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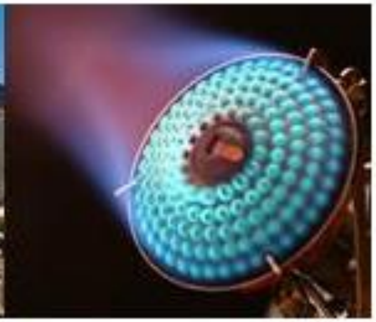

Practical Experience of Gas Heat Pump (GHP) Technology in both Domestic and Commercial Heating Sector

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Contents

Political Framework as Market Driver

e.g. 

Energy Saving Ordinance	Renewable Heat Energy Act

Targets for:

- Primary energy efficiency
- Envelope transmission rates
- Share of renewables for public buildings

EPBD

CE

Nearly Zero Energy Buildings:

- By 2021 for all new buildings
- By 2019 for new public build.

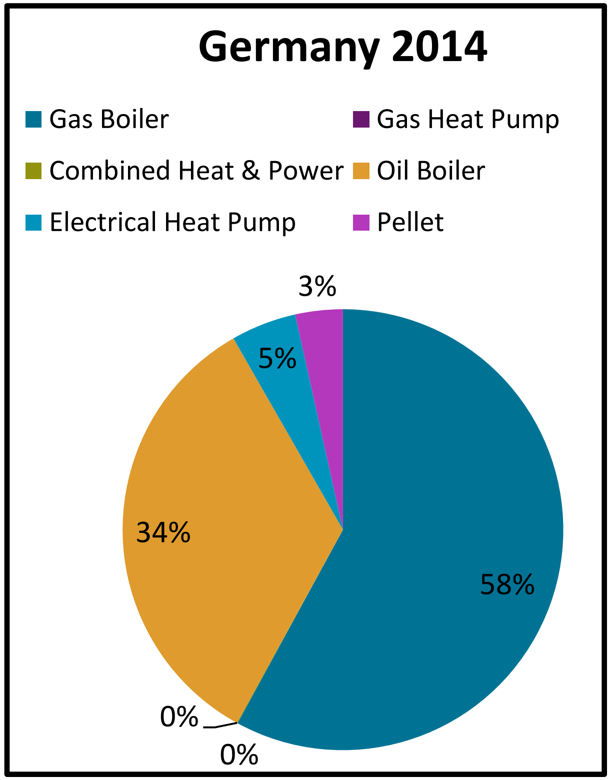
Market situation: Existing Buildings

Residential buildings =
Largest portion of the overall European building stock (60%)

Residential buildings =
Largest specific consumption (kWh/m²/yr)

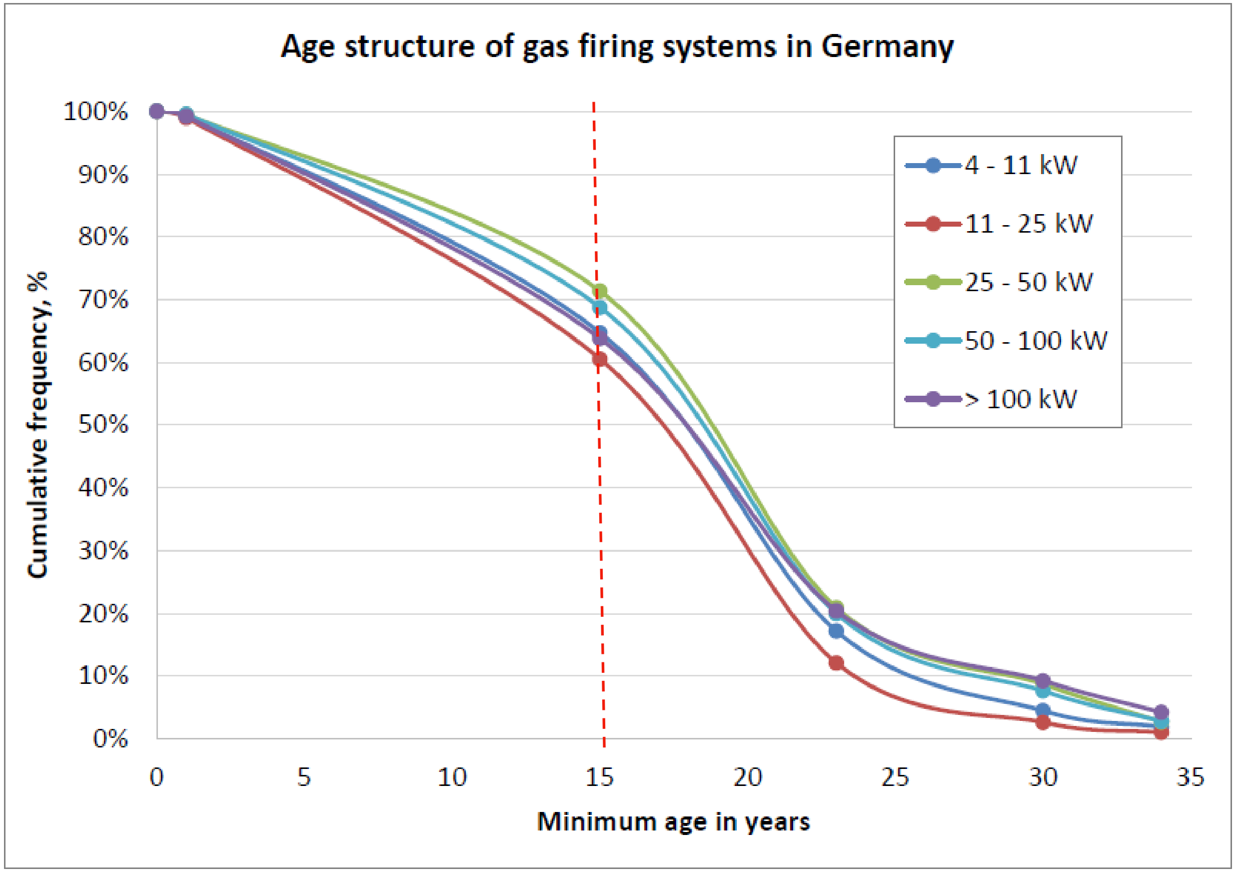
Residential buildings =
Low refurbishment rate (2% per yr)

Residential buildings =
Largest potential to drastically reduce energy use and CO_2 emissions



Further Driver for High Efficiency Technology

- Technical life expectancy of boilers: 15 – 18 yrs
- 60%-70% through all sizes are at least 15 yrs old!
- Current replacement rate is ≈ 3% per yr



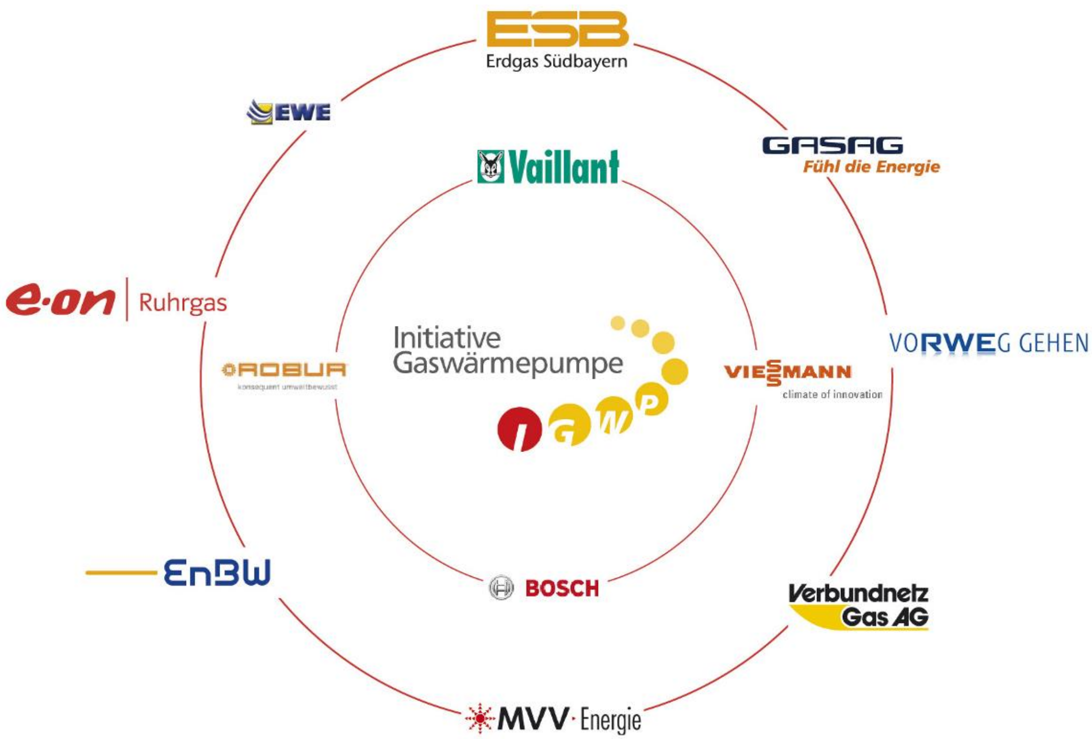
Source: chimney sweeps‘ report 2012

→ **A significant replacement market potential is available on mid-term.**

Development of Gas Heat Pump (GHP) Technology

Initiative Gas Heat Pumps (2008 – 2012):

- Develop the Gas Heat Pump technology until readiness for marketing
- Result: GAHP products available on German market in 2013



Appliances at a glance

Adsorption | **Absorption**





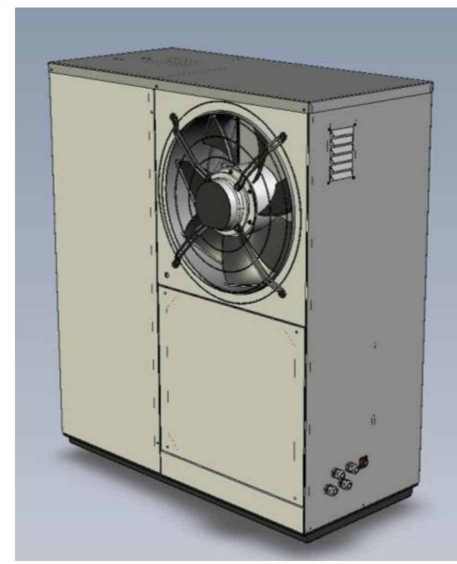
	Adsorption		Absorption		
	Vaillant	**Viessmann**	**Robur/Bosch (Buderus)**		**Robur**
Output	10 and 15 kW	< 16 kW	< 18 kW	< 40 kW	< 40 kW
Status	in the market	in the market	in development	in the market	in the market
Applica-tions	Residential	Residential	Residential	SME / light commercial	SME / light commercial
Systems	space heating (radiator and floor heating) and domestic hot water				

HEAT4U – EU Project: Development of a GHP for the Retrofit Single Family Home Market

Lab-tests at different laboratories with respect to different test standards

The main objectives of the field trial were to:

- demonstrate reliable, comfortable and efficient heating and DHW service in different countries and situations representative of the most typical installations for existing buildings,
- improve the installation guideline and have first feedback from installers,
- optimize the GAHP appliance control,
- optimize the GAHP system control,
- obtain measurements of primary energy efficiency under real conditions and energy savings compared to the previously installed systems.



HEAT4U – 5 Field Trials in 5 Countries (Heating Season 2013/2014)

- **France** - Existing individual house without buffer tank
  (Average Climate) - GDF SUEZ

- **UK** - Existing individual house
  (limited space, small buffer) - BRITISH GAS

- **Poland** - Low temperature demonstration testing
  (Cold climate) - FLOWAIR

- **Germany** - High humidity demonstration testing
  (Average Climate) - E.ON

- **Italy** - Demonstration testing
  (Warm Climate) - ENEA

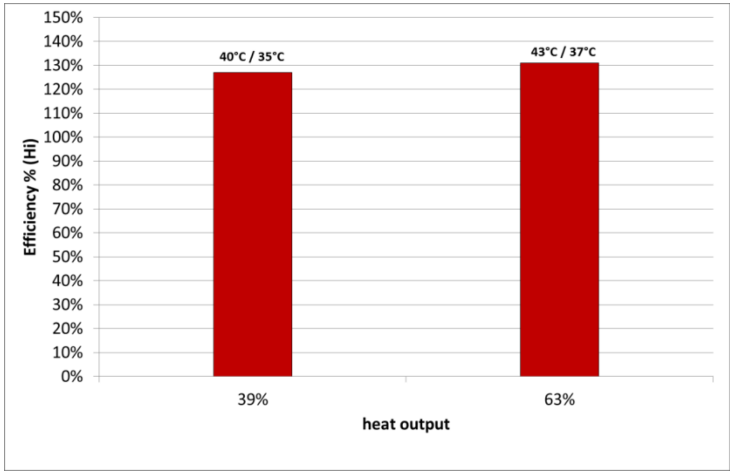
German Field Test Location and Conditions

General description		
Title		
Country	GERMANY	
City	Bottrop	
Building type	One-family low insulated house GAHP behind the garage in the garden	
Number of inhabitants	3	
Year of construction	Ca. 1954	
Heated building area [m2]	Ca. 140	
Specific heat load [W/m2]	-	
Design load for heating [kW]	15	
Design outdoor temperature of location (°C)	-10	
Design supply temperature of heating system (°C)	60/45	
Connection to the gas network	Existing	
Distribution system	High temperature radiators	
Operation mode	monovalent (with back up boiler)	
Output of peak load boiler (if bivalent operation) [kW]	-	
Alternative / complementary heating system	Gas condensing boiler	

Comparison Between Results of Lab Test and Field Trial

First GAHP Prototype

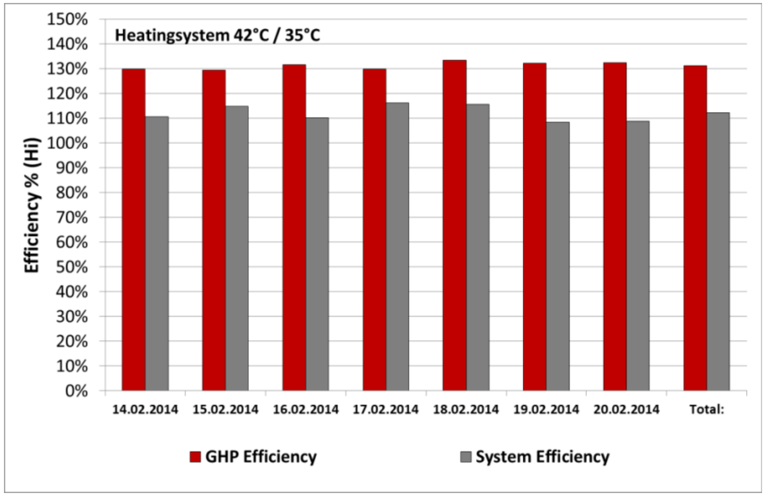
Lab test with respect to
EN12309 – 3
EN12309 – 6
VDI 4650 - 2



Achieving an efficiency of 130 % (NCV) compared with an efficiency of 100 % (NCV) for a condensing boiler (both measured at the same boundary conditions)

Second GAHP Generation

Field Trial in Bottrop
Semi-detached house



In comparison to the old heating system nearly 40 % energy savings could be realized

Further improvements with respect to performance are expected in the next GAHP generations

Results from the Field Trial after the First Heating Period

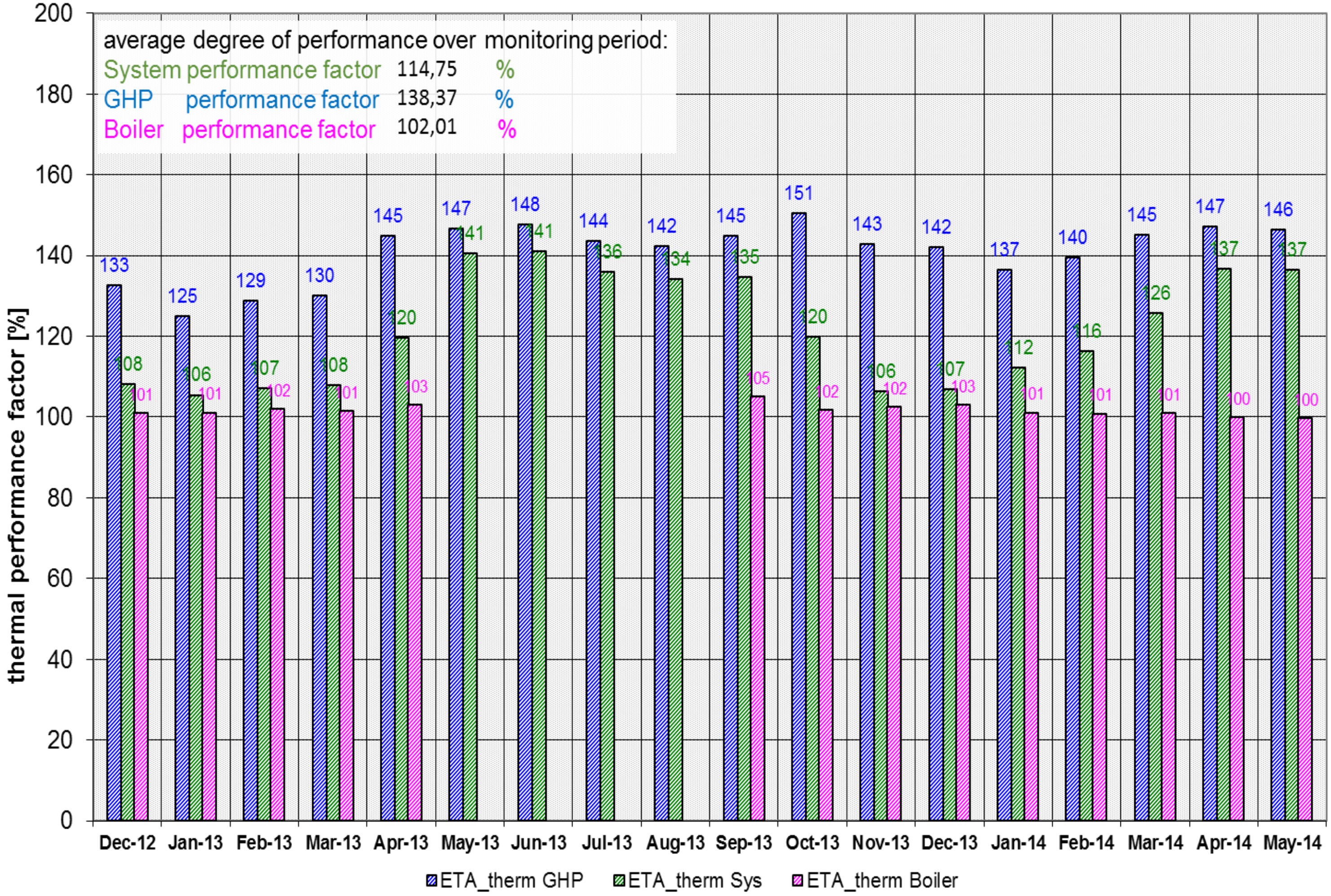
- **High efficiency** of the gas absorption heat pump
  (efficiency ~ **130 %** NCV) despite the following obstacles:
  - only radiator system → high temperature level
  - only an air/water heat pump
  - including DHW service
  - high part load conditions (warm winter)
- **No comfort losses** (end user wants to continue the field trial)
- Since completion of commissioning the GAHP system operated without failures → **reliable operation**
- **Recommendation**: some additional modifications are being carried out in the hydraulic and control system (e. g. different flow rates, algorithm of regulation, buffer tank concept)
- The experience from a field trial with real customers helps us to evaluate the possible integration of this technology

These results demonstrate that the adaptation of the GAHP technology to a retrofit residential house has been successfully achieved by providing a solution able to deliver substantial energy savings and to integrate a high share of renewable energy.

Demonstration Site: GHP in a public building

- Primary School
  - Approx. 200.000 kWh annual heating demand
  - Formerly gravity heating system, large old radiators
  - No domestic hot water demand
- Former heating device:
  - Gas low temperature boiler
- New System:
  - Peak load gas condensing boiler
  - Base load gas heat pump (40 kW_{th})
- **Goal: end-energy reduction by 30% compared to old system**

Thermal Performance of GHP



→ Approx. 40% reduction of CO_2 emissions and end-energy consumption with respect to former system!

Practical Challenges

GHP

Location of GHP:

- School's parking lot
  → public accessibility
  → safety issue for passers-by and device
- Cage enclosure to prevent harm

Noise Nuisance:

- Complaint was filed by next-door neighbour
- Found that neighbourhood is purely residential area
  → very strict limits, especially during night time
- Measurements by E.ON proved complaint valid
- Enhanced ventilation capable of modulation installed
- Time control to shut off GHP during night-time, if necessary

Use of ammonia:

- Concern about health issue
  → small children are present
- Risk assesment by independent expert
  → no problem due to volatility and shortening reaction

Condenser water drainage:

- No standard accessory available → custom-made
- Challenge to keep it clean (trees) → caretaker

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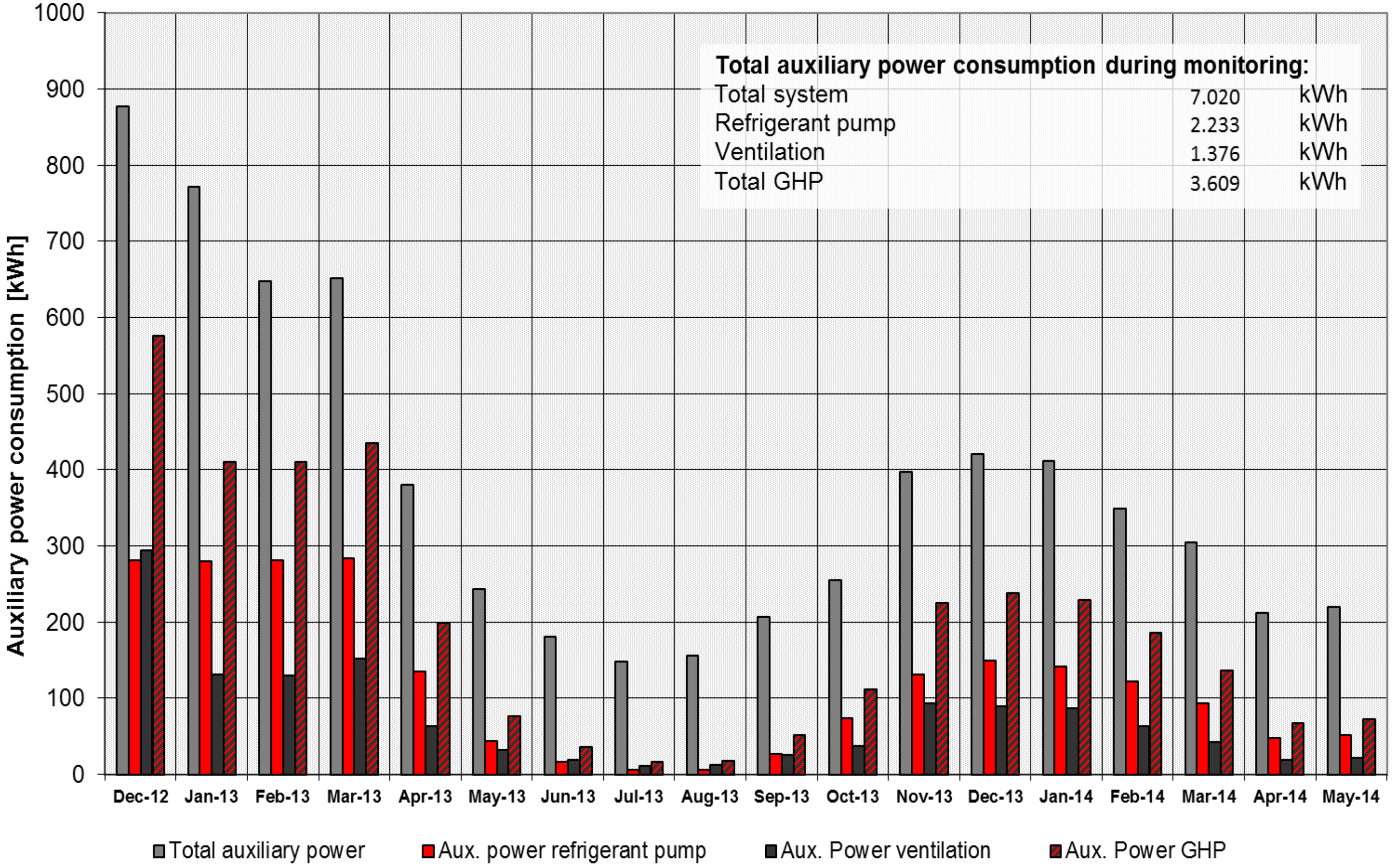
Demonstration Site in a Multi-Family Home

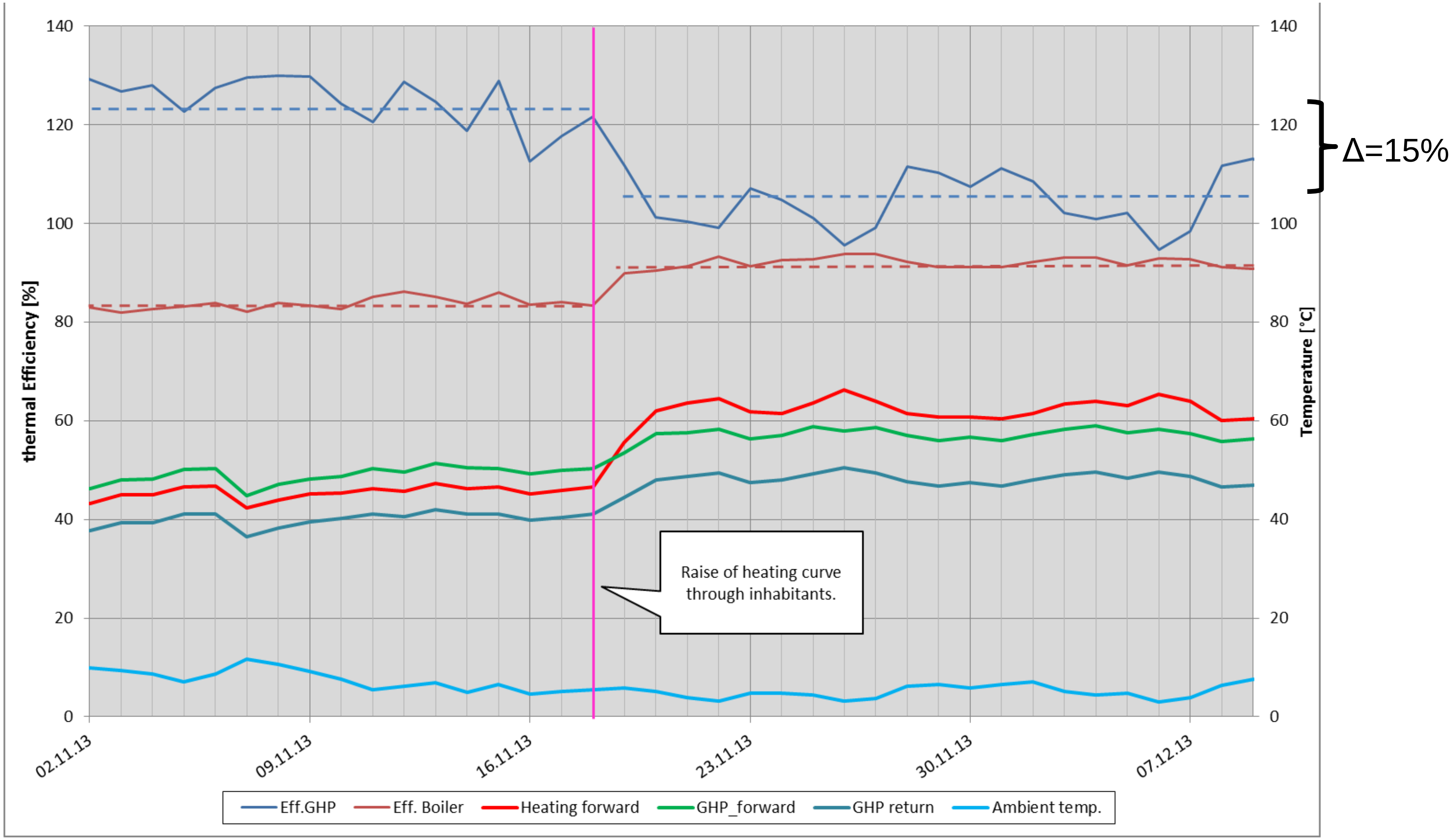
- 7-flat multi-family-home
  - Existing building, equipped with radiators
  - Approx. 110.000 kWh annual heating demand
  - Approx. 20.000 kWh annual domestic hot water demand
- Former heating device:
  - Gas condensing boiler
- New System:
  - Peak load gas condensing boiler
  - Base load gas heat pump (40 kW_{th})
- **Goals: optimisation of auxiliary power consumption and investigation of DHW influence**

Optimisation of Auxiliary Power Consumption



→ Auxiliary power consumption could be reduced by approx. 60% from first to second monitoring season.

Example of Customer Behaviour Influence



→ Customer influence can severely harm performance of sophisticated high efficiency technology

Conclusion & Future Prospect

- In all field trials, after initial issues had been overcome, reliable operation could be achieved
- GHPs are able to achieve very satisfying efficiency values
- On-site optimisation with respect to specific conditions is mandatory
- Practical issues, especially when placing a GHP in a public building have to be addressed
  → valuable experience was gained
- GHP bear a substantial potential to conquer their market share in both the residential existing buildings and the public buildings segment
- There is still a way to go to fully integrate GHP technology to all regulatory schemes, currently GHP is still a niche
- Today GHPs are capable to fulfill the German Energy Savings Ordinance for newly built houses (but are not accredited to date)
  → with already anticipated tightening of requirements, additional measures like the introduction of biogas is needed

- **GHPs have the potential to be part of the solution!**