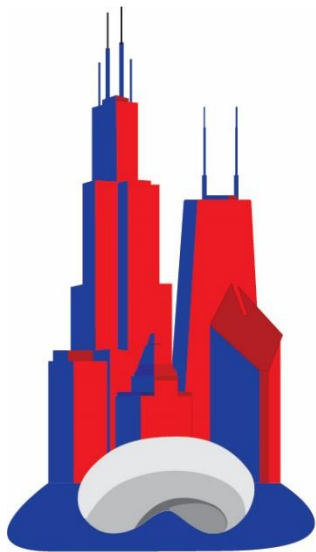




Conference Program



14th IEA
HEAT PUMP
CONFERENCE

RENAISSANCE CHICAGO DOWNTOWN HOTEL
MAY 15—18, 2023 | CHICAGO, IL

Monday, 7:00 – 17:00

Registration

Monday, 09:00 – 17:00

Workshops (four parallel tracks)

- ✓ **Advanced Cooling and Refrigeration technology development (09.00-12.00)** - Reinhard Radermacher, USA, [HPT Annex 53](#)
- ✓ **Flexibility in energy grids provided by heat pumps (13.00-15.00)** – Svend Pedersen, Denmark, [HPT Annex 57](#)
- ✓ **[Progress in Heat Pumps with Low GWP Refrigerants \(15.15-16.45\)](#)** – Yunho Hwang, USA, [HPT Annex 54](#)
- ✓ **Decarbonizing process heating with High-Temperature Heat Pumps: How to exploit the potential (09.00-12.00)** - Benjamin Zühlsdorf, Denmark, [HPT Annex 58](#)
- ✓ **[Acoustic Signatures and Placement Impact of Heat Pumps, interactive augmented reality and psychoacoustics \(13:00-16.15\)](#)** – Christoph Reichl, Austria, [HPT Annex 63](#)
- ✓ **[Heat Pumps in positive energy districts – opportunities, challenges and perspectives \(09.00-12.00\)](#)** - Carsten Wemhöner, Switzerland, a joint workshop of HPT [Annex 61](#), EBC Annex 83 and SHC Task 66
- ✓ **Comfort and Climate Box for cooling and dehumidification (13.00-15.00)** – Kashif Nawaz, USA
- ✓ **Comfort and Climate Box (15.15-16.45)** – Peter Wagener/Tom van Aalten, the Netherlands, [HPT Annex 55](#)
- ✓ **Investors’ role in different parts of the value chain of heat pumps (09.00-12.00)**- Monica Axell, Caroline Haglund Stignor, Sweden, [Heat Pump Centre](#)
- ✓ **The role of public and private funded projects to tenfold the number of heat pumps (13.00-15.00)** – Monica Axell, Caroline Haglund Stignor, Sweden, [Heat Pump Centre](#)

Monday, 09:00 – 12:00

Workshops (four parallel tracks)

WS 1.1 Advanced Cooling and Refrigeration technology development (09.00-12.00)

Organizer: Reinhard Radermacher, USA, Operating Agent of [HPT Annex 53](#)

Background

IEA HPT Annex 53 was initiated in late 2018 and focuses on the longer-term RD&D need. Technologies under investigation include the vapor compression (VC) based systems and non-traditional cooling approaches. Advanced VC R&D underway by participant teams includes a combined absorption/VC/thermal storage concept, a large chiller based on water (R-718) as refrigerant, a novel pressure exchange (PX) concept for expansion work recovery, and enhanced source and sink stream matching using zeotropic refrigerants.

About the workshop

The number of cooling systems that are in service by 2050 will greatly increase. It is the goal of HPT Annex 53 to coordinate and share research in advanced cooling technologies that may at some point reduce the resources that go into these systems and their environmental impact. This workshop provides an overview of the latest advances made by the contributing organizations. The workshop will conclude with a discussion on next steps in terms of research and technology development that will facilitate the market introduction of these new concepts.

Agenda

- Introduction
- Brief update presentations about individual projects
- Discussion with audience: What additional advances are needed or desirable?

WS 2.1 Decarbonizing process heating with high-temperature heat pumps – How to exploit the potential? (09.00-12.00)

Organizer: Benjamin Zühlsdorf, Danish Technological Institute, Operating Agent of [HPT Annex 58](#)

Background

High-temperature heat pumps are having a considerable potential for decarbonizing industrial process heating by electrification and energy efficiency and are therefore a key-technology in the sustainability strategy towards 2030 of various companies. While most of the applications require temperatures above 100 °C, there is only a limited number of suitable technologies available and demonstration cases. There are however various developments, aiming at developing and demonstrating technologies that can provide heat above 100 °C at competitive efficiencies and cost.

About the workshop

In order to exploit the massive potential of high-temperature heat pumps for industrial applications, a variety of stakeholders has to collaborate by:

- Developing and demonstrating a variety of high-temperature heat pump technologies
- Mastering the transition from fossil fuel-based heating systems towards heat pump-based heating systems
- Creating clear and long-term regulatory frameworks supporting energy efficient and electricity-based technologies

This workshop will bring together the key stakeholders from technology suppliers, end-users, policy makers and R&D organizations in order to create a common understanding of the technology potentials and the required actions to exploit the full potential.

Agenda

- 09:00 – 09:40: Keynote session
The keynote session will be setting the scene with short, inspirational keynotes on the application potential of HTHPs in industries and the technology status and perspectives.
 - General introduction, Benjamin Zuhlsdorf, DTI (10 min)
 - Application potential of HTHPs in industry, Steven Lecompte, Ghent University (15 min)
 - Technology status and perspectives, Jonas Lundstedt Poulsen (15 min)
- 09:40 – 11:25: Group session
During the group session, we will discuss the potentials and challenges associated with high temperature heat pumps, as well as the required actions to exploit the potentials. The topic will be discussed from the perspectives of 4 different stakeholders, namely technology suppliers, end-users, policy makers and R&D organizations to provide a holistic picture of the topic. For each of the four end-users, the following aspects will be addressed:
 - What are the potentials for the respective stakeholder associated with HTHPs?
 - What are the challenges for the respective stakeholder working with HTHPs?
 - What actions should be taken to exploit the potential for the respective stakeholder?
- 11:25 – 12:00: Summary and plenary discussion
During the plenary discussion, we will summarize the results from the group session and open up for a plenary discussion.

WS 3.1 [Heat Pumps in positive energy districts – opportunities, challenges and perspectives](#) (09.00-12.00)

Organizers: Carsten Wemhöner, OST, Switzerland, Operating Agent of [HPT Annex 61](#), together with representatives from EBC Annex 83 and SHC Task 66

Background

Climate protection targets require a fast reduction of greenhouse gas emissions. The building sector has large reduction potentials in many countries. Heat pumps are seen as the dominating HVAC system of the future, so the integration of heat pumps in the urban energy systems is an important future task. Positive energy districts are a highly ambitious concepts to promote the urban energy transition. Heat pumps can establish as core technology to reach these high-performance requirements both in building blocks and on the district level.

About the workshop

The Workshop will introduce the work in three IEA projects (IEA HPT Annex 61, EBC Annex 83, SHC Task 66) on high performance buildings and positive energy district concepts to enhance collaboration and promote HP in positive energy districts for the energy transition on the urban level. The objective is to discuss and learn from experiences of the audience with heat pump integration on the building and district level regarding technical and economic opportunities and challenges. Good examples from the IEA

projects are presented and further spread of heat pumps in high performance districts is discussed in an interactive panel discussion.

Agenda

Introduction to IEA projects

- 9:00 – 9:05: Welcoming and Workshop overview (C. Wemhoener, OST)
- 9:05 – 9:20: IEA HPT Annex 61 Heat pump in Positive Energy Districts (C. Wemhoener, OST)
- 9:20 – 9:35: IEA EBC Annex 83 Positive Energy Districts (U. Eicker, Concordia University)
- 9:35 – 9:50: IEA SHC Task 66 Solar Energy Buildings (L. Oppelt, TU Freiberg)

Outline and interim results of research projects

- 09.50– 10:30: Short presentations of research projects in the IEA Projects (IEA project attendees)

Coffee break 10:30-10:45

- 10.45 – 11.00: EU DUT Partnership, Mission Innovation (E. Pasic, Swedish Energy Agency)

State of Positive Energy Districts, Opportunities and challenges for Heat Pumps

- 11:00 – 11:45: Panel discussion with involvement of the audience (panel, all)

Conclusion and outlook

- 11:45 – 12:00: Summary, perspectives, Q & A (C. Wemhoener, all)

WS 4.1 Investors' role in different parts of the value chain of heat pumps (09.00-12.00)

Organizers: Monica Axell, Caroline Haglund Stignor, Heat Pump Centre (HPT TCP)

Background

To reach the climatic ambitions, investment in clean energy need to more than triple by 2030 in clean electricity generation, energy infrastructure and end-use, such as new clean, efficient equipment and renovation, etc. This will result in an increase in global GDP. According to IEA, the number of heat pumps needs to be tenfold by 2050 and increase by a factor of 3-4 if the Net Zero emission target by 2050 shall be met, which requires extensive investments in the whole value chain of heat pumps. Channeling private investment to the transition to a climate-neutral economy as a complement to public money would accelerate the energy transition. Private investors are “betting” on clean energy technology, with improved security of supply – a future safe investment!

About the workshop

During the workshop, representatives from different stakeholders will share their views on possibilities and barriers related to investments in the value chain of heat pumps- what could spur such investments

and what hinders them? During interactive discussions with the audience, we will explore where the most prominent bottlenecks for accelerating the roll-out of heat pumps are and where different types of investors could make a difference, while making a beneficial investment.

Agenda

- Introduction
- Interventions by different stakeholders on different types of investors' role in accelerating heat pump deployment
- Interactive session with the audience
- Panel discussion

Monday, 12:00 – 13:00

Lunch

Monday, 13:00 – 17:00

Workshops (four parallel tracks)

1.2 Flexibility in energy grids provided by heat pumps (13.00-15.00)

Organizer: Svend Pedersen, Danish Technological Institute, Operating Agent of [HPT Annex 57](#), ExCo delegate of Denmark and Marion Bakker, RVO, ExCo delegate of the Netherlands

Background

IEA HPT Annex 57 focuses on coming technologies, and the possibilities of heat pumps to increase the flexibility in energy systems with different sources such as PV, wind-power, and biomass and where end users can be consumer or prosumer or both (Multi-Vector). Individual heat pumps, as well as heat pumps in a district or local grid, can increase the flexibility.

About the workshop

The workshop will consist of a presentation session and discussions afterwards. Results from Annex 57 based cases will be presented.

The purpose of the workshop is to give the attendants an input of the flexibility created by heat pumps and the possibilities both for individual heat pumps and largescale heat pumps.

The attendants will after the presentations have possibility for discussion and sharing of their knowledge.

Agenda

Presentations from at least 3 different presenters.

WS 2.2 Acoustic Signatures and Placement Impact of Heat Pumps, interactive augmented reality and psychoacoustics (13.00-16.15)

Organizer: Christoph Reichl, Austrian Institute of Technology, Operating Agent of [HPT Annex 51](#) and [HPT Annex 63](#)

Background

The new IEA HPT Annex 63 “Placement Impact on Heat Pump Acoustics” has been set up as a follow up to the recently finalized IEA HPT Annex 51 “Acoustic Signatures of Heat Pumps” conducted by Austria, Denmark, Germany, France, Italy, and Sweden. IEA HPT Annex 63 is focusing on the placement impact of Heat Pumps on their surrounding. Noise emissions are a potential threat to further spreading of heat pumps in the years to come. Thus, working on the acceptance of heat pumps by minimizing these adverse environmental impacts while keeping high energy efficiency is of great importance.

About the workshop, purpose and objective

The purpose of the workshop is to greatly increase awareness on the importance of an optimal placement of heat pumps with regards to acoustic emissions both towards the heat pump’s owner and his/her neighbours. Attendees will have the opportunity to test innovative placement tools based on augmented reality on tablets and using immersive augmented reality headsets and report their technology experience. Furthermore a psychoacoustic test setup is made available for the participants to experience and rate different sound samples. The results will be analyzed during the workshop and discussed in a final presentation. Documentation of the technology experiences will make their way into the upcoming IEA HPT Annex 63.

Agenda

- Introductory presentations to set the scene
- Interactive sessions with AR/VR equipment to allow for immersive experience for the participants
- Psychoacoustic “panel test” using a psychoacoustic awareness test kit
- Discussion of the results of the psychoacoustic test and the technology experience of the AR/VR tools
- Brainstorming for enhanced functions and features, getting feedback
- Wrap up

For more information, please visit the workshop website:

<https://heatpumpingtechnologies.org/annex63/hpc2023>

WS 4.2 The role of public and private funded projects to tenfold the number of heat pumps (13.00-15.00)

Organizers: Monica Axell, Caroline Haglund Stignor, Heat Pump Centre (HPT TCP)

Background

One of IEA's key messages in the report "The Future of Heat Pump", released in November 2022, is that heat pumps are the key solution to reducing natural gas use for heating, supporting energy security, cutting emissions and keeping energy bills affordable. To reach the climate ambitions of IEA's Net Zero Emissions by 2050 scenario, 50% of the heating needs in buildings should be covered by heat pumps. This would mean a tenfold increase compared to today and an increase by a factor of 3-4 already in 2030. To reach these ambitions. Investments in clean energy technologies and infrastructure will be needed, both from the public and the private sector, as well as policies which stimulate the energy transition. Wisely designed public investments, sometimes in combination with private funding, can contribute to removing barriers and spur the transition.

About the workshop

The aim of the workshop is to inspire representatives from the public sector and industry to learn from good examples and to provide an improved understanding of how to optimize public investment and how different types of public (or public/private) funding can make a significant difference depending on the stage of market maturity. During the workshop, representatives from different stakeholders will share information about and experiences from different types of public or public/private investments designed to stimulate an accelerated deployment of clean energy technologies such as heat pumps. These interventions will be followed by a panel discussion with representatives from the public sectors as well as from the industry.

Agenda

- Introduction
- Interventions by different stakeholders on different types of public (or public/private) funding to stimulate heat pump deployment
- Panel discussion with representatives from the public sector and industry

WS 1.3 Progress in Heat Pumps with Low GWP Refrigerants (15.15-16.45)

Organizer: Yunho Hwang, University of Maryland, USA, Operating Agent of [HPT Annex 54](#)

Background

IEA HPT Annex 54 aims to promote the low-GWP refrigerant application to accelerate the phase-down of high-GWP HFCs through in-depth case studies of component optimization, providing design guidelines and real-world experiences.

About the workshop

This workshop is our series of the biannual workshop organized by the IEA HPT's Annex 54: *Heat Pumps with Low GWP Refrigerants*. Our workshop goal is to disseminate our latest progress in Annex 54 activities. This workshop will provide an update on the LC150 project for R290 heat pump development, market data, and safety topics; the low-GWP heat pump research and development activities in Austria; a comparison of four ecologic assessment criteria for heat pump systems; and analysis results on the influence of refrigerant choice and application of shape-optimized air-to-refrigerant heat exchangers on low-GWP refrigerants including propane, R454B, and R32.

Agenda

- Introduction: Annex 54 Heat Pumps with Low GWP Refrigerants, Yunho Hwang
- 150 Project – Update on final results about heat pump development, market data, and safety topics, Thore Oltersdorf
- Austria's activities in IEA HPT Annex 54, Christian Köfinger
- Ecologic Assessment of Heat Pump Systems: Evaluation of the Refrigerant's Impact, Christoph Höges
- Shape Optimized Air-to-Refrigerant Heat Exchangers for Low-GWP Refrigerants: Dehumidification & Acoustics Considerations, Vikrant Aute

WS 3.3 Comfort and Climate Box (15.15-16.45) – Peter Wagener/Tom van Aalten, the Netherlands, [HPT Annex 55](#)

Tuesday, 7:00 – 17:00

Registration

Tuesday, 9:00 – 12:00

Welcoming Remarks and Plenary Lectures

- Welcome by the International Organizing Committee (IOC) Chair
- Welcome by the National Organizing Committee Chair (NOC) Chair
- Introduction of the IEA Heat Pumping Technologies (HPT) Technology Collaboration Programme (TCP), Stephan Renz

Policy and Market

- Fatih Birol, Executive Director, IEA
- U.S. Department of Energy Leadership
- Mechthild Woersdoerfer, Directorate-General for Energy, European Commission

Technology

- Min Soo Kim, International Institute of Refrigeration (IIR) and Seoul National University
- Reinhard Radermacher, University of Maryland
- David Porter, Electric Power Research Institute (EPRI)

Tuesday, 12:00 – 13:00

Lunch, Poster Session and Exhibition

Tuesday, 13:00 - 14:25

1.1 Heat Pumps in Residential Buildings

Session Chair: Sophie Ducassy Hosatte

Session Keynote: Design and operational optimisation of an integrated thermal energy storage ground-source heat pump with time-varying electricity prices (715)

*Paul Sapin, Andreas V. Olympios, Matthias Mersch, Christos N. Markides**

Heat Pumps and Thermal Storage for Domestic Dwellings (460)

Neil J Hewitt, Babak Kamkari, Patrick Keatley*

Field tests of variable speed heat pumps to compare load-based and fixed-speed test and rating methods (438)

Bruce Harley, James Butler, Christopher Dymond, Gary Hamer, Jennifer McWilliams, David P. Yuill*

Development of a gas absorption heat pump for residential applications (515)

Tommaso Toppi, Lorenzo Pistocchini, Marco Guerra, Luigi Tischer, Pietro Brevi*

2.1 Markets and Policy

Session Chair: Stephan Renz

Invited Session Keynote: Global heat pump sales continue double-digit growth, IEA Global Energy Transition Stocktake

*Rafael Martinez-Gordon**

The Performance Playbook: A policy strategy for scaling heat pump adoption with happy consumers and utilities (1127)

*Andy Frank, Nate Kinsey**

Methodologies for high-density domestic heat pump deployment in the UK (364)

Nicola Lazenby, Alex Hobley*

Assessing the peak demand implications of air-source heat pumps in Canada and identifying potential mitigation strategies (504)

Justin Tamasauskas, Sarah Mollier, Martin Kegel*

3.1 Industrial Heat Pumps and Waste Heat

Session Chair: tbd

Session Keynote: Industrial Heat Pumps in Japan: Current Status and Future Prospects (195)

Takenobu Kaida, Toshihiro Mukai, Tsuyoshi Hamayashiki*

Decarbonizing Steam Generation with High Temperature Heat Pumps: Refrigerant Selection and Flowsheet Evaluation (59)

Christoph Höges, Valerius Venzik, Christian Vering, Dirk Müller*

Efficiency Improvement Of A High Capacity Transcritical CO2 Heat Pump For Human Comfort In Large Buildings (142)

*Hakim Nesreddine, Dominique Monney, Wayne Wehber, Michael Nielsen**

Industrial high temperature heat pump for steam and hot water production (87)

*Tim Hamacher**

Tuesday, 14:25 – 14:45

Coffee Break and Poster Session

Tuesday, 14:45 - 16:10

1.2 Heat Pumps in Residential and Commercial Buildings

Session Chair: Roger Hitchin

Session Keynote: A Review of Recent Residential Heat Pump Systems and Applications in Cold Climates (331)

*Hanlong Wan, Yunho Hwang**

Application of multipurpose heat pumps in museums: a case study (90)

Eva Schito, Paolo Conti, Daniele Testi*

Single Fault Impact Analysis of a Residential Heat Pump in the Cooling Mode According to the Temperature Conditions (717)

Minkyu Jung, Sanghun Jeong, Soyeon Kim, Donik Ku, Minsung Kim*

Simulation-assisted development of a mini-split air-to-water façade-integrated heat pump for minimal invasive renovations (652)

William Monteleone, Fabian Ochs*

2.2 Markets and Policy in Americas

Session Chair: Ed Vineyard

Session Keynote: Addressing the barriers to heating electrification in the US (1161)

Ed Vineyard, Jim Young, Samuel Yana Motta, Brian Fricke*

TECH Clean California: Paving the Way to Heat Pump Market Transformation (329)

Evan Kamei, Teddy Kisch*

Heat pumps in the United States: Market potentials, challenges and opportunities, technology advances (222)

Mini Malhotra, Zhenning Li, Xiaobing Liu, Melissa Lapsa, Tony Bouza, Edward Vineyard*

Impact Analysis of Transitioning to Heat Pump Rooftop Units for the U.S. Commercial Building Stock (1143)

Chris CaraDonna, Andrew Parker, Ryan Meyer*

3.2 Industrial Heat Pumps and Waste Heat

Session Chair: Tomas Caha

Session Keynote: Techno-economic optimization of high-temperature heat pumps using pure fluids and binary mixtures (95)

Elias Vieren, Toon Demeester, Wim Beyne, Martin Pihl Andersen, Brian Elmegaard, Michel De Paepe, Steven Lecompte*

Performance Analysis of High-Temperature Heat Pumps with Two-Phase Ejectors (806)

*Pengtao Wang, Stephen Kowalski, Cheng-Min Yang, Jian Sun, Zhiming Gao, Kashif Nawaz**

Numerical study of the part load operation for a reverse Brayton high-temperature heat pump (240)

Enrico Jende, Nancy Kabat, Panagiotis Stathopoulos*

Steam generating heat pumps – Measuring results and market potential (164)

Bernd Windholz, Johannes Riedl, Sophie Knöttner, Paula Schmidberger, Franz Helminger, Annemarie Schneeberger, Clément Gachot, Florence de Carlan, Yannick Beucher*

Tuesday, 16:10 – 16:30

Coffee Break and Poster Session

Tuesday, 16:30 – 17:55

1.3 Heat Pumps for Domestic Hot Water Heating

Session Chair: tbd

Session Keynote: Performance Analysis of Heat Pump Water Heater System Operating on a New Storage Heat Pump Cycle to Achieve Higher Operating Range (258)

*Purav Patel, Stefan Elbel**

Development of a new GAX-based absorption heat pump for Domestic Hot Water production (73)

Hai Trieu Phan, Fabio Aste, H el ene Demasles*

Searching for eco-friendly working fluids for an ejector-driven heat pump for domestic water heating (939)

Ramy H. Mohammed, Jeremy Spitzenberger, Pengtao Wang, Hongbin Ma, Ahmad Abu-Heiba, Stephen Kowalski, Kashif Nawaz*

Transcritical CO₂ heat pump for tap water heating: experimental validation of an auto adaptive algorithm for high pressure optimization (625)

Chiara Corazzol, Giovanni Rossanese, Sergio Maria Capanelli, Luca Mattiello*

2.3 Markets and Policy in Europe

Session Chair: Caroline Haglund Stignor

Session Keynote: Making progress in the decade of heat pumps – status and trends of the European heat pump markets in 2022 (959)

*Thomas Nowak**

Impact of the European Building Energy Requirements on the Heat Pump Market (778)

Mara Magni, Fabian Ochs, Elisa Venturi, Georgios Dermentzis, William Monteleone*

European heat pump market data – evolution of the state of the art heat pump over time and its possible knowledge gain (895)

Thore Oltersdorf, Hannes Fugmann, Lena Schnabel*

Innovative technologies and tools to increase deployment of domestic heat pumps in the UK (365)

*Alex Hobley, Nicola Lazenby**

3.3 Industrial Heat Pumps and Waste Heat

Session Chair: tbd

Session Keynote: Performance of a new ultra-high temperature industrial heat pump (430)

Arne Høeg, Kristian Løver, Trond-Atle Asphjell, Norbert Lümmer*

New Perspectives for the Application of large-scale Heat Pumps (277)

*Christian Huettl, Norbert Wenn, Juergen Voss, Florian Reissner, Jochen Schaefer**

Industrial High Temperature Heat Pumps – Ongoing Research in the USA (83)

Ammi Amarnath, Baskar Vairamohan*

Green Solutions To Facilitate Heat Pump Technology Adoption For Tobacco Baking Application In China (115)

Yanchun Han, Hengyi Zhao, Ying Xie*

Wednesday 8:30 – 17:00

Registration

Wednesday, 8:45 – 10:10

1.4 Heat Pumps in Commercial and Multifamily Buildings

Session Chair: tbd

Session Keynote: General classification of heat pumps solutions for multi-family buildings (878)

*Marek Miara**

Case Study of the Largest Air Source Heat Pumps Central Heating Project in China

*Zhao Mishen, Wang Huping, Zhao Hengyi, Xie Sherry, Ni Long, Ziyu Zhao**

Integration of heat sources for heat pump operation in the larger capacity range (896)

Carsten Wemhoener, Christoph Meier*

Decarbonization of Affordable Multifamily Housing – Application of high-efficiency monoblock heat pumps (292)

*Maggie Sheng, Zack Allen, Siva Sankaranarayanan**

2.4 Smart Grids and District Heating and Cooling

Session Chair: tbd

Session Keynote: Large scale demand response of heat pumps to support the national power system (731)

Tommy Walfridson, Markus Lindahl, Niclas Ericsson, Tobias Bergentz, Morgan Willis, Ola Gustafsson, Caroline Haglund Stignor*

In-situ monitoring of a groundwater heat pump for a low-temperature district heating network: energy performance, issues and challenges (451)

Pauline Brischoux, Stefan Schneider, Pierre Hollmuller*

An energetical, exergetical and experimental analysis of an absorption-heat exchanger used as transfer sub-station in an already existing district heating grid (199)

Gerald Zotter, Damian Eberhöfer, Carina Seidnitzer-Gallien*

Fields of application of large-scale heat pumps and challenges in planning (201)

Franziska Bockelmann, Joris Zimmermann*

3.4 Industrial Heat Pumps and Waste Heat

Session Chair: Benjamin Zuhlsdorf

Session Keynote: The Dynamic behaviors on Drying Performance of Heat Pump Dryer using a Reduced Order Model (262)

Yoonjei Hwang, Jinwook Lee, Wansoo Kim, Kangwook Lee, Yeonha Seong, Mansu Park, Saikee Oh*

Characterization of the fluid flow phenomena in an ejector for a high temperature heat pump (459)

Manuel Schieder, Constantin Zenz, Julian Unterluggauer, Michael Lauermann, Adam Buruzs, Veronika Wilk, Thomas Fleckl, Christoph Reichl*

A novel heat pump-based energy recycling system of an industrial building utilizing waste heat flows and geothermal energy (183)

Niklas Söderholm, Tuomo Niemelä*

Economic and Environmental considerations for the deployment of VHTHPs in European markets (684)

Kim Högnabba, Ron Zevenhoven, Tor-Martin Tveit, Stefano Vittor*

Wednesday, 10:10 – 10:30

Coffee Break and Poster Session

Wednesday, 10:30 – 11:55

1.5 Heat Pumps in Residential and Commercial Buildings

Session Chair: Marek Miara

Session Keynote: Assessing the potential of air-source heat pumps in the Canadian residential sector (514)

Justin Tamasauskas, Laurence Rousseau, Alex Lachance, Martin Kegel*

HpCosy - Heat Pump Comfort System (1013)

Christoph Messmer, Robert Haberl, Kanchan Bohara, Michel Haller, Michele Zehnder, Ralph Eismann*

Performance evaluation of multi-functional cascade heat pump system for a residential building (585)

*Beom-Jun Kim, Hye-Jin Cho, Soo-Jin Lee, Taek-Don Kwon, Jae-Weon Jeong**

Heat pumps in existing heating and hot water systems: an evaluation of primary energy savings and reduction of CO₂ produced (402)

Alberta Carella, Luca Del Ferraro, Annunziata D'Orazio*

2.5 Poster Session

Session Chair: Thomas Fleckl

A list of poster presentations may be found on Page 26.

3.5 Industrial Heat Pumps and Waste Heat

Session Chair: Naohiko Goto

Session Keynote: Integration of High-Temperature Heat Pumps in Swiss Industrial Processes (HTHP-CH) (494)

Cordin Arpagaus, Frédéric Bless, Stefan Bertsch, Pierre Kruppenacher, Daniel A. Flórez-Orrego, Eduardo A. Pina, François Maréchal, Nicole Calame Darbellay, Fabrice Rognon, Stéphane Vesin, Pascal Achermann, Christian Jansen*

Numerical evaluation of high-temperature heat pump and thermal energy storage system for industrial processes (1072)

Seon Tae Kim, Robert Hegner, Göksel Özüylasi, Panagiotis Stathopoulos, Eberhard Nicke*

Achievement report of NEDO R&D Project on Innovative Thermal Management Materials and Technologies (525)

Yoichi Fujita, Tetsushiro Iwatsubo*

Simulation Towards Demonstration: A Comparison Of Different Control Concepts Of An Industrial-Scale Rotation Heat Pump (793)

Michael Laueremann, Stephan Kling, Bernd Windholz, Andreas Sporr, Andreas Längauer, Georg Kaltenbaek, Bernhard Adler*

Wednesday, 12:00 – 13:00

Lunch, Poster Session and Exhibition

Wednesday, 13:00 - 14:25

1.6 Heat Pumps in nZEB Buildings and Positive Energy Districts and Field Measurements

Session Chair: tbd

Session Keynote: Heat pump application in cluster of buildings and positive energy districts (885)

*Carsten Wemhoener**

nZEB with GWHP in cold region of Japan (816)

Katsunori Nagano, Ye Minzhi, Hideki Sato*

Optimization of SPF or CO₂ emissions? Impact of control strategies on a bivalent waste water heat pump system for high energy standard buildings (432)

Simon Callegari, Fleury de Oliveira, Pauline Brischoux, Pierre Hollmuller*

Field Experience with Residential Heat Pumps in Switzerland: Potential for Improvement and Future Developments (478)

Cordin Arpagaus, Matthias Berthold, Michael Uhlmann, Ralph Kuster, Mick Eschmann, Stefan Bertsch*

2.6 Market and Policy

Session Chair: Monica Axell

Invited Session Keynote: Policies related to refrigerants and their impact on research needs within heat pumping technologies

*Didier Coulomb**

Tracking the carbon impact of space heating appliances from cradle to grave (298)

Laure Meljac, Martin Forsen*

Towards integral assessment of heat pumps and refrigerants using LCA: A case study for the German building stock (311)

*Christian Vering, Christian Zibunas, Felix Tessarek, Nils Moschner, Katharina Breuer, Christoph Höges, Niklas von der Aßen, Dirk Müller, Hannah Romberg**

Strategies to overcome the dilemma in renovating and integrating HPs and RE into the building stock (651)

Fabian Ochs, Alice Tosatto, Mara Magni, Elisa Venturi, William Monteleone, Georgios Dermentzis*

3.6 Industrial Heat Pumps and Waste Heat

Session Chair: tbd

Session Keynote: Industrial heat pumps: electrifying process heat supply in the United States through technology demonstration and market transformation actions (81)

Paul Scheihing, Andrew Hoffmeister, Ed Rightor, Riyaz Papar*

Ammonia - Steam cascade heat pump for +100°C steam generation (787)

Kenneth Hoffmann, Michael Bantle, Kjetil Evenmo, Vebjørn Nilsen*

Exploration of Heat-Driven Ejector High-Temperature Heat Pumps (1133)

*Pengtao Wang, Stephen Kowalski, Cheng-Min Yang, Jian Sun, Zhiming Gao, Kashif Nawaz**

Development of industrial heat pump simulator (1020)

Jongsoo Jeong, So Muto, Yoichi Miyaoka, Kiyoshi Saito*

Wednesday, 14:25 – 14:45

Coffee Break and Poster Session

Wednesday, 14:45 – 16:10

1.7 Ground Source Heat Pump Systems

Session Chair: tbd

Session Keynote: Heat pump system performance measurement in Annex 52 (303)

Signhild Gehlin, Jeffrey D. Spitler*

Abandoned mines as a source of heat and cold (44)

Lukas Oppelt, Thomas Grab, Thomas Storch, Timm Wunderlich, Tom Ebel, Tobias Fieback*

Assessment of ambient loop-coupled GSHP and WWHP systems in a cold-climate institutional/residential development (924)

Monica Brands, Usama Sohail, Alan Fung*

Optimisation of a Novel Dry Air-Ground Source (DAGS) Heat Pump System (954)

Metkel Yebiyo, Bassam E. Badran, Caroline Haglund Stignor, Monica Axell, Ola Gustafsson*

2.7 Hybrid Heat Pumps, Combination of Technologies

Session Chair: Minsung Kim

Session Keynote: Long term performance analysis of a Dual-Source Heat Pump system by means of the Matlab/Simulink tool ALMABuild (725)

Christian Natale, Claudia Naldi, Matteo Dongellini, Gian Luca Morini*

Hybrid thermally driven ionic liquid heat pump water heater and dehumidifier for commercial applications (358)

*Rohit Bhagwat, Michael Schmid, Paul Glanville, Saeed Moghaddam**

Investigation of a Novel Hybrid Heat Pump Concept (113)

Tobias Reum, David Schmitt, Thorsten Summ, Tobias Schrag*

Performance Analysis of Hybrid Ground Source Heat Pump and PVT System for Nordic Climate (829)

Mohammad Liravi, Carsten Wemhoener, Yanjun Dai, Laurent Georges*

3.7 Systems and Components Development

Session Chair: tbd

Session Keynote: Analysis of Large-Scale Ammonia Heat Pumps in Transient Operating Conditions (697)

Kenneth Rugholm Kramer, Jonas Lundsted Poulsen, Wiebke Meesenburg, Mathias Kjær Christensen, Peter Reinholdt, Brian Elmegaard, Benjamin Zühlsdorf*

Development and Evaluation of Ammonia Vapor Compression Coupled to a CO₂ Convection Loop (1180)

Ron Domitrovic, Ethan Tornstrom, Troy Davis, Jerine Ahmed*

Laboratory characterization of a cascade heat pump system with intermediate water loop (761)

Diego Menegon, Matteo Campidelli, Roberto Fedrizzi*

Leveraging MultiSource Heat Pump Technology to Produce Electricity and/or Hydrogen Through Enhanced Reverse Electrodialysis Process (1014)

Rahul Nana, Rafael Feria, Piotr Dlugolecki*

Wednesday, 16:10 – 16:30

Coffee Break and Poster Session

Wednesday, 16:30 – 17:55

1.8 Ground Source Heat Pump Systems

Session Chair: Signhild Gehlin

Session Keynote: Development of a Simulation Tool for Ground Source Heat Pump Systems Using Horizontal Ground Heat Exchangers (928)

Takao Katsura, Motohiro Maeda, Yutaka Shoji, Katsunori Nagano*

Development and application of a new calculation method for double spiral ground heat exchangers (535)

Kunning Yang, Takao Katsura, Katsunori Nagano*

Simplified ground-source heat pump models for predicting heat extraction (181)

Sara Bordignon, Jeffrey D. Spitler, Angelo Zarrella*

A novel oscillatory thermal response test for deep U-tube borehole heat exchanger: In situ data (931)

*Ahmed A. Serageldin, Nagano Katsunori**

2.8 Hybrid Heat Pumps, Combination of Technologies

Session Chair: Tom van Aalten

Session Keynote: Enabling Electrification of Domestic Hot Water and Space Conditioning with Multi-function Heat Pumps (192)

Subhrajit Chakraborty, Stephen Chally, Timothy Levering*

Experimental testing of solar photovoltaic/thermal collector as a heat pump source under outdoor laboratory conditions (375)

Francisco Beltrán, Nelson Sommerfeldt, Hatef Madani*

An Assessment of Gas Absorption Heat Pump Integration Strategies with Combination and Commercial Space Conditioning Systems (335)

Abinesh Ravi, Michael Mensinger Jr., Paul Glanville, Jason LaFleur, Steven Arnold*

Monovalent and Hybrid Air-source Heat Pump Concepts for Existing Multifamily Buildings – Energy Performance and CO₂ Savings (947)

Omar Montero, Pauline Brischoux, Carolina Fraga, Matthias Rüetschi, Nicole Calame, Fabrice Rognon, Pierre Hollmuller*

3.8 Systems and Components Development

Session Chair: Yoichi Fujita

Session Keynote: Development of vapor compression system using natural refrigerant (1058)

Jungchul Kim, Jin Woo Yoo, Kong Hoon Lee, Chan Ho Song*

Detecting Leaks of Flammable Refrigerants below the 5% Lower Flammability Limit with a Low-Cost Sensor Platform (692)

Moonis R. Ally, Stephen Killough*

High temperature test results and application cases of a Rotation Heat Pump (413)

Andreas Längauer, Bernhard Adler*

Design of non-flammable mixed refrigerants Joule-Thomson refrigerator below -100°C (86)

*Taejin Park, Junhyuk Bae, Sangkwon Jeong**

Wednesday, 18:30 – 21:00

Banquet and Ritter von Rittinger Award

Thursday 8:30 – 12:00

Registration

Thursday, 8:45 – 10:10

1.9 Control, Monitoring and Digitalization

Session Chair: tbd

Session Keynote: Development of dynamic model of variable refrigerant flow cooling system based on moving boundary method (531)

*Jeong Kuk Hong, Hongryul Joo, Min Soo Kim**

Maximizing operational efficiency of heat pumps with Model Predictive Control: An experimental case study for residential application (805)

Stephan Göbel, Phillip Stoffel, Florian Will, Christian Vering, Dirk Müller*

Frost Detection with Neural Networks: Determining Necessary Sensors to Predict Optimal Defrost Initiation Time for Air Source Heat Pumps (231)

Jonas Klingebiel, Paul Salomon, Christian Vering, Dirk Müller*

Development and validation of data-driven soft sensors for heat pumps (680)

Yang Song, Davide Rolando, Javier Marchante Avellaneda, Gerhard Zucker, Hatef Madani*

2.9 Systems and Components Development

Session Chair: Jussi Hirvonen

Session Keynote: Experimental study of steam-driven ejector heat pump (938)

Jeremy Spitzenberger, Ramy H. Mohammed, Pengtao Wang, Hongbin Ma, Ahmad Abu-Heiba, Stephen Kowalski, Kashif Nawaz*

Pool boiling on metal-foam enhanced tube bundle: heat transfer characteristics and flow visualization (1098)

Cheng-Min Yang, M. Muneeshwaran, Pengtao Wang, Kashif Nawaz*

A study on heat and water recovery performance of membrane heat exchanger using different membrane (1104)

*Van Cong Le, Thi Nhan Nguyen, Min Sung Lee, Jae-il Kwon, Dae Hae Kim, Sung Joo Hong, Min Soo Kim, Chan Woo Park**

Numerical comparison of the yearly performance of an indirect vapour compression heat pump working with R290 with R410A systems (289)

*Nicholas Croci, Matteo Fusaro, Luca Molinaroli**

3.9 Sorption Technologies

Session Chair: tbd

Session Keynote: Thermally driven industrial ionic liquid absorption heat pump dryer (354)

Michael Schmid, Rohit Bhagwat, Saeed Moghaddam

Steady state measurements and dynamic behaviour of an absorption heat transformer operating in an industrial environment (564)

José L. Corrales Ciganda, Asier Martinez-Urrutia*

Ionic liquid absorption system for dehumidification and IAQ enhancement in built environment (349)

*Rohit Bhagwat, Michael Schmid, Abbas Ahsan, Navin Kumar, Paul Glanville, Saeed Moghaddam**

Performance of a State-of-Art Packaged Heat Pump for Residential Space Conditioning and Hot Water (343)

Navin Kumar, Alejandro Guada, William Asher, Alex Fridlyand, Paul Glanville, Matt Blaylock, Thao Strong*

Thursday, 10:10 – 10:30

Coffee Break and Poster Session

Thursday, 10:30 – 11:55

1.10 Smart Grids, Flexibility and Control

Session Chair: Marion Bakker

Session Keynote: Interconnected heat pumps in Austria: A technology implementation survey (237)

Veronika Wilk, Reinhard Jentsch, Tilman Barz*

Flexibility potential of heat pumps in Swedish thermal grids: for district heating companies and end users (394)

Meng Song, Anna-Lena Lane, Markus Lindahl, Tommy Walfridson, Metkel Yebiyo*

Numerical performance assessment of heat pumps in Rankine-based Carnot battery systems for grid balancing services (170)

Robin Tassenoy, Jari De Craecker, Katarina Simić, Toon Demeester, Michel De Paepe, Steven Lecompte*

Evaluation of the potential of heat pumps in the reduction of energy consumption in energy communities: a case study in a Mediterranean district (500)

*Ximo Masip, Rossana Boccia, Emilio Navarro-Peris**

2.10 Systems and Components Development

Session Chair: Steffen Linsmayer

Session Keynote: Pumped Supercritical CO₂ as Distribution Fluid for an Air Source Heat Pump (1067)

*Matt Robinson, Aaron Tam, Scott Goedeke, Dennis Nasuta, Paul Kalinowski, Andrea Mammoli**

Progress and challenges in rolling bearing technology for compressors in industrial heat pumps (143)

Guillermo E. Morales-Espejel, Rudolf Hauleitner, Paul Dietl*

Experimental Investigation Into The Effect of Charge Optimization And Standard Test Conditions On The Seasonal Performance In An R410A Heat Pump With Dedicated Subcooler (506)

Sugun Tej Inampudi, Stefan Elbel*

Optimisation study on a transcritical CO₂ heat pump with or without cold thermal energy storage (62)

Ji Wang, Michael Evans, Martin Belusko, Ming Liu, Frank Bruno*

3.10 Sorption Technologies

Session Chair: tbd

Session Keynote: Boiling Heat Transfer of Ammonia in a Flooded Evaporator of Adsorption Heat Pumps (424)

Jin Sub Kim, Dong Hwan Shin, Wookyoung Kim, Seok Ho Yoon*

Study on a hybrid refrigeration cycle by combining an absorption process with a compression process using Low-GWP refrigerant (1125)

Tsutomu Wakabayashi, Saori Sakurai, Ryosuke Takioka, Hajime Yabase, Naoyuki Inoue, Yonezo Ikumi, Kiyoshi Saito*

Performance test of a gas-fired absorption heat pump with total recovery of exhaust heat applied for distributed space heating (716)

Ding Lu, Zijian Liu, Maoqiong Gong*

Numerical evaluation of simultaneous cooling and heating absorption system using H₂O/ionic liquid and R32/ionic liquid as working fluids (972)

*Sejun Park, Doseong Yun, Hyun Uk Cho, Nam Soo Lee, Yong Tae Kang**

Thursday, 12:00 – 13:00

Lunch, Poster Session and Exhibition

Thursday, 13:00 - 14:25

1.11 Heat Pumps Integrated with Thermal Energy Storage

Session Chair: Maurizio Pieve

Session Keynote: Feasibility Analysis for the Use of Retrofitted Air-Conditioners Using Thermal Energy Storage (TES) for High Ambient Temperature (HAT) Countries (763)

Al-Hussain Othman, Vikrant Aute, Daniel Bacellar*

Carbon Mitigation Potential of Heat Pump Integrated with Thermal Storage for Grid-Interactive Residential Buildings (286)

Sara Sultan, Jason Hirsche, Zhenning Li, Bo Shen, Samuel Graham, Kyle R. Gluesenkamp*

Experimental Investigation of a Phase Change Material Charged Serpentine Heat Exchanger with Louvered Fins (327)

Jangho Yang, Jan Muehlbauer, Daniel Bacellar, Vikrant Aute, Yunho Hwang**

A proposed methodology to reduce heat pump size with integrated thermal energy storage (812)

Jason Hirsche, Kyle R. Gluesenkamp, Bo Shen, Zhenning Li, Samuel Graham*

2.11 Working Fluids and Refrigerants

Session Chair: tbd

Session Keynote: Development of a Refrigerant Evaluation Tool for Air Conditioners (1044)

Yoichi Miyaoka, Niccolo Giannetti, Jongsoo Jeong, Kiyoshi Saito, Komei Nakajima, Koji Yamashita, Shigeharu Taira*

Optimization of a Residential Air Source Heat Pump using Refrigerants with GWP <150 for Improved Performance and Reduced Emission (1974)

Zhenning Li, Samuel F. Yana Motta, Bo Shen, Hanlong Wan*

LCCP Evaluation for Air-to-Air Heat Pumps using Next-Generation Refrigerants - Residential Air Conditioners (1016)

Shigeharu Taira, Eiji Hihara*

Performance and safety analysis of charge reduced brine to water heat pumps using R290 (622)

Timo Methler, Hannes Fugmann, Clemens Dankwerth, Christian Sonner, Katharina Morawietz, Lena Schnabel*

3.11 Non-Traditional Technologies

Session Chair: tbd

Session Keynote: Modelling and Simulation of a Thermoelectric Heat Pump with Micro-Channel Heat Transfer (282)

Hanlong Wan, Bo Shen, Kyle R. Gluesenkamp*, Zhenning Li*

Evaluation of proper HFO refrigerant/ionic liquid mixture for absorption refrigeration system (206)

*Younggyun Lee, Gilbong Lee, Junhyun Cho, Bongsu Choi, Nyeon Gu Han, Dong Kyu Kim**

High Efficiency Heat Pump Industrial Drying with Water Vapor-Selective Membranes (106)

Andrew J. Fix, James E. Braun, David M. Warsinger*

A Study on Isothermal Compression System Applying Electrochemical Compressor (630)

Soyeon Kim, Minkyu Jung, Donik Ku, Soojin Bae, Gijeong Seo, Dong Kyu Kim, Minsung Kim*

Thursday, 14:25 – 14:45

Coffee Break and Poster Session

Thursday, 14:45 – 16:10

1.12 Systems and Components Development

Session Chair: tbd

Session Keynote: Development of a Near-isothermal Compressor for Transcritical Carbon Dioxide Cycle (217)

Cheng-Yi Lee, Timothy Kim, Jan Muehlbauer, Yunho Hwang*, Reinhard Radermacher*

Techno-environmental evaluation of a river-source heat pump system using a hot gas bypass valve (385)

Hyun Ku Cho, Hyun Ho Shin, Se Hyeon Ham, Sun An Jeong, Kyoung-Tae Park, Yongchan Kim*

Comparison of seasonal energy efficiency of different compressor types (807)

Christian Stahel, Lukas Wick, Frank Tilkamp, Silvan Steiger, Manuel Diem*

Flow Boiling Heat Transfer Performance of R448A inside Multiports Mini-Channel tubes with different geometry (376)

Hoang Ngoc Hieu, Nurlaily Agustiarini, Jong-Taek Oh, Jong Kyu Kim*

Innovative small capacity gas driven ammonia-water absorption heat pump prototype for space heating and domestic hot water production (520)

Lorenzo Pistocchini, Giorgio Villa, Cesare Paulin, Tommaso Toppi*

2.12 Working Fluids and Refrigerants

Session Chair: tbd

Session Keynote: Performance evaluation and optimization of lower GWP refrigerants in a residential heat pump (1106)

Jethro Medina, Joshua Hughes*

Evaluation of lower GWP alternatives to R410A in AC and HP applications (123)

Michael Petersen, Steve Kujak, Gurudath Nayak*

Testing of alternative refrigerants for unitary air-conditioning and heat pump applications (127)

Sarah Kim, Robert Elliott Low, Christopher Seeton, Ke Tang, Francesco Botticella*

Novel HFO Refrigerant Blend R-474A for GWP <1 Automotive Heatpump Application (266)

Ivan Rydkin, Tsubasa Nakae, Alvaro Leon*

3.12 Sorption Non-Traditional Technologies

Session Chair: tbd

Session Keynote: Theoretical analysis of membrane based liquid desiccant air conditioning system (399)

*Seong-Yong Cheon, Beom-Jun Kim, Jae-Hee Lee, Minseong Kim, Hyo-Lim Park, Jae-Weon Jeong**

Ideal performance analysis of membrane-based vacuum dehumidification systems (636)

Donik Ku, Soyeon Kim, Minkyu Jung, Soojin Bae, Young Soo Chang, Minsung Kim*

Numerical evaluation of simultaneous cooling and heating absorption system using H₂O/ionic liquid and R32/ionic liquid as working fluids (527)

Sejun Park, Doseong Yun, Hyun Uk Cho, Nam Soo Lee, Yong Tae Kang*

Resorption heat pump development (147)

George H. Atkinson, R. E. Critoph, S. J. Metcalf, G. S. F. Shire

Thursday, 16:30 – 18:00

Closing Ceremony and Best Poster Award

Poster Presentations

Heat Pumps in Residential Buildings / Hot Water

Hydronic Optimization for a good Heat Pump Performance (543)

Gaia Balzarini, Peter Gammeljord, Jan Eric Thorsen, Torben Funder-Kristensen*

A heat pump system for simultaneous comfort floor cooling and domestic hot water (573)

Tingting Zhu, Jierong Liang, Jan Eric Thorsen, Oddgeir Gudmundsson, Wilko Rohlf, Brian Elmegaard*

Heat Pumps in Commercial Buildings

Cold Climate Field Demonstration of Variable Refrigerant Flow (VRF) Heat Pump and Variable-Air-Volume (VAV) System (777)

Patricia F. Rowley, Alex Fridlyand, David J. Schroeder, Shawn Scott*

Free cooling in air conditioning: Investigation of its potential in Switzerland (792)

Silvan Steiger, Christian Stahel, Stefan Rohrer, Martin König, Frank Tillenkamp*

Load-based performance characterization of air conditioners using an emulator-type assessment technique (156)

Damiano Dondini, Ryohei Mori, Niccolo Giannetti, Yoichi Miyaoka, Kiyoshi Saito*

Hybrid Heat Pumps, Combination of Technologies

Performance analysis of hybrid operating modes for dual coolant-source heat pump system applied to electric-driven vehicles (1102)

*Hoseong Lee, Hanbeol Jeon, Jaehyeong Seo, Dongchan Lee, Yongchan Kim**

Industrial Heat Pumps and Waste Heat

Heat pump application approach to abate plume generation from a cooling tower (608)

Gilbong Lee, Junhyun Cho, Bong Su Choi, Bong Seong Oh, Ki-Chang Chang*

Thermodynamic analysis of the cascade economization cycle for high temperature heat pump applications (363)

Elias N. Pergantis, Abd Alrhman M. Bani Issa, John K. Brehm, Andreas J. Hoess, Eckhard A. Groll, Davide Ziviani*

Investigation of industrial high-temperature heat pumps for simultaneous heating and cooling: A brewery case study (273)

Martin Pihl Andersen, Roger Padullés I Solé, Benjamin Zühlsdorf, Wiebke Brix Markussen, Jonas Kjær Jensen, Brian Elmegaard*

Integration of high-temperature heat pumps in Germany (476)

Stefan Henninger, Cordin Arpagaus, Sebastian Benkert, Hannah Teles de Oliveira, Peter Schöttl, Wolfgang Kramer, Florencia Cherri, Stefan Bertsch*

Multiparametric Analysis of Novel Multilevel Temperature Heat Pumps (LEAP) for Multi-Sink Heating (485)

Bassam E. Badran, Metkel Yebiyo, Caroline Haglund Stignor, Monica Axell, Ola Gustafsson, Morgan Willis*

Techno-economic comparative analysis of solar thermal collectors and high-temperature heat pumps with PV for industrial steam generation (1166)

Mohammad Ghasemi, Puneet Saini, Cordin Arpagaus*, Frédéric Bless, Stefan Bertsch, Xingxing Zhang*

Feasibility study for the application of a high-temperature heat pump in the pulp and paper industry: an Italian case study (815)

Marco Pellegrini, Alessandro Guzzini, Cesare Saccani*

Systems and Components Development

A novel method for estimation of the annual energy assessment of using an external subcooler in a refrigeration machine (788)

Manuel Diem, Lukas Wick, Christian Stahel, Frank Tillenkamp*

Analysis of the performance of a heat pump with subcooling control as a function of the refrigerant charge (498)

*Belén Llopis-Mengual, Emilio Navarro-Peris**

Fan Replacement offers an instant energy rebate of 40% in every heat exchanger (996)

*Gilbert Staffend**

A modified effectiveness-based approach in performance prediction of simultaneous heat and mass transfer in heat pump operating conditions (522)

*Ruozhou Du, Jiabao An, Long Huang**

Design methodology of vapor compression heat pump module in Smart Thermal Energy Design platform (1037)

*Bong Seong Oh, Gilbong Lee, Bongsu Choi, Hyunki Shin, Young-Jin Baik, Beomjoon Lee, Jongjae Cho, Gyunchul Hur, Sun Ik Na, Ho-Sang Ra, Eunseok Wang, Min Soo Kim, Junhyun Cho**

Upscaling and case study design: Influence on the environmental impact assessment of high-temperature heat pumps using LCA (1175)

Lukas Zeilerbauer, Stefan Puschnigg, Johannes Lindorfer, Felix Hubmann*

Working Fluids and Refrigerants

Preliminary test result of an oil compatibility of a low-GWP refrigerant as an alternative to R410A in a compressor test loop (598)

Junhyun Cho, Gilbong Lee, Bongsu Choi, Bong Seong Oh, Ho-Sang Ra, Sun Ik Na, Eunseok Wang, Gyunchul Hur, Jongjae Cho, Beomjoon Lee, Young-Jin Baik*

Investigation of the performance of a ground-coupled CO₂ heat pump for space and water heating (140)

Thor Alexis Sazon, Homam Nikpey*

Comparative Analysis on Ejector and Converging Tee-driven Refrigeration Systems (301)

*Gwang Soo Ko, Waseem Raza, Youn Cheol Park**

Sorption and Non-Traditional Technologies

Design and energy performance of the heat pump-driven liquid desiccant system with an ultrasonic atomization (941)

*Soo-Jin Lee, Seong-Yong Cheon, Su-Young Jo, Jae-Won Joung, Jae-Weon Jeong**

Optimum Capacity-Matching Performance of a Heat-Pump-driven Liquid-Desiccant Air-conditioning System (389)

*Jae-Hee Lee, Yong-Kwon Kang, Seheon Kim, Gyu-Bae Lee, Jae-Weon Jeong**

Development of a Novel Sorption-Type Heat Pump Water Heater for North American Homes (660)

Paul Glanville, Navin Kumar, Abbas Ahsan, Alex Fridlyand, Magnus Ekblad, Ingemar Hallin, Corey Blackman, Noe Contreras*

An Experimental Study on the Chemisorption Heat Pump for Low Temperature Heat Source (979)

*Hak Soo Kim, Jeong Hyun Kim, Dong Ho Kim, Young Kim, Seok Ho Yoon**