**NELE RENDERS**
VITO / ENERGYVILLE

**NELSON GARCIA**
CIRCE

**LORCAN LYONS**
JRC

**JONATHAN VOLT**
JRC

**THOMAS NOWAK**
EHPA

stream SAVE

# WEBINAR

## AMBITIOUS TARGETS FOR HEAT PUMPS: HOW TO STREAMLINE ENERGY SAVINGS CALCULATIONS ACROSS THE EU?

ON TUESDAY,
13 DEC 2022

START AT
14:00 - 15:30

@stream_save

# Housekeeping

Recording and slides will be circulated

Chat pod for introductions and soft networking

Written questions in the Q&A pod

Upvote questions from other participants

# Agenda

| | | |
|---|---|---|
| 14:00 | Introduction to streamSAVE by the project coordinator | Nele Renders, VITO/EnergyVille |
| 14:10 | Heat Pumps in the EU – Key findings from the recent status report on technology development, trends, value chains and markets | Lorcan Lyons, JRC<br>Jonathan Volt, JRC |
| 14:25 | The streamSAVE guidance and its platform illustrated: Streamlined energy savings calculations for small scale heat pumps | Nelson Garcia, CIRCE |
| 14:55 | The use of heat pumps in industrial processes | Thomas Nowak, EHPA |
| 15:05 | Panel discussion and Q&A with the audience | Moderator: Nele Renders |
| 15:25 | Conclusions and wrap-up | |

# Introduction

Nele Renders, VITO/EnergyVille

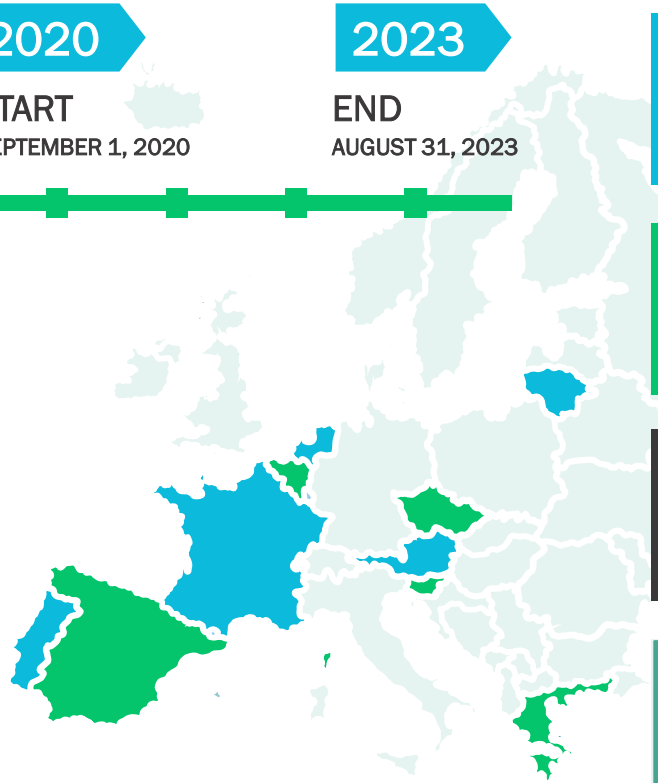
*Ambitious targets for heat pumps*

This project has received funding from the Horizon 2020 programme under grant agreement n°890147. The content of this presentation reflects only the author's view. The European Commission is not responsible for any use that may be made of the information it contains.

# Who are we?

**2020**
START
SEPTEMBER 1, 2020

**2023**
END
AUGUST 31, 2023



**COORDINATOR**

vito, EnergyVille

**12 PARTNERS**
**10 COUNTRIES**

**RESEARCH & POLICY INSTITUTIONS**

vito, IEECP (Institute for European Energy and Climate Policy), ISR, circe, Jožef Stefan Institute

**ENERGY AGENCIES OR RELATED**

AUSTRIAN ENERGY AGENCY, ADEME (Agence de l'Environnement et de la Maîtrise de l'Energie), ΚΑΠΕ CRES, LIETUVOS ENERGETIKOS AGENTŪRA, SEVEn7

**CONNECTORS TO MARKET & TECHNOLOGY ACTORS**

Cu European Copper Institute Copper Alliance, LGi sustainable innovation

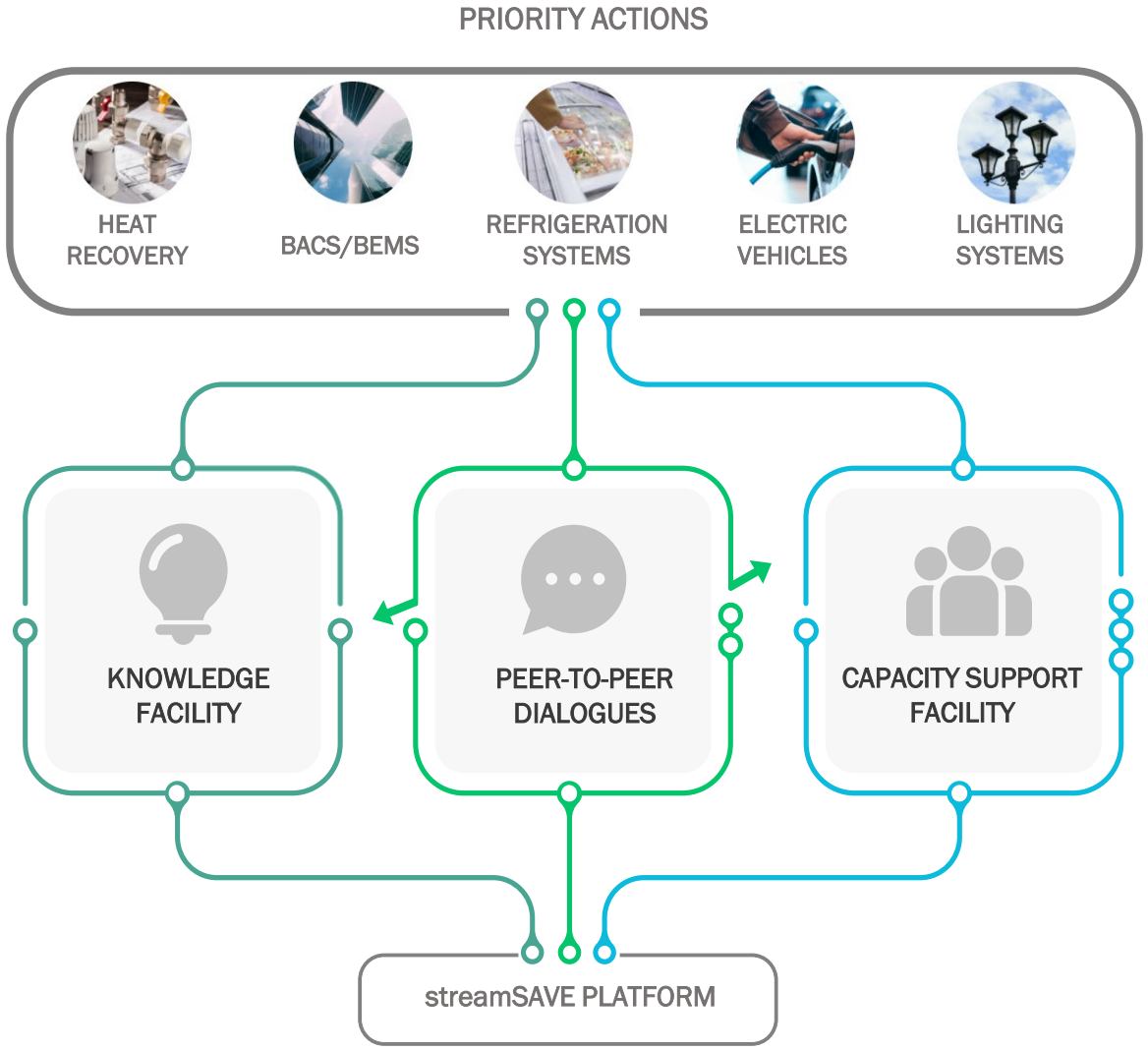
# What do we aim for?

- Building capacity among public authorities on Article 3 & Article 7 of the Energy Efficiency Directive:

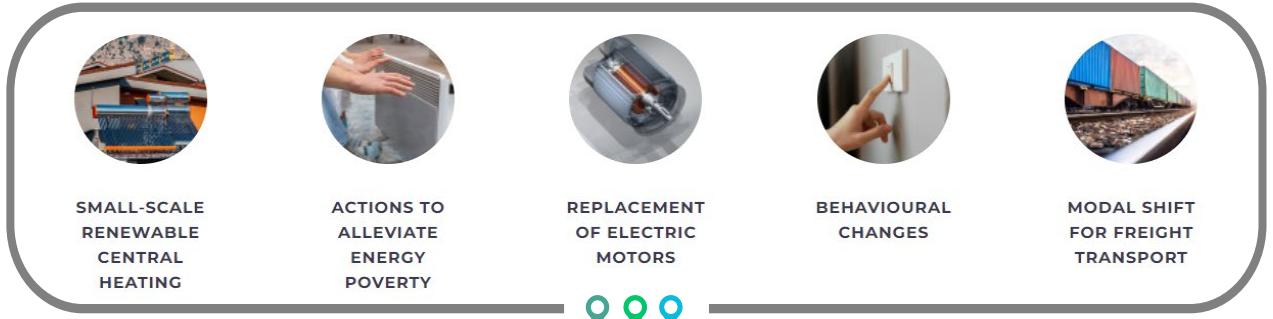
  *streamSAVE will build capacity through the creation of an open dialogue that will focus on streamlining calculation methodologies to estimate bottom-up savings and cost effectiveness of technical energy savings actions. The project will target priority actions i.e., new actions with high energy saving potential and considered as a priority issue by national public authorities.*

- Address additional efforts in EU Member States in realizing energy savings by 2030 under Article 3 & Article 7 of EED.

# How do we realize these objectives?



# How do we realize these objectives?




PRIORITY ACTIONS

KNOWLEDGE FACILITY

PEER-TO-PEER DIALOGUES

CAPACITY SUPPORT FACILITY

streamSAVE PLATFORM

Register for methodologies in detail

https://streamsave.flexx.camp/signup-0818ml

# Thank you

## Get in touch for more information!


Project coordinator - Nele Renders, VITO

All project reports will be available for download on the streamSAVE website www.streamsave.eu

Email the project at contact@streamsave.eu

Follow the project on LinkedIn @streamSAVEH2020

Follow the project on Twitter @stream_save

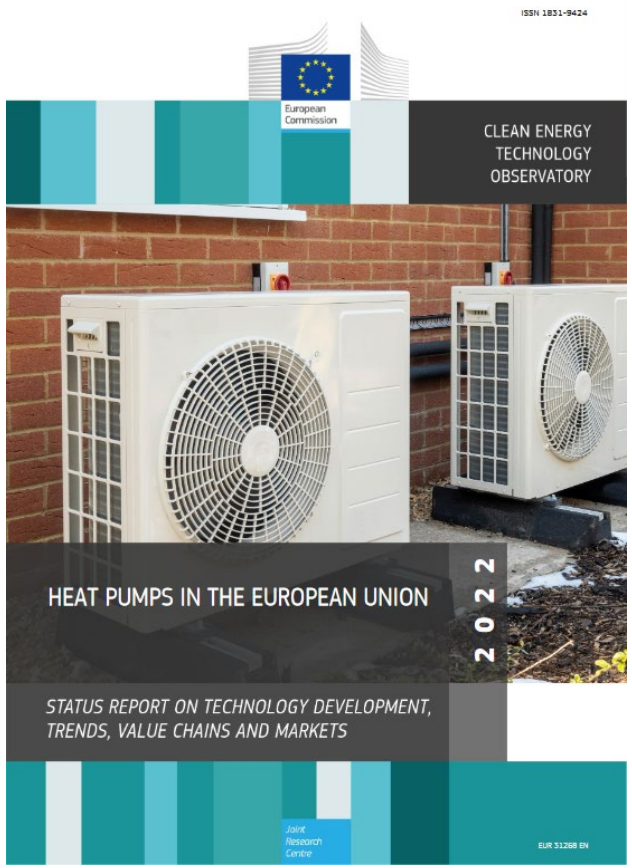
# Heat pumps in the EU: Technology development, value chains and markets

Lorcan Lyons and Jonathan Volt,

Clean Energy Technology Observatory, European Commission Joint Research Centre

streamSAVE webinar, Leonardo ENERGY platform, 13 December 2022

# Context




- State of the Energy Union (DG ENER, from 2015)
- Competitiveness Progress Report (ENER, from 2020)
- Clean Energy Technology Observatory **#CETO2022** (JRC with ENER and R&I, from 2022)
  - **Heat Pumps in the European Union**
  - 27 other reports, including Industrial and District Heat and Cold Management

# CETO report contents

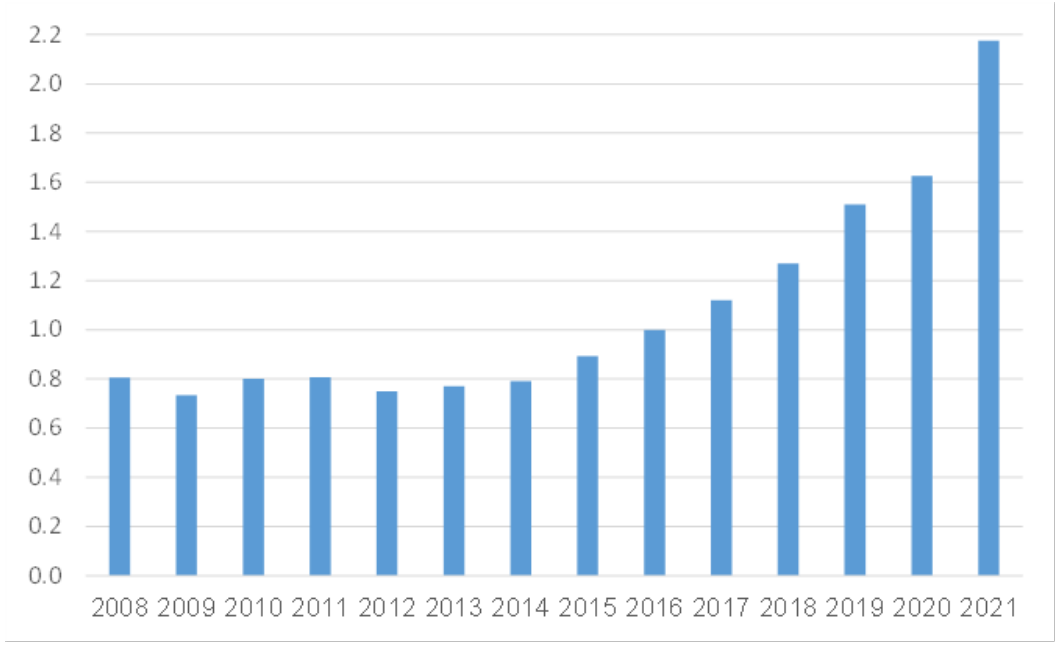
- **Technology description, research areas**
- **Stock and sales**
- **Drivers and barriers**
- **Costs**
- **Public research funding**
- Private research funding
- Patenting
- Scientific publications
- EU-funded research
- Turnover
- Environmental and social sustainability
- **EU companies**
- Employment
- **Energy intensity**
- Global market leaders
- **Trade**
- Resource efficiency
- Conclusions

# Technology

- Source: **air**, ground, water
- Medium: air, **water** (hydronic, i.e. radiators)
- Technology: **electric** compression, others
- Purpose: **heat**, hot water, cooling
- Size: **small** (houses), large (apartment, offices, DHC, industry)
- System: **stand-alone**, hybrid, integrated with solar, 5G DHC

# Stock and sales

- 17 million installed by 2021
- Sales +34% to 2.2 million
- 21.5% of heating systems sold
- Stock meets 10% of heating demand




Source: EHPA data for 21 European countries

# Drivers and barriers

+ Policy:
energy savings, decarbonisation, energy security, ecodesign
+ Prices of gas and oil
+ Technology improvements
+ Trends in heating demand

- Up-front cost
- Installation
- Semiconductors
- Macroeconomics, finance

? Building stock
? F-Gases
? Grid investment

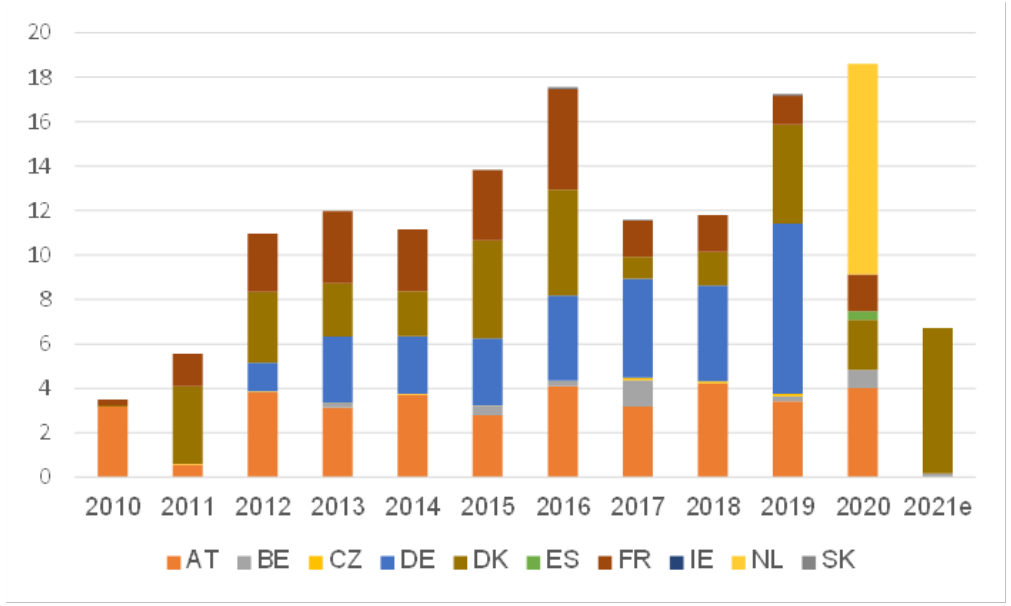
# Research areas

- Up-front cost and installation time
- Efficiency
- Operating temperature range
- Size and noise
- Refrigerants
- Business model

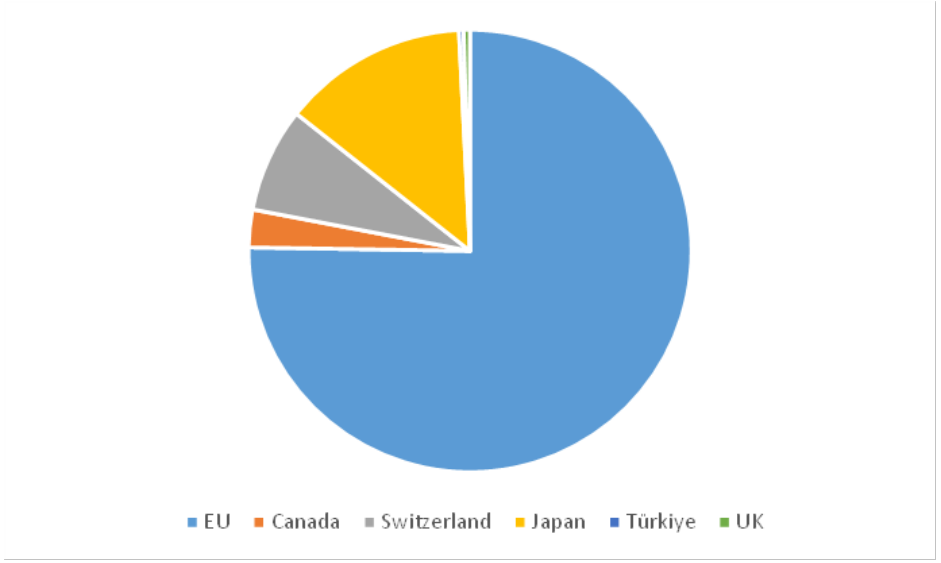
- Optimisation (heating *and* cooling)
- Integration (ventilation, hot water, storage, solar PV, flexibility)
- Large heat pumps
- Alternative technologies

# Public research funding

- Modest funding
- But increasing (e.g. DE, NL)
- And more than some others




EUR millions. Source: JRC based on IEA and BMWi.




2020. Source: JRC based on IEA.

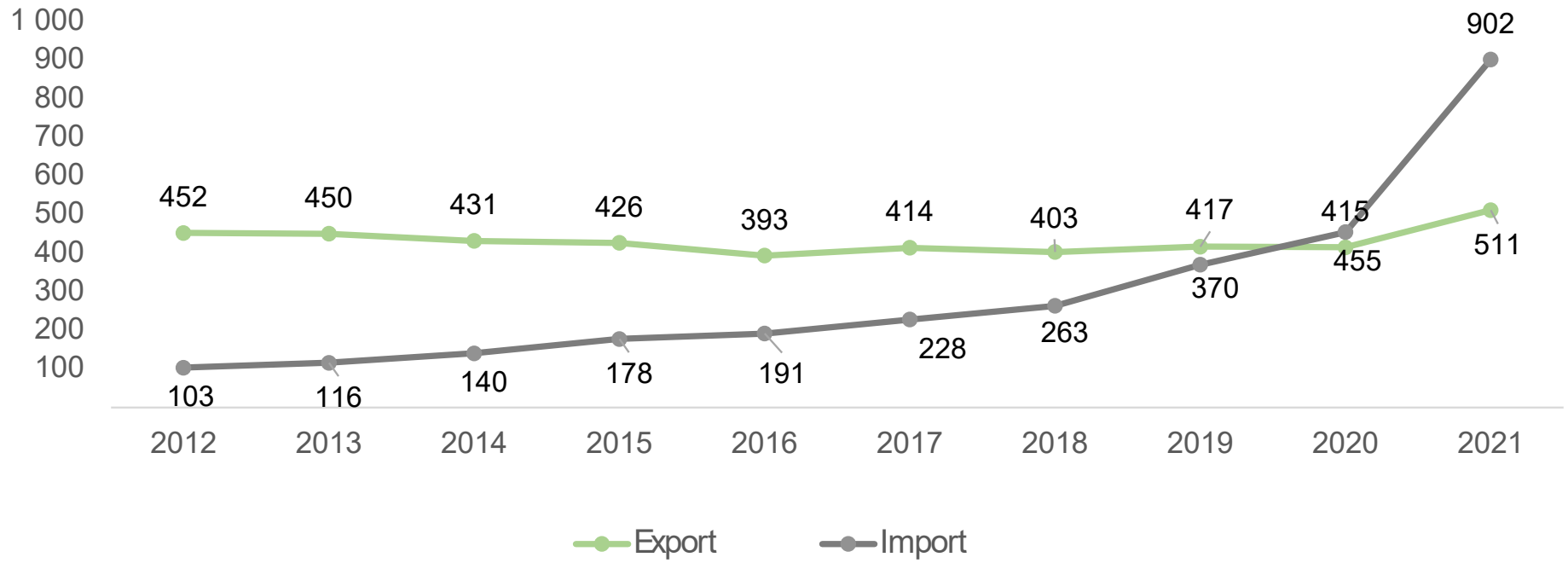
European Commission

# EU companies

- Leaders especially in large heat pumps and hydronic heat pumps
- About 170 factories, 18 countries
- Often also manufacture other heating systems such as boilers
- Competitors often have EU subsidiaries
- Specialised in assembly but many components also made in EU
- Investments happening and on the way: EUR 4 billion to 2025

# Trade

Extra-EU imports and exports, 2012-2021 (EUR millions)



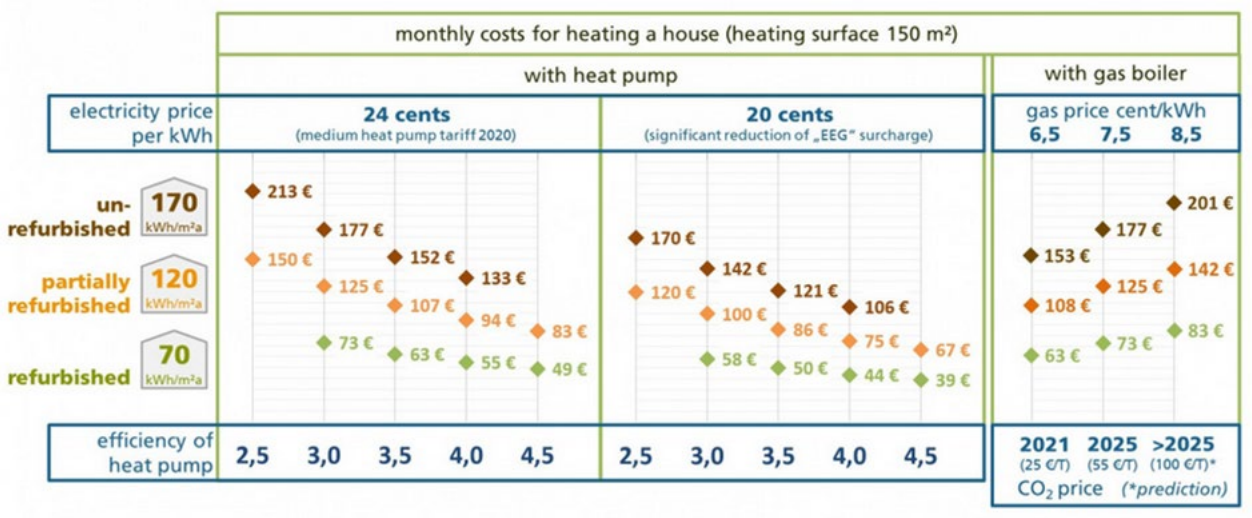

Source: JRC based on COMEXT, code 841861



European Commission

# Costs 1

- Limited cost data, see also new work by IRENA
- Ground-source higher up-front cost, often more efficient
- Operating cost depends on prices, energy performance, area, efficiency

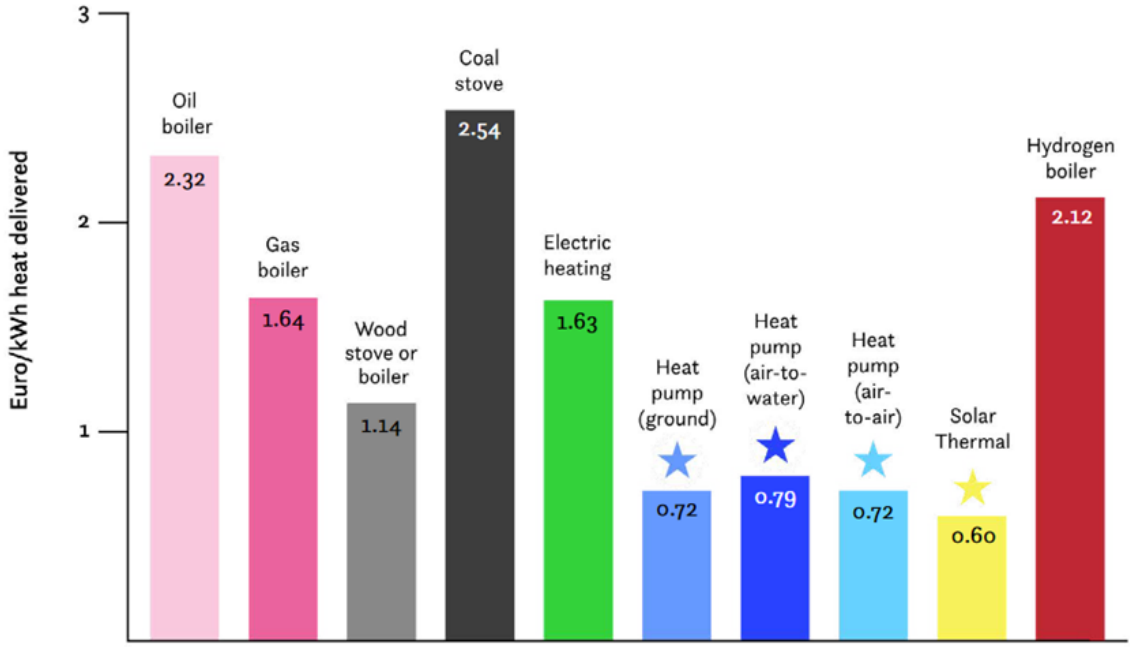



Source: Miara, 2021

European Commission

# Costs 2

- Levelised cost falling, likely to continue
- Add cost of e.g. underfloor heating, insulation?
- Also consider property value?

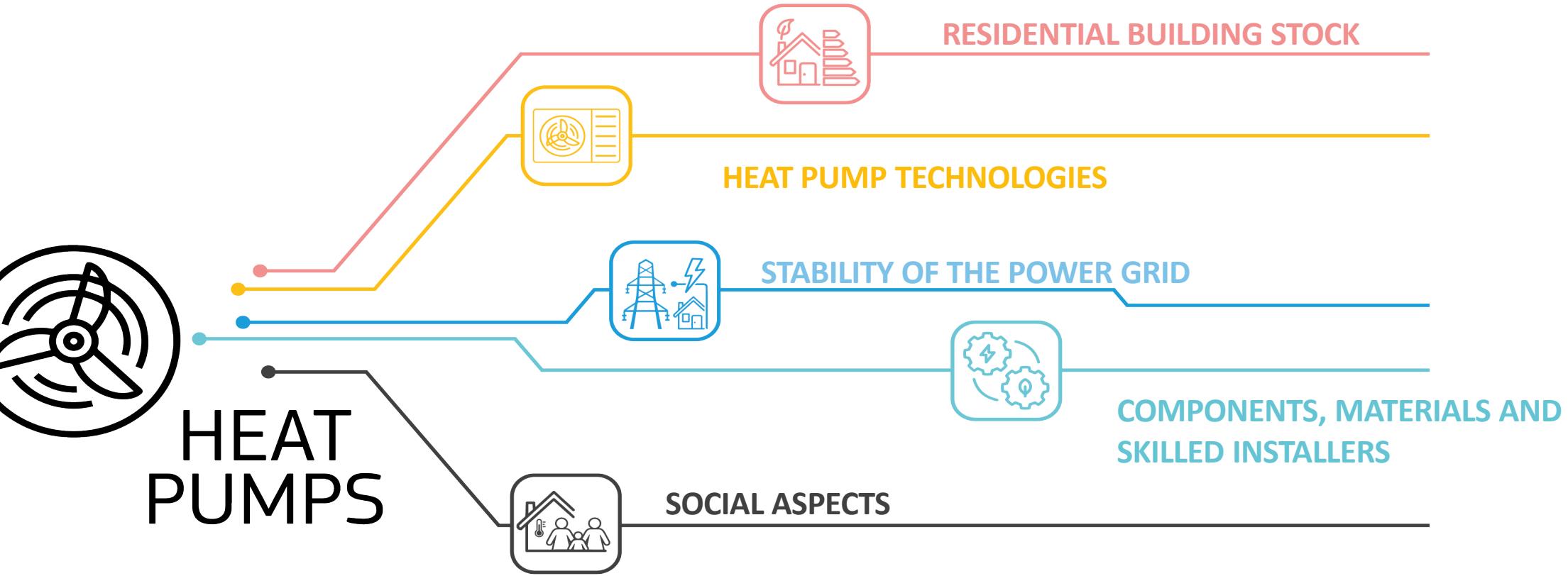



Total cost of ownership, 2030-2040. Source: Mixed scenario with hydrogen produced domestically, from ECF et al. (2022)

# Energy intensity

- COP typically 3-5, with ground-source tending to be most efficient
- Performance can deteriorate without annual maintenance
- Electricity dominates the life-cycle emissions of heat pumps, followed by refrigerants (about 14%)
- Carbon intensity of electricity = 384 g/kWh (VHK and BRG Ecodesign preparatory study, 2019)

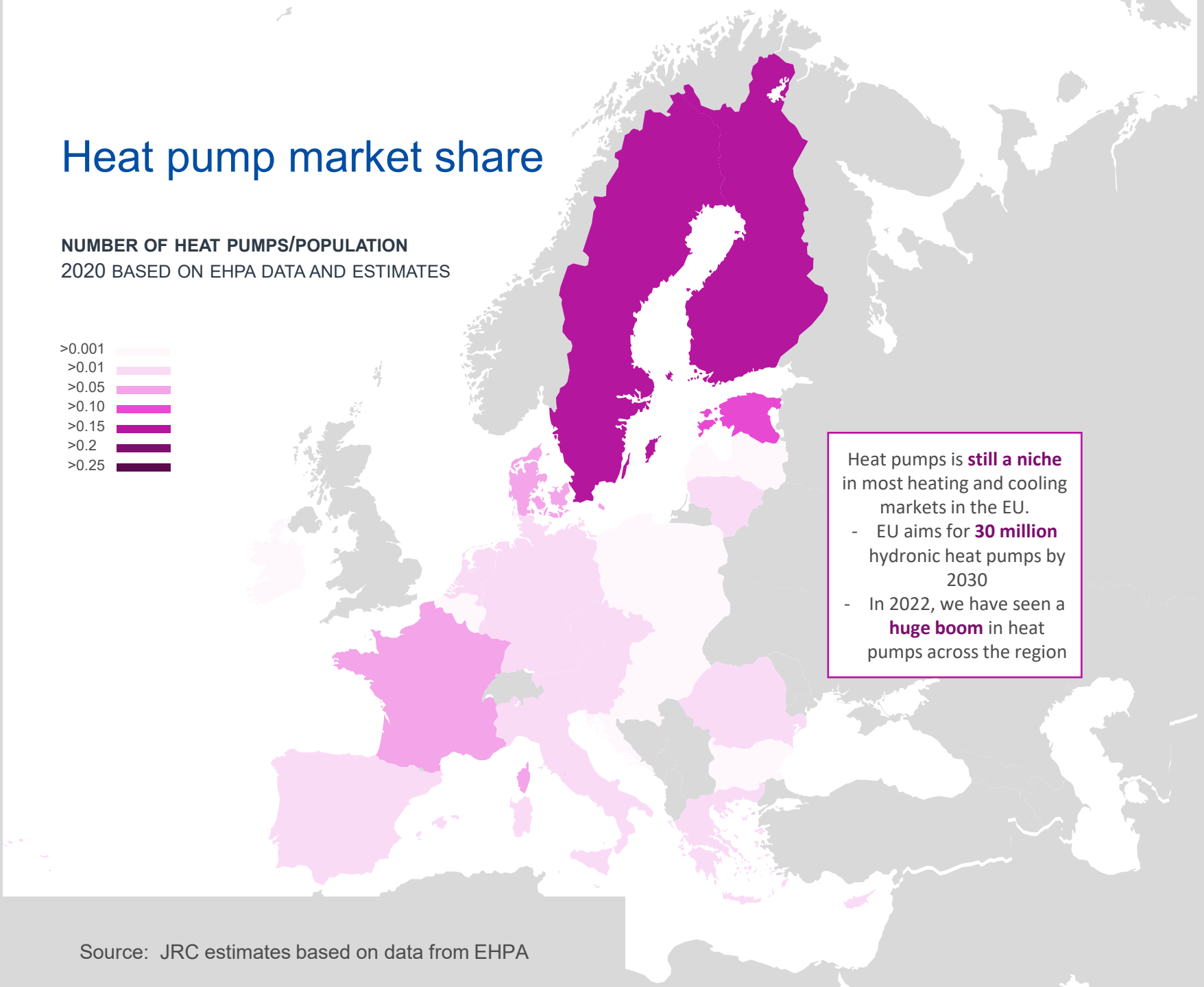
# JRC’s ongoing Heat Pump study




European Commission

# Heat pump market share

**NUMBER OF HEAT PUMPS/POPULATION**
2020 BASED ON EHPA DATA AND ESTIMATES



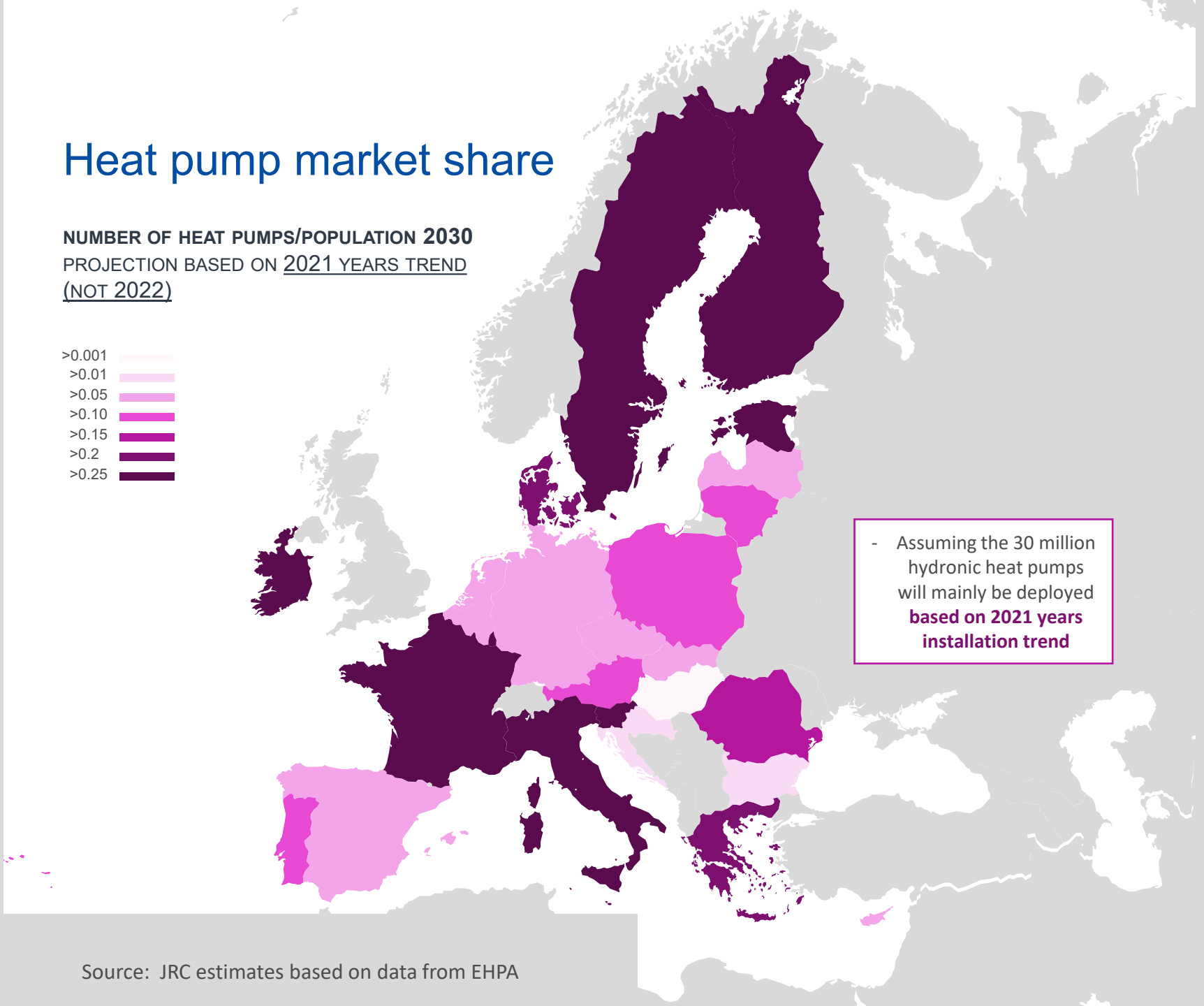

Heat pumps is **still a niche** in most heating and cooling markets in the EU.

- EU aims for **30 million** hydronic heat pumps by 2030
- In 2022, we have seen a **huge boom** in heat pumps across the region

Source: JRC estimates based on data from EHPA

# Heat pump market share

**NUMBER OF HEAT PUMPS/POPULATION 2030**
PROJECTION BASED ON 2021 YEARS TREND
(NOT 2022)

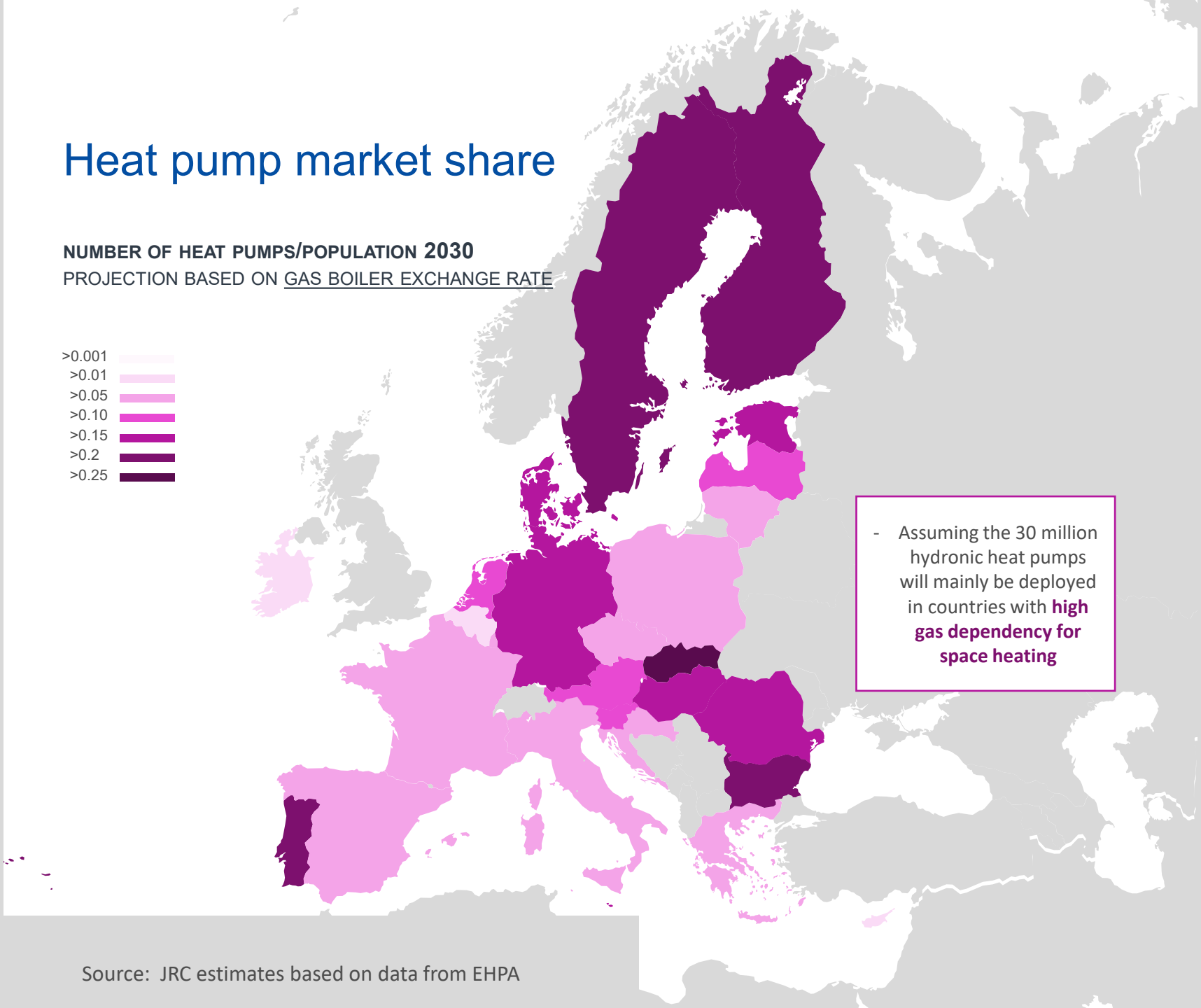



- Assuming the 30 million hydronic heat pumps will mainly be deployed **based on 2021 years installation trend**

Source: JRC estimates based on data from EHPA

# Heat pump market share

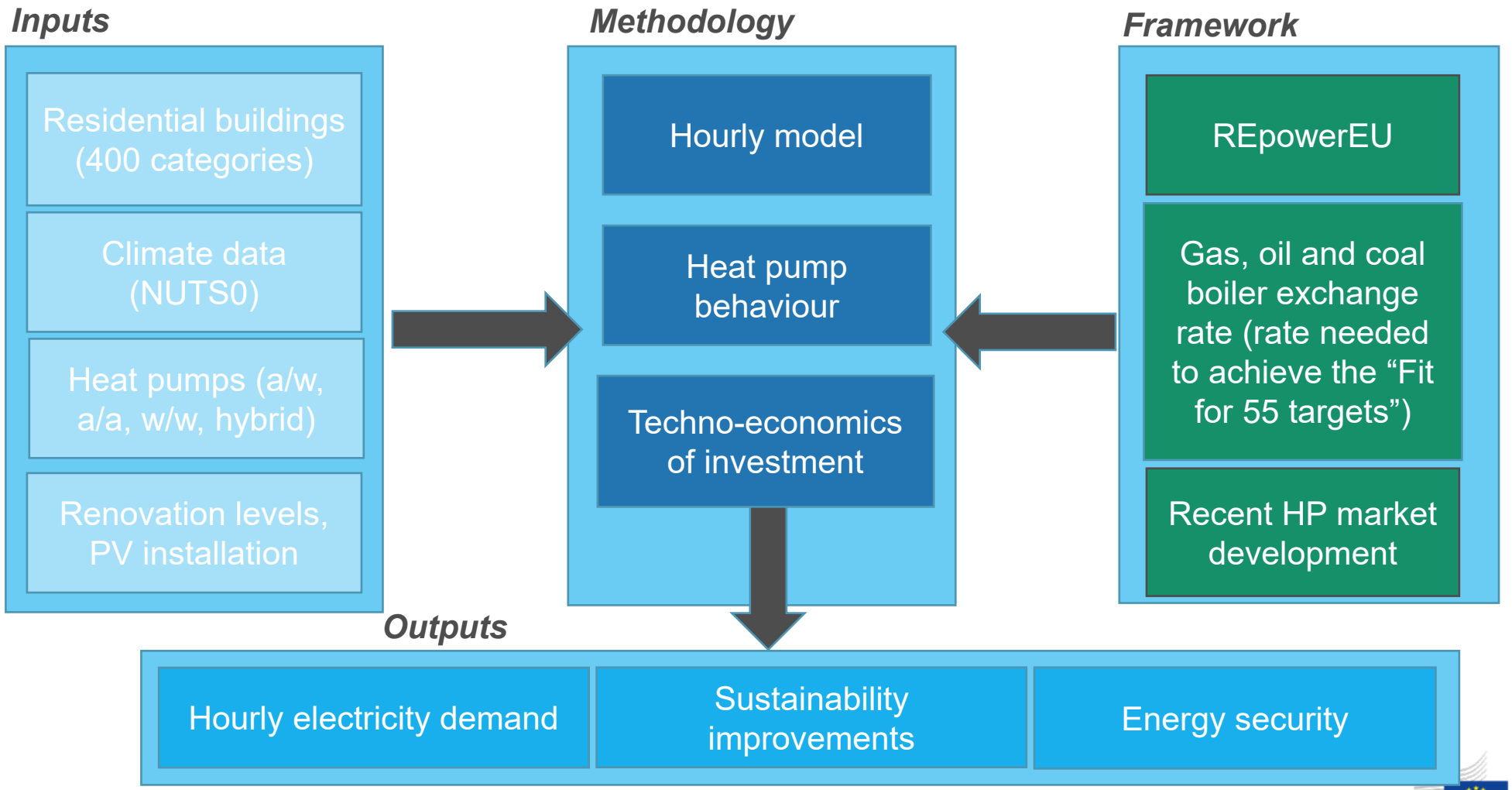
**NUMBER OF HEAT PUMPS/POPULATION 2030**
PROJECTION BASED ON GAS BOILER EXCHANGE RATE




- Assuming the 30 million hydronic heat pumps will mainly be deployed in countries with **high gas dependency for space heating**

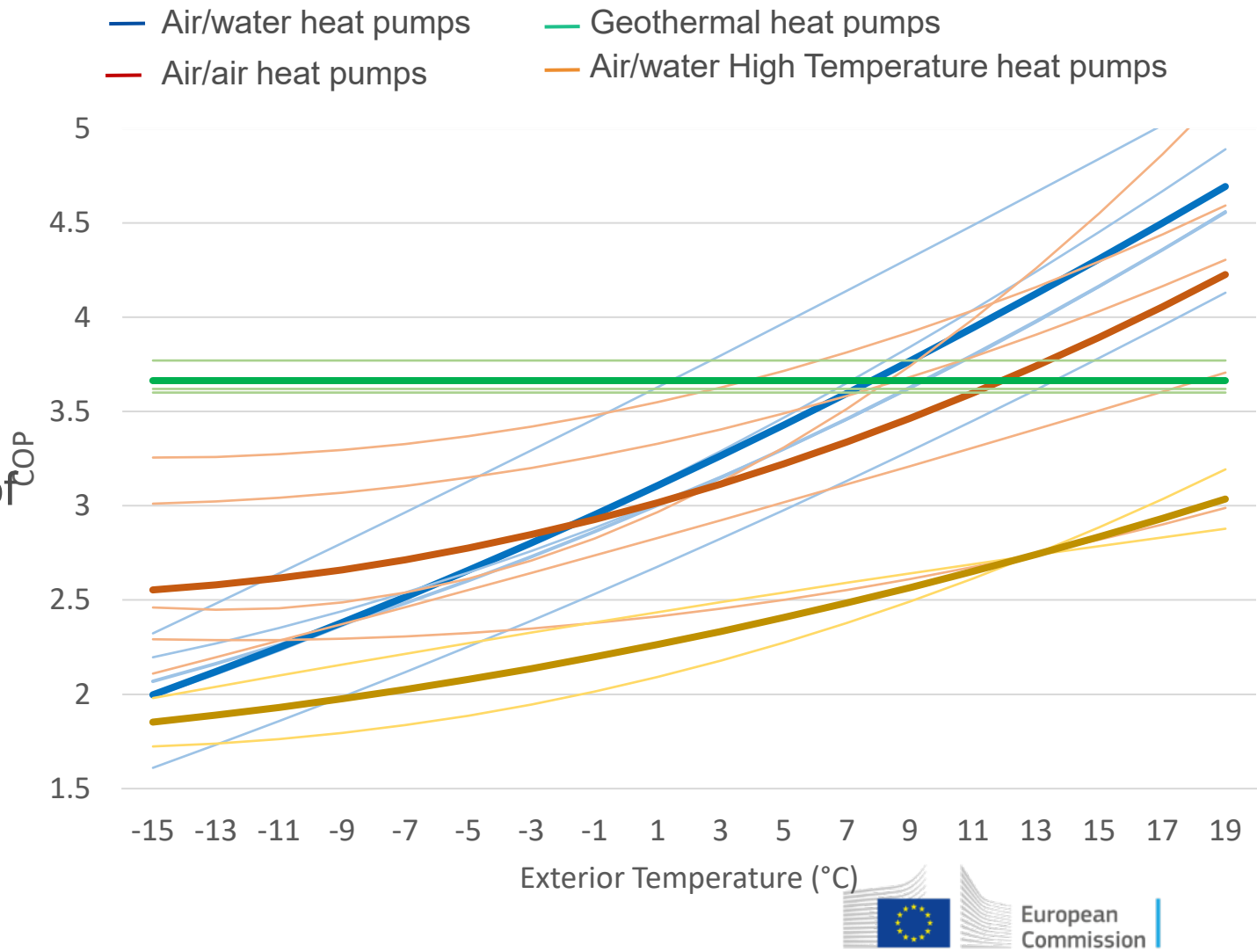
Source: JRC estimates based on data from EHPA

# Modelling approach



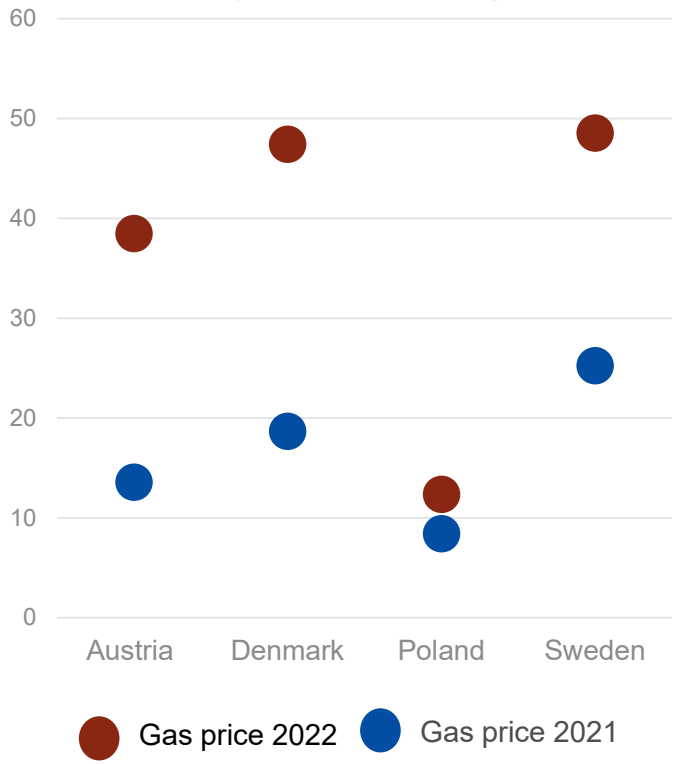
# Heat pump efficiency

- Characteristics of 15 HP models
- Two types of air/water HPs (for supply temperature of 45°C and 65°C)
- Air/air HP as a hybrid solution in most of the cases

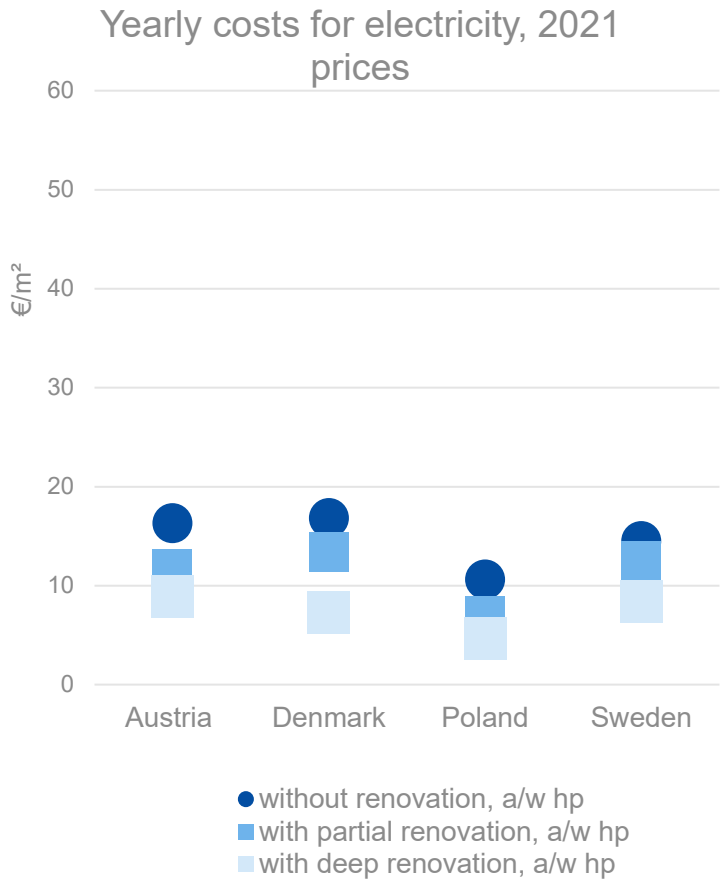


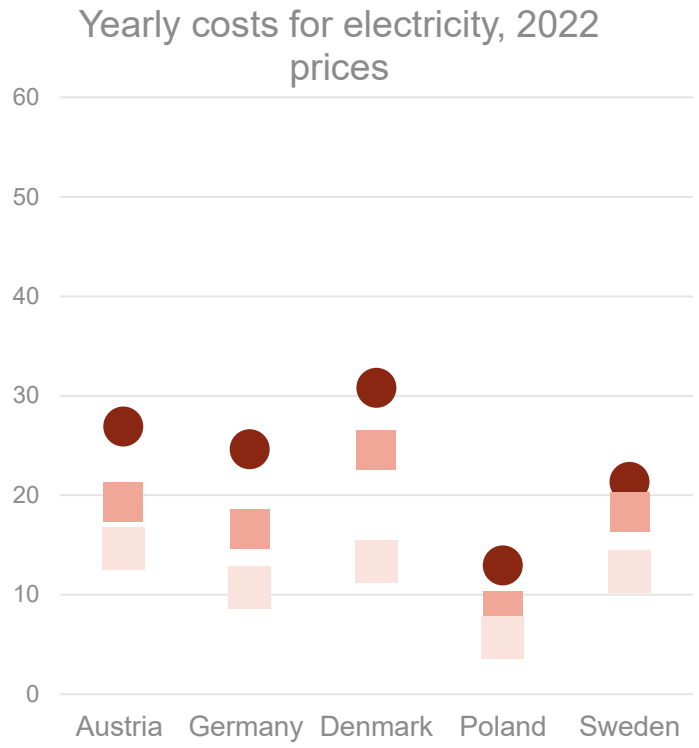

European Commission

# Economics




| Specific energy use for heating, kWh/m² | 213 | 208 | 223 | 204 |
|---|---|---|---|---|




European Commission

# JRC’s ongoing Heat Pump study

- The study will provide insights on:
  - heat pump suitability for different building typologies
  - costs (OPEX/CAPEX) and energy savings
  - impact on the power grid
  - financial effects on (vulnerable) households
  - competitiveness of EU companies
  - heat pump value chain

- The study will be published in the first half of 2023

# Thank you

lorcan.lyons@ec.europa.eu
sven.volt@ec.europa.eu



European Commission

# Extra slide: Refrigerants

The refrigerant sector is dominated by China (e.g. Dongyue and Sinochem), with the United States in second place (Chemours (with a subsidiary in Switzerland), DowDuPont and Honeywell).

- Other major international  players are Asahi Glass and Daikin (Japan); SRF (India); and Koura (Mexico)
- EU suppliers: Arkema (France) and the Linde Group (Germany)

**F-gases** made up 2.3% of total EU GHG emissions in 2019 (EEA, 2021). Proposed amended F-Gas Regulation (4 April 2022) for more ambitious phase-down of refrigerants with high Global Warming Potential:

- helps reduce GHG emissions, even with increasing heat pump installations
- helps reduce EU reliance on imported refrigerants
- proposal is mindful about the timing of the switch from high GWP

**Natural refrigerants**:

Not patented, lower and more stable price, market opportunity and area for innovation

# Extra slide: Industrial heat pumps

- **EU leadership**
- **Customised**: By sector, process, plant, environment
- **Sometimes outsourced:** Energy Service Companies (ESCOs) can provide design, service
- **Growing demand**: agrifood, paper
- **Market trends:** Higher temperatures, standardisation

# Small scale renewable heating: heat pumps

## Guidance on standardized saving methodologies: Energy, $CO_2$ savings and costs

Nelson García (CIRCE)

This project has received funding from the Horizon 2020 programme under grant agreement n°890147. The content of this presentation reflects only the author's view. The European Commission is not responsible for any use that may be made of the information it contains.

# Structure of guidance document

- General aspects of:
  - Estimation of energy savings:
  - Differences in savings calculation for Article 3 & Article 7
  - Definition of a baseline
  - Approaches for cumulating energy savings under Article 7
- Correction for behavioural effects
- Estimation of relevant costs connected to energy savings actions
- Estimation of GHG savings

## Bottom-up methodologies for our 10 Priority Actions

# Methodology contents per Priority Action

- For each calculation methodology:
  - Calculation of total final energy savings (Article 7)
  - Calculation of impact on energy consumption (Article 3)
  - Overview of costs related to the action
  - Calculation of greenhouse gas savings

# Heat pumps for heating and domestic hot water (DHW)

## [residential and non-residential buildings]

# Definition and scope heat pumps

- Definition: small scale RES

  Small-scale renewable heating technologies are systems that supply central heating without polluting emissions, in this case, to cover the heat demand of buildings and provide domestic hot water

- Scope of the streamSAVE:
  - Measures targeting residential sector and non-residential sector
  - Methodologies prepared for following technologies:
    - **Heat pumps for heating and domestic hot water**
    - Biomass boilers for heating and domestic hot water

# Calculation methodology – Art. 7

$$TFES = A \cdot (SHD + HWD) \cdot \left( \frac{1}{eff_{baseline}} - \frac{1}{eff_{action}} \right) \cdot f_{BEH} \cdot cf_x$$

| | |
|---|---|
| TFES | Total final energy savings [kWh/a] |
| A | Useful floor area of the building or dwelling [m²] |
| SHD | Area specific heating demand of the building or dwelling [kWh/m²a] |
| HWD | Area specific hot water demand of the building or dwelling [kWh/m²a] |
| $cf_x$ | Climate correction factor |
| $eff_{baseline}$ | Conversion efficiency of a reference heating system [dmnl] |
| $eff_{action}$ | Conversion efficiency of the heat pump [dmnl] |
| $f_{BEH}$ | Factor to calculate behavioural aspects [dmnl] |

# Calculation methodology – Art. 7

| Action type | Indicative lifetime (years) |
|---|---|
| Heat pumps for residential buildings | 10 (air-to-air) |
| Heat pumps for non-residential buildings | 15 (air-to-water); |
| Heat pumps | 25 (geothermal) |

(Appendix VIII of Commission Recommendation (EU) 2019/1658)

EUR-Lex - 32019H1658 - EN - EUR-Lex (europa.eu)

| $cf_x$ | [dmnl] | | |
|---|---|---|---|
| | North | West | South |
| Residential | 1.21 | 1 | 0.76 |
| Non-Residential | 1.16 | 1 | 0.70 |
| $f_{REH}$ | [dmnl] | | |
| Residential | 0.75 | | |
| Non-Residential | Not available | | |
| Lifetime of savings | [years] | | |
| Lifetime of savings | 10 (air to air)<br>15 (air to water)<br>25 (geothermal) | | |
| $eff_{Baseline}$ – reference heating system | [dmnl] | | |
| Residential | 0.887 | | |
| Non-Residential | 0.947 | | |
| SHD | [kWh/m² useful floor area a] | | |
| Residential | 92.1 | | |
| Non-Residential | 106.9 | | |
| HWD | [kWh/m² useful floor area a] | | |
| Residential | 19.2 | | |
| Non-Residential | 18.1 | | |

# Calculation methodology – Article 3

## Heat pumps for heating and DHW (residential and non-residential buildings)

$$EPEC = FEC_{Baseline} \cdot \sum_{ec} (share_{ec,Baseline} \cdot f_{PE,ec}) - FEC_{Action} \cdot \sum_{ec} (share_{ec,Action} \cdot f_{PE,ec})$$

| | |
|---|---|
| EPEC | Effect on primary energy consumption [kWh/a] |
| FEC | Annual final energy consumption [kWh/a] |
| $share_{ec}$ | Share of final energy carrier on final energy consumption [dmnl] |
| $f_{PE,ec}$ | Final to primary energy conversion factor of the used energy carrier [dmnl] |
| Baseline | Index for the baseline situation of the action |
| Action | Index for the situation after the implementation of the action |
| ec | Index of energy carrier |

# Calculation methodology – Article 3

## Indicative values for the share of energy carriers for Article 3:

| Share$_{ec}$ space heating & domestic hot water preparation | | Reference heating system [%] | Heat Pump [%] |
|---|---|---|---|
| Residential | Solids | 5% | / |
| | Liquefied petroleum gases | 2% | / |
| | Gas/Diesel oil | 16% | / |
| | Natural gas | 37% | / |
| | Wood/wood waste | 19% | / |
| | Geothermal energy | 0% | / |
| | District heat | 11% | / |
| | Electricity | 9% | 100% |
| | Solar | 1% | / |
| Non-residential | Solids | 2% | / |
| | Liquefied petroleum gases | 1% | / |
| | Gas/Diesel oil | 21% | / |
| | Natural gas | 44% | / |
| | Wood/wood waste | 2% | / |
| | Geothermal energy | 0% | / |
| | District heat | 13% | / |
| | Electricity | 18% | 100% |
| | Solar | 0.2% | |

# Overview of cost related to the action

## Indicative costs (excl. taxes or fiscal incentives) for heat pumps and reference heating systems:

| [euro2020] | Investment costs (single family house - SFH) | |
|---|---|---|
| | SFH existing stock | SFH newly built |
| District heat | 14,731 | 14,731 |
| Gas condensing boiler | 9,223 | 8,607 |
| Oil condensing boiler | 14,615 | 12,993 |
| Firewood boiler | 15,286 | no data |
| Wood pellet boiler | 16,655 | 15,899 |
| Heat pump – air | 15,785 | 12,372 |
| Heat pump – ground probe | 25,426 | 20,002 |
| [euro2020/a] | Variable operational costs | |
| Costs of reduced fuel input | Energy prices from chapter 1.2.1 of D2.2 (fuel prices before/after for household consumers) | |
| [euro2020/a] | Fixed operational costs: Maintenance | |
| District heat | 1.15 % | |
| Gas condensing boiler | 1.15 % | |
| Oil condensing boiler | 2.12 % | |
| Firewood boiler | 2.55 % | |
| Wood pellet boiler | 2.62 % | |
| Heat pump – air | 2.35 % | |
| Heat pump – ground probe | 2.25 % | |
| [euro2021] | Revenues | |
| | No revenues | |
| [a] | Lifetime | |
| Lifetime | 10 | |

# Calculation of $CO_2$ savings

- Based on Article 7 savings

$$GHGSAV = \left[FEC_{Baseline} \cdot \sum_{ec}\left(share_{ec,Baseline} \cdot f_{GHG,ec}\right) - FEC_{Action} \cdot \sum_{ec}\left(share_{ec,Action} \cdot f_{GHG,ec}\right)\right] * 10^{-6}$$

| | |
|---|---|
| GHGSAV | Greenhouse gas savings [t $CO_2e$ p.a.] |
| FEC | Annual final energy consumption [kWh/a] |
| share | Share of final energy carrier on final energy consumption [dmnl] |
| $f_{GHG}$ | Emission factor of final energy carrier [t $CO_2$/kWh] |
| Baseline | Index for the baseline situation of the action |
| Action | Index for the situation after implementation of the action |
| ec | Index of energy carrier |

| $f_{GHG}$ | Greenhouse [g $CO_2$/kWh] |
|---|---|
| Emission factor of the reference heating system | 158.6 |

WP4 T4.3

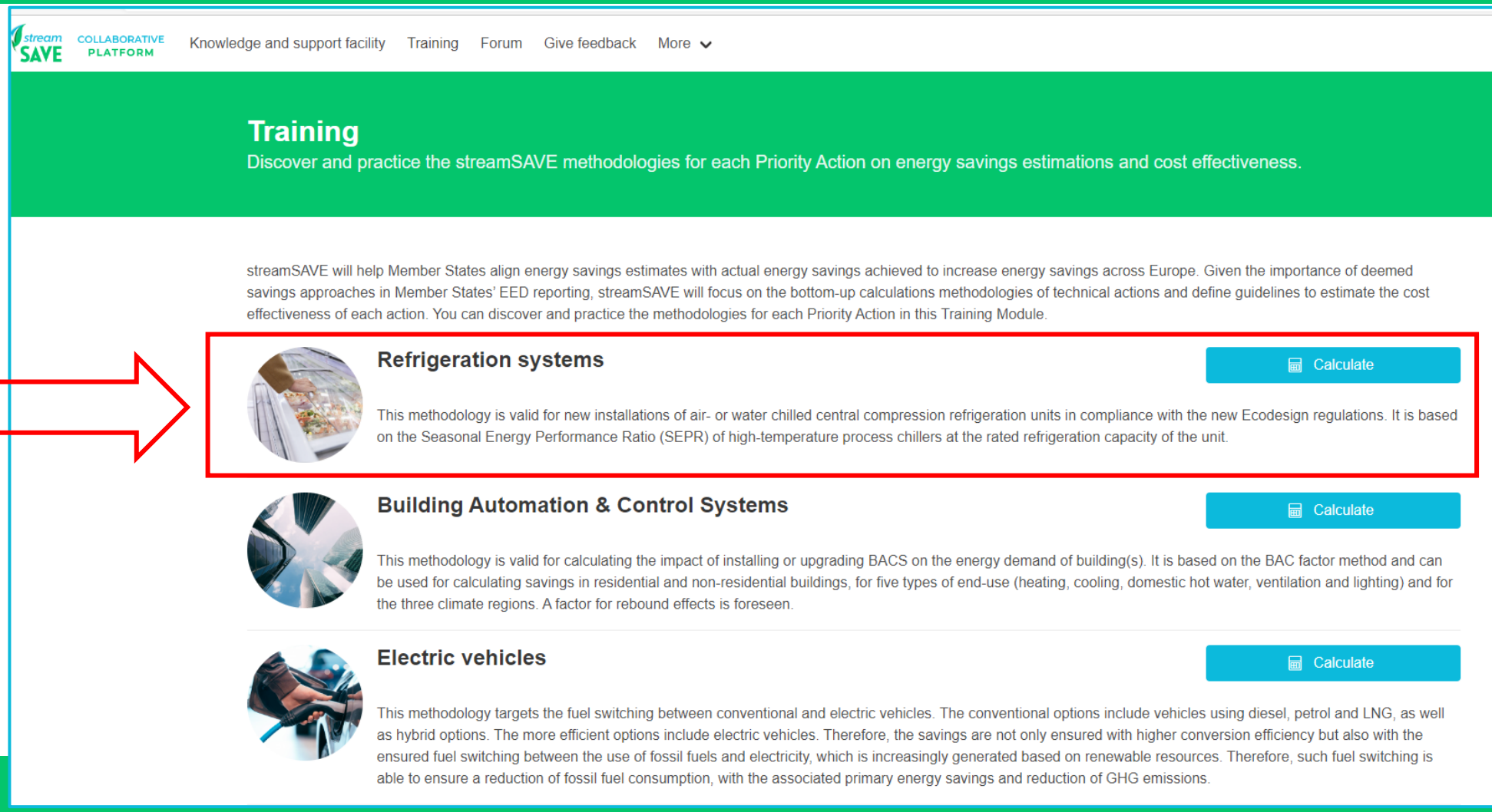
# Training Module

(CIRCE)

This project has received funding from the Horizon 2020 programme under grant agreement n°890147. The content of this presentation reflects only the author's view. The European Commission is not responsible for any use that may be made of the information it contains.

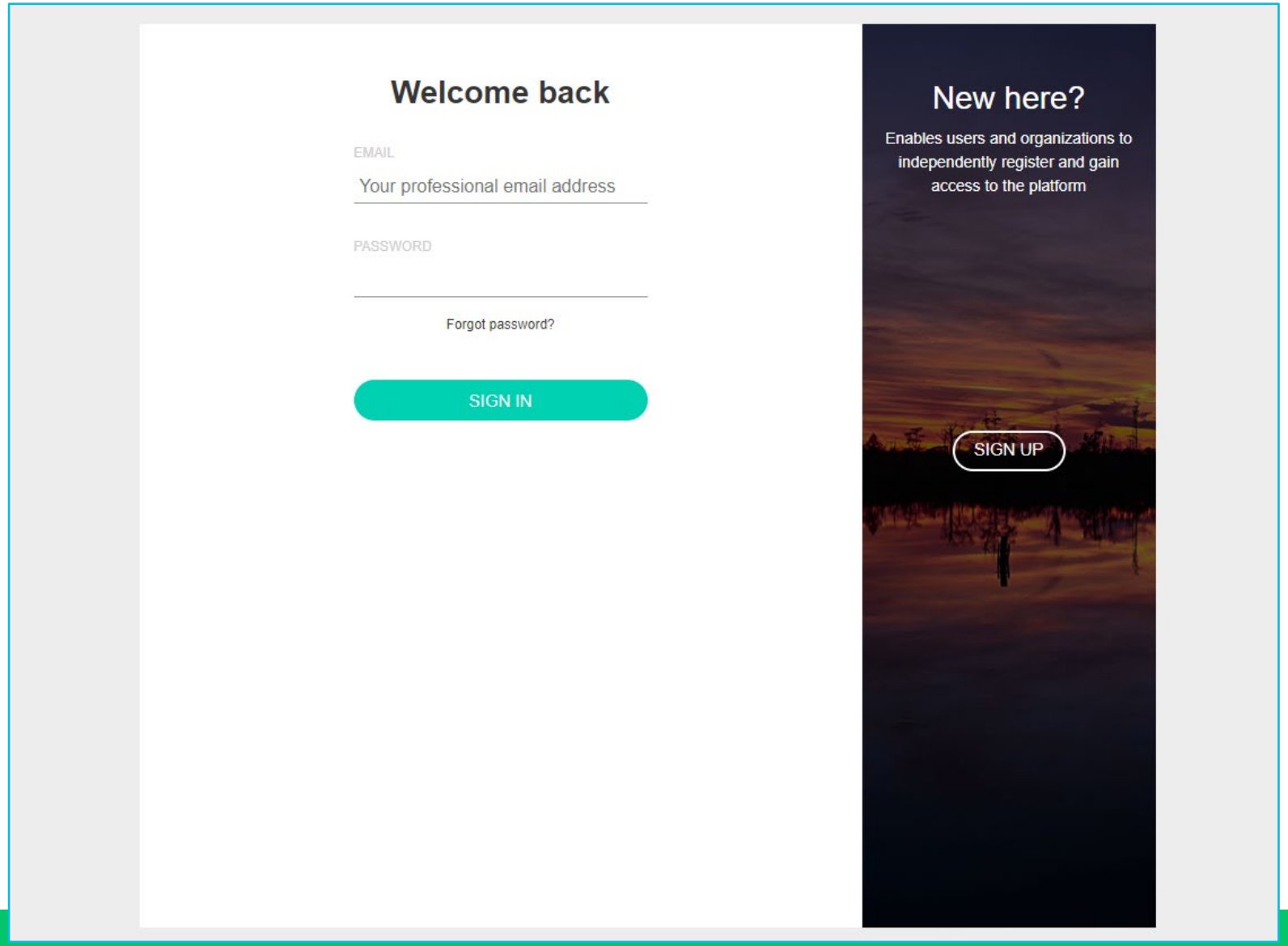
# Training Module: priority actions(PA)

Priority Actions



# How to subscribe to platform

LINK: https://streamsave.flexx.camp/login



# Thank you

## Get in touch for more information!


Project coordinator - Nele Renders, VITO

All project reports will be available for download on the streamSAVE website www.streamsave.eu

Email the project at contact@streamsave.eu

Follow the project on LinkedIn @streamSAVEH2020

Follow the project on Twitter @stream_save