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IEA HPP Annex 32
«Economical heating and cooling systems for low energy houses»

Participants

Since the autumn ExCo meeting 2006 the nine countries AT, CA, CH, DE, JP, NL, NO, SE and US are participating in the Annex 32. All letters of participation have been sent and participants have paid the fee for 2008.
In Sept. 2008, France with the participant Electricité de France (EDF) R&D joined the Annex 32. The letter of participation has been sent.
Concerning the extension of Annex 32 in 2009, the funding of Norway for 2009 is not yet confirmed.

6th Annex 32 working meeting in Graz, Austria

The 6th working meeting of Annex 32 took place at the Graz Technical University, Austria from Monday, March 2 until Wednesday, March, 4, 2009.
The working meeting consisted of

- One and a half day working meeting containing
  - Presentation of the state of the national projects
  - Discussion of the deliverables of Annex 32
- A half day technical tour to a field monitoring system integrated in an Austrian passive house

A summary of the working meeting will be published in the HPC Newsletter Volume 1/2009.

State of the national projects

Details of the national projects can be found in the interim report. In the following latest developments and an outlook on following activities are given:

Austria (AT)

Austria is represented by the Institute to Thermal Engineering (IWT) of Graz Technical University and arsenal research, Vienna. At IWT, a B/W CO_2-heat pump prototype in the small capacity range of 3-5 kW is developed. A test rig of the system has been set up and first tests with a CO_2-compressor have been performed, which turned out not to be suited very well for the application. Currently, a better suited CO_2-compressor of a Japanese manufacturer is awaited. Results are taken to calibrate a model and perform system simulations of the prototype systems for evaluating the SPF and the control of the system.
At arsenal research results of heat pumps for space heating and DHW in field monitoring are presented, containing as well two ground-coupled compact units, which cover the functions space heating, DHW, ventilation and passive space cooling function. The winter operation of the compact units yielded an overall SPF for space heating and DHW of 3.6. Final results of the field testing are expected for autumn 2009.

Canada (CA)

Canada is represented by Hydro-Quebec in co-operation with the Concordia University in Montreal. The project is dedicated to design and field-testing of 2 EQuilibrium Net Zero Energy Houses (NZEH). The first field test object, the EcoTerra™ House, is equipped with 3 kW building integrated

PV/Thermal system (BI-PV/T), DHW preheating by the solar thermally heated air and storage of the solar heat in the massive concrete floor storage. Moreover, the house is equipped with a ventilation heat recovery and a ground-source heat pump as well as a waste water heat recovery. The EcoTerra™ home is a prefabricated house, which has been built in 1 working day. Year-round results of measurement data of EcoTerra™ home are available.
Field test of the second object, the Alstonvale Net Zero Energy house will start in June 2009.

France (FR)

France joined Annex 32 in Sept. 2008 and is represented by Electricité de France (EDF) R&D.
In France the market for low energy houses is still in the introduction phase. However, the French low energy house label BBC shall become law in 2012, the Bepos label (Net zero energy house) in 2020. A field monitoring plant at St. Sever according to the BBC label has a 60% reduced energy consumption. An A/A heat pump and 25 m^2 of PV panels on the roof are used in the house (see www.effinergie.org, category Projet/En Aquitaine).
Challenges seen for the heat pump development are a higher performance at low outside temperatures, efficient storage, efficient DHW production and lower costs.
Contributions of France to Annex 32 will be simulation work, proven technology of a reversible air-to-air HP by lab-testing and field testing at St. Sever.

Germany (DE)

The German participant in Annex 32 is the Fraunhofer Institute of Solar Energy systems (FhG-ISE). The German project is dedicated to a large field test of ~100 heat pumps (source: 68 ground-source (GS), 26 air-source (AS), 7 ground-water-source (WS), emission system: 92 floor heating, 5 radiators, 4 combination) installed in low energy houses in co-operation with 7 manufacturers and 2 utilities. In parallel, a field test of ~75 heat pumps (source: 38 GS, 35 AS, 2 WS, emission system: 53 radiator heating, 20 combination, 2 floor heating) for the application in existing building is in progress.
Tab. 1 gives the resulting overall seasonal performance values for the different system configurations of the monitoring period 2008, which refers to the first 43 GS, 6 AS and 4 WS heat pumps in low energy buildings and 35 GS and 33 AS heat pump in existing buildings.

Tab. 1: Seasonal performance of year-round measurement data in 2008 in the two German field tests

Field monitoring	HP Efficiency (low energy buildings)			HP existing buildings (high flow temperatures)	
HP-Type	A/W	B/W	W/W	A/W	B/W
SPF SH&DHW	3.0	3.8	3.5	2.6	3.3
Electric Back-up	2%	2%	2%	1%	2%
DHW share	n.a.	22%	18%	14%	12%
Auxiliary energy	7%	6%	15%	3%	5%

Only 6 of 43 ground-source heat pumps (GSHP) in the low energy houses have back-up consumption. Optimisation potentials have been found in the design and the adaptation of the heat pump to the emission and control systems. In the second measurement campaign the measurements will continue until 2010, maybe some of the systems will be monitored even longer.

Japan (JP)

Japan has a large national team of manufacturers, utilities and universities represented by the University of Hokkaido and the Tokyo Electric Power Company (TEPCO). At TEPCO, design of single-split and multi-split heat pump solutions for the moderate climate zone of Japan are developed. Simulation results confirmed that current design methods for the heat pump lead to over-dimensioned systems. An adequate design procedure for low energy houses is currently worked out.
The project at the University of Hokkaido is dedicated to field testing and optimisation of ground-coupled heat pumps in the Hokkaido region, i.e. the cold climate zone of Japan to replace fuel boilers common in this region. The first field test was concluded in 2007 showing considerable saving potentials. Year round results are available of a follow-up field test with an optimised system which started in Dec. 2007. The primary energy consumption is reduced by 53% compared to a conventional house. Without any cooling system the indoor temperature varies in summer time between 23°C and 28°C. In the summer season, overall SPF incl. solar energy is 4.8, in winter season, the overall SPF is 2.8.

Netherlands (NL)

Netherlands is represented by SenterNovem, which is head of a group of stakeholders in the low energy building field in the Netherlands. In the Netherlands by 2015 all new buildings shall be built climate neutral (carbon neutral). Probably, this will be accomplished by prefabricated or industrial buildings, where the quality can be controlled in the manufacturing process. The target is reflected in the intended development of Energy Performance Coefficient (EPC)-characteristic: present houses comply to an EPC of 0.8, in 2010 the EPC will be lowered to 0.6, since 2015 an EPC of 0.4 corresponding to ~20 kWh/(m^2a) will be prescribed.

Therefore, the main work of the Netherlands is committed to:

- Standardised system solutions and design recommendations
- Prototypes system development
- Field test results

However, some of the activities may start too late to match the deadline of the conclusion of the national projects in 2009.

Norway (NO)

SINTEF Energy Research is the participant for Norway in Annex 32 in co-operation with the Norwegian Technical University NTNU. The Norwegian contribution is dedicated to prototypes and feasibility studies for the application of heat pumps using natural refrigerants in low energy houses. Even though the funding for the continuation in 2009 is not yet secure, a novel design of an integrated water-to-water propane heat pump installed in an ultra-low energy house is field monitored for a second heating period. Results are expected in May 2009.

Sweden (SE)

Participants for Sweden are SP the Technical Research Institute of Sweden as well as 3 heat pump manufacturers (Nibe, Thermia and IVT) and the building companies NCC Teknik, LB Hus AB, VästkustStugan and Sätila Bygg AB. Sweden is analysing and redesigning the systems of the Swedish heat pump manufacturers for the use in low energy dwellings. Starting points are exhaust-air heat pumps. Extensions are combined DHW and space cooling for summer operation, use of a second heat source (hybrid heat source), increased efficiency of auxiliaries (pump, fan) and change in the control of the systems. Planned smaller field tests of the prototype units for exhaust-air and ground-coupled units have been postponed due to the financial crisis, thus the main contribution of Sweden will be in the field of system calculation and system comparison.

Switzerland (CH)

Switzerland is represented by the University of Applied Sciences Northwestern Switzerland. The focus of the Swiss national project is the integration of passive and active cooling function in heat pump systems for low energy houses. A first system with ground-coupled heat pump and low temperature floor heating distribution system, which is also used for space cooling in summer time has been investigated by simulations and design recommendations have been derived. Presently, models for further system configurations are updated and amended.

Year-round field monitoring data of a ground-coupled heat pump with passive cooling function in a multi-family house acc. to the Swiss standard MINERGIE-P® are presented, which show a satisfying heat pump performance of an overall performance of 3.8 (SH & DHW) and ≈9 for passive cooling. Although the building showed in the measurements a considerable higher energy requirement for heating and DHW, the end energy consumption is as high as expected, due to compensation effects by better SPF and lower DHW requirement. The building was not entirely occupied during the first year, thus a second heating period with normal building use will be measured.

A second field test has been instrumented, where a single family house acc. to MINERGIE® with a ground-coupled heat pump with electronically controlled expansion valve and passive cooling option will be measured.

Further investigation on standard systems solutions with regard to hydraulic scheme, design and control will be the emphasis of the upcoming work to result in a design guide.

USA (US)

The long-term objective of the Department of Energy (DOE) is the spread of so-called Net Zero Energy Houses (NZEH). Thus, the US contribution to the Annex 32 is a project funded by the DOE Building Technology Program (BT) and conducted by Oak Ridge National Laboratory (ORNL) to develop integrated heat pump (IHP) technology for application to net zero energy homes (NZEH). Designs for both air-source (AS) and ground-source (GS) IHPs have been developed for the functionalities space heating, space cooling, DHW and ventilation including de-/humidification. Compared to a baseline system consisting of separate systems operating at current US minimum efficiency standards, the AS-IHP achieves energy savings ranging from 46% to 67% depending upon location while the GS-IHP achieves savings from 52% to 65%. Energy savings assessments were conducted in five locations representing more than 90% of US climatic conditions. Payback times are in the range of 5 – 14 years depending on climate and heat source.

DOE/BT and ORNL are now working with manufacturers to develop field test prototypes of initial product configurations for both IHP types. These initial prototypes will likely differ in some respects with the full IHP designs in order to meet the requirements of the current high-performance housing market and the capabilities and needs of the specific manufacturer partners. However, these field tests will not start before late autumn 2009 for the ground-source IHP and 2010 for the air-source IHP. Furthermore, a market evaluation of standard system solutions will be elaborated in order to characterise the system presently used in today's efficient housing market.

Deliverables of Annex 32

On the second day of the working meeting deliverables of Annex 32 were discussed.

The discussion resulted in the following structure of intended deliverables:

- Executive summary as framework, introducing 5 deliverables
- D1: Standard system solutions
- D2: Design recommendations for system solutions
- D3: Prototype systems
- D4: Field monitoring results (Best practice systems)
- D5: System monitoring recommendation

Depending of the state in the national projects a tentative time schedule for the deliverable will first concentrate on D3, D4 and D5 and give more time for the D1 and D2 as follows:

- **after completion of field tests**
  - D4b: Best practice systems
- **until autumn 2009**
  - D5: Draft System monitoring recommendations
  - D3: Draft prototype systems
- **until end of 2009**
  - D1: Draft report standard system solutions
  - D2: Draft report design guidelines
  - D4a: Draft field test results
- **until spring 2010 (April)**
  - Draft Executive summary
  - Final discussion of all deliverables
- **Spring ExCo meeting 2010 (May or June)**
  - Completion of Annex 32 with all deliverables

Date and venue of next meeting

The next working meeting of Annex 32 will be held in Canada. The main topics of the meeting are:

- Update of interim and final results and state of national contributions to Annex 32
- Discussion and review of draft reports and deliverables
- Organisational issues