Conference Program

14th IEA Heat Pump Conference
Renaissance Chicago Downtown Hotel
May 15–18, 2023 | Chicago, IL
Monday, 7:00 – 17:00

Registration
2\textsuperscript{nd} Floor, Pre-Function

Monday, 09:00 – 17:00

Workshops (four parallel tracks)

- **WS 1.1 Advanced Cooling and Refrigeration technology development (09.00-12.00)** -
  3rd Floor, Cloud Gate 1-2
  Reinhard Radermacher, USA, HPT Annex 53

- **WS 1.2 Flexibility in energy grids provided by heat pumps (13.00-15.00)** –
  3rd Floor, Cloud Gate 1-2
  Svend Pedersen, Denmark, HPT Annex 57

- **WS 1.3 Comfort and Climate Box (15.15-16.45)** –
  3rd Floor, Cloud Gate 1-2
  Peter Wagener/Tom van Aalten, the Netherlands, HPT Annex 55

- **WS 2.1 Decarbonizing process heating with High-Temperature Heat Pumps: How to exploit the potential (09.00-12.00)** -
  3rd Floor, Cloud Gate 3-4
  Benjamin Zühlsdorf, Denmark, HPT Annex 58

- **WS 2.2 Acoustic Signatures and Placement Impact of Heat Pumps, interactive augmented reality and psychoacoustics (13:00-16.15)** –
  3rd Floor, Cloud Gate 3-4 + Cloud Gate 5 Test Room
  Christoph Reichl, Austria, HPT Annex 63

- **WS 3.1 Heat Pumps in positive energy districts – opportunities, challenges and perspectives (09.00-12.00)** -
  3rd Floor, Looking Glass
  Carsten Wemhöner, Switzerland, a joint workshop of HPT Annex 61, EBC Annex 83 and SHC Task 66

- **WS 3.2 Comfort and Climate Box for cooling and dehumidification (13.00-15.00)** –
  3rd Floor, Looking Glass
  Kashif Nawaz, USA

- **WS 3.3 Progress in Heat Pumps with Low GWP Refrigerants (15.15-16.45)** –
  3rd Floor, Looking Glass
  Yunho Hwang, USA, HPT Annex 54
Workshops (four parallel tracks)

**WS 1.1 Advanced Cooling and Refrigeration technology development (09.00-12.00)**
3rd Floor, Cloud Gate 1-2
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)**
3rd Floor, Cloud Gate 3-4
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)
3rd Floor, Looking Glass

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)
- 9:20 – 9:35: IEA EBC Annex 83 Positive Energy Districts (U. Eicker, Concordia University)

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)
3rd Floor, Urban Blue

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
• 9.00-9.15: Introduction, Monica Axell and Caroline Haglund Stignor, Heat Pump Centre
• 9.15-9.30: IEA Energy Technology Perspectives 2023 – The importance of private investments for the clean energy transition: Rafael Martinez Gordon, IEA
• 9.30-9.45 How European policy package support investments in the value chain of heat pumps, Julian Dieler, European Commission
• 9.45-9.55: How investments can contribute to decarbonize heating by deployment of heat pumps (tbc), Nigel Jollands
• 9.55-10.05: The most prioritized actions from an industry perspective to scale the market, Ryan Dougherty, GeoExchange
• 10.05-10.30: Interventions by industry – The most critical bottlenecks for continued market growth, where investors can make a difference
  ✓ Daikin, Patrick Crombez
  ✓ Vaillant, Barbara Priesching
10.30-10.45: BREAK
• 10.45-11.30: Workshop – group discussions
• 11.30-11.50: Panel discussion - Investors’ role in different parts of the value chain of heat pumps
  • Martin Forsén, Nibe
  • Patrick Crombez, Daikin
  • Barbara Priesching, Vaillant
  • Rafael Martinez Gordon, IEA
Monday, 12:00 – 13:00

Lunch
2nd Floor, Explore

Monday, 13:00 – 17:00

Workshops (four parallel tracks)

1.2 Flexibility in energy grids provided by heat pumps (13.00-15.00)
3rd Floor, Cloud Gate 1-2

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)
3rd Floor, Cloud Gate 3-4 + Cloud Gate 5 Test Room
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 3.2 Comfort and Climate Box solutions for cooling and dehumidification (13.00-15.00)
3rd Floor, Looking Glass

Organizer: Kashif Nawaz, Oak Ridge National Laboratory, USA

Background

The demand for comfort cooling is growing rapidly in many parts of the world and stated policies will not be able to curb electricity use for cooling, which is set to grow threefold according to IEA. Similarly cost effective moisture management (dehumidification) has been noted as an energy-intense process.
There are great possibilities to increase the energy efficiency and the share of renewable electricity used for comfort cooling, by combining heat pumping technologies with energy storages and integrated control.

**About the workshop**

The purpose of the workshop is to discuss and refine the proposal for a new international collaboration project (i.e., Annex) aiming at developing so called “Comfort and Climate Box” solutions for cooling and dehumidification – solutions that are efficient, affordable, applicable and scalable.

**Agenda**

- Introduction: The objective of the annex (Kashif Nawaz)
- Why energy storage is important? (TBD)
- Overview of challenges and opportunities associated with process integration (Brian Fricke)
- Discussion sessions (TBD)

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

3rd Floor, Urban Blue

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 in 2045. 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

• 13.00-13.10: Welcome and introduction, Monica Axell and Caroline Haglund Stignor, Heat Pump Centre
• 13.20-13.30: How the Inflation Reduction Act will contribute to increased investment and scaling of the heat pump sector– Narayanamurthy, Ramachandran, Department of Energy, US
• 13.50-14.05: The role of utilities and federal/state governments to increase heat pumps deployments in the USA - Amarnath, Ammi aamarnath@epri.com, EPRI
• 14.05-14.15: The role of public funding when transforming the heating sector, examples from the Netherlands – Marion Bakker/Tom van Aalten, RVO, the Netherlands
• 14.15-14-25: The importance of public funded demonstration projects to increase use, awareness and acceptance, examples from UK (tbc)– Nicola Lazenby, BEIS, UK
• 14.25-14.35: Public funding of research and innovation projects an overview of new opportunities, Emina Pasic, Swedish Energy Agency.
• 14.35-14.55: Panel discussion:
  • Rafael Martinez Gordon, IEA
  • Thomas Nowak, European Heat Pump Association.
  • Stefan Moser, European Commission, DG Energy
  • Narayanamurthy, Ramachandran, Department of Energy, US
  • Nicola Lazenby, BEIS
  • Patrick Crombez, Daikin
  • Barbara Priesching, Vaillant
• 14.55-15.00 Summary and wrap up of workshop, Monica Axell and Caroline Haglund Stignor, Heat Pump Centre

WS 1.3 Comfort and Climate Box (15.15-16.45)
3rd Floor, Cloud Gate 1-2

Organizers: Peter Wagener, BDO / Tom van Aalten, RVO, the Netherlands, HPT Annex 55

WS 3.3 Progress in Heat Pumps with Low GWP Refrigerants (15.15-16.45)
3rd Floor, Looking Glass

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
- Shape Optimized Air-to-Refrigerant Heat Exchangers for Low-GWP Refrigerants: Dehumidification & Acoustics Considerations, Vikrant Aute
Tuesday, 7:00 – 17:00

Registration
2nd Floor, Pre-Function

Tuesday, 9:00 – 12:00

Welcoming Remarks and Plenary Lectures
2nd Floor, Grand Ballroom
- Welcome by the International Organizing Committee (IOC) Chair
- Welcome by the U.S. Department of Energy
- Welcome by the National Organizing Committee Chair (NOC) Chair

Policy and Market
- Fatih Birol, Executive Director, IEA
- U.S. Department of Energy
- Mechthild Woersdoerfer, Directorate-General for Energy, European Commission
- Introduction of the IEA Heat Pumping Technologies (HPT) Technology Collaboration Programme (TCP), Stephan Renz

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
2nd Floor, Grand Ballroom
Tuesday, 13:00 - 14:25

1.1 Heat Pumps in Residential Buildings 3rd Floor, Looking Glass

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 3rd Floor, Cloud Gate 1-2

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 3rd Floor, Cloud Gate 3-4

Session Chair: Yunho Hwang

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 Transcrirical CO2 Heat Pump For Human Comfort In Large Buildings (142)

Hakim Nesreddine, Dominique Monney, Wayne Wehber, Michael Nielsen*
Tuesday, 14:25 – 14:45

Coffee Break and Poster Session
2nd Floor, Pre-Function and Grand Ballroom

Tuesday, 14:45 - 16:10

1.2 Heat Pumps in Residential and Commercial Buildings
3rd Floor, Looking Glass

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
3rd Floor, Cloud Gate 1-2

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
2nd Floor, Pre-Function and Grand Ballroom

Tuesday, 16:30 – 17:55

1.3 Heat Pumps for Domestic Hot Water Heating  

Session Chair: Carsten Wemhoener

  Purav Patel, Stefan Elbel*

Development of a new GAX-based absorption heat pump for Domestic Hot Water production (73)
  Hai Trieu Phan*, Fabio Aste, Hélène Demasles

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

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  
3rd Floor, Cloud Gate 1-2

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  
3rd Floor, Cloud Gate 3-4

Session Chair: Takahiro Asahi

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 Vairamohon

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  
2\textsuperscript{nd} Floor, Pre-Function

**Wednesday 8:15 – 2:00**  
Tour to GTI Energy

The tour is by website sign-up only. Please meet in the Renaissance Hotel lobby by 8:15AM to board the busses to GTI Energy.

Lunch will be provided at GTI Energy. Please check email for updates about the tour.

**Wednesday, 8:45 – 10:10**

1.4 Heat Pumps in Commercial and Multifamily Buildings  
3\textsuperscript{rd} Floor, Looking Glass

Session Chair: Oliver Sutton

Session Keynote: General classification of heat pumps solutions for multi-family buildings (878)  
\textit{Marek Miara}*

Case Study of the Largest Air Source Heat Pumps Central Heating Project in China (110)  
\textit{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)  
\textit{Maggie Sheng, Zack Allen, Siva Sankaranarayanan}*

2.4 Smart Grids and District Heating and Cooling  
3\textsuperscript{rd} Floor, Cloud Gate 1-2

Session Chair: Svend Vinther Pedersen

Session Keynote: Large scale demand response of heat pumps to support the national power system (731)  
\textit{Tommy Walfredson}*\textsuperscript{, 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)  
\textit{Pauline Brischoux, Stefan Schneider, Pierre Hollimuller, Omar Montero Dominguez}*

An energetical, exergetical and experimental analysis of an absorption-heat exchanger used as transfer sub-station in an already existing district heating grid (199)  
\textit{Gerald Zotter}*\textsuperscript{, 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
2nd Floor, Pre-Function and Grand Ballroom

Wednesday, 10:30 – 11:55

1.5 Heat Pumps in Residential and Commercial Buildings
3rd Floor, Looking Glass

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 2nd Floor, Grand Ballroom

Session Chair: Thomas Fleckl

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3.5 Industrial Heat Pumps and Waste Heat 3rd Floor, Cloud Gate 3-4

Session Chair: Tomas Vorisek

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Cordin Arpagaus*, Frédéric Bless, Stefan Bertsch, Pierre Krummenacher, 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 Özuylasi, 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 Lauermann*, Stephan Kling, Bernd Windholz, Andreas Sporr, Andreas Längauer, Georg Kaltenbaek, Bernhard Adler

Wednesday, 11:55 – 13:00

Lunch, Poster Session and Exhibition

2nd Floor, Pre-Function and Grand Ballroom
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**3rd Floor, Looking Glass**

**Session Chair:** Emina Pasic

**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, Omar Dominguez*

**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

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**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)**

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

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*Paul Scheihing*, Andrew Hoffmeister, Ed Rightor, Riyaz Papar
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**3**nd Floor, Looking Glass

**Session Chair:** Christoph Reichl

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- **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  
**3**nd Floor, Cloud Gate 1-2

**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 Marini

**Hybrid thermally driven ionic liquid heat pump water heater and dehumidifier for commercial applications (358)**
- **Rohit Bhagwat**, Michael Schmid, Paul Glanville, Saeed Moghaddam*

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- **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

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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

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Coffee Break and Poster Session
2nd Floor, Pre-Function and Grand Ballroom

Wednesday, 16:30 – 17:55
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Session Chair: Signhild Gehlin

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

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Kunning Yang*, Takao Katsura, Katsunori Nagano

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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, Katsunori Nagano*

2.8 Hybrid Heat Pumps, Combination of Technologies
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Session Chair: Tom van Aalten

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Subhrajit Chakraborty*, Stephen Chally, Timothy Levering

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Francisco Beltrán*, Nelson Sommerfeldt, Hatef Madani

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


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Session Chair: Yoichi Fujita

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

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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*

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### Thursday, 8:30 – 12:00

**Registration**  
*2nd Floor, Pre-Function*

### Thursday, 8:45 – 10:10

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*3rd Floor, Looking Glass*

**Session Chair:** Veronika Wilk

**Session Keynote:** Development of dynamic model of variable refrigerant flow cooling system based on moving boundray method (531)  
*Jeong Kuk Hong, Hongryul Joo, Min Soo Kim*

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*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

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**Session Chair:** Jussi Hirvonen

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

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

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*José L. Corrales Ciganda*, Asier Martinez-Urrutia

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

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

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*Veronika Wilk*, Reinhard Jentsch, Tilman Barz

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

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

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

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**3rd Floor, Looking Glass**

Session Chair: Maurizio Pieve

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*Al-Hussain Othman, Vikrant Aute*, Daniel Bacellar

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

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

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

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Session Chair: Didier Coulomb

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


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

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*Shigeharu Taira*, Eiji Hihara

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

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**Thursday, 16:30 – 18:00**

**Closing Ceremony and Best Poster Award**

**2nd Floor, Grand Ballroom**

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14th IEA Heat Pump Conference
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