

# **SUSTAINABLE SOLAR HOUSING**

## **Marketable Housing for a better Environment**

*A research and demonstration project of the International Energy Agency*

Gerhard Faninger  
Faculty for Interdisciplinary Research and Continuing Education, iff,  
University of Klagenfurt, Austria  
E-mail: gerhard.faninger@uni-klu.ac.at

### **1. Situation in the Building Sector**

About 40% of the energy consumption in IEA-member countries is used for the heating of buildings. Half of this is allotted to residential buildings. The reduction of energy consumption in buildings as well as the increase of renewable energy in the heating systems have priority in the European energy policy. In the past, many buildings and heating systems were realized without considering their environmental impacts. The most of the existing buildings are not energy-efficient, considering the available technologies. For European countries it is estimated that more than 30% of the energy demand in the building sector could be saved, without losses in the comfort. Especially building renovation is an important task to achieve a *sustainable energy economy*.

In its Energy Policy as well as in the Energy Research-, -Development and - Demonstration Programme the most European countries emphasizes the *efficient use of energy* and the use of *renewable energy sources* for substitution of fossil and nuclear energy carriers.

Building ecological housing with extremely low heating and cooling demand and minimal CO<sub>2</sub> emissions is a growing movement. Just as cars requiring only three litres of fuel per hundred km are entering the market, houses consuming annually less than the equivalent of three litres of heating oil per m<sup>2</sup> of floor area are now being built. Projects range from apartment buildings and row houses to detached housing. However, ambitious goals are not always met and higher costs among other factors hinder market penetration.

### **2. Project Description: Objectives and Work Plan**

To address these questions, fourteen countries in Europe, North and South America, Asia, and Australia are collaborating in the IEA project "Sustainable Solar Housing": Australia, Austria, Belgium, Brazil, Canada, Finland, Germany, Italy, Japan, The Netherlands, Norway, Sweden, Switzerland and UK.

An essential goal for this project is to help designers plan economical sustainable housing to increase market penetration and assure that the goals promised customers are met. The standard approach concentrates on reducing loads. In heating climates this means extremely compact building form, thick insulation, super windows, air tight construction, and mechanical ventilation with heat recovery.

This project will be carried out as joint co-operation between two IEA research programmes: *SHC - Solar Heating and Cooling Programme* (IEA - SHC Task 28)

and *ECBCS - Energy Conservation in Buildings & Community Systems Programme* (IEA-ECBCS Annex 38). Task 28/38 is exploring the combination of energy conservation and solar strategies in the context of marketable sustainable housing.

A still unsolved problem is how to economically meet the remaining very small amount of heat demand, ideally also with renewable energy. Energy use for water heating and appliances becomes important in such housing. Solar water heating is a proven technology. Photovoltaic panels can cover part of the electricity demand but needs a high investment. Systems serving multiple functions may be more economical, i.e. facade integrated solar collectors which also serve as the outer skin of the building. Further, heat losses from the back of the solar collector can reduce the space heating demand.

Which mix of strategies makes sense under these new circumstances? How is comfort affected? What features will homebuyers accept? What spin-offs can be applied for retrofitting the existing housing stock? What integrated solutions lend themselves to achieving ecological housing in hot climates?

IEA-SHC-Task 28/ECBS-Annex 39 consists of four Subtasks.

### **A - Market analysis and Communication**

In order to adapt sustainable solar housing to a larger market segment, it is important to know how the market will behave and change in the future. Information will be collected on national housing trends, governmental goals, preferences from the building industry, and most important - preferences from homeowners. Results will be used for technical, functional, and architectural solutions.

Communication of results is vital. Vehicles for this include a web site documenting existing projects, design guideline, and constructing next generation demonstration buildings.

### **B - Design and Analysis**

This Subtask provides insights to plan housing with extremely low energy demand and minimal environmental impact that is affordable. The features and components that contribute the most at least cost may change according to building type, market segment, and region. Design guidelines are being developed through cross comparisons of built projects (input from Subtask D) and computer modelling.

Advice will be given for apartment buildings, detached-, and attached houses in climates ranging from temperate to Nordic. The basis for comparison is conventional housing built to local standards in 2001. In parallel, solutions for sustainable housing in warm climates address both comfort and the use of renewable energy.

### **C - Construction and Demonstration**

What measures are necessary to initiate and successfully complete a demonstration project for high performance housing? Pioneers who have built such demonstration projects are sharing experience in planning for next-generation projects. Participants include innovative builders, financial institutions, and planners. At semi-annual

meetings advice is offered on how to write a design brief, provide quality control during construction, debug the houses during commissioning and get the maximum public relations impact afterwards. The activity is led by an Australian team bringing fresh new ideas. Their motto is: Prove it by doing it!

## **D - Measurement and Evaluation**

Monitored data from housing projects is being analysed to learn what has proven most effective. Results show the consequences of construction by traditional trades and occupancy by people. A Task reporting format allows information sampled according to national procedures to be reduced to common denominators and then compared. Thereby it is possible to learn what is effective under diverse climatic-, user-, and economic circumstances. In a complimentary activity, key building components are being tested in renowned national laboratories. Valuable input is being provided to manufacturers to help them optimise their products to these new working conditions.

The results will be:

- An internet web site offering advice for accelerating market penetration of high-performance housing.
- Design guidelines for high performance, environmental friendly and affordable housing.
- Testing reports to manufacturers for key building and technical system components.
- Documentation of exemplary *Sustainable Solar Housing*.
- Open houses and press articles.

For information on the IEA-Solar and Heating Programme visit: [www.iea-shc.org](http://www.iea-shc.org)

## SUSTAINABLE SOLAR HOUSING: IEA-SHC-TASK 28

### IEA Solar Heating and Cooling Programme, Task 28

<b>Subtask A – Market analysis and Communication</b>	<p>Gerhard Faninger:</p> <ul style="list-style-type: none"> <li>• The building sector in Austria</li> <li>• Towards sustainable housing in Austria: Lessons Learned, Measures for Market Deployment and Future Prospects</li> <li>• Strategies and measures for accelerating the market deployment of <i>Sustainable Housing</i></li> </ul> <p>Peter Biermayr:</p> <ul style="list-style-type: none"> <li>• The introduction of innovative concepts and technologies into the building sector</li> </ul> <p>Harald Rohrer:</p> <ul style="list-style-type: none"> <li>• User acceptance of balanced ventilation systems in residential low-energy buildings in Austria</li> </ul>
<b>Subtask B – Design and Analysis</b>	<p>Gerhard Faninger:</p> <ul style="list-style-type: none"> <li>• Biomass Heating Systems</li> <li>• Thermal Energy Storage</li> <li>• Solar Thermal Systems with Water Collectors</li> <li>• Heat Losses through Heat Bridges: <i>Requirements for Sustainable Housing and Solutions</i></li> <li>• Check-list for the Design of Sustainable Housing</li> </ul> <p>Susanne Geißler</p> <ul style="list-style-type: none"> <li>• Total quality building assessment</li> </ul> <p>Sture Larsen:</p> <ul style="list-style-type: none"> <li>• Building Insulation versus Passive Solar Utilization</li> </ul>
<b>Subtask C – Construction and Demonstration</b>	<p>Martin Trebersburg and Wilhelm Hofbauer:</p> <ul style="list-style-type: none"> <li>• Solar City Linz</li> </ul> <p>Helmut Schöberl et al:</p> <ul style="list-style-type: none"> <li>• Applying passive technologies in social housing</li> </ul> <p>Sture Larsen:</p> <ul style="list-style-type: none"> <li>• Building Insulation versus Passive Solar Utilization</li> </ul>
<b>Subtask D – Measurement and Evaluation</b>	<p>In Preparation</p>
<b>Additional Contributions</b>	<p>Gerhard Faninger</p> <p><b>Success stories:</b></p> <ul style="list-style-type: none"> <li>• Market Deployment of Solar Thermal Systems in Austria <i>A Success Story of Interdisciplinary Co-operation</i></li> <li>• Market Deployment of Solar Housing in Austria</li> <li>• A Success Story for Market Introduction of Sustainable housing through Co-operation <i>Research &amp; Planning %Industry</i></li> </ul> <p><b>New innovative products:</b></p> <ul style="list-style-type: none"> <li>• New Generation of Pellets-Boilers</li> <li>• Solar-Biomass-Combined Heat Recovery Unit</li> <li>• Facade Integrated Collector</li> </ul> <p><b>Demonstration projects:</b></p> <ul style="list-style-type: none"> <li>• Solar Supported District Heating for Housing Estates</li> <li>• Combined Solar-Biomass Heating System for Row Houses</li> </ul>

# SUSTAINABLE SOLAR BUILDINGS

## *Marketable Housing for a better Environment*

**IEA-SHC Task 28/  
IEA-ECBCS Annex 38**



SHC Task 28: / Annex 38  
Sustainable Solar Housing

# SUSTAINABLE SOLAR BUILDINGS

## IEA-SHC Task 28

presented by

**Gerhard Faninger**

**iff, University of Klagenfurt**

**Vienna, 26 March 2004**



SHC Task 28: / Annex 38  
Sustainable Solar Housing

## The IEA-Project SHC-TASK 28

**Duration:** April 2000 – April 2005

**Objectives:** Market penetration of sustainable solar housing

**Means:**

- Web site
- Documentation of projects
- Design Handbook
- Demonstration Buildings
- Workshops

**Scope:**

- Energy
- Ecology
- Economy



SHC Task 28: / Annex 38  
Sustainable Solar Housing

## Project Management

**This project will be carried out as joint co-operation between two IEA research programmes:**

***SHC - Solar Heating and Cooling Programme (IEA - SHC Task 28)***

**and**

***ECBCS - Energy Conservation in Buildings & Community Systems Programme***

***(IEA-ECBCS Annex 38).***



SHC Task 28: / Annex 38  
Sustainable Solar Housing

## **Project Management**

### **Operating Agent:**

**Robert Hastings, CH**  
on behalf of  
**Bundesamt für Energiewirtschaft, Bern,**  
**Switzerland**

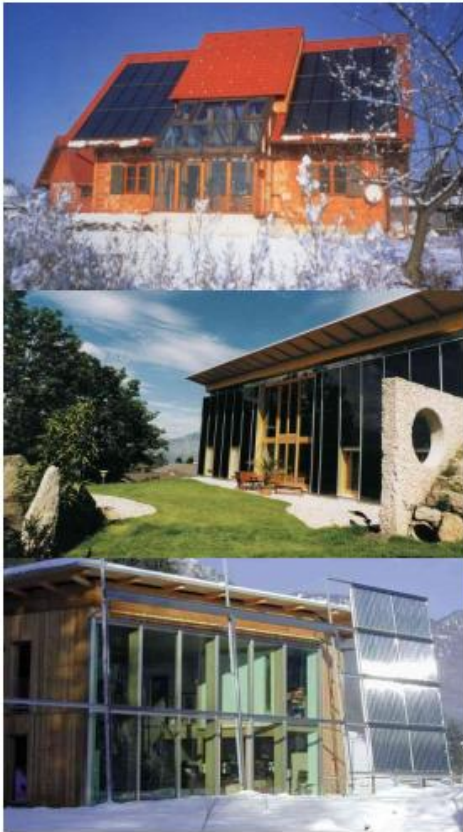
**Austrian Experts**  
on behalf of  
**Ministry for Transportation, Innovation and**  
**Technology, BMVIT:**  
**Gerhard Faninger, co-ordination,**  
**Helmut Schöberl et al.,**  
**Martin Trebersburg and**  
**Wolfgang Hofbauer,**  
**Sture Larsen.**

With additional contribution from  
**Susanne Geißler, Peter Biermayr,**  
**Harald Rohracher**



SHC Task 28: / Annex 38  
Sustainable Solar Housing

**Task 28/38 is exploring**  
**the combination of**  
**energy conservation**  
**and**  
**solar strategies**  
**in the context of**  
**marketable sustainable**  
**housing.**



**An essential goal for this project is to help designers plan economical sustainable housing to increase market penetration and assure that the goals promised customers are met.**

**The standard approach concentrates on reducing loads and CO<sub>2</sub>-emissions.**



## **Workplan**

**IEA-SHC-Task 28/ECBS-Annex 39 consists of four Subtasks.**

**A - Market analysis and Communication**

**B - Design and Analysis**

**C - Construction and Demonstration**

**D - Measurement and Evaluation**



**Austria**  
**Australia**  
**Belgium**  
**Brazil**  
**Canada**  
**Finland**  
**Germany**  
**Italy**  
**Japan**  
**Netherlands**  
**Norway**  
**Sweden**  
**Scotland**  
**Switzerland**

**Participating Countries: 14**



**Subtask A:**  
**Market Assessment & Communication**

---

**Purpose:** Get results into practice  
**Focus:** Brochure and Web Site  
**Progress:** Task brochure:  
 - written and illustrated  
  
**Web site:**  
 - Created and on line  
[www.shc-org](http://www.shc-org)



## Market-Assessment

**Purpose:** Link research to marketplace

**Focus:** National market situations

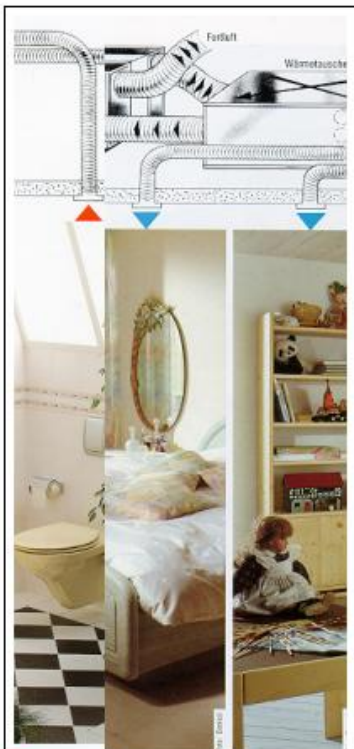
**Progress:** Market situations presented:

- Austria
- Brazil
- Finland
- Italy
- Netherlands
- Norway

**Interesting survey results from Austria and North America:**



SHC Task 28: / Annex38  
Sustainable Solar Housing



## Austrian Marketing Survey

### Acceptance of mechanical ventilation

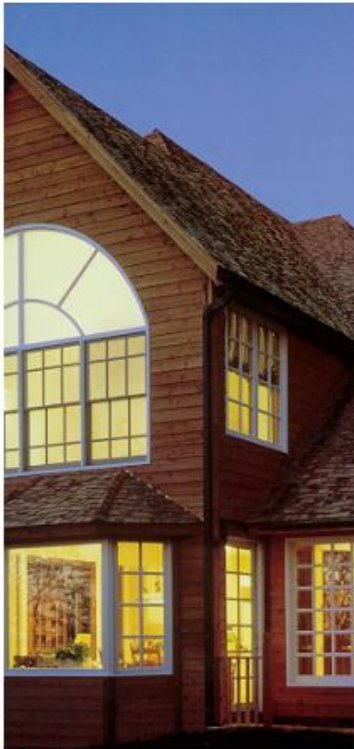
- Questionnaires: 144 residents
- In-depth interviews: 30 residents
- Resulting marketing strategy

#### Main results:

- Satisfaction with ventilation systems  
> 90% of s.f.h. occupants would install system again
- Significant % of negative responses:
  - noise (41% of residents!)
  - too dry air
  - bad control system
- Satisfaction improves for recent systems



SHC Task 28: / Annex38  
Sustainable Solar Housing



SHC Task 28: / Annex38  
Sustainable Solar Housing

## Homebuilder survey in North America (National Fenestration Council)

- Energy an issue to homebuyers, (more so than commercial clients)
- Window selection criteria (rank 1 to 5)
 

Durability	4.5
Style	4.4
Maintenance	3.9
Heating cost savings	3.8
Price	3.7
Cooling cost savings	3.6
- Lesson for Task 28/38:
  - Maintenance an important issue
  - Aesthetics decisive
  - Energy cost savings a selling point



SHC Task 28: / Annex38  
Sustainable Solar Housing

## Catalog

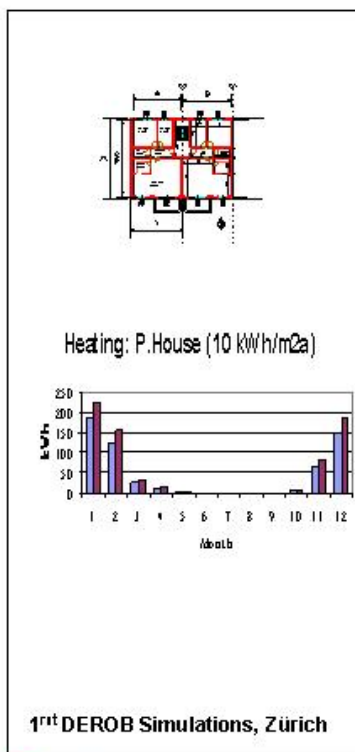
**Purpose:** Share Experts' awareness of key components with designers

**Focus:**

- insulation technologies
- windows
- ventilation systems
- package HVAC systems
- controls

**Proposal:**

- Make part of Website
- Use Handbook structure
- Links to manufacturers' & Associations' websites



## Subtask B: Design and Analysis

**Purpose:** Provide detailed advise to specify components for design strategies of typical solution sets

**Focus:** Economical and ecological design: low energy buildings

**Progress:** Chapter outlines tested



SHC Task 28: / Annex38  
Sustainable Solar Housing

**Design Strategies**

- Landscaping
- Form & Orientation
- Direct Solar Gains
- Indirect Gain (sunspaces)
- Heat Storage
- Daylighting
- Shading and Venting

**Technologies**

- Building Envelope
- Ventilation
- Heat Delivery
- Heat Production
- Storage
- Electricity
- Control Systems
- Water

## Handbook Structure

- I. Introduction
  - II. General Principles
  - III. Advice by Building Types and Climates
  - IV. Typical Solution Sets
  - V. Design Strategies
  - VI. Technologies
- Appendices**
- Tools / Methods
  - Climates
  - Calculation Assumptions
  - Key Data



SHC Task 28: / Annex38  
Sustainable Solar Housing



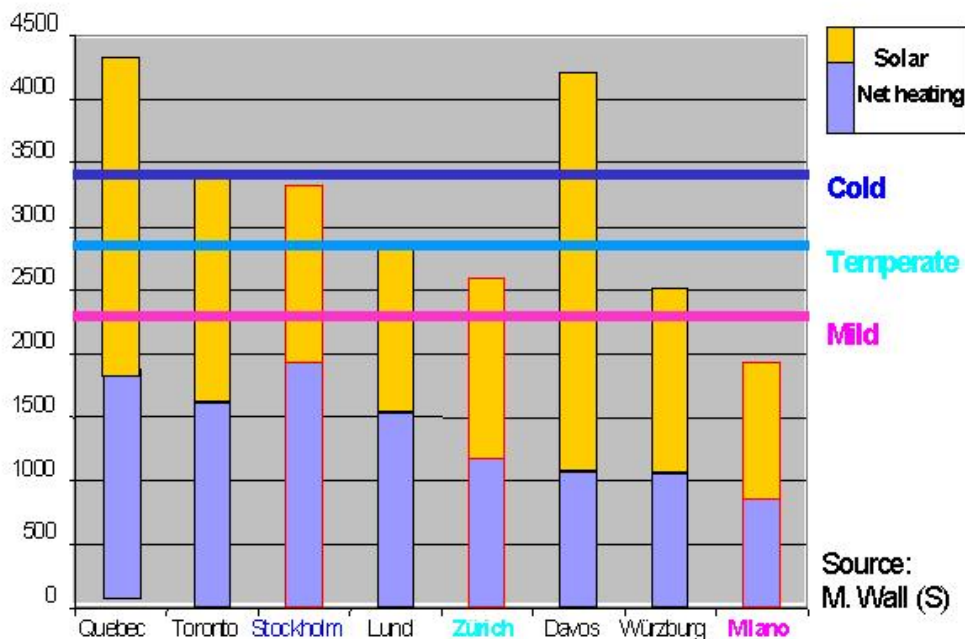
## Energy Analysis

- Purpose:** Quantitative advice for the HB on relative importance of design decisions
- Focus:** Typical solution sets for  
 - three reference building types  
 - three climates
- Progress:** - Ref. buildings defined  
 - Construction specified per 10 national building codes  
 - Climates analyzed, selected  
 - Test simulations done

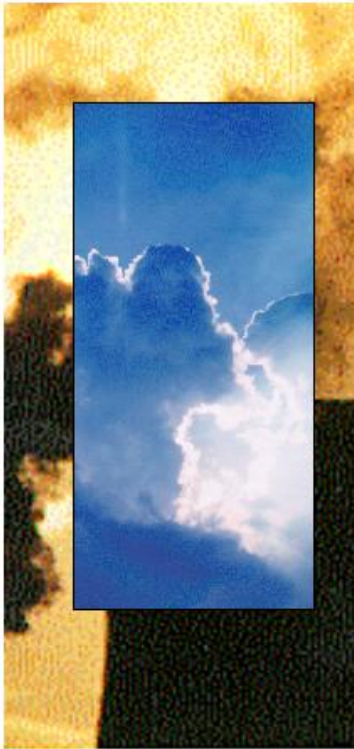


SHC Task 28: / Annex38  
Sustainable Solar Housing

Heating Demand of the IEA Reference Row House - unoccupied



SHC Task 28: / Annex38  
Sustainable Solar Housing



 SHC Task 28: / Annex38  
Sustainable Solar Housing

## LCA Analysis

**Purpose:** Check if less energy used over building life justifies conservation and solar

**Focus:** LCA of selected buildings and typical solution sets

**Progress:** Criteria developed to characterize houses



 SHC Task 28: / Annex38  
Sustainable Solar Housing

## Subtask C: Demonstration

**Purpose:** Help market penetration by showing results as built projects

**Focus:** Design briefs to specify goals and preferred technologies  
(Rules for the design)

**Progress:** Outline for a working document



SHC Task 28: / Annex 38  
Sustainable Solar Housing

## Subtask D: Monitoring and Evaluation

**Purpose:** Characterize exemplary sustainable housing in a standardized way

**Focus:** Data sets, text and graphics

**Progress:**

- Excel sheet distributed
- Data sets submitted from D, SE, FIN, CH, A + NL
- Cross comparisons begun



SHC Task 28: / Annex 38  
Sustainable Solar Housing

## Natural Cooling and Solar Use

**Purpose:** Design advice for sustainable solar housing in hot climates illustrated with examples

**Focus:** Hot, humid climates

**Progress:**

- Key design indicators identified from buildings
- Technologies and strategies selected
- Prototype designs:
  - Houses: BR, AUS
  - Facade system: Italy