Technology Collaboration Programme
by IEA

heatpumpingtechnologies.org

# WS8
# *Comfort cooling concepts for different types of climates and regions*

Organizers:
**Heat Pump Centre,**
**HPT TCP by IEA**
and
***Zhaw School of Engineering,***
***IEFE Institute of Energy Systems and Fluid-Engineering***

Technology Collaboration Programme
by IEA

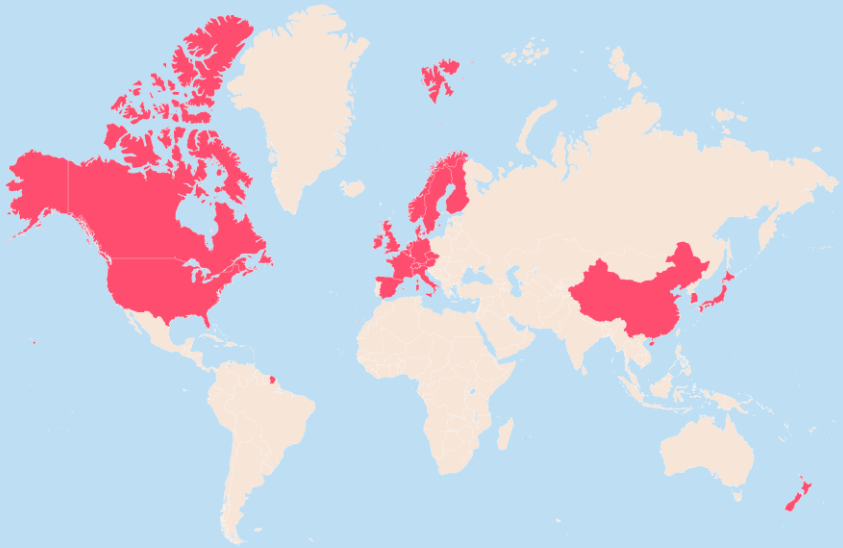
# Technology Collaboration Programme on Heat Pumping Technologies (HPT TCP)

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



heatpumpingtechnologies.org

# About Heat Pumping Technologies TCP



Austria
Belgium
Canada
China
Czech Republic
Denmark
Finland
France
Germany
Ireland
Italy
Japan
Netherlands
Norway
South Korea
Spain
Sweden
Switzerland
United Kingdom
United States
New Zealand (limited sponsor)

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

# RDD&D Priority Areas 2023-2028 - International collaboration projects

| System integration | Robust, sustainable and affordable value chains | Extending operation range and applications | Refrigerants and new technologies |
|---|---|---|---|
|  |  |  |   |
| Sector coupling, energy efficiency, flexibility, resilience, storage, digitalization, positive energy districts | Improving affordability, securing value chains, circular economy, removing barriers deployment | To fulfill demand from all climate zones, new markets, new d new demand. emerging | Non-traditional heat pumping technologies (for heating and cooling)<br>Refrigerants (low GWP, safety etc.) |
| • Project 61: Heat Pumps in Positive Energy Districts<br>• Project 67: Digital Services for Heat Pumps **NEW**<br>• Project 70 Flexibility from Large-Scale and Aggregated Heat Pump Systems **NEW** | • Project 63 Place Heat Pump Aco<br>• Project 65 Heat Circular Economy<br>• Project 66 Optimal Heat Pump Design and Operation for Broader Acceptance<br>• Project 69 Enhanced Miniaturized Components **NEW** | ofit Heat Pump in estic Buildings<br>Pumps for Drying<br>Project 62: Heat Pumps in residential multifamily buildings in cities<br>Project 68: Industrial High Temperature Heat Pumps **NEW** | Project 53: Advanced **Cooling**/Refrigeration Technologies Development **FINALIZED**<br>Project 64: Safety Measures on Flammable Refrigerants |

**HPT TCP aims to start new projects in the field of comfort cooling**

# Purpose and objective of workshop

- The workshop will focus on affordable and efficient cooling solutions for different types of climates and regions.

- Its main objective is to define the focus and scope of new potential international collaboration projects within HPT TCP.
  - One specific proposal will be presented and discussed
  - Other suggestions of challenges to be solved are welcome

- Exchange of experiences while gathering input from a wide range of stakeholders.

# Workshop hosts

**Heat Pump Centre**

Monica Axell

Caroline Haglund Stignor

Metkel Yebiyo

Emilia Pisani Berglin

**ZHAW**

Frank Tillenkamp

Serena Danesi

Mirco Ganz

Zoe Abeln

| Agenda | Session 1 | |
|---|---|---|
| 14.00 | **Welcome & Opening Remarks** | Heat Pump Centre |
| 14.05 | **Introductory interventions, session 1** | |
| | *The global cooling challenge with rapidly growing demand for comfort cooling* | Axel Nordin Furdos, International Energy Agency (IEA) |
| | *Cooling demand and potential in EU* | Johan Carlsson, Joint Research Centre, European Commission (JRC) |
| | Q&A, interaction with audience | All |
| 14.35 | **Panel discussion**<br>*Regional and local perspectives related to comfort cooling technologies* | Yunho Hwang (US)<br>Johan Carlsson (EC)<br>LU Han (China) |
| 15.05 | **Coffee break** | Frank Tillenkamp, Serena Danesi, Mirco Ganz, (Zhaw) |
| | | |

| Agenda | Session 2 | |
|---|---|---|
| 15.25 | *Presentation of project proposal* | |
| 15.40 | **Workshop** | **All** |
| | *Group discussions* | |
| | *Reporting* | |
| | *Open discussion* | |
| | *Definition of project tasks* | |
| | Wrap-up and Closing remark | Heat Pump Centre |
| 17.00 | **End of workshop** | |

# How do you feel today?

- Too warm
- Comfortable
- Too cold

# Session 1

## Introductory interventions

# Presenters, session 1

**Axel Nordin**, International Energy Agency (IEA)

**Johan Carlsson**
Joint Research Centre, European Commission (JRC)

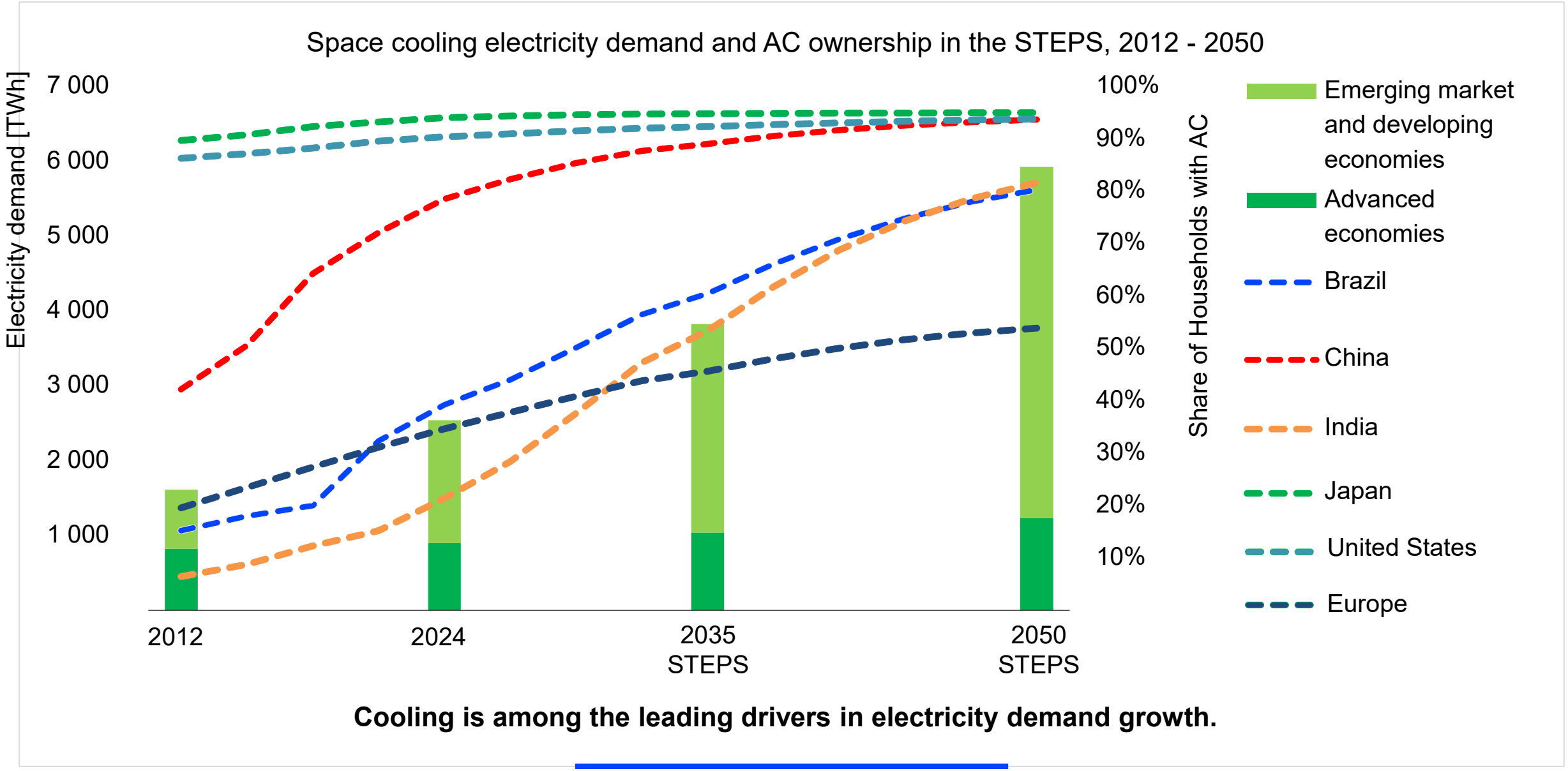
International Energy Agency

# Comfort cooling and heat pumps

Axel Nordin Fürdös

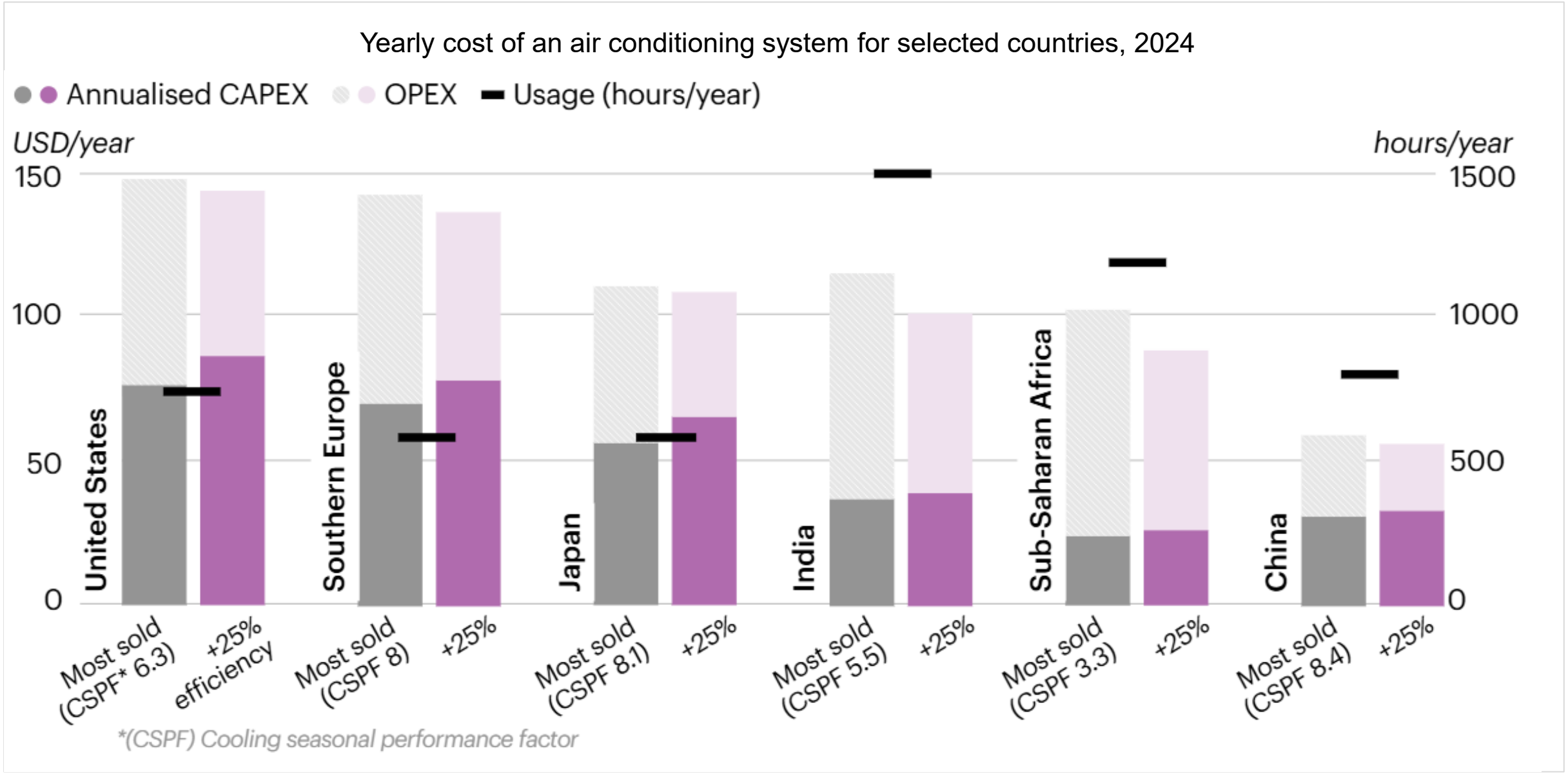
26 May 2026, Vienna

# Cooling in the Age of Electricity

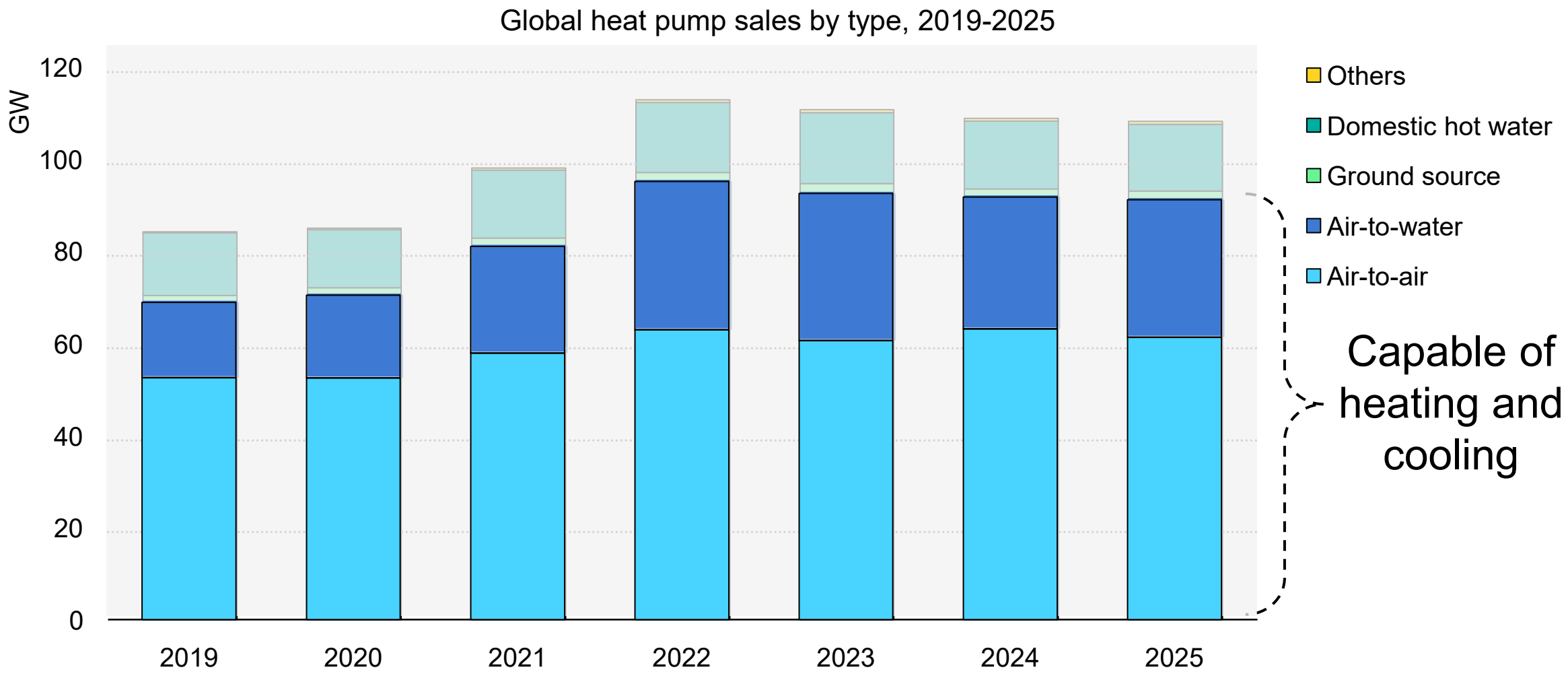



**Cooling is among the leading drivers in electricity demand growth.**

# Higher performance models pay back over their life cycle



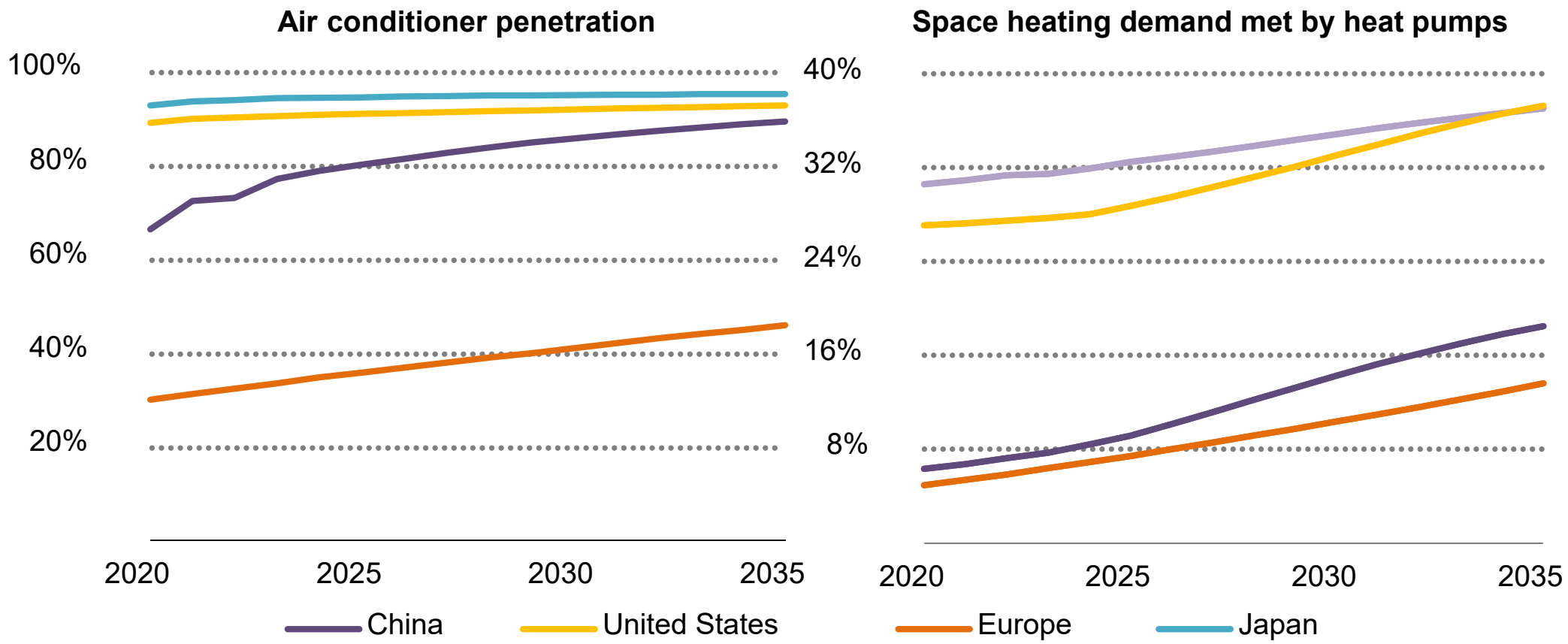
# Heat pumps blur traditional lines between heating and cooling




**The most popular heat pump types are already compatible with providing both heating and cooling.**

# Cooling markets in advanced economies lead in heat pump uptake

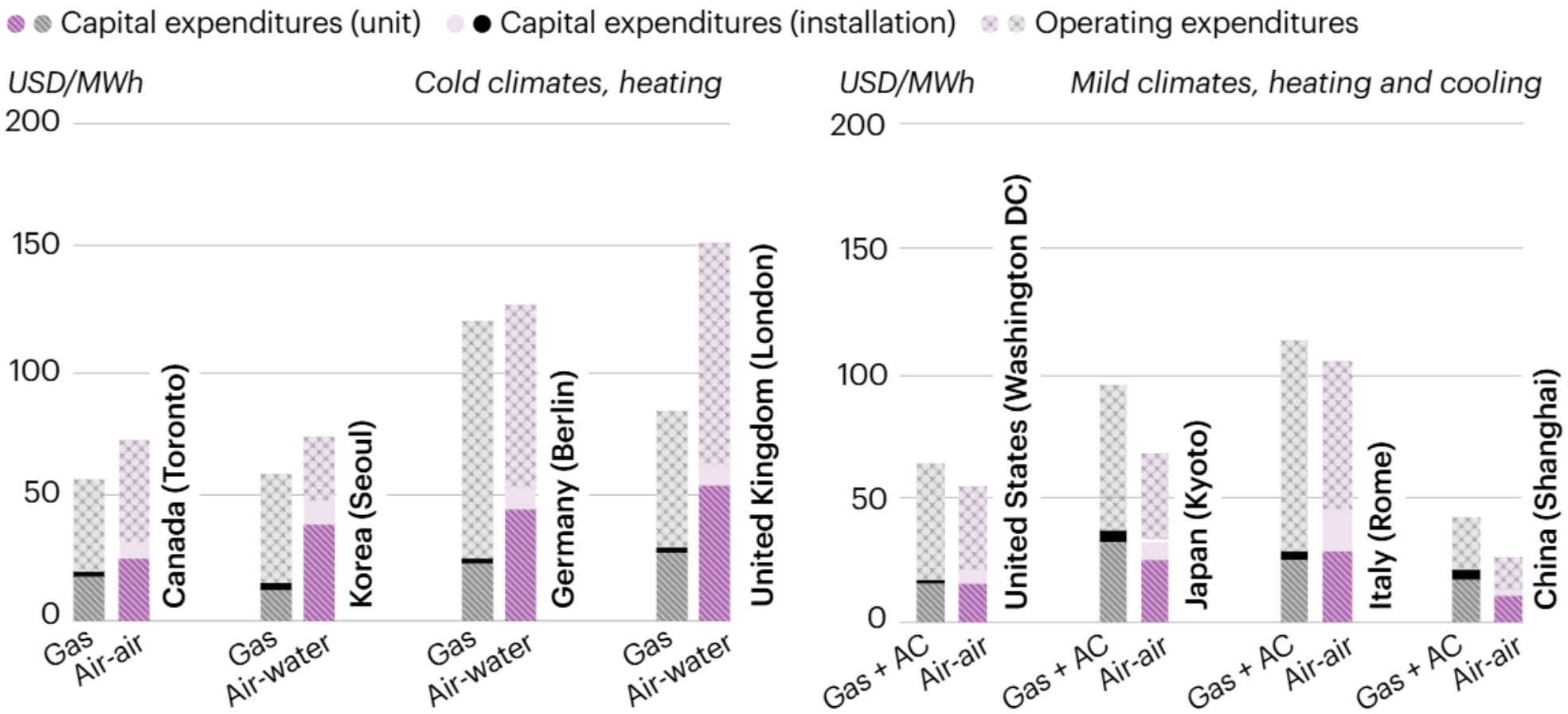
Share of space heating demand met by heat pumps and air conditioner penetration in the STEPS, 2020-2035




**Markets with the highest rates of air conditioner penetration also have tend to the highest share of space heating needs met by heat pumps.**

# Heat pumps are most cost-competitive in mixed-climate regions

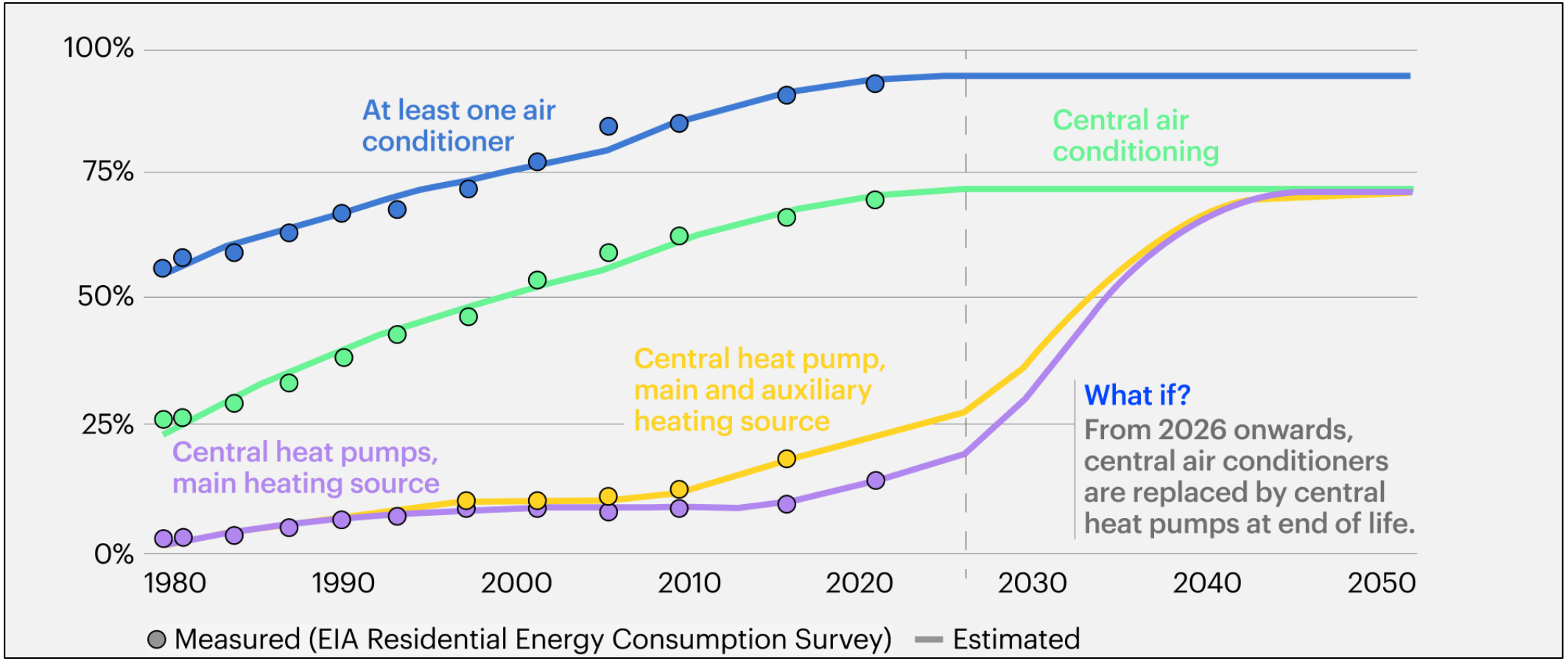
Levelised cost of heating and cooling in select regions, 2024




**Heat pumps are frequently the most cost-competitive option in climates with both heating and cooling needs.**

# Air conditioning as a pathway for heat pump deployment

Share of households using air-conditioning systems and heat pumps in the United States, 1980-2050




**Upgrading existing central air conditioners to reversible heat pump systems at their end of life could provide heating in 60% of households by 2035 at low additional cost.**

Dr. Reichl is senior scientist and working for AIT since 2001 primarily involved in experimental methods and computational analysis in fluid flows, aeroacoustics and acoustics. He is

# Panel discussion

**Yunho Wang**,
NRL, US

**Johan Carlsson,**
Joint Research Centre (JRC)
European Commission

**LV Han**
China Heat Pump Alliance (CHPA)

# Which is the most important challenge related to comfort cooling in your country?

Write on post-it and place on the wall

# Coffee Break

Subtitle chapter

# Presentation of project proposal

Subtitle chapter

# Idea for new project

# CLImate-friendly COmfort units (CliCo) with focus on NATural refrigerants
# CLICO-NAT

Frank Tillenkamp, zhaw IEFE, Switzerland

# Who we are

## IEFE Institute of Energy Systems and Fluid-Engineering - Organization and strategy

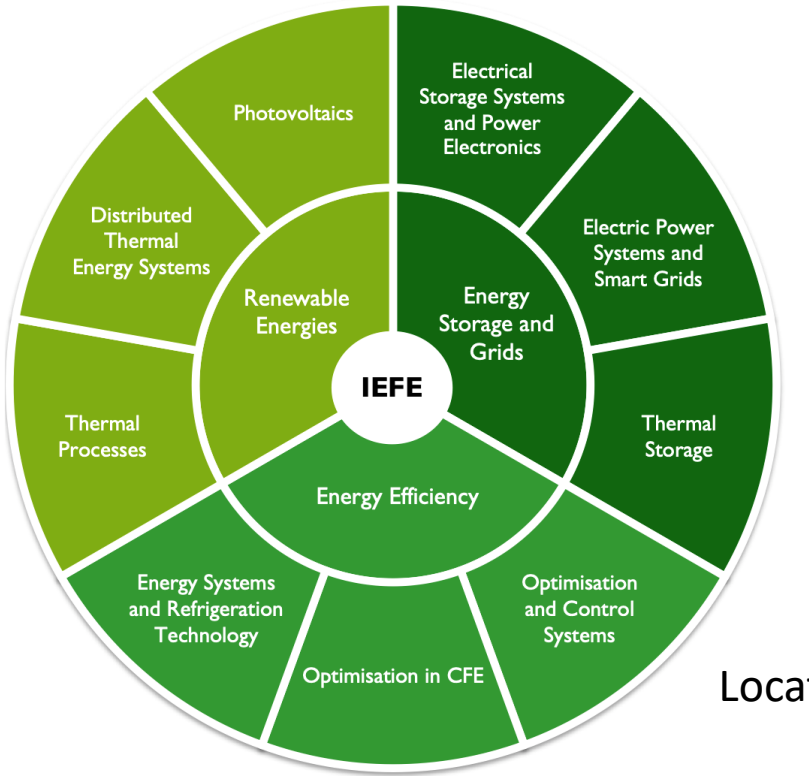
zh aw School of Engineering
IEFE Institute of Energy Systems and Fluid Engineering

Prof. Dr. Frank Tillenkamp
Head of Institute
frank.tillenkamp@zhaw.ch

**1 Energy efficiency**
We must utilise the available thermal and electrical energy as efficiently as possible

**2 Energy storage and grids**
We need to connect the producers and consumers of energy and store energy temporarily.
Thermal **and** electrical

**3 Renewable Energies**
We need to increase the amount of electricity available




Located in Winterthur, Switzerland

# Who we are

## Energy Systems and Refrigeration Technology

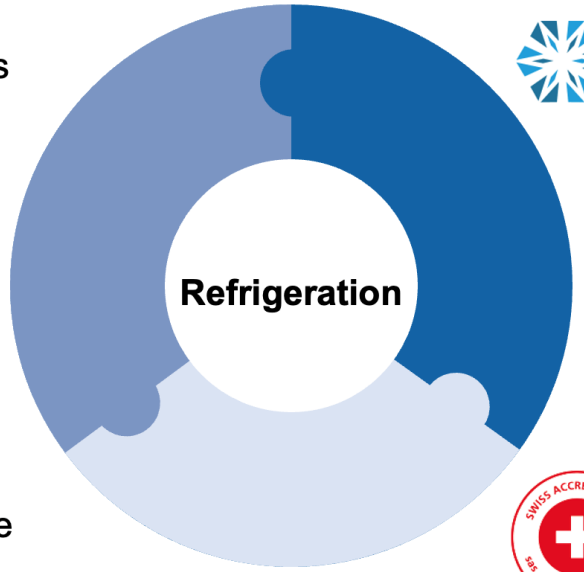
### Focus

zhaw School of Engineering
IEFE Institute of Energy System and Fluid Engineering

**1 Simulations and evaluation methods**
- Refrigeration circuit calculations and simulations
- Seasonal efficiency assessments
- Research and industry projects

**2 Investigations in the laboratory**
- Experimental investigations for R&D
- Validation of simulations
- Training and further education

**3 Investigations in the field**
- Mobile performance measurement (non-invasive measurements)
- Operational optimisation based on monitoring data
- Database with field measurements




SVK ASF ATF
Schweizerischer Verband für Kältetechnik

KKWIN
Kältemaschinen und Wärmepumpentechnik Kompetenzzentrum Winterthur

energieschweiz

SNV
standards connect the world

TC 113,182, 228, 44

TC 86

Prof. Dr. Frank Tillenkamp
Head of Refrigeration Research
frank.tillenkamp@zhaw.ch

# Background

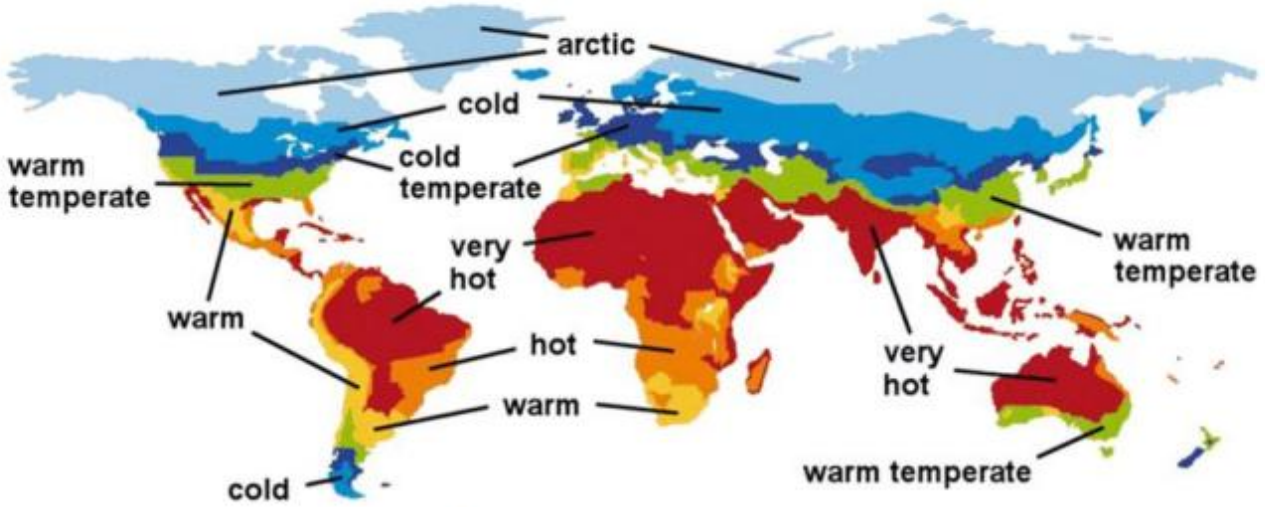
## Rising Air Conditioning demand

Building comfort cooling or air conditioning (AC) and refrigeration systems are responsible for a rapidly growing share of worldwide energy consumption, representing a **$ 100 billion market** with over **100 million units** sold annually.

Aside Europe and the US, large regions with hot and humid climates and growing populations such as Brazil, China, India, and Middle Eastern nations, will experience an even more increased **need for cooling** and **locally need for dehumidification**.

**Environmental challenges** from HFC/HCFC refrigerants not only according to **GWP** but to **PFOA**

**Need for** sustainable, **PFOA-free solutions** (CO2, Propane, iso-butane, ammonia,…) -> **natural refrigerants for comfort cooling**

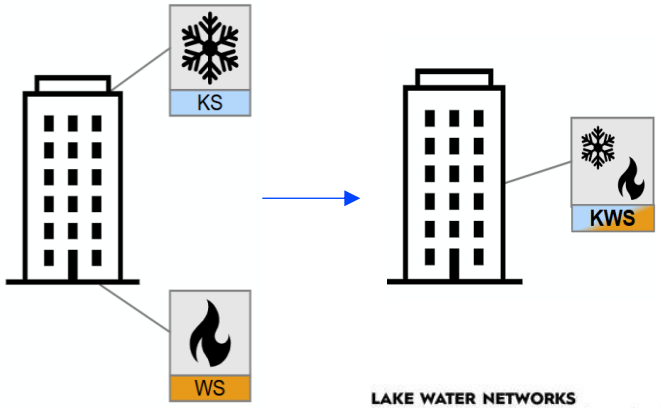



World-wide hot and humid climate



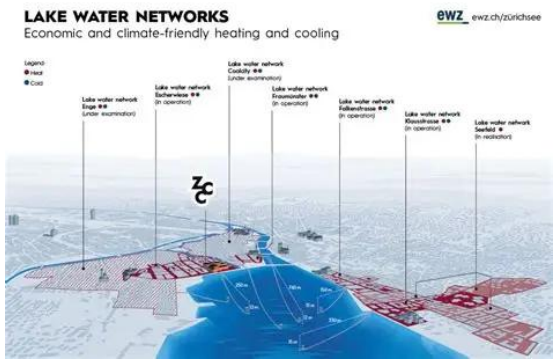
IEA (2023), Final energy consumption and carbon emissions for space cooling by region in the Net Zero Scenario, 2000-2030, IEA, Paris

# Key Challenges



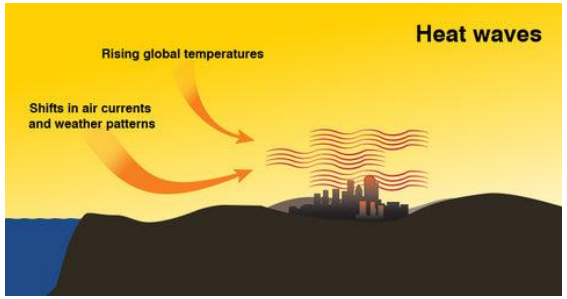

**Every country has different challenges:**

- Retrofitting AC in existing buildings
- Combining heating and cooling applications
- Low temperature district heating and cooling networks
- Humidity
- Handing increasingly frequent and intense heat waves
- Switching to natural refrigerants



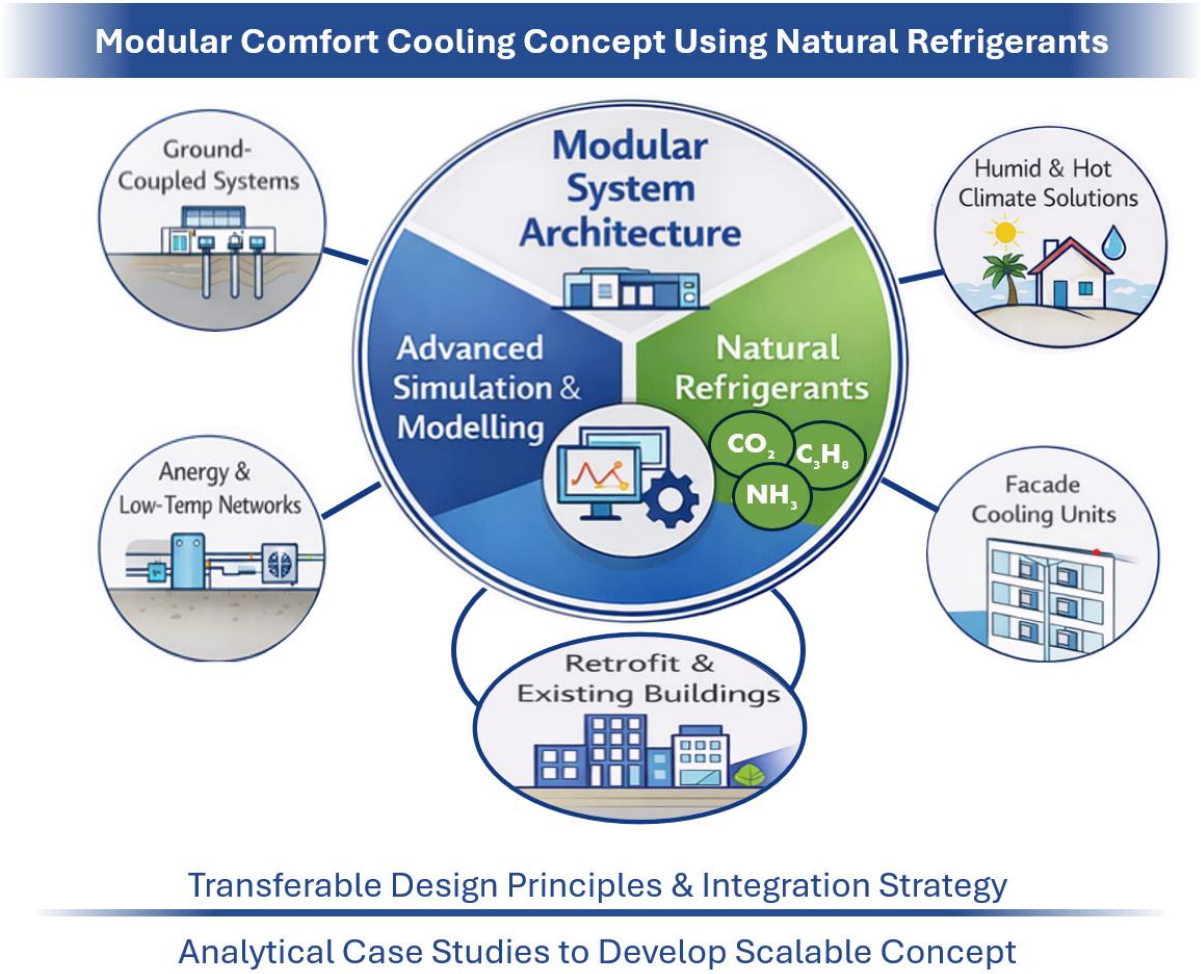

**Is there a core Comfort Cooling Unit that adapts to these needs?**

**Which localizations are necessary?**



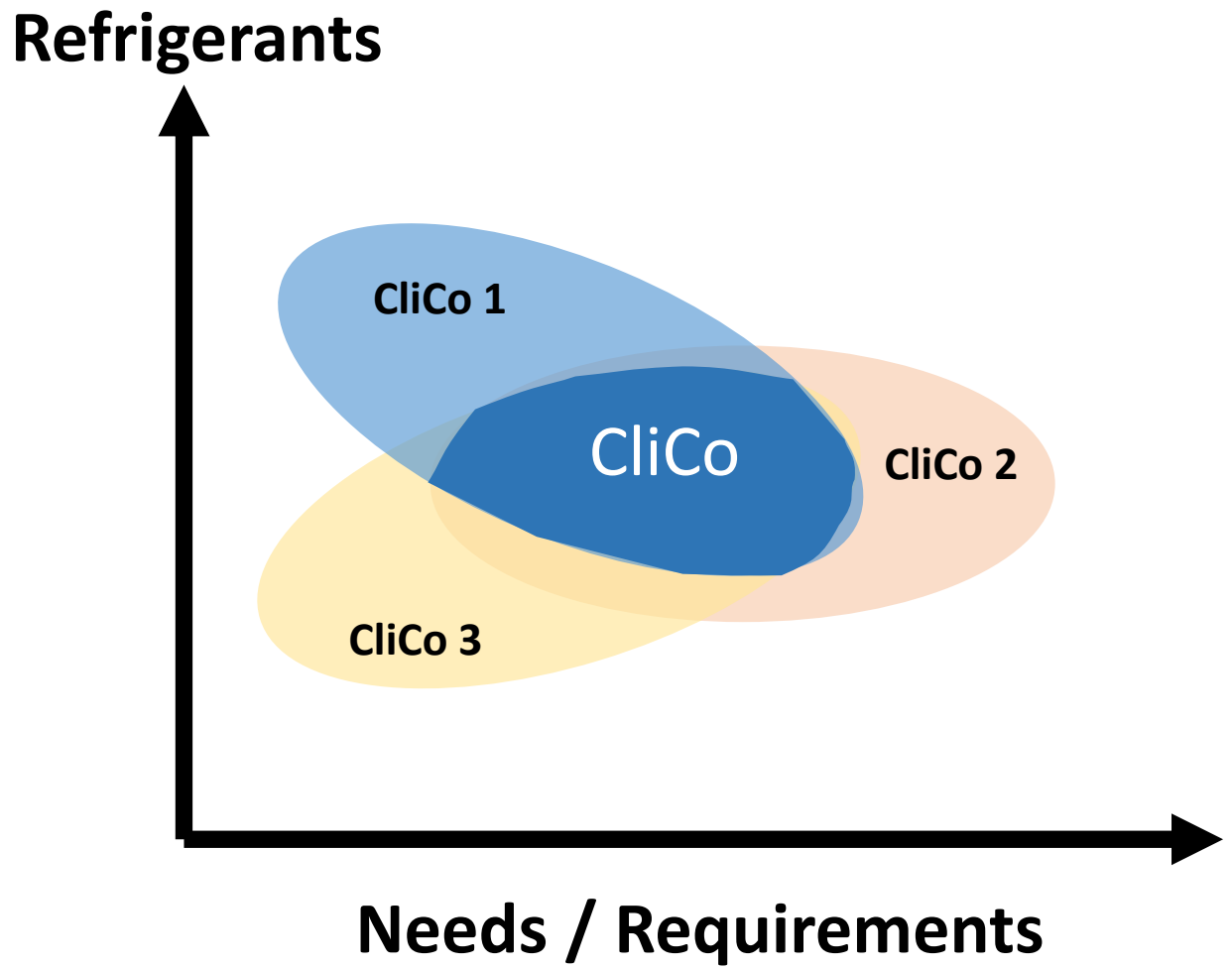
# Why CliCo-NAT?

- **One modular platform** for multiple climate solutions and applications
- **Simulation-based design** and evaluation of modular CliCos
- Assessment of **natural refrigerants** ($CO_2$, Propane, Ammonia)
- Building upon the **results of Annex 55**
- Application of **local adaptions**
  - Retrofitted buildings
  - District networks
  - Ground-source free-cooling
  - Heat collector for small single units
  - Dehumidifying booster box



# Five applications with common objectives

- Development of **standardized** Climate friendly Cooling Units
- **Regional** adaption and integration
- Market readiness and **knowledge dissemination**
- **Cost reduction** & economies of scales
- Contribution to **UN-SDG**

# Common goals

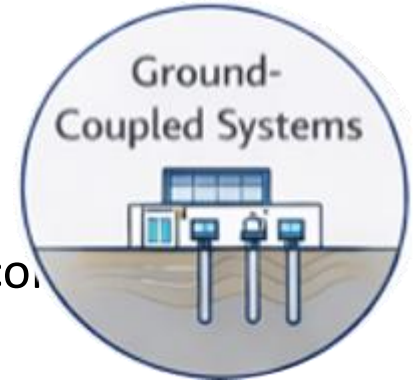
**Technical challenges**
Technical barriers, safety requirements, component limitations, co
strategies and integration challenges

**Geographical and climatic relevance**
Evaluation of the climatic conditions and geographical regions where each solution is most relevant

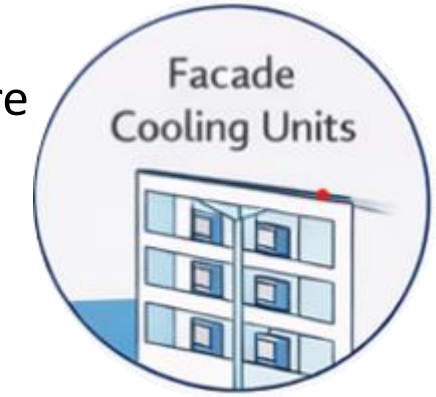
**Green electricity connection and compensation mechanisms**
Physical connection to renewable electricity sources as well as compensation by Certificates

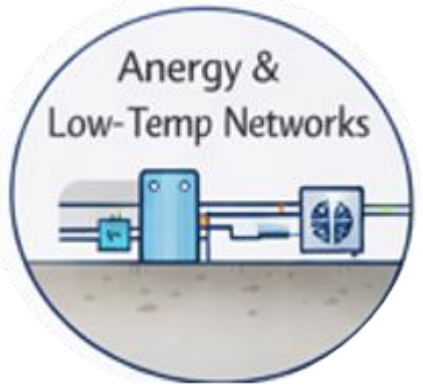
**Regulatory aspects**
Safety standards, refrigerant regulations and building codes

**Stakeholder involvement**
Identification of stakeholders  as manufacturers, planners, utilities, building owners and policy makers

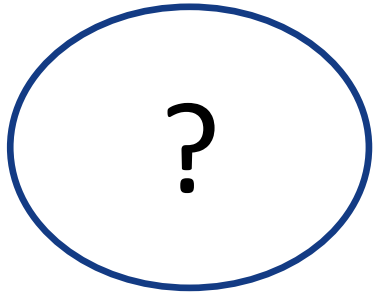










# Target Audience, Benefits

- Planners, manufacturers, building operators, policy makers, academia, society
- Access to **open simulation tools**, retrofit **guidelines**, standardized CliCo **designs**
- Supports **sustainable co**oling adoption and **emission reductions**
- Meeting **SDGs**

# Deliverables

- **Technical:** Standardized CliCo, simulations, control strategies, field test data
- **Economic/Social:** Scaling strategies, retrofit guidance, market insights
- **Environmental:** Reduced emissions, improved efficiency
- **Dissemination:** Reports, open-access models, workshops, publications

# THANK YOU FOR YOUR ATTENTION!

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ZHAW School of Engineering
Technikumstrasse 9
8400 Winterthur

# Group discussions

# Group discussions

# Group discussions

Task 2: Small cooling units for building connected to district networks

Task 3: Ground source free cooling

Task 4: Smart ways to extract heat from multiple facade single cooling units

Task 5: Solution for dehumidification integrated in Comfort Cooling concepts

Task 6: Retrofitted buildings

# Group discussions

**Technical challenges**
Technical barriers, safety requirements, component limitations, control strategies and integration challenges

**Geographical and climatic relevance**
Evaluation of the climatic conditions and geographical regions where each solution is most relevant

**Green electricity connection and compensation mechanisms**
Physical connection to renewable electricity sources as well as compensation by Certificates

**Regulatory aspects**
Safety standards, refrigerant regulations and building codes

**Stakeholder involvement**
Identification of stakeholders  as manufacturers, planners, utilities, building owners and policy makers

# Reporting back

2-3 minutes per group

# *Are there other challenges related to comfort cooling that you would like to engage in finding solutions for?*

*(not covered by the project proposal)*


Interest form for future HPT TCP
project about comfort cooling

heatpumpingtechnologies.org

# Thanks for your contribution!