SWEDISH CONTRIBUTION ANNEX 49

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BUILT ENVIRONMENT
ENERGY AND RESOURCES

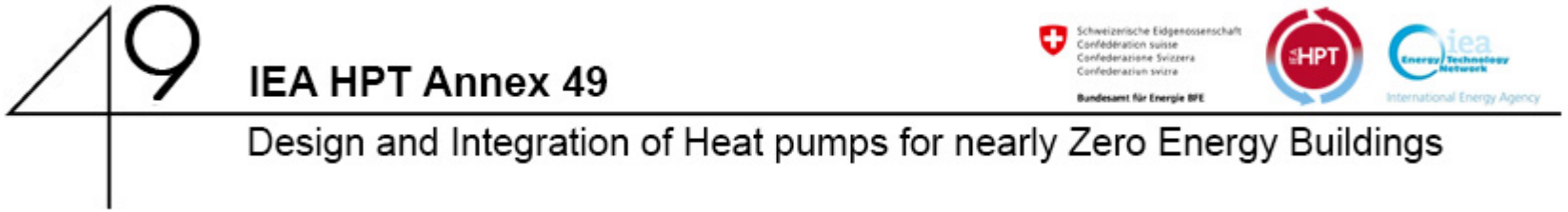
Agenda

- Evaluation of two type of heat pump systems for nZEB
- LCC analysis of new heat pump systems for a nZEB

Acknowledgements

- The study has been funded by the Swedish Energy Agency - through the research program EffsysExpand, Bosch Thermoteknik, Thermia, NIBE, Skanska and TMF companies

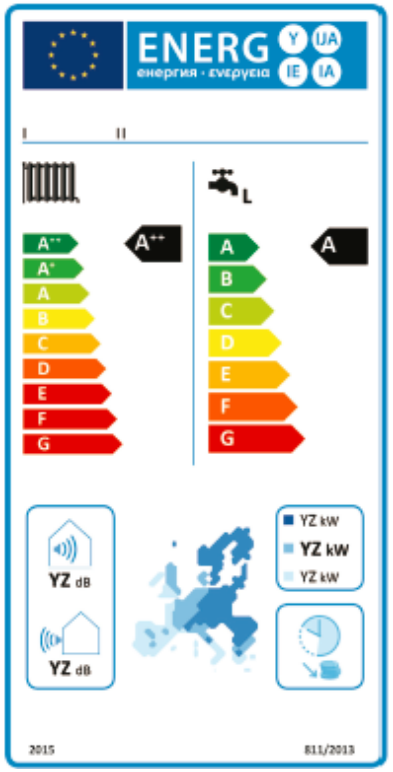
- The project is a part of Annex 49 of the IEA Technology Collaboration Programme on Heat Pumping Technologies



- National project finalized June 2018

Background

- Energy Performance of Buildings Directive (**EPBD**) requires **very low energy consumption**
- Many heat pumps oversized for the low energy demand – what system types are most cost efficient?
- **Ecodesign and Energy Labeling**
  - **EN14825** developed for more **traditional applications for heat pumps** – higher space heating demand, heating systems with higher supply temperatures
  - Important to know about a heat pump systems operating parameters in nZEB

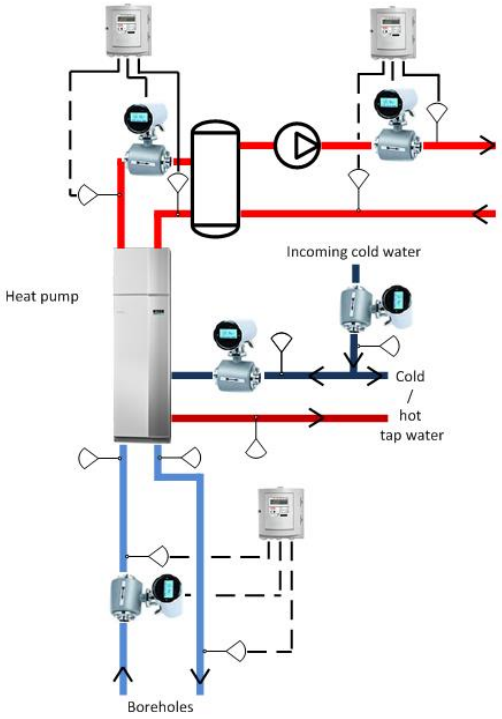


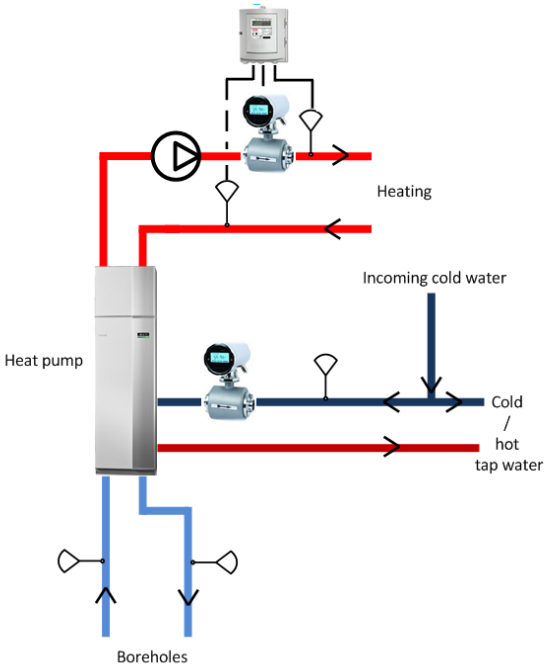
Scope

- Increase the knowledge of **how different operation parameters** are affected by the type of control system – **inverter vs on-off** - and **type of distribution system**
- Present **life cycle cost comparisons of existing and newly developed heating systems** for nZEB buildings in a Nordic climate

Measurement objects

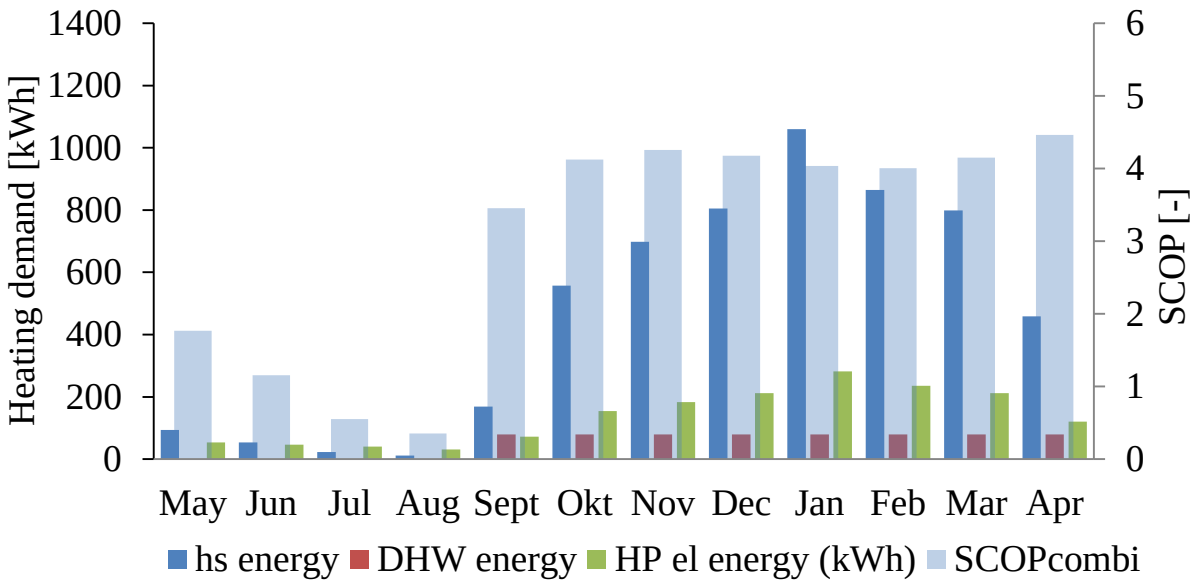
Place	Borås	Varberg
Size	• 166 m^2, 22 kWh/m^2/yr (projected for space heating and DHW demand)	• 166 m^2, 20 kWh/m^2/yr (projected for space heating and DHW demand)
Ventilation	• Balanced ventilation system with heat recovery	• Balanced ventilation system with heat recovery
Heating source	• Ground source heat pump (4.5 kW, on/off controlled) • Storage tank 150 l • Borehole 90 m (81m active) • Dimensioning temperature: 0°C	• Ground source heat pump (6 kW, inverter controlled) • Borehole 90 m (71m active) • Dimensioning temperature: 0°C
Heating system	• Floor heating on upper and 1st floors • Dimension temperature: 36°C at dimensioning outdoor winter temperature	• Low temperature radiators, upper floor • Floor heating, 1st floor
Solar	• PV-panels 3000 kWh/yr	• PV-panels 3000 kWh/yr
Habitants	• Simulated family	• Real family



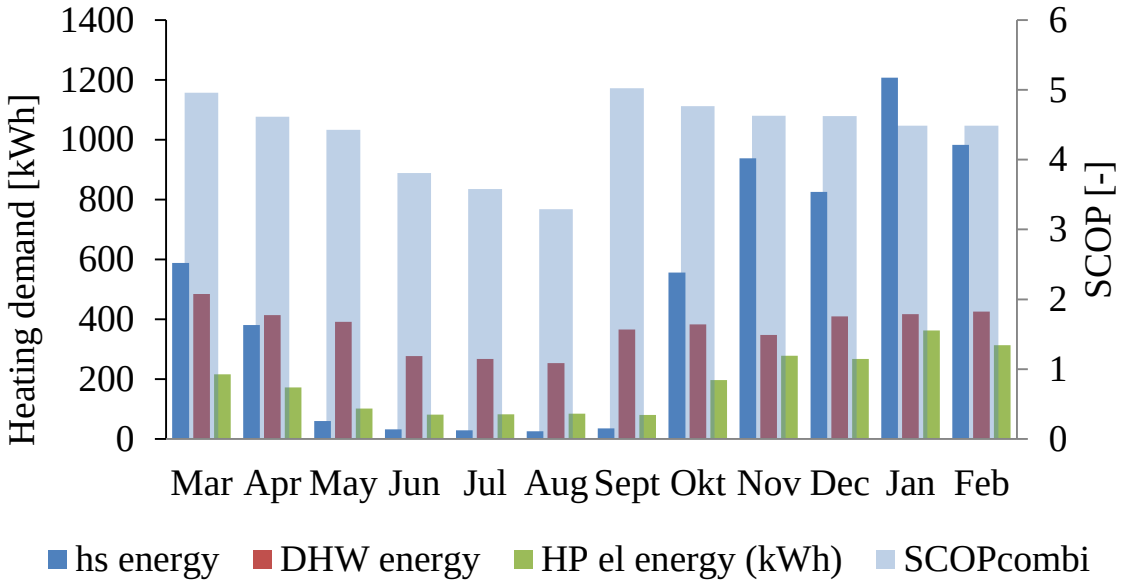


Heating demand, electric energy input and SCOP

Borås, simulated family, no/low DHW demand



Varberg, real family, normal DHW demand



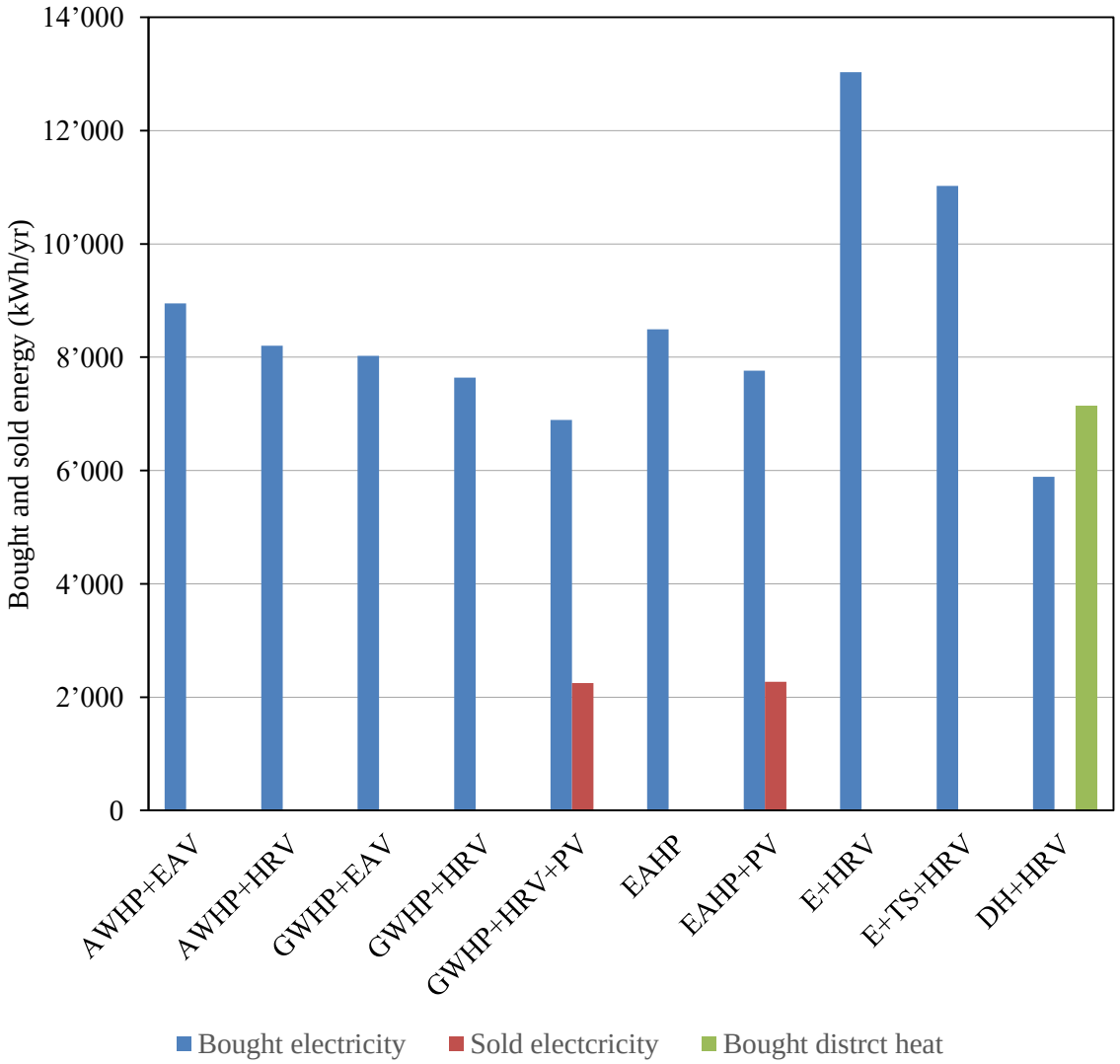
SCOP

System Coefficient of Performance

(Seasonal Coefficient of Performance in EN14825)

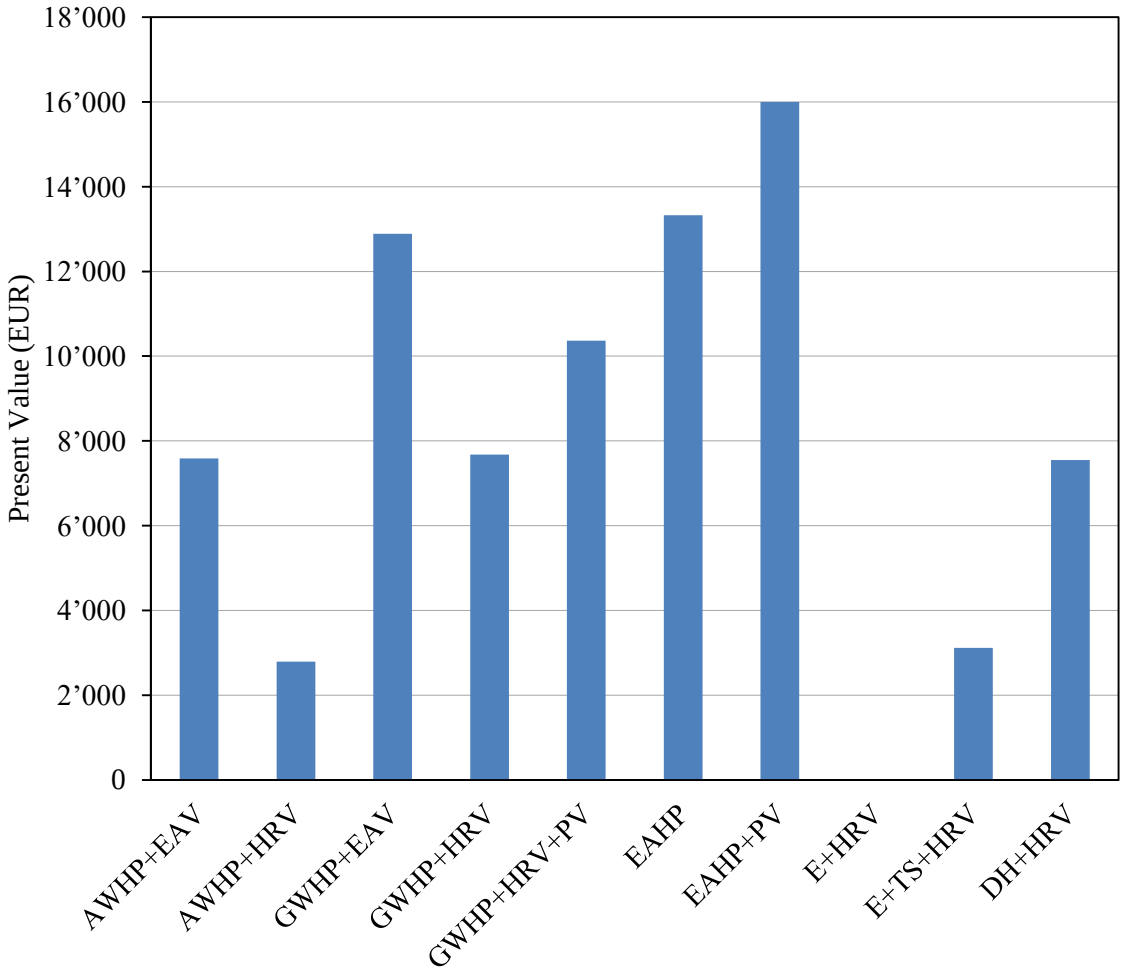
$$SCOP = \frac{\sum\left(\left(t_{w,s,hs}-t_{w,r,hs}\right)\cdot q_{hs}\cdot c_p\cdot\rho+\left(t_{w,DHW,h}-t_{w,DHW,c}\right)\cdot q_{DHW}\cdot c_p\cdot\rho\right)+Q_{losses}}{\sum P_{hps}}$$

New and other heat pump types – calculated energy use



Abbreviation	Description
AWHP+EAV	Outside air-to-water heat pump with exhaust ventilation
AWHP+HRV	Outside air-to-water heat pump with heat recovery ventilation
GWHP+EAV	Ground source heat pump with exhaust ventilation
GWHP+HRV	Ground source heat pump with heat recovery ventilation
GWHP+HRV+ PV	Ground source heat pump with heat recovery ventilation + 3 kW (3000 kWh/year) photovoltaic solar electrical system
EAHP	Exhaust air-to-water heat pump
EAHP+PV	Exhaust air-to-water heat pump + 3 kW (3000 kWh/year) photovoltaic solar electrical system
E+HRV	Electrical boiler with heat recovery ventilation
E+TS+HRV	Electric boiler including thermal solar and additional storage system + heat recovery ventilation
DH+HRV	District heating with heat recovery ventilation

New and other heat pump types - LCC



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Conclusions

- The standard EN14825, and the models based on it, **predict relatively well the performance** of the heat pump system. It is quite conservative in terms of the brine temperature.
- The **heat pump** and the **heating system** should be **optimized and controlled together** for best overall **efficiency**
  - Heat pump and floor/radiator heating system
- In RISE's research villa in Borås the **most profitable** heating and ventilation system based on the life cycle cost is an inverter-controlled **exhaust air heat pump combined with a PV-system**.
- For a somewhat **less well-insulated house** than RISE's research villa, an inverter-controlled **ground-source heat pump** would likely be most profitable.
- The outdoor **air-to-water** heat pump gets **lower present value** than the ground source heat pump. However, it is a good alternative when it is not desirable or possible to drill.

THANK YOU!

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