



Dissemination Activities of Subtask A of the IEA SHC Task 44 / HPP Annex 38

A technical report of subtask A – Report A3

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IEA Solar Heating and Cooling Programme

The *International Energy Agency* (IEA) is an autonomous body within the framework of the Organization for Economic Co-operation and Development (OECD) based in Paris. Established in 1974 after the first “oil shock,” the IEA is committed to carrying out a comprehensive program of energy cooperation among its members and the Commission of the European Communities.

The IEA provides a legal framework, through IEA Implementing Agreements such as the *Solar Heating and Cooling Agreement*, for international collaboration in energy technology research and development (R&D) and deployment. This IEA experience has proved that such collaboration contributes significantly to faster technological progress, while reducing costs; to eliminating technological risks and duplication of efforts; and to creating numerous other benefits, such as swifter expansion of the knowledge base and easier harmonization of standards.

The *Solar Heating and Cooling Programme* was one of the first IEA Implementing Agreements to be established. Since 1977, its members have been collaborating to advance active solar and passive solar and their application in buildings and other areas, such as agriculture and industry. Current members are:

Australia	Finland	Singapore
Austria	France	South Africa
Belgium	Italy	Spain
Canada	Mexico	Sweden
Denmark	Netherlands	Switzerland
European Commission	Norway	United States
Germany	Portugal	

A total of 49 Tasks have been initiated, 35 of which have been completed. Each Task is managed by an Operating Agent from one of the participating countries. Overall control of the program rests with an Executive Committee comprised of one representative from each contracting party to the Implementing Agreement. In addition to the Task work, a number of special activities—Memorandum of Understanding with solar thermal trade organizations, statistics collection and analysis, conferences and workshops—have been undertaken.

Visit the Solar Heating and Cooling Programme website - www.iea-shc.org - to find more publications and to learn about the SHC Programme.

Current Tasks & Working Group:

Task 36	<i>Solar Resource Knowledge Management</i>
Task 39	<i>Polymeric Materials for Solar Thermal Applications</i>
Task 40	<i>Towards Net Zero Energy Solar Buildings</i>
Task 41	<i>Solar Energy and Architecture</i>
Task 42	<i>Compact Thermal Energy Storage</i>
Task 43	<i>Solar Rating and Certification Procedures</i>
Task 44	<i>Solar and Heat Pump Systems</i>
Task 45	<i>Large Systems: Solar Heating/Cooling Systems, Seasonal Storages, Heat Pumps</i>
Task 46	<i>Solar Resource Assessment and Forecasting</i>
Task 47	<i>Renovation of Non-Residential Buildings Towards Sustainable Standards</i>
Task 48	<i>Quality Assurance and Support Measures for Solar Cooling</i>
Task 49	<i>Solar Process Heat for Production and Advanced Applications</i>

Completed Tasks:

Task 1	<i>Investigation of the Performance of Solar Heating and Cooling Systems</i>
Task 2	<i>Coordination of Solar Heating and Cooling R&D</i>
Task 3	<i>Performance Testing of Solar Collectors</i>
Task 4	<i>Development of an Insolation Handbook and Instrument Package</i>
Task 5	<i>Use of Existing Meteorological Information for Solar Energy Application</i>
Task 6	<i>Performance of Solar Systems Using Evacuated Collectors</i>
Task 7	<i>Central Solar Heating Plants with Seasonal Storage</i>
Task 8	<i>Passive and Hybrid Solar Low Energy Buildings</i>
Task 9	<i>Solar Radiation and Pyranometry Studies</i>
Task 10	<i>Solar Materials R&D</i>
Task 11	<i>Passive and Hybrid Solar Commercial Buildings</i>
Task 12	<i>Building Energy Analysis and Design Tools for Solar Applications</i>
Task 13	<i>Advanced Solar Low Energy Buildings</i>
Task 14	<i>Advanced Active Solar Energy Systems</i>
Task 16	<i>Photovoltaics in Buildings</i>
Task 17	<i>Measuring and Modeling Spectral Radiation</i>
Task 18	<i>Advanced Glazing and Associated Materials for Solar and Building Applications</i>
Task 19	<i>Solar Air Systems</i>
Task 20	<i>Solar Energy in Building Renovation</i>
Task 21	<i>Daylight in Buildings</i>
Task 22	<i>Building Energy Analysis Tools</i>
Task 23	<i>Optimization of Solar Energy Use in Large Buildings</i>
Task 24	<i>Solar Procurement</i>
Task 25	<i>Solar Assisted Air Conditioning of Buildings</i>
Task 26	<i>Solar Combisystems</i>
Task 27	<i>Performance of Solar Facade Components</i>
Task 28	<i>Solar Sustainable Housing</i>
Task 29	<i>Solar Crop Drying</i>
Task 31	<i>Daylighting Buildings in the 21st Century</i>
Task 32	<i>Advanced Storage Concepts for Solar and Low Energy Buildings</i>
Task 33	<i>Solar Heat for Industrial Processes</i>
Task 34	<i>Testing and Validation of Building Energy Simulation Tools</i>
Task 35	<i>PV/Thermal Solar Systems</i>
Task 37	<i>Advanced Housing Renovation with Solar & Conservation</i>
Task 38	<i>Solar Thermal Cooling and Air Conditioning</i>

Completed Working Groups:

CSHPSS; ISOLDE; Materials in Solar Thermal Collectors; Evaluation of Task 13 Houses; Daylight Research



IEA Heat Pump Programme

This project was carried out within the Solar Heating and Cooling Programme and also within the *Heat Pump Programme*, HPP which is an Implementing agreement within the International Energy Agency, IEA. This project is called Task 44 in the *Solar Heating and Cooling Programme* and Annex 38 in the *Heat pump Programme*.

The Implementing Agreement for a Programme of Research, Development, Demonstration and Promotion of Heat Pumping Technologies (IA) forms the legal basis for the IEA Heat Pump Programme. Signatories of the IA are either governments or organizations designated by their respective governments to conduct programmes in the field of energy conservation.

Under the IA collaborative tasks or “Annexes” in the field of heat pumps are undertaken. These tasks are conducted on a cost-sharing and/or task-sharing basis by the participating countries. An Annex is in general coordinated by one country which acts as the Operating Agent (manager). Annexes have specific topics and work plans and operate for a specified period, usually several years. The objectives vary from information exchange to the development and implementation of technology. This report presents the results of one Annex. The Programme is governed by an Executive Committee, which monitors existing projects and identifies new areas where collaborative effort may be beneficial.

The IEA Heat Pump Centre

A central role within the IEA Heat Pump Programme is played by the IEA Heat Pump Centre (HPC). Consistent with the overall objective of the IA the HPC seeks to advance and disseminate knowledge about heat pumps, and promote their use wherever appropriate. Activities of the HPC include the production of a quarterly newsletter and the webpage, the organization of workshops, an inquiry service and a promotion programme. The HPC also publishes selected results from other Annexes, and this publication is one result of this activity.

For further information about the IEA Heat Pump Programme and for inquiries on heat pump issues in general contact the IEA Heat Pump Centre at the following address:

IEA Heat Pump Centre
Box 857
SE-501 15 BORÅS
Sweden
Phone: +46 10 16 55 12
Fax: +46 33 13 19 79

Visit the Heat Pump Programme website - <http://www.heatpumpcentre.org/> - to find more publications and to learn about the HPP Programme.

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Executive Summary

In Subtask A of the joint IEA Solar Heating and Cooling Programme Task 44 and Heat Pump Programme Annex 38, different concepts for solar and heat pump heating systems are evaluated based on annual system simulations.

This report gives an overview on dissemination activities in relation to Subtask A "Solutions and Generic Systems". These dissemination activities include:

- 19 conference papers
- 5 reports
- 6 undergraduate theses
- 8 (reviewed and non-reviewed) journal papers
- 10 presentations that were not connected to a conference / conference paper

1 Task Reports

The technical reports of Subtask A are:

- A1 – A Review of Market-Available Solar Thermal Heat Pump Systems
- A2 – Reporting Field Test Results
- A3 – Dissemination Activities of Subtask A of the IEA SHC Task 44 / HPP Annex 38

Table 1 shows more detailed information, including their status.

Table 1: Reports of Subtask A

No.	Title	Authors	Date	Status
A1	A Review of Market-Available Solar Thermal Heat Pump Systems	Jörn Ruschenburg and Sebastian Herkel with contributions from Walter Becke, Matteo D'Antoni, Sara Eicher, Klaus Ellehauge, Hilbert Focke, Michel Haller, Marion Huber, Ivan Katić, Anja Loose, Ivan Malenković, Alexander Thür and Martin Vukits	18 March 2013	Final
A2	Reporting Field Test Results	Sebastian Herkel and Jörn Ruschenburg with contributions from Erik Bertram, Carolina Fraga, Pierre Hollmuller, Floriane Mermoud, Andreas Palzer, Peter Pärtsch and Bernard Thissen	22 October 2013	Started
A3	Dissemination Activities of Subtask A of the IEA SHC Task 44 / HPP Annex 38	Sebastian Herkel and Jörn Ruschenburg	25 February 2014	Draft

2 Conference Papers

The following is a list of conference papers that have been published in connection with the work of the Subtask A of the IEA SHC Task 44 / HPP Annex 38. **Not** included are:

- publications prior to the start of the Task/Annex
- publications in the field of solar and heat pump systems that did not have any connection with the Task
- publications not analysing solar and heat pump systems, theoretically or market-related, or not presenting field trial activities

Balslev-Olesen O., 2013 *Solar heat pump – Flamingohuset*. In: Energy Procedia (to be published). Proceedings of the International Conference on Solar Heating and Cooling for Buildings and Industry (SHC), Freiburg, Germany.

Bertram E., Glembin J., Rockendorf G., 2012. *Unglazed PVT collectors as additional heat source in heat pump systems with borehole heat exchanger*. In: Energy Procedia, Volume 30. Proceedings of the International Conference on Solar Heating and Cooling for Buildings and Industry (SHC), San Francisco, USA.

Bertram E., Stegmann M., Scheuren J., Rockendorf G., 2010. *Condensation heat gains on unglazed solar collectors in heat pump systems*. In: Proceedings of the EuroSun 2010 International Conference on Solar Heating, Cooling and Buildings, International Solar Energy Society (ISES), Graz, Austria.

Bertram E., Stegmann M., Scheuren J., Rosinski C., Kundmüller K., 2010. *Unglazed Photovoltaic Thermal Collectors in Heat Pump Systems*. In: Proceedings of the EuroSun 2010 International Conference on Solar Heating, Cooling and Buildings, International Solar Energy Society (ISES), Graz, Austria.

Fraga C., Mermoud F., Hollmuller P., Pampaloni E., Lachal B., 2013. *Large solar assisted heat pump systems in collective housing – in-situ monitoring results for summer season*. In: Energy Procedia (to be published). Proceedings of the International Conference on Solar Heating and Cooling for Buildings and Industry (SHC), Freiburg, Germany.

Fraga C., Mermoud F., Hollmuller P., Pampaloni E., Lachal B., 2012. *Direct coupling solar and heat pump at large scale: experimental feedback from an existing plant*. In: Energy Procedia, Volume 30. Proceedings of the International Conference on Solar Heating and Cooling for Buildings and Industry (SHC), San Francisco, USA.

Frank, E., Haller, M., Herkel, S., Ruschenburg, J., 2010. *Systematic classification of combined solar thermal and heat pump systems*. In: Proceedings of the EuroSun 2010 International Conference on Solar Heating, Cooling and Buildings, International Solar Energy Society (ISES), Graz, Austria.

Haller M., Frank E., 2012. *System-Jahresarbeitszahl grösser 4.0 mit Luft-Wasser Wärmepumpe kombiniert mit Solarwärme*. In: Proceedings of the 22. Symposium Thermische Solarenergie. Ostbayerisches Technologie-Transfer-Institut (OTTI), Bad Staffelstein, Germany.

- Lerch W., Heinz A., Thür A., Vukits M., 2012. *Optimierung von Solar-Wärmepumpen-Kombianlagen anhand von dynamischen Anlagensimulationen*. In: Proceedings of the 22. Symposium Thermische Solarenergie. Ostbayerisches Technologie-Transfer-Institut (OTTI), Bad Staffelstein, Germany.
- Loose A., Drück H., 2013. *Feldtest von drei kombinierten Solarthermie-Wärmepumpenanlagen mit geothermischen Wärmequellen*. In: Proceedings of the 12. Internationales Anwenderforum oberflächennahe Geothermie. Ostbayerisches Technologie-Transfer-Institut (OTTI), Neumarkt i.d.OPf., Germany.
- Loose A., Drück H., 2013. *Field test of an advanced solar thermal and heat pump system with solar roof tile collectors and geothermal heat source*. In: Energy Procedia (to be published). Proceedings of the International Conference on Solar Heating and Cooling for Buildings and Industry (SHC), Freiburg, Germany.
- Loose A., Bonk S., Drück H., 2012. *Investigation of combined solar thermal and heat pump systems – field and laboratory tests*. In: Proceedings of the EuroSun 2012 ISES-Europe Solar Conference. International Solar Energy Society (ISES), Rijeka and Opatija, Croatia.
- Loose A., Drück H., Hanke N., Thole F., 2011. *Field Test for Performance Monitoring of combined Solar Thermal and Heat Pump Systems*. In: Proceedings of the ISES Solar World Congress. International Solar Energy Society (ISES), Kassel, Germany.
- Perers B., Andersen E., Furbo S., Chen Z., Tsouvalas A., 2012. *Measurement and modeling of a multifunctional solar plus heat-pump system from Nilan – Experiences from one year of test operation*. In: Proceedings of the EuroSun 2012 ISES-Europe Solar Conference. International Solar Energy Society (ISES), Rijeka and Opatija, Croatia.
- Ruschenburg J., Herkel S., 2012. *A comparative analysis of market available solar thermal heat pump systems*. In: Proceedings of the EuroSun 2012 ISES-Europe Solar Conference. International Solar Energy Society (ISES), Rijeka and Opatija, Croatia.
- Ruschenburg J., Palzer A., Günther D., Miara M., 2012. *Solare Wärmepumpensysteme in Einfamilienhäusern – Eine Modellbasierte Analyse von Feldtestdaten*. In: Proceedings of the 22. Symposium Thermische Solarenergie. Ostbayerisches Technologie-Transfer-Institut (OTTI), Bad Staffelstein, Germany.
- Thür A., Vukits M., Becke W., Heinz A., Lerch W., 2012. *Ein Jahr Feldmessung von sechs Solar-Kombianlagen mit Wärmepumpen*. In: Proceedings of the 22. Symposium Thermische Solarenergie. Ostbayerisches Technologie-Transfer-Institut (OTTI), Bad Staffelstein, Germany.
- Thür A., Vukits M., Becke W., 2012. *Ein Jahr Feldmessung von fünf Solar-Kombianlagen mit Wärmepumpen*. In: Proceedings of the 10. Internationale Konferenz für thermische Solarenergienutzung Gleisdorf SOLAR 2012, Gleisdorf, Austria.
- Vukits M., Becke W., Fink C., Heinz A., Lerch W., 2013. *Analyse und Bewertung solarer Hybridsysteme*. In: Proceedings of the 23. Symposium Thermische Solarenergie. Ostbayerisches Technologie-Transfer-Institut (OTTI), Bad Staffelstein, Germany.

3 Reports

Bertram E., Stegmann M., Rockendorf G., 2011. *Solarthermie 2000plus: Solare Gebäudewärmeversorgung mit unverglasten photovoltaisch-thermischen Kollektoren, Erdsonden und Wärmepumpen für 100% Deckungsanteil, Teilprojekt B: Wissenschaftliche Begleitung*. Emmerthal.

Energie Solaire S.A. (ed.) 2011. *Chauffage par pompe à chaleur solaire avec des capteurs sélectifs non vitrés et accumulateur à changement de phase*. Berne: OFEN.

Kurmann P., Mesot T., Ursenbacher T., 2012. *Optimierung der Einbindung eines 28 m³ Wasser-Speichers in die Beheizung und die WW-Versorgung eines EFH mit W/W-Wärmepumpe und Solarkollektoren*. Bern: BFE.

Mermoud F., Fraga C., Hollmuller P., Pampaloni E., Lachal B., 2014. *COP5: Source froide solaire pour pompe à chaleur avec un COP annuel de 5 généralisable dans le neuf et la renovation*. Berne: OFEN.

Mørck O. et al. 2011. *Demonstration af omkostningseffektive lavenergibygninger*. Afslutningsrapport.

4 Theses

Becke W., 2011. *Hocheffiziente Kombinationen von Solarthermie- und Wärmepumpenanlagen – Dokumentation und Analyse von existierenden und möglichen Systemkonzepten*. Diploma Thesis, Institut für Allgemeine Physik, Technische Universität Wien, Vienna, Austria.

Gemperle S., 2010. *Analyse einer solarthermisch unterstützten Luft-Wasser-Wärmepumpenheizung*. Bachelor Thesis, Hochschule für Technik Rapperswil HSR, Institut für Solartechnik SPF, Rapperswil-Jona, Switzerland.

Odorfer S., 2013. *Hocheffiziente Kombinationen von Solarthermie- und Wärmepumpen – Primärenergetische und Wirtschaftliche Betrachtung*. Masterarbeit, Fakultät für Verfahrens- und Systemtechnik, Otto-von-Guericke-Universität Magdeburg, Germany.

Palzer A., 2011. *Solare Wärmepumpensysteme in Einfamilienhäuser – Eine modellbasierte Analyse von Feldtestdaten*. Diploma Thesis, Fakultät für Maschinenwesen, Rheinisch-Westfälische Technische Hochschule, Aachen, Germany.

Tsouvalas A., 2011. *Combined solar heating and heat pump system*. Master Thesis, Danish Technical University, Lyngby, Denmark.

Wurm N., 2012. *Primärenergetische und wirtschaftliche Betrachtung solarer Kombi-Anlagen mit Wärmepumpen*. Master Thesis, Fachhochschule Burgenland, Pinkafeld, Austria.

5 Journal Articles

- Balslev-Olesen O., 2013. *Energirenovering af enfamiliehus ramte plet*. HVAC Magasinet, Volume 7, pp. 28–32.
- Fraga C., Mermoud F., Hollmuller P., Pampaloni E., Lachal B., 2014. *Large solar assisted heat pump systems in collective housing – long term in-situ monitoring results*. Solar Energy (to be published).
- Loose A., Drück H., 2012. *Field test of a novel combined solar thermal and heat pump system with an ice store*. REHVA European HVAC Journal, Volume 49(5), pp. 38–42.
- Loose A. Drück H., 2013. *Kombinierte Solarthermie-Wärmepumpenanlagen im Feldtest*, bbr Sonderheft Geothermie 2014, pp. 56–61.
- Ruschenburg, J., Herkel S., Henning H.-M., 2013. *A statistical analysis on market-available solar thermal heat pump systems*. Solar Energy, Volume 95, pp. 79–89.
- Steinmann H.C., 2013. *Wärmepumpen + Solarthermie – Eine Frage der Einstellung*. a3B:Tec, Volume 2013-6.
- Thür A., Vukits M., 2011. *Hocheffiziente Kombinationen von Solarthermie- und Wärmepumpenanlagen*. ee – Erneuerbare Energie, Volume 2011-1.
- Vukits M., et. al, 2013. *Potential der Kombination von Solarthermie- und Wärmepumpenanlagen – Erfahrungsbericht aus einem Forschungsprojekt*. ee – Erneuerbare Energie, Volume 2013-3.

6 Presentations

Table 2 lists presentations of Subtask A work in addition to the presentations that were given at conferences listed in Section 2.

Table 2: Presentations held on Subtask A topics with dissemination beyond the task members.

Event, Date & Place	Title	Presenter & Authors
Industry Workshop of the IEA SHC Task 44 / HPP Annex 38, 30 April 2010, Bolzano, Italy	Systemintegration Solar + Wärmepumpe	<u>S. Herkel</u> , M. Miara, F. Kagerer
see above	Speichersysteme und geothermische Sonden zur Verwendung in solarthermischen Systemen	<u>F. Thole</u>
see above	Market overview and financial issues	<u>C. Stadler</u>
Industry Workshop of the IEA SHC Task 44 / HPP Annex 38, 28 October 2010, Vienna, Austria	Subtask A: Classification	<u>S. Herkel</u>
VDI-Fachkonferenz Wärmepumpen, 7 June 2011	Solare Wärmepumpensysteme – Aktivitäten des Task 44 des IEA SHC	<u>J. Ruschenburg</u> , S. Herkel
Industry Workshop of the IEA SHC Task 44 / HPP Annex 38, 2 May 2012, Póvoa de Varzim, Portugal	Solar heat pump systems	<u>S. Herkel</u> , J. Ruschenburg
see above	Research project WPSol and former Solar + HP related activities at the ITW	<u>A. Loose</u>
Industry Workshop of the IEA SHC Task 44 / HPP Annex 38, 8 October 2012, Copenhagen, Danmark	Monitoring of Danish HP/solar thermal projects	<u>K. Ellehaug</u>
see above	Solar heat pump systems	<u>S. Herkel</u> , J. Ruschenburg
see above	Overview of solar thermal / heat pump systems on the Danish Market	<u>I. Katic</u>
Industry Workshop of the IEA SHC Task 44 / HPP Annex 38, 8 April 2013, Mechelen, Belgium	A comparative analysis of market available solar thermal heat pump systems	<u>J. Ruschenburg</u> , S. Herkel

7 Handbook Project

The content of Chapter 2 (System Description, Categorisation and Comparison) and chapter 6 (Monitoring) has been elaborated.