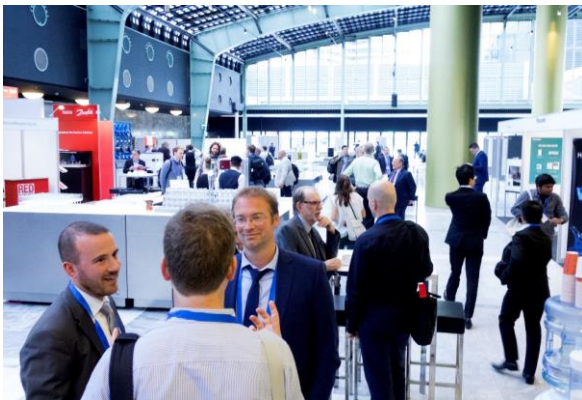


OUTLOOK FOR HEAT PUMPING TECHNOLOGIES TCP

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.

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	

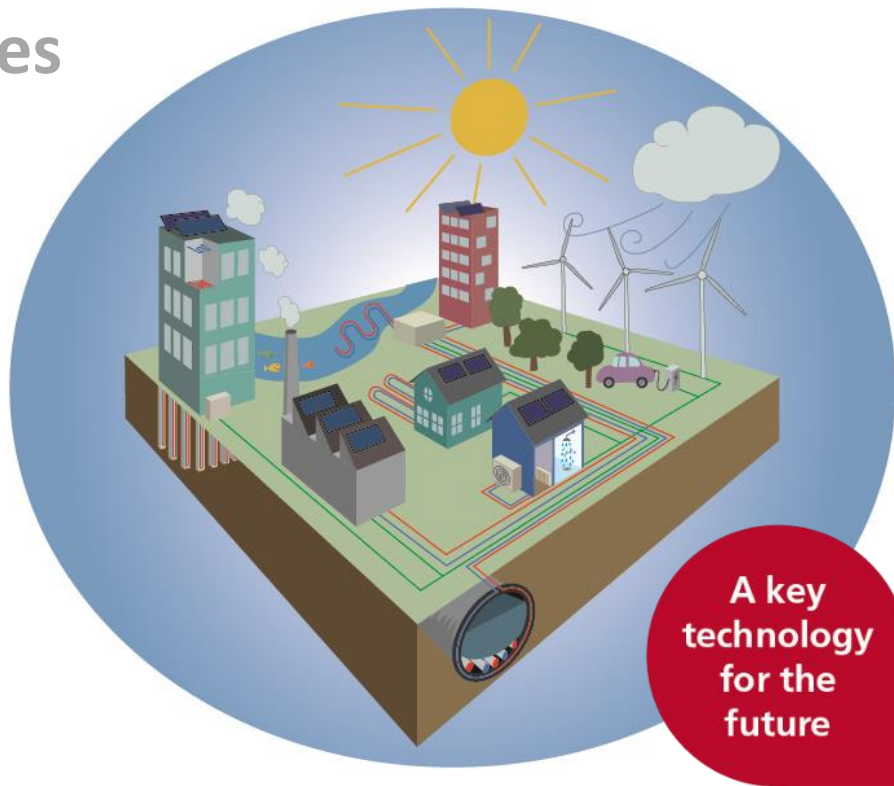
Heat Pumping Technologies

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



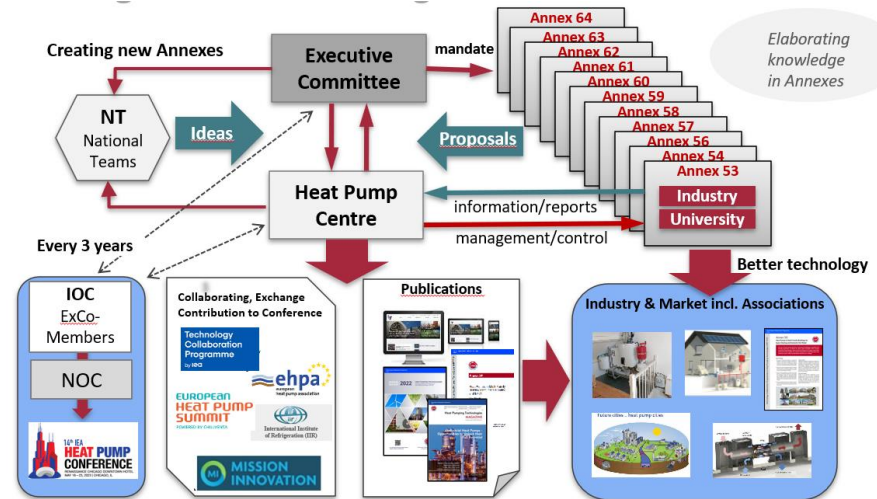
Heat Pump Centre



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



Alternative and new business models
Topic Proposals for new Annexes/Projects

Heat Pumps for Circular Economy
Martin F / Laura M

Safety Measures
Besam to discuss with Iijon P KTH

Sector Coupling
Topic Proposals for new Annexes/Projects

Solutions where both the cold and the warm sides of the thermodynamic cycle are used

Digitalization for heat pumping technologies
Topic Proposals for new Annexes/Projects

Collaboration
Diverse to explore new types of collaboration partners, networks, communication channels? If so where?

Outcomes
What will be the results from the Annex?
How should the main outcomes be communicated?

Present Status
What is the situation today?
What changes do you foresee?

Aspirations
What are the ideal desired outcomes?
What do you want to achieve?

Challenges
What problems are you trying to solve?
What obstacles limit you now/next?

Solutions
How do you overcome the challenges?
What are the most important areas to focus on?

Activities
What type of activities solve the problem?
What skills and capabilities are required?

Collaboration
Diverse to explore new types of collaboration partners, networks, communication channels? If so where?

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HPT TCP STRATEGIC WORK PLAN 2023-2028

Technology Collaboration Programme
by IEA

IEA TECHNOLOGY COLLABORATION PROGRAMME ON
HEAT PUMPING TECHNOLOGIES

**STRATEGIC PLAN
2023 - 2028**

www.heatpumpingtechnologies.org

Vision of HPT TCP
Heat pumping technologies are the cornerstone for a secure, affordable, high-efficient, clean and secure emission energy system for heating, cooling and refrigeration. We are the key worldwide independent actor to deliver the secure access to energy applications and services, the promote and communicate information, expertise and knowledge related to heat pumping technologies as well as enhance international collaboration.

STRATEGIC OBJECTIVES

Accelerated deployment

- The deployment rate is accelerated for efficient heat pumping technologies in different applications: buildings, industry, transport, marine, and thermal energy systems – to keep pace with the initiatives set out in the IEA Roadmap towards Net Zero Emissions by 2050.

Energy security

- Integrate affordable solutions for heating and cooling, where heat pumping technology is a key element, are exploited, through collaboration with other TCPs, existing energy storage, flexibility and responsiveness in the energy system and demand response (DR) options.

Economic growth of secure and sustainable solutions

- The HPT TCP contributes to removing gas and overcoming barriers in the sustainable value chain of heat pumping technologies.

Environmental protection

- Key decision-makers (policy, investors, utilities, retail estate actors, industry, users etc.) acknowledge the multiple benefits of heat pumping technologies as sustainable, clean, enabling connecting and affordable heating and cooling solutions to reach the climate mitigation and energy security goals. Sectors which promote heat pumping technologies are empowered.

Engagement activities

- HPT TCP has more member countries representing the largest economies, different parts of the world facing different contexts, IEA key partners and association countries.
- HPT TCP is an active player in, or partner to, IEA other TCPs, other international initiatives and organisations related to secure and sustainable heating and cooling and flexible energy solutions for everyone.

Mission of HPT TCP
To accelerate the transformation to an efficient, renewables, clean and secure energy sector in heat emitting domains and beyond by performing collaborative research, demonstration and data collection and enabling innovations and deployment within the area of heat pumping technologies.

STRATEGIC INITIATIVES

- Advance the RDD&D** of heat pumping technologies through the creation of research ecosystems, involving and training teams for academic, industry, start-ups, investors and policy makers to collaborate under new awards (grants, prizes) and other activities in workshops across the HPT TCP, as priority areas for RDD&D topics.
- Contribute to advanced and/or disruptive innovations** through cross-cutting networking and collaboration with other TCPs, IEA, Mission Innovation and other relevant organisations, attracting new actors transposing other relevant areas of knowledge.
- Communicate the results and impact from the RDD&D work**, tailor the messages and the dialogue using selected channels to reach relevant target groups, including policy makers, energy and environmental agencies, investors, utilities, manufacturers, city and building partners, system designers, architects, industry associations, academia, researchers, local and users. **Arrange a high-quality case research** about their changing technologies at least every third year, and establish the connectivity to the most relevant research groups.
- Providing and enlarging a dialogue platform** to share and report back experiences to those stakeholders and actors who could benefit from such knowledge.
- Provide IEA, standardisation organisations and regional or national policy makers with reliable and independent guidance, data and knowledge** about heat pumping technologies, especially in its combination with other technological options.
- Increase activities to attract new members**, including IEA key partners and association countries.

RDD&D Priority Areas 2023-2028

System Integration	Technical Innovation and User Centred	Scale-up/Commercialisation and Applications	Policy Enablers and Regulations
<ul style="list-style-type: none"> Energy storage: energy efficiency, flexibility, building decarbonisation, district heating, industrial process integration 	<ul style="list-style-type: none"> Hydrogen: heating, cooling, industrial process integration, marine propulsion 	<ul style="list-style-type: none"> Build research hubs: all the areas new research centres, centres for excellence, technology transfer, start-ups 	<ul style="list-style-type: none"> Market uptake: energy efficiency, building decarbonisation, industrial process integration, marine propulsion, start-ups
<ul style="list-style-type: none"> The Heat Pump Technology Innovation Centre (HPTIC) and other research centres Energy storage: energy efficiency, flexibility, building decarbonisation, district heating, industrial process integration Hydrogen: heating, cooling, industrial process integration, marine propulsion 	<ul style="list-style-type: none"> Energy storage: energy efficiency, flexibility, building decarbonisation, district heating, industrial process integration Hydrogen: heating, cooling, industrial process integration, marine propulsion 	<ul style="list-style-type: none"> Build research hubs: all the areas new research centres, centres for excellence, technology transfer, start-ups 	<ul style="list-style-type: none"> Market uptake: energy efficiency, building decarbonisation, industrial process integration, marine propulsion, start-ups

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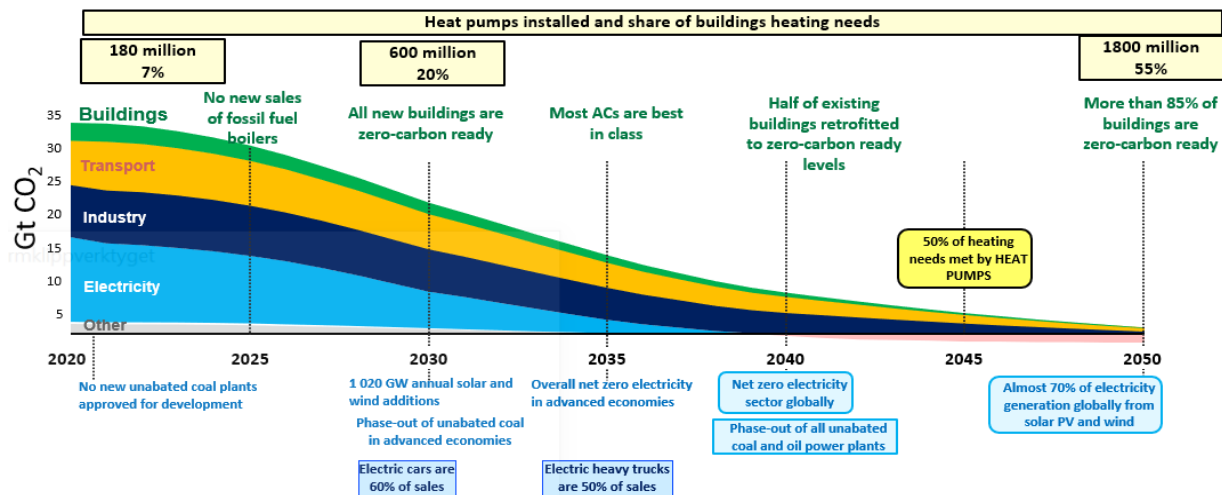
Members: HPT TCP is a joint effort of governments, leading research centres in each of the participating countries, industry, academia, energy and environmental agencies, investors, utilities, manufacturers, city and building partners, system designers, architects, industry associations, academia, researchers, local and users. **Arrange a high-quality case research** about their changing technologies at least every third year, and establish the connectivity to the most relevant research groups.

<p>CONTACT Dr. Christoph Reinle General Manager Phone: +49 371 271 21 28 E-mail: christoph.reinle@iea.org</p>	<p>CONTACT Prof. Purnima Chandra (HPTC) General Manager Phone: +91 88600 20000 E-mail: purnima@hptc.org</p>
<p>CONTACT Dr. Verónica Ruiz General Manager Phone: +34 91 231 21 21 E-mail: veronica@iea.org</p>	<p>CONTACT Dr. Ludmila Inghelbrecht General Manager Phone: +36 70 22 23 22 E-mail: ludmila.inghelbrecht@iea.org</p>



Expected energy developments

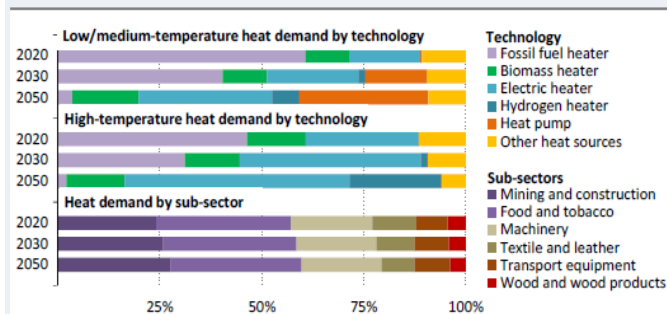
- According to the **IEA Net Zero by 2050 Roadmap**, 55% of the heating needs in buildings should be met by heat pumps to reach net zero emissions by 2050, an **increase by a factor of 3-4** in 2030 and a **tenfold increase to 2050**.



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**.

Figure 3.20 ▶ Share of heating technology by temperature level in light industries in the NZE



IEA. All rights reserved.

The share of electricity in satisfying heat demand for light industries rises from less than 20% today to around 40% in 2030 and about 65% in 2050

Notes: Light industries excludes non-specified industrial energy consumption. Low/medium-temperature heat corresponds to 0-400 °C and high-temperature heat to >400 °C. Other heat sources includes solar thermal and geothermal heaters, as well as imported heat from the power and fuel transformation sector.



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



ETP2020

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

ETP2017

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

ETP2008

Heat pumps **first mentioned** in ETP

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 dependence on Russian gas

Action 7



Speed up the replacement of gas boilers with heat pumps
Impact: Reduces gas use for heating by an additional 2 bcm in one year.

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

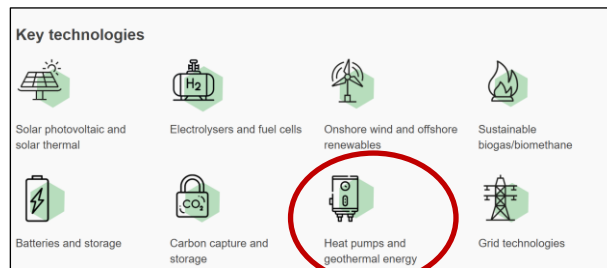
REPowerEU

“Double the planned yearly pace of deployment of heat pumps”

Heat pumps - action 1a 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
			
<p>Sector coupling, energy efficiency, flexibility, resilience, storage, digitalization, positive energy districts</p>	<p>Improving affordability, securing value chains, circular economy, removing barriers for mass deployment</p>	<p>To fulfill demand from all climate zones, new markets, new applications and new demand. Refrigeration in emerging countries.</p>	<p>Non-traditional heat pumping technologies (for heating and cooling) Refrigerants (low GWP, safety etc.)</p>
<ul style="list-style-type: none"> • 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 	<ul style="list-style-type: none"> • 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 	<ul style="list-style-type: none"> • 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 	<ul style="list-style-type: none"> • 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
			
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<ul style="list-style-type: none"> ● 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 	<ul style="list-style-type: none"> ● Annex 63 Placement Impact on Heat Pump Acoustics NEW ● Heat Pumps in a Circular Economy ● New or alternative business models for heat pumps 	<ul style="list-style-type: none"> ● 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 	<ul style="list-style-type: none"> ● 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.



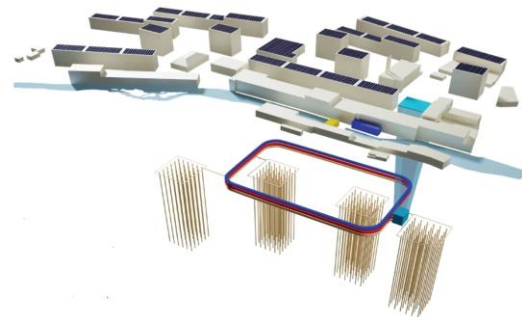
Work to do

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.

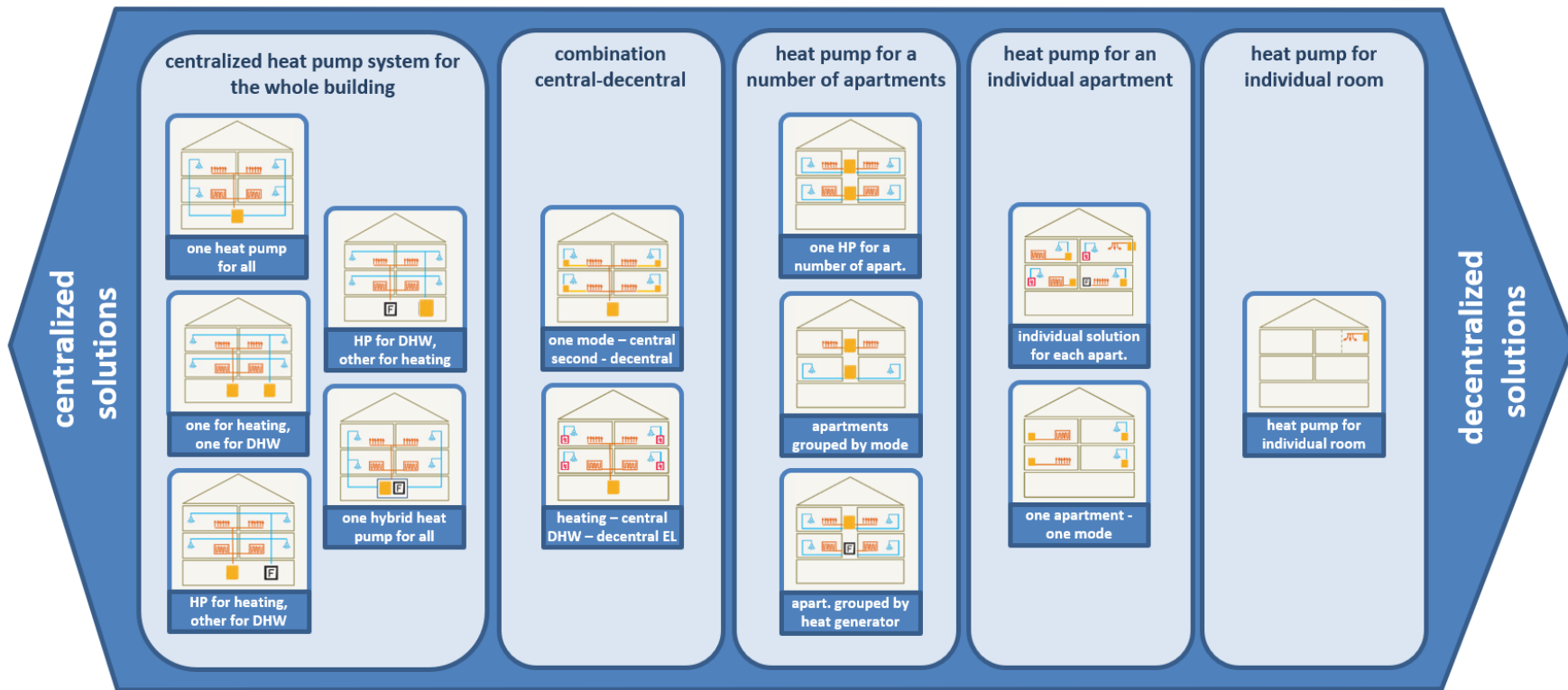


Annex **50** IEA
MFB HPT

Image source: RISE Research Institutes of Sweden



RESULTS – CATEGORIZATION AND CLASSIFICATION





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.



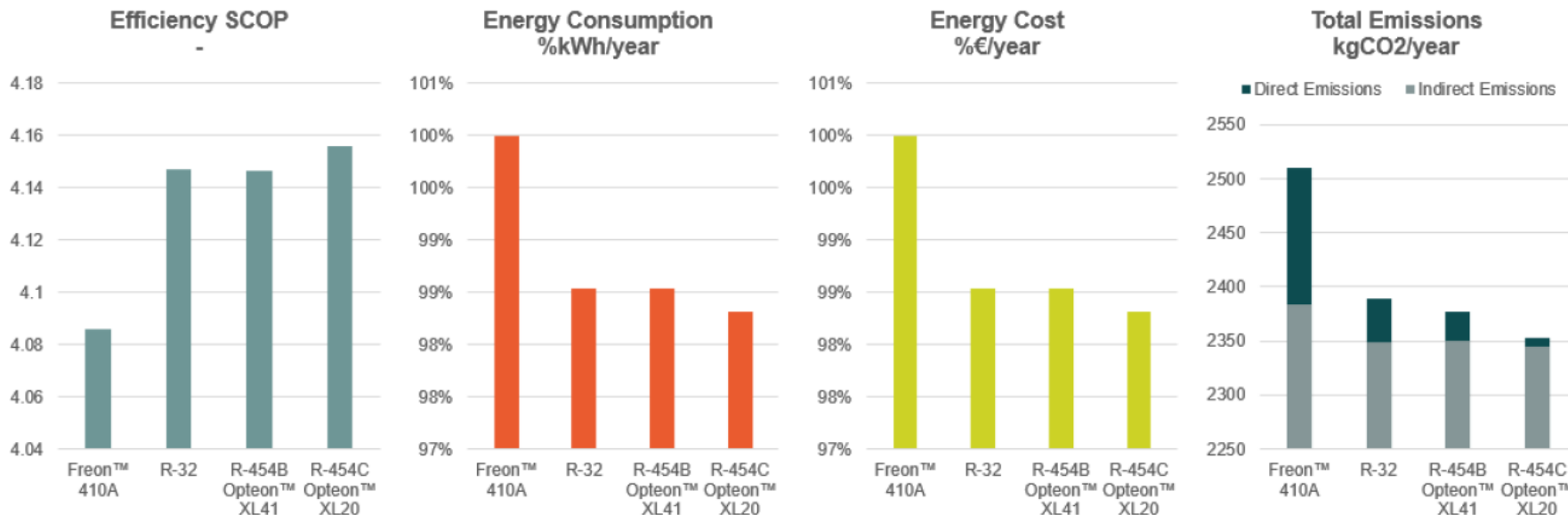
Results & benefits

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.



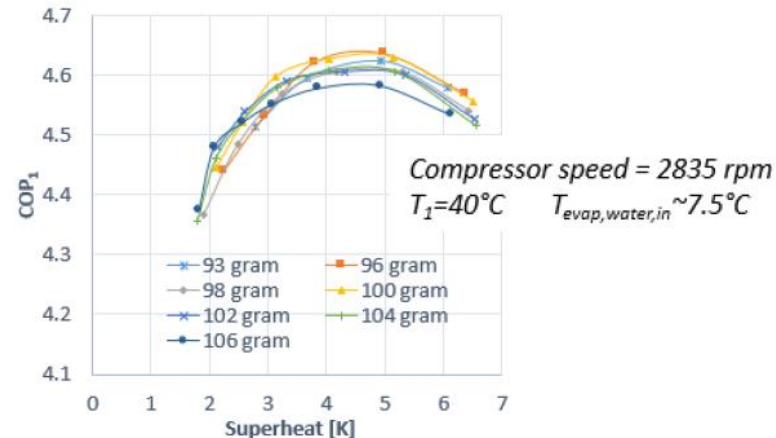
Examples of interim results from Annex 54

- 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 CO₂ 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.



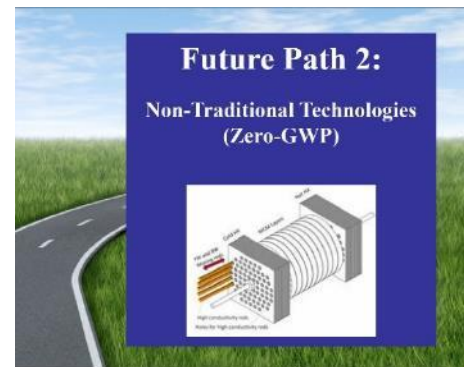
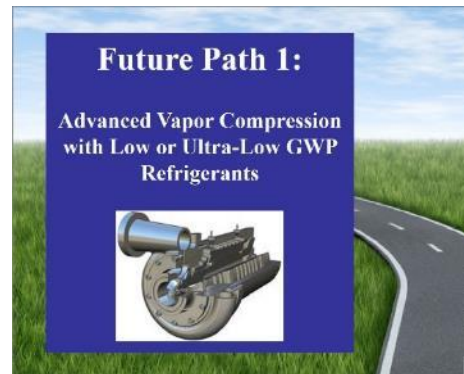
Work to do

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).

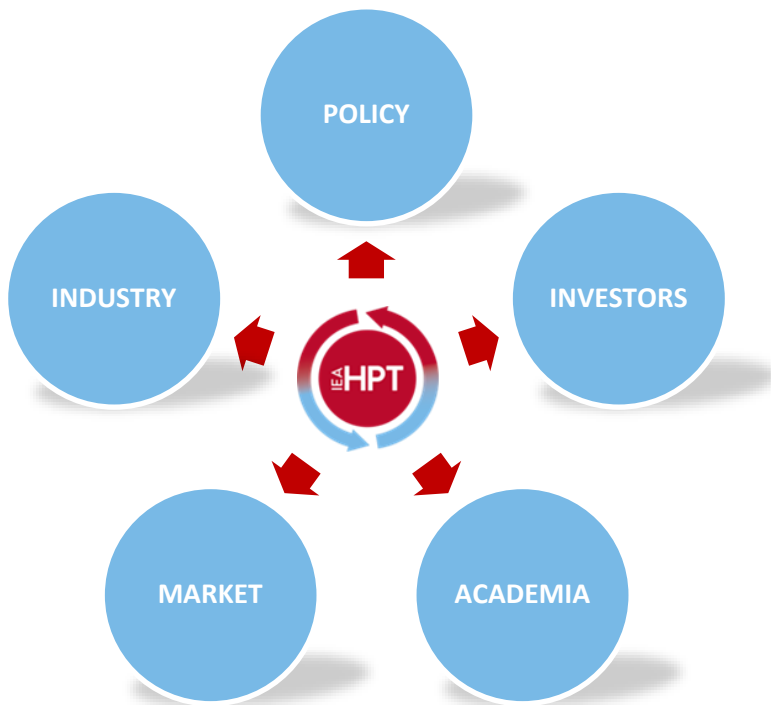


Results & benefits

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



Contacts



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