Recent findings and outcome of the German heat pump market
Introduction
Research about the European and German (EU/D) heat pump market

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  - Findings from the „heat pump market“ eligible for the German funding scheme (MAP)
  - Additional analysis of the „state-of-the-art“ of heat pumps from public available sources
- Conclusions
- General Trends on the heat pump market
  - Technical level
  - System level
Background
Research about the EU/D heat pump market

- Fraunhofer ISE conducted investigations of the public subsidised heat pump market
  - Data from 2016 until 2020 from the German public funding scheme were analysed

- Additionally, as a member of IEA Annex 54 „Heat pump systems with low Global Warming Potential (GWP) refrigerants"
  - Market data analysis
    - to build reference case for comparison purposes for heat pumps for newly developed low-GWP refrigerants
    - to see state on available equipment with low-GWP refrigerants
    - compare equipment operated with different low-GWP refrigerants
Methodology
Research about the EU/D heat pump market

- Publicly available informations are
  - GET product database (from Austria)
  - HP Keymark database
  - Manual websites (e.g. www.manualslib.com)
  - Eurovent Certita
  - Some other collections of such informations
    - Heizungslabel, Edibatec, MCS Database
    - Subsidization scheme documents from other EU member states (e.g. B, A, CZ, PL, D, DK, ES, and others)
    - And of course the technical data from the manufacturer or the distributing company

- Additionally we had access to the non-public data of the MAP funding scheme
Methodology
Research about the EU/D heat pump market

• What data are helpful for a further understanding?
  • Technical data like available in data bases (efficiency, sound emissions, capacity, refrigerant charge...)
  • For evaluation of trends, new product categories and refrigerant specific questions are the following aspects relevant:
    • period of market availability of one product

• How to get it and what are challenges?
  • Manufacturers data
    • Documents for declarations of conformity are often changed, not easy to find but usually freely available
    • Next to this we used technical specification PDF metadata from manuals / installation instructions including the date
    • Risks?
      • Were there model revisions placed to the market instead of the original equipment? → unknown
  • BAFA lists
    • We used the information when equipment occurred the first time in the BAFA list (which we stored regularly since 2010)
    • Risks?
      • Are there model revisions done and maybe never digitized / updated in the list? → unknown
Results from the analysis of the MAP funding scheme
Research about the EU/D heat pump market (all heat pump types sold)

• What is the share of specific refrigerants in sold heat pump units in MAP?

  • **Attention:** these market data might be biased since a large market share is outside MAP (e.g. other funding schemes like from KfW bank or heat pumps without subsidies)

  • In general the MAP funding scheme application data represent about 20 % of the heat pump market

  • In 2021 the renewed funding scheme will have much higher market shares such that new data for 2021 should be very valuable for further analysis → should be available soon for Fraunhofer ISE

Source: MAP-Antragsdaten, BMWK, 2022
Results from the analysis of market-available heat pumps
Research about the EU/D heat pump market (air-to-water)

- **Refrigerant specific efficiencies (source: HP Keymark)**
  - System efficiencies (see slides before) as well as heat pump efficiencies on the right side are close together and need to be analysed thoroughly before taking final decisions what is the best heat pump
  - Just from thermodynamics R-290 could be higher, choice of components/heat pump design has an additional influence
  - Version of HP Keymark being used here was from June 2021
  - Currently (as of September 2022) the amount of models in HP Keymark with low GWP refrigerants are much larger

Source: HP-Keymark Database, accessed at June 21st 2021
Results from the analysis of market-available heat pumps
Research about the EU/D heat pump market (air-to-water)

- Evolution of the general system efficiencies with time (source GET product database)
  - About 50% of equipment in GET database could be correlated with the market introduction date
  - Offered equipment reaches a time range from about 2010 until beginning of 2022 (some individual units before with dates before 2010, neglected for the discussion)
  - There is a clear trend of growing efficiencies visible. Where does it come from?
    - more efficient components?
    - control optimisation/ general and for efficiency evaluation?
    - choice of refrigerant?

Source: GET-Produktdatenbank, accessed at 6th October 2022
Results from the analysis of market-available heat pumps
Research about the EU/D heat pump market (air-to-water)

• Evolution of the refrigerant-specific system efficiencies with time (source: BAFA list)
  • Difficult to see trends due to multiple regular CE marking document updates (column-like point clusters, these systems were removed for the linear regression put to the plot)
  • Introduction of R-290 heat pumps with new compressor platforms clearly visible

• What about the „age of equipment“ being sold when being funded by MAP subsidization scheme?
  • Market introduction of equipment for 2020 approved heat pumps
    • Mean: 01.08.2015, Median: 30.06.2015
    • This leads to an „age of sold units“ of about 4-5 years.

Source: BAFA list, October 2022
Results from the analysis of market-available heat pumps
Research about the EU/D heat pump market (air-to-water)

- Are there other „evolution“ analysis possible?
- What about evolution of acoustics or refrigerant charge reduction?

- Situation of acoustics (source: GET product database)
  - Can we conclude and compare heat pumps based on the published acoustic figures?
  - Partially, operating conditions are not constant and comparable since every manufacturer can choose conditions, zero or negative deviations from max sound power level are unrealistic
  - Any maximum sound power level should almost behave linearly as a function of frequency and does not end at the same level as the ErP sound power level

→ Human errors due to confusion of nom/max sound power
→ No evolution analysis possible

Source: Above: GET-Produktdatebank, last visit 6th October 2022
Below: WAMS, BMWK-funded project, FKZ03ET1535A, 10/17-9/20.
Results from the analysis of market-available heat pumps
Research about the EU/D heat pump market (air-to-water)

• Situation of acoustics (corrected differences)
  • Can we conclude and compare heat pumps based on the published acoustic figures?
  • Partially, operating conditions are not constant and comparable since every manufacturer can choose conditions, zero or negative deviations from max sound power level are unrealistic
  • Any maximum sound power level should almost behave linearly as a function of frequency and does not end at the same level as the ErP sound power level
  • Difference between nominal and max sound power level approaches a difference of about higher dB(A) values for newer systems from

→ Evolution analysis possible, but still lots of systems show zero difference between nominal and max sound power level

Source: Above: GET-Produktdatenbank, last visit 6th October 2022
Below: WAMS, BMWK-funded project, FKZ03ET1535A, 10/17-9/20.
Results from the analysis of market-available heat pumps
Research about the EU/D heat pump market (air-to-water)

- Situation of acoustics (corrected differences)
  
  - Can we conclude and compare heat pumps based on the published acoustic figures?
  
  - No, operating conditions are not constant and comparable since every manufacturer can choose conditions, zero or negative deviations from max sound power level are unrealistic
  
  - Any maximum sound power level should almost behave linearly as a function of frequency and could never end up at the same level (zero line in upper graph) as the ErP sound power at nominal conditions.

→ Evolution analysis possible, sound power level is decreasing for nominal and maximum conditions at realistic differences between nom and max values, still issues of the data quality / outliers due to zero differences, could be improved by fixing and standardizing operating conditions for max sound power

Source: Above: GET-Produktdatenbank, last visit 6th October 2022
Results from the analysis of market-available heat pumps
Research about the EU/D heat pump market (air-to-water)

- Situation of refrigerant charge for air-to-water (source: ISE generated database starting from BAFA lists)
  - Dividing the refrigerant charge by the nominal or a reference heating capacity for the same operating conditions (A7/W35 chosen) needed
  - Graphs distinguish between systems smaller/larger 12kW nominal heating capacity at this operating condition
  - Again, column-like point clusters due to generally updated CE marking documents
  - The „cloud“ of R-410A parameters distributes very high. The specific charge above 800g/kW is not reflecting nominal conditions
  - The large range and specific charges above 0,6kg are more related to systems operated at part-load at the chosen operating condition
  - → Evolution analysis not possible and/or charge-reduction measures played no role in design of newly developed heat pumps in the last decade

Why such a large range of specific charge?

Source: Own database plus technical specifications from manufacturers and plus BAFA lists
Conclusions about market data analysis
Research about the EU/D heat pump market

- Transparent data availability of heat pump products are very helpful for evaluation of trends
- For a more precise analysis of trends testing standards for acoustics and efficiency with strictly defined operating conditions would lead to better comparable results (e.g. choice of bivalence point, fixed operating conditions for acoustic testing)
  - Trend analysis could be used as a powerful tool for product design of next generations of heat pumps
- Analysis of other heat pumps types pending
- Data quality improvement ongoing for cross-correlating databases
General trends – system level
Research about the EU/D heat pump market

- Testing standards should be improved to improve comparison possibilities between different models.

- The heat pump sector prepares for changes. How quick these changes arrive depends on legal constraints but technically some but not a lot more time is needed.

- The roadmap is clear, all heat pump products will help to boost the market growth on a short-term level.

- But also R-290 jumps already in quickly and has like R-32 fastest growing market share.

- R-290 systems are developed and offered currently from about 45 manufacturers with about 300 different models.

- Charge-reduced systems based on R-290 applicable in indoor appliances – could reduce safety zones.

- Air-to-air room air conditioners where already developed for up to 4 kW cooling capacity with 300 g R-290 by a Japanese consortium on R&D level. This can even become less charge by certain design measures.

- Fraunhofer ISE works on all these levels to improve the situation for manufacturers.
General trends – technical level
Research about the EU/D heat pump market

• Lots of new systems are in development or were put to the market recently. Indoor R-290 systems are currently under development from several manufacturers.
• Due to size constraints of the compressors an urgent need for cascade controllers to use multiple smaller units in one modular system are in development or are used already
• But compressor manufacturers currently develop or have already developed larger R-290 compressors such that cascade systems will be a temporary solution or being upscaled for larger systems when large systems are technically mature and available on the market
• Acoustic improvements from fan improvements are unrealistic, they are already very quiet
• Charge reduction came more into focus which will lead to more degrees of freedom for installation locations
• **Project LC150 news: 124 g R-290 for a heating capacity of 12,8 kW and a COP of 4,7, see press release from today**
• Safety design came more into focus in all engineering departments, knowledge is growing and handling flammable refrigerants becomes more common.
• Training for safety on A3 refrigerant is currently upscaled by different players (see for example Real Alternatives’ Coolingpost News)
• Supply issues popped up on fans, hydronic pumps, inverters and compressors; heat exchangers are safe* – no intel on control valves, thus R-290 compressors should be no bottleneck*
Thank you!

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