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## Strategy for the Promotion of Passive Solar Housing Technology in Western Himalayas (December 2006)

S.S. Chandel

**Abstract** - Himachal Pradesh is the first state in India to implement Solar passive housing technology on large scale. A policy decision was taken by the state Govt that all the govt & semi-govt buildings will be designed as per solar passive housing technology. The experience in implementing passive solar building programme in Himachal Pradesh, is presented. The monitoring of constructed Solar buildings shows comfortable living conditions in winters as well as energy saving. The long term strategy for continuous Research & Development, capacity building and technical manpower development for the successful propagation of the technology, is also discussed. The follow up action for the implementation of the technology is outlined for other countries.

**Keywords** - Solar Passive Technology, Passive buildings, Solar Energy, Mountains.

### 1. INTRODUCTION

The State of Himachal Pradesh [HP] lies in the Western Himalayas and extends from snow covered mountains separating Tibet in the North to plains of Punjab in the South and West. The State with a geographical area of 55673 sq km is located between latitude 30° 22' 40" to 33° 12' 40" North and longitude 75° 45' 55" to 79° 4' 20" East. The altitude ranges from 250 m to 6,975 m above mean sea level. Due to peculiar topography and snowfall in high altitude regions, the state experiences severe winters. Areas above 2000 metres receive light to heavy snow fall whereas alpine zone remains under snow for 5-6 months in a year.

About 92% of 5.2 million population (as per 1991 census) of the state lives in villages and largely depend on fuel wood for space heating and cooking. About 4.82 million tons of fuel wood is used in the state annually for cooking, space heating, water heating, tarring of roads etc. out of which 4.5 million tons is used by the rural population. This requirement has resulted in large scale denudation of forests posing serious threat to the environment. In Himachal Pradesh wood, charcoal, coal, kerosine, LPG and electricity are mainly used for cooking and space heating during winters. In tribal areas of the state, the fuelwood, coal and kerosine are supplied on subsidy resulting in serious burden on Govt. exchequer.

In high altitude regions, Govt. buildings like offices, hospitals, residences requiring winter heating, have to be fitted with electric/fossil fuel heating systems to create comfortable indoor conditions. The installation and annual running costs of such heating systems are quite high. This cost can be considerably reduced if the building is designed incorporating solar passive features.

Contrary to popular belief 250-300 sun shine days per year are available in Himachal Pradesh with 7-8 mean sun shine hours per day, as such solar energy can effectively be utilised for space heating.

Passive solar building technology is environmentally sound and economically viable technology in which the design is evolved by considering the site planning, climatic conditions & movement of sun during summers and winters so as to create comfortable living conditions. The adoption of solar passive heating or cooling technology in the design of buildings reduces the large consumption of fossil fuels and electricity for space heating, cooling and daylighting.

The solar passive building programme has been implemented in the state successfully and a stage has now reached to propagate this technology in other hill states of India. The states of Uttranchal, Sikkim, J&K, Manipur, Meghalaya, Arunachal Pradesh, Nagaland have shown interest in propagating the technology in their states.

In the following sections, the current status and strategy leading to the successful implementation of Solar passive building technology, have been outlined.

### 2. POLICY ON SOLAR PASSIVE HOUSING TECHNOLOGY

In the year 1994, Himachal Pradesh Govt. took a decision that all the future Govt/ Semi Govt Buildings are to be designed & constructed as per solar passive housing technology in a phased manner [1]. HP is the first state in the country to take such a policy decision. A Solar House Action Plan for Himachal Pradesh, formulated by the HP State Council for Science, Technology and Environment [HPSCTE], was approved on May 12, 1994. HPSCTE is the nodal agency for implementing Solar Passive Housing Programme in the state.

#### *Implementation of Solar House Action Plan*

Under the Passive Solar House Action Plan in the State, a Technical Project Management Cell has been established in the State Council for Science, Technology and Environment, H.P. for which the Ministry of Non-Conventional Energy Sources, [MNES], GOI is also providing support. The Cell comprises of scientific, architectural and engineering staff. A panel of experts provides technological inputs. The Cell

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S.S.Chandel is with State Council for Science, Technology & Environment, Himachal Pradesh, B-34, Kusumpati, Shimla-171009, India. e-mail: chandel\_shyam@yaoo.com

co-ordinates with state housing agencies in the state for the implementation of the Plan. The main components of the Plan are :

- Design and construction of all Government /semi Govt buildings like hospitals, health centers, schools, residential colonies, offices etc. as per solar passive architecture by all housing agencies including HP Public Works Department, & HP Urban Development Authority ,in a phased manner.
- Establishment of a Technical Project Management Cell in the State Council for Science, Technology and Environment H.P. for co-ordination with state housing agencies for the Solar House Action Plan and to create inhouse facilities for technology dissemination.
- Organization of specialized training courses for scientists, engineers, architects and artisans in passive solar housing techniques for dissemination of the technology and development of technical manpower.
- Constitution of expert group from State/ National / International R&D Institutions for co-ordinating the solar house programme in the State.
- Retrofitting of old buildings with passive solar heating systems.
- Modification in building bye-laws for making Passive Solar features compulsory in buildings in Himachal Pradesh.
- Incentives to public for solar house construction in urban and rural areas construction of Solar demonstration buildings in different climatic zones of H.P.
- Research , development and monitoring of Passive solar buildings.
- Course Curriculum Development on Passive Solar Architecture, Engineering and Scientific aspects in State Universities and Engineering Colleges.
- Energy audit of Government buildings in Himachal Pradesh to suggest measures for reducing energy consumption.
- Solar radiation and other Climatic data compilation and analysis of Himachal Pradesh.
- Traditional hill architecture data compilation and identification of passive features for evolving Solar design incorporating Himalayan Architecture.
- Establishment of a Solar Energy Research Centre for Hilly areas at Shimla for carrying out R&D related to solar technologies for cold climates. This Centre is to provide technical support and carry out R&D related to solar energy not only for Himachal Pradesh but for the hilly regions of the country.

### **Strategy for Implementation**

Based on the successful demonstration of the technology in Himachal Pradesh, the govt took a policy decision in August 2000 that all the large energy consuming buildings above 2000 metre altitude will be designed and constructed as per Solar passive housing technology by all govt & semi govt agencies. The guidelines prepared by the HPSCTE were approved by Govt for implementation.

### **(i) Role of implementing agency**

1) All govt./ semi govt agencies including HP Public Works Department, & HP Urban Development Authority engaged in building construction above 2000 m altitude will design and construct buildings as per passive solar building technology in the state. Necessary steps will be taken by these agencies for effective implementation of the plan in co-ordination with the Technical Project Management Cell set up in the State Council for Science & Technology & Environment, HP.

2) The Govt./Semi Govt agencies will make systematic efforts to orient / train their architectural and engineering wings for adopting this technology. Each agency will set up a Computerised solar passive design Cell with architects, design engineers [structural], executive engineer and a computer programmer well versed in Autocad/ design, seismic analysis softwares. This Cell will co-ordinate with the State Council for Science, Technology & Environment, HP for effective implementation of this technology.

3) Besides analysing requisite data evolving preliminary sketch drawings/ final working drawings of buildings and preparing brief technical reports, role of such a Design Cell will also include visits to sites prior to designing to ensure correct marking of North/ South, collect information on obstruction, shading and sunshine duration at the site & climatic data.

4) Implementation schedule:

#### *First Phase:*

i) In the first phase, all the large energy consuming buildings like Hospitals, Health Centres, Govt. Residential Buildings, Rest houses, Office buildings requiring central heating, Hotels etc. above the altitude of 2000m will be designed as per solar passive technology strictly.

ii) In other buildings minimum energy conserving features & orientation for utilising South Sun in winters, day lighting & environment friendly building materials will be followed.

iii) All standard designs of buildings like Govt. residences, hospitals, schools, colleges, hostels, hotels, health centres, etc. will be revised & new designs evolved by Govt /semi Govt. / housing agencies, incorporating solar passive features with the assistance of the Technical Project Management Cell of the HPSCSTE.

#### *Second Phase:*

Implementation of the programme will be reviewed. .Based on the experience gained & monitoring results, the technology will be extended to cover all parts of the state and all types of buildings.

5) The concerned executing agency will construct buildings as per solar passive design strictly and will maintain strict quality control.

6) Buildings requiring central heating systems [like electrical/oil /wood fired ] will have solar passive heating/cooling systems with electrical backups so that high installation costs and the recurring expenditure on running central heating systems could be reduced . These buildings shall have double glazed windows, air lock lobbies & electricity conserving measures .

7) The executing agency will be required to certify that solar passive recommendations, as per approved design, have been followed in construction.

8) Strict quality control while constructing buildings, as per solar passive design, will be the responsibility of architectural & engineering wings of the executing agency.

9) To make maximum use of natural daylight such features in buildings, as Sky lights, Roof lights etc. shall be incorporated in design so as to reduce consumption of electricity during day time.

10) Electricity conservation measures in buildings will be followed strictly by Electrical Engineering wings of housing agencies. Auto cutoffs, use of Photo- voltaic lights, wherever possible will be encouraged.

**Nodal Agency**

The State Council for Science, Technology & Environment, HP, is the nodal agency for the implementation of Solar Passive House Action Plan in Himachal Pradesh , which provides necessary design /scientific inputs to the implementing agencies. The Technical Project Management Cell carry out the monitoring of solar buildings.

**3. STATUS OF SOLAR BUILDING PROGRAMME**

In 1994 the Council identified buildings to be constructed as per solar passive design by state housing agencies. The Council identified experts in solar architecture and obtained additional funding from Ministry of Non Conventional Energy Sources, Govt of India. The solar passive designs of these buildings were provided out of which twenty have been constructed till now [Table.1].

**Comfort Evaluation of Solar passive buildings**

Under Ministry of Non- Conventional Energy Sources, Govt of India [MNES],sponsored project, monitoring of the constructed solar passive buildings has been done by the cell to study the thermal comfortable conditions, efficacy of solar passive features, actual energy savings. The monitoring of constructed Solar passive HP Co-operative Bank Himurja office and MLA Hostel buildings shows that buildings are comfortable in winters and dependence on the electricity for heating has been reduced considerably. The users have also expressed satisfaction over the comfort level.

**i) HP co-operative bank building**

The multi-storeyed bank building is oriented to 10° West of South with two sunspaces, solar heat collecting wall, double glazed windows and roof top solar air collector with a electrical backup heating system. The monitoring of the building during 1998-2000 shows a temperature rise of 10-17 °C above the ambient temperature and the electric backup is required only for one or 2 hours during extreme cold and partial cloudy days.

**Table 1. Solar passive buildings in HP**

Building Name/Location	No.
<b><i>i. Constructed</i></b>	
MLA’s Hostel, Shimla	4
200 bed Govt. hospital, Rampur, Distt Shimla	1
Minister’s houses, Shimla	6
Judge’s Houses at Shimla	6
HP Co-operative Bank building, Shimla	1
HIMURJA office building, Shimla	1
State Bank of Patiala, Shimla	1
<b><i>ii. Under Construction</i></b>	
HPPWD rest house, Kotgarh , Distt. Shimla	1
IGMC Hospital Phase –2, Shimla	1
Nirman Bhavan, Shimla	1

**ii) MLA hostel buiding , Shimla**

During Feb 2000 the inside temperature of the Solar designed MLA Hostel building varied between 10° C to 26° C with ambient temperature as 4.5° C to 7 °C.

**iii) Himurja building, Shimla**



**Fig. 1. Himurja solar passive building at Shimla**

The building exposed to winter sun has day lighting features, sunspace, thermo-syphoning heating

panels, double glazed windows, solar water heating and solar photovoltaic lighting features [Fig. 1]. This building does not require any auxiliary heating in winters. The monitoring of building in Jan 2001 shows inside temperatures as 18°C to 28°C with ambient temperature variation from 9°C to 15°C.

### **Economics of Solar Passive Buildings**

In the Solar passive buildings constructed in the state, there is only a marginal increase in the cost ranging from 0 to 10% depending on the nature of solar passive features adopted. This minor increase in cost further reduces, if proper site planning, design and selection of materials are done at initial stages. Due to continuous saving of fuel/electricity required for space heating/cooling in such buildings, this additional cost can be recovered within 2–3 years. The Solar passive buildings can be classified into three main categories:

#### **i) Solar buildings with no additional costs**

Buildings for which there is a freedom of proper site planning, appropriate building materials and efficient functional planning at initial stages, the Solar passive design features will cost very little extra expenditure. In the Minister's and Judge's residences constructed in Shimla, there is virtually no extra cost of construction.

#### **ii) Solar buildings with incremental costs of 5-10%**

Buildings for which there is less independence in selecting the site and orientation, there may be small incremental cost of 5 to 10%. In case of Passive Solar designed Rs 2 crore HP State Co-operative Bank building which had a little choice of orientation as well as availability of sunshine and in which an electrical backup system was also installed, the cost of passive solar features is 5% of the total cost with a pay back period of 3-5 years due to saving in fuel bills.

#### **iii) Buildings requiring retrofitting - back up electric heating systems**

Buildings like hospitals or offices, in extreme cold sites above 3000m requiring roof collector solar space/air/water heating systems with electric back ups or in which Solar passive systems are to be retrofitted, the cost can go up to 15%. However, due to lesser fuel consumption this incremental cost can be recovered within 2-3 years.

## **4. SUSTAINING TECHNOLOGY PROPAGATION**

Following initiatives have been taken for making the propagation of the technology self sustaining.

### **Establishment of a Technology R&D Centre**

The Council has setup an Appropriate Technology Centre at Sunder Nagar where Solar passive heating systems like Trombe wall, Sunspace, Green house, Solar window box heater, Thermosyphoning air heating panels

etc. are fabricated and tested using local materials by local artisans. These systems have also been successfully installed in traditional houses. The Centre has also organized a large number of training for the engineers and artisans.

### **Study of Traditional Architecture of HP**

A survey of traditional hill architecture of Himachal Pradesh has been carried out to identify design features for evolving solar passive designs of houses for hilly regions.

### **Climatic Data Compilation of HP**

A compilation of sunshine hour/solar radiation and other meteorological data of Himachal Pradesh has been done under Council's sponsored project.

### **Retrofitting of Traditional Houses**

The Council has retrofitted traditional houses with locally fabricated and low cost thermo air syphoning panels, sunspace and Trombe wall heating systems in the tribal areas of the HP for popularising the technology in Sangla Valley, Distt. Kinnaur and Bharmour, Distt Chamba.

### **Solar Passive Design of Schools & Teacher Hostels**

41 solar passive primary schools and teacher's hostel designs for Shimla and Spiti districts have been provided. Fifteen solar passive primary schools in Shimla and Spiti districts and 8 solar passive teacher hostels at Tabo, Kaza, Sagnam, Dhankar, Rangrik, Kibber, Hansa and Losar in Spiti Valley have been constructed at altitudes from 12,500ft to 14,500ft where the minimum temperature during winters drops to -40°C [Fig. 2].



**Fig .2 Solar passive teacher hostel in spiti valley**

### **Consultancy Cell for Residential Houses**

A Consultancy Cell has been set up in the Council which is providing services to public in the Solar passive designs of residential houses.

### **Establishment of Solar Energy Research Centre for Cold Regions**

A high level committee has been constituted by MNES for setting up of a Solar Energy Research Centre for Cold

Regions for the dissemination of this technology in all the hill states of India. The Committee has submitted its report to MNES recommending the establishment of a Centre.

### **International Collaboration**

#### **(i) ICIMOD, sponsored project**

Under the project funded by International Center for Integrated Mountain Development (ICIMOD), Nepal, a National workshop on Solar Passive technology was organized for establishing a network of experts and institutions.

#### **(ii) AusAid project on rural passive housing**

An Aus-Aid project on Capacity building in Solar passive housing in rural areas of HP was implemented [1999-2001]. Under the project five scientific personnel of the Technical Project Management Cell were trained at the University of New South Wales, Sydney in the latest Solar passive concepts. 25 rural Teacher hostels primary schools and Teacher Residence houses were designed and constructed in HP.

### **Developing Technical Manpower**

In order to sustain the programme it is essential to train the local manpower. The Council organised a number of training programmes for architects, engineers, of Housing agencies during 1994 to 2001. Specialised training programmes for junior Engineers from Rural Development Blocks were organised for carrying out construction in rural areas. More than 100 rural artisans were trained in the construction techniques of solar passive houses and fabrication of Sunspaces, Trombe wall, cavity wall, thermosiphoning air heating panels, Window box air heaters etc. The main aim of training rural artisans was to propagate the technology in villages since these artisans are already involved in the construction of houses in villages and once their skills are upgraded the technology propagation will become self sustainable.

### **Promoting Technology in other Hill Regions**

A Technical Backup Unit for promoting solar passive housing technology in hill states of India, was established by Department of Science Technology, Govt of India. This unit coordinated with hill Science & Technology Councils J&K, Sikkim, Manipur, Mizoram, Meghalaya, Tripura, Arunachal Pradesh, Nagaland, W.Bengal hills, Uttaranchal Pradesh. The training and awareness programmes for the architects, engineers, scientist and artisans of Sikkim and Mizoram, Tripura, Manipur states were organised.

The Science & Technology Councils of Sikkim and Manipur states identified buildings to be designed as per Solar passive technology for which designs were provided. The Solar passive design of a Conference / Banquet hall at Gangtok, Sikkim was prepared and sent to for implementation. The J & K, Uttaranchal Pradesh and Mizoram have also shown interest in the technology.

A survey of the traditional houses in Chamba, Kinnaur, Lahaul & Spiti in Himachal Pradesh have been conducted for retrofitting and to develop new designs. The Solar passive design guidelines for hill areas of India are being prepared.

After reviewing the successful implementation of the programme another policy decision was taken by Govt of Himachal Pradesh in the year 2005 that it will be mandatory for all Govt./ semi Govt. agencies [ including, Industrial Complexes, Tourist Resorts, Hotels in Govt./Semi Govt. & Private sector, to incorporate solar passive heating & cooling features, earth quake resistant features and rain water harvesting structures in all the buildings in the state of Himachal Pradesh.

## **5. FOLLOW UP STRATEGY**

In order to propagate the Passive Solar technology in hilly regions, it is important to identify demonstration buildings which are to be designed by experts. The construction must be carried out under strict supervision so that there is no compromise with the proposed design and quality of building materials. The Scientific Institutions must be involved for providing long term technical backup to the housing agencies alongwith carrying out R&D studies related to traditional architecture. The local architects, engineers and artisans should be trained in the design and construction techniques. The recording of accurate climatic data including hourly temperature, solar radiation, wind speed and wind direction data is a prerequisite for the successful implementation of the programme. Establishment of Solar Radiation Data Recording stations is important to create a scientific data base.

Steps to modify building bye laws for making provision for solar passive features, solar space heating systems, solar access to buildings, colonies & new townships needs to be taken by appropriate departments like Country & Town Planning, Municipal bodies. Awareness campaigns about technologies need to be launched. Specialized training and orientation programmes, architects & engineers, scientists, artisans and, builders needs to be organized.

In order to propagate solar passive housing technology, a long term technology backup is essential for which a Project Management Cell in a Scientific Institution needs to be set up to prepare manuals, guidelines on house designs incorporating solar passive technology features, earth quake resistant features & rain harvesting structures for wider dissemination.

## **6. REFERENCES**

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