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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.

After the workshop of Annex 32 at the IEA HP Conference 2008 in Zurich, Electricité de France (EDF) R&D contacted the operating agent to join Annex 32. Participants of Annex 32 agreed, so in Sept. 2008, the joining of France was confirmed. The administrative requirement of the letter of participation to be sent to the IEA Secretary, Mr. Nobuo Tanaka, is underway.

Annex 32 workshop on the 9th IEA Heat Pump Conference 2008 in Zurich

The workshop took place on Monday, May 19, 2008 in the afternoon.

The programme of the workshop contained

- a summarising introduction to the state-of-the-art of heat pumps for low energy dwellings
- interim results on new system concepts and designs
- field monitoring interim results
- conclusions and outlook

Presentations of the workshop can be downloaded Annex 32 website at <http://www.annex32.net>.

A summary of the workshop will be published in the HPC Newsletter Volume 3/2008.

Issue of the HPC Newsletter Volume 2/2008 on heat pumps in low energy buildings

Volume 2/2008 of the HPC Newsletter was dedicated to heat pumps in low energy houses. Participants of the Annex 32 contributed most of the topic articles in this issue of the HPC Newsletter.

Interim report Annex 32

An interim report of Annex 32 for the ExCo has been prepared, comprising a summary on the result in Task 1, the state-of-the-art analysis in low energy buildings and systems, and the interim results in the national project. After final comments have been received after the summer holiday break the interim report is delivered to the ExCo for the autumn meeting based on the state in the national project in summer 2008.

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 heat pump prototype in the small capacity range of 3-5 kW is developed. A system and refrigerant analysis resulted in a brine-to-water heat pump with CO₂ refrigerant. Currently, the test rig for the prototype system is finished. After finishing the test rig

capacity and COP measurements of the prototype will be performed. 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 10 heat pumps for space heating and DHW are in field monitoring (5 brine/water, 3 air/water, 1 direct expansion/water and 1 water/water), which has started in 2007, so year-round results are expected in the end of 2008. Moreover, in Sept. 2008, field monitoring of 2 ventilation compact units with space heating, DHW, space cooling and ventilation has been started, which will continue for a year, i.e. results 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 house is in field monitoring since October 2007 and year-round results will be available in the beginning of 2009. The second field test will be started in spring 2009.

France (FR)

France joined Annex 32 in Sept. 2008 and is represented by Electricité de France (EDF) R&D. France has performed a study of different system options for typical French low energy houses. Under the considered boundary conditions heat pumps for heating and domestic hot water production offered the best compromise regarding energy and investment costs as well as CO₂ emissions. Based on this study France will be working on the following items in Annex 32

- French market overview for new houses and new collective buildings and evolution of applicable regulations
- Economical optimisation of heat pump solutions for heating and domestic hot water production for low energy buildings
- Low cost solutions of air-to-air heat pumps, including laboratory tests or field monitoring.

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 pump installed in low energy houses in co-operation with 7 manufacturers and 2 utilities. The field monitoring started in 2007 and will continue until 2010. Preliminary results of the field test of the first ~70 systems have been presented at the HP Conference 2008 in Zurich. Currently, the last ~30 systems are installed. Afterwards, an overview of the performance of the systems and a more detailed analysis of single systems will be performed.

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. A follow-up field test with an optimised system started in Dec. 2007 and is ongoing. In parallel simulations of the whole energy system in low energy houses which utilize heat pumps for space heating/cooling, ventilation and DHW supported by solar energy, ground heat and waste heat of the house is performed.

The domestic meeting of the Japanese Annex 32 team will be held in December in Sapporo, where interim results of the second field test and the simulation will be discussed.

Netherlands (NL)

Netherlands is represented by SenterNovem, which is head of a group of stakeholders in the low energy building field in the Netherlands. Since both the low energy and the heat pump market are in

the introduction phase, the aim is to couple the two markets by integrated heat system solutions for low energy houses for space heating and ventilation. The steps in the Dutch national project comprise the following items:

- Analysis of calculation models and development of new models
- Development of subsidy scheme and setting up demonstration projects.
- certification scheme for systems and integrated developments
- Technology development with two Dutch heat pumps and ventilation systems manufacturers
- Evaluation of monitoring technology as well as building processes
- Information and guideline dissemination for project developers and building companies
- Development of a set of standard details for buildings.

Norway (NO)

SINTEF Energy Research is the participant for Norway in Annex 32 in co-operation with the Norwegian Technical University NTNU. The Norwegian project is dedicated to system evaluation of heat pumps with natural refrigerants in low energy applications. This comprised among others the feasibility study of a central CO₂ heat pump water heater for the use in low energy apartment houses. The simulations results show an SPF of 3.8 for the DHW production, which can save ~75% of energy compared to a direct electrical system and 25% compared to a common layout of a Nordic solar DHW systems. Moreover, a novel design of an integrated water-to-water propane heat pump has been installed in an ultra-low energy house and is field monitored for an entire year. Results of the first heating season 2007/2008 showed an SPF of 3.3, but problems with the expansion valve and the evaporator have been encountered in the prototype version. An improved system shall be field-monitored in the second heating period 2008/2009. However, the funding for the Norwegian participation in 2009 is not yet clear.

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, Väst kustStugan and Sättila 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. Prototypes shall be lab-tested and from autumn 2008 on, smaller field tests of the prototype units for exhaust-air and ground-coupled units are planned.

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 guidelines have been derived. Presently, models for further system configurations are updated and amended.

In parallel, a field monitoring system with ground-coupled passive cooling with borehole heat exchanger and additional ground-to-air heat exchanger in the ventilation system installed in the first residential multi-family ultra low energy house in canton Basel has been instrumented and measured for an entire year. In the heating season the overall SPF of ~3.8 for space heating and DHW operation was measured. The SPF for the DHW summer operation is 2.5. The performance of the passive ground cooling system is in the range of 8-12. However, the cooling energy use was rather low, so higher cooling energy use will further increase the performance of the cooling operation. Simulated values were in the range of 10-25 depending on the cooling energy use.

A second field-test of a ground-coupled heat pump system for space heating, DHW and passive ground-coupled cooling in a MINERGIE® house is starting in autumn 2008.

USA (US)

The long-term objective of the 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 Buildings Technology Program and conducted by ORNL to develop integrated heat pump (IHP) technology for application to near zero energy homes (ZEH). Designs for both air-source (AS) and ground-source (GS) IHPs have been developed. Compared to a baseline system consisting of separate systems operating at current US minimum efficiency standards to provide space heating/cooling, water heating, ventilation, and year-round indoor humidity control, 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 representative of >90% of US climatic conditions.

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. It is planned to field test the GS-IHP prototype beginning in the 2009/2010 heating season and the AS-IHP prototype beginning a year later.

Date and venue of next meeting

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

- Update of interim results and state of national contribution to Annex 32
- Discussion of deliverables
- Organisational issues and final meeting in autumn 2009.