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

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High
Efficiency
Solutions.

CAREL

High efficient residential AHU with active heat recovery

Speaker: Arne Müller
Buisness Developer EU HVACmarket
Carel Deutschland GmbH

Germany: Market data 2014

Luftleistung < 500 m³/h

Zentrale Geräte
ca. 40.000

Geräte mit Wärmepumpe
ca. 6.000

Dezentrale Geräte
ca. 32.000

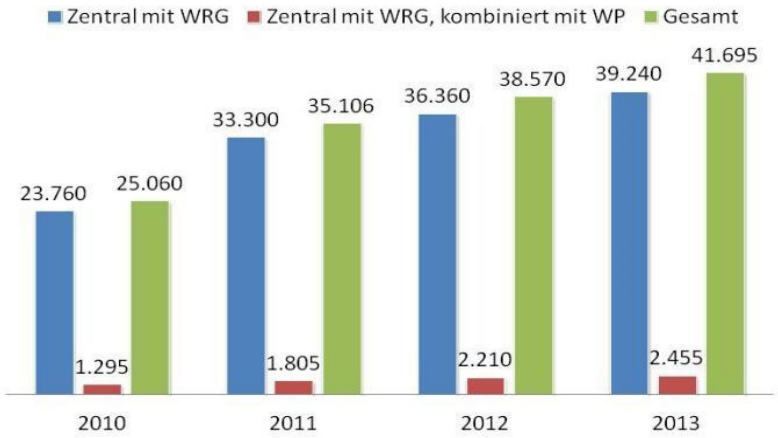
Luftleistung > 500 m³/h

Zentrale Geräte
ca. 20.000 davon 75% mit Wärmerückgewinnung

(1) Zentrale Lüftungsgeräte sind nach Systematik des TZWL Lüftungsgeräte mit Anschluss an ein Kanalsystem. Sie belüften mehrere Räume, eine Wohnung oder ein ganzes Haus

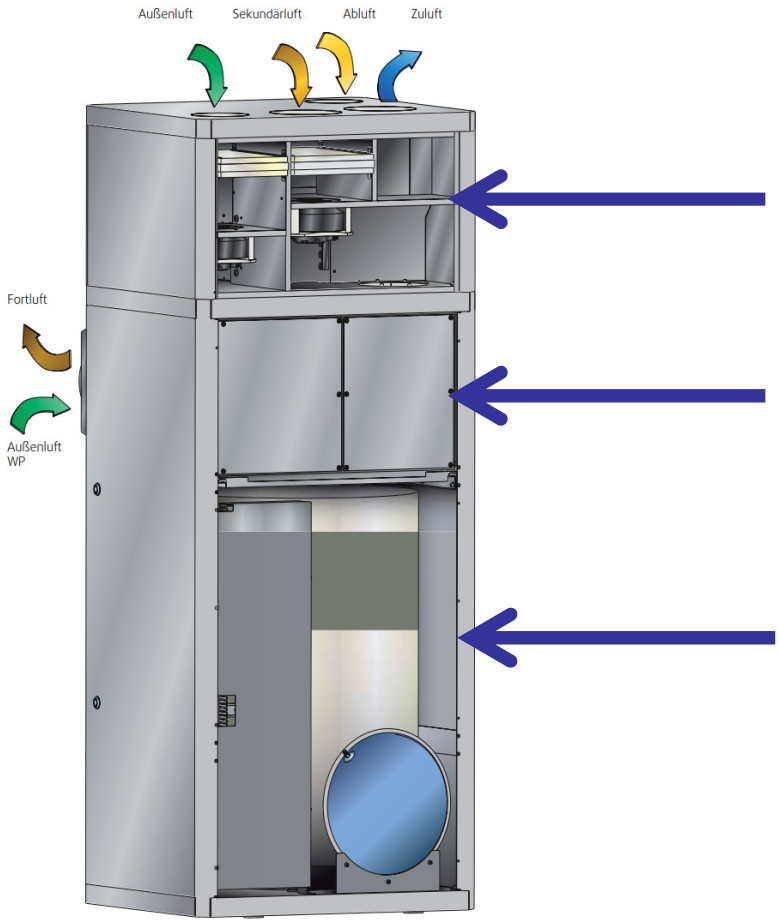
(2) Dezentrale Lüftungsgeräte belüften nach Systematik des TZWL nur einen einzelnen Raum. Nicht enthalten sind hier die sogenannten „Badlüfter" nach DIN 18017-3

Inlandsmarkt für Wohnungslüftung: 2010-2013



Fachverband Gebäude-Klima e.V.

PRODUCT CONCEPT



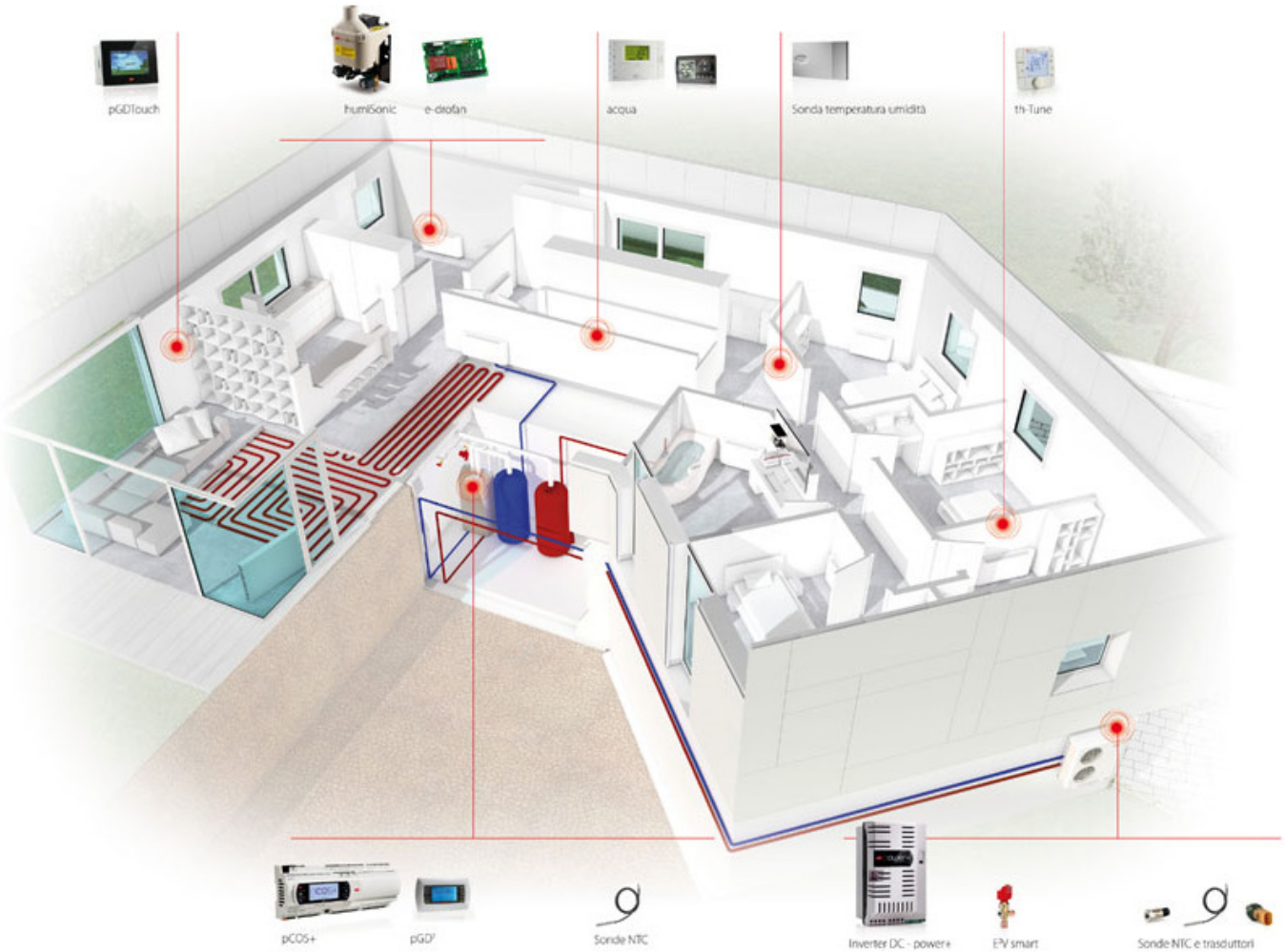
AHU Modul with integration of Humidification

HP Modul with BLDC inverter

Integration of HotWater Tank

Quelle: http://www.systemair.com/Documents/Downloads/Leaflets%20and%20Catalogues/Deutsch/Genius_Planerbroschuere_2014-11_DE_E1456_web.pdf

Full Integration



How to serve the Heat Pump technology at the very best

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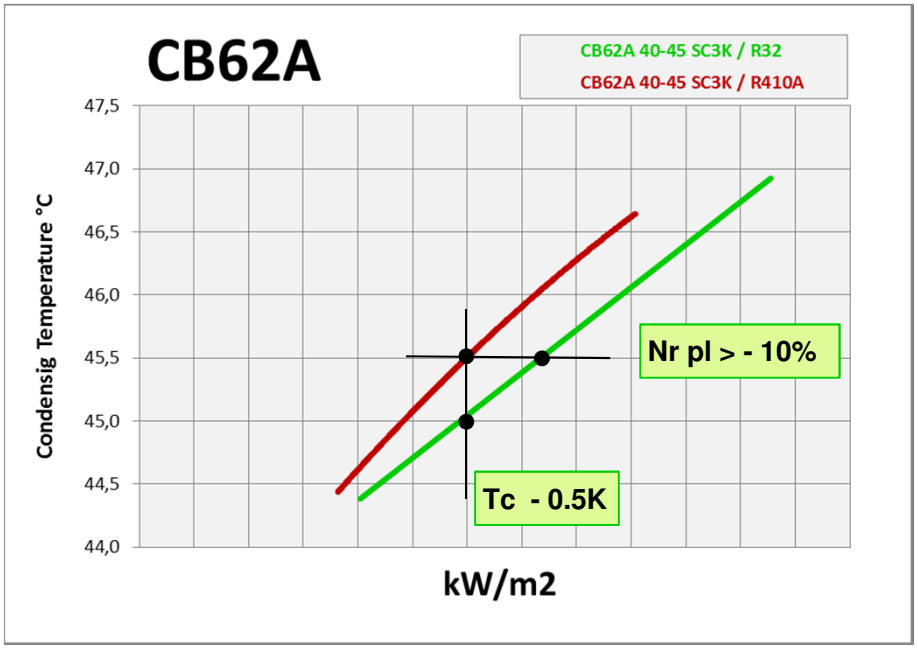
Matteo Munari – Application Development Mgr
Alfa Laval

R32



- **CB62A**
- Mild Asymmetry

- R32 vs R410A gives a **better efficiency** as condenser. We can use the extra efficiency as cost down of the component (less number of plates).

Compressor technology outlook in the HP market
A tiered approach

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Enrico Fraccari
Manager Residential Comfort Marketing
Emerson Climate Technologies

HP Pricing Vs. Boilers

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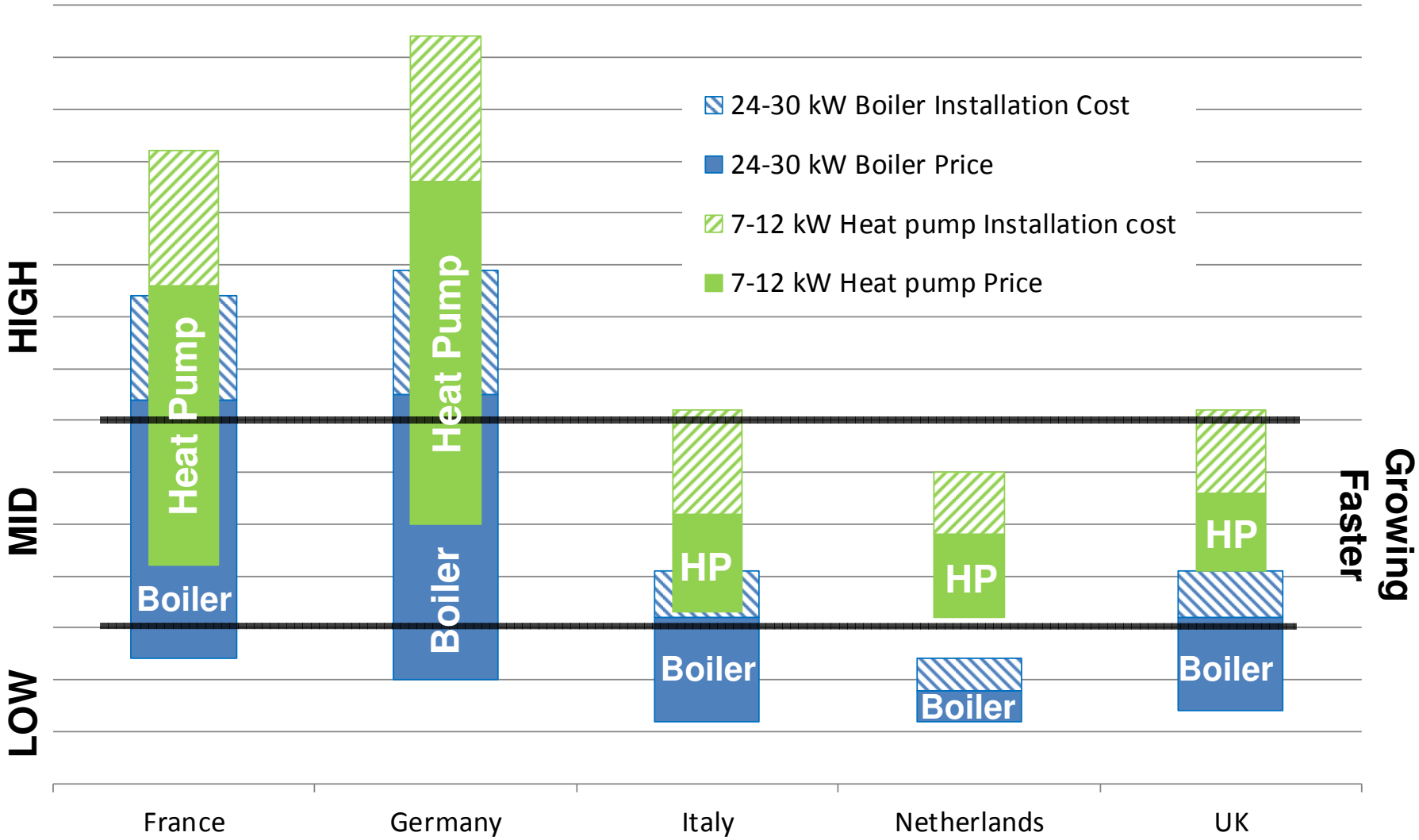

Today electricity/gas price ratio is not favorable for HP

Variable Speed Compressor Technology
Providing high level of expertise

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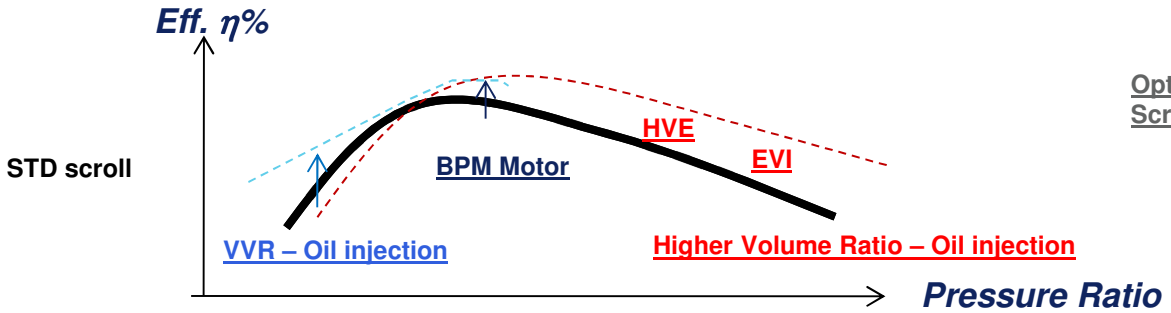
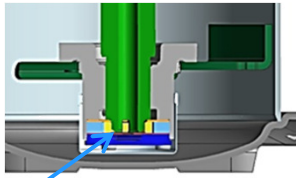
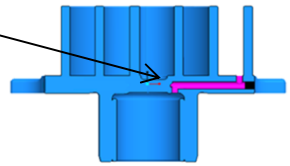
	XHV	ZHW
Scroll Optimization	35ºC Low Temp	55ºC High Temperature
Oil Injection	Yes	Yes
High volumetric Efficiency Valve (HVE)	Yes	Yes
Oil Pump	Yes	Yes
Variable Volume Ratio	No	Yes
Enhanced Vapor Injection (EVI)	No	Yes (wet)
0K suction superheat	Yes	No





Oil Pump
Positive Displacement
- Low Speed Capability

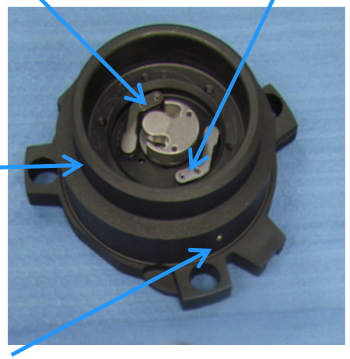
Oil Injection
- Low Speed Performance
- Heating Performance



HVE Valve
- Heat Pump Performance
- Shutdown device (no reverse rotation)

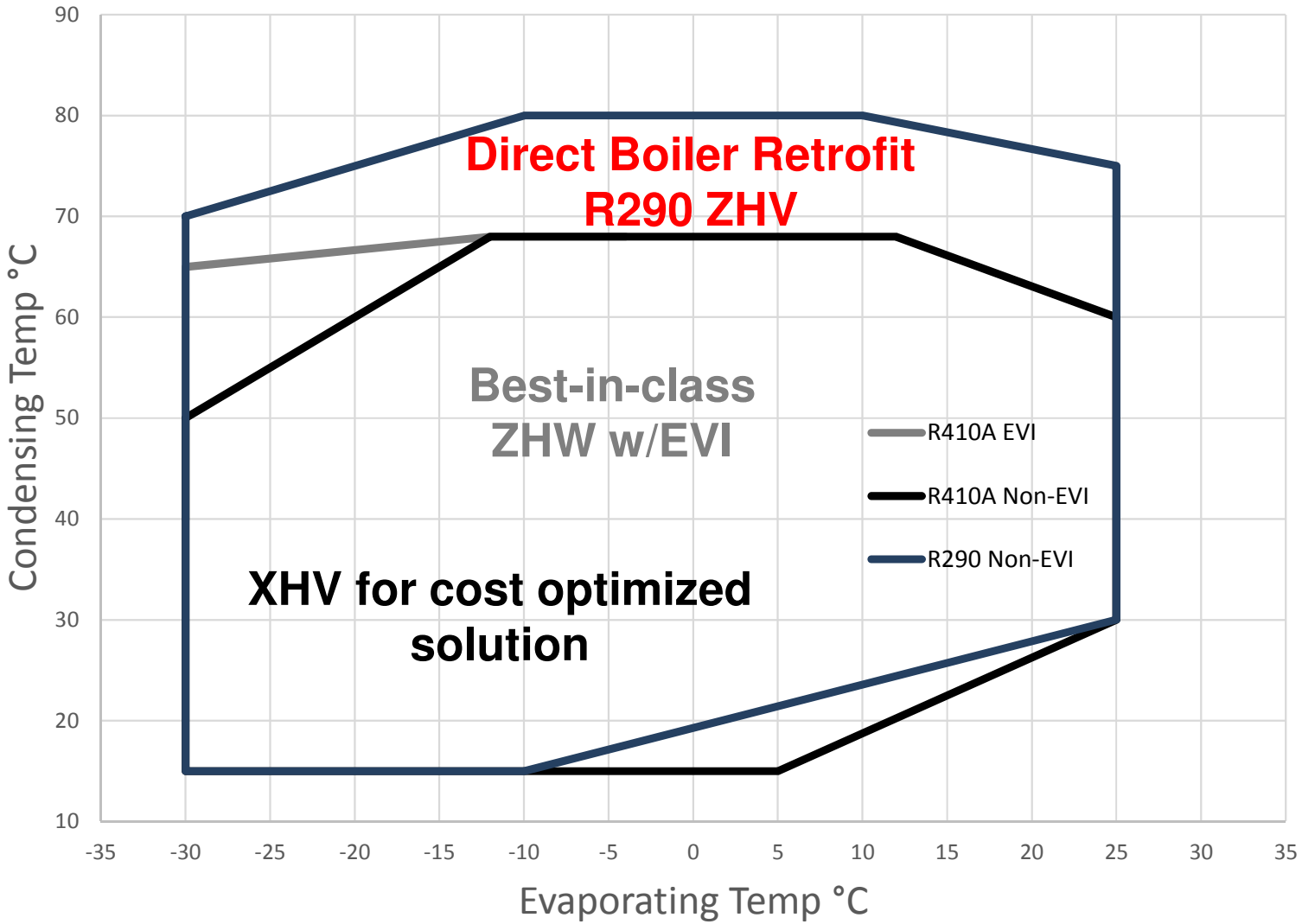
Variable Volume Ratio
- Improve Cooling Efficiency
- Transient Sound (Defrost)

Optimized Scrolls (BIVR)



EVI: Enhanced vapor injection

Compressor Platform Overview



Conclusions

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- Market trends (oil vs. electricity prices, overall economical situation)
- Space heating market overall flat (<2% CAGR)
- A/W gaining market share
- Fast VS technology adoption
- Shift to mid tier price competitive, but high efficiency at 35ºC
- No clear candidate to replace high pressure refrigerant
- R290 viable candidate for long term F-Gas targets
- HP can gain market share in direct boiler replacement

WELCOME

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Best fans for air source heat pumps possible ?!

Dr.Ing. Frieder Lörcher, Basic Research Fans
Dipl.Ing.(FH) Joachim Dietle, Product Management Axial Fans

How to optimize a component on system level?

System Level

interaction with smart electric grids, other energy systems and components as well as control of different system components

Heat Pump Unit

developing, assembling and testing of a 30 kW lab-scale air/water pilot heat pump under stationary and transient conditions

green Heat Pump

Component Level

Refrigerant:
charge reduction and the use of refrigerants with low GWP

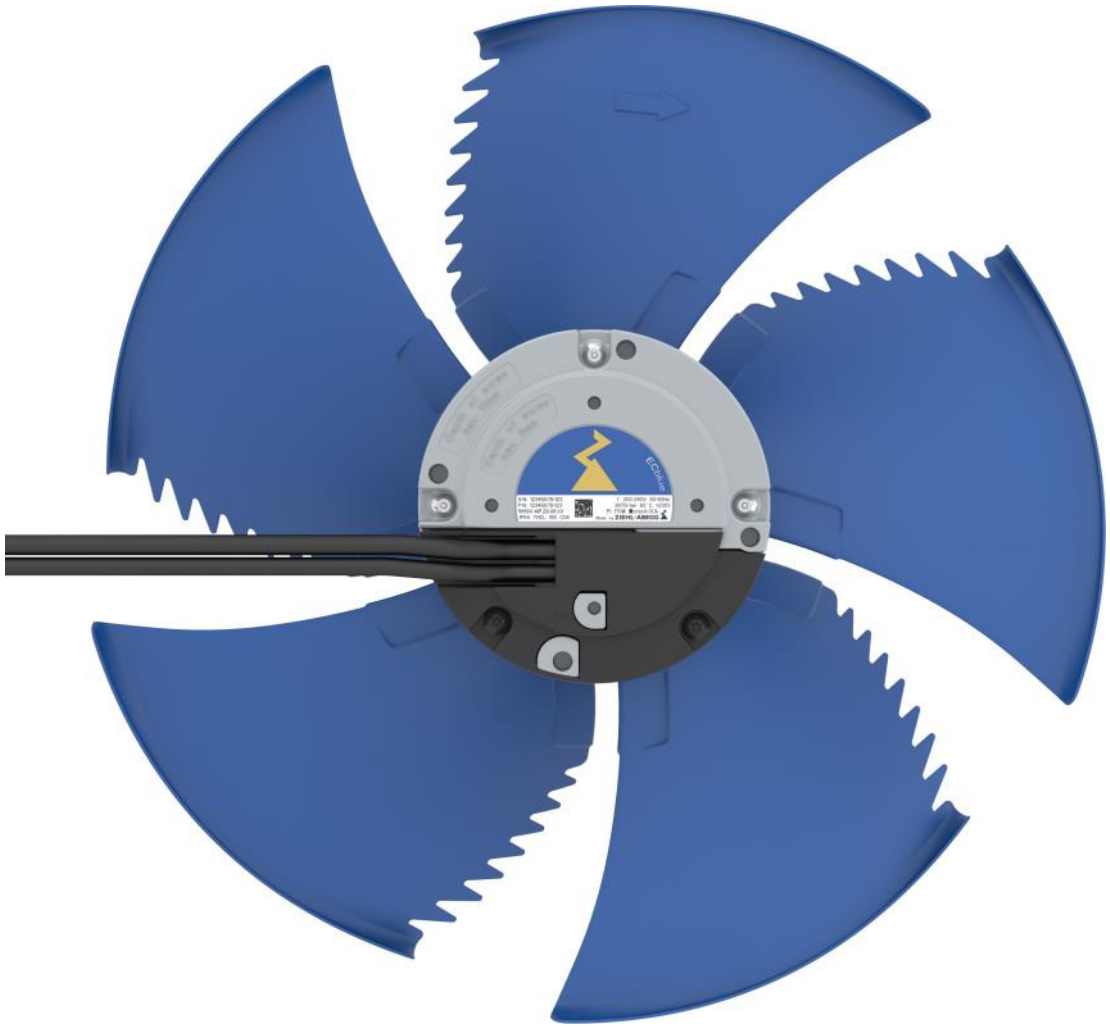
Evaporator:
brazed aluminum micro-channel heat exchanger with high performance fin designs offering good defrosting and optimized refrigerant flow distribution

Compressor:
modulating compressor with a large turndown ratio and low oil charge

Fan and air duct:
high efficiency, low noise air duct for the evaporator including an advanced fan concept

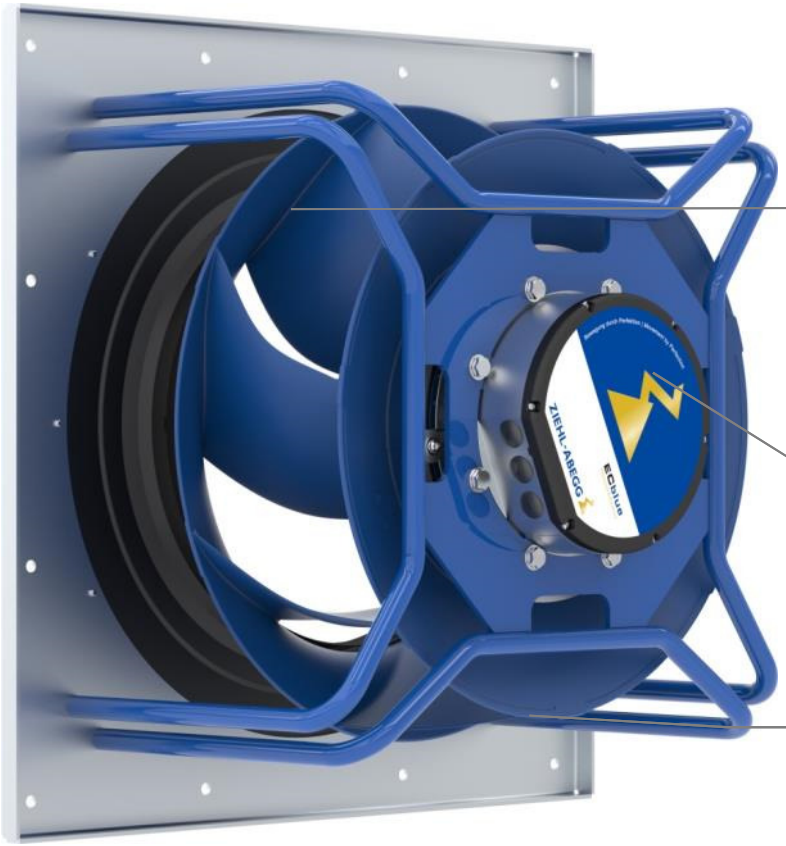
Condenser:
brazed aluminum shell and tube heat exchangers based on MPE tubes

New FE2owlet



- New motor EC055
- New optimized impeller
- New solutions for heat pumps

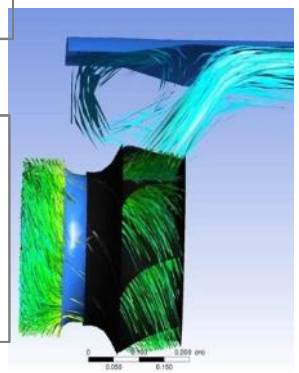
ZAvblue Conclusion



bionic lightweight construction

ECblue-technology

impeller for future-proof heat pumps



- Silent
- Efficient

Performance testing of a lab-scale high temperature heat pump with HFO-1336mzz-Z as the working fluid

THOMAS FLECKL, Michael Hartl, Franz Helminger
Austrian Institute of Technology (AIT)

Konstantinos (Kostas) Kontomaris, Ph.D.
Chemours Fluoroproducts

Julian Pfaffl
BITZER Kühlmaschinenbau GmbH

Lab Heat Pump

	HFO-1336mzz-Z
Nominal Boiling Point (°C)	33,4
Critical temperature (°C)	171,3
Critical pressure (MPa)	2,9
ODP	None
GWP_{100}	9,4

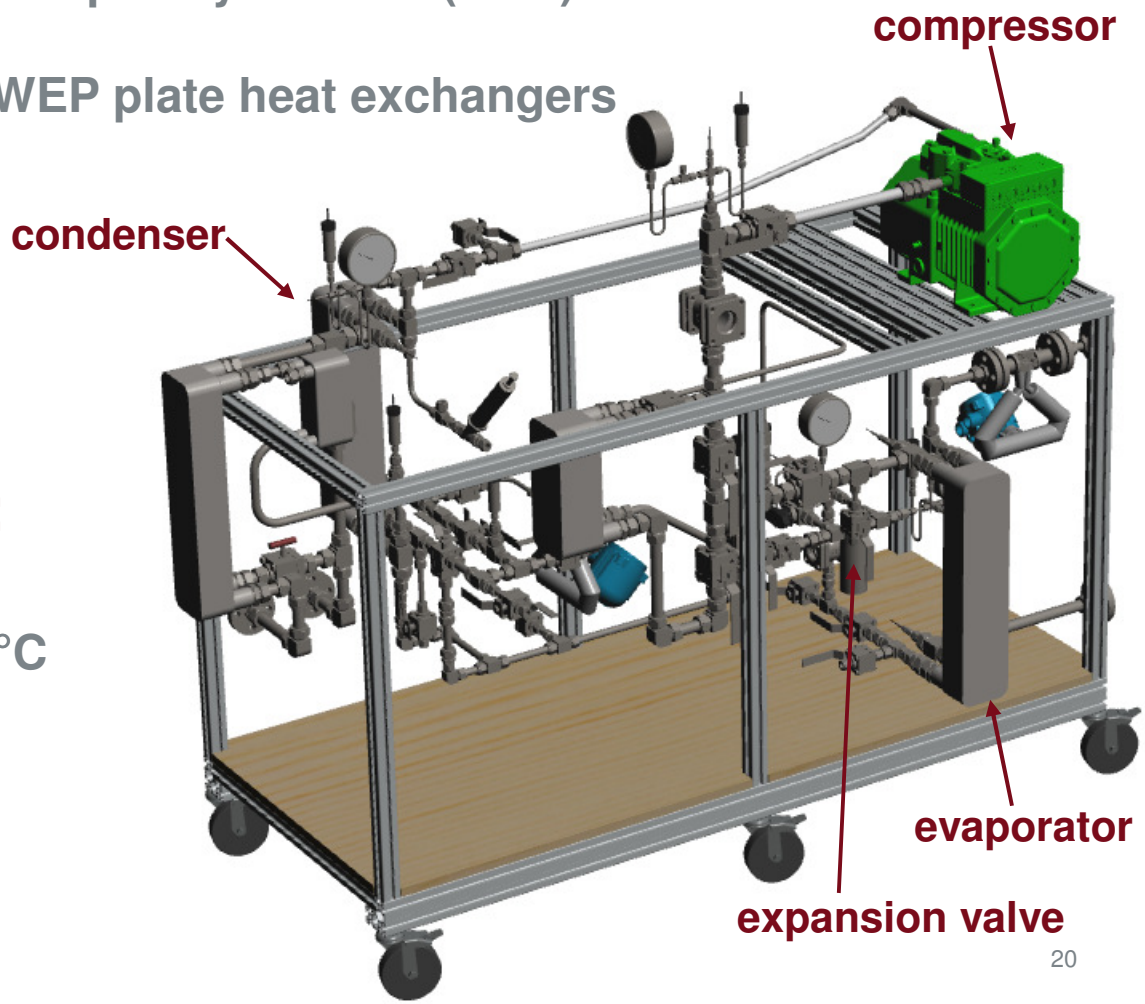
Non-flammable at 60 and 100°C according to ASTM E681-2001

Lab Heat Pump

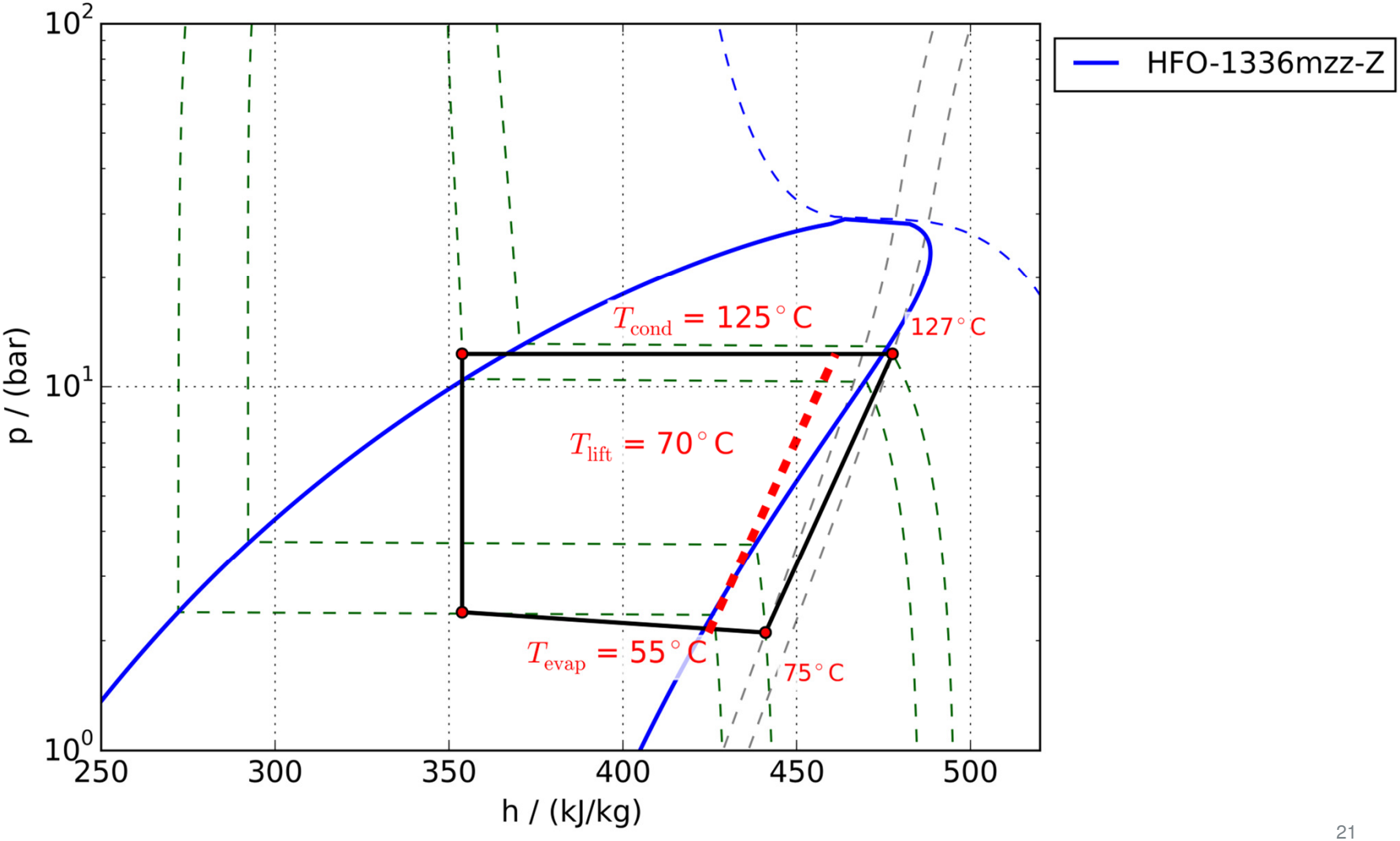
- Mobile and modular experimental setup
- Minimally adapted BITZER semi-hermetic reciprocating compressor with external frequency inverter (ABB)
- Commercially available SWEP plate heat exchangers

Nominal Heating Capacity: 12 kW

at T_{cond}=100°C & T_{evap}=65°C



Results: Suction gas and discharge temperature



Summary

- Small scale (12 kW) heat pump with largely existing equipment components operating with **HFO-1336mzz-Z** was tested
- Condensing temperatures up to about **150°C** and evaporating temperatures up to **90°C** demonstrated!
- Performance figures under lab scale conditions

	COP_h	f_0
T_{lift} = 35K	up to 5,8	up to 0,5
T_{lift} = 70K	up to 2,5	up to 0,45

- Superheating of suction gas required
- Discharge temperature slightly above condensing temperature

High
Efficiency
Solutions.

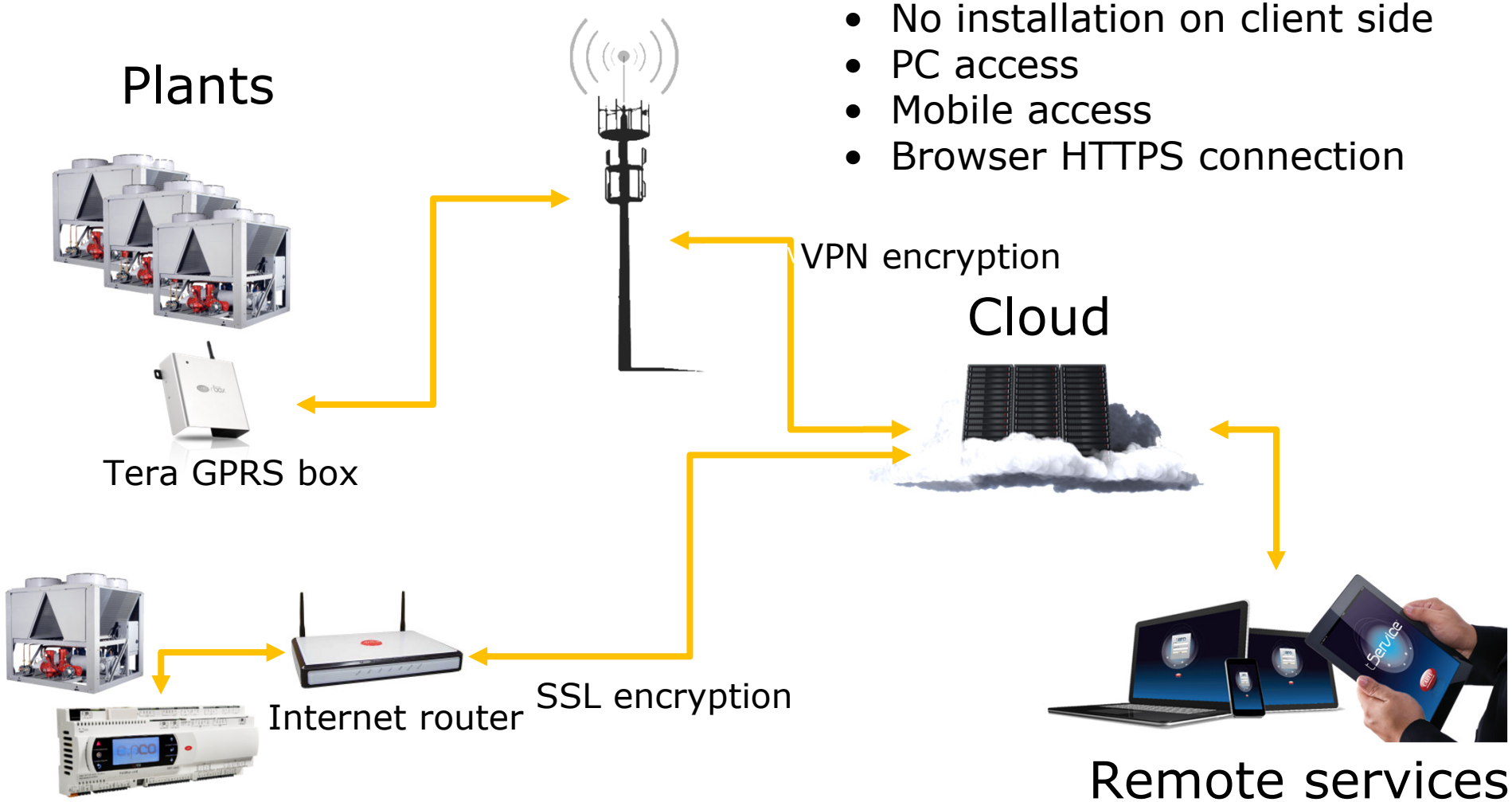
CAREL

Connected world new control solution

Speaker: Alexander Blümel
Sales Manager HVAC OEM
Carel Deutschland GmbH

5. Cloud solution

- No installation on client side
- PC access
- Mobile access
- Browser HTTPS connection



6. Conclusions

- The Smart Home market will grow a lot
- **Connectivity getting more and more important in the future**
- OEMs have to offer Smart System Solutions instate of units
- **Cloud computering is a chance to offer also services**
- Integrated connectivity with standard protocols is needed

boostHEAT

HEAT PUMP BOILER

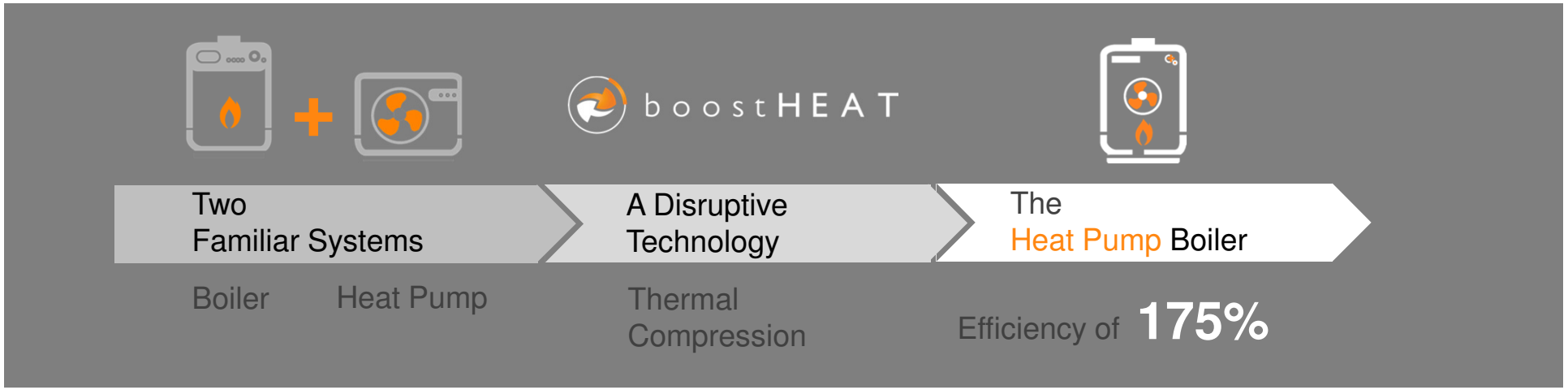
Michael Miranda

> THE INNOVATIVE HEAT PUMP BOILER

> boostHEAT has achieved the FUSION of the boiler and the heat pump, into ONE efficient and renewable heating system, thanks to our patented thermal compression technology

THE BOILER efficiently consumes natural gas

THE HEAT PUMP extracts heat from the air outside

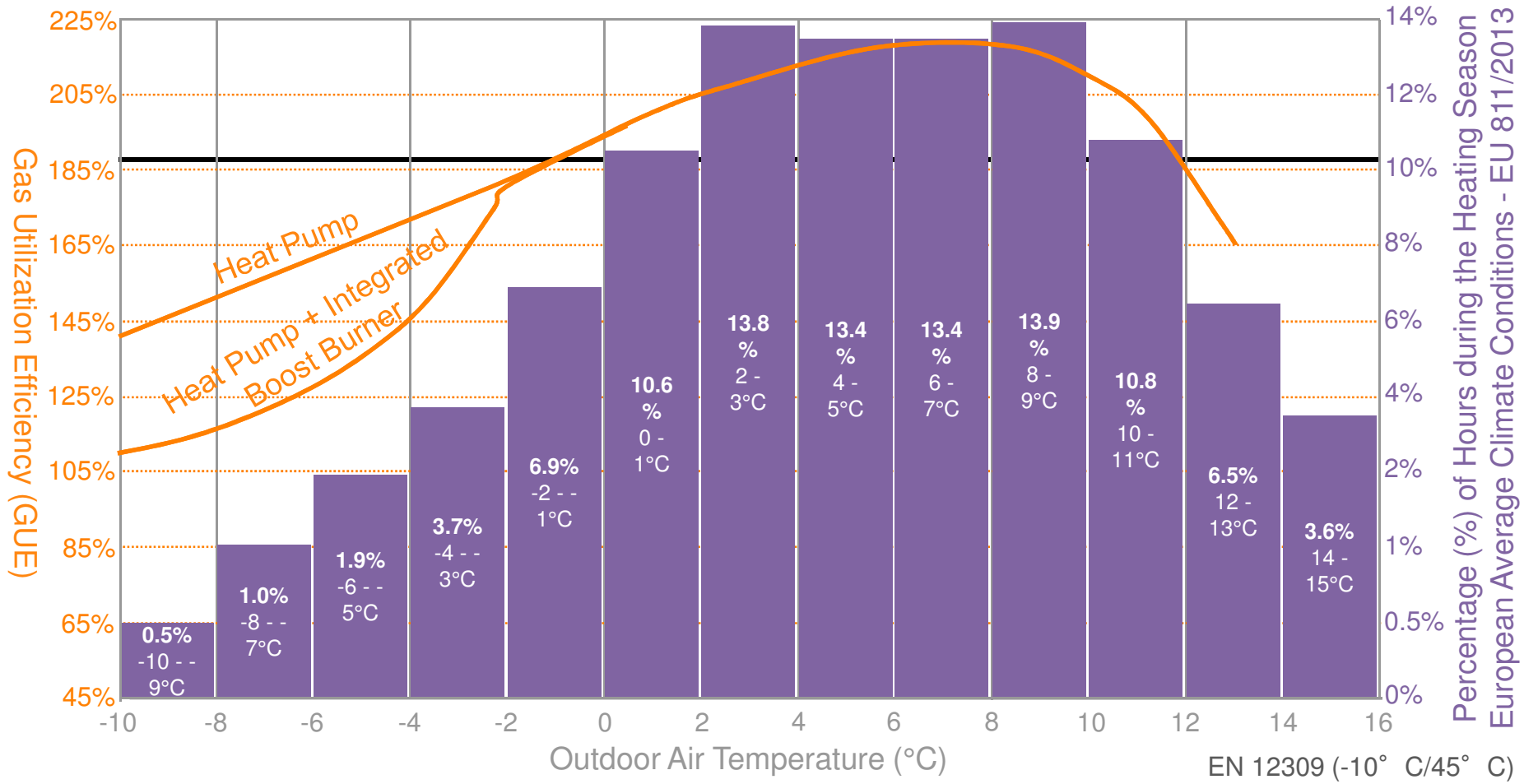


> HOME HEATING + DOMESTIC HOT WATER

Technology	Thermal Compression Air-Water CO_2 Heat Pump
Heat Pump Capacity Modulation	4 kW at -10 °C Outdoor Air Temp. 4 - 13 kW at 7 °C 4 - 18 kW at 15 °C
Capacity Modulation	20% - 100%
Integrated Boost Burner Capacity Modulation	4 - 20 kW Integrated boost burner to provide additional capacity if needed
Domestic Hot Water Supply Temperature	50 - 60+ °C Internal 75 - 85 °C hot water storage tank with adjustable mixing valve
Domestic Hot Water Specific Flow Rate	≥ 18 l/min (EN 13203) “XL” load capacity
Indoor Unit Dimensions	H 200 cm x W 60 cm x D 80 cm
Outdoor Unit Dimensions	H 116 cm x W 85 cm x D 50 cm

> EFFICIENCY OF HEATING + HOT WATER PRODUCTION

188% SGUE for 45°C Medium Temp. Heating + Hot Water Production



EN 12309 (-10° C/45° C)
Expected values based on lab tests and modelling

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Leibniz University Hannover

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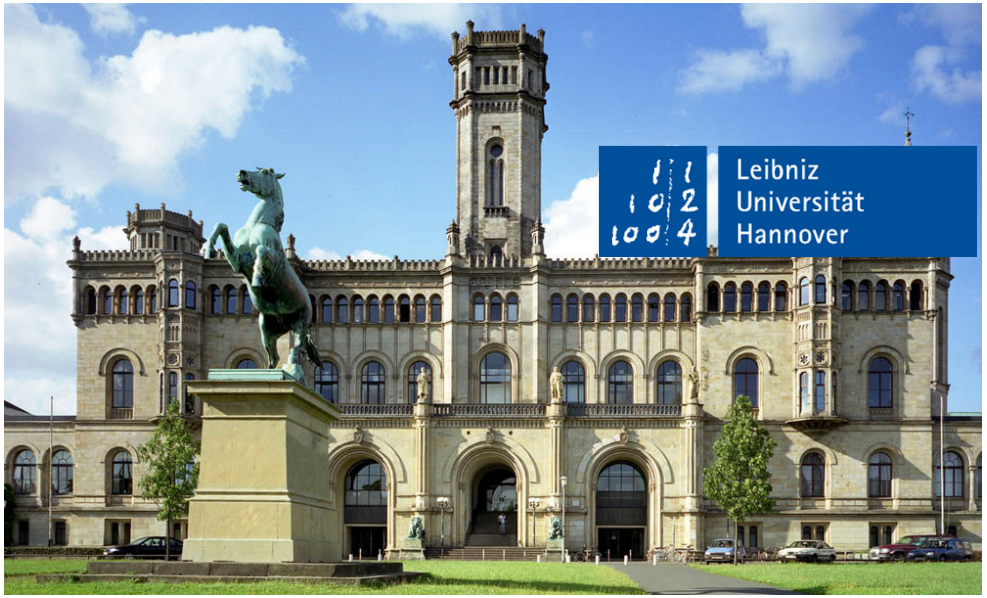
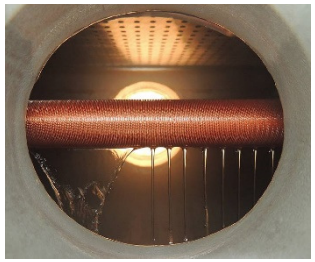
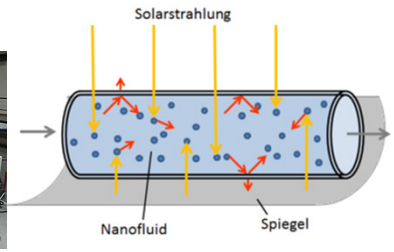


- Member TU9
- 25.700 students
- 2.980 employees





Johann-Christoph Ebeling

Institute for Thermodynamics
at the Leibniz University of Hannover

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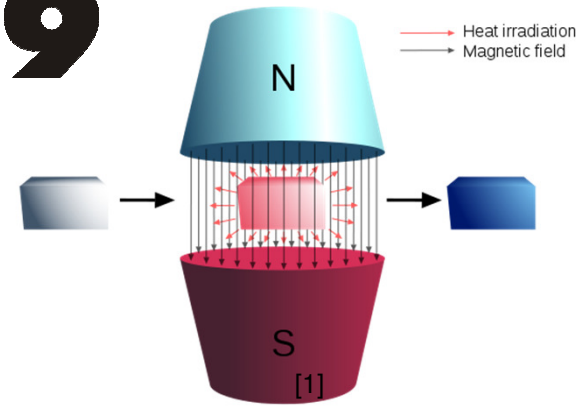
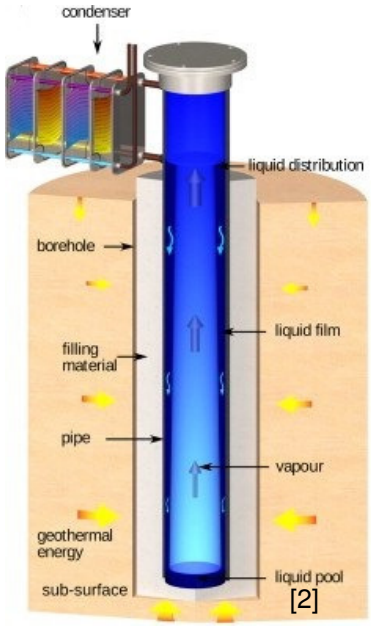
Leibniz Universität Hannover

TU 9

Research

- Substance Data
- Energy Converters
  - **Magnetocaloric**
- Heat and Mass Transfer
  - **Geothermal Thermosyphons**
- Thermodynamics of Complex Systems





Teaching

Winter semester
- Thermodynamics I for Mechanical Engineering
- Thermodynamics of Mixtures
- Refrigeration and Air Conditioning Technology
- Numerical Heat Transfer
- Practice of Energy and Process Engineering
- Cryogenic and Bio-Refrigeration (IMP)

Summer semester
- Thermodynamics II for Mechanical Engineering
- Heat Transfer II (Boiling and Condensation)
- Fuel Cells and Fuel Cell Systems
- Thermal Separation Technology
- Thermodynamics of Chemical Processes

[1] Wikipedia
[2] HARTMANN, Frank ; BEHREND, Ralph ; HANTSCH, Andreas ; GRAB, Thomas ; GROSS, Ulrich: *Numerical investigation of the performance of a partially wetted geothermal thermosyphon at various power demand schemes.* In: *Geothermics* 55 (2015), S. 99–107

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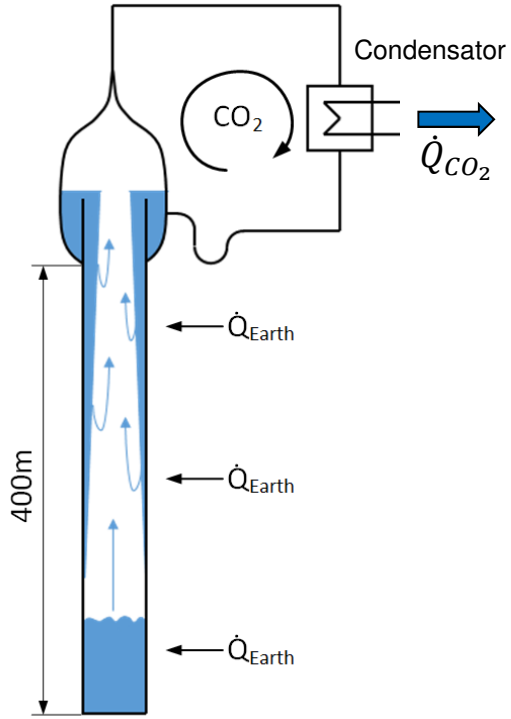
CO_2 driven Geothermal Thermosyphon (400m)

What?

- Probe as one closed pipe
- Saturated working fluid (CO_2)
- Heat transfer through phase change



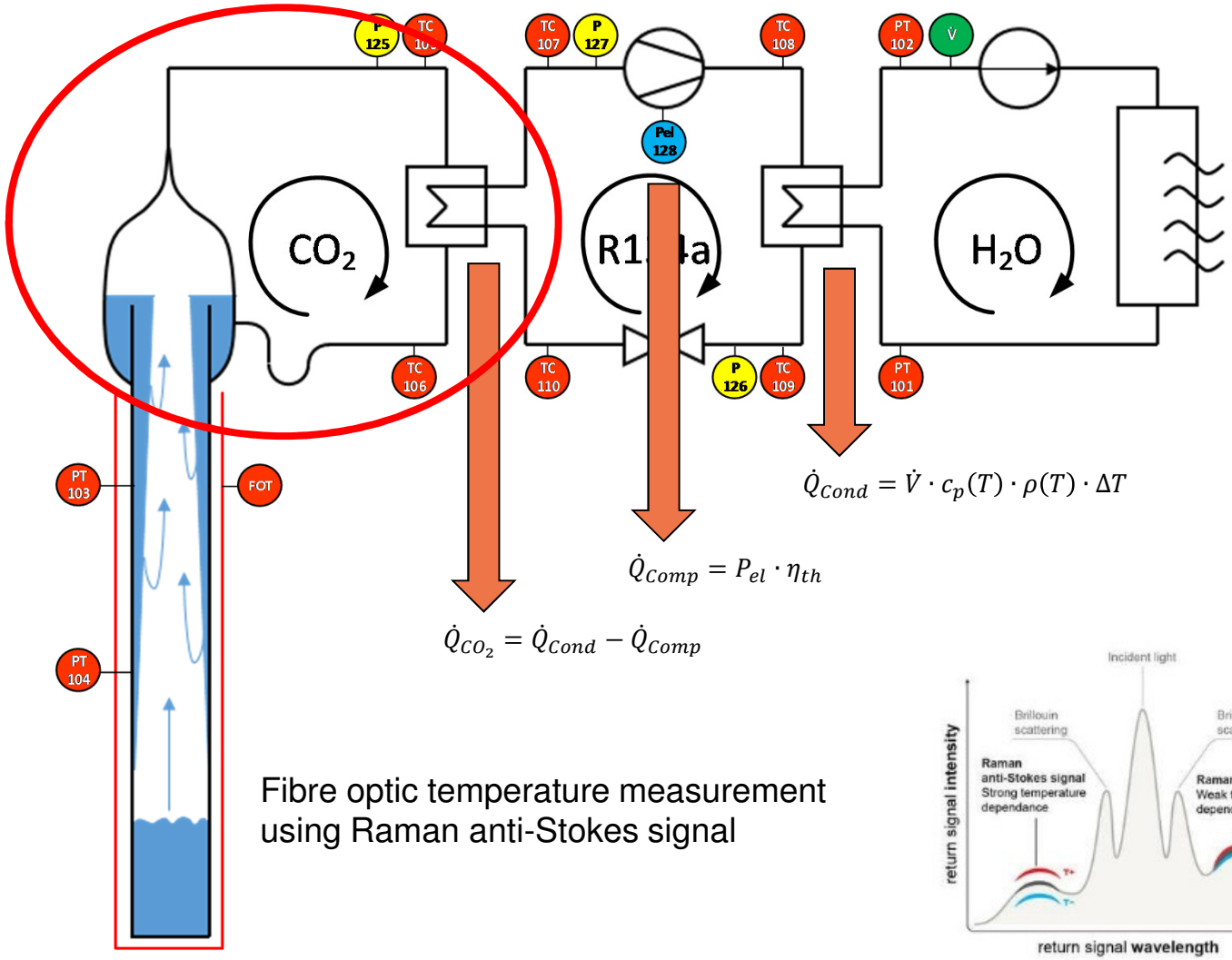
Why?

- Intense heat transfer due to phase change
- No pumps due to natural circulation
- Possible within water protection areas
- High extraction rate for urban application

Research topics

- Maximal heat flow
- Optimal filling rate
- Validation data for Simulation
- Plain pipe or helically corrugated pipe

Setup - theoretical

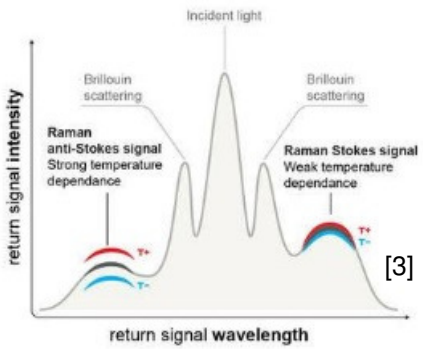


$$\dot{Q}_{Cond} = \dot{V} \cdot c_p(T) \cdot \rho(T) \cdot \Delta T$$

$$\dot{Q}_{Comp} = P_{el} \cdot \eta_{th}$$

$$\dot{Q}_{CO_2} = \dot{Q}_{Cond} - \dot{Q}_{Comp}$$

Fibre optic temperature measurement using Raman anti-Stokes signal



[3]

[3] Graph by AP Sensing

Setup - practical

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Instalation of the:
Helically corrugated DN 80 pipe

Continuous instalation in one piece

Probe dimensions:

L_{plain}: 368 m
$L_{corr.}$: 384 m
V_{plain}: 3,77 m³
$V_{corr.}$: 3,32 m³

Filling:

$m_{CO2, plain}$: 642 kg
$m_{CO2, corr.}$: 921 kg
$h_{Pool, plain}$: 9 m
$h_{Pool, corr.}$: 79 m

Location:
Nienburg (Weser)
Lower Saxony

Instalation of the:
Plain pipe DN 100

Instalation in pieces per 10m
Screwing together and welding necessary

Conclusion and lookout

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- There is a natural circulation while non-operating HP
- The temperature profile in the Probe depends on the pressure in the probe
- The pool surface is detactable
- The pool surface is moving while the starting process
- The speed of the film line is detactable
- The film line is moving faster in the plain pipe

Further investigation of the pool surface behavior

Effect of the filling level

Simulation of the starting process (unsteady)

Who am I ???

Name, Surname: Taylan Tokan

Date of Birth: 10.04.1989

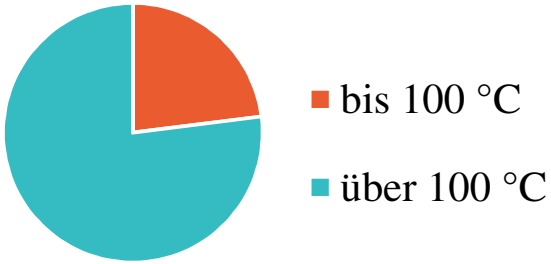
Work Experience: PhD. Student / scientific Assistant –
Institut für Thermodynamik Hannover
Topic: Control and Optimization of a industrial Heat Pump

Enexi Engineering - Applied technology consulting for the cooling and heat pump industry
www.enexi-engineering.de

Motivation

Why should you use a high temperature heatpump?

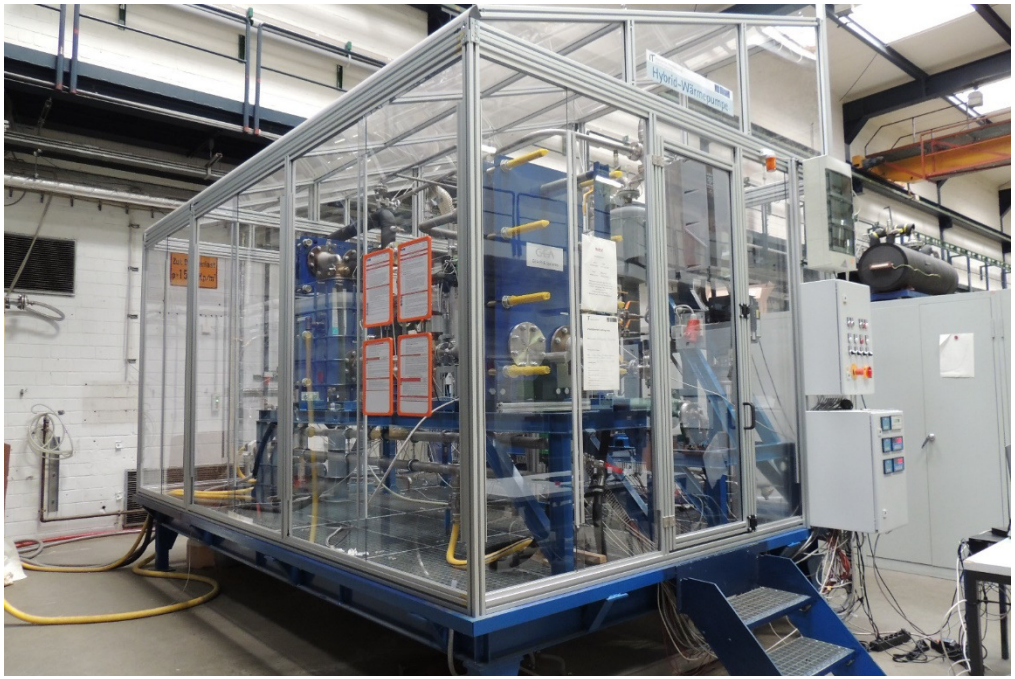
- industriall Potential in : 120 TWh/a
- lower primary energy consumption

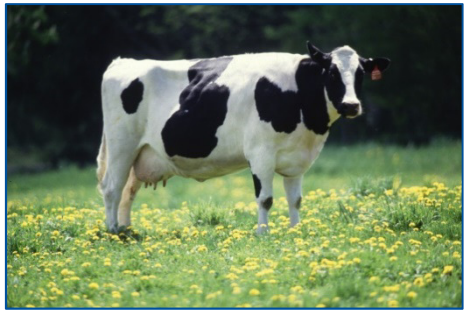


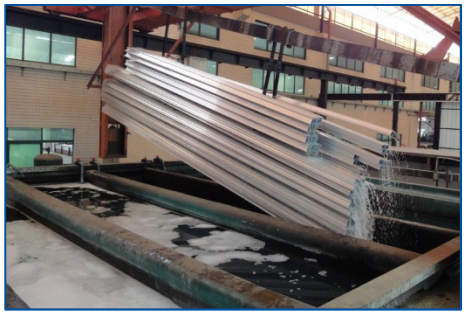
Why should it be a refrigerant mixture of $NH_3 + H_2O$?

- No GWP or ODP
- High efficiency
- Low pressure ratio

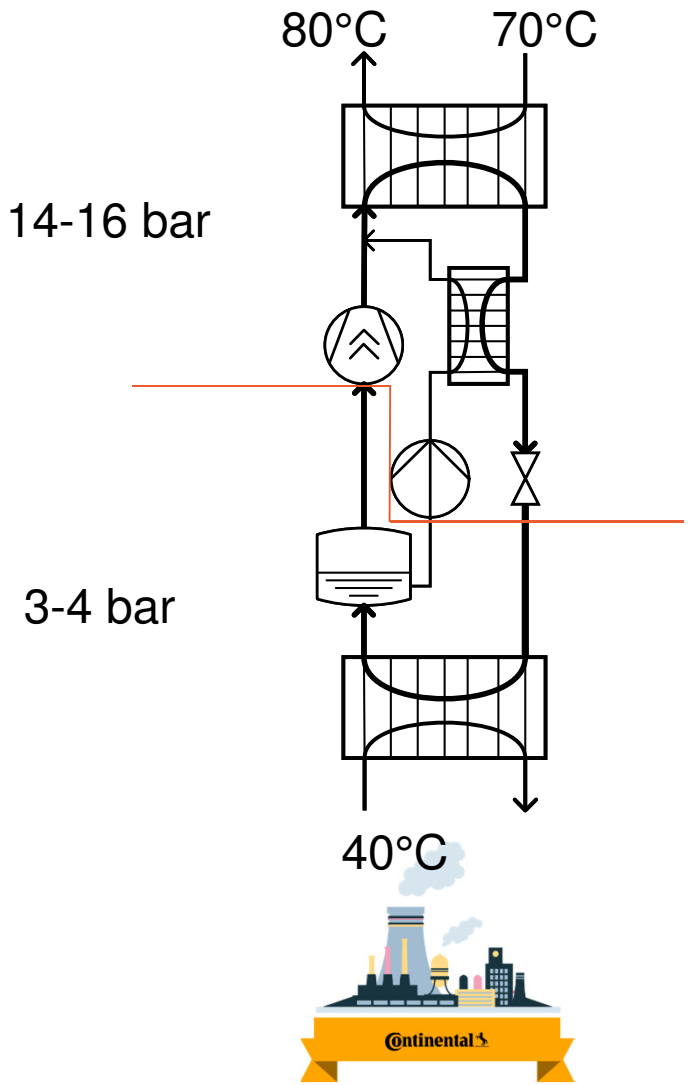
Possibilities







Setup



- **Characteristics:**
- NH3/H2O mixture
- Standard components
- Low pressure
- High efficiency

- **Tasks:**
- Oil-Water behaviour ✓
- Optimal mixing poor solution with ammonia gas ✓
- control mechanism for automatization ✗
- Complete Condensation ✓
- Cavitation liquid pump ✗

Calculation of the seasonal efficiency of solar thermal and heat pump combination by using the Bin method

CHRISTIAN KÖFINGER, Michael Hartl
Austrian Institute of Technology (AIT)

Optimization of the seasonal efficiency of heat pumps by varying the bivalent temperature

CHRISTIAN KÖFINGER, Markus Köfinger, Andreas Zottl
Austrian Institute of Technology (AIT)

AIT heat pump laboratory

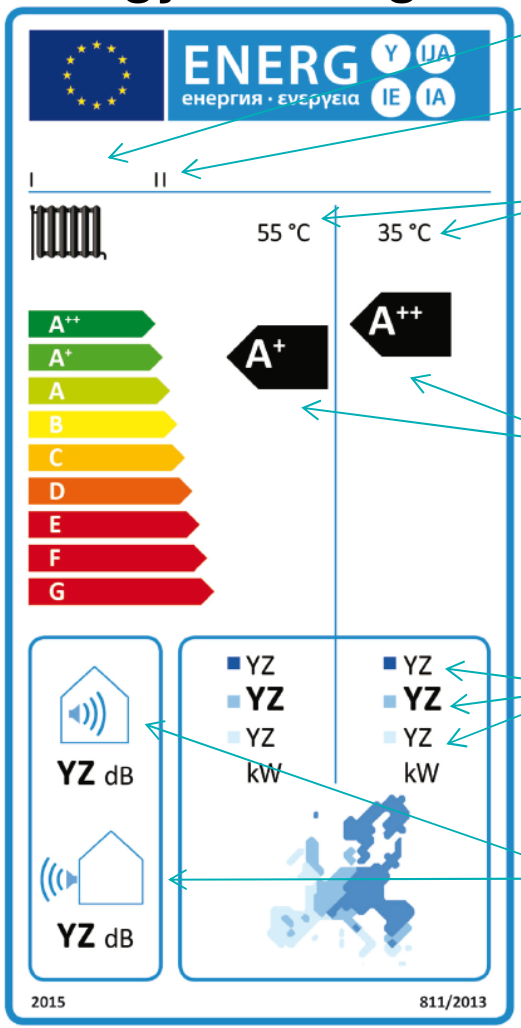
History

- First tests at AIT in 2000
- New Laboratory 2005
- Expansion of the Laboratory 2010 and 2014

Capacity

- 2 Air/Water test rigs
- 1 ground source test rig
  - BW/WW
  - DX
- 1 Test rig for Domestic hot water heat pumps

Energy Labeling of space heating heat pumps



Suppliers name or trade mark

Suppliers identifier

Spaceheating function by means of low and medium temperature

Seasonal space heating efficiency

Rated heat out put under average, colder and warmer climate condition and in medium and low temperature application

Sound power level indoor and outdoor measurement

Energy Labeling of space heating heat pumps

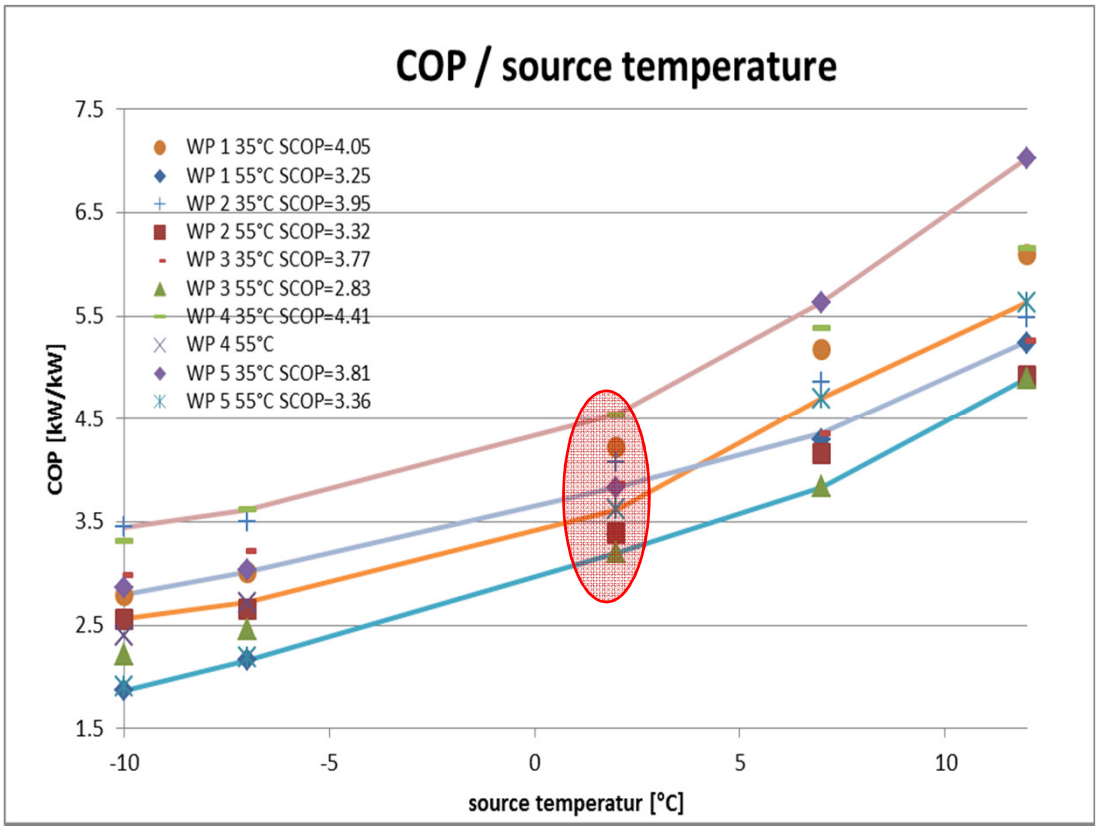
COP values at

- Bivalent temperature (-7°C)
- Operation limit
- 12°C
- 7°C
- 2°C
- -7°C

SCOP in the range

- 3.77 and 4.41
- 2.83 and 3.36

Air 2°C has highest influence on SCOP

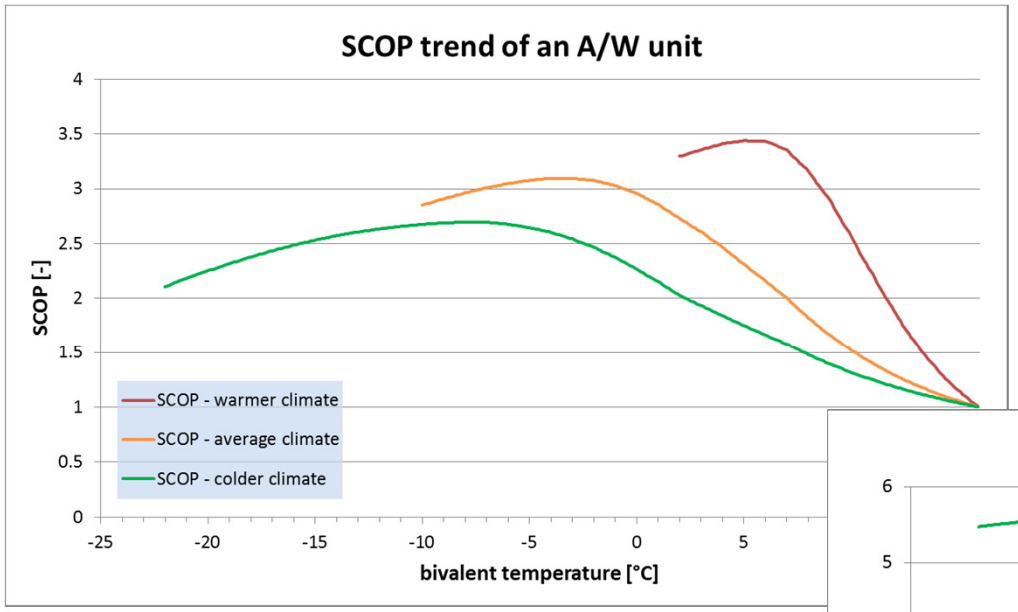


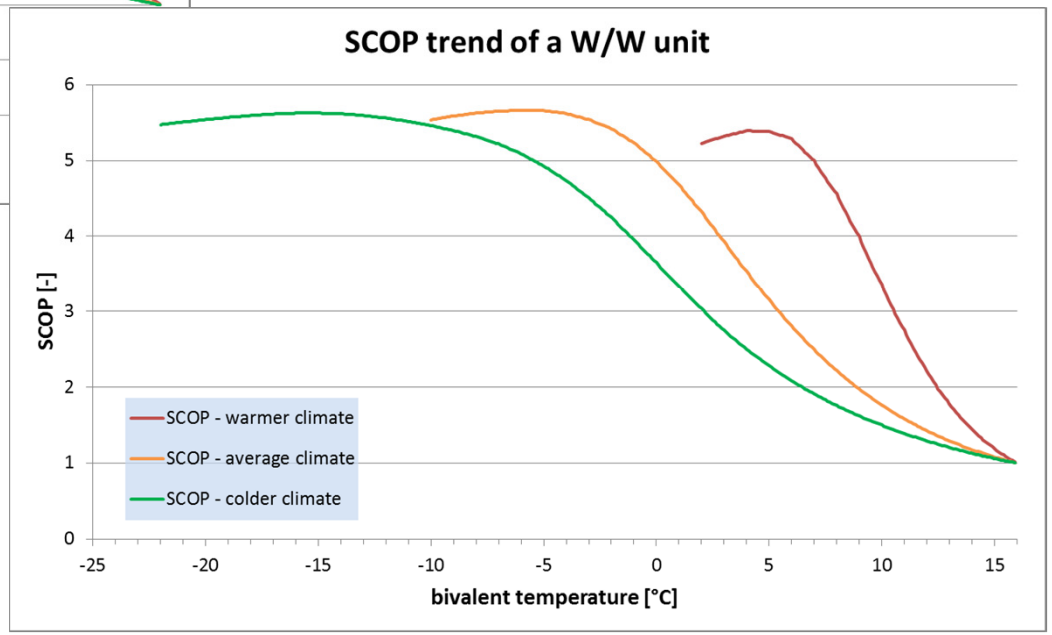
SCOP in dependency on bivalent temperature

Comparison of 5 air/water heat pumps

	SCOP monovalent	lowest outdoor temperature	SCOP-Optimum	optimal bivalent temperatur	ΔSCOP	ΔSCOP relativ
	[-]	[°C]	[-]	[°C]	[-]	[%]
warmer climate	3.46	2	3.70	5	0.24	6.79
average climate	2.96	-10	3.21	-4	0.25	8.29
colder climate	2.30	-22	2.79	-8	0.48	20.89
warmer climate	3.30	2	3.44	5	0.14	4.30
average climate	2.85	-10	3.09	-4	0.24	8.57
colder climate	2.11	-22	2.70	-8	0.59	27.90
warmer climate	3.78	2	3.97	5	0.19	5.07
average climate	3.39	-10	3.58	-4	0.20	5.83
colder climate	2.87	-22	3.20	-10	0.34	11.76
warmer climate	3.84	2	3.95	3	0.11	2.86
average climate	3.48	-10	3.56	-9	0.08	2.16
colder climate	2.75	-22	3.11	-12	0.37	13.33
warmer climate	3.48	2	3.65	5	0.17	4.99
average climate	3.07	-10	3.30	-4	0.23	7.48
colder climate	2.47	-22	2.88	-8	0.41	16.65

SCOP in dependency on bivalent temperatur





Evolution of Heat Pump Certification

François-Xavier BALL

Summary

- Introducing product certification
- Overview of Eurovent Certita Certification
- Main trends in the evolution of Heat Pump certification
  - technologies
  - standards and regulatory framework
  - breakthroughs
- Conclusion

Eurovent Certita Certification (ECC): a European certification body focused on HVAC-R products

- Managing, over 20 years of experience, 38 product certification programmes related to indoor climate, ventilation and air quality, refrigeration and Food cold chain
- Accredited against EN ISO/CEI 17065 standard by Cofrac, a signatory of the European cooperation for accreditation (EA) multilateral agreement
- Granting certification marks ensuring that products not only comply with specifications but will perform as advertised

Some facts and figures

- **Scope :** we certify products manufactured in 44 countries by 615 manufacturers using 745 trade marks

- **Assessment** : 1800 verification tests and more than 400 audits in 27 countries per year

- **Delivery :** 95 000 models certified, 24/7 online access to certified product lists and performances

- **Recognition** : 66 % of HVAC-R products sold in Europe are ECP certified

What value for the Heat Pump Certification

Certification brings **confidence**

… equipment is **compliant** to design specification
… **energy savings** can be demonstrated
… product meets initial **investment target**

Certification is the ground for **fair competition**

... **equal terms** for a common language
… same testing standards for **comparable data**

Certification is key to **progress**

… by improving products, gaining efficiency, certified companies or product win **new market**

The European heat pump keymark

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- **Thomas Nowak**
- Secretary General EHPA

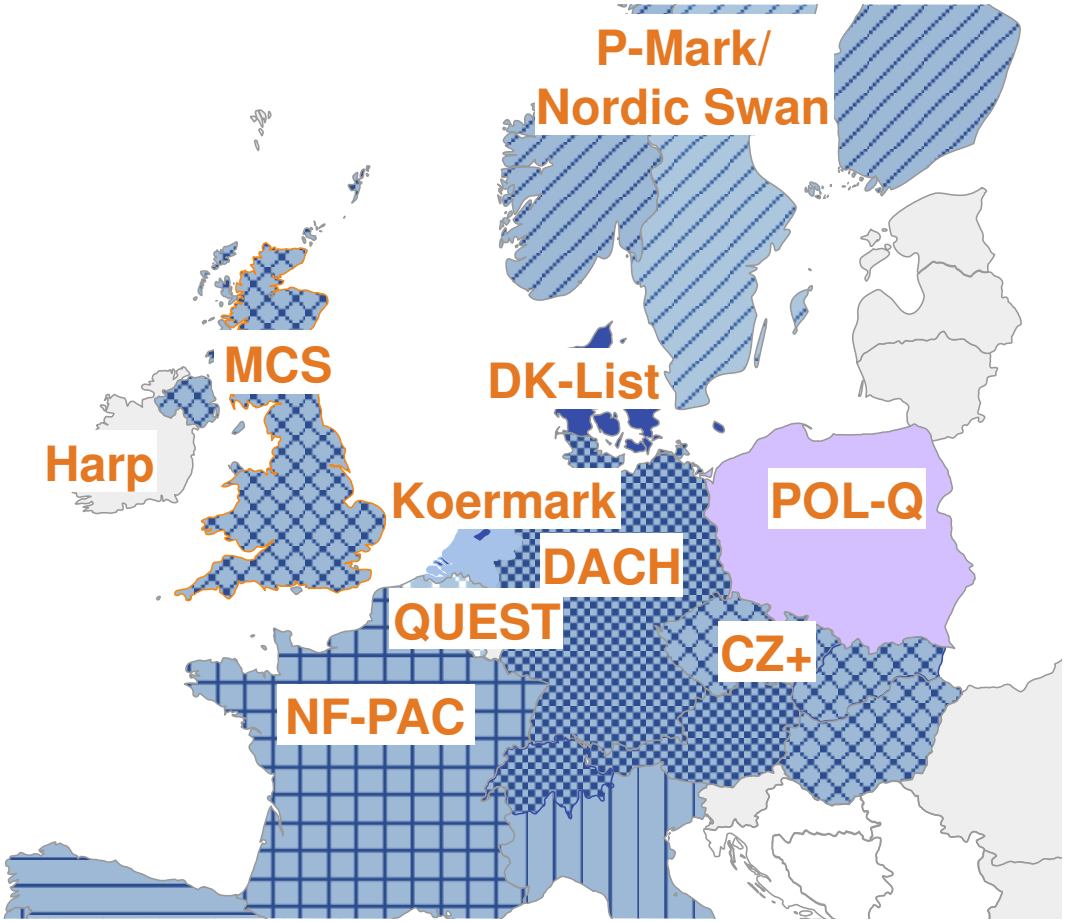
- Contact
- thomas.nowak@ehpa.org
- +49 176 6320 1140

An unpleasant future…

- Multiple schemes
- Multiple FPC
- No mutual acceptance

➔More work/time
➔higher cost

Better quality?



Idea of a single certificate was developed from 2013 - 2015

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- Requirements
  - A single certificate
  - Open to all interested parties
  - Transparent and strong to create trust in the market place
  - Mutually accepted
  - no minimal requirements

    Indirectly, due to Ecodesign, minimum requirements will apply (eta s, noise)
- Need to incorporate a transition period for the different existing schemes: EHPA – quality label, MCS in UK, NF-Pac in France, heat pumps positive list in Denmark, Harp list in Ireland
- Consideration of cooperation with existing schemes, development of EHPA certificate
- Conclusion: development of **CEN HP keymark as a sufficient proof of heat pump quality in Europe**

Pre-Scheme Development Group

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- **Certification Bodies**
  - DIN CERTCO
  - BRE
  - SP Cert

- **Associations**
  - Ehpa (Secretariat)
  - Informative: national associations
  - Informative: EHI, BDH (supportive!)

- **Manufacturers**
  - Atlantic
  - Daikin
  - Emmerson
  - Dimplex
  - Nibe
  - Stiebel Eltron
  - Vaillant
  - Viessmann

Schematics of admission test and annual control test

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Type: Air-water

3kW	Manufacturer data	3kW	1 of the marked models to be tested - 3rd party witness test in authorised man. lab **OR** - 3rd party independent lab
7kW	Test by **ind. 3rd party** lab	7kW	
11 kW	Manufacturer data	11 kW	
14 kW	Manufacturer data	14 kW	
17 kW	Test by **ind. 3rd party** lab	17 kW	
19 kW	Manufacturer data	19 kW	

Still to be finalised

Year 1: admission test → **Year 2 and following: type test**

Participants of the heat pump KEYMARK network

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CEN: Scheme owner

Scheme development group:
Highest decision making body

- Steering group
- Operator: Technical and administrative secretariat

Interested parties

- Manufacturers
- Certifcation bodies — Certifcation body **WG**
- Inspectors — Inspector **WG**
- Test labs — Test labs **WG**
- HP associations

Complementary relation of heat pump keymark with other schemes

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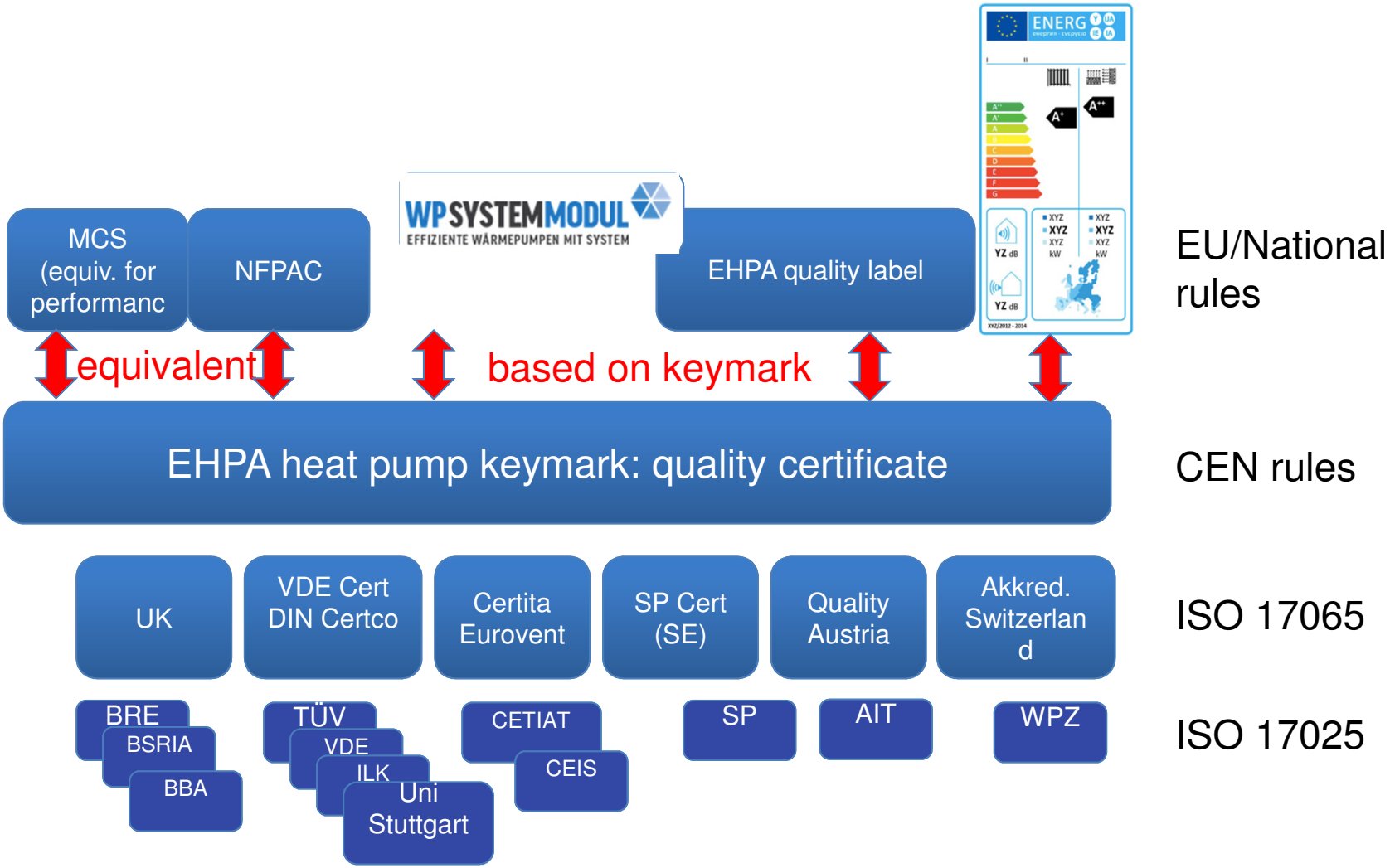

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Operation of a Testing Station for High Temperature Heat Pumps

Magdalena Wolf, Benedikt Kogler, David Wöß, Tobias Pröll

University of Natural Resources and Life Sciences, Vienna
Department of Material Sciences and Process Engineering

Magdalena Wolf

Content

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- Vision: Energy Efficient Industry
- Why High Temperature Heat Pumps?
- Testing High Temperature Heat Pumps
  - Construction of a High Temperature Heat Pump Test Station
  - Innovation
  - System Components
  - Evaluation and First Results

Vision:
Energy Efficient Industry

Vision: Energy Efficient Industry

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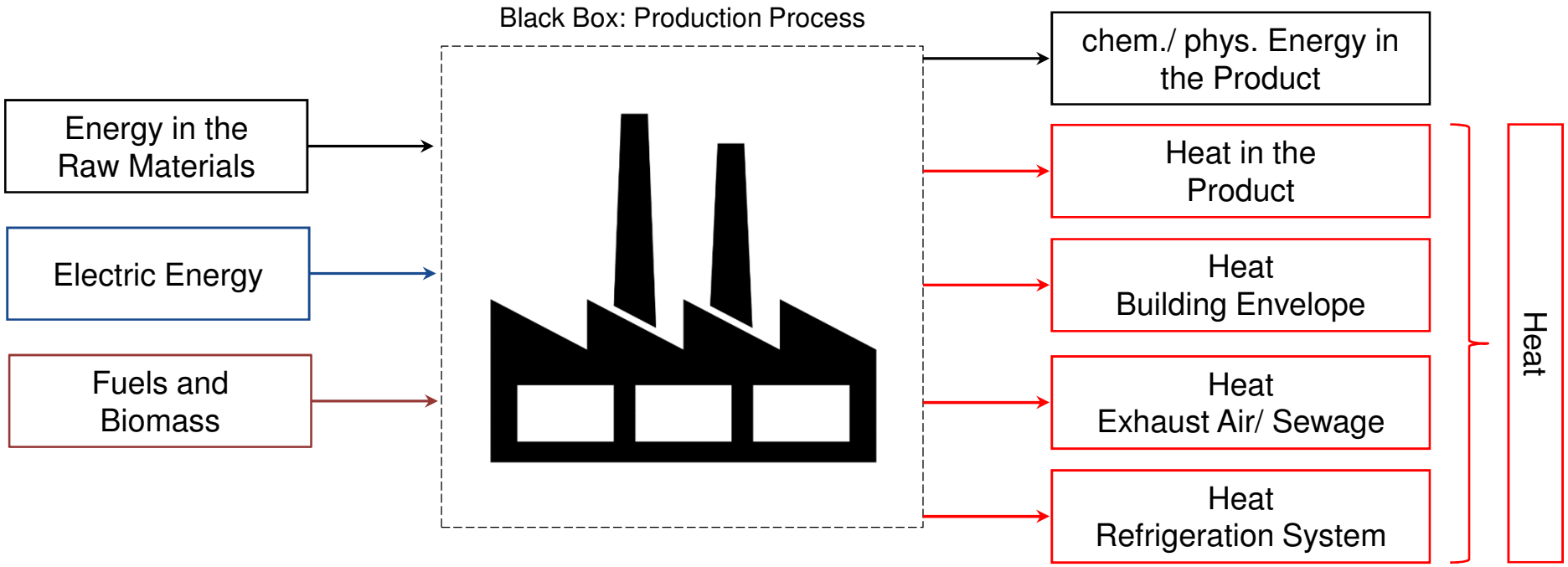

- Process Heat
- Space Heat
- Cooling & Refrigeration
- Lighting
- Actuation

Why High Temperature Heat Pumps?

Why High Temperature Heat Pumps?

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- Concept for a High Temperature Heat Pump
- First Loop: Driven with Ammonia as Refrigerant
  - Evaporator Temperature NH_3: 30°C
  - Condensation Temperature NH_3: 85°C
- Second Loop: Driven with Water as Refrigerant
  - Evaporator Temperature H_2O: 80°C
  - Condensation Temperature H_2O : 150°C
- Comparison of
  - COP
  - Power
  - Volumetric Heating Capacity

Why High Temperature Heat Pumps?

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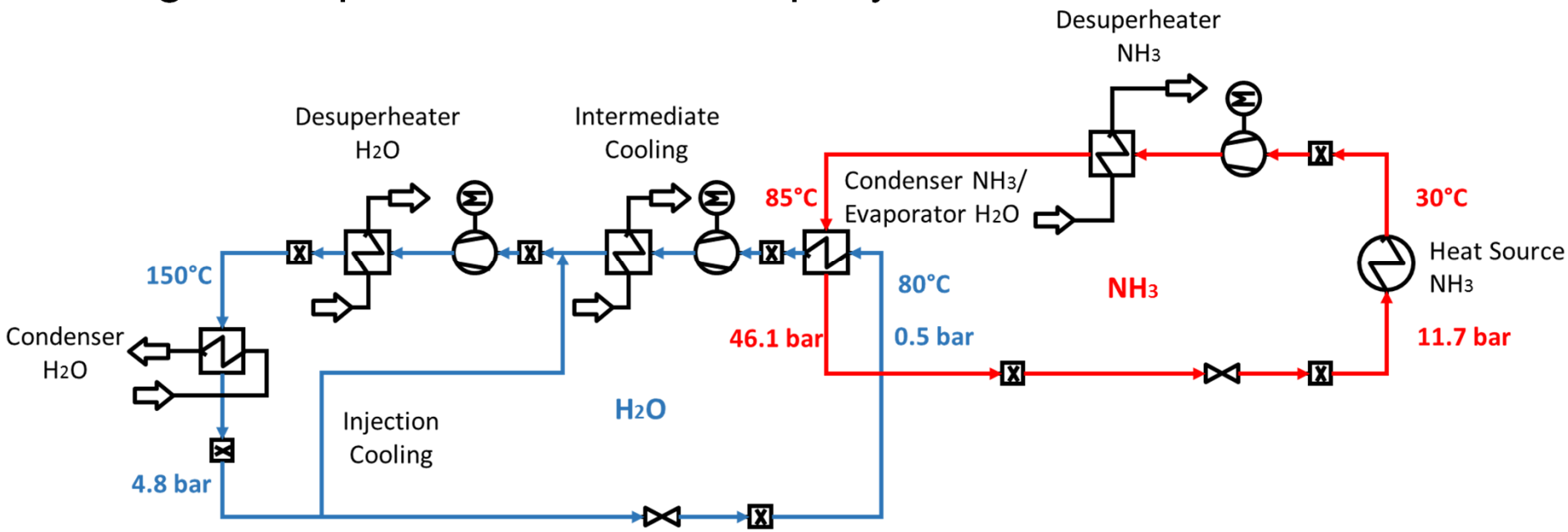
- High Temperature Heat Pump System



Isentropic Compressor Efficiency	80	[%]
Temperature Difference C/E	5	[K]

Why High Temperature Heat Pumps?

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Results of the Simulation

P_{el_Total}	56.4	[kW]
$\dot{Q}$ Desuperheater NH_3	100.0	[kW]
$\dot{Q}$ Desuperheater NH_3	0.0	[kW]
$\dot{Q}$ C/E	130.2	[kW]
$\dot{Q}$ Intermediate Cooling	13.0	[kW]
$\dot{Q}$ Desuperheater H_2O	15.4	[kW]
$\dot{Q}$ Condenser H_2O	138.0	[kW]

COP NH_3	4.10	[-]
COP H_2O	4.37	[-]
COP Total	2.38	[-]
Vol. Heat. Capacity NH_3	10101	[kJ/m³]
Vol. Heat. Capacity H_2O 1	755	[kJ/m³]
Vol. Heat. Capacity H_2O 2	2201	[kJ/m³]

System Components

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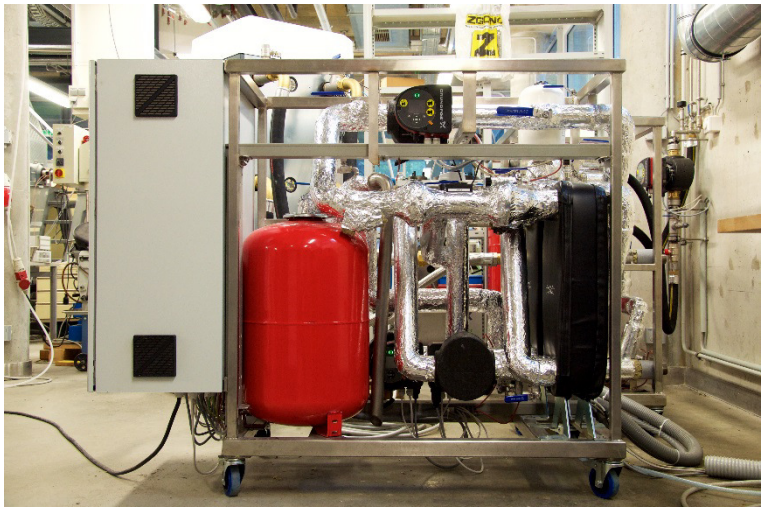

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POWERED BY CHILLVENTA

*future:***heatpump**

Energetic and economic evaluation of heat sources for heat pumps

SYMPOSIUM + EXPO
NUREMBERG, 20–21.10.2015

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

Dipl.-Ing. **Franziska Bockelmann**

hp-summit.de

20.+21. October 2015, Nürnberg

Research project

EUROPEAN HEAT PUMP SUMMIT

- *future*:**heatpump**
- Energetic and economic evaluation of heat sources for heat pumps

- Operating time: 03/2015 to 02/2018

- Project partners and sponsors:

STIEBEL ELTRON
VIESSMANN
uponor
DOPPELACKER
EURO POLES
eTank Energie auf Vorrat
geoKOAX

Federal Ministry for Economic Affairs and Energy
Projektträger Jülich Forschungszentrum Jülich

State of the art

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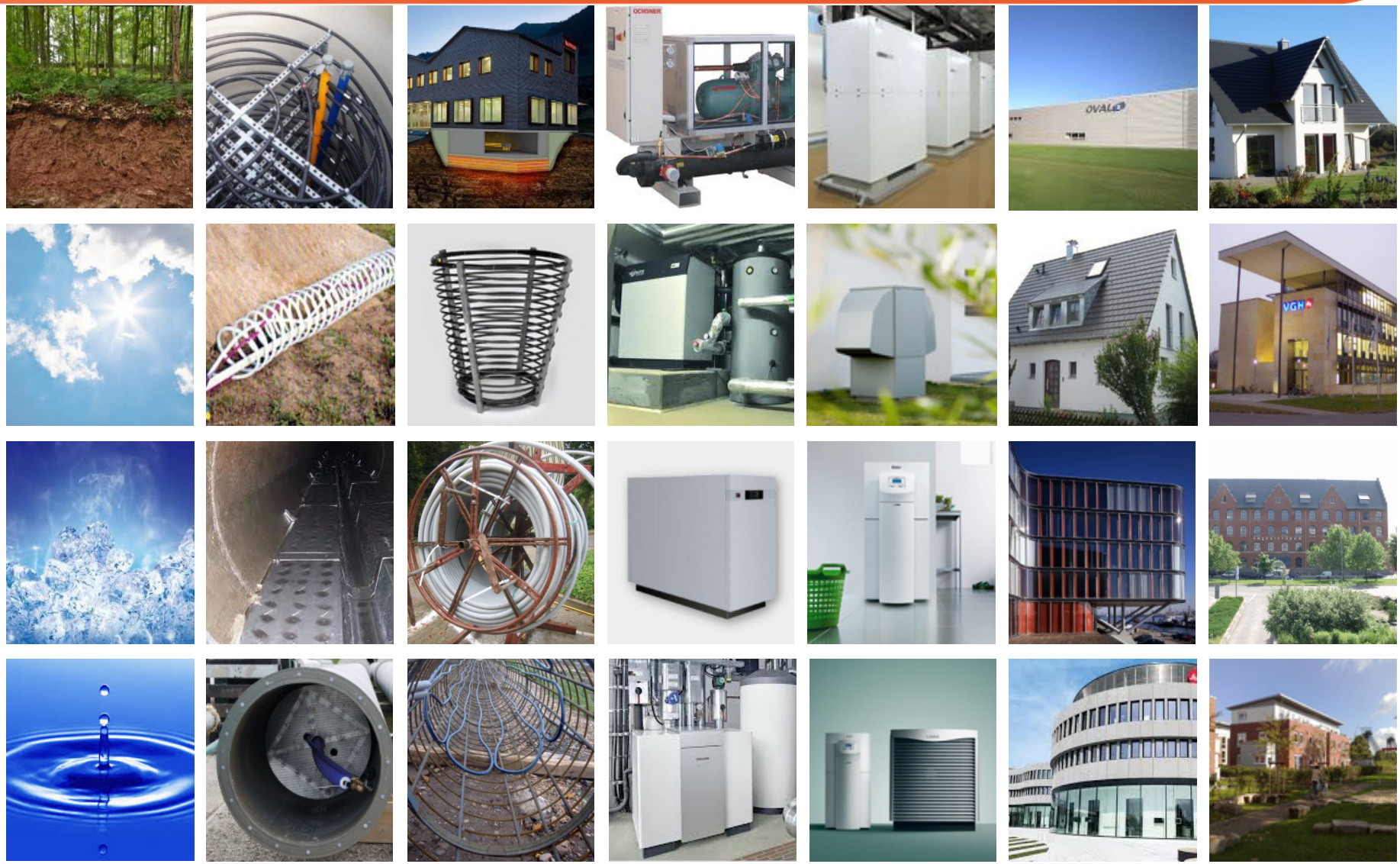

Bildquellen: u.a. www.waermepumpe.de, WP-Hersteller, Hersteller

Planing and energy concept

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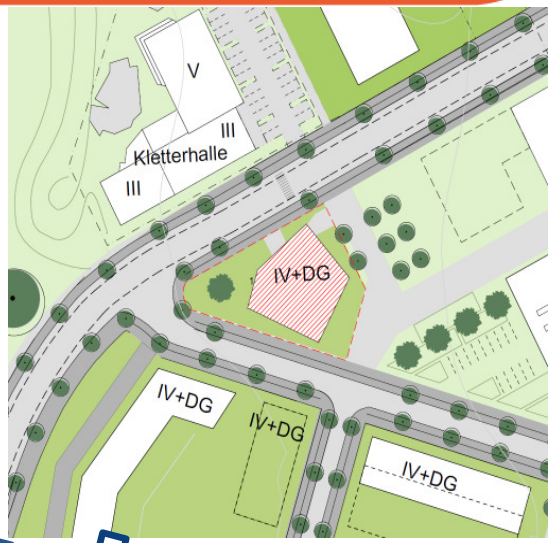
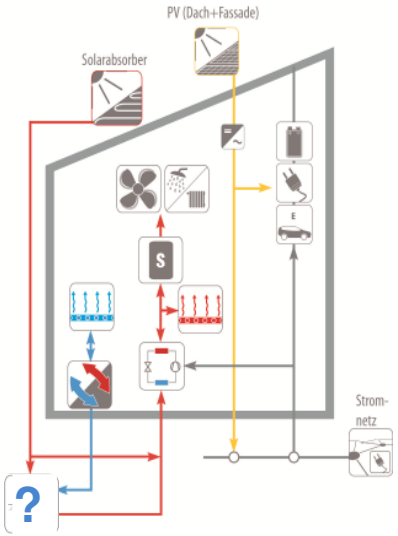
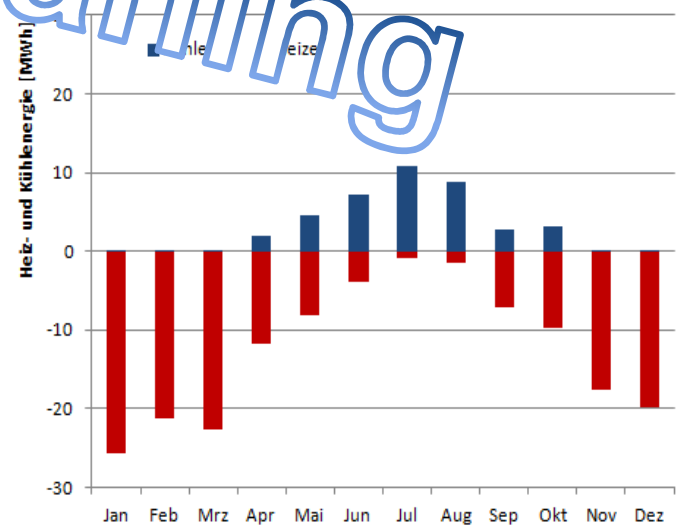


Planing





Processing

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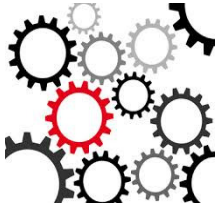

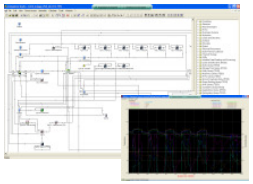

Work packages

Research (AP1) | System Configuration (AP2) | Monitoring (AP3) | Simulation (AP4) | Source - Building System (AP5) | Technical + Energetic Evaluation (AP6) | Economic Efficiency (AP7) | Pre-Check-Tool (Excel) (AP8)

Which functions should the tool have?
What is needed as an input and / or background information?
Which results are provided by the tool – the output?
How will this tool be implemented?

Processing of work packages

… | Simulation (AP4) | System Configuration (AP2) | Research (AP1) | Pre-Check-Tool (AP8)

Building Typology

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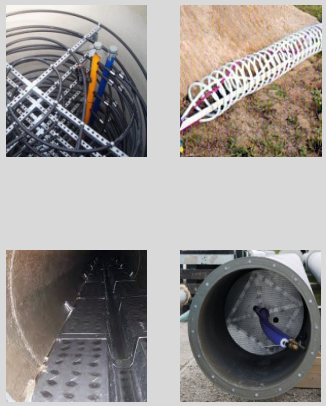
	Single family houses	Multiple family houses	Non-residential buildings	Heat sources and transfer
New building				
Refurbish-ment				

Pre-Check-Tool

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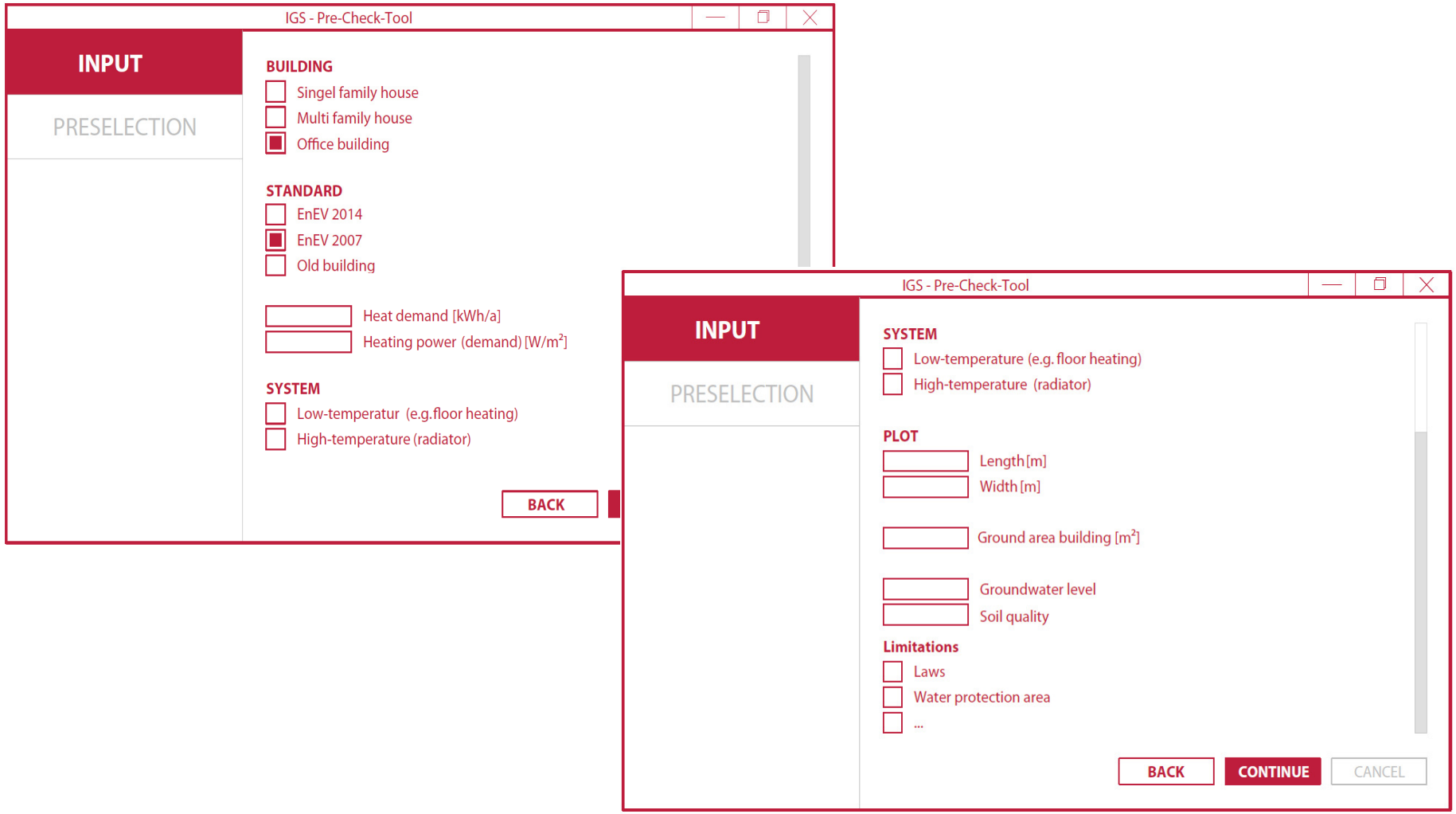
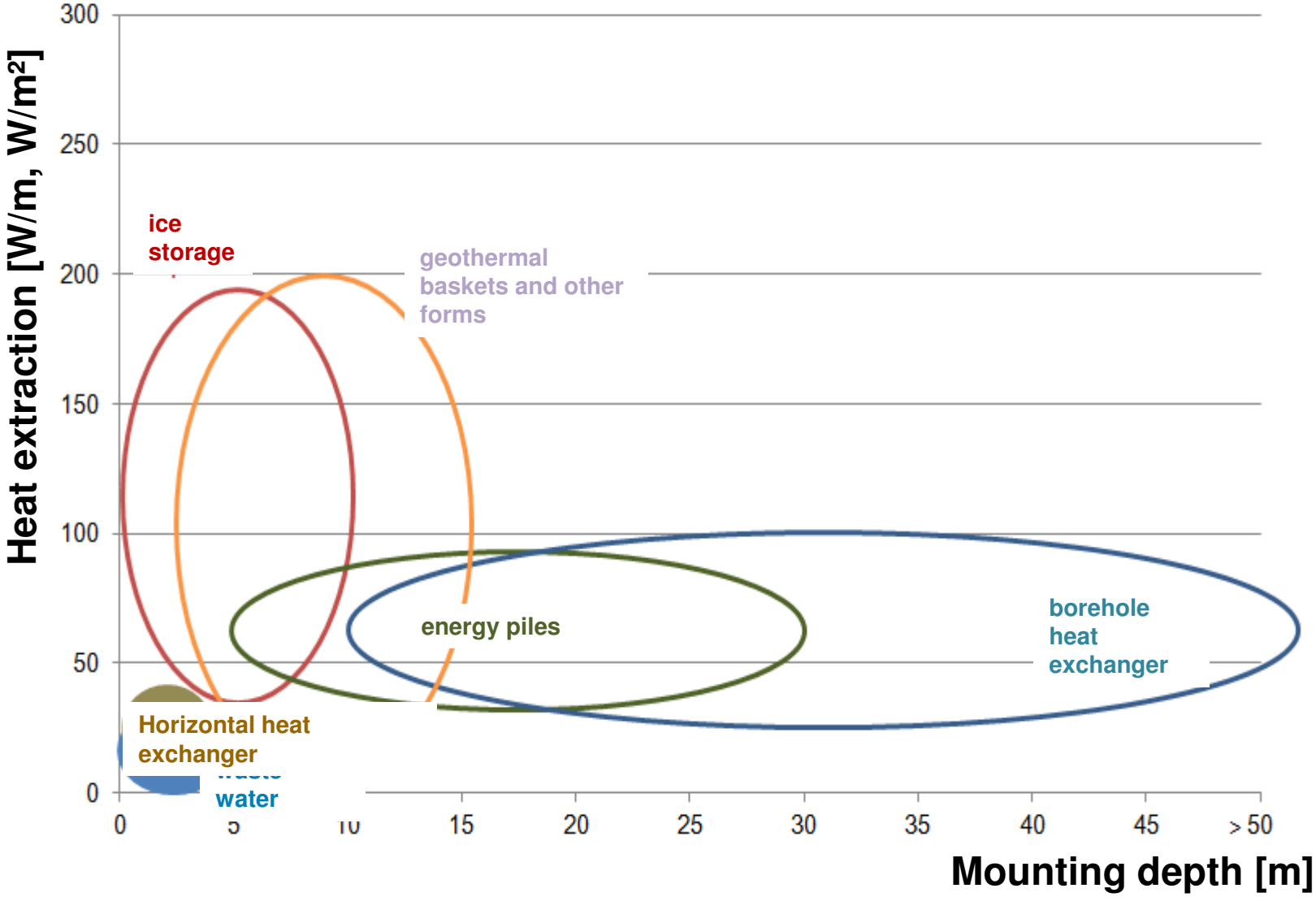
- Ideas and approaches for input / selection



Comparison


Heat extraction [W/m, W/m²]
300
250
200
150
100
50
0
ice storage
geothermal baskets and other forms
energy piles
borehole heat exchanger
Horizontal heat exchanger
water
0
5
10
15
20
25
30
35
40
45
> 50
Mounting depth [m]

Many thanks!

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We see us !

CHILLVENTA

Nuremberg, Germany 11–13.10.2016

International Exhibition

Refrigeration | AC & Ventilation | Heat Pumps

EUROPEAN HEAT PUMP SUMMIT

powered by Chillventa

Nuremberg, Germany 24–25.10.2017