HEAT PUMP NOISE

Operation dependence and seasonal averaging

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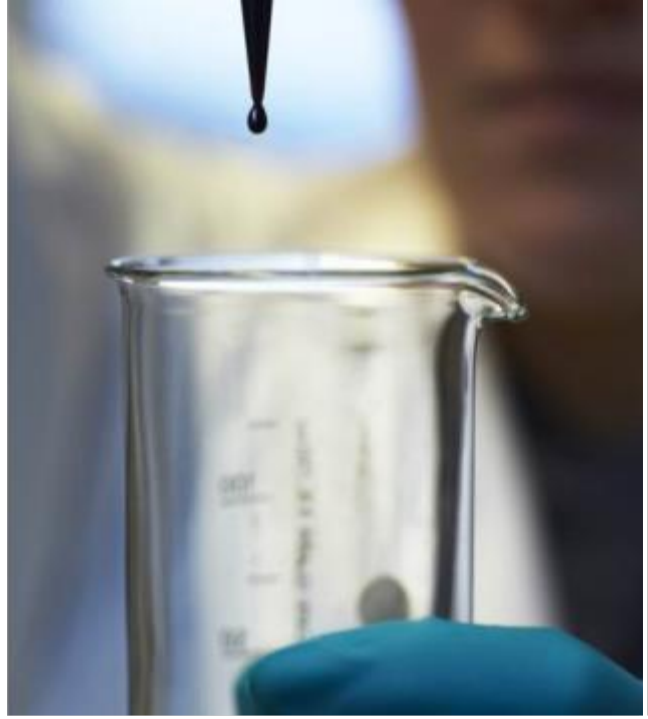
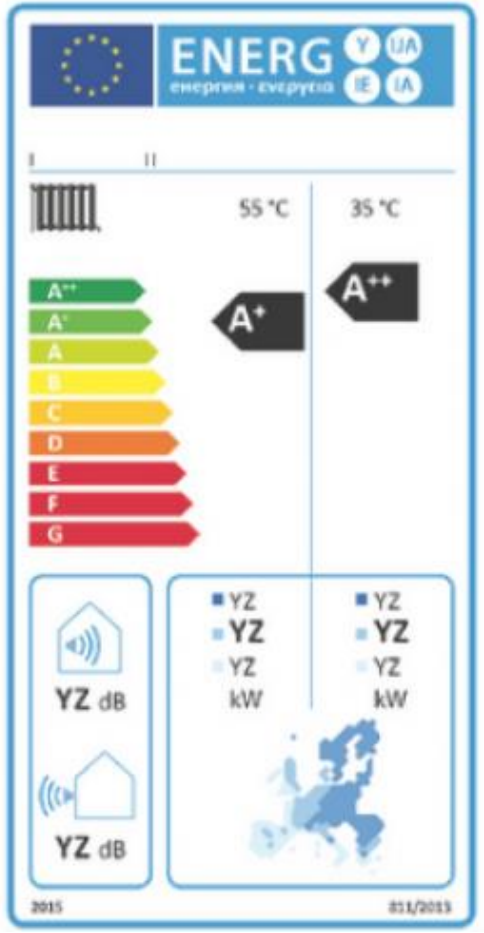
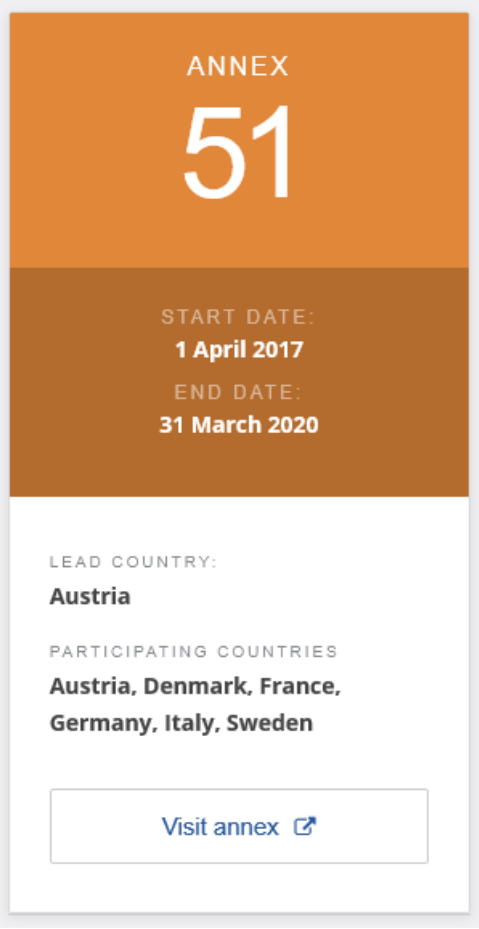


Swedish contribution to IEA HPT Annex 51: Method development - Declaration of noise from heat pumps

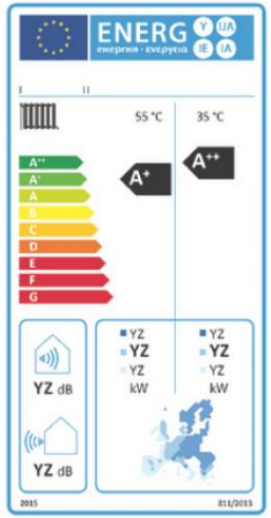
- Main funder Swedish Energy Agency
- Co-funder and project partners
  - Bosch Termoteknik
  - Thermia Heat Pumps
  - Enertech
  - NIBE
  - Villaägarnas Riksförbund



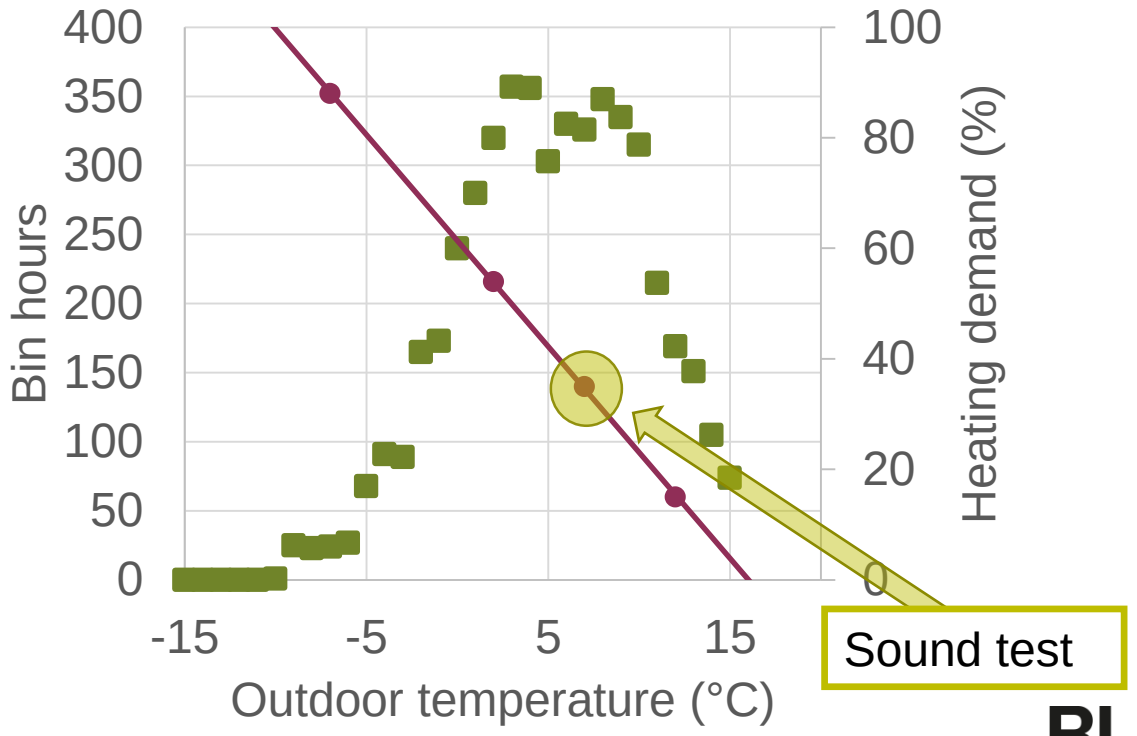


Background

- In Ecodesign and Energy Labelling Regulations 811 and 813/2013 heat pump energy performance: COP→SCOP (Seasonal COP)
- Noise is evaluated according to EN12102 in **one test point**
  - A-Weighted sound power level according to e.g. ISO3741
  - Evaluation at ”Standard operating condition” according to EN14511
  - Inverter controlled heat pumps
    - ”Test mode” – manufacturer provide settings
    - Fan and compressor speed according to ”Rated Capacity” according to EN14511-3 and EN14825 → C-conditions, i.e.: **+7°C outdoor condition, 35% part capacity**

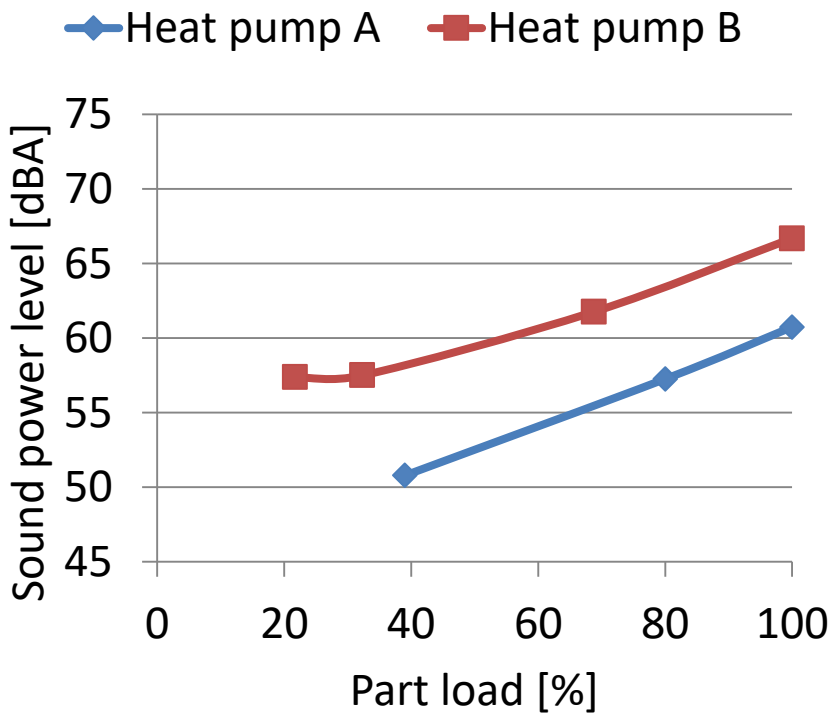


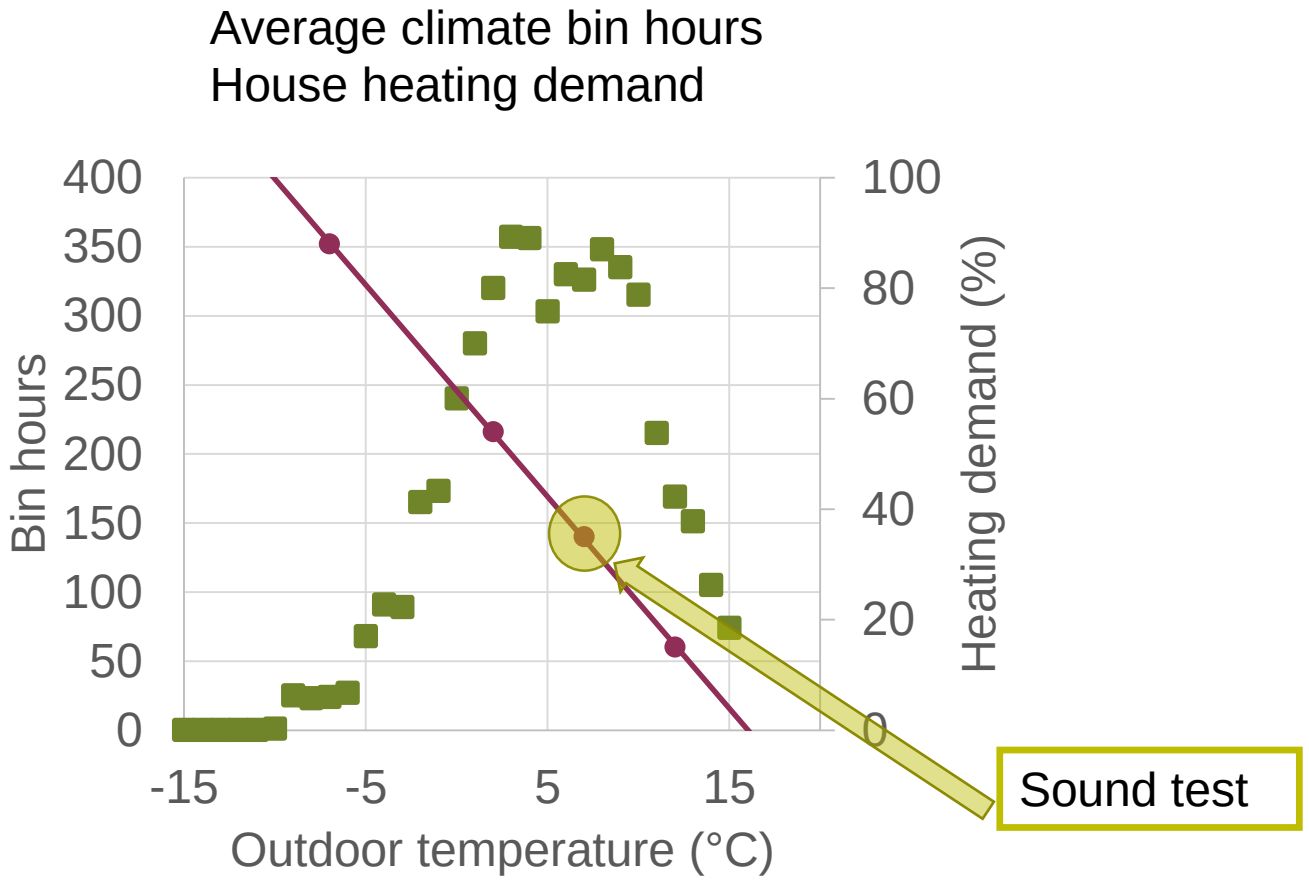
Average climate bin hours
House heating demand



Background

- Noise is evalutated as sound power in one test point but vary with heat capacity (pary load) of heat pump – declared value not representative for the heating season



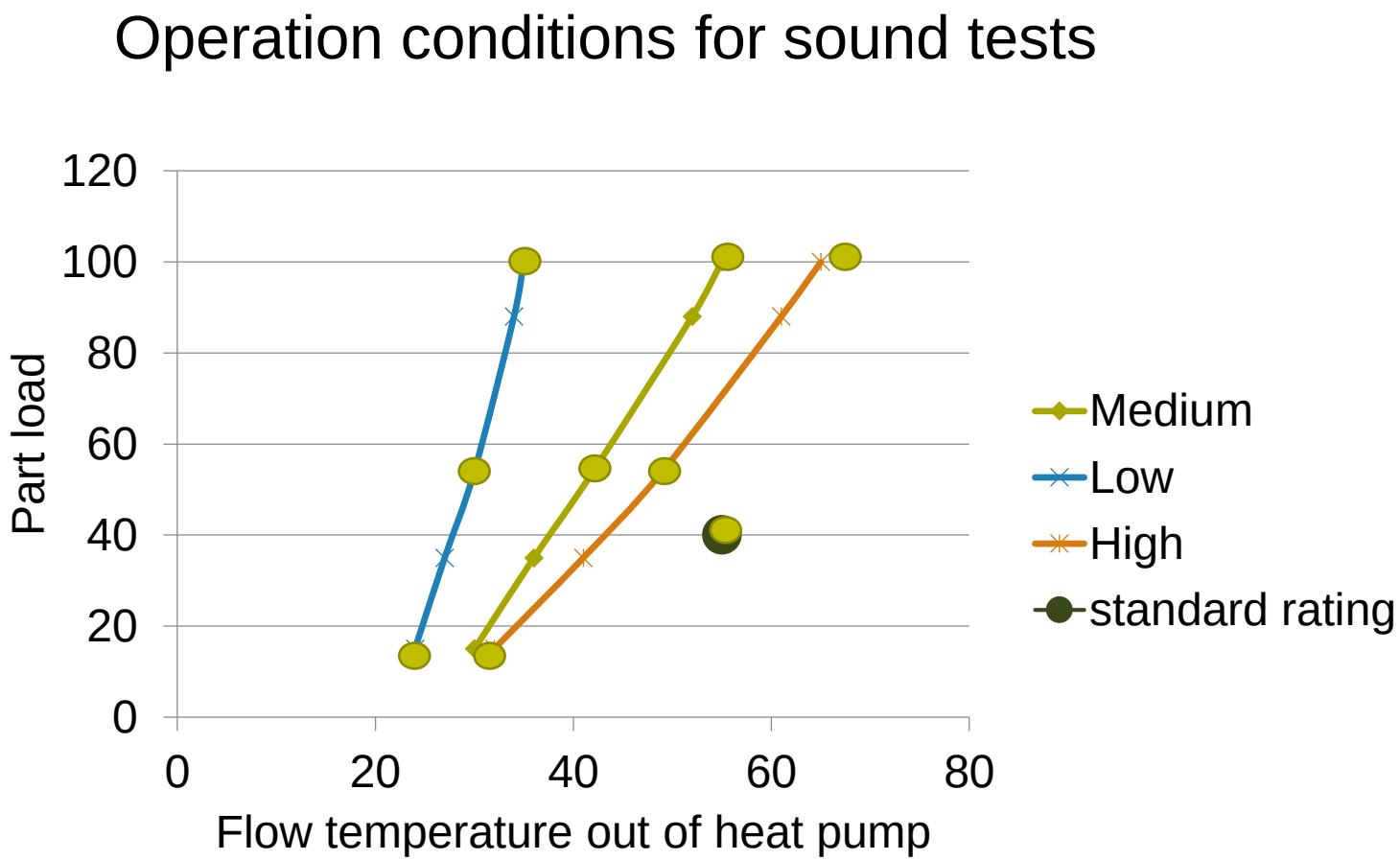


Scope and objective

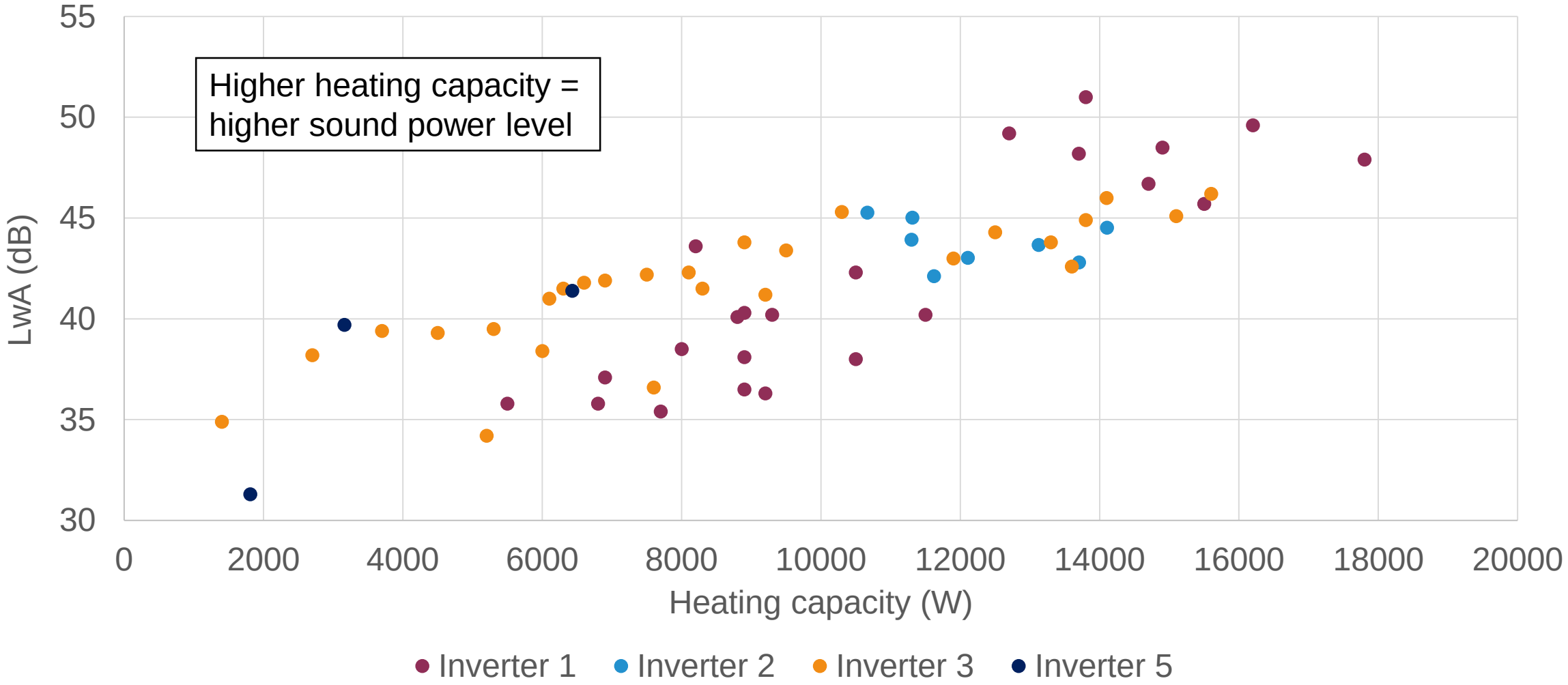
- Focus on air-to-water and brine-to-water heat pumps (ground source)
- Define the noise of heat pumps at different states of operation
- Develop and suggest an improved method for evaluation of noise
- Investigate the relation of heat pump noise characteristics and annoyance

Method

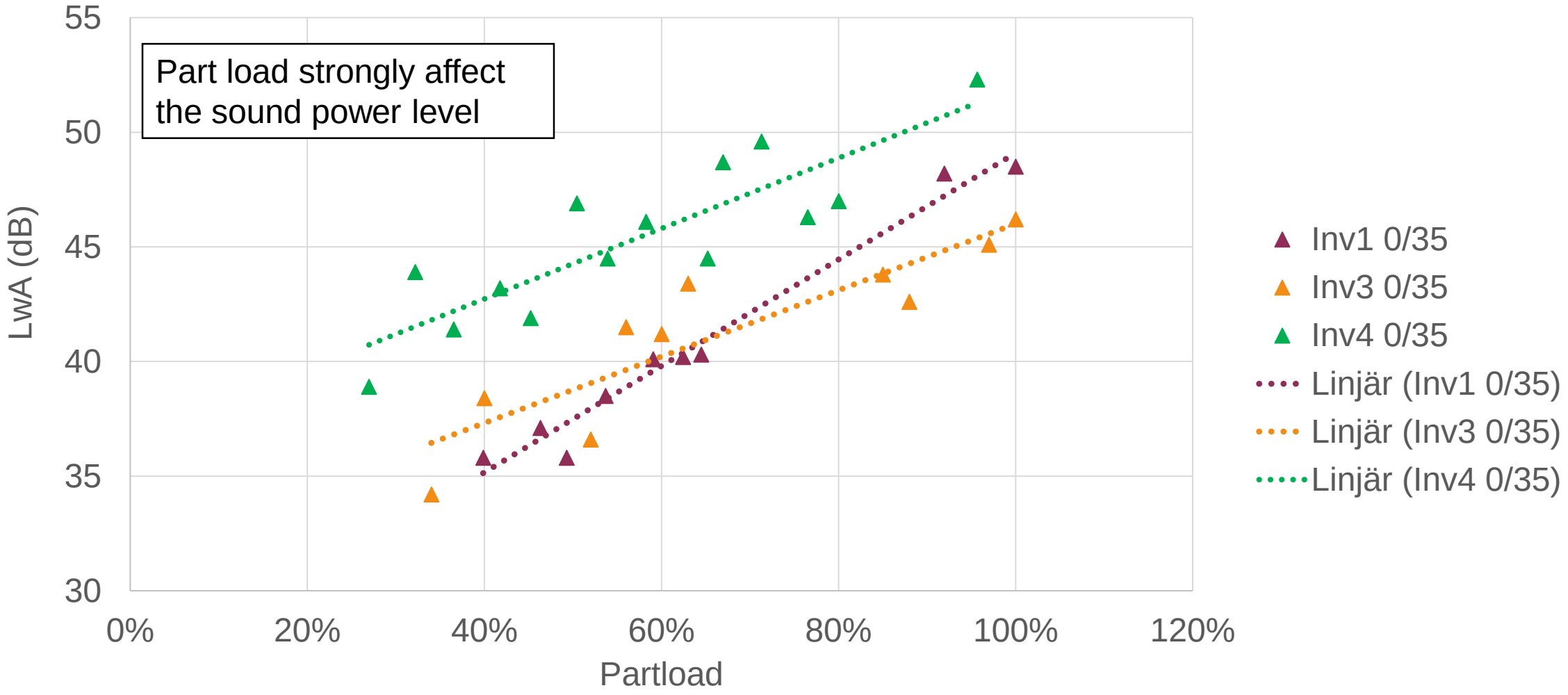
- Laboratory measurements of sound power on 14 heat pumps
  - 7 brine/water
  - 7 air/water
  - EN12102
  - Tests at large range of temperatures and part loads
- Estimation of seasonal noise performance
  - EN14825 methodology
- Listening test – dissimilary rating and preference mapping



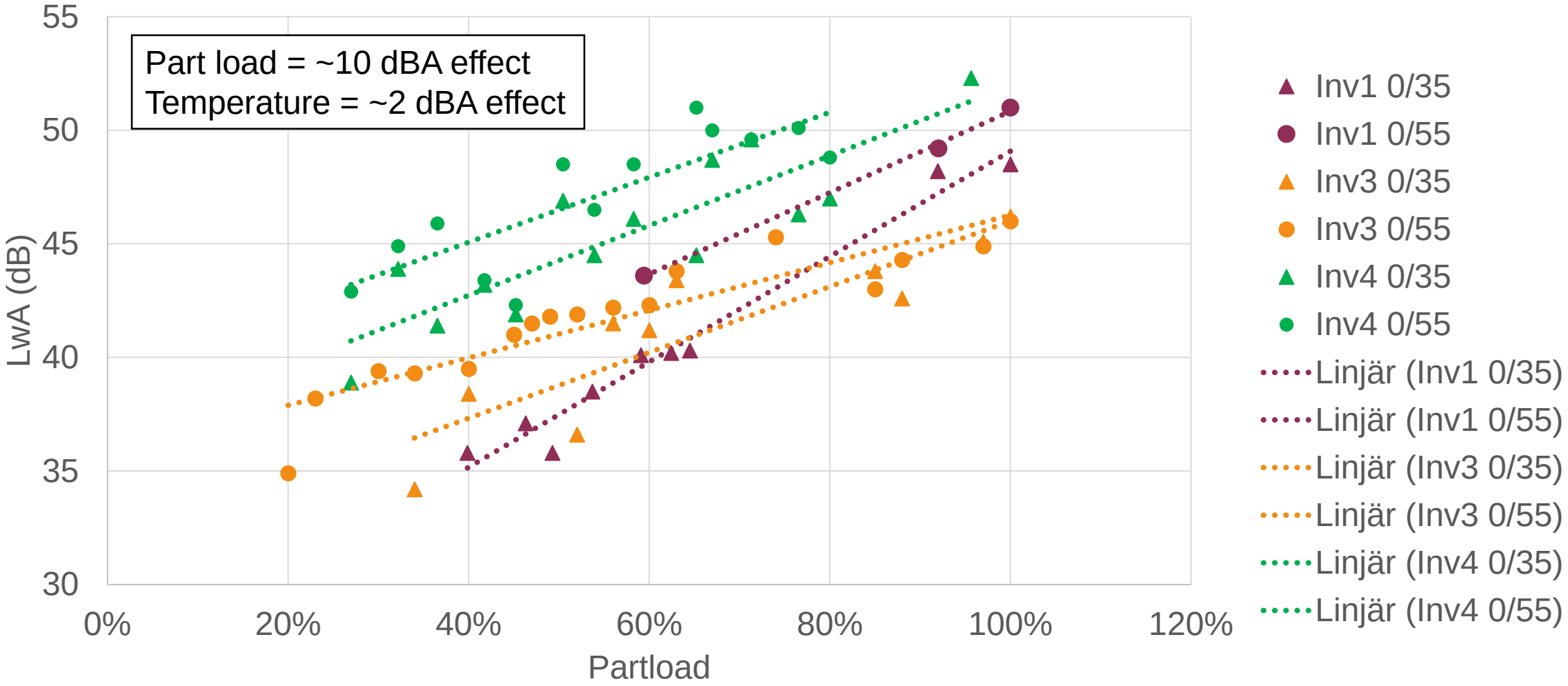
Ground source (brine-to-water) heat pumps
Sound power level vs heating capacity - inverter



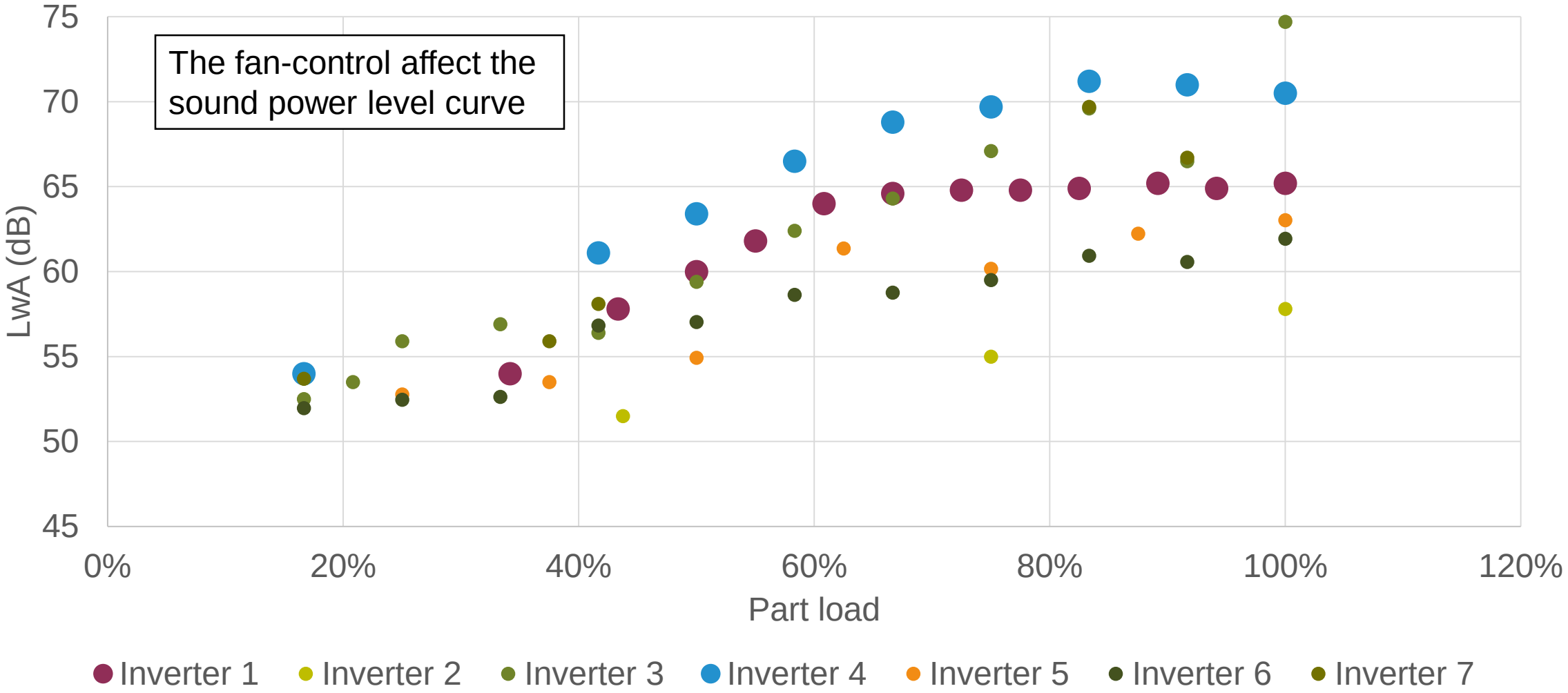
Ground source (brine-to-water) heat pumps
Sound power level vs part load – inverter – 0/35



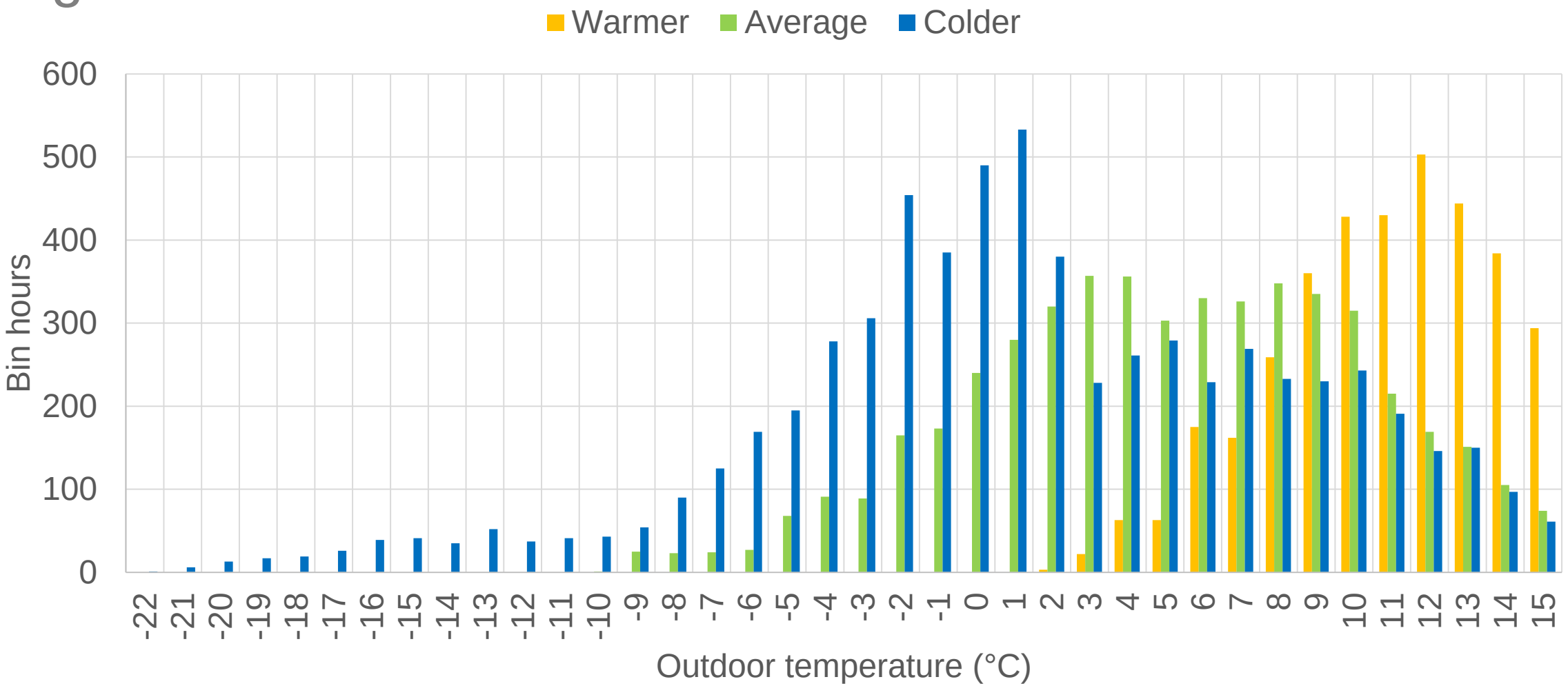
Ground source heat pumps
Sound power level vs part load - inverter



Air-to-water heat pumps
Sound power level vs part load - inverter



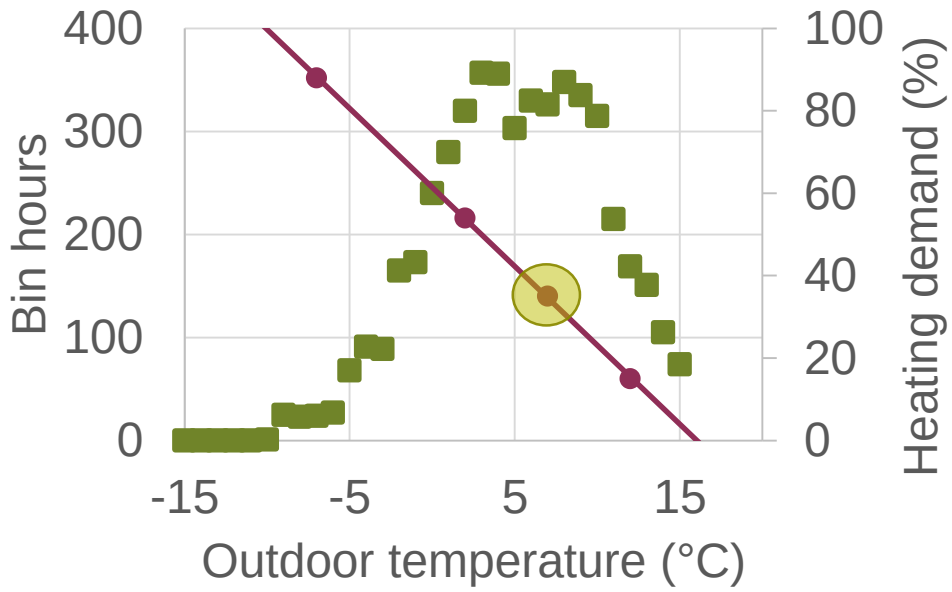
Number of hours in each temperature bin according to EU Regulation 811 and 813/2013 and EN14825



Seasonal noise

A weigted sound power level was calculated as the log-based average of the sound power level in each bin multiplied with the corresponding bin hours based on **input data from sound tests in all test points in EN14825, see graph**

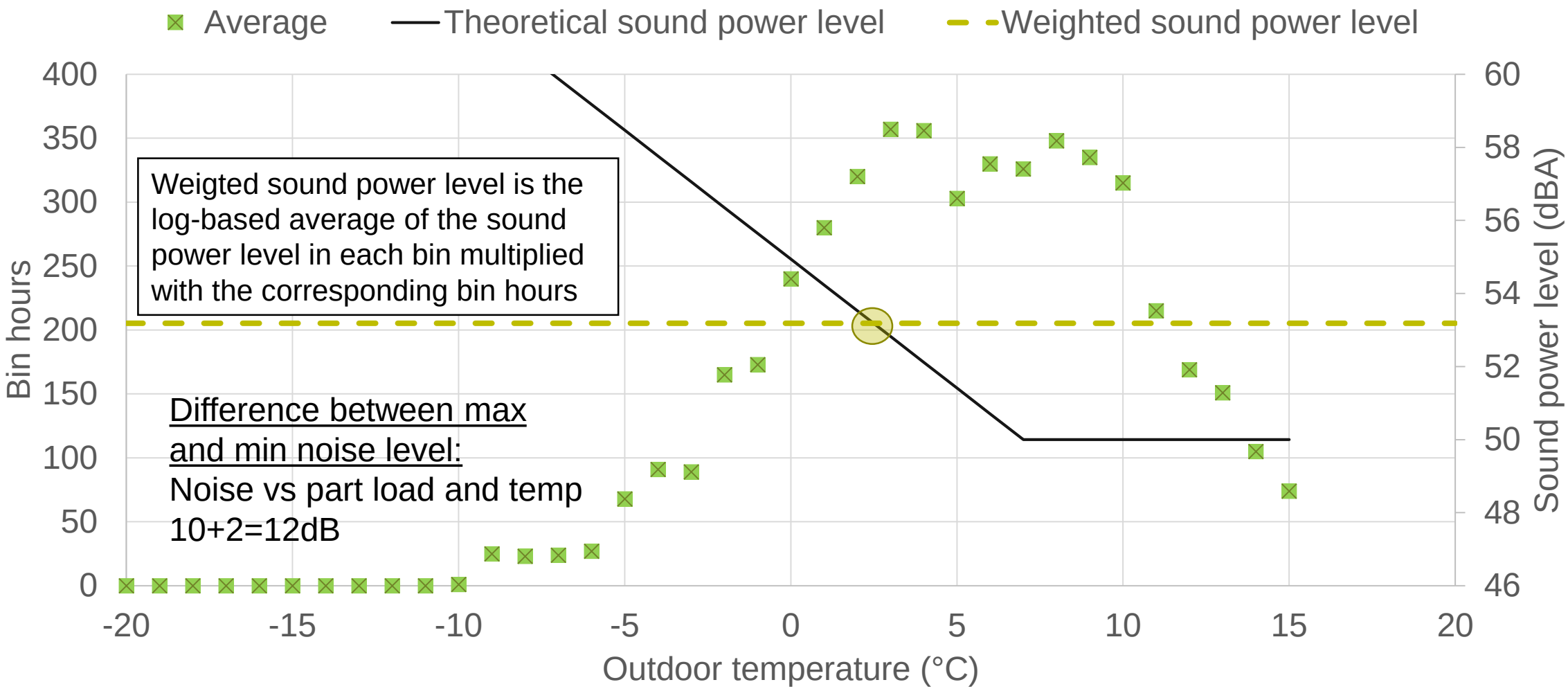
Heat pump type	Soundpower Standard rating conditions dB(A)	Seasonal sound Averge climate dB(A)	Seasonal sound Cold climate dB(A)
BWHP1	36	40	42
BWHP2	34	39	42
BWHP3	39	44	46
AWHP1	57	62	65
AWHP2	53	56	58



Result

- The seasonal sound power is 4 – 8 dB higher compared to the sound power at rated capacity
- Requires extensive testing!

Seasonal noise – average climate – simplified method

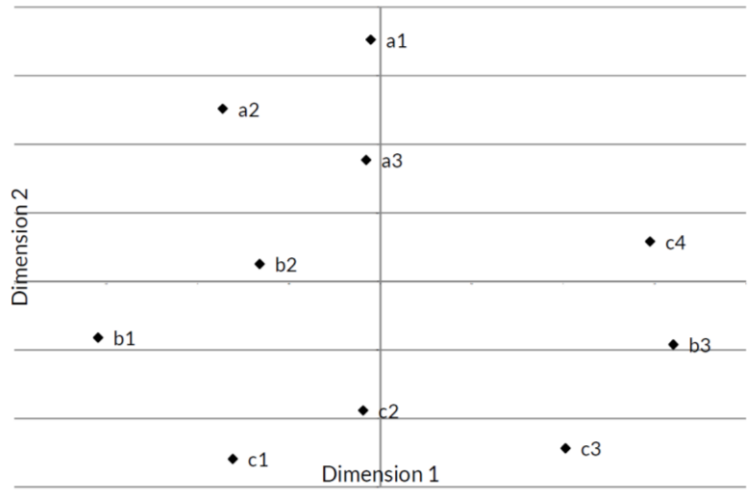


Proposed test point for sound power test: +2°C, 54% (test point B in EN14825), for air source heat pumps +7°C, but part load according to test point B (54%)

Psycho acoustics – Noise vs annoyance - Listening tests

- **Scope:** Determine the prevalent or dominant perceptual features in different ground source (brine-to-water) heat pumps
- **Method:**
  - 3 different heat pump models and 10 different recordings of varying situations with 14 persons
  - Pairwise dissimilarities were investigated
    - equal sound level

- **Results:** The most prominent parameters are compressor speed and the sharpness level. The participants preferred sounds with less sharpness and a compressor speed at higher frequency.



Conclusions and recommendations

- The **compressor and fan speed** are the **dominating factors** for the sound power level of a heat pump. The temperature levels and the temperature lift are of less importance.
- The noise of a heat pump should be evaluated at:
  - The temperature/part load that corresponds best to the seasonal averaged noise = **+2°C, 54%** (or +7°C, but 54% part load for air source heat pumps)
  - Maximum compressor speed (and fan speed) – to inform about the range
- Listening tests: sounds with less sharpness and a compressor speed at higher frequency are preferred

THANKS FOR LISTENING!

Questions?

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