ccem-house2000

Innovative Building Technologies for the 2000 Watt Society

In cooperation with the ccem-retrofit project.

Scope of project

The ccem-house2000 project is looking for new technical solutions in the building construction sector to reduce the CO_2 emissions substantially. The projects are based on individual national and international research projects (SFOE, CTI, swisselectric research, International Energy Agency IEA) and cover the topics of building materials, advanced building installations and smart control.

Goals and activities of sub-projects

The project is structured in four parts:
A Advanced building materials and components;
B Soft heating and cooling technologies;
C Smart control and user interfaces;
D Demonstration and dissemination.

A1: High performance insulation materials based on fiber reinforced aerogels

A new generation of insulation material is based on the very good thermal performance of aerogels. Material development is ready for patent registration.

A2: Advanced vacuum insulation panels (VIP of 2nd generation)

New technologies such as vacuum insulation panels (VIP) offer the possibility to achieve highly insulating walls by slim overall wall thickness and/or better integration into buildings. Degradation and failure risks as well as high production cost are main drawbacks of existing market products. The main activities are:

- Development of VIP with coarse core materials.
- Development of advanced solutions with integrated VIP.
- Service life investigation, improved quality procedures.
- Design of the VIP building envelope for the demonstrator unit.

Development work on VIP façade insulation systems of type «ventilated curtain wall» and «external thermal insulation composite system» is in progress.

A3: Colored glazed solar collectors for heating and cooling

Solar thermal façade systems with improved architectural quality by using colored glazing with high solar transmittance are the main focus of this project. The activities are divided into three parts:

- Development of new thin film technology and process (MgF2-SiO2 thin films).
- Architectural integration of the collector-glass into the building envelope (recommendations).
- Scale-up to prototypes in collaboration with industrial partners, design of demonstration elements (full size demonstration prototypes on Schweizer collectors).

A4: Thermally activated ceiling panel with PCM

The concept of a thermally activated ceiling panel with phase change material (PCM) has been developed at Empa and has been registered as international patent.

B1: Open absorption systems for cooling and air conditioning

A conceptual design of a new type of air handling unit (AHU), operating with a liquid desiccant (LiCl) shall be developed, built and tested

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experimentally in the laboratory. The concept considers an absorber/dehydrator, an evaporative cooler and a desorber/regenerator, built as compact membrane contactors. The driving energy shall be provided by a hot source at temperatures in the 70-90 °C range (solar heat or waste heat). A laboratory-scale prototype has been designed and built. First tests have been performed successfully.

B2: Solar long-term sodium hydroxide heat storage

Conventional storage systems are voluminous and loose energy during storage time. But for a mono-valent system, it is essential that even with an almost empty storage (in spring), domestic hot water can be delivered at usable high temperatures, which is possible with the NaOH storage. To store solar heat effectively in a seasonal storage, a sodium hydroxide long-term heat storage system with a 3 to 6 times higher heat capacity compared to conventional water storage systems will be developed. The heat is stored chemically by using an absorption/desorption process. The working pair is NaOH and water. A pre-prototype is designed and built.

B3: Solar thermal absorption cooling (STAC)

An increased economic interest on solar thermal cooling is noticed because of the high availability of solar energy in summer time (hot season) and because of a high price electrical energy peak cutting pressure. Common absorption chillers have originally been designed for large-scale industrial application of cooling power in the range of 100 kW_R, steady-state operation, mostly using comparably high generator driving temperatures (> 110 °C for single-effect machines; > 185 °C for double-effect machines).

This project focuses on applied R&D in the areas of system integration as well as controls using a newly developed 10 kW_R LiBr-H_2O absorption chiller in combination with a 30 m^2 array of novel high-efficiency flat-plate solar hot water collectors installed at the HSR campus. The system integration with these flat-plate solar hot water collectors and optimal buffer storage devices as well as associated adaptive controls is now needed and will be supported by a new developed «solar cooling» module in the «Polysun» software to progress this promising technology development path.

B4: Efficient heating and cooling with heat pumping technologies

The project aims to deliver new integrated solutions for combined operating systems covering heating, cooling and domestic hot water especially adapted to the requirements of low and ultra-low energy houses representing the vision of the 2000-Watt society. Complete system solutions for MINERGIE® and MINERGIE-P® housing are to be developed using the most advanced active and passive systems combined with the use of heat pumping technology.

Problems to be solved by means of simulations and measurements are:

- Which building type requires which hydraulic design (capability, costs)?
- What is the best control scheme (efficiency, robustness, investment)?
- Which rules and guidelines can be derived?
- How can advanced heating and cooling concepts be disseminated with a real space unit?

C1: Control of thermally activated building systems (TABS-Control)

The scope and activities given in the CTI project are:

- Develop comprehensive solutions for the control of thermally activated building systems (TABS).
- Implementation of functional software units in existing control systems.
- User-friendly description of the concepts for HVAC- and control engineers (guide book).
- Simulation tool for the evaluation of control strategies for TABS.
- Field test of the prototype software in a real building. Provide evidence of the functionality of the concept.

C2: Advanced bio-mimetic user-adaptive blind and lighting controller using wireless sensors

The CTI research and development project BELControl, carried out by LESO-PB/EPFL (Lausanne) and Adhoco (Winterthur) is the base for the contribution to the ccem-retrofit and ccem-house2000 projects. The project includes 3 tasks:

- Control algorithm development for user-adaptive blind and lighting control.
- Experimental tests preparation.
- Field tests.

Info web pages
www.empa-ren.ch
www.opticontrol.ethz.ch
www.ocwdb.ethz.ch

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The CCEM specific tasks address two issues: the specificity of control system issues for a building retrofit, and the experimentation on a demonstration building unit which will be implemented on the EPFL campus in Lausanne, in the framework of the ccem-house2000 project.

C3: Use of weather and occupancy forecasts for optimal building control (OptiControl)

OptiControl is an entirely new, interdisciplinary project that started from scratch.

The following activities took place:

- Launching of the OptiControl project website (www.opticontrol.ethz.ch).
- Identification of potential «applications» and selection of first 2 applications: integrated room automation (IRA) for office zones with HVAC system variants «cooled ceiling», and «night cooling» strategies.
- Elaboration of a 3-Step concept for «potential assessment» (1. «perfect world»; 2. «real world, no knowledge on forecast uncertainties»; 3. «real world, but with uncertainty information available»), prototype software for 1. and 2. implemented.
- Elaboration of a concept for hierarchical modeling of buildings (5 levels, from «verbal description» to «very detailed quantitative model»), first models defined.
- Design of a modular, flexible, distributed modeling and simulation environment for «potential assessment» (implementation and testing of the software ongoing).
- Launching of the OptiControl «weather and occupancy database» website (www.ocwdb.ethz.ch).

D1: Design and construction of an energy sufficient space unit using advanced building technologies

The aim of this project is to demonstrate the effectiveness of energy technologies developed under ccem-house2000. They will – in combination with other advanced technologies – be integrated into a self sufficient space unit that is independent from external energy supply.

Besides energy efficient systems for heating, cooling, ventilation, hot water and electricity based on renewable energies the space unit will include architectural features for future life style, advanced highly insulated light weight constructions and building materials. It will be easy transportable to allow demonstration at different locations and occasions. It can be used as advanced shelter for research work in extreme climates.

The FHNW (School of Applied Psychology) will investigate the user acceptance of new technologies with a special focus on the design of user-centered interactive control systems for the demonstrator space unit.

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