European Heat Pump Market Data

Evolution of the State-of-the-art Heat Pump over Time and
its possible Knowledge Gain

Agenda

1. Introduction / motivation

2. Available databases and needed additional measures

3. Certain investigated properties / specifications
   1. Capacity-specific refrigerant charge
   2. Sound power
   3. Performance
   4. Special focus on R290 / propane

4. Summary / outlook

Introduction / motivation

- **Bottom-up approaches** are typical for development of new systems, usually with a subset of well-performing known heat pumps and their specifications

- There is a more systematical need for **top-down approaches** to overcome incomplete measures to compare only small subsets of well-performing or arbitrarily selected heat pumps

- The idea of product data comparison was born, this work focuses on ATW HPs

- One main challenge is the variation of model names between databases

Example for Database 1 for the same product	Example for Database 2 for the same product
HP09X IDU + MX09 ODU	HP09/11/13X – M(X)09/11/13

Available databases

Database	Origin	Database size	Usable version freeze	Used in this work
HP Keymark*	EU	428 btw, 4271 atw	11/2022	Efficiencies
SAP Q*	GB	650 btw, 4010 atw	11/2022	Market introduction
GET*	AT	578 btw, 1453 atw	11/2022	Sound power
BAFA*	DE	1212 btw, 4221 atw	12/2021 + 12/2022	Efficiencies
HARP*	IE	163 btw, 605 atw	03/2022	Market introduction
Eurovent certita*	EU/F	394 btw, 12324 atw	11/2022	-
TOPTEN*	EU	between 100-200	2022	-
R290 hps	EU	5 btw, 120 atw	11/2022	Efficiencies, market introduction
National databases*	IT, DK, NL, CDN, US	between 110-25500 and more	2020-2022	-
Product sheets	World	unknown	10/2022	All

atw: air-to water heat pumps; btw: brine-to-water heat pumps; hps: heat pumps / water-to-water and other types were neglected
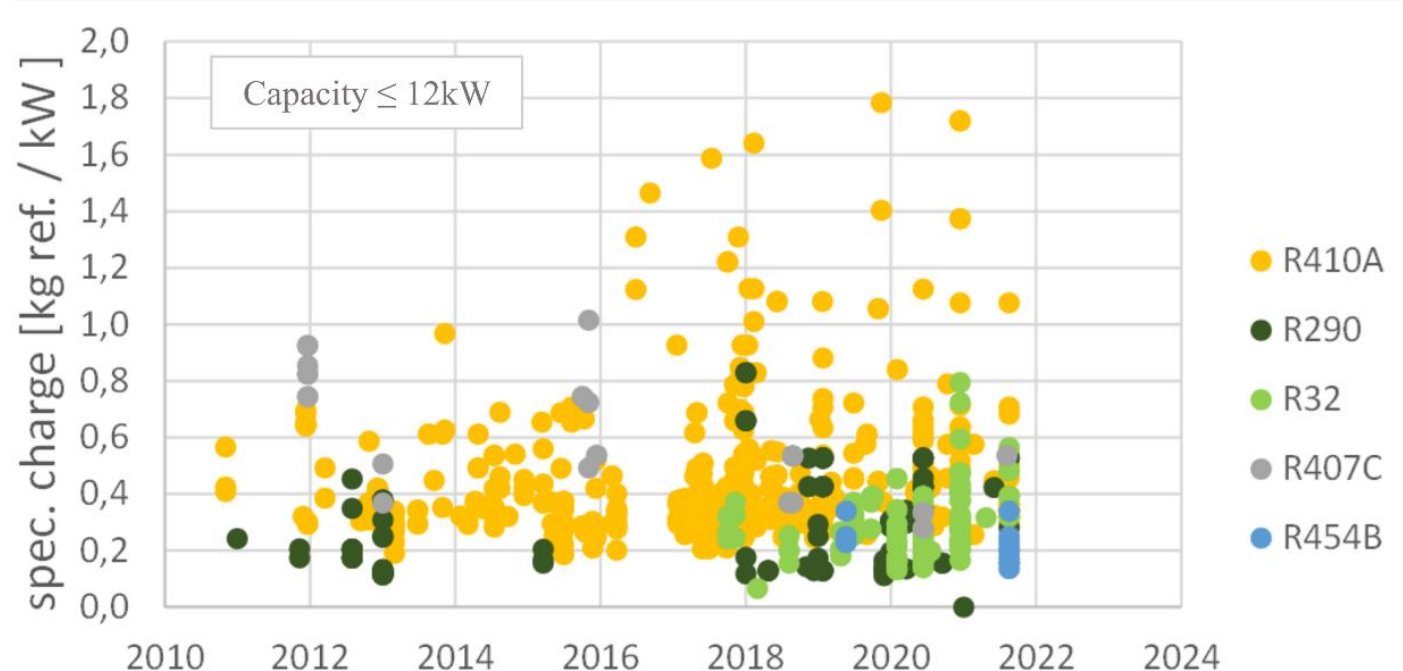
*for literature references, see IEA HPC 2023 paper

Specific refrigerant charge

- Gathered CE marking data as well as market introduction data from HARP, SAP Q database are only partially useful

>>> market introduction of R407C systems is unrealistic after 2016 (or even 2012)

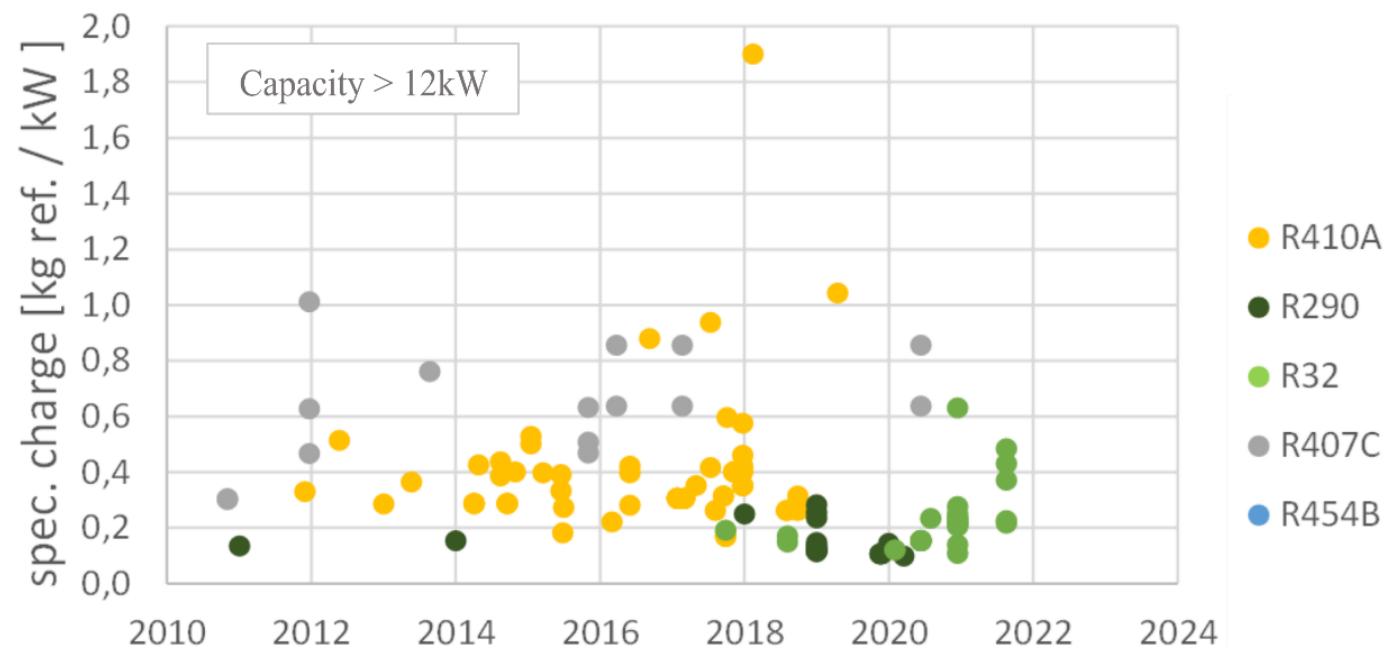>>> cluster-like data pretend as if dozens of systems were introduced at the same time

- Variation of R410A shows that several products are declared at lower heating capacities than possible

- No tendency visible that refrigerant-charge reduction measures ever played a role

- Evolution of fin-and-tube heat exchangers and refrigerant-specific properties are slightly visible (see R32 and R290 models)

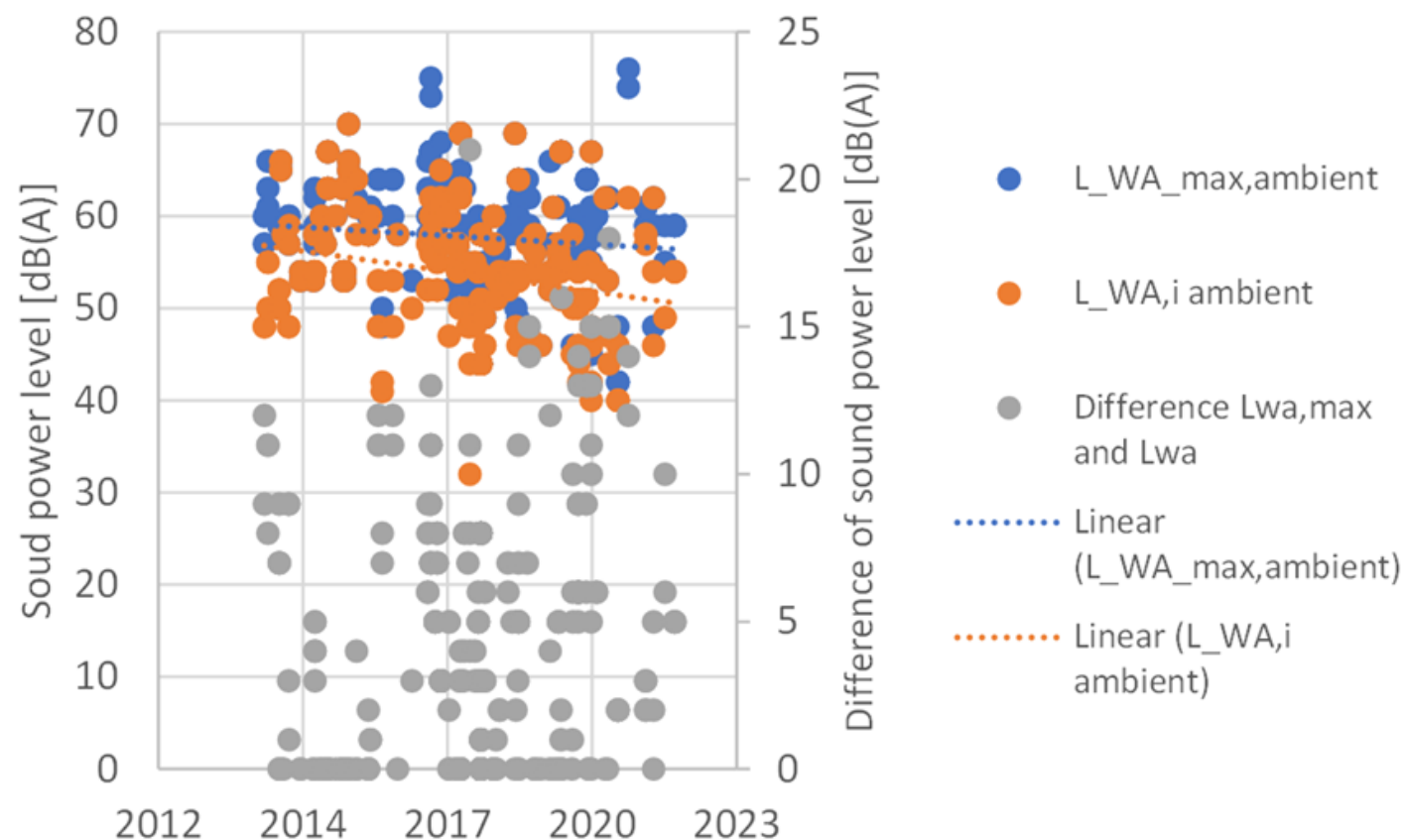The nominal heating capacity at A7/W35 was used.

for literature references, see IEA HPC 2023 paper

Specific refrigerant charge

- Data for larger systems are more scarce

>>> adding Eurovent data could help here to show more

- Less issues with cluster-like market introduction data as for the smaller models

- No clear but slightly visible changes in charge-reduction due to the evolution of fin-and-tube heat exchangers as well as refrigerant properties of R290 and R32

- Further charge reduction potential could be the introduction of microchannel evaporators or the general usage of 5mm round copper tubes in fin-and-tube evaporators

Capacity > 12kW

- R410A
- R290
- R32
- R407C
- R454B

for literature references, see IEA HPC 2023 paper

Sound power

- Sound power data show small trend on its reduction

- The difference of sound power at nominal operating conditions compared to the maximum occurring sound power reveals several models are provided with wrong data

- This difference for non-zero values with filtering out the 90% max/min outliers is in-between 3-15db(A)
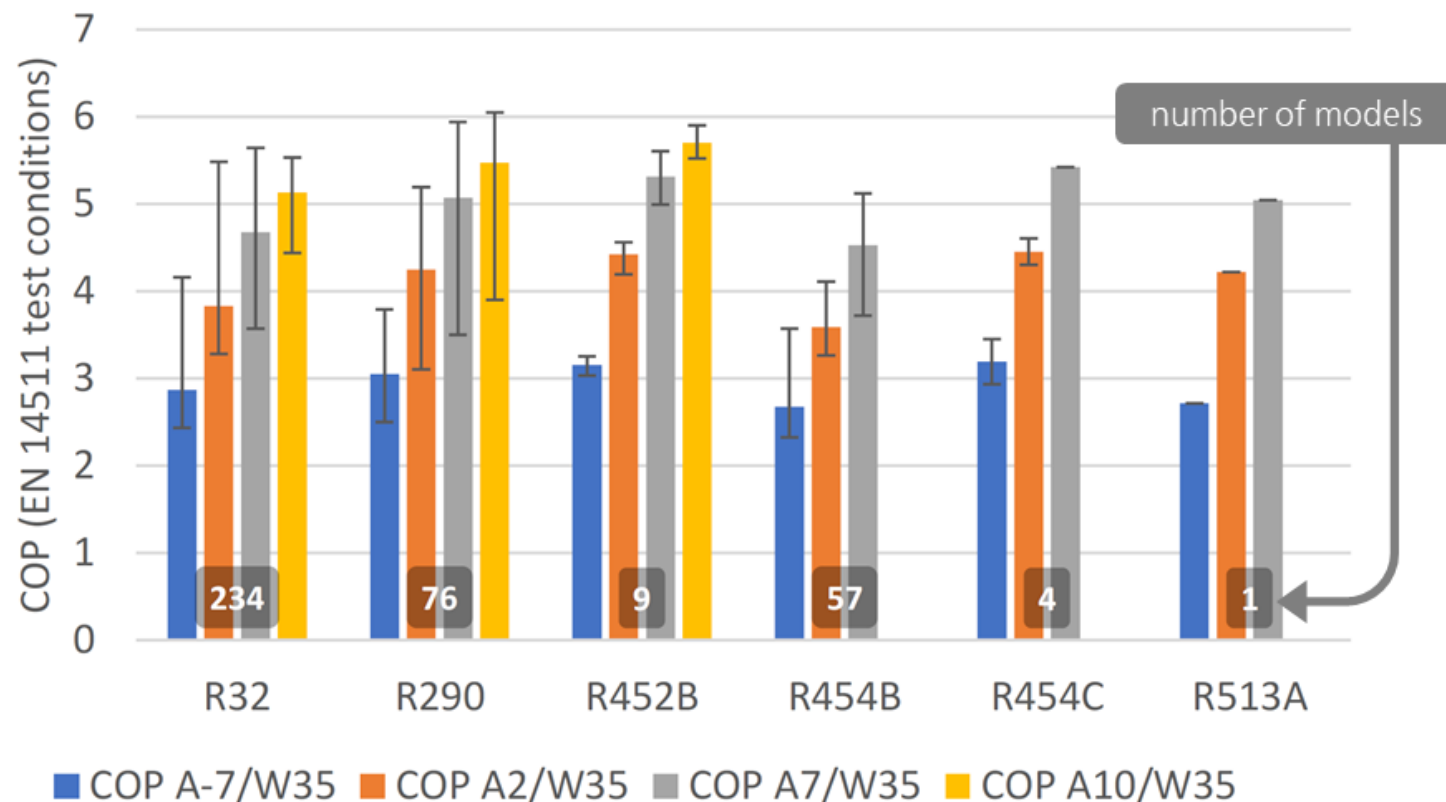

for literature references, see IEA HPC 2023 paper

Performance

- The shown efficiencies are already filtered and show only future-proof low GWP refrigerants

- COP performance figures (EN 14511 test conditions) were used since it is closer to experimentally tested data

- R290 heat pumps perform best

(when considering that not only a single market participant should reflect data for one presented refrigerant: R452B, R454C, R513A would vanish from this figure)

Attention: this figure is a version freeze of HP Keymark database from 06/2021 – it changed already and still changes quickly, since lots of new systems were introduced.
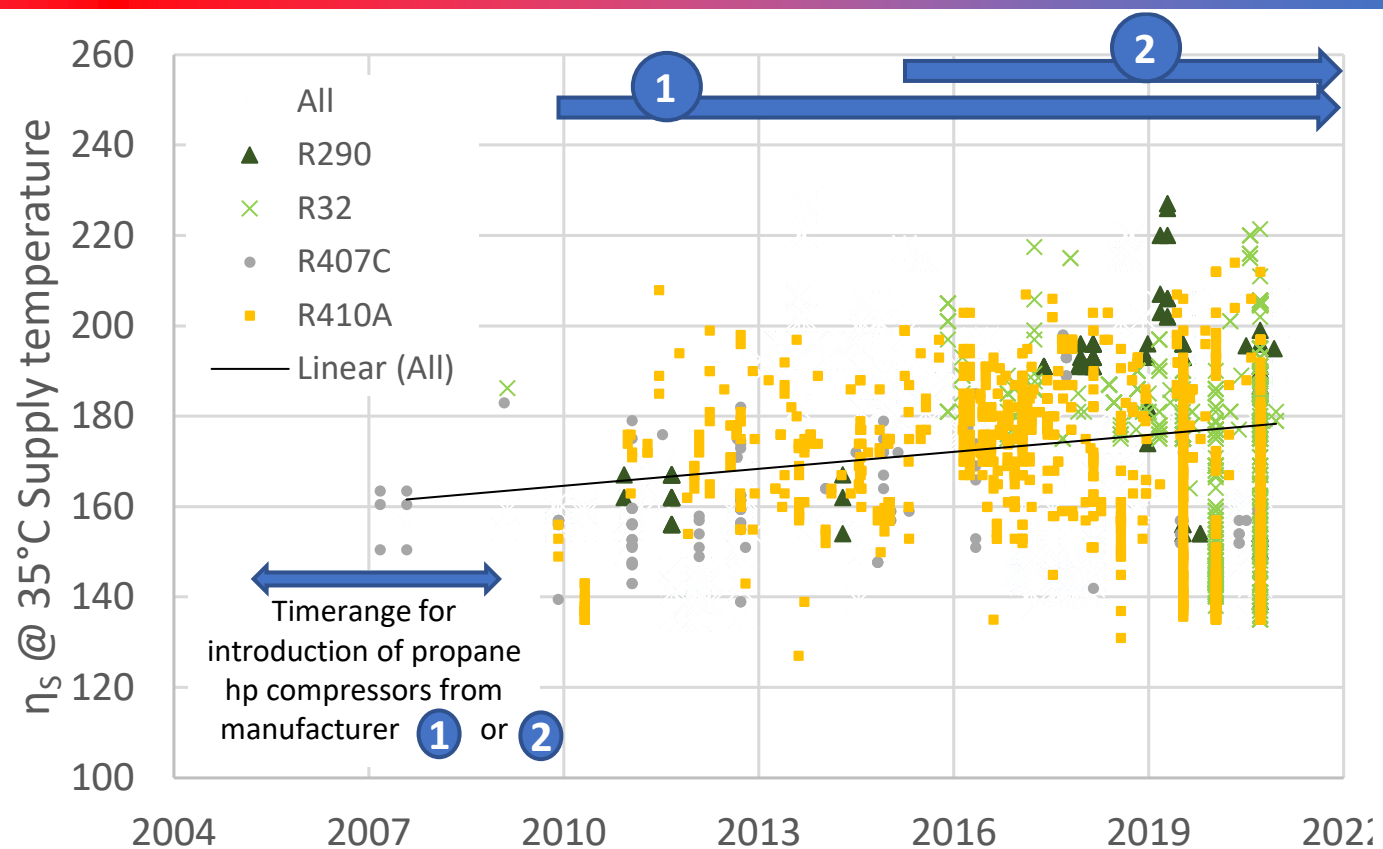

for literature references, see IEA HPC 2023 paper

Special focus on R290

- Evolution of ηs over time

- Definition of ηs: **seasonal space heating energy efficiency** which used in EU for the so-called ecodesign regulation to place only energy-efficient products on the market

$$\eta_s = \left(\frac{1}{CC}\right) \times SCOP - \sum F(i)$$

- Clear trend of increasing efficiencies

- Again, the cluster-like structures are obvious for market introduction data

- Newer compressors and high-end / expensive / large heat exchangers allowed high-efficient R290 heat pumps

for literature references, see IEA HPC 2023 paper

Summary / outlook

- About a dozen product databases and thousands of product data sheets were investigated for some of their properties

- This analysis could support development projects with state-of-the-art benchmark data

- Market introduction data are generally usable but company policies and needs to update conformation declarations makes this source demanding, SAP Q + HARP data were in this context more reliable

- Investigation of certain properties revealed surprising information which are not generally bound to gain knowledge on the market introduction data…

Summary / outlook

- Investigation of certain properties

  - There is no clear trend that refrigerant charge reduction ever played a role for new designs

  - Refrigerant charge divided by nominal heating capacity shows a multitude of systems being declared at too low heating capacities

  - Heat pumps become quieter but…

  - …declared sound power data is often not useful due to the provision of unrealistic data

  - Newly introduced refrigerants like R290 perform promising compared to established refrigerants in terms of efficiencies

  - The evolution of system efficiencies shows generally that heat pumps become better, here again the introduction of new developed R290 heat pumps shows a leap in efficiencies

Summary / outlook

- The analysis is ongoing and will focus on
  - weight

  - outer dimensions

  - Changes over time of the investigated product databases

- This facilitates the development of sustainable figures that could be deduced...
  - material resource intensities

  - needed installation space

  - other constraints for transport and installation measures

  - power density of heat pumps (with filtering out undersized models)

End of presentation

Thank you for your attention!

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