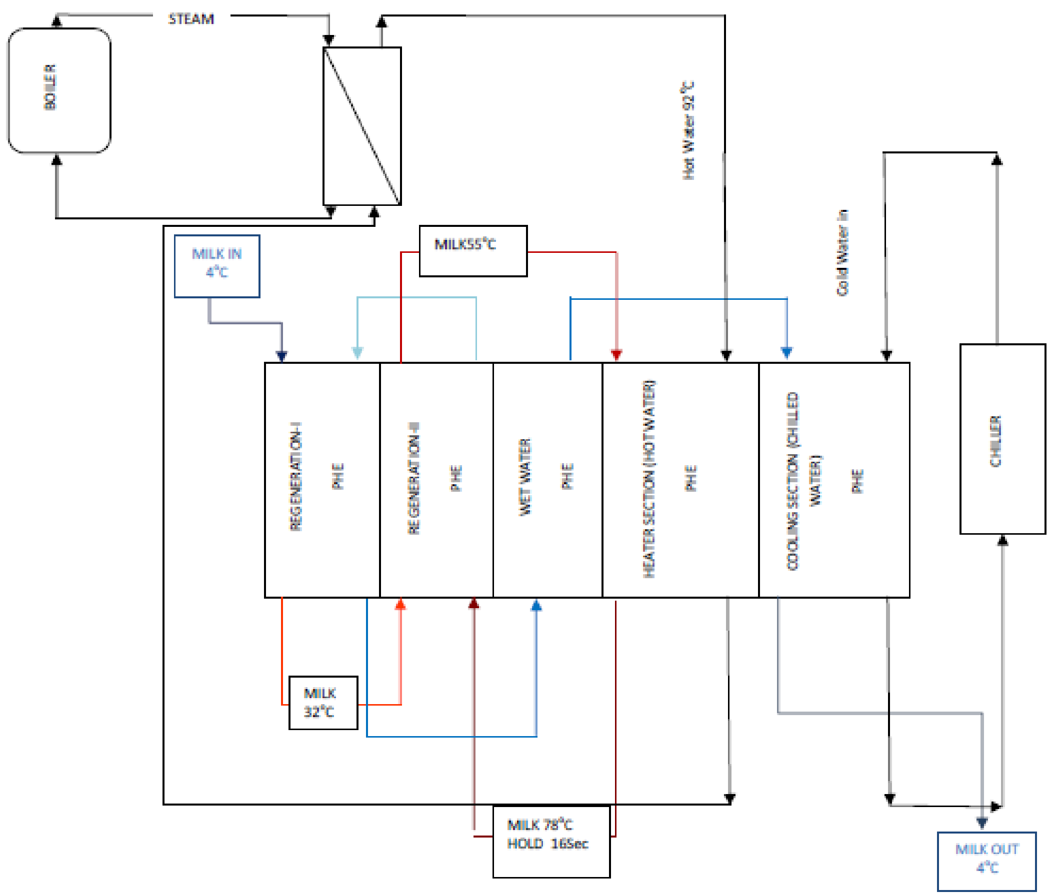
Objective:
Hybrid of Solar water heater with Waste heat recovery unit for generating hot water for dairy application

Project Description:

<u>*Introduction*</u>:
Daily production capacity in terms of milk, dahi & ice-cream are one million liter, twenty five thousand kg & twenty five thousand liter respectively. Dairy Industry consumes large amount of energy for milk processing. Pasteurization, clarification & homogenization require thermal energy, whereas cooling of milk after pasteurization, packaging and storage requires electrical energy.
As an energy conservation measure, the feasibility of using a hybrid system of solar water heater and waste heat recovery unit on DG's for producing the thermal energy required for *pasteurization* of the milk is studied.

<u>*Current Technology & DG Capacity*</u>:
In the pasteurization process milk heated from 4^{o}C to 78^{o}C, where it is to be held for 16 sec, to destroy all harmful bacteria, and again cooled to 4^{o}C. To reduce the wastage of energy, heat regeneration cycles are used where the heat gained during cooling of the heated pasteurized milk is used to pre-heat the raw milk to around 55^{o}C. After pre-heating, hot water generated using a furnace oil based steam boiler is used to provide heating from 55^{o}C to 78^{o}C.

Parameters	
Furnace oil consumption	3000 kg/day (approx)
Make-up water boiler	36000 lt/day
Efficiency of the boiler	85%
Efficiency of the Steam-Water Heat Exchanger	95%
Efficiency of the Water- Milk Heat Exchanger	92%
Overall Efficiency	74%
Total heating energy required	31 kcal/lt of milk
DG Capacity	1500 kVA x 1 + 750kVA x 2 =3000kVA



Sizing Techniques:

The strategy used for determining the size of the solar water heating system is as follows

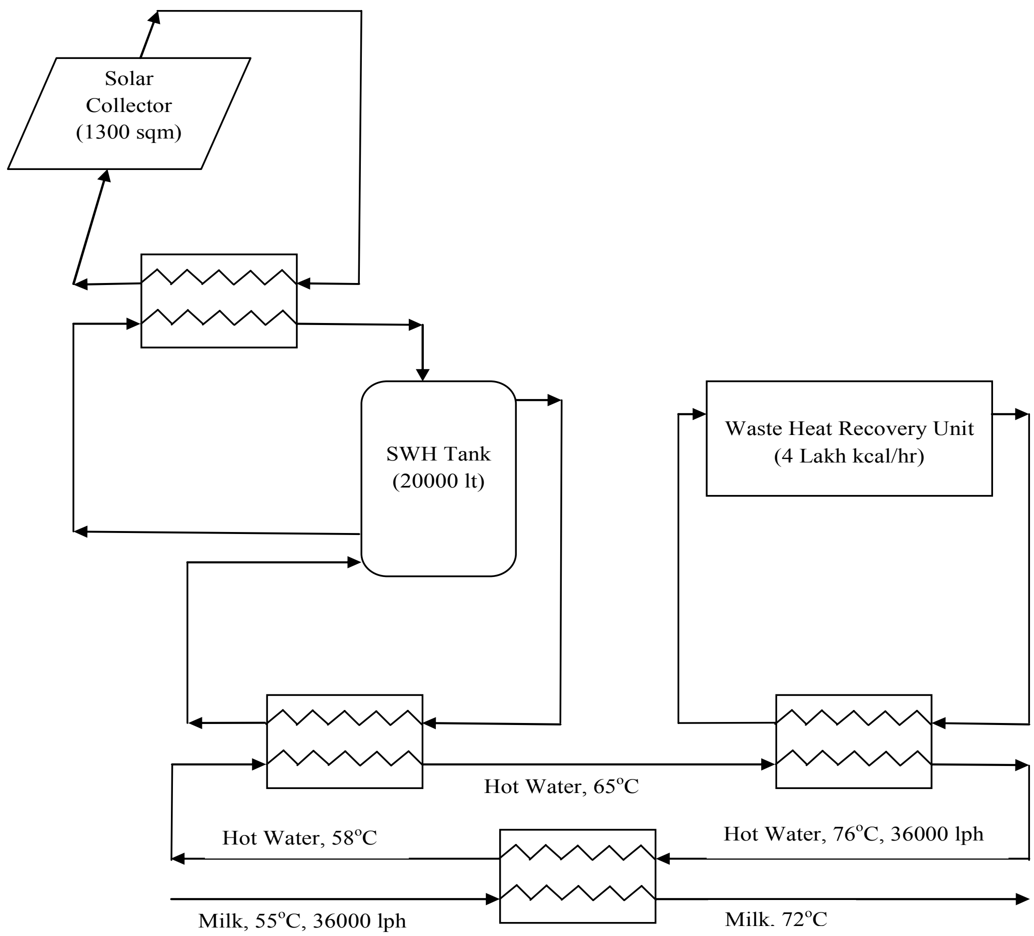
- Solar energy should be used only in the day time as storage of energy is accompanied by losses.
- Storage should be as little as possible.
- System should be designed for the 100% performance in the month of March, so that no wastage of energy takes place. If the system is sized to give 100% performance round the year it may end up wasting lots of energy in the good solar radiation months like March & April.
- The aim of the solar water heating system is to provide first 7°C rise i.e. 55-62°C during the day time from the solar energy.
- WHRU is designed in such a fashion that it can derive heat from any of the DG set using a flue gas diverter. The average usage of the back-up system is for 12 hrs a day for a 1500 kVA DG capacity which leads to the output of 4 lakh kcal/hr from the WHRU.
- The waste heat recovery unit can provide the next 10°C i.e. 62-72°C rise to the milk, the rest of the heat can be provided through conventional heating system.

Estimated Size and layout of the SWH & WHRU system:

The sizing of the Solar water heating system was done with the use of RETScreen software, which takes in to account the ambient temperatures and solar radiations of the site, hot water usage pattern etc. The results of the simulation are stated below:

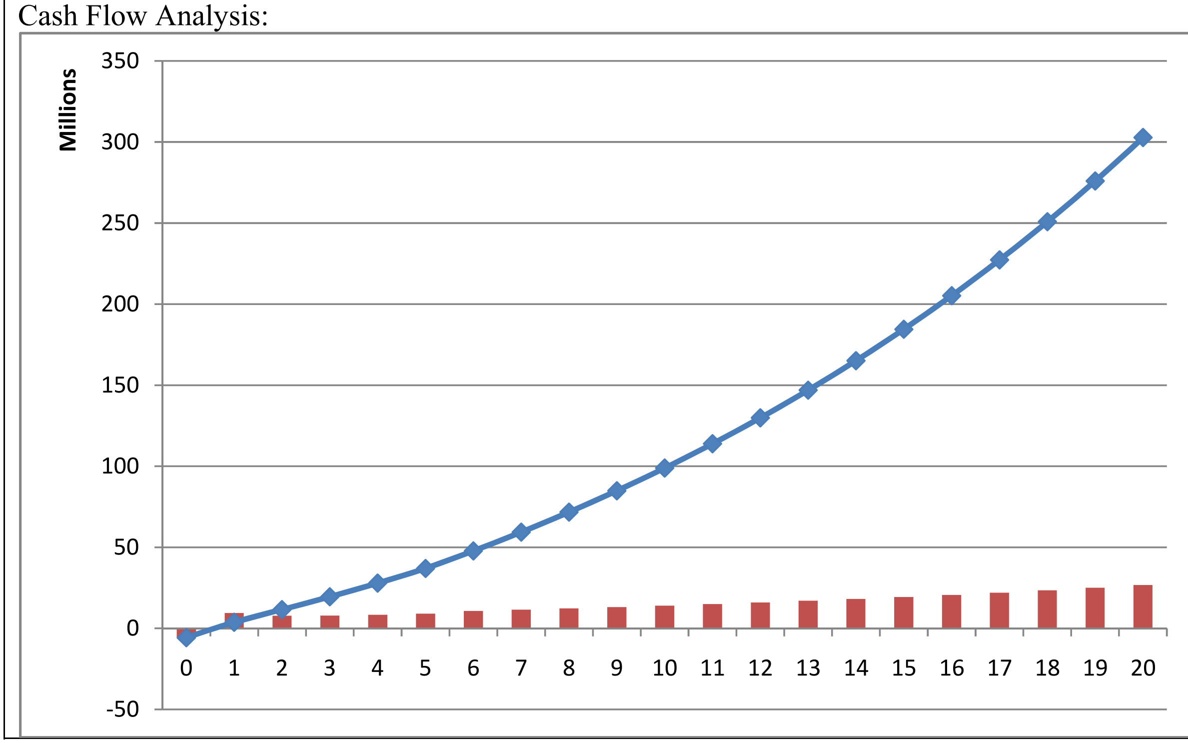
Results	
Collector Type	Evacuated Tubes
Total Collector Area	1300 sqm
Insulated Solar Tank	20000 liters
Total Heating delivered	650 MWh/Annum

The size of the catchments surface for the Dairy complex has been calculated approximately, given that the exact characteristics of the panel model eventually chosen will directly condition the calculations. For the dairy *complex* installation the figure is *1300 sq m* of catchment surface, approximately 500 manifolds. These will be fitted on metal structures secured to the roof, making use of their inclination (30^{o}), facing towards south direction. The extra load on the roof will be no more than 35 kg/sq m. The solar accumulation will be 20000 *litres*, and will act as a solar tank for providing process heat. The layout of the system is shown



Financial Data	
Capacity of SWH (Sqm)	1300 sqm
Life	20 years
Capital Cost (SWH)	Rs. 1.1 Crores (approx)
O&M Cost	2% per annum
MNRE Subsidy	Yes
Type of Subsidy	Capital + Interest Subsidy on Balance of systems (Soft loan @5% for 5 years)
Amount of Subsidy	Rs. 39 lakhs (Capital)
Capacity of WHRU	4 lakh kcal/hr
Life	15 years
WHRU usage	12 hrs/day
Capital Cost (WHRU)	Rs. 36 lakh (Approx)
O&M Cost (WHRU)	2% per annum
Net Equity (SWH+WHRU)	Rs. 58 lakhs (approx)
Soft Loan Amount @ 5%	Rs. 49 lakh (approx)
Depreciation Benefits	Accelerated depreciation @ 80% Rs. 34 lakhs (in 2 years)
Expected Savings	820 kg Furnace Oil/day (Average)
Savings	Rs. 80 lakhs/annum (As per current furnace oil price i.e. Rs. 27per kg
Loan Amortization	Rs. 11.32 Lakhs/annum
Simple Payback	7 Months (approx)
NPV	Rs. 14.8 Crores
IRR	150%
Saving to Investment ratio	41

Cash Flow Analysis:



MPR 2: Omax Industries

Project Details	
Location	Omax Industries, Sradhavalli Village, Manesar
Company Profile	
Technology	Solar Thermal Application

Technical Summary of Project

Objective:
Solar water heater for generating hot water for industrial application (electroplating) in an Automobile industry

Project Description:

Introduction:
Omax Autos Ltd, the wholly owned subsidiary of Omax Group. Omax is one of the biggest producers of auto components in the Gurgaon-Manesar industrial area and an OEM to all the major auto brands of India. They have two manufacturing units in the Gurgaon region.

One of the main operations carried out in the Auto-component industries is electroplating. Sradhavalli village is the centre for Omaxe's electroplating operations. The daily electroplated area from the Sradhavalli unit is around 110000 dcm sq. Electroplating consumes large amount of energy in the form of heat and electricity. Thermal energy comprises of more than 70% of the total energy required for the process, also the heat required is at low temperature levels i.e. 50-85^{o}C.
As an energy conservation measure, Omax is examining the feasibility of using a solar water heating system for producing the thermal energy required for *electroplating* process. This requirement is studied under the current project.

Current Technology:
The conventional manner of heating electroplating baths is by means of electric resistance heating or steam baths. In Omax plant steam is used to maintain the temperatures of the electroplating baths, which in turn is produced with the help of a boiler running on Furnace oil.

Parameters	
Furnace oil consumption (Electroplating)	800 kg/day (approx)
Make-up water boiler	15000 lt/day
Efficiency of the boiler	80%
Efficiency of the Heat Exchanger in the baths	90%
Overall Efficiency	72%
Total heating energy required	70 kcal/decimeter sq
Net heating delivered	50 kcal/decimeter sq

SWH Sizing Techniques:

The strategy used for determining the size of the solar water heating system is as follows

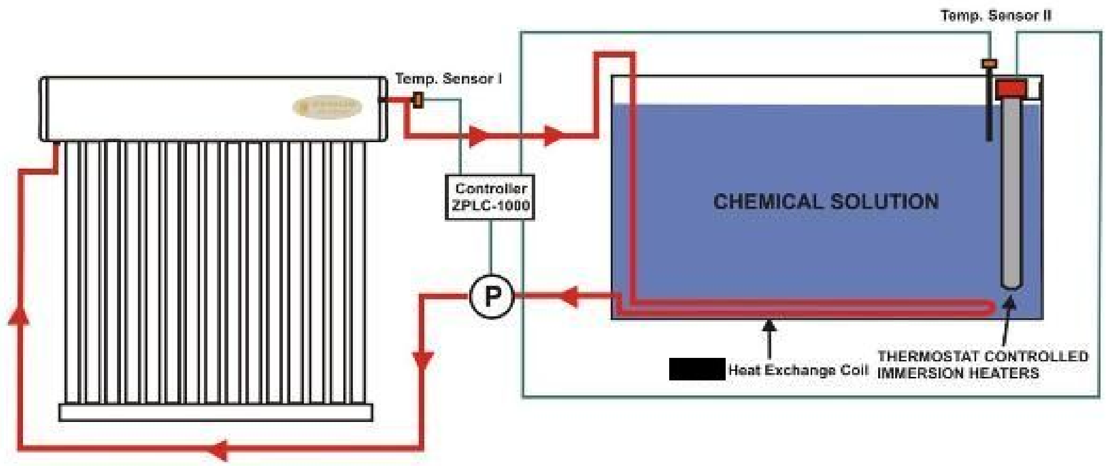
- Solar energy for heating should be used only in the day time as storage of energy over a long period of time leads to heat losses. For the efficient functioning of the operations,
  the energy should be consumed as it is produced so storage designs should just adequate for emergency situations.
- System should be designed for the 100% performance in the month of March, so that no wastage of energy takes place. If the system is sized to give 100% performance round the year it may end up wasting lots of energy in the good solar radiation months like April to July.
- The aim of the solar water heating system is to provide process heat to the baths enabling the temperature to be maintained up to 70^{o}C
- Baths maintained above 70^{o}C cannot be efficiently given heat from Solar water heating system as the efficiency of current SWHS technology declines when the water is be heated aver 40 degrees from ambient i.e. Delta T > 40 ^{o}C
- The solar water heating system will also provide pre-heated make-up water to the boiler during the day time.

Estimated Size and layout of the SWH system:

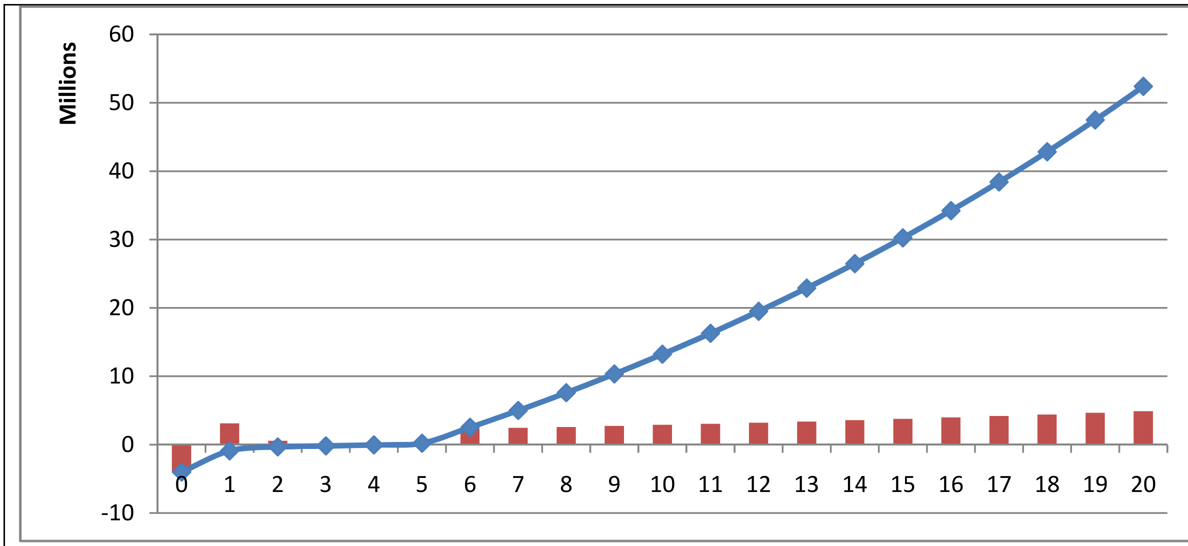
The sizing of the Solar water heating system was done with the use of RETScreen software, which takes in to account the ambient temperatures and solar radiations of the site, hot water usage pattern etc. The results of the simulation are stated below:

Results	
Collector Type	Evacuated Tubes
Total Collector Area	2500 sqm
Insulated Solar Tank	25000 liters
Total Heating delivered	674 MWh/Annum
Furnace Oil Savings	220 kg/day (approx)
Reduction in Boiler Load	13%

The size of the catchment surface for the Electroplating complex has been calculated approximately, given that the exact characteristics of the panel model eventually chosen will directly condition the calculations. For the electroplating process installation the figure is 25*00 sq m* of catchment surface, approximately 300 manifolds. These will be fitted on metal structures secured to the roof, making use of their inclination (30^{o}), facing towards south direction. The extra load on the roof will be no more than 35 kg/sq m. The solar accumulation will be 10000 *liter*, and will act as a thermal store water.



Financial Data	
Capacity (Sqm)	2500 sqm
Life	20 years
Capital Cost	Rs. 2 Crores (approx)
O&M Cost	2% per annum
MNRE Subsidy	Yes
Type of Subsidy	Capital + Interest Subsidy on Balance of systems (Soft loan @5% for 5 years)
Amount of Subsidy	Rs. 75 Lakhs (Capital)
Expected Savings	220 kg furnace oil per day
Depreciation Income TAX Benefits	Accelerated depreciation @ 80% Rs. 40 lakhs (in 2 years)
Equity	Rs. 40 lakhs (approx)
Soft Loan Amount @ 5%	Rs. 85 lakhs (approx)
Savings	Rs. 22 lakhs/annum (As per current furnace oil price i.e. Rs. 27per kg)
Loan Amortization	Rs. 19.6 Lakhs/annum
Simple Payback	4 years
NPV	Rs. 2.6 Crores
IRR	39%
Saving to Investment ratio	5.5
Cash Flow Analysis:	



All the equity invested in the project in 2 yrs time, will be gained back through the savings and other benefits. After 2 years savings can take care of the rest of the annuity to be paid to the bank till the 5th year. After 5th year Savings can be realized in the balance sheet also.

MPR 3: Group Housing Society

Project Details	
Location	Gurgaon
Type	Group Housing Society
Technology	Solar Thermal & Solar PV Application
Technical Summary of Project	

Objective:
Solar PV system in a group housing society for reducing the diesel consumption by the DG's used to generate back-up power during the day time.

Project Description:

Introduction:
Residential sector in Gurgaon consists of large number of Group housing societies, ranging from medium to premium high end price range. In the luxurious group housing societies, most of the residential units have a connected load of 8-10 kW and are full backed up with DG sets because of frequent power outages. The back-up system (Diesel Generators) are sized according to peak load i.e. connected load. Most of the power cuts in Gurgaon are during the day-time and in daytime hours. Group housing societies have a very low electrical load because most of the residents are working professionals who are away at office. At these times the DG of the size equivalent to the connected load is used for back-up . This is a very expensive and inefficient use of power and it leads to diesel wastage and higher wear and tear on the generator sets. In the current project feasibility of using Solar PV system to provide power back-up during the day time power outage, is studied.

Current Technology:
For the purpose of the feasibility study, a Group housing society was chosen and all the data required for the study was gathered from this society. The general information about the society is provided in the table below

General Information	
No. of Apartments	373
Total No. of Residents	2000 (approx)
No. of transformers	4
Total No. of DG's	4
Total No. of kWh required	40 lakhs kWh/annum (approx)
Total No. of kWh provided by DG's	3.5 lakhs kWh/annum (approx)
Total Installed DG Capacity	2X1000 kVA + 2X 625 kVA= 3250 kVA
Day-time load	1000-1200 kVA
Part Load on DG's during day-time	35%-40%
Diesel consumption	150,000 l/annum (approx)

Presently, the group housing society has 4 DG's for 4 transformers. Each DG serves for a specific portion of the society for each transformer. The two 1000 kVA DG's are connected to higher loads as compared to the two 625 kVA ones. While the management of the DG's is easy in this configuration as compared to the centralized system, the inefficiency related to the DG's is much larger as even for a load of say 1000 kW all the four DG's will be used.

Sizing Techniques:

Sizing of Solar PV System

- Strategy for sizing of Solar PV system was to take care of the day-time load during the power cut through solar energy with an aim to eliminate the DG during the daytime.
- The first strategy is to make a centralized system of the grid as well as DG supply for the whole of the society. DG's should run on at least 85% load. Therefore during the day time instead of using 4 DG's, one 1000 kVA DG can take care of around 850 kW load while the rest of 250-300 kW can be catered through solar PV system.
- A 200 kWp solar PV system with a minimal battery bank can be used to provide a 250 kW load during the power cut time
- Battery bank was sized, so as to provide the difference between the required power and the power received from solar.
- During the day time power cut

Load	Back-up System
Up to 250 kW load	Solar
250 kW< load< 780 kW	Solar + 625 kVA DG
780 kW< load< 1100 kW	Solar + 1000 kVA DG

- When the grid electricity will be available during the day-time, solar energy will first charge the batteries and after charging is done, solar power will be used in combination with grid electricity, so that maximum possible savings can be achieved.

Estimated Size and design of the Solar PV system:

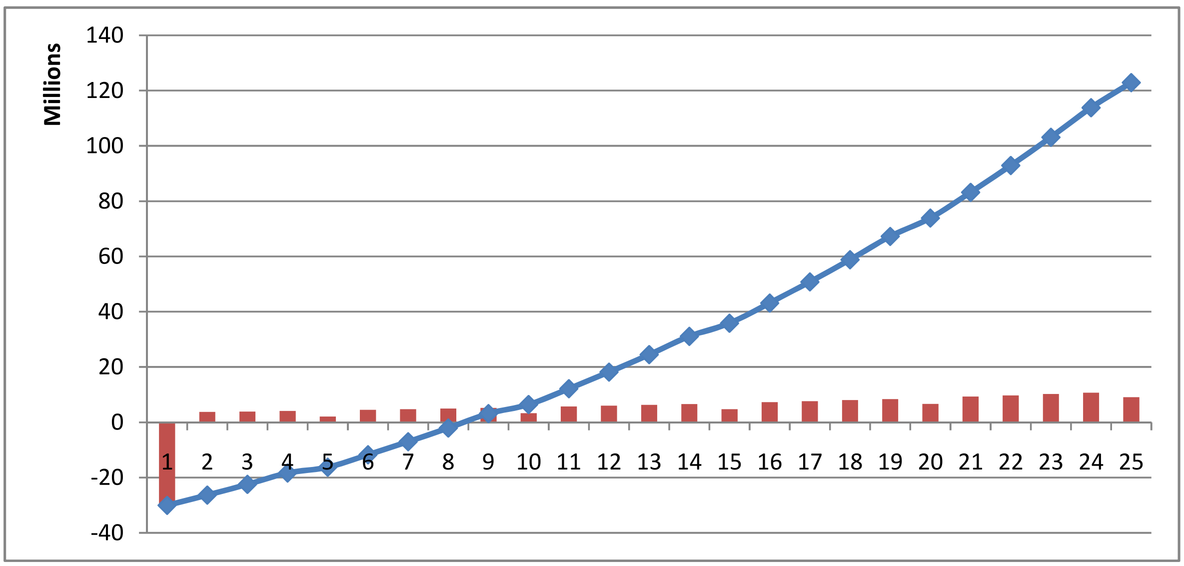
The sizing of the Solar PV system was done with help of SAM software, which takes in to account the ambient temperatures and solar radiations of the site, power usage pattern etc. The results of the simulation are stated below:

Result Solar PV System	
PV System Capacity	200 kWp
Inverter	300 kVA
Day time back up requirement	2.5 hrs (Approx)
Battery Bank	110 Nos X 2400 Ah X 2 V
Diesel Saved	91000 lts/ Annum
Grid electricity saved	100000 kWh/ annum

The size of the PV system for the typical Group housing has been calculated, given that the exact characteristics of the panel model eventually chosen will directly condition the calculations. For the Group housing having similar loads as mentioned above, the figure is *200 kWp* PV panel, integrated with minimal battery bank and properly sized inverter as the day time load. These panels will be fitted on metal structures secured to the roof, making use of their inclination (30^o), facing towards south direction.

Financial Data (SPV)	
Capacity (PV System)	200 kWp
Life	25 years
Inverter Capacity	300 kVA
Battery bank	530 kWh
Capital Cost	Rs. 5.76 Crores (approx)
Recurring Cost	Rs. 21.88 lakhs per 5 years
MNRE Subsidy	Yes
Type of Subsidy	Capital
Amount of Subsidy	Rs. 2.4 Crores
Expected Savings	91000 lt diesel/yr + 100000 kWh/yr
Depreciation Benefits	No
Savings	Rs. 3.9 Crores/annum (As per current price diesel @ Rs. 37/lt & Electricity @ Rs. 4.5/unit)
Simple Payback	8.4 years
NPV	Rs. 3.37 Crores
IRR	15 %
Saving to Investment ratio	6.2

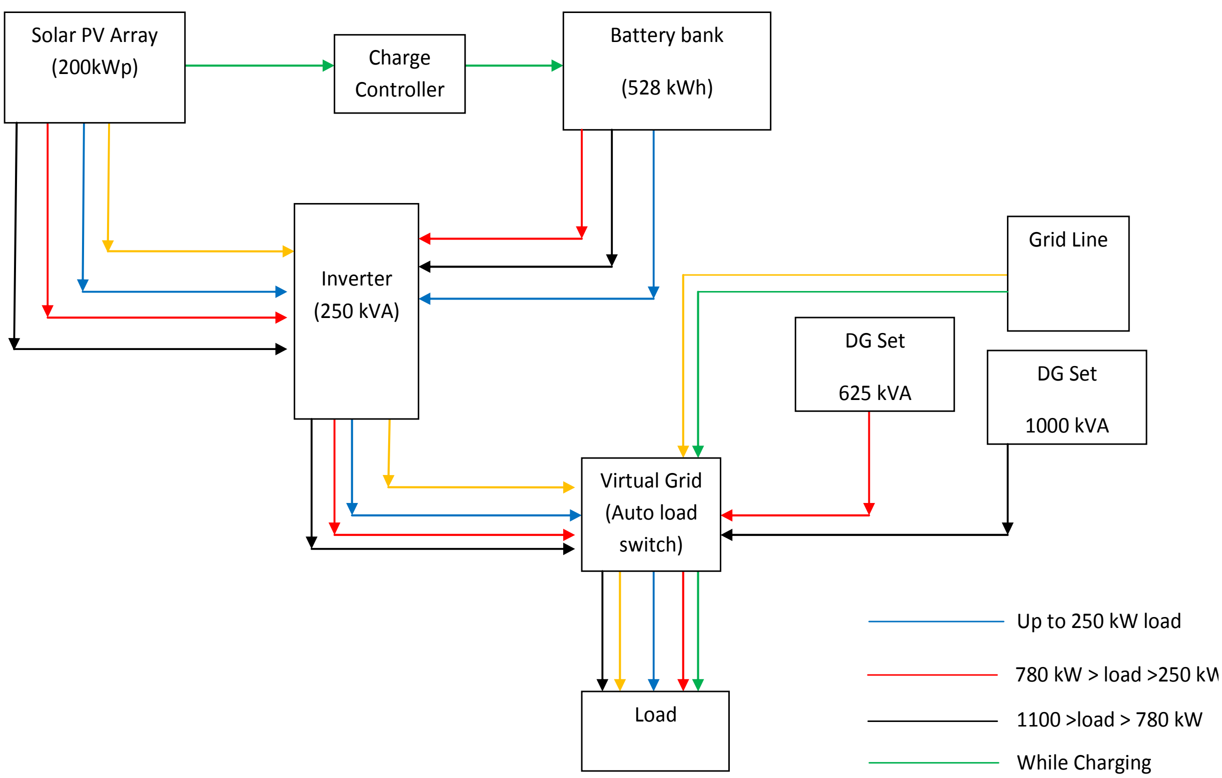
Cash Flow Analysis:



Remarks
• To reduce the diesel consumption of DG's to generate back-up power first step is to make a centralized system of power supply, so that DG's run on higher part loads and not all the DG's have to be used simultaneously • Financial implications especially practical Finacial considerations will need to be looked into much more in detail. RWA's being non commercial entities will find it very difficult to raise this quantum of funds. • Other smaller PV usage options like solar water pumping/ solar LED street lights could be taken up initially as they may be more feasible due to shorter paybacks and lower capital outlays.

Lay out of Garden Estate Group Housing Complex

Configuration of the Proposed Solar PV system



MPR 4: Guest House, Mr. Ashok Singh

Project Details	
Name	Mr. Ashok Singh, Sec: 17, Gurgaon
Type	Guest House
Technology	Solar Thermal & Solar PV Application

Technical Summary of Project

Objective:
Solar water heater & solar PV applications for saving the electricity and reducing the diesel consumption by the DG's.

Project Description:

Introduction:
Guest Houses in Gurgaon are one of the largest segments in the commercial sector having a huge potential for utilizing solar energy for both of the applications, solar thermal & solar PV. There are more than 2000 guest houses present in Gurgaon and the numbers are growing at a very fast rate (more than 20% growth). They have an almost 250 days requirement for hot water that makes it a potential candidate for Solar Water Heater. Also at the day time they have a very low electrical load but still when the grid fails, a DG of the size equivalent to the connected load of the whole guest house is used. This technique of providing back-up power is quite prevalent in Gurgaon, which has an average daily power cut of 3-4hrs, in which 2 hrs power cut is in during day-time.
In the current project feasibility of using Solar water heater for providing hot water in the rooms as well as in the kitchen and using Solar PV system to provide power back-up during the day time power cut, is studied.

Current Technology:
For the purpose of the feasibility study, a guest house was chosen and all the data required for the study was gathered from this guest house. The general information about the guest house is provided in the table below

General Information	
No. of rooms	15
Average Occupancy	80%
No. of Bathrooms	15
Kitchen Services	Yes
Average Daily Hot Water Requirement	1000 liter per day
DG Capacity	62 kVA
Day-time Load	10kW
Average Back-up required during day time	3 hrs
Diesel Consumption	7000-8000 lts/Annum

Currently, one electric geyser with storage in each of the bathrooms is used to provide the hot water in the rooms and the kitchen requirements are fulfilled with LPG. Hydro-pneumatic pumps are used to provide pressure in the pipelines for the constant flow of water in every bathroom. They have a 62 kVA Diesel Gen-set which is used whenever there is a power cut.

Sizing Techniques:
Sizing of solar water heating system is used taking a consumption of 70 LPD per bath

- A 1000 lpd ETC based pressurized system to provide hot water in each of the bathroom and in the kitchen.
- Return piping and circulation pump system to provide instant hot water without any wastage.
- Electric backup given to ensure systems work even during the peak winters taking into account foggy weather conditions.

Sizing of Solar PV System

- Strategy for sizing of Solar PV system was to take care of the day-time load during the power cut through solar energy with an aim to eliminate the need to switch on the DG during the daytime
- The sizing of the PV panel was done according to the total units required for back-up during the day time.
- Battery bank was sized, so as to provide the power collected through the panel during the day during day time power cut.
- During the day time power cut, first electricity directly from solar will be used and if it is inadequate, battery bank will provide the rest of the power so that use of DG is minimized.
- When the grid electricity will be available during the day-time, solar energy will first charge the batteries and after charging is done, solar power will be used in combination with grid electricity, so that maximum possible savings can be achieved.
- As there is a possibility of one or two rooms being occupied during the daytime the system is so configured to permit short time usage for two air conditioners during the grid failure.
- System need to be oversized hence in calculations we have taken 4 hours of daytime use during the peak summer when outages peak.

Estimated Size and layout of the SWH system:
The sizing of the Solar water heating system was done with the use of RETScreen software, which takes in to account te ambient temperatures and solar radiations of the site, hot water usage pattern etc. The results of the simulation are stated below:

Results SWH	
Collector Type	Evacuated Tubes or FPC
Total Collector Area	20 sqm
Insulated Solar Tank	1000 liter
Auxiliary heating type	Electrical 8 Kw
Total Heating delivered by Solar	10.2 MWh/Annum

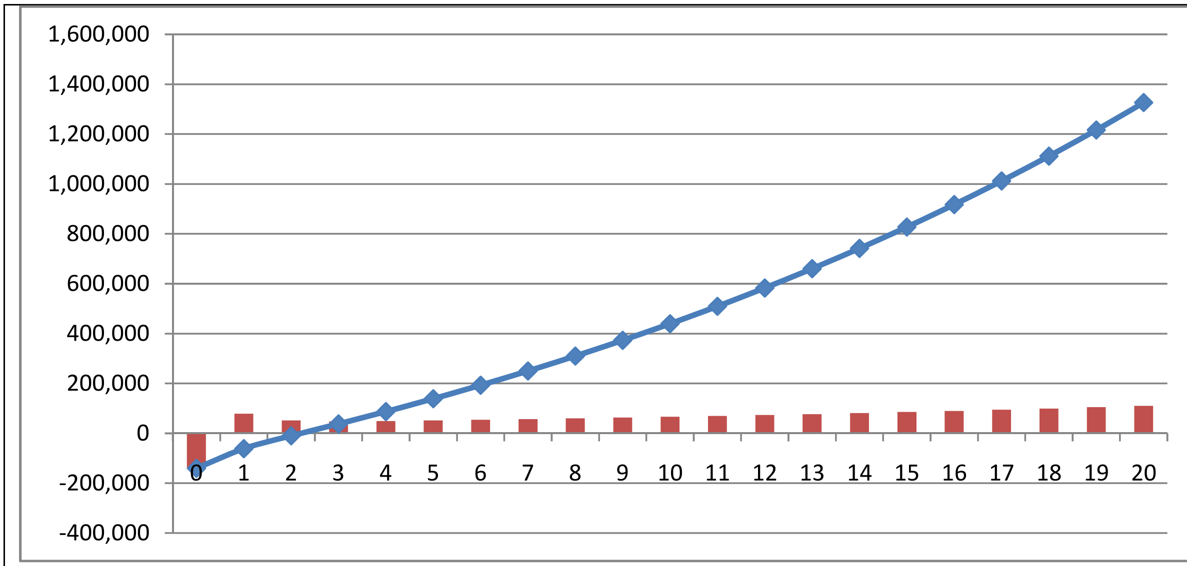
For the guest house installation the figure is *20 sq m* of catchment surface, approximately 2 manifolds of ETC collector or 8 collector in FPC These will be fitted on metal structures secured to the roof, making use of their inclination (30^o), facing towards south direction. The layout of the system is shown

Estimated Size and layout of the Solar PV system:
The sizing of the Solar PV system was done with help of SAM software, which takes in to account the ambient temperatures and solar radiations of the site, power usage pattern etc. The results of the simulation are stated below:

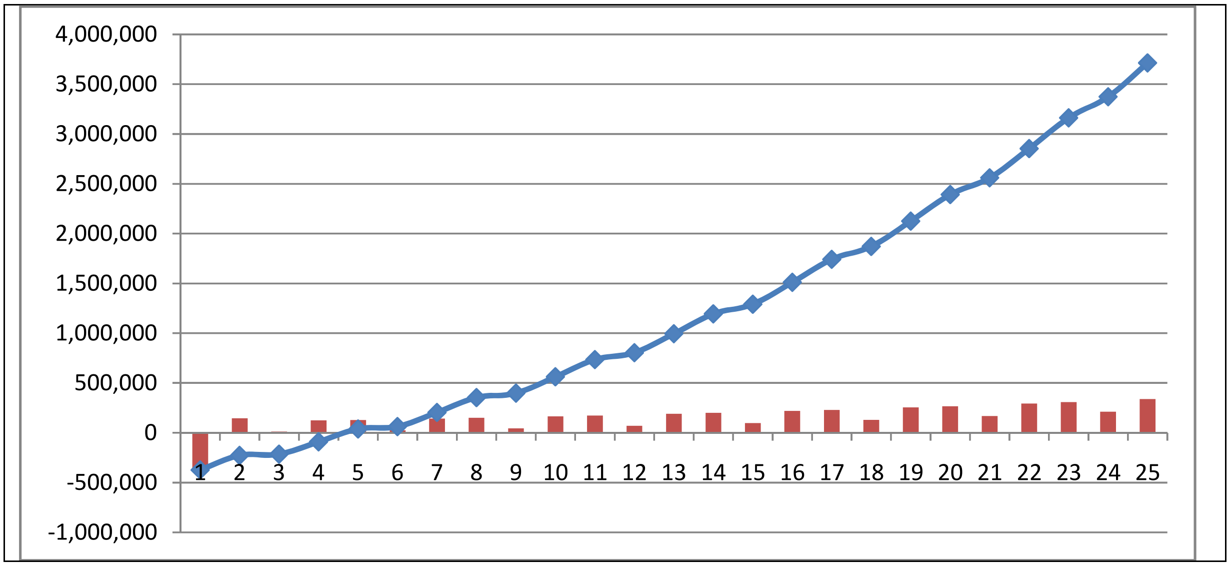
Result Solar PV System	
PV System Capacity	5 kWp
Day time back up load	10 kW (Approx)
Inverter	12 kVA
Day time back up	2 hrs (Approx)
Battery Bank	16 Nos X 150 Ah X 12 V
Diesel Saved	3000 lts/ Annum

The size of the PV system for the typical guest house has been calculated approximately, given that the exact characteristics of the panel model eventually chosen will directly condition the calculations. For the guest house installation the figure is *5kWp* PV panel, integrated with minimal battery bank and properly sized inverter as the day time load. These panels will be fitted on metal structures secured to the roof, making use of their inclination (30^o), facing towards south direction. The layout of the system is shown

Financial Data (SWH)	
Capacity (SWH)	1000 lpd
Life of SWH	20 years
Capital Cost	Rs. 2 lakhs (approx)
O&M Cost	**2% per annum pressurized 4% pa**
MNRE Subsidy	Yes
Type of Subsidy	Capital
Amount of Subsidy	Rs. 60000
Expected Savings	10200 kWh/yr
Depreciation Income tax Benefits	Accelerated depreciation @ 80% Rs. 45000 (in 2 years)
Savings	Rs. 46000/annum (As per current price i.e. Rs. 4.5 per kWh)
Simple Payback	2.2 Years
NPV	Rs. 7.5 Lakhs
IRR	43%
Saving to Investment ratio	7.8
Cash Flow Analysis:	



Financial Data (Solar PV System)	
Capacity (PV System)	5 kWp
Life	25 years
Inverter Capacity	12 kVA
Battery bank	28.8 kWh
Capital Cost	Rs. 11 lakhs (approx)
Recurring Cost	Rs. 1.12 lakhs per 3 years
MNRE Subsidy	Yes
Type of Subsidy	Capital
Amount of Subsidy	Rs. 4.5 lakhs
Expected Savings	3000 lt diesel/yr
Depreciation Benefits	Accelerated depreciation @ 80% Rs. 2 lakhs (in 2 years)
Savings	Rs. 1.14 lakhs/annum (As per current price i.e. Rs. 37 per lt)
Simple Payback	4.7 years
NPV	Rs. 9.67 Lakhs
IRR	28%
Saving to Investment ratio	9.4
Cash Flow Analysis:	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ANNEXURE III: CONCEPT NOTE ON TECHNICAL SOLAR FACILITATION CELL

The studies done in the Gurgaon-Manesar has highlighted the potential for large-scale solar water heating projects in both industry and the multi-storey residential buildings. The realization of this potential may be a gradual process and would require a systematic approach to remove barriers.

In the Industrial segment, the two main barriers are:

1. Lack of awareness: The use of solar technology is relatively unknown and hence the lack of awareness about the technology and its applications.
2. Lack of necessary expertise to carry-out the preparatory work within industries: Once awareness is created, there would be several industries that may be keen on adopting the technology but would require additional technical information and expertise for carrying-out the analysis and preparing preliminary proposals for approval by the top management. This preliminary analysis would have to consider the possibility of integrating SWH with waste heat recovery systems, which will require coordination with not only SWH manufacturers/suppliers but also waste heat recovery specialists. Commercial considerations are of primary importance in this segment and feasibility and payback calculations needs to be professionally done. Several industries may not have necessary manpower or expertise for this task. Assistance by an external agency at this juncture in quickly putting together a preliminary project report can go a long way in realization of the SWH systems

In the residential sector multi-story apartment complexes also there are several barriers:

1. Lack of knowledge and understanding of the mandatory provisions among the builders and architects. It is important that this segment understands the logic and necessity as well as long-tern commercial and environmental benefits of SWH systems, so that SWH systems are not considered as a burden but are considered a beneficial system.
2. Lack of technical knowledge for designing and selecting a proper SWH system: For proper installation SWHs need to be incorporated while the plumbing systems are being designed however this intervention is rarely done so we usually end up with sub optimal designs. In this segment use of solar technology is relatively new and the expertise to evaluate different design and technology options by the builders and their

consultants does not exist. There are also issues related with the availability of roof-top area, provision of back-up heaters and metering of hot water.

In view of the ambitious targets laid down by the national solar mission, it is important to address these barriers in the initial phase of the mission. One of the ways, in which these barriers can be addressed, is through making available services of a consultancy group (in the form of creation of SWH facilitation cell) for a limited period of time (initially for 6 months to 1 year) which can carry out the following tasks:

- Pro-actively identify potential large-scale SWH projects.
- Create awareness about the SWH systems through making focused presentations in the meetings with industry associations; associations of builders, architects, plumbing consultants; etc. In addition, participation and presentations in the green building seminars organized by GRIHA, BEE and IGBC can also help in reaching-out to a large potential segment of users.
- Assist potential projects in preparing preliminary project reports.
- Coordination with SNA and MNRE for fast-track approval of these projects for availing subsidies.

The cell can focus on Gurgaon-Manesar as well as Noida-Greater Noida regions. The primary target for project facilitation in this cell should be the residential multi storey apartments as well as high potential industrial market segments such as the Diary Industry / Auto components industry/ Laundry/ Food Processing / Food Service segment.
The aim of such a cell should be to facilitate 15 large-scale SWH projects in about a year's time.

The cell may be funded through the UNDP-GEF Solar Water Heating project. While the cell would provide most of the services free of cost; services such as preparation of preliminary project report or specific technical support for designing of the systems or implementation support, etc. may be partially charged to the beneficiary.