EUROPEAN HEAT PUMP SUMMIT

POWERED BY CHILLVENTA

SYMPOSIUM + EXPO
NUREMBERG, 20–21.10.2015

Industrial | Commercial | Residential
Heating & Cooling | Components & Equipment

hp-summit.de

NÜRNBERG MESSE

Summary

EUROPEAN HEAT PUMP SUMMIT

Tuesday 20.10.2015

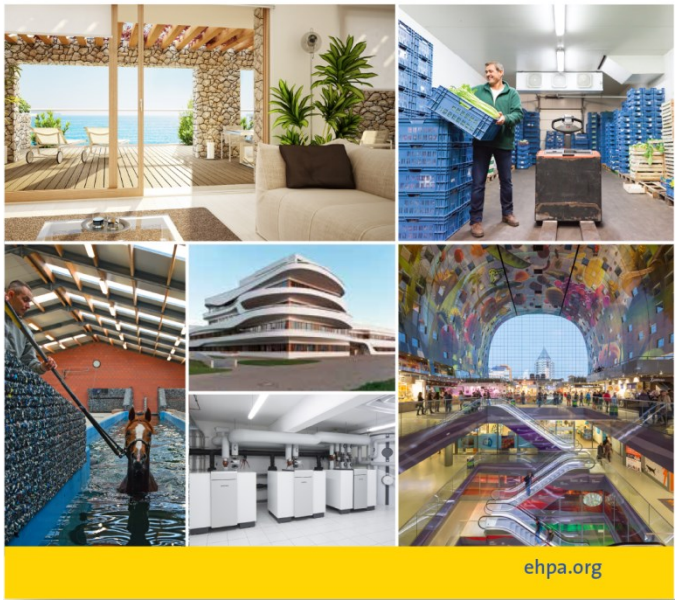
European Heat Pump Market and Statistics report 2015 version available now

EUROPEAN HEAT PUMP SUMMIT

Thomas Nowak

ehpa european heat pump association

European Heat Pump Market and Statistics Report 2015



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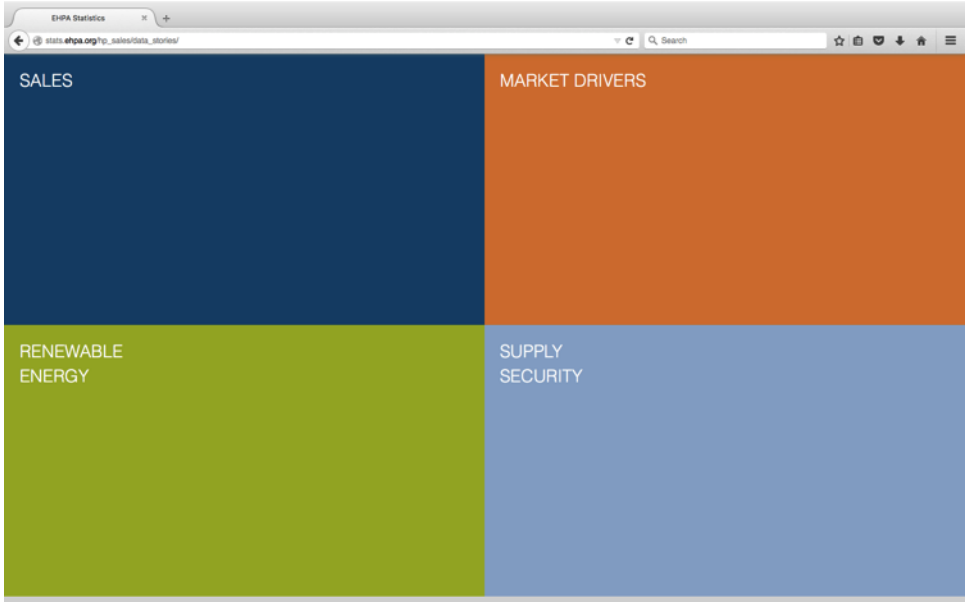

http://www.ehpa.org/market-data/2014/

market development 2005 – 2014 accumulated: 7.5 million units installed

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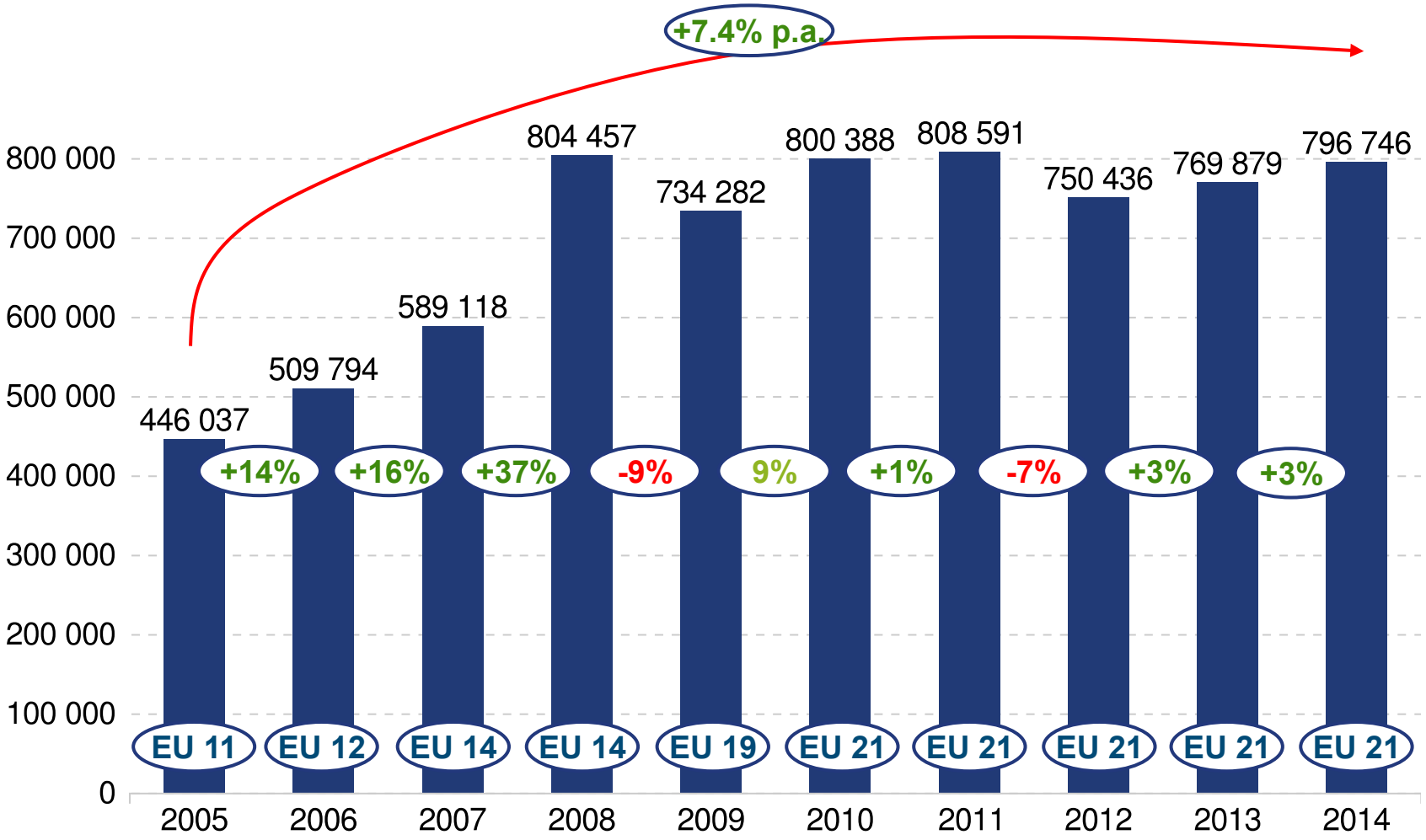
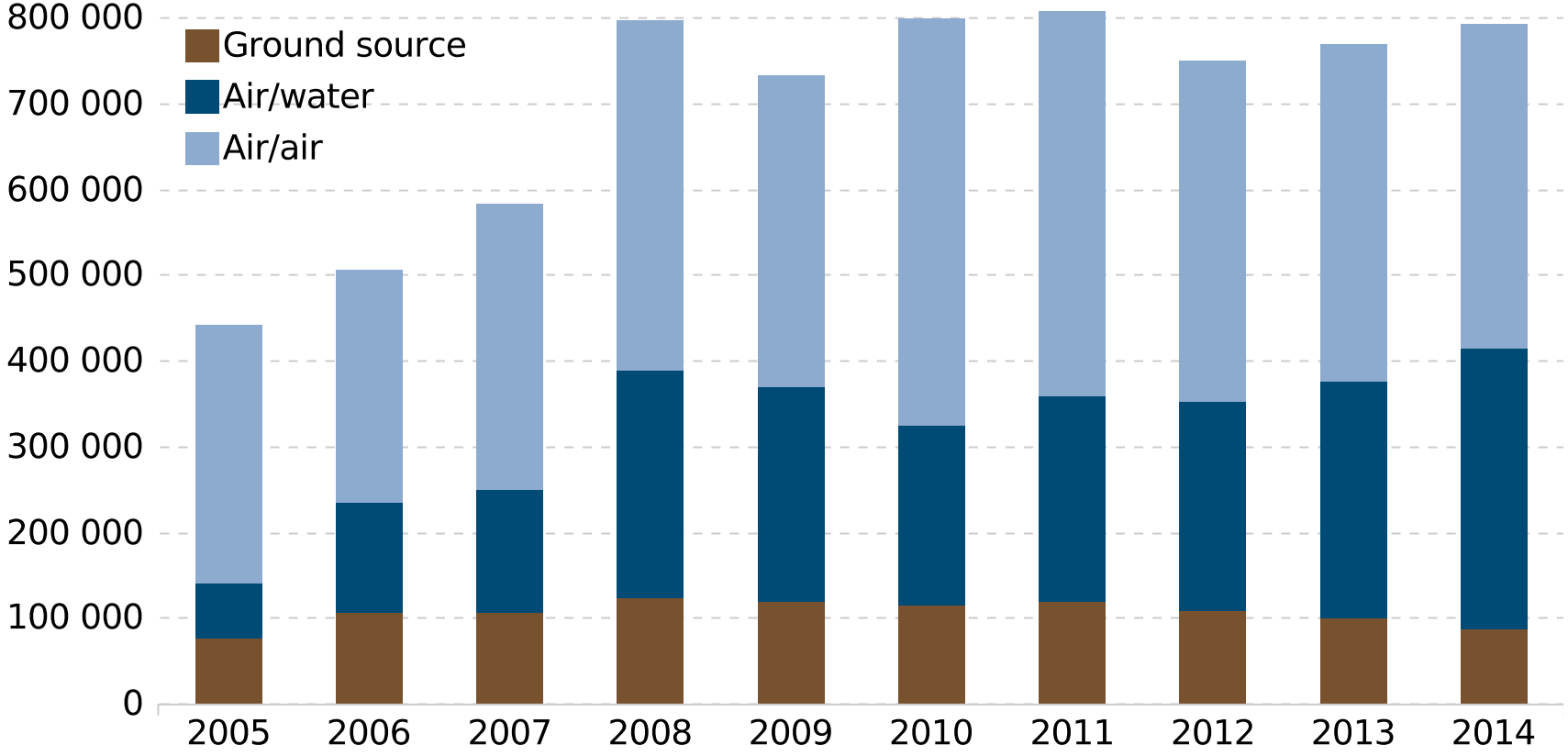
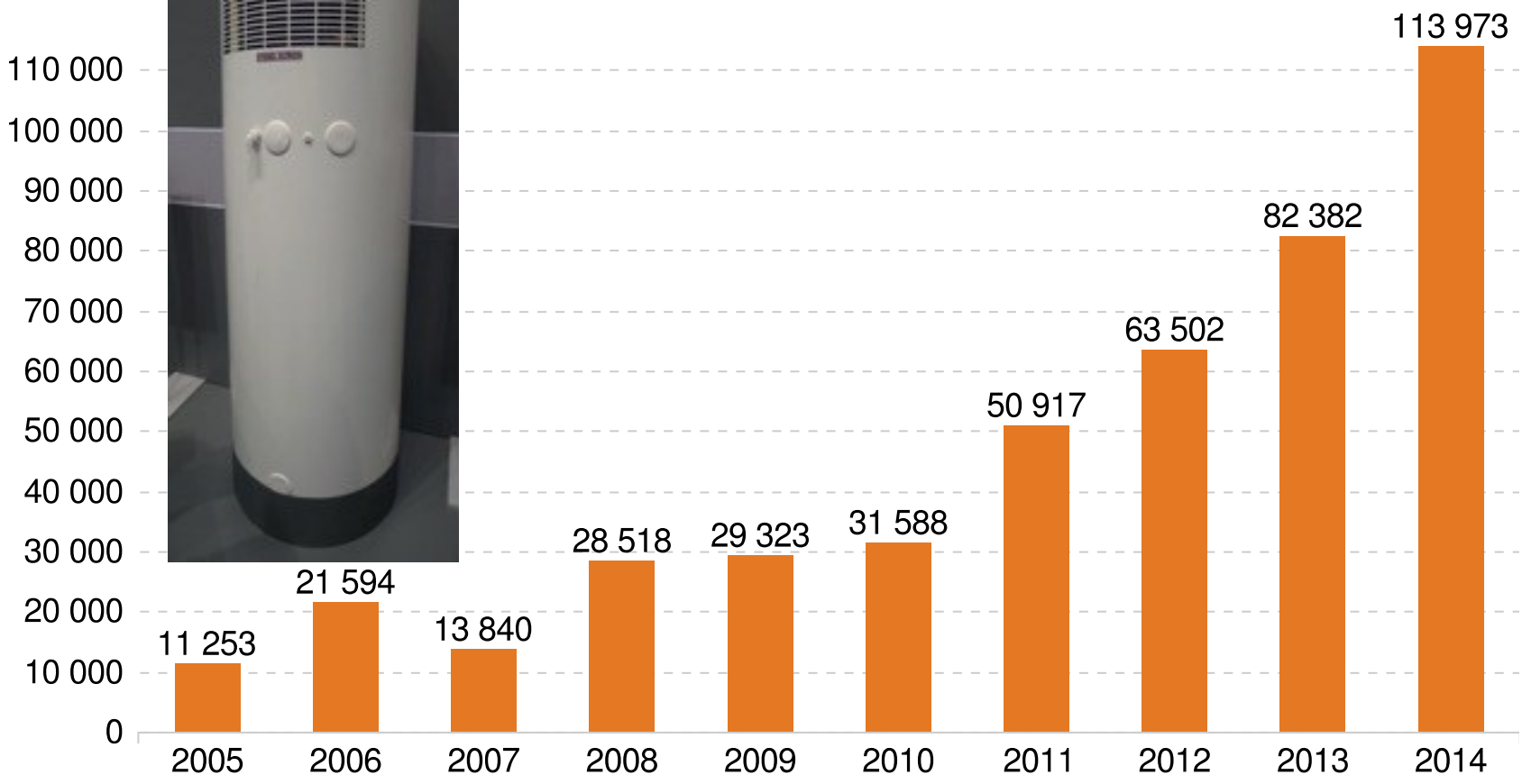


Air dominant energy source for HP in Europe
Annual sales by energy source



Biggest growth in Domestic hot water HPs



market potentials
if Sweden was everywhere

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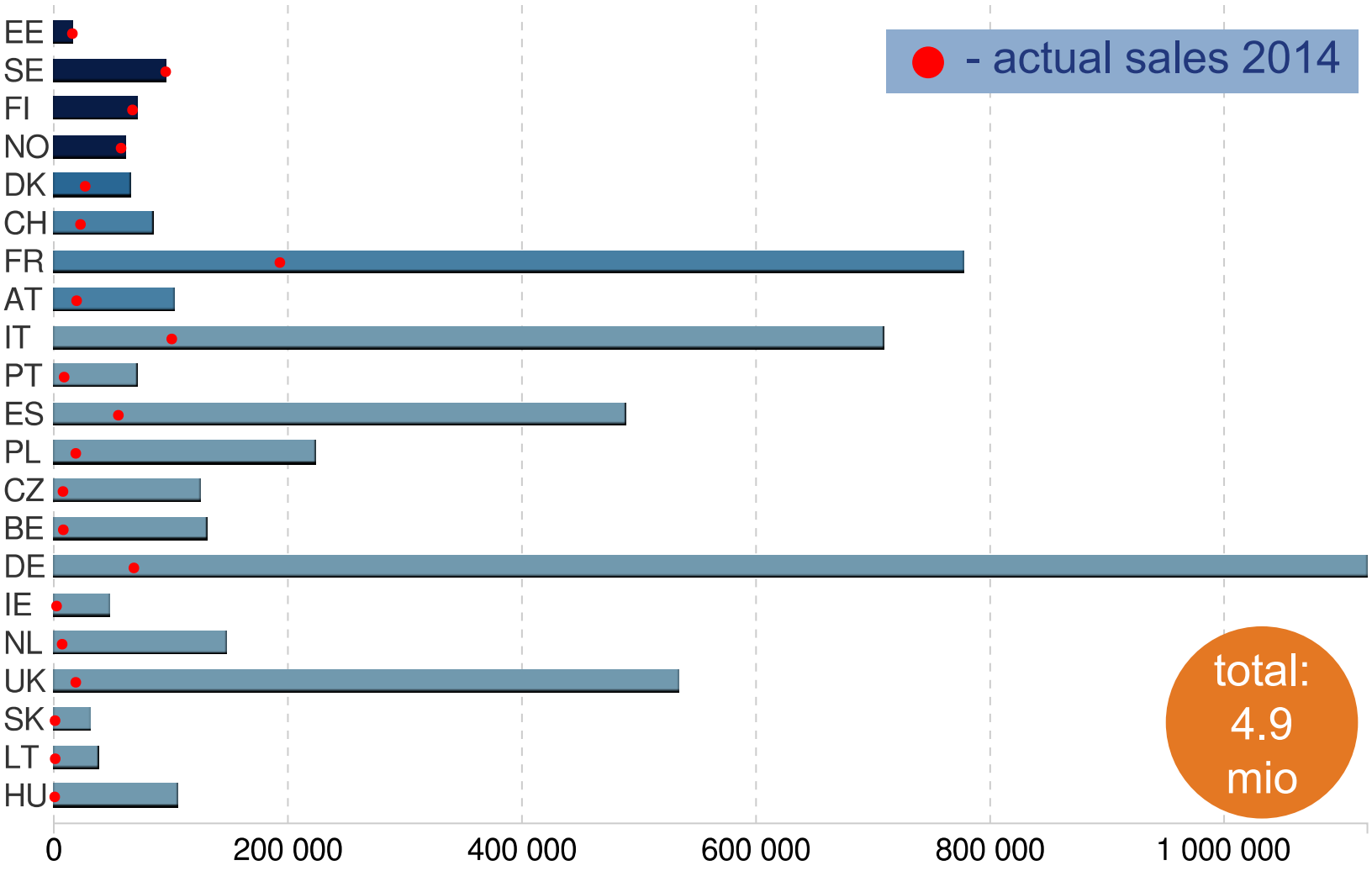


Delta Energy & Environment Ltd
Registered in Scotland: No SC259964
Registered Office: Floor F, 3 Lady Lawson Street, Edinburgh, EH3 9DR

Hybrid Heat Pumps – Are they living up to their potential?

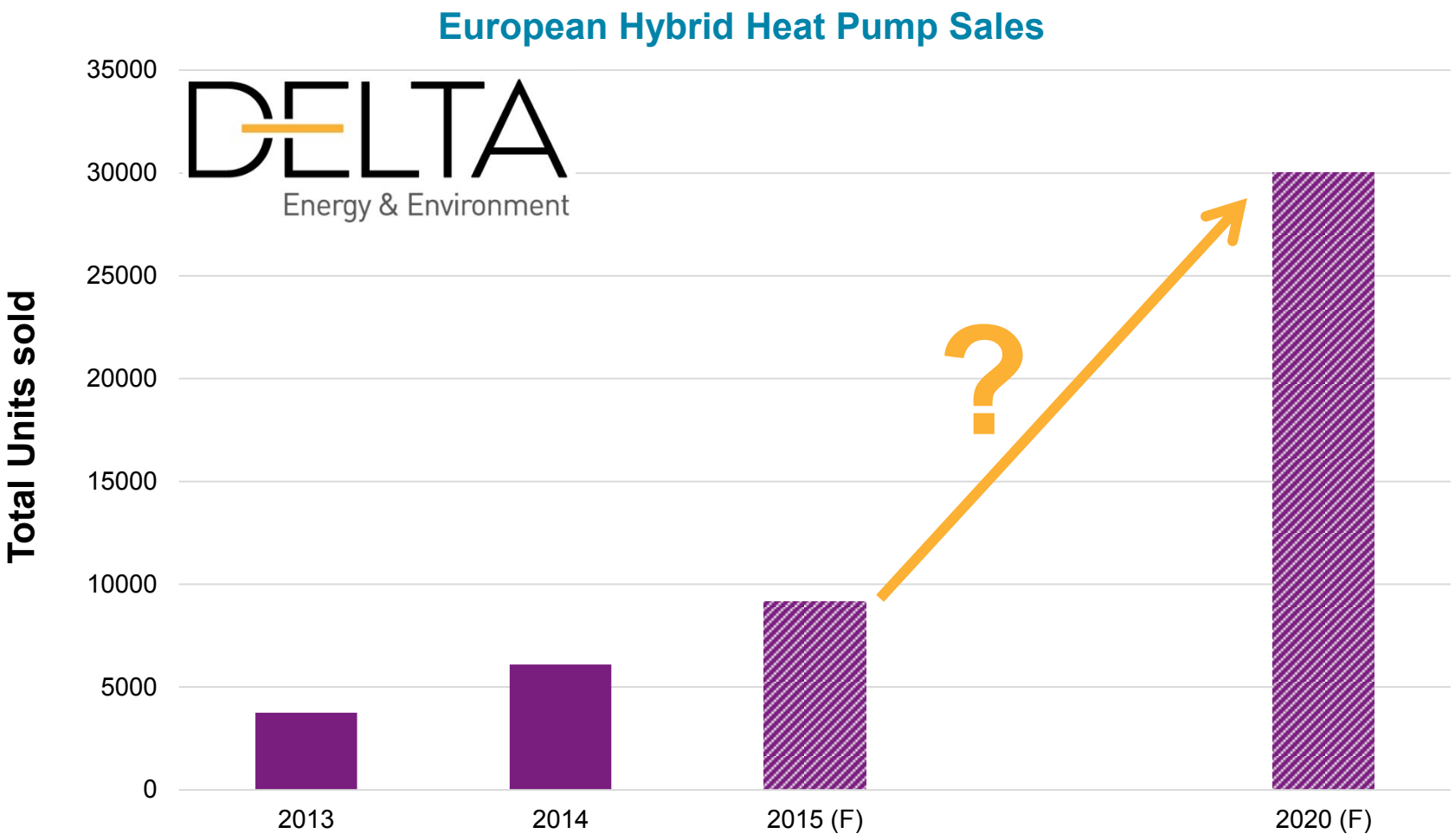
European Heat Pump Summit – 20.10.2015

Contact:

Julian Jansen, +44 131 625 1006, julian.jansen@delta-ee.com

Lukas Bergmann, +44 131 625 3332, lukas.bergmann@delta.ee.com

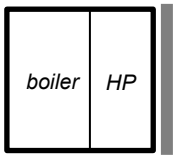
Hybrid HP sales have been growing, but what is needed to realise their full market potential?



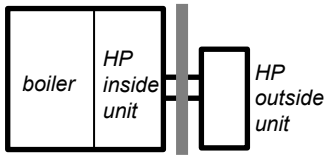
Source: Delta-ee

Defining Hybrid Heat Pumps (Delta-ee)

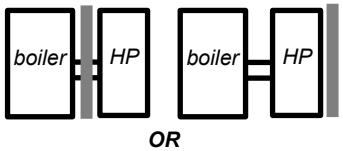
- A HP combined with a fossil fuel-fired boiler…



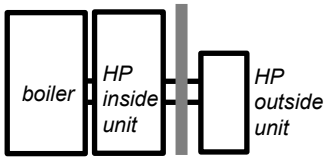
Integrated / monobloc



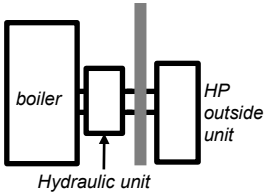
Integrated / split



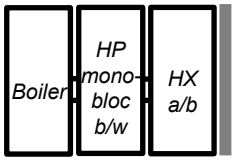
Un-integrated / monobloc



Un-integrated / split



Hydraulic unit

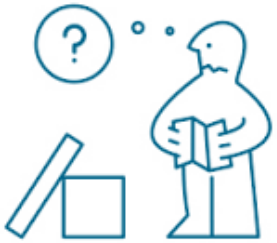


Special case: Un-integrated / "brine-split"

- **…where the system components are connected and operated via an intelligent central control system…**
  - Running cost driven
  - Primary energy/emission savings driven
  - Noise level driven (NIBE)

- **...and that is sold as a hybrid system.**

Engaging with the value chain to increase installer buy-in



Reduce size and installation complexity

- Keeping the installation complexity of hybrids to a minimum is key to getting conventional heating system installers on board

Engage with and support a new kind of heat pump installer

- Delivering free training on the system and ensuring a strong pre- and after-sales support gives the more risk-averse installers the confidence and reassurance they need to embrace a new heating system

IEA Heat Pumping Technologies – An overview of the programme and its activities

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Roger Nordman, PhD
IEA Heat Pump Centre

What is the IEA Heat Pump Programme?

An Implementing Agreement within **the IEA** since 1978

An international framework of **cooperation** and **networking** for different HP actors

A forum to exchange **knowledge** and **experience**

A contributor to **technology improvements** by RDD&D projects

IEA Road Map Key Actions – Transform the future heating and cooling market

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- Increase R& D effort
- Implement new polices to transform the market for heating and cooling technologies.
- Address policy and industry needs at a national or regional level.
- Improve data collection, metrics and standards.

IEA Road Map Key Actions – Transform the future heating and cooling market

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Heat pumps could be utilised in many different positions in the region/city/consumer (Future Building Forum)

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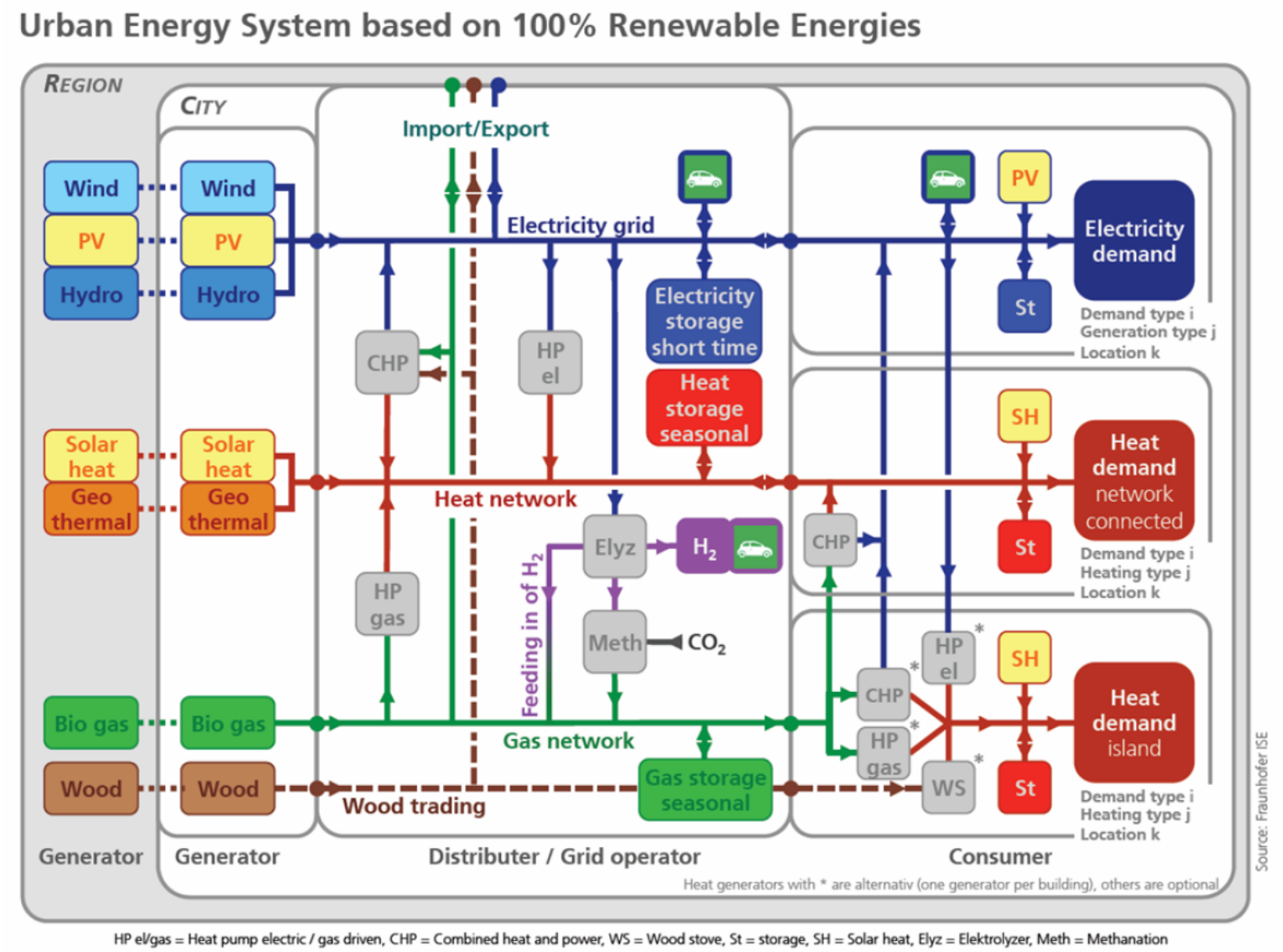

Heat pumps could be utilised in many different positions in the region/city/consumer (Future Building Forum)

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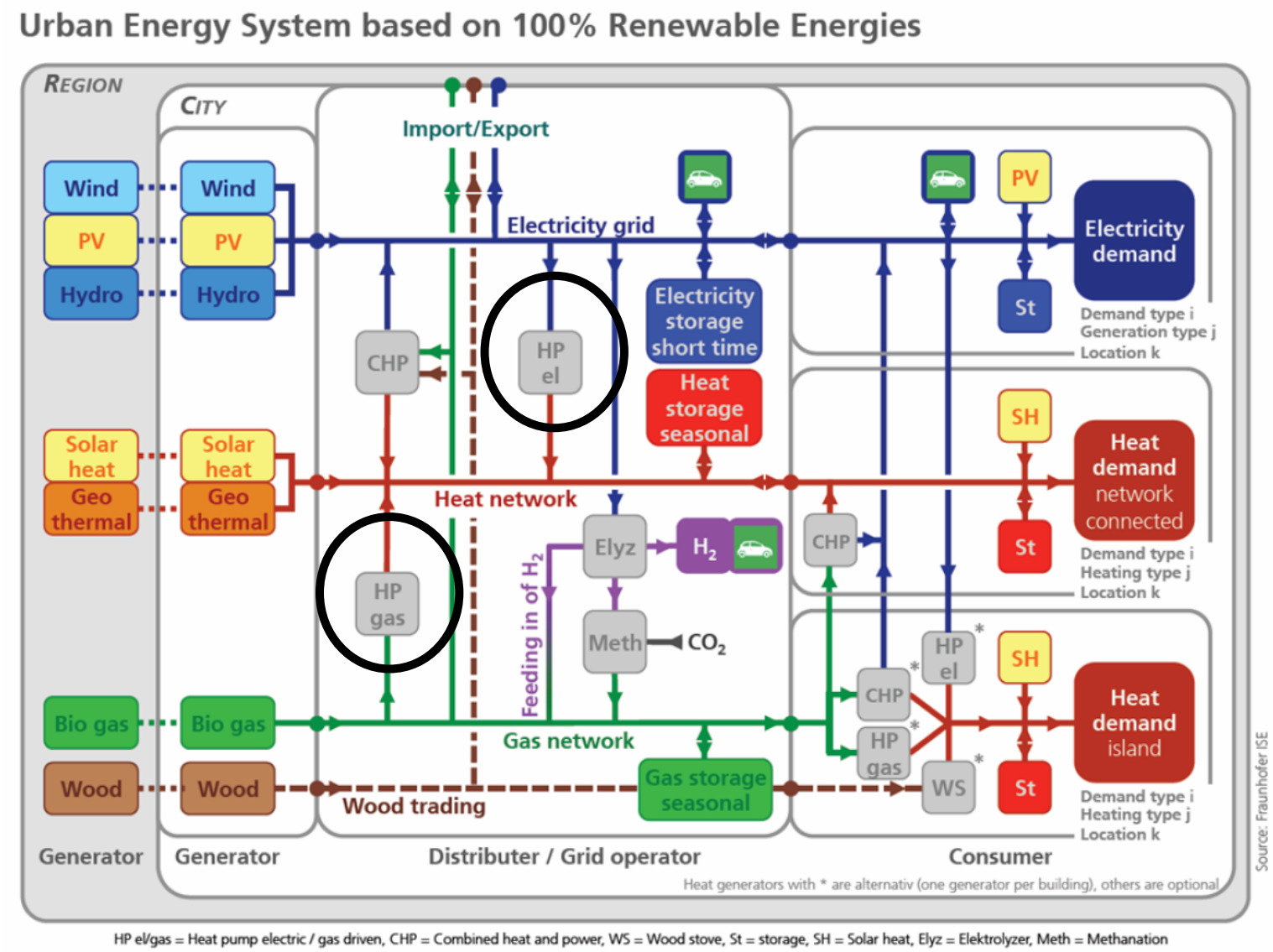

National Teams' meeting (2)

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The main focus of the meeting will be to find and develop new interesting annex ideas, in discussion groups.

These will be based on challenges submitted by the participants (from which HPC will make a selection)

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Flexibility with

(hybrid) heat pumps

With contributions from:

IEA Annex 42 'Heat pumps in smart grids'

IEA Annex 45 'Hybrid heat pumps'

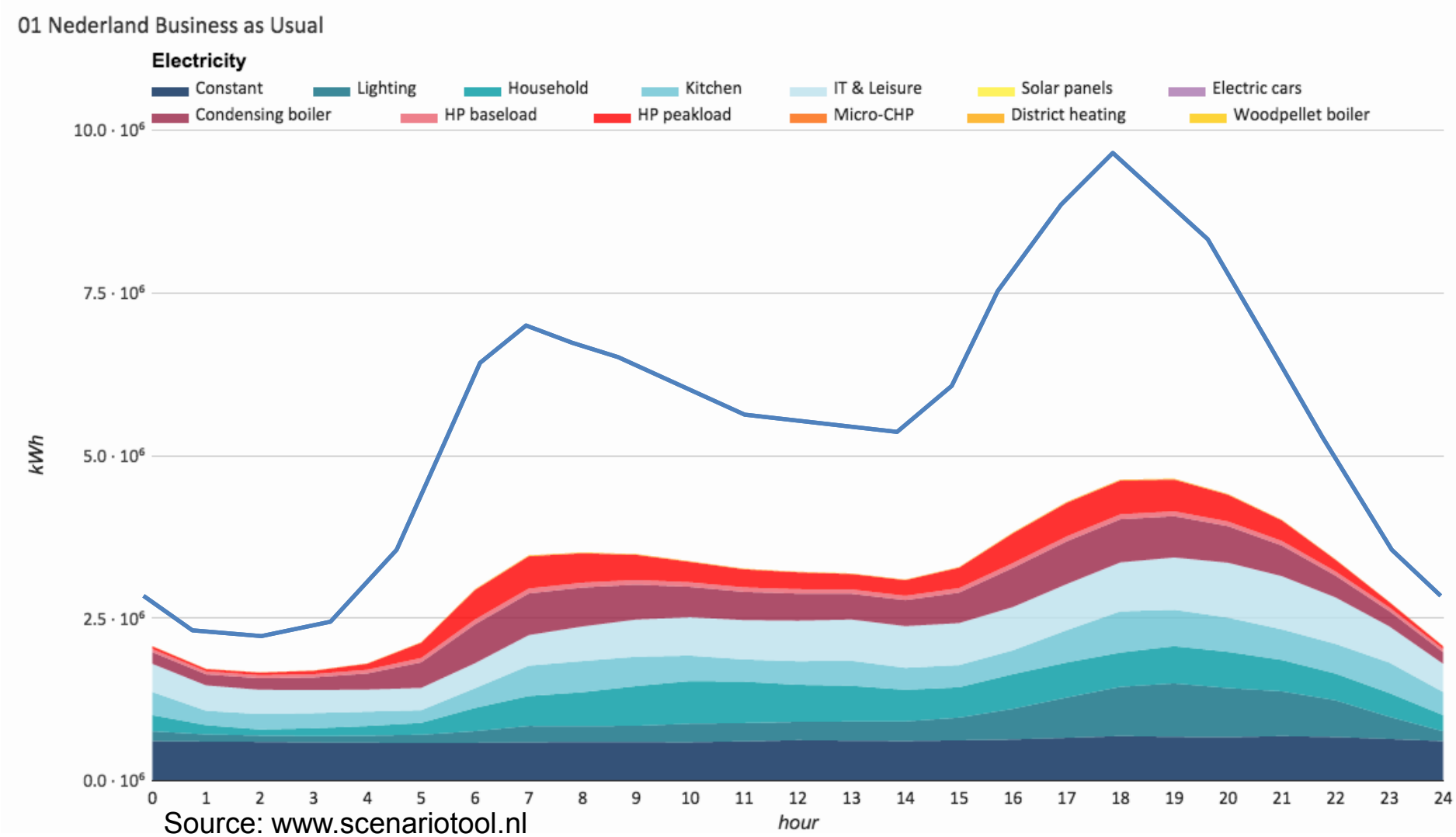
Peter Wagener BDH – NL

SCOPE OF ACTIVITIES

What are we doing?

- Scenario development:
  - Energy consumption;
  - Grid load simulations.
- Project management:
  - Renewable energy programs.
- Studies:
  - Potential studies;
  - Positioning papers;
  - Technology books.
- Tooling:
  - Online configurators;
  - Scenario tools;

WINTERDAY 2013 **VS** WINTERDAY 2030



Source: www.scenariotool.nl

CRITICAL SUCCES FACTORS (HYBRID) HEAT PUMPS IN SMART GRIDS

1. **Characteristics of the building stock**;
2. Availability, affordability home battery facilities;
3. ‘Tangible’ advantages for the end user;
4. Wholesale electricity pricing for end-users;
5. Standardization of communication protocols;
6. **Reliable technology applications**;
7. Transparent and cost efficient arrangements;
8. **“Foolproof” and user friendly technology**;
9. **DO NOT wait for the ultimate solution, it will never co**

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Let’s take care of it,

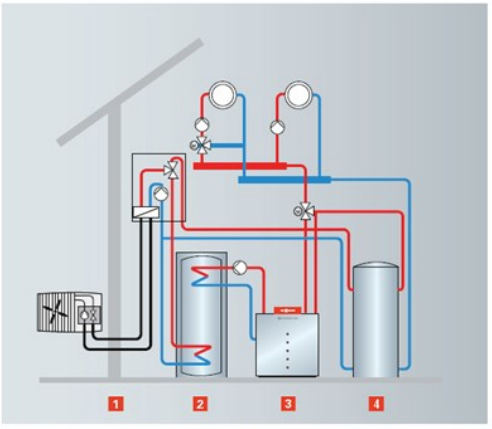
with *heat pumps* in *smart grids*

Danish demonstration project with implementation of hybrid heat pump systems

Svend Pedersen
Senior Consultant DTI

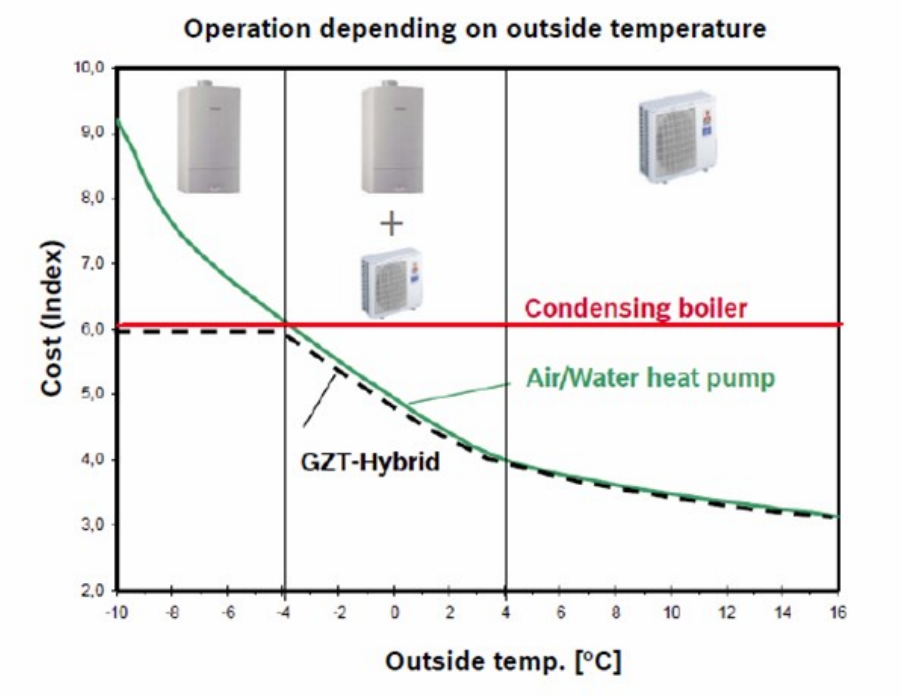
Types of gas hybrid heat pumps

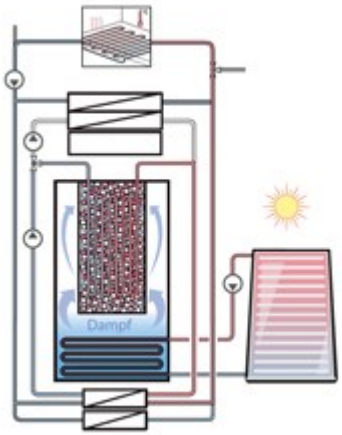
1: Electrical HP and gas boiler sold as a package solution
2: Electrical HP sold as a add-on to an existing gas boiler
3: Gas fired adsorption HP (Zeolite)
4: Gas fired absorption HP



Vitocal 200-S und Öl-/Gas-Heizkessel für den bivalenten Betrieb bei der Modernisierung (1 = Vitocal 200-S Außen- und Inneneinheit | 2 = Warmwasserspeicher | 3 = Heizkessel | 4 = Heizwasser-Pufferspericher)

print close





Challenges

- Slow start of the sale of hybrid heat pumps
- Few products on the Danish market
- Expensive products
- The technology is hard to explain for installers
- Needs expert knowledge and backup of installers
- Compability problems between products
- Decreasing oil and gas prices

IEA HPT Annex 40
Heat pump concepts for nearly Zero Energy Buildings

Carsten Wemhöner
Institute of Energy Technology
HSR University of Applied Sciences Rapperswil
EHPS 2015, Nuremberg, October 20, 2015

nZEB projects worldwide

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NET ZEB TASK 40 /ANNEX 52

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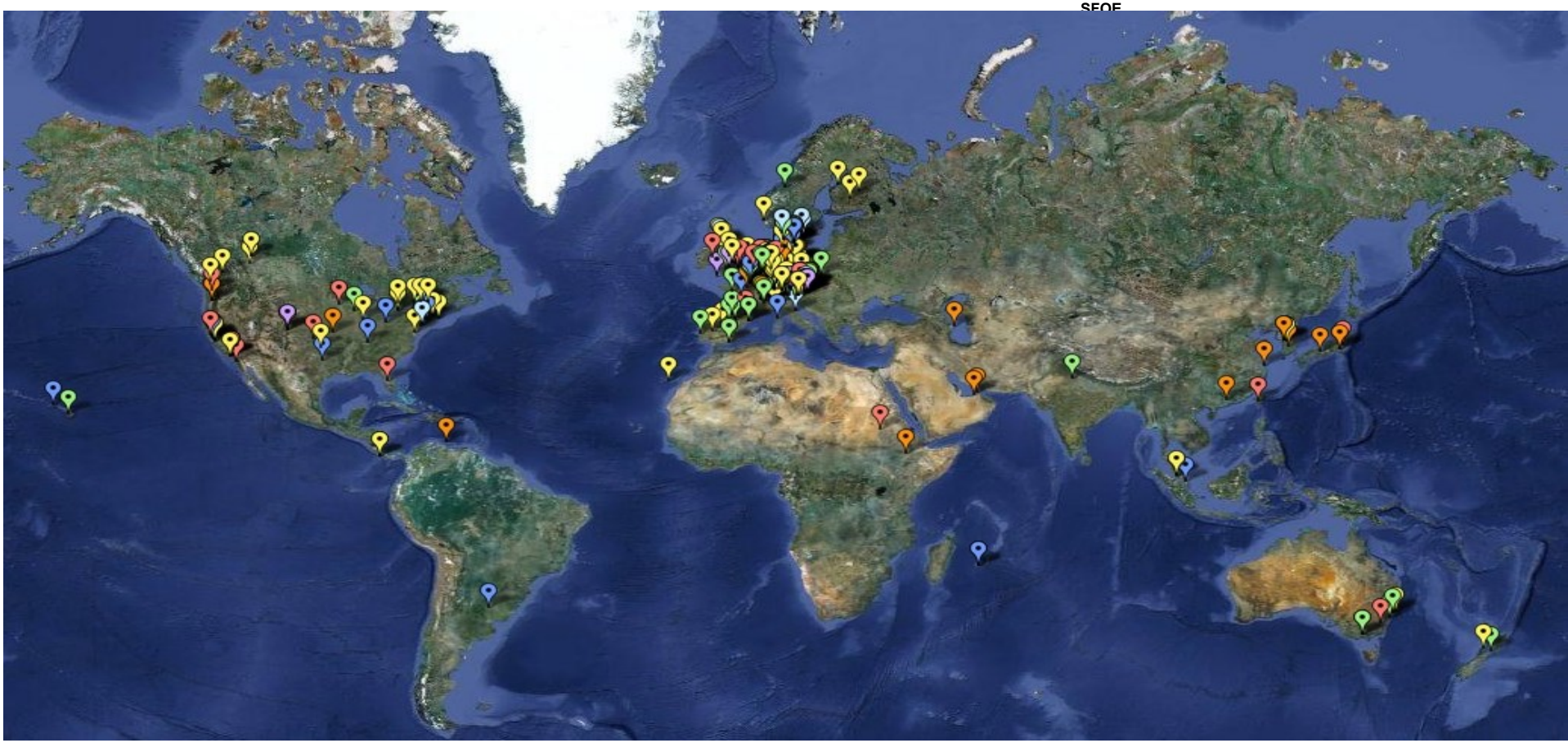
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Swiss Federal Office of Energy SFOE

iea Energy Technology Network



State of Definitions of nZEB in the EU

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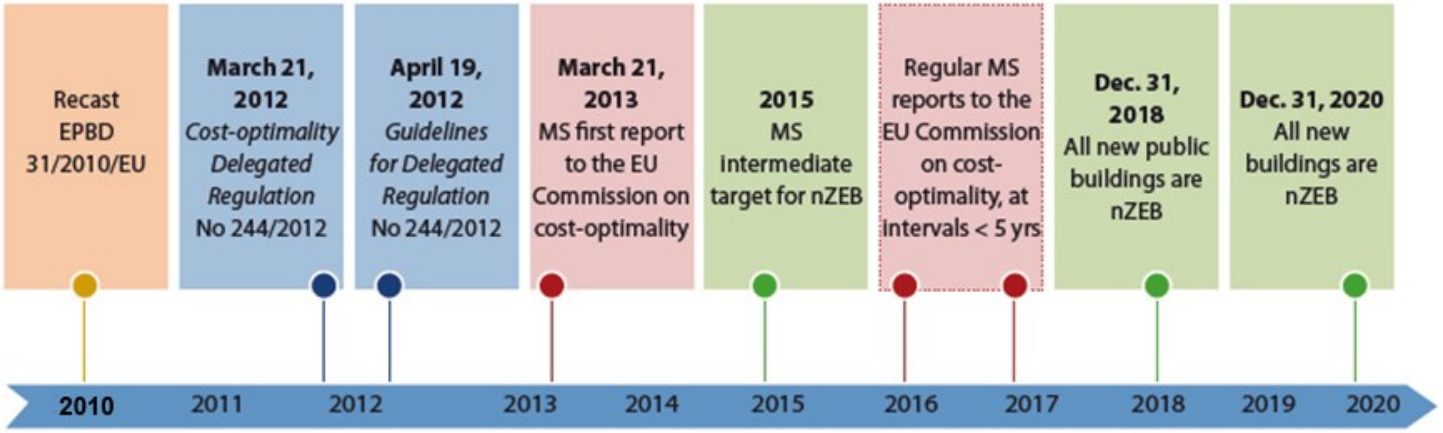
Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Swiss Federal Office of Energy SFOE

DEFINITION "Nearly Zero Energy Building" (nZEB)

- Means a building that has a very high energy performance
- ***Nearly or very low energy amount*** should be covered to a ***very significant extent by energy from renewable sources***, including renewable energy produced ***on-site or nearby***
- **Presently no common definition of nZEB, neither in policy nor in the market**



Quelle: BPIE.

State of Definitions of nZEB in the EU

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Confédération suisse
Confederazione Svizzera
Confederaziun svizra
Swiss Federal Office of Energy SFOE

CEN/REVHA nZEB definition and rating

- "on-site" energy production refers to on the building or building parcel => unique and strong link to the building
- "nearby energy source" refers to a dedicated connection to the building requiring specific equipment
- Renewable energy ratio (RER) is the ratio of renewable to non renewable primary energy

Hurdle 1:
Building needs

Hurdle 2:
Building use
total primary energy

Hurdle 3:
Building use
non-renewable prim. energy

nZEB rating:
Primary energy balance

Quelle: Zirngibl, 2014.

Comparison of concepts

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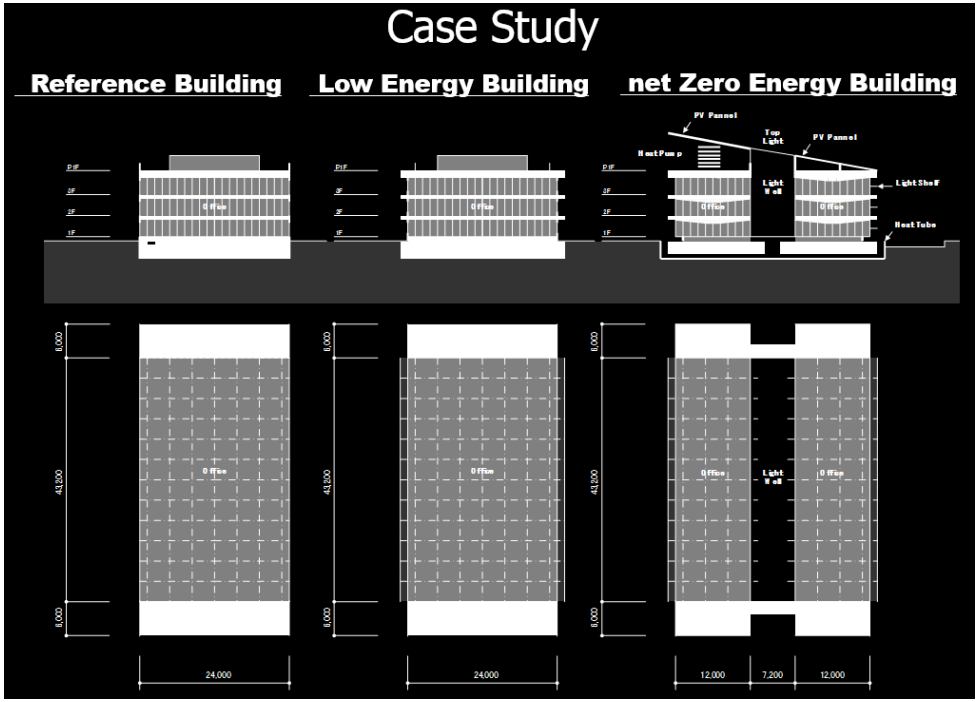
- Case study in Japan for office buildings



Outline Japanese case study

- Comparison of three building types
- Reference building with conventional layout and technology
- Low energy building with improved building envelope
- nZEB with improved daylighting, high performance appliances and electric lighting and PV generation system on the roof

Comfort Evaluation Tool

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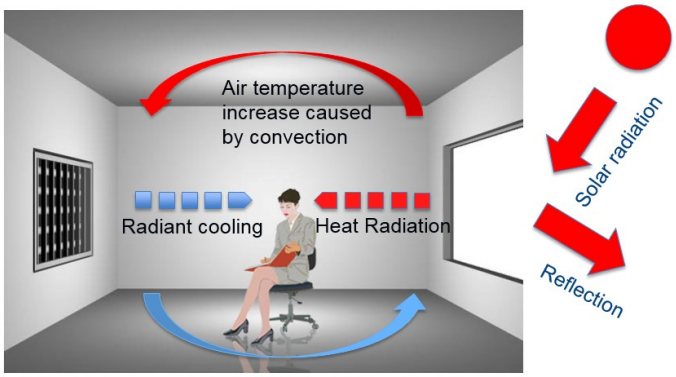
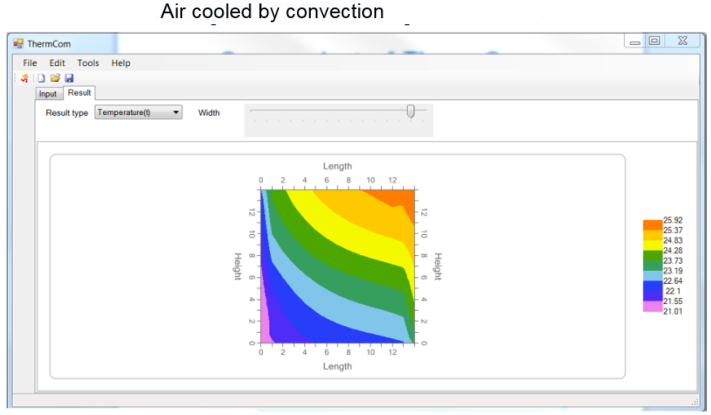
- University of Maryland



Air cooled by convection



Comfort evaluation tool for room emission

- Motivation: low supply temperature for HP
- Radiative cooling/heating panels evaluation
- Reduced order model based on 3-D CFD investigation
- Software offers comfort evaluation of 3-D room
  - equipped with radiative panels
  - equipped with conventional ceiling mounted Air conditioning outlets
- Thermal comfort simulation in automotive cabin (mid-sized sedan)

NZERTF

NIST National Institute of Standards and Technology U.S. Department of Commerce

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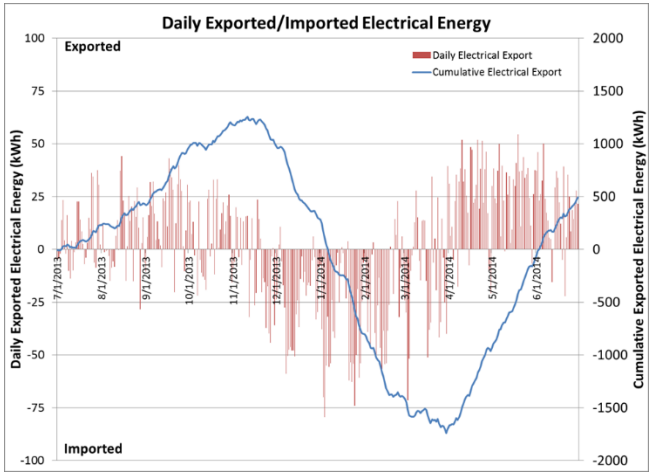
iea Energy Technology Network

- Test platform for NZEB technologies at NIST
  - NZEB residential testing facility on the NIST campus
  - Test house built according to NZEB design
  - Test house equipped with tunable loads in order to realise arbitrary load patterns
  - Real-world testing of NZEB equipment, which can be installed in the test house
  - NZERTF is operated for two years since 2013
  - First year energy balance resulted in a plus energy house
  - Further research dedicated to indoor air quality and respective technology



source: NIST

Conclusion of IEA HPT Annex 40

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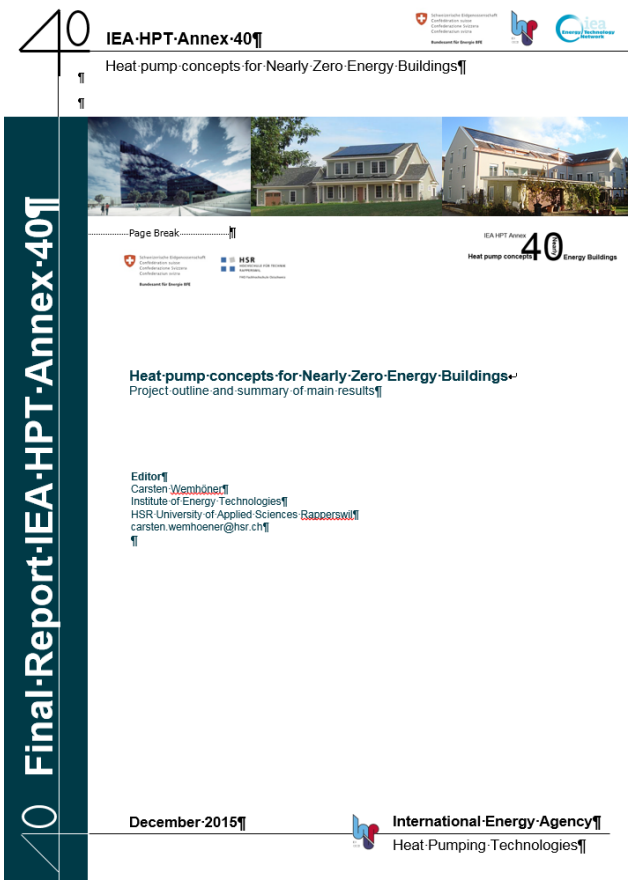
Swiss Federal Office of Energy SFOE

- **Final reports currently in preparation**
- ExCo Review until March 2016
- Implementation of comments afterwards
- Final approval on HPT ExCo spring meeting
- **Reports to be published by June 2016**



Industrial screw compressor heat pumps

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Kenneth Hoffmann, M.ScE
GEA

Heat pump range

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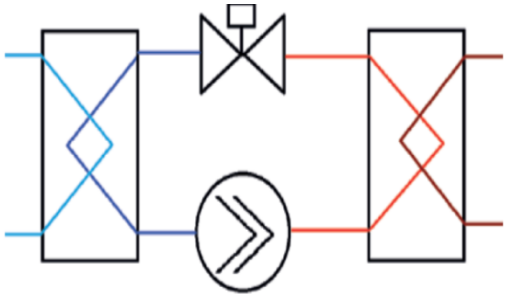
With screw compressors



20+ years service life

300 – 15,000 kW heating duty

35°C to 82°C hot water (on request up to 90°C)

22 models

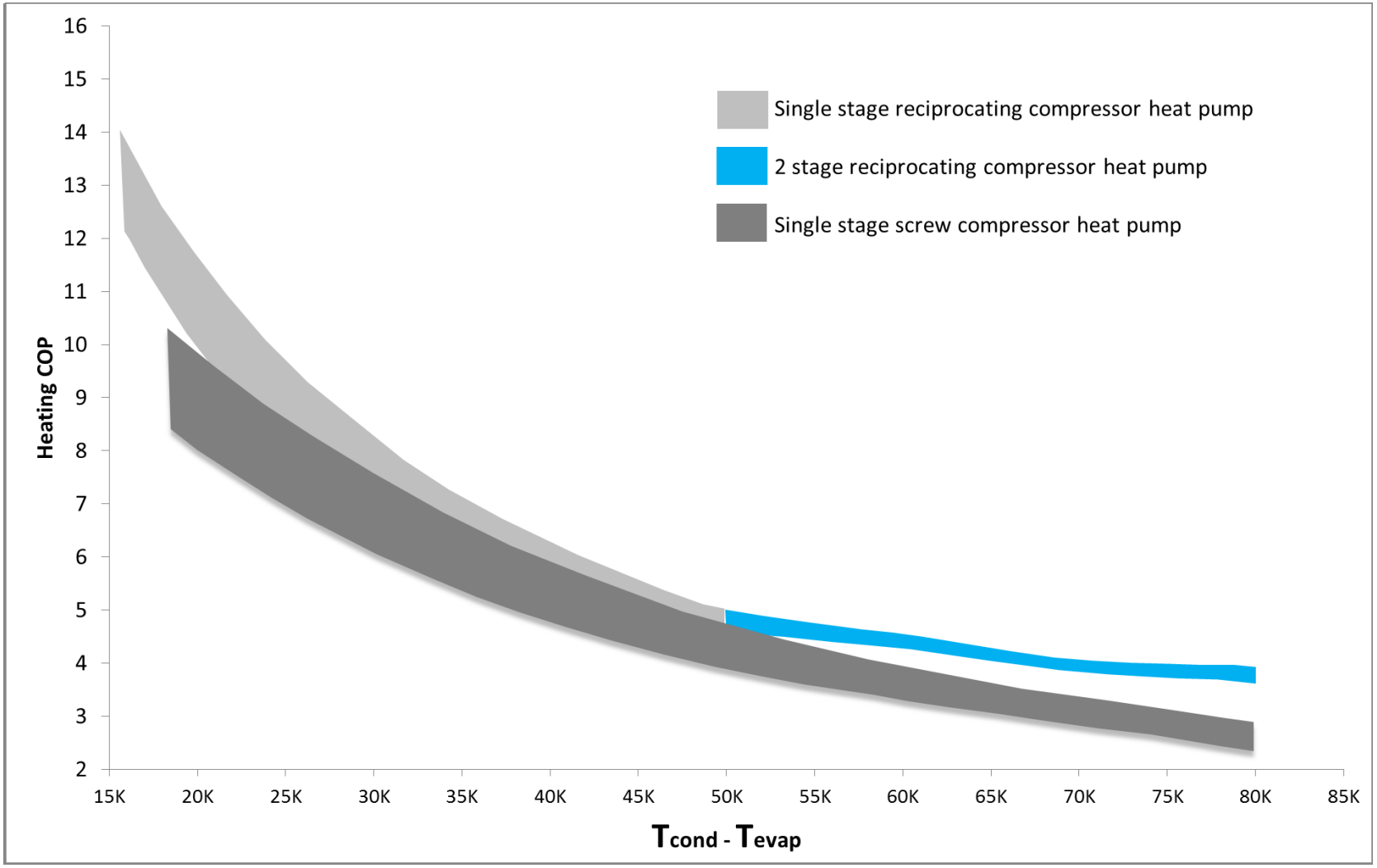
Low mainte-nance

High reliability

VSD

28, 40, 52 or 63 bar design

Screw vs Piston heat pumps



Reference

- Installation: Sweden
- Heat pump:

  - VSD Drive 50 – 100% duty
  - With subcooler
  - Hot water temperature: 40 → 78°C
  - Chilled water temperature: 20 → 10°C
  - Heating duty 560 kW
  - Cooling duty 380 kW
  - COP $_{Heating}$ 3,11
  - L x B x H: 5000 x 1200 x 2100 mm
  - NH3 charge: 110 kg

Title: Multi biomass energy driven absorption heat pump in Hjorring, Denmark

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Hu Haidong, Sales Manager
Broad Europe

Broad absorption heat pump in Hjorring, Denmark

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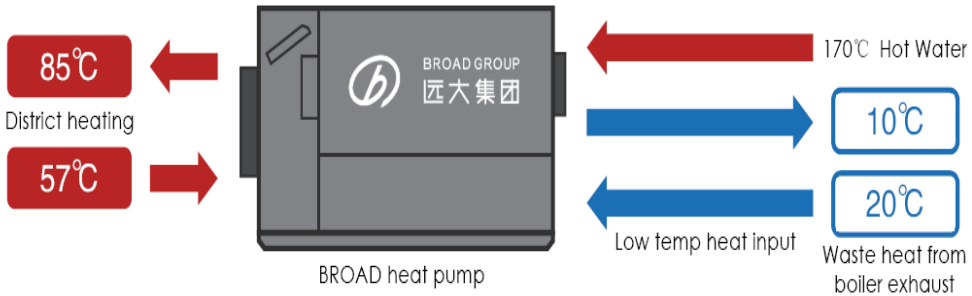
The biggest biomass heat pump project in Europe.

Fatory witness test before shipment.

- BROAD heat pump recycles the waste heat from the flue gas of biomass boiler to provide district heating and lower the flue gas temp.
- Heating capacity 13,000 kW
  Heating efficiency 130%
- Cooling capacity 3,000 kW
- Payback period 3.0 years
- Yearly energy saving 697,800 m3 NG
- Yearly CO2 cutting 1,800 ton
- Equivalent of planting 98,000 trees

BROAD Hot Water Driven Heat Pump

Energy Efficiency: Heating + Cooling 160%



System diagram of Biomass energy driven heat pump

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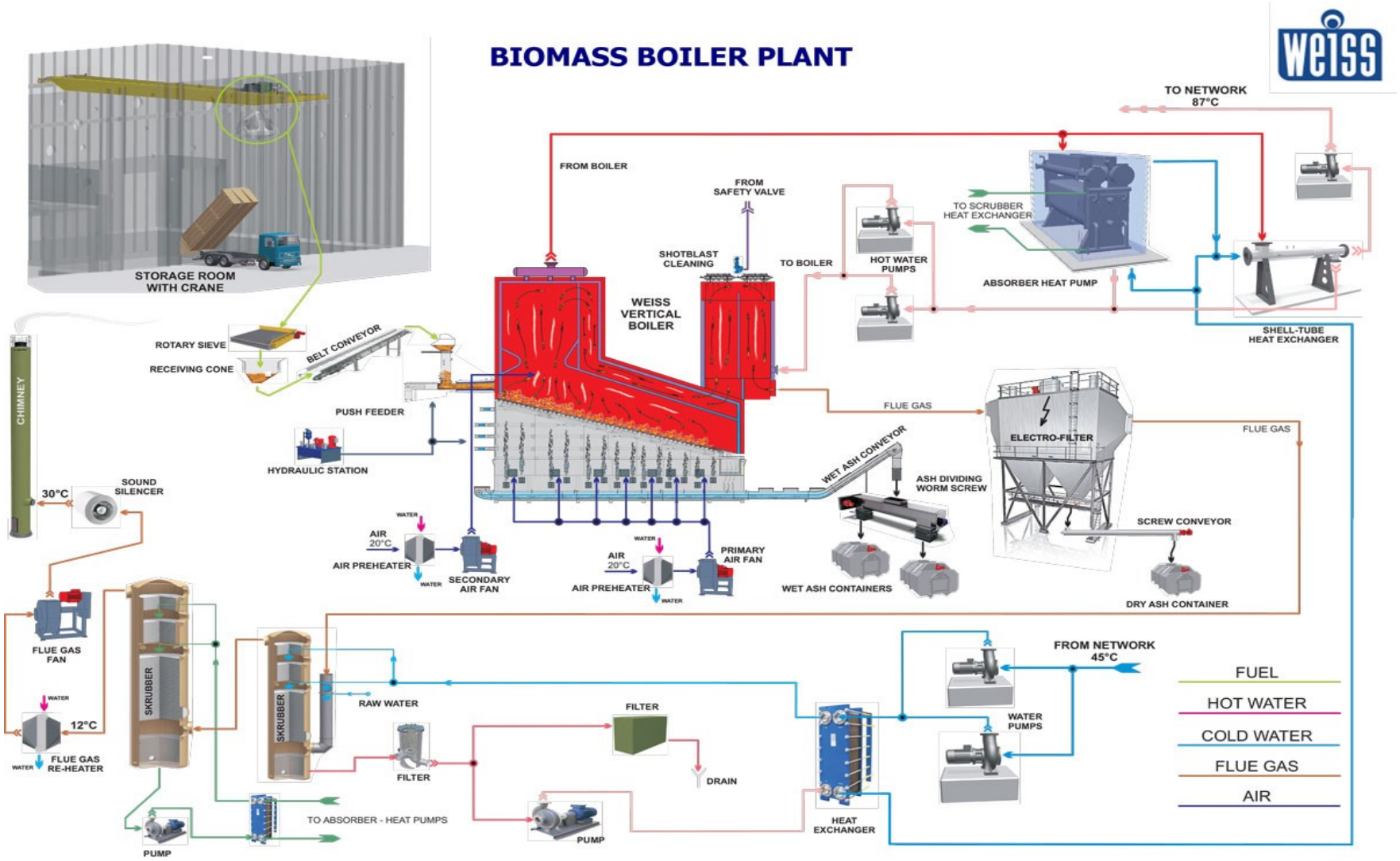


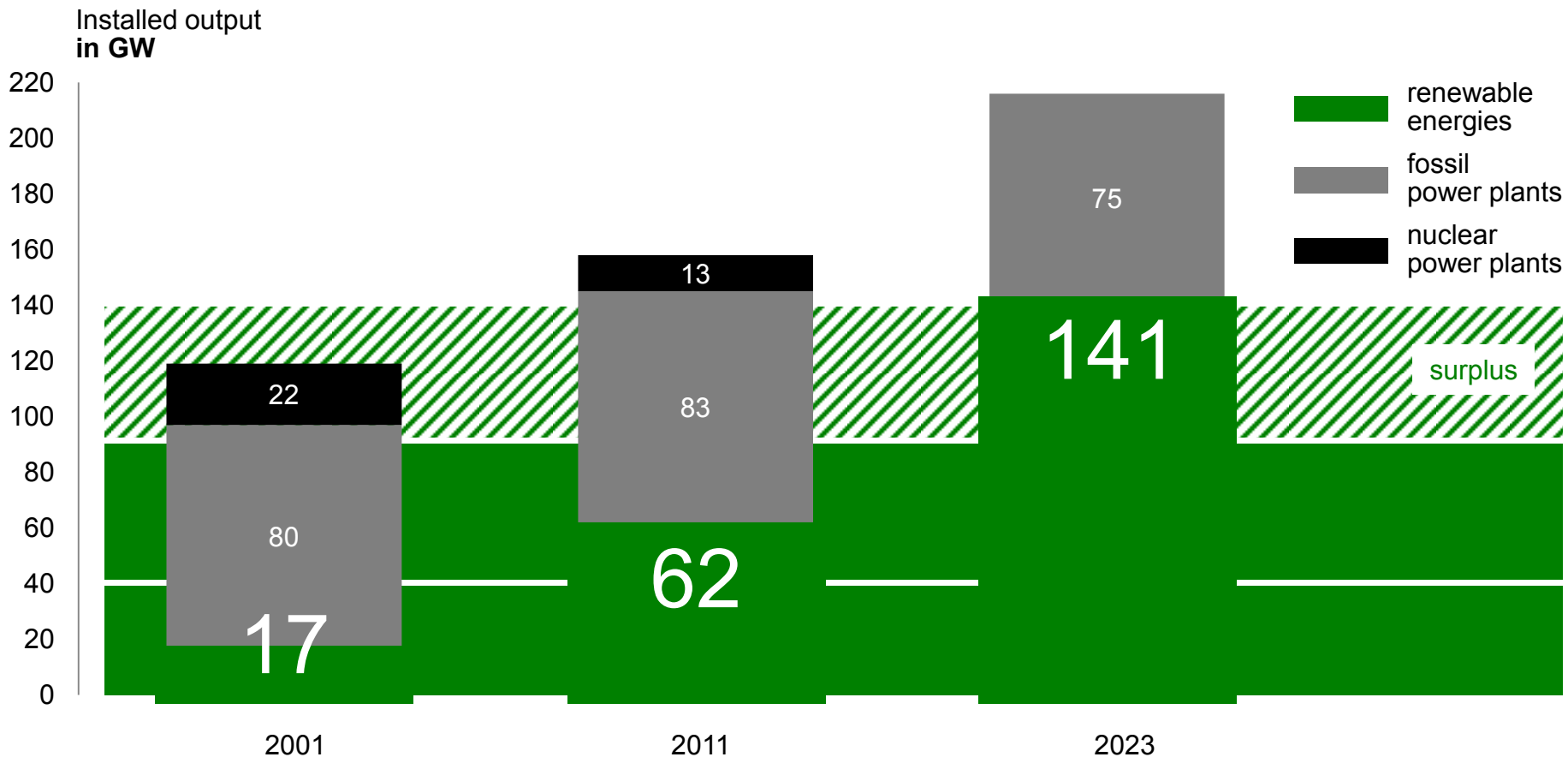
Sven Staudt, Training Manager - Glen Dimplex Deutschland

Glen Dimplex DEUTSCHLAND

Power to Heat
Smart Energy Management

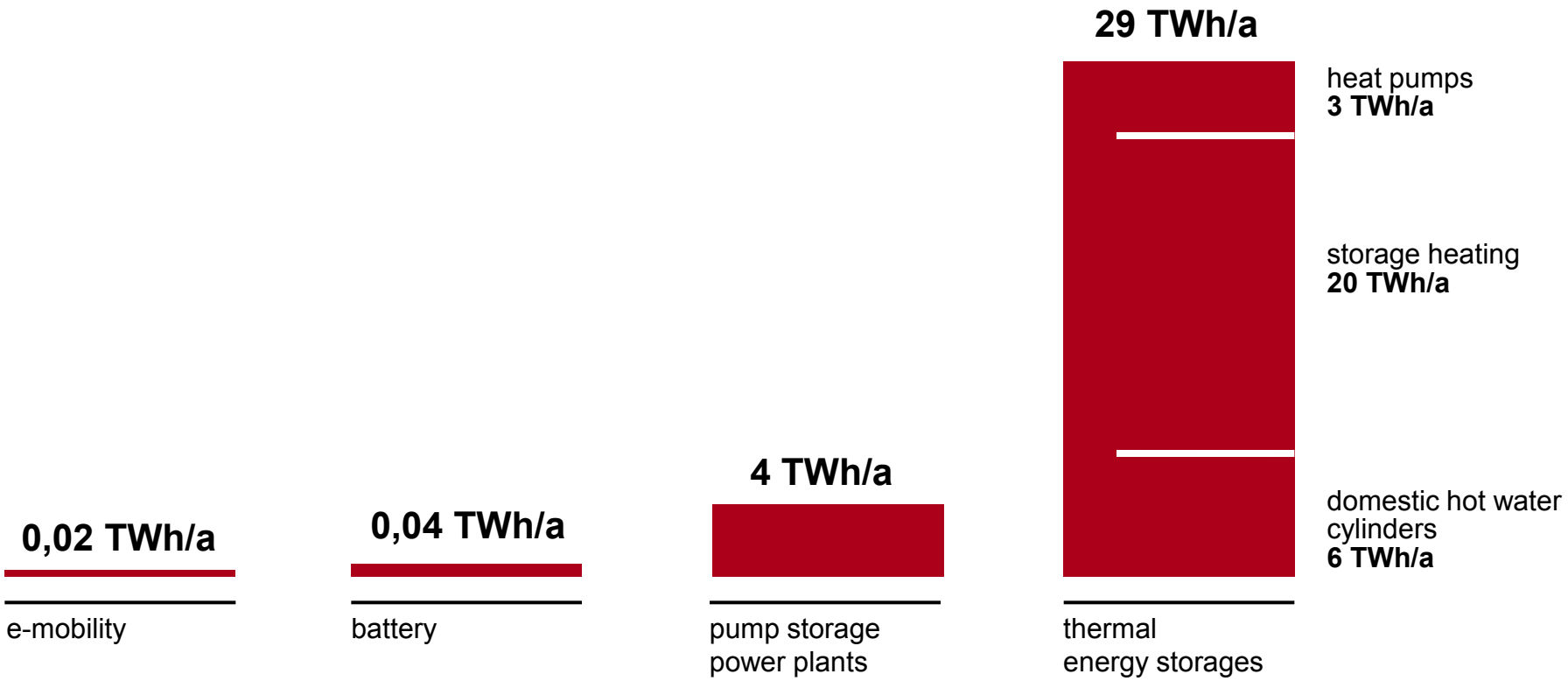
Installed power plant output.

At this stage renewable energies produce a surplus of useful, electric power.



Storage capacity in comparison.

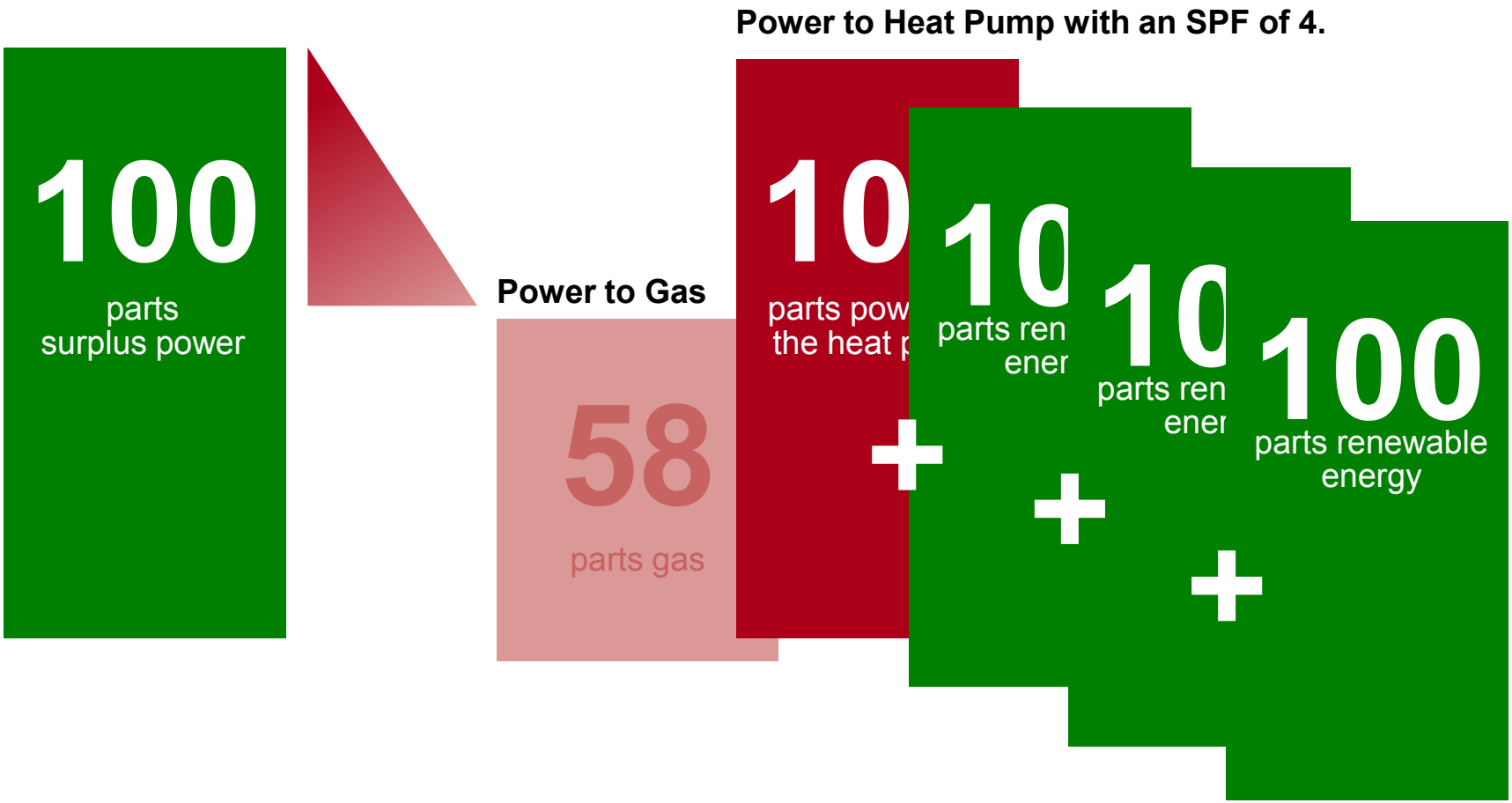
Thermal storages offer the highest currently available storage capacity.



Quelle.
E-Mobilität: Wikipedia, Batterie: Wikipedia,Thermische Speicher: Fraunhofer IBP, Bericht ES-342 01/2012 und BWP-Branchenstudie

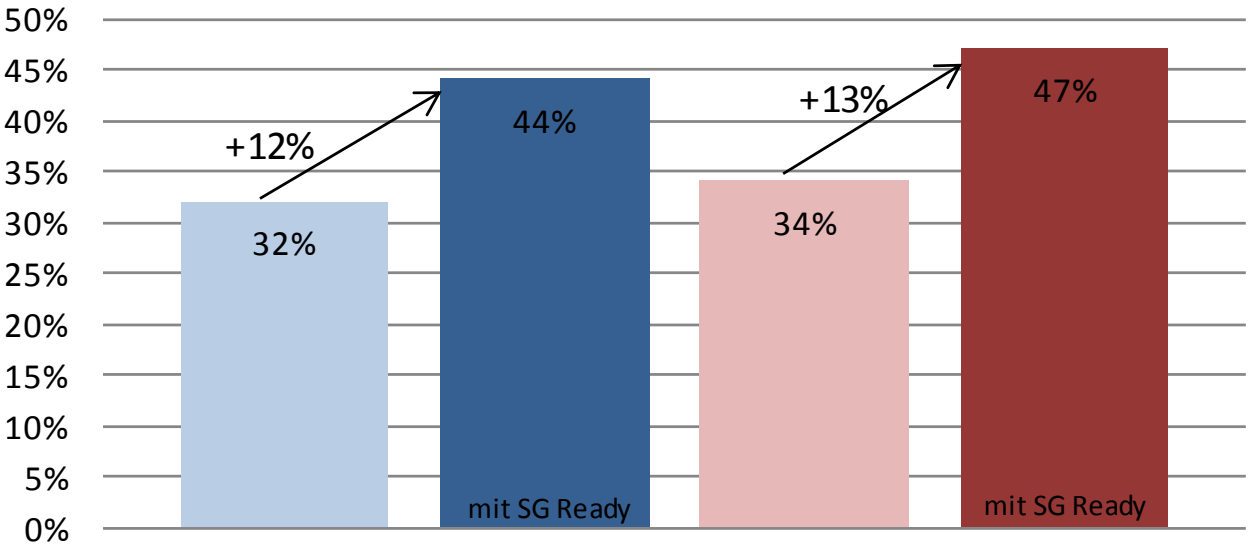
Power to Gas vs. Power to Heat (Pump).

The conversion from power to heat with a heat pump is unbeatable in efficiency.



By the way...
Heat pumps with Smart Grid functionality do it better.

Coverage ration Solar PV system and heat pump



Air source LA 6TU

Ground source SI 6TU

SG ready pushes efficiency.
By enabling the SG ready functionality (means increasing DHW temperature and increasing the room or return set temperature) the coverage ratio of the PV system can noticeably be increased.

The best place for heat is under your feet.
Additional buffer cylinder vs. floor heating system.

700ltr. buffer cylinder
temperature rise of **25 K**
~ 20 kWh

- High flow temperatures reduce the efficiency (2,5 % per 1 K)
- Additional heat losses
- Additional investment cost

air source Heat pump
with 10 kW capacity

150m² floor heating
temperature rise **2 K**
~ 20 kWh

- Low flow temperatures
- No extra investment cost
- Little influence on the room temperature
- Ideal for Utility block times
- Smart room thermostats

The opportunities of the energy revolution.
Summary.

01
The energy revolution happens on the thermal energy market

02
Heating and domestic hot water preparation offer the highest potential for the short term

03
The SG Ready functionality as a technical standard for load-variable tariffs as well as for solar PV systems offers the possibility to integrate heat pumps as thermals storages

04
By the use of smart energy management systems all possible storages can be enabled

05
The storage of renewable electricity as heat (Power-to-heat) is cost-effective already today

Large Scale Absorption Heat Pumps

For Industry, Data Center and District Heating

Based on Lithium bromide units

Daniel Keller

Different types of absorption heat pumps and heat transformer

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We are classifying the Absorption Heat Pumps and Heat transformers into 3 categories

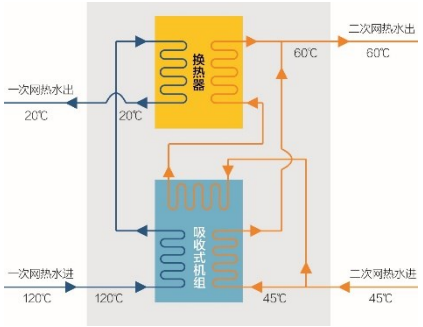
- Heat pumps driven by external heat source such as steam, flue gas, gas burner etc.
  The capacity range from 1MW to 90MW
  max. supply heat 100°C
  COP 1.4 to 2.4

- Heat pumps driven by heat source
  The capacity range from 1MW to 10MW
  max. supply heat 160°C
  COP 0.4 to 0.6

- Heat transformers
  The capacity range from 10MW to 30MW
  Primary 120 to 20°C
  Secondary 45 to 60°C

Heat Pump Class I

Heat Pump Class II



Heat Transformer

Project University of Bern, Switzerland

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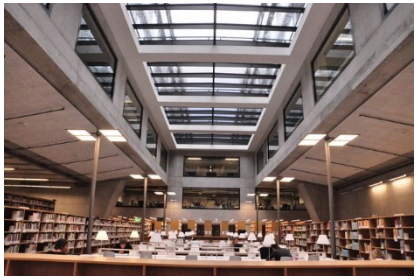
The Building is according to Swiss Standarts Minergie-P (30kWh/m^{2}J)



Original Design for heating was the use of district heating
The cooling for data centre by chillers and free cooling.

To increase the efficency the solution was

Heat Pump Class I

District heating
100%
Driving heat

160 / 125°C

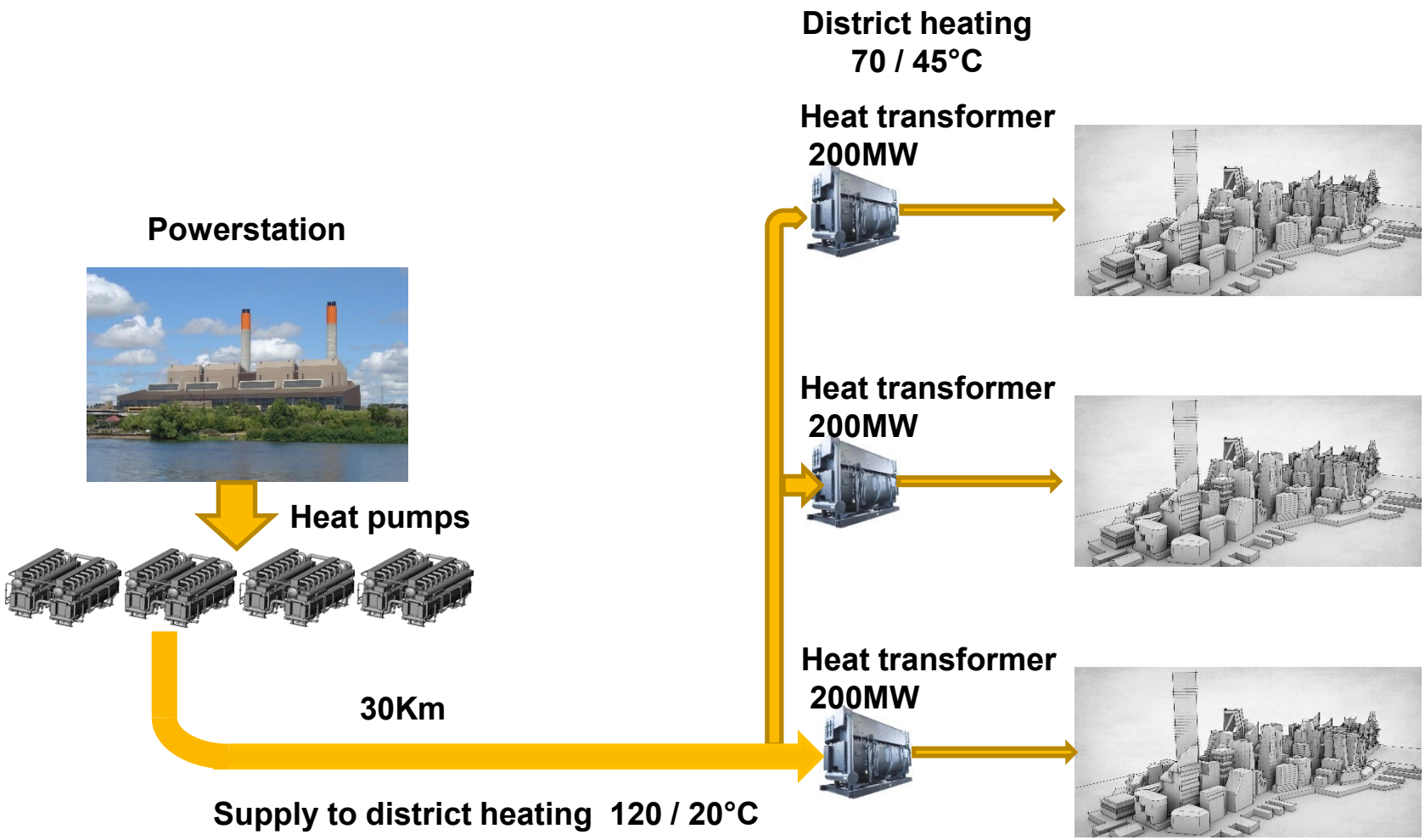
15 / 11°C

Data Center
70%
Heat source

30 / 70°C

Heating 170%
of Driving heat

Heat Transformer



Fuel driven heat pumps – overview technology and markets (IEA HPT Annex 43)

Dr.-Ing. Peter Schossig

Dipl.-Ing. Ivan Malenkovic

Fraunhofer Institute for
Solar Energy Systems ISE

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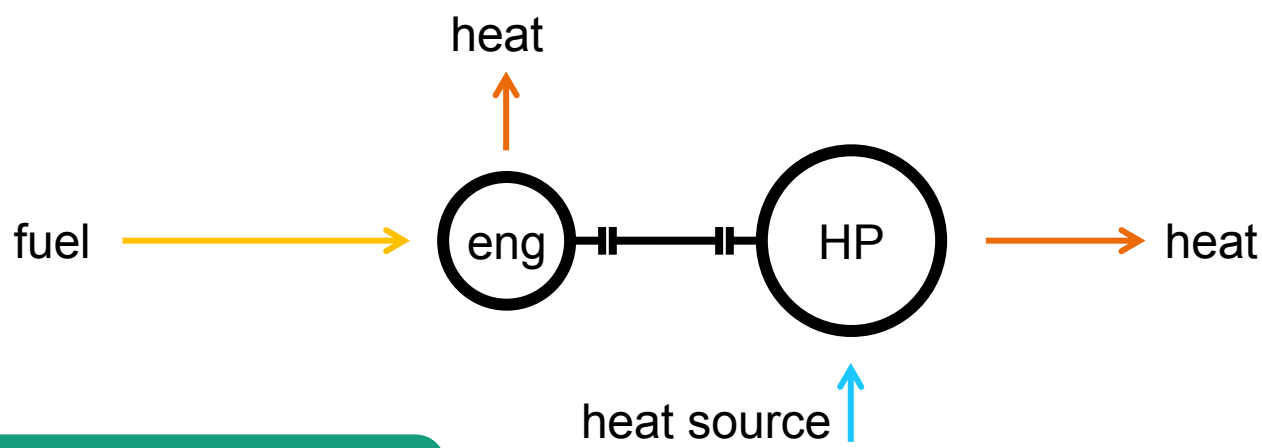
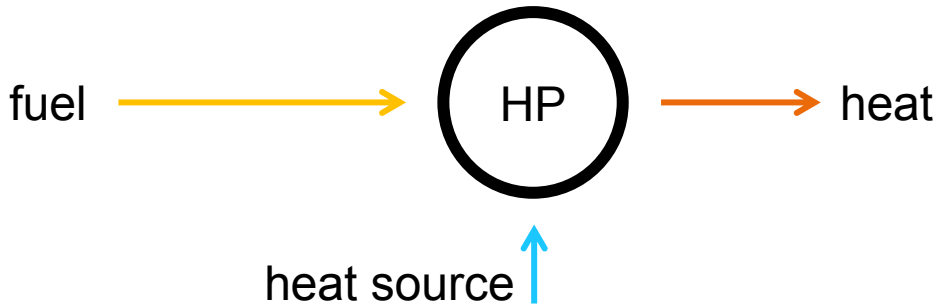
Fuel driven heat pumps



Source: Aisin

Scope of Annex 43



Source: Robur

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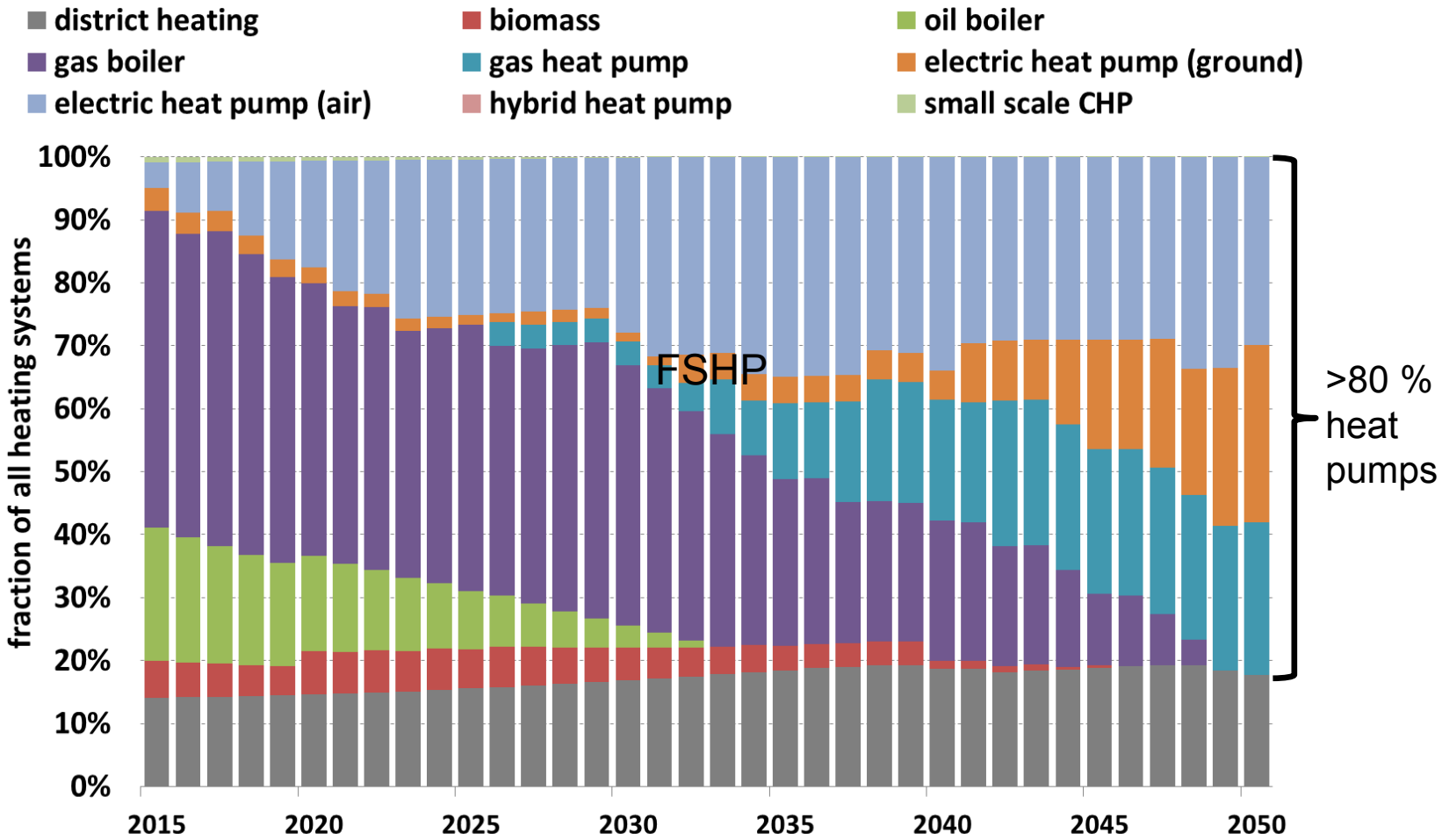
Forecast of the heating market development in Germany

Scenario: -85% reduction in CO_2 emissions; housing stock fully retrofitted until 2040 with 10 % share of passive houses



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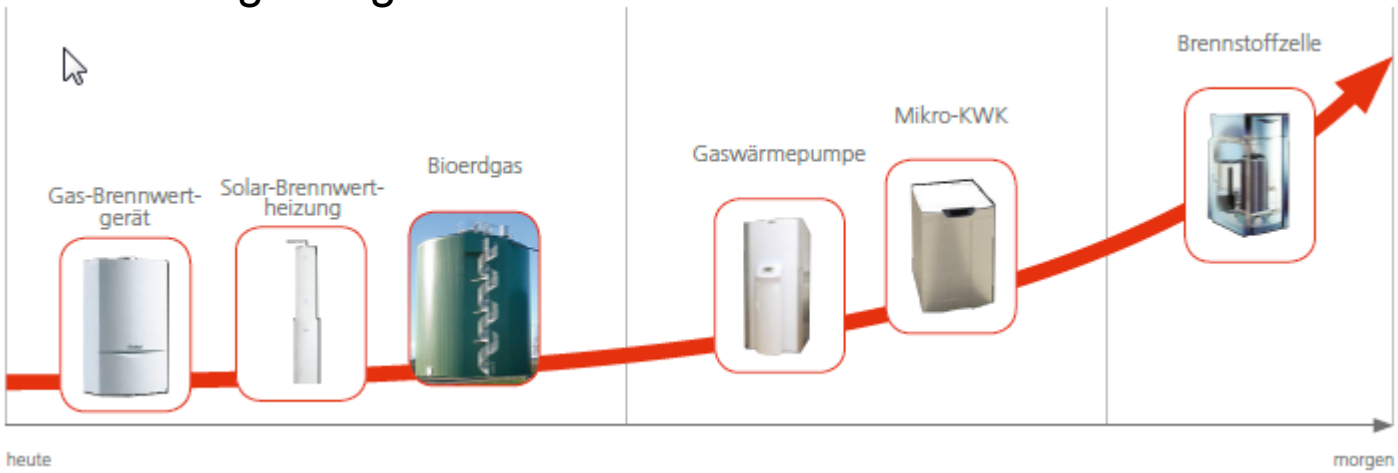
Goals for the development of FSHPs

- FSHP are marketed mostly as „efficient gas boilers“ or „the next generation in gas heating“
- Being well suited for the delivery of heat in higher temperature areas and needing smaller heat sources, the predominant application is retrofit or boiler exchange
  - Small in size and easy to connect and operate
  - Suitable for in-house installation
  - High efficiency and reasonable pay-back times
  - Comparable effort regarding maintenance



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Comparing Gas Driven Heat Pumps to Other Technologies - A Simulation Study

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Marcello Aprile, PhD
RELAB, Dipartimento di Energia
Politecnico di Milano

FSHP Model and Performance

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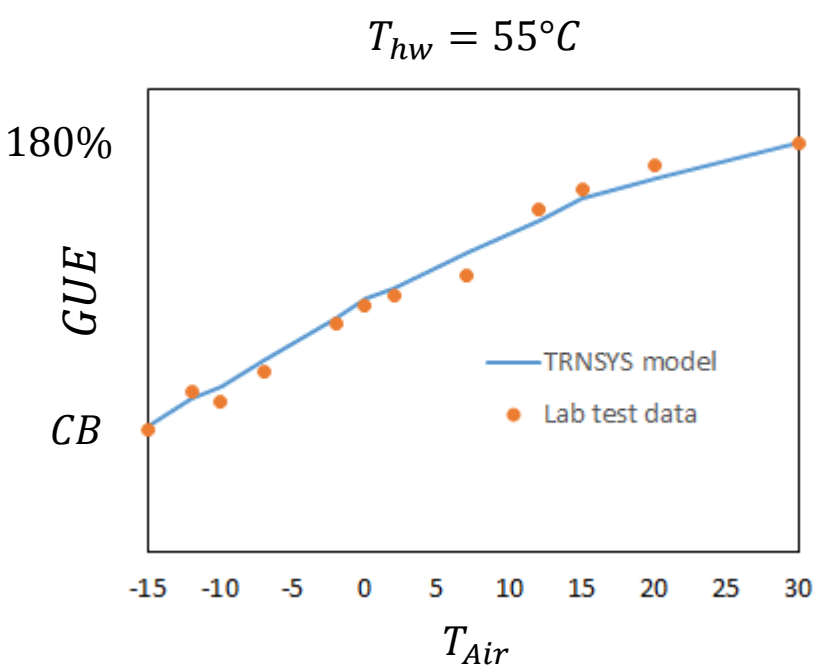
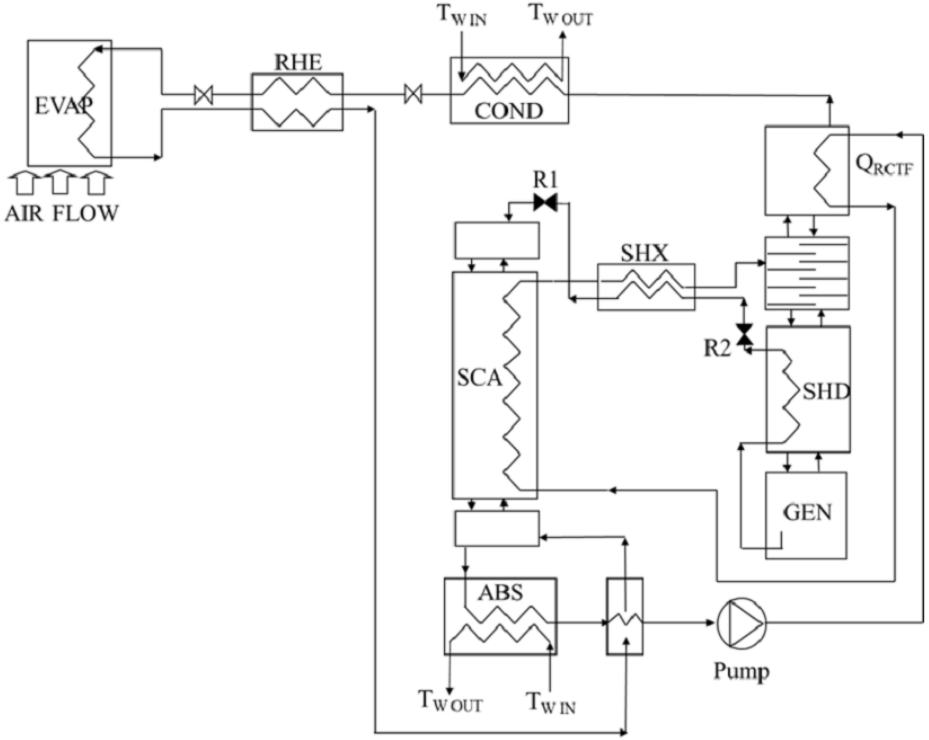
- Gas-Driven Ammonia-Water Absorption Heat Pump
- Air-Source, Gas-Condensing, Nominal Heating Capacity 18 kW
- Lab tested according to EN12309-6 (partial load & defrosting) [1]





[1] ISHPC 2014 (Toppi et al., 2014) - HEAT4U project

Analysis of Simulation Results

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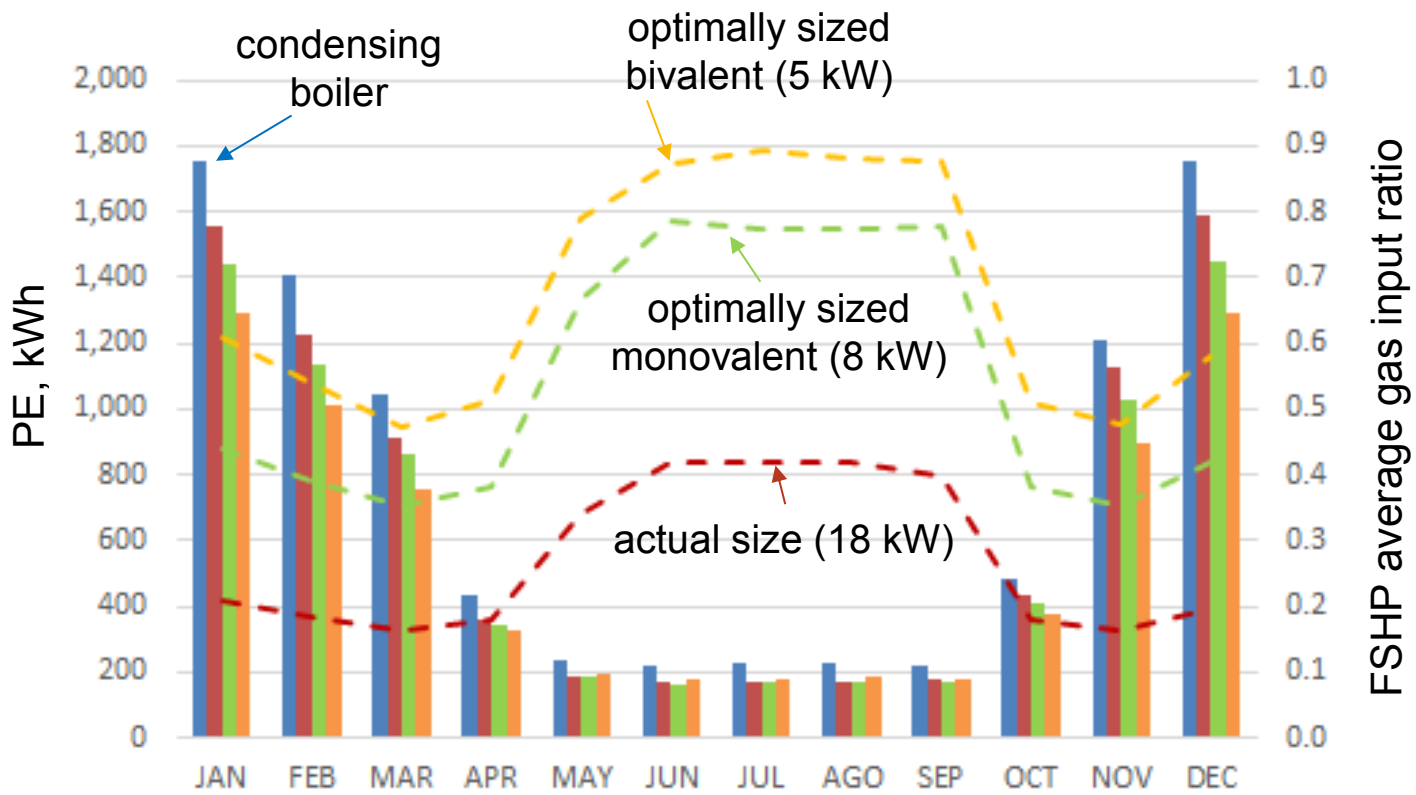
- Impact of Plant Dimensioning

Example
Climate: Average
Building: New



Analysis of Simulation Results

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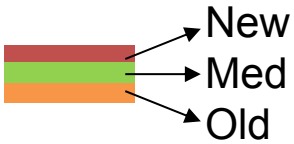
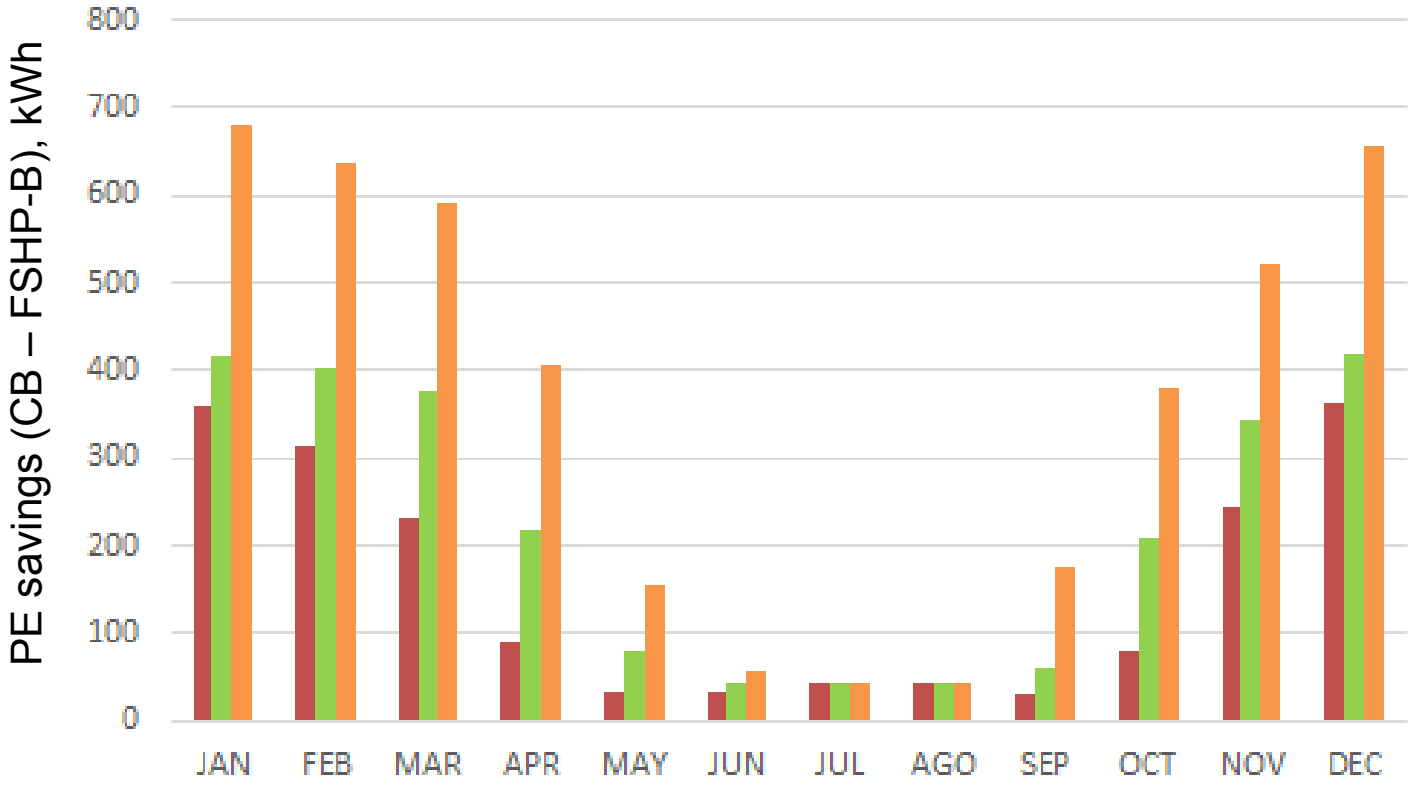
- Impact of Building Class



Example
System: FSHP-B (Bivalent)
Climate: Average



Analysis of Simulation Results

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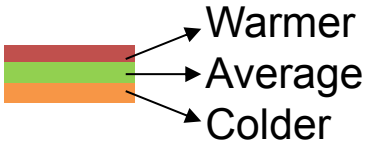
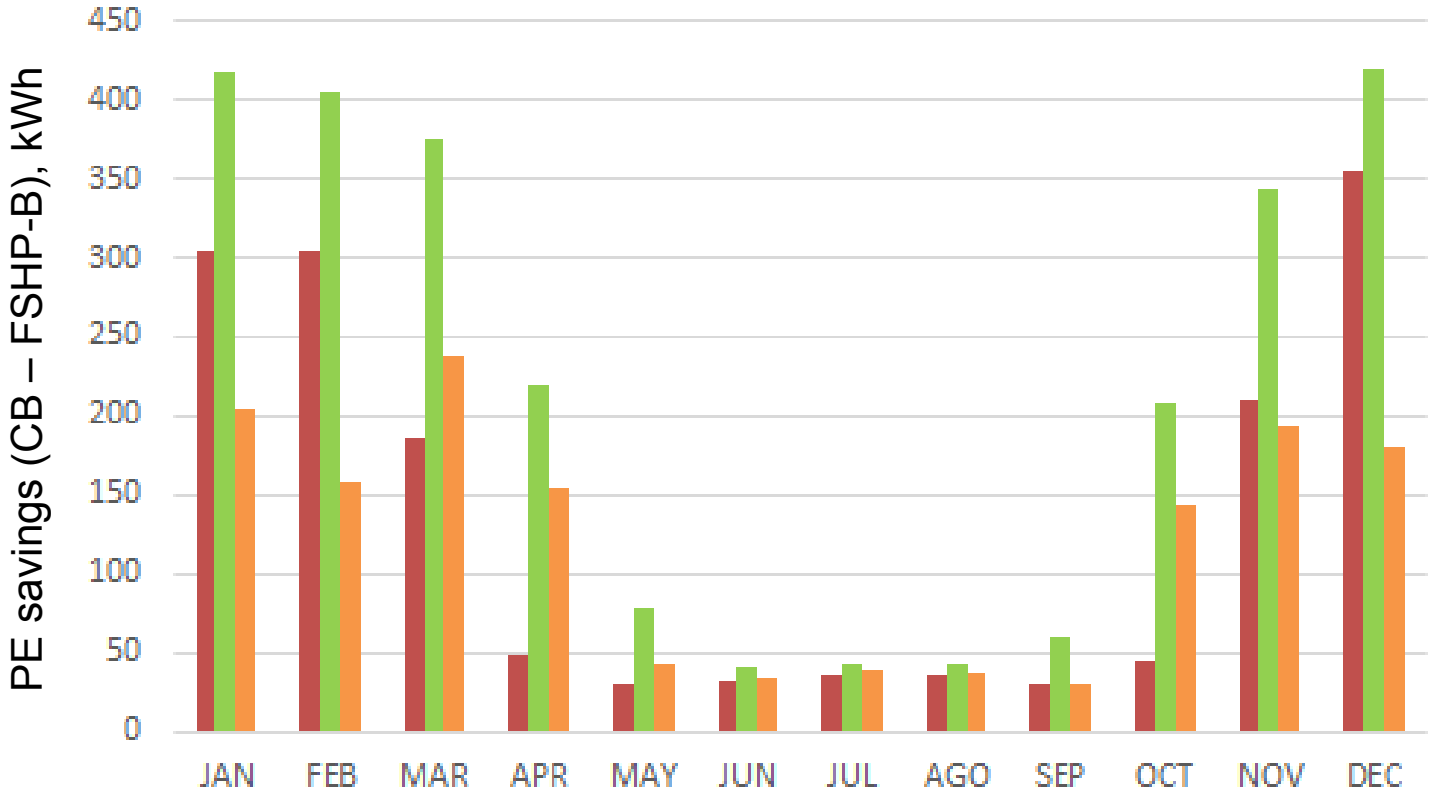
- Impact of Climate



Example
System: FSHP-B (Bivalent)
Building: Medium



Conclusions & Next Steps

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IN CONCLUSION:

- FSHP can achieve good PE and CO2 savings w.r.t. the Condensing Boiler
- FSHP environmentally sound also w.r.t.:
  - Condensing Boiler + Solar Thermal (when SH loads are not too low)
  - EHP + Auxiliary Electrical Heater (when high thermal lifts are needed)

  } Retrofitting applications

BUT:

- In single family homes with moderate SH loads, the energy saving potential is not fully exploited (degradation at partial loads)
- This might be addressed by bivalent FSHP+CB systems or monovalent FSHP with improved efficiency at partial loads

NEXT STEPS:

- Extend the range of analysis to different Climates / Building Classes
- Evaluate Financial Indicators
- Account for Country-Specific Boundary Conditions

Application of gas driven heat pumps and field test results

Axel Albers

HPP Annex 43

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Demonstration object

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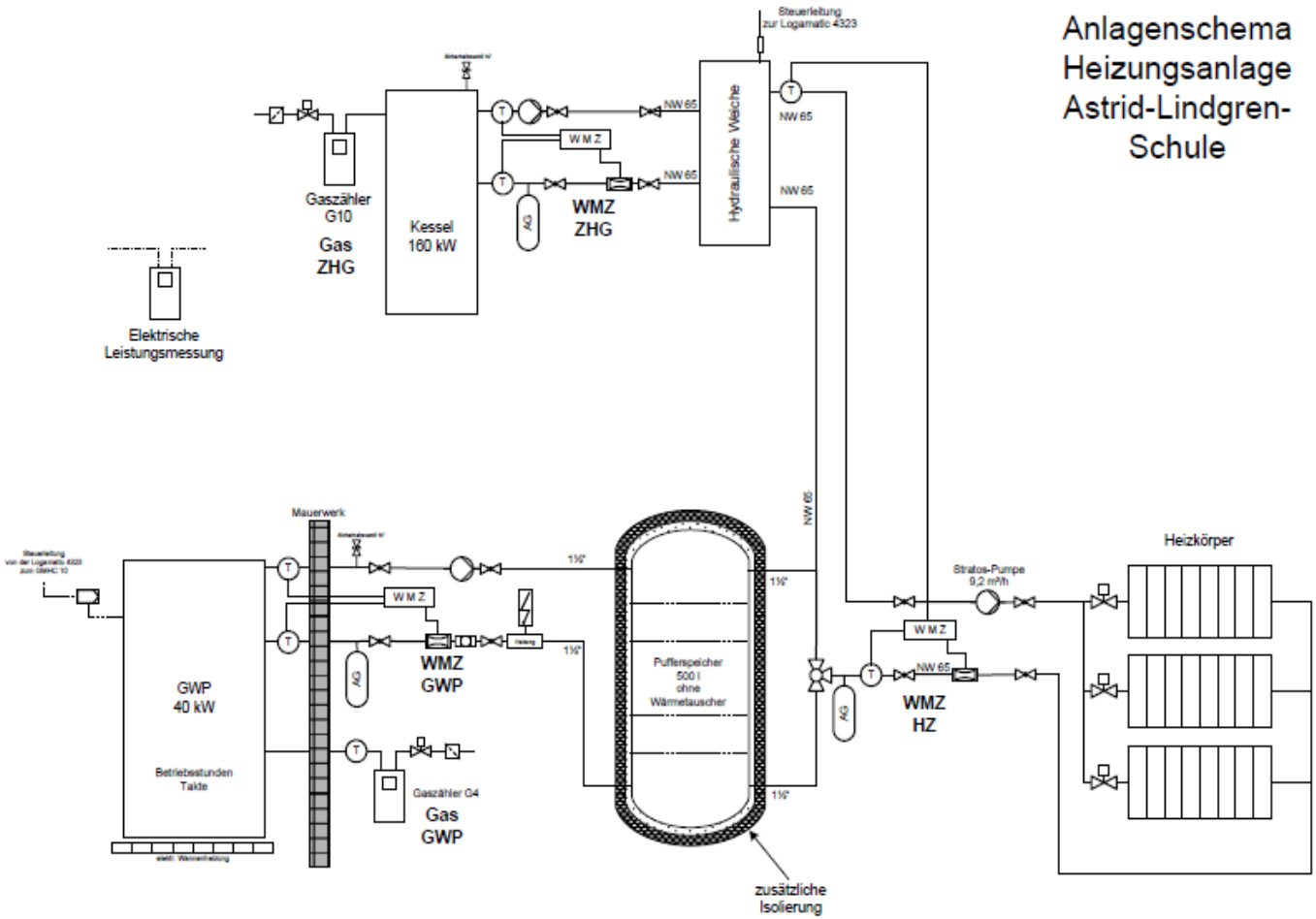
Hydraulic setup



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Results

- Historical data used and compared to monitoring results
- Climate compensated: heating limit degree days,
  Assumption: Heating limit T_HG = 15°C

Time Period	G15 [Kd]	Gas consumption		Saving [%]
		absolute [kWh]	specific [kWh/Kd]	
13.11.2008 - 22.10.2009	1996	187.000	93,7	33%
23.10.2009 - 14.12.2010	2692	282.000	104,8	40%
06.04.2012 - 05.04.2013	2169	136.371	62,9	

Average saving: 37% → target achieved!

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Setting The Standard For Heat Pump Thermal Fluids

Dr Philip J Gray

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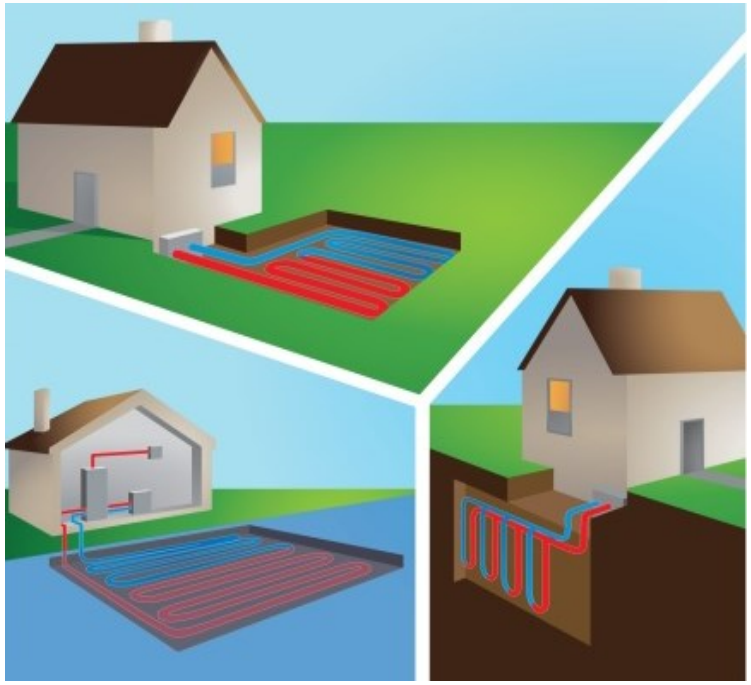
Today's Agenda

Setting the standard on thermal fluids for closed loop ground and water source heat pumps

1. What is a thermal fluid?
2. Importance of thermal fluids
3. Current practices and industry compromises
4. Industry requirements
5. New development: Kilfrost Geo



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Kilfrost GEO®

- Designed for its intended application
- Proves that safety and efficiency are not mutually exclusive
- Removes the need for any compromise

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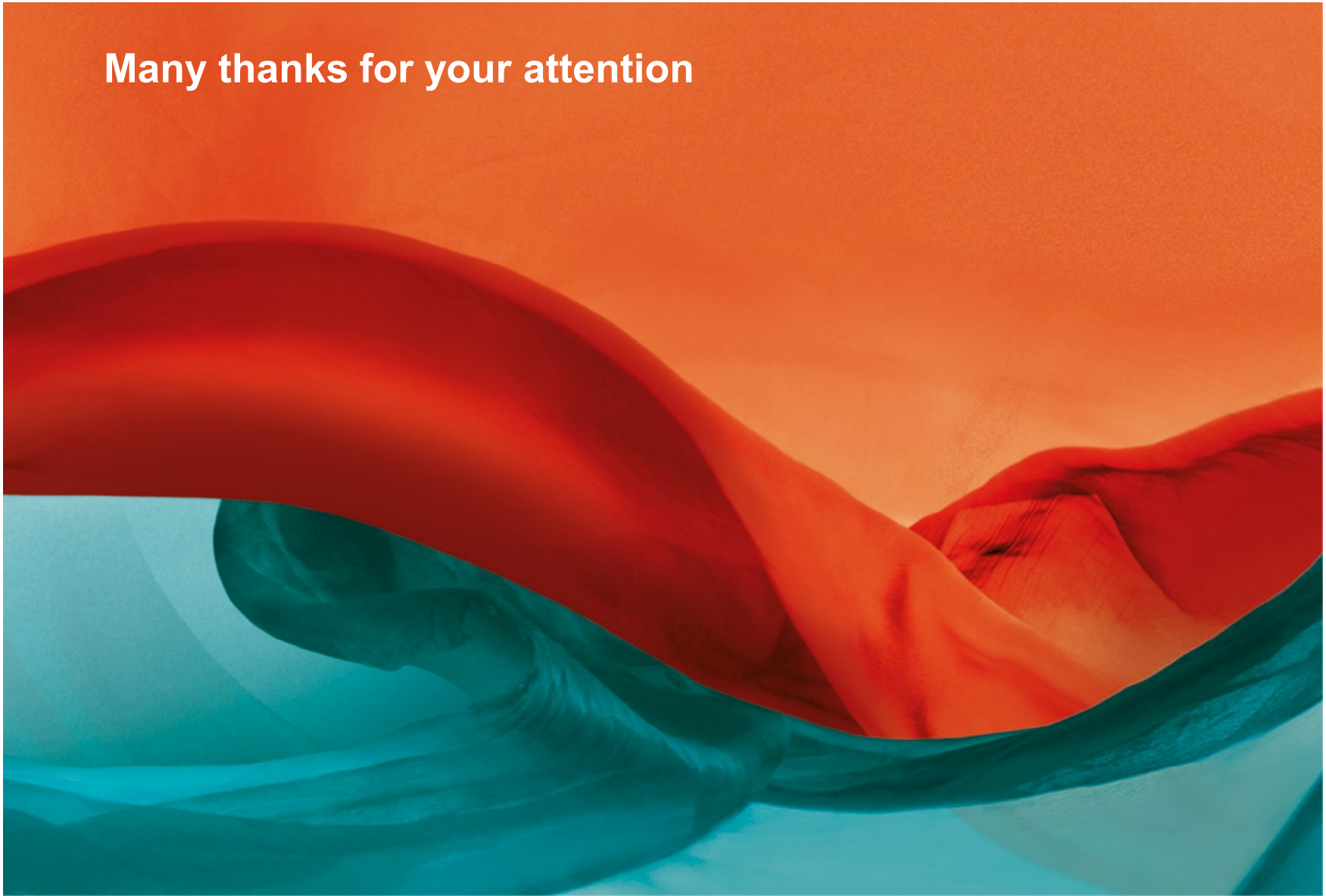
Many thanks for your attention



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