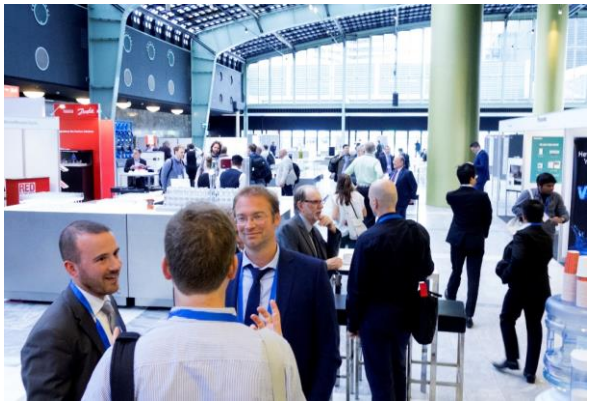
OUTLOOK FOR HEAT PUMPING TECHNOLOGIES TCP

Caroline Haglund Stignor, Heat Pump Centre

HP_sim&app23 - Carnot User Meeting, 22 June 2023

IEA Technology Collaboration Programme on Heat Pumping Technologies (HPT TCP)

Research, Development, Demonstration, and Deployment of Heat Pumping Technologies

The HPT TCP is part of a network of autonomous collaborative partnerships focused on a wide range of energy technologies known as Technology Collaboration Programmes or TCPs. The TCPs are organized under the auspices of the International Energy Agency (IEA), but the TCPs are functionally and legally autonomous. Views, findings, and publications of the HPT TCP do not necessarily represent the views or policies of the IEA Secretariat or its individual member countries.

www.heatpumpingtechnologies.org

About Heat Pumping Technologies TCP

- A Technology Collaboration Programme (TCP) within **the IEA** since **1978**
- An international framework of **cooperation** and **networking** for different HP actors
- A forum to exchange **knowledge** and **experience**
- A contributor to **technology improvements** by RDD&D projects

19 member countries

Austria	Denmark	Japan	Sweden
Belgium	Finland	Netherlands	Switzerland
Canada	France	Norway	United Kingdom
China	Germany	South Korea	United States
Czech Republic	Italy	Spain	

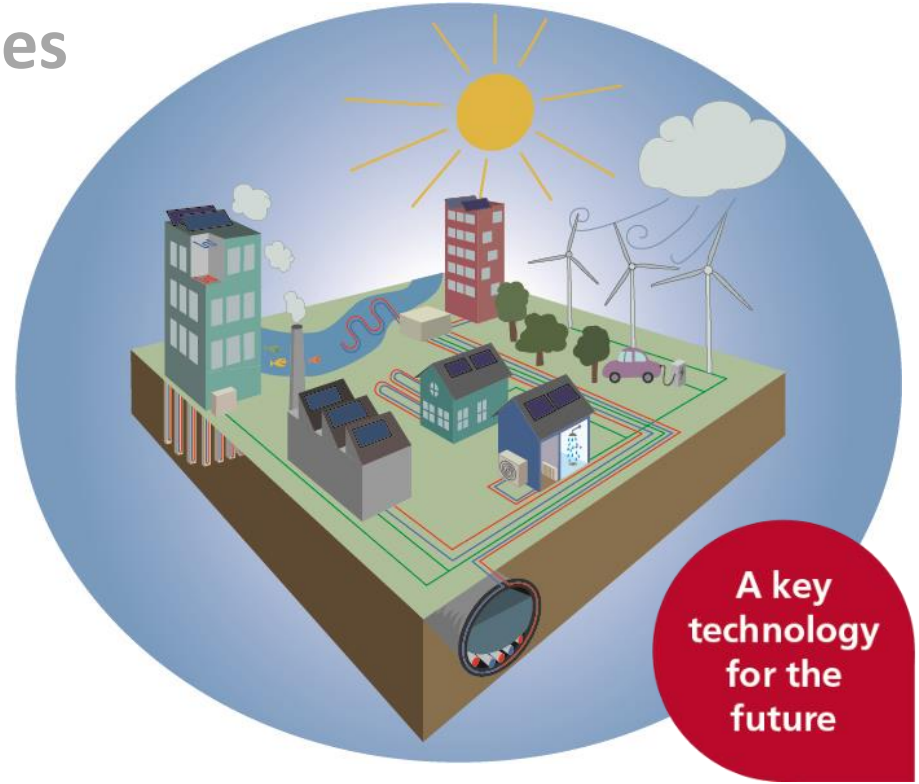
Heat Pumping Technologies

Includes

- **Heating and cooling**
- **Air conditioning**
- **Refrigeration**

Covers applications in

- **Residential and commercial buildings**
- **Industries**
- **Thermal grids in cities and communities**
- **Other applications**



HPT TCP Organization and Management

Executive Committee

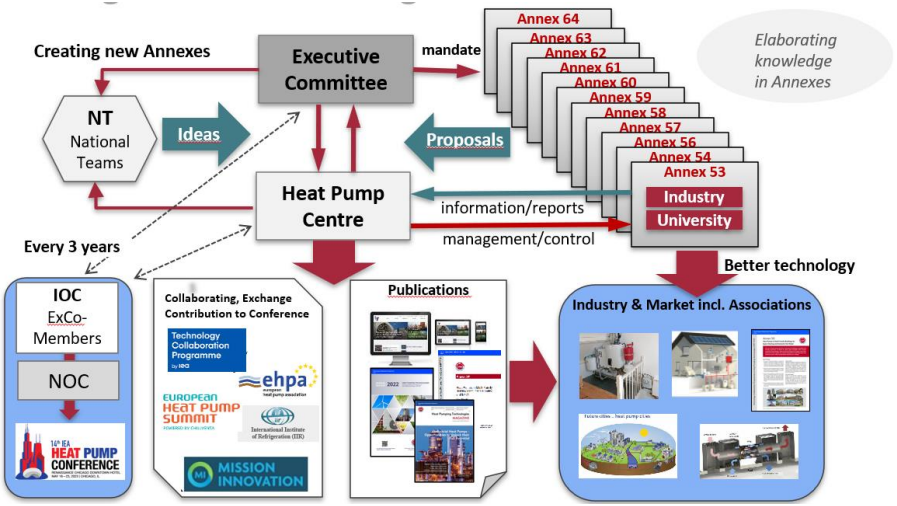
National teams

National experts meeting

Heat Pump Centre

Annexes

- **Executive Committee:** The board of HPT TCP - one vote per member country
- **National Teams:** Organizations representing national HPT activities. A forum for discussion networking and creation of new ideas. Meet at joint National Experts meetings.
- **The Heat Pump Centre:** The central program office and communication center of HPT TCP
- **Annexes:** Elaborating new knowledge through collaborative RDD&D work



The Heat Pump Centre

Information dissemination and communication

- Publications (e.g. project reports)
- HPT Magazine and Newsletter(digital)
- Website www.heatpumpingtechnologies.org
- Social media: LinkedIn, Twitter (@heatpumpingtech) and WeChat

Program Support

- to ExCo, NTs and Project leaders (OAs)

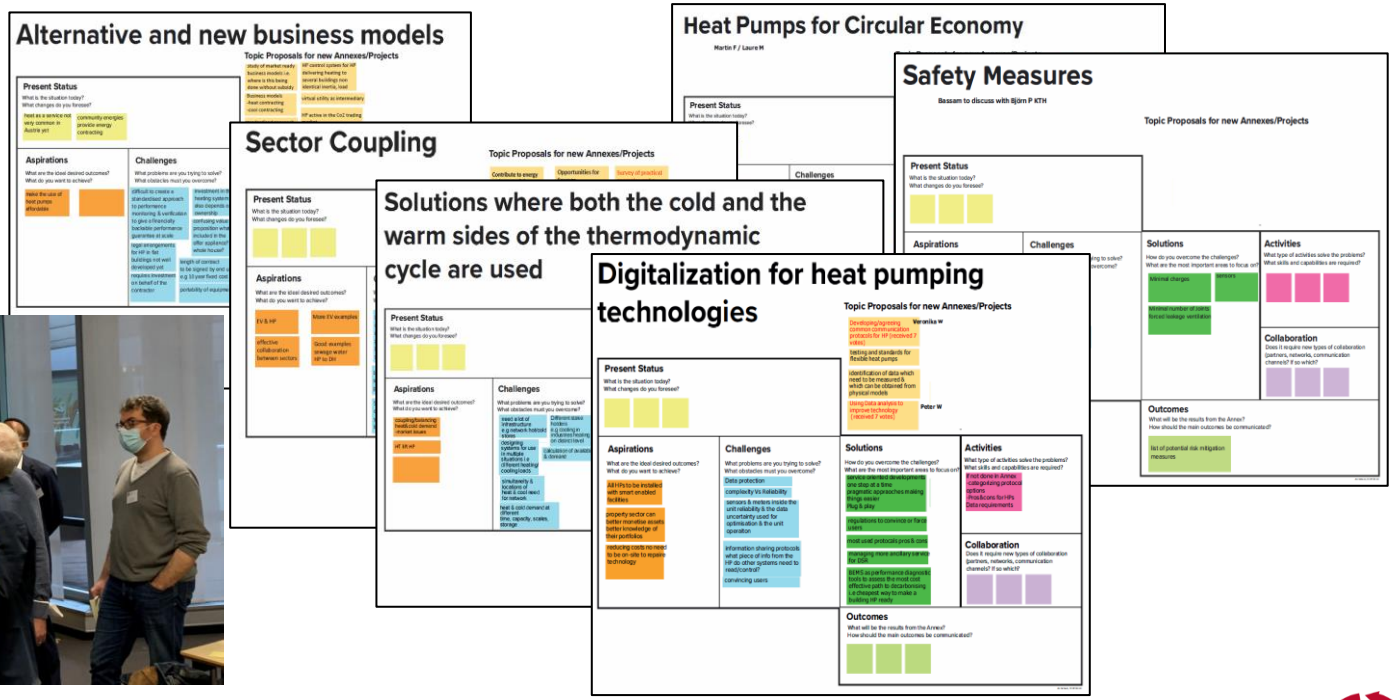
And

- Generation of new activities
- National Experts meetings
- Support to IEA publications
- Outreach activities

Ideation according to the Strategic Work Plan of HPT TCP

Outcome from last National Experts Meeting October 2021 in Nuremberg

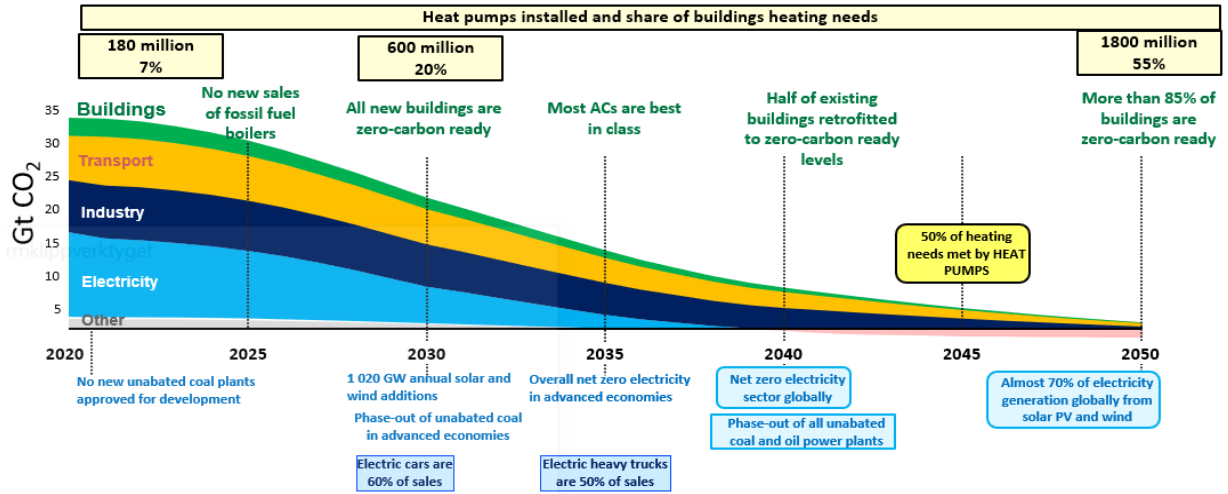
Next meeting in October 2023



HPT TCP STRATEGIC WORK PLAN 2023-2028

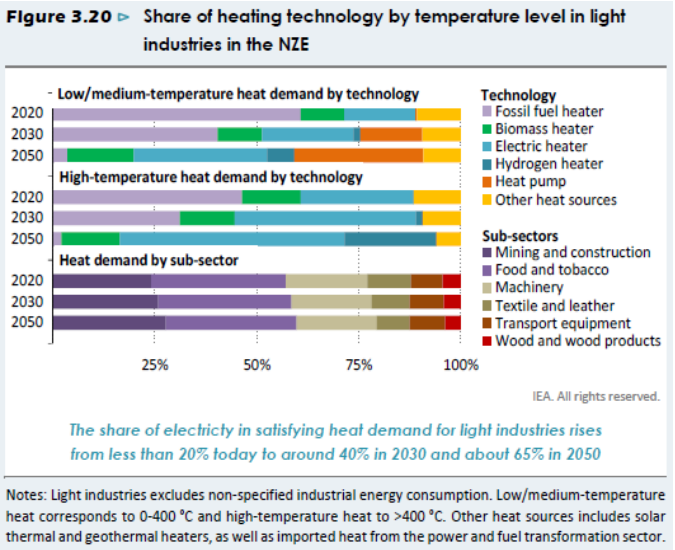
Expected energy developments

- According to the **IEA Net Zero by 2050 Roadmap,** 55% of the heating needs in buildings should be met by heat pumps to reach net zero emissions by 2050, an **increase by a factor of 3-4** in 2030 and a **tenfold increase to 2050**.



Expected energy developments

- According to the **IEA Net Zero by 2050 Roadmap,** 55% of the heating needs in buildings should be met by heat pumps to reach net zero emissions by 2050, an **increase by a factor of 3-4** in 2030 and a **tenfold increase to 2050**.
- Heat pumping technologies can also contribute considerably to **decarbonizing the industrial sector and district heating**.



Expected energy developments

- According to the **IEA Net Zero by 2050 Roadmap,** 55% of the heating needs in buildings should be met by heat pumps to reach net zero emissions by 2050, an **increase by a factor of 3-4** in 2030 and a **tenfold increase to 2050**.
- Heat pumping technologies can also contribute considerably to **decarbonizing the industrial sector and district heating**.
- Heat pumps (for heating and cooling) could and need to become **flexibility providers** to **stabilize the grid** when the share of **intermittent renewable** electricity production increases.
- The **demand for comfort cooling is set to soar** during the coming decades. Without further action to address equipment and buildings' performance, **energy consumption** for space cooling will almost **triple by 2050.**
- Without a major **acceleration in clean energy innovation**, net-zero emissions targets will not be achievable

Progress of Recognition of Heat Pumping Technologies

ETP2008

Heat pumps **first mentioned** in ETP

ETP2017

Heat pumping technologies are a **critical enabler** to reach **climatic ambitions**

ETP2020

Heat pumps need to **become the norm** for heating in buildings, contribute to decarbonization of the industrial sector and DH grids

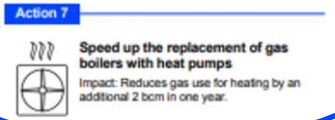
ETP2023

Heat pumps one of six, **most important clean** energy technologies analysed

IEAs NZE by 2050 Roadmap:

"In 2045 50% of the heating demand should be met by heat pumps"

IEAs 10-point plan to reduce dependance on Russian gas



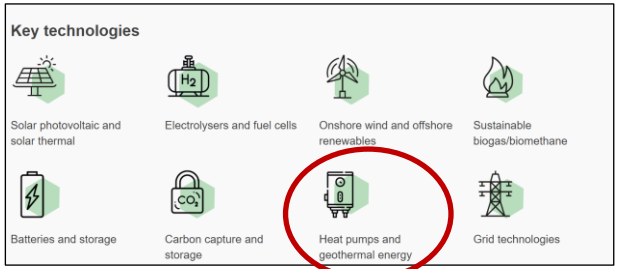
Heat Pumps prioritized in US Inflation Reduction Act (IRA) Defence Production Act (DPA)

REPowerEU

"Double the planned yearly pace of deployment of heat pumps"

Heat pumps - action lan to accelerate roll-out across the EU

Net Zero Industry Act



Similar trends for recognition of heat pumps in other regions of the world

Vision

Heat pumping technologies are the cornerstone for a **secure, affordable, high-efficiency, clean** and **net-zero emission energy system** for **heating, cooling** and **refrigeration.**

We are the **key worldwide independent actor** to achieve this vision across **multiple applications** and **contexts**. We **generate** and **communicate information, expertise and knowledge** related to heat pumping technologies as well as enhance **international collaboration**.

Mission

To **accelerate the transformation** to an **efficient, renewable, clean** and **secure energy sector** in our member countries and beyond by performing collaborative **research, demonstration** and data collection and **enabling innovations and deployment** within the area of heat pumping technologies.

RDD&D priority areas 2023-2028

System integration	Robust, sustainable and affordable value chains	Extending operation range and applications	New technologies and refrigerants
			
Sector coupling, energy efficiency, flexibility, resilience, storage, digitalization, positive energy districts	Improving affordability, securing value chains, circular economy, removing barriers for mass deployment	To fulfill demand from all climate zones, new markets, new applications and new demand. Refrigeration in emerging countries.	Non-traditional heat pumping technologies (for heating and cooling) Refrigerants (low GWP, safety etc.)
• The role of heat pumps in integrated energy systems on building, district and city levels. • Heat pumps as an enabler for sector coupling • Methods for evaluating smart, flexible heat pumps	• Systems for circular economy for heat pumps • New business models • Easy to install products (plug and play and self-commissioning) • Standardization for scaling • User behaviour/ acceptance of HPT, comfort and flexibility	• Heat pumps for industrial applications • Heat pumps for district heating and cooling applications • Heat pumps for retrofitting of existing buildings with special requirements • Heat pumps/AC for cooling, dehumidification and drying • Cold climate heat pumps	• Non-vapour compression technologies • Other areas that need low TRL level research • Efficient operation, components and systems for Low GWP refrigerants • Safety measures for operating with low GWP refrigerants

RDD&D Priority Areas 2023-2028

System integration	Robust, sustainable and affordable value chains	Extending operation range and applications	New technologies and refrigerants
			
Sector coupling, energy efficiency, flexibility, resilience, storage, digitalization, positive energy districts	Improving affordability, securing value chains, circular economy, removing barriers for mass deployment	To fulfill demand from all climate zones, new markets, new applications and new demand. Refrigeration in emerging countries.	Non-traditional heat pumping technologies (for heating and cooling) Refrigerants (low GWP, safety etc.)
• Annex 56: IoT for Heat Pumps • Annex 57: Heat pumps in multi-vector energy systems • Annex 61: Heat Pumps in Positive Energy Districts **NEW** • CCB for cooling and dehumidification • Sector Coupling - Survey of practical examples • Digital Services for Heat Pumps	• Annex 63 Placement Impact on Heat Pump Acoustics **NEW** • Heat Pumps in a Circular Economy • New or alternative business models for heat pumps	• Annex 60: Retrofit Heat Pump in Larger Non-domestic Buildings • Annex 58: High Temperature Heat Pumps • Annex 59: Heat Pumps for Drying • Annex 62: Heat Pumps in residential multifamily buildings in cities **NEW**	• Annex 53: Advanced cooling and refrigeration technology development • Annex 54: Heat Pump Systems with low GWP Refrigerants • Annex 64: Safety Measures on Flammable Refrigerants **NEW**

Annex 61 – Heat Pumps in Positive Energy Districts

The issue

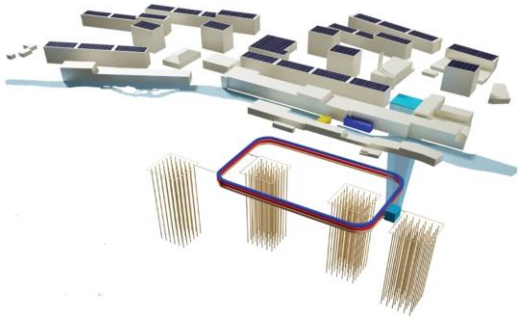
Positive energy districts (PED) are a high-performant concept for parts of cities, which can act as prosumers and provide flexibility for connected energy grids. Due to their unique features, heat pumps are favorable building technology systems for high-performance districts like PED.

Work to do

Based on a state-of-the-art analysis, heat pump integration options for PED are elaborated as generic system concepts and are investigated in detail by simulations. In parallel, real heat pump application in positive energy districts is evaluated and optimized by monitoring.

Results & benefits

Results of heat pump monitoring and simulations are summarised to guidelines for the heat pump integration in districts and enhanced design and control strategies for high performance and energy flexibility are derived.



Annex 63 – Placement Impact on Heat Pump Acoustics

The issue

Noise emissions are a potential threat to further spreading of heat pumps in the years to come. Both acoustic emissions and immissions are relevant as outdoor and indoor noise negatively affect the acceptance of this technology.

Work to do

Each placement situation is unique and several aspects contribute to successful installation. Therefore, as a proper installation is key to low acoustic impact on the environment, the existing guides will be revised and linked to the developed placement tools.

Results & benefits

Refinement of numerical and measurement methods. Generation of a data base of acoustic characteristics of heat pumps. Guidance to proper installation.

Annex 50 – Heat pumps in multi-family buildings for space heating and DHW

The issue

How can we increase the use of heat pumps in multi-family buildings?

Work to do

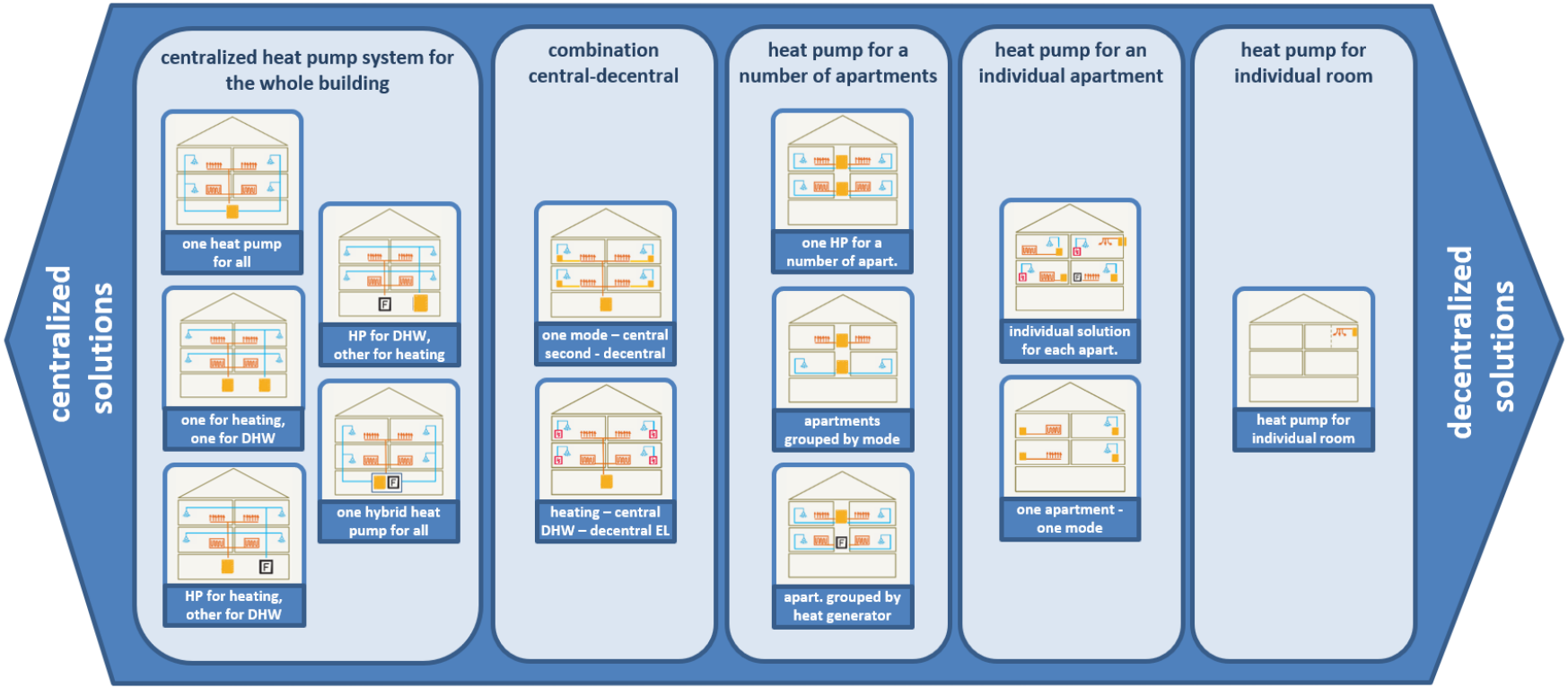
Identify barriers for heat pumps on these markets and how to overcome them. Enhancement of heat pump systems and/or heat pump components for their adaptation in multi-family buildings.

Results & benefits

Demonstration of possible energy savings and the utilisation of renewable energy by means of heat pumps in buildings retrofitted with heat pumps without improving the building envelope.

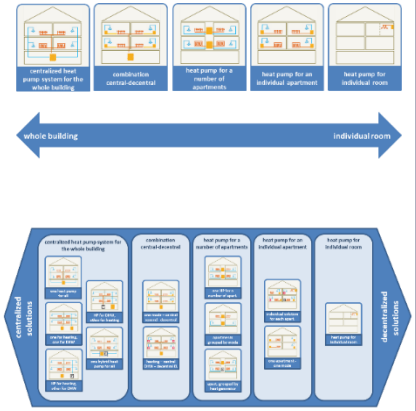
Image source: RISE Research Institutes of Sweden

RESULTS – CATEGORIZATION AND CLASSIFICATION

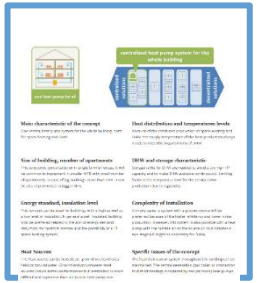


HOLISTIC APPROACH TO PRESENT THE RESULTS OF ANNEX 50

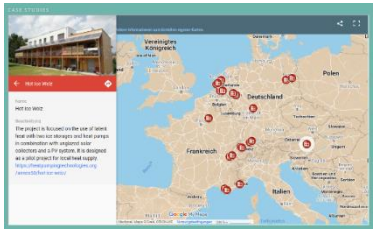
General classification



Description of each solution



Case studies database



Description of each case study

Annex 62 – Heat pumps for multi-family residential buildings in cities

The issue

To find the best solutions for heat pump implementation in all types of buildings, there is a pressing need to search for and to provide optimal solutions for heat pump implementation in high-density cities, with the focus on new and existing multi-family buildings.

Work to do

This Annex will focus on heat pump solutions for multi-family houses in high-density cities. In respect to the demand of the participating countries new buildings and retrofit will be considered, as well as buildings with higher specific heating demand.

Results & benefits

Identification of robust and proofed solution helping the wide application of heat pumps.

Annex 58 – High-Temperature Heat Pumps

The issue

Electrically driven heat pumps are a promising technology for industrial processes, increasing system efficiencies and decreasing GHG emissions.

Work to do

Provide an overview of the technological possibilities and applications for high temperature heat pumps (up to 200°C) as well as to develop concepts and strategies for the transition towards heat pump-based process heat supply.

Results & benefits

Improve the understanding of the technology's potential and provide supporting material for the transition to a heat pump-based process heat supply for industrial applications.

Annex 54 – Heat Pump Systems with low GWP Refrigerants

The issue

How to promote low-GWP refrigerant applications to accelerate phase down of high-GWP HFCs?

Work to do

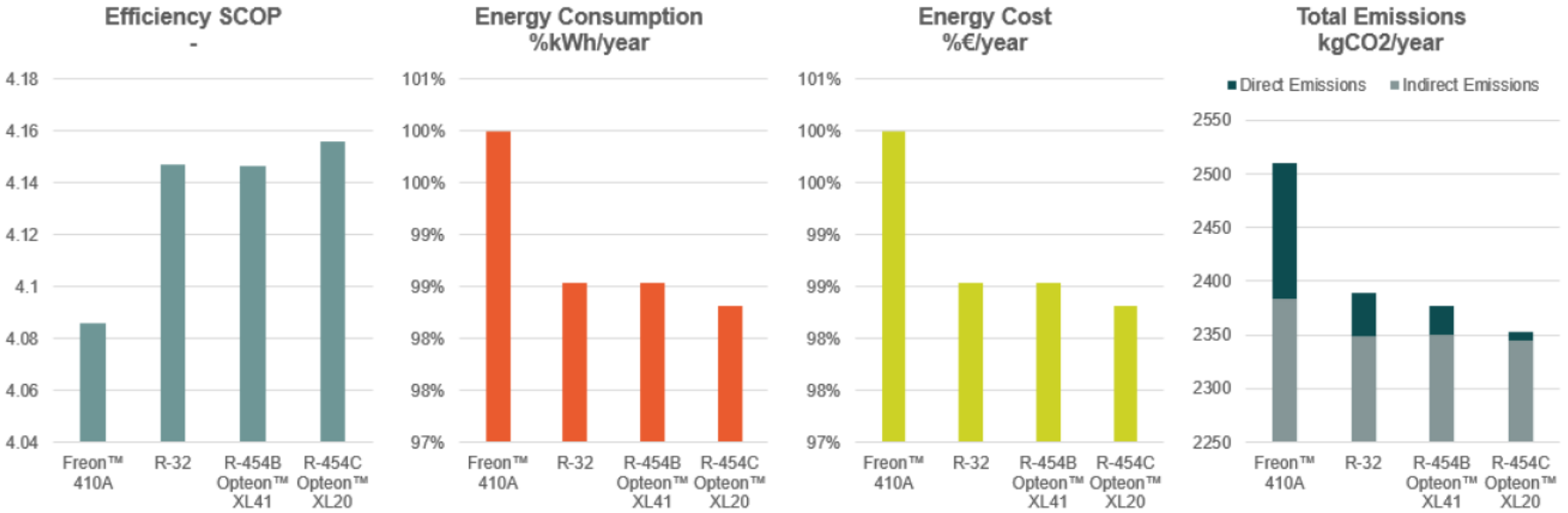
Develop design guidelines of optimized heat pump components and system for low-GWP refrigerants through the review of available low-GWP refrigerants.

Results & benefits

Replacing current high-GWP working fluid of vapor compression technology to low-GWP ones while keeping and/or improving its efficiency so that the environmental impacts by the building's cooling and heating systems are minimized.

Examples of interim results from Annex 54

Codella (2022, Chemours) compared R410A alternatives: R32, R454B and R454C.

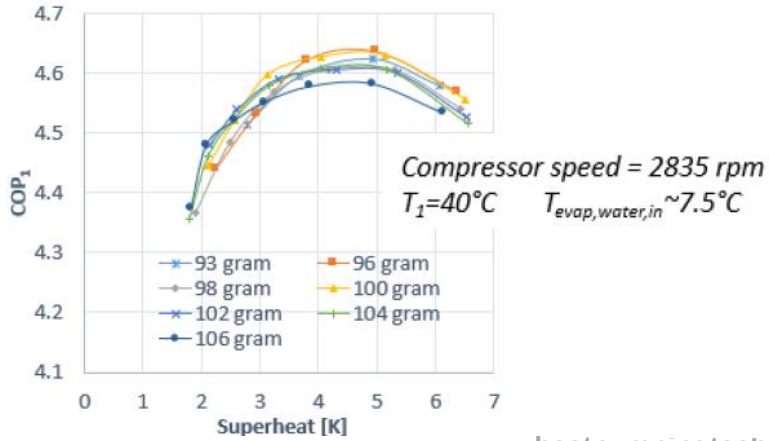


Examples of interim results from Annex 54

- Palm (2022, KTH, Sweden) provided the details of the Swedish HP market from smaller residential units to larger residential and commercial units.
- He shared case studies and design guidelines for optimizing components and systems, including a geothermal R290 HP for multifamily buildings, a CO_2 system for heating & cooling the commercial building, and an R290 HP and chiller for the process cooling & heating.

Water to water heat pump

100g of R290
10 kW heating capacity
33cc compressor



Annex 64 – Safety measures for flammable refrigerants

The issue

It is likely that we in the future will see a market dominated by (mildly) flammable synthetic refrigerants and flammable hydrocarbons. Better understanding of the risks and novel ideas to limit the risks is necessary to safe use of flammable refrigerants for larger capacity systems.

Work to do

Investigations of a selected set of measures to limit the risks associated with using flammable refrigerants in heat pumps, AC-systems, refrigeration systems or similar based on the vapour compression cycle.

Results & benefits

Contribute to a broader safe use of flammable refrigerants.

Annex 53 – Advanced cooling/refrigeration technologies

The issue

Global demand for space cooling, dehumidification, and refrigeration is projected to see huge increases in the coming decades, especially in the developing world.

Work to do

Investigate technology solutions for higher efficiency air-conditioning/refrigeration systems focusing on two principal paths: advanced vapor compression with low or ultra-low GWP refrigerants and non-traditional technologies (zero-GWP).

Results & benefits

Propose candidate technology solutions to help minimize expected energy demand growth.

To summarize - Heat Pumping Technology

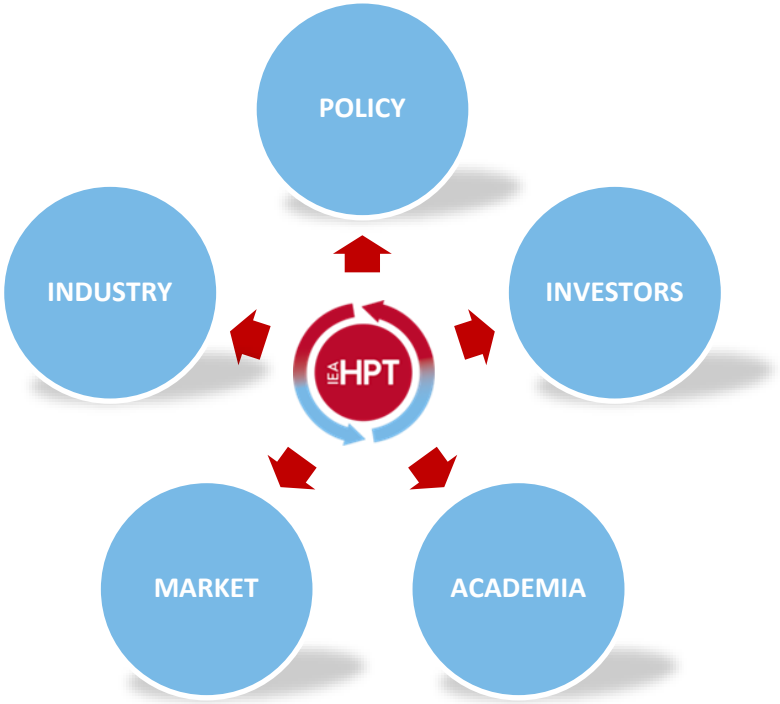
… is a **proven efficient and clean technology available** on the market

- upgrades renewable energy & reduces CO_2 emissions
- is an excellent flexibility provider to **balance the grid** to handle **intermittent production**
- contributes to improved **energy security and resilience**
- contributes to improved **energy efficiency**
- can deliver **heating AND cooling**

…but there is still a **need for research, development and innovations**

- sharpen the technologies and widen the operating range
- adopt solutions for complex building and retrofit market
- adopt solutions for sector coupling and system integration with other clean renewable energy technologies
- safe and efficient operation with low GWP refrigerants
- alternative cycles
- to overcome non-technical barriers

Contacts



IEA HPT Executive Committee
Stephan Renz (Chairman)
info@renzconsulting.ch

Heat Pump Centre
Monica Axell (General Manager)
monica.axell@ri.se
Caroline Haglund Stignor (Assistant Manager)
caroline.haglundstignor@ri.se
Metkel Yebiyo, Technical Expert
metkel.yebiyo@ri.se

hpc@heatpumpcentre.org
www.heatpumpingtechnologies.org