

CONNECTING  
EXPERTS.

# CHILLVENTA eSPECIAL

Refrigeration | AC & Ventilation | Heat Pumps

13.–15.10.2020

NÜRNBERG MESSE

# Low Charge Heat Pump Module

—

## development and evaluation of charge reduced designs using 150g of R-290

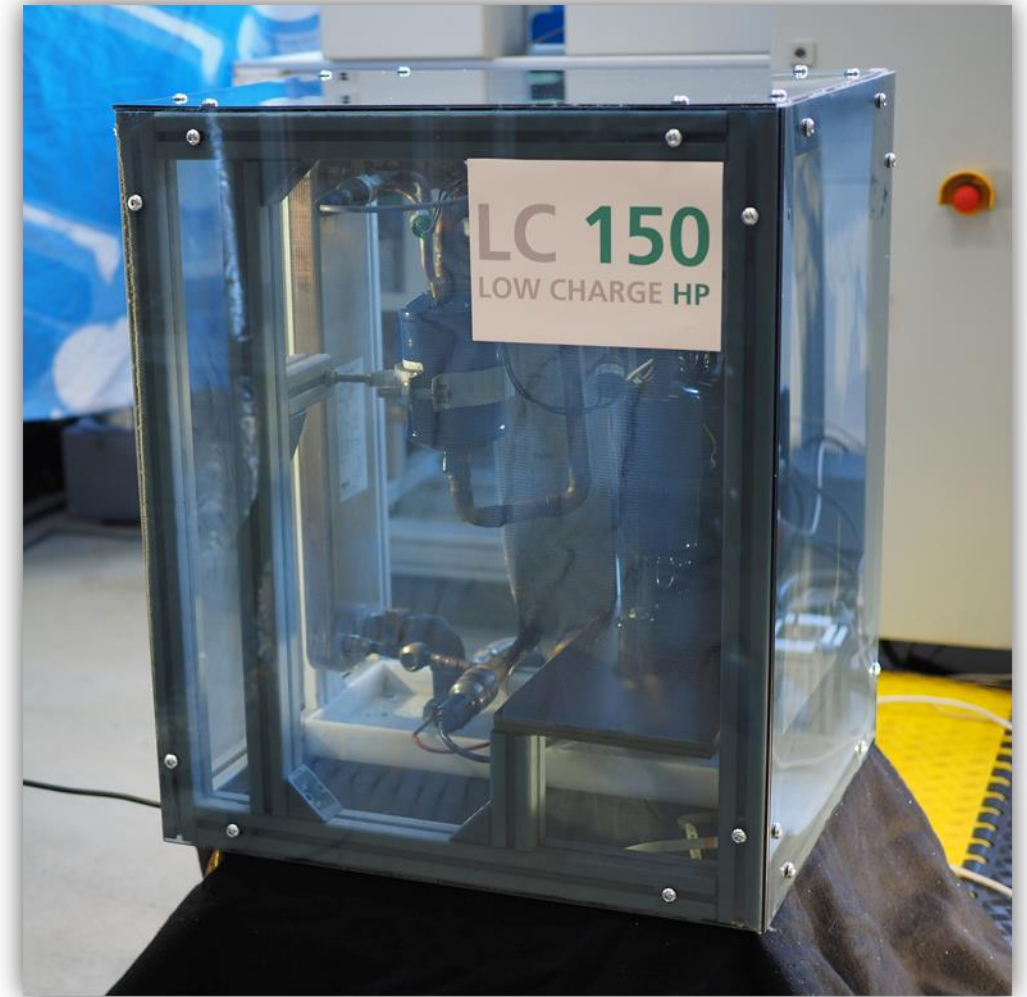
Lena Schnabel, Clemens Dankwerth, Timo Methler, Peter Schossig

Fraunhofer-Institute for Solar Energy Systems – ISE

[www.ise.fraunhofer.de](http://www.ise.fraunhofer.de)

# Low Charge Heat Pump Module using 150g of R-290

- Motivation and targets of the feasibility study
- Design of the heat pump module
- Measurements and results
- Targets of the LC150 project and consortium

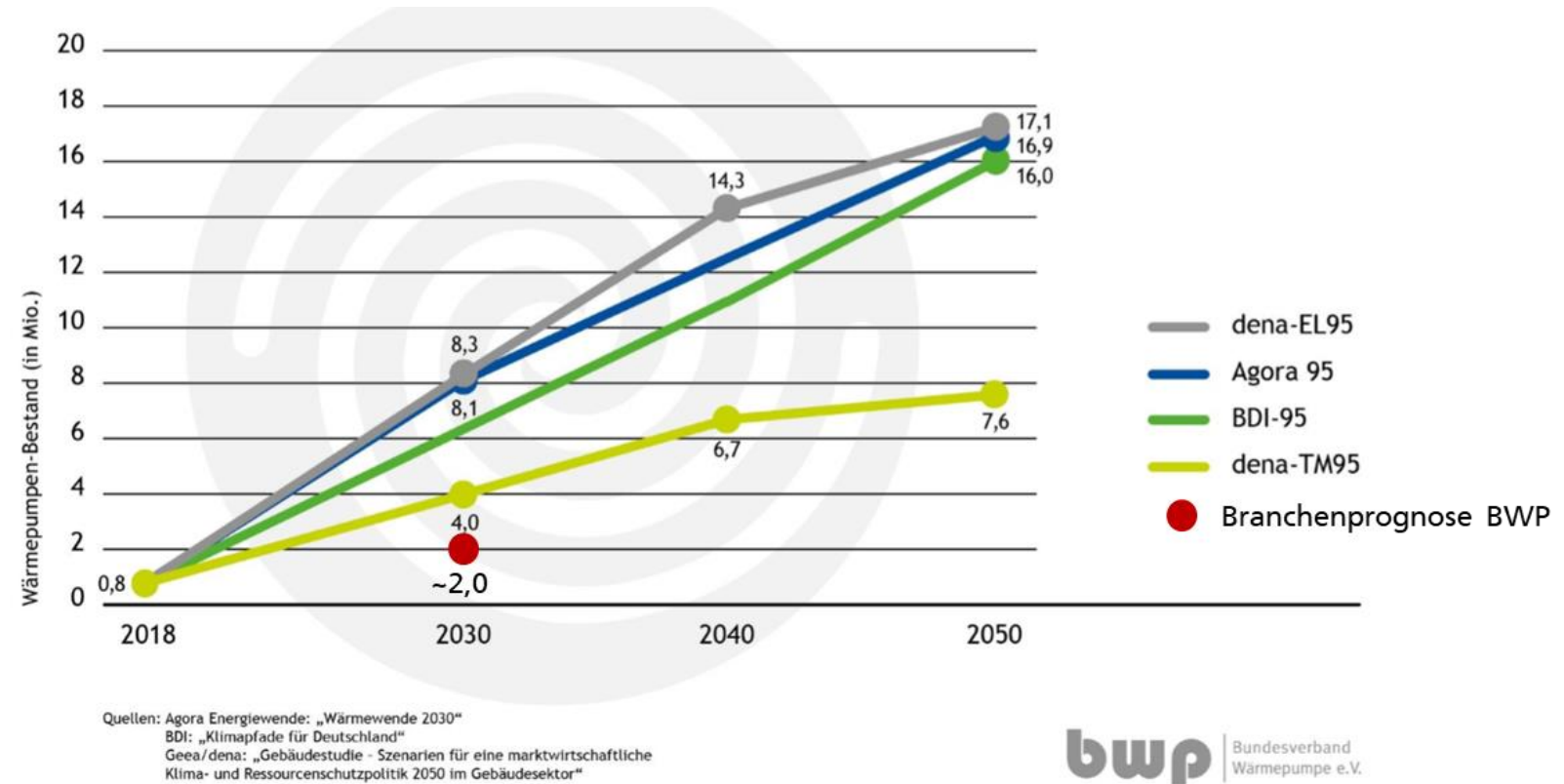




# Low Charge Heat Pump Module using 150g of R-290

## motivation and targets

- Heat pumps are the central heating technology for a climate-friendly future
- The market share has to increase drastically in order to reach the needed reductions in CO<sub>2</sub> emissions
- New refrigerant solutions are needed due to F-Gas-Regulation

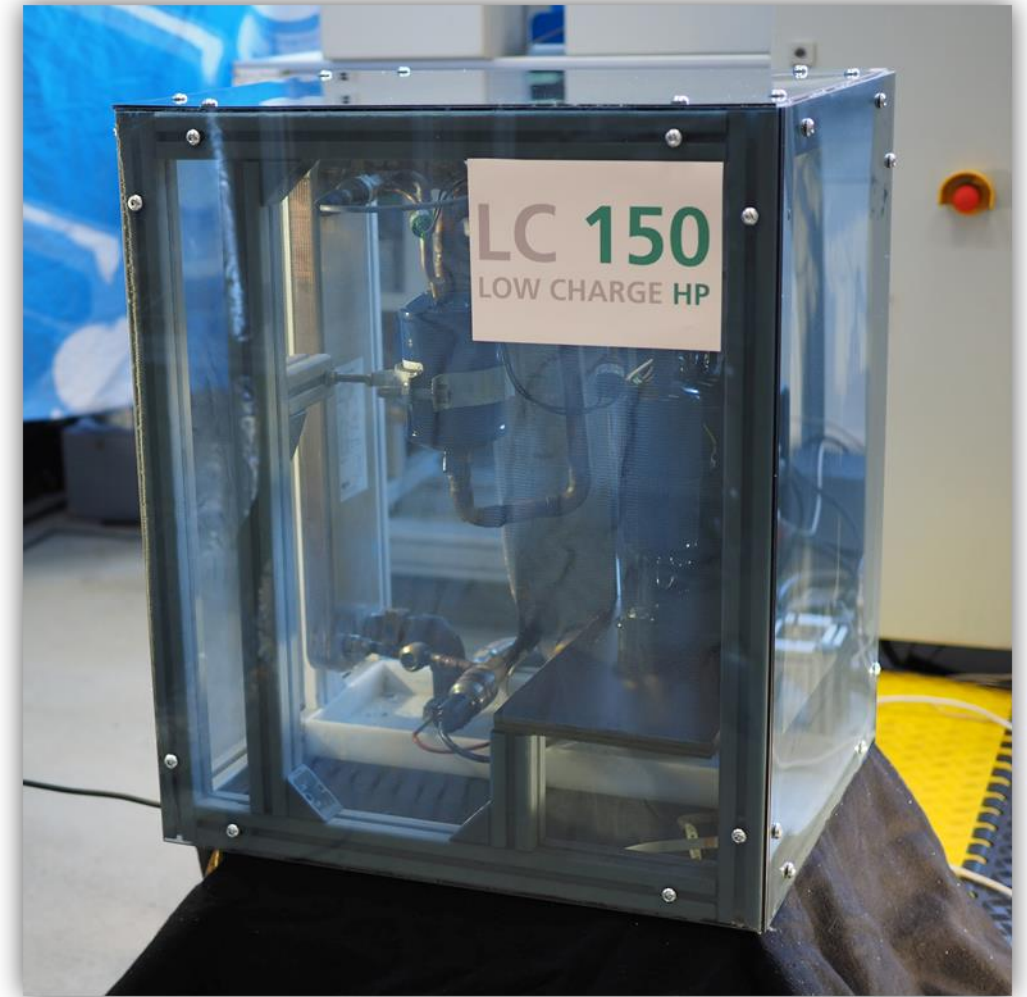


# Low Charge Heat Pump Module using 150g of R-290

## motivation and targets

### Targets of the feasibility study

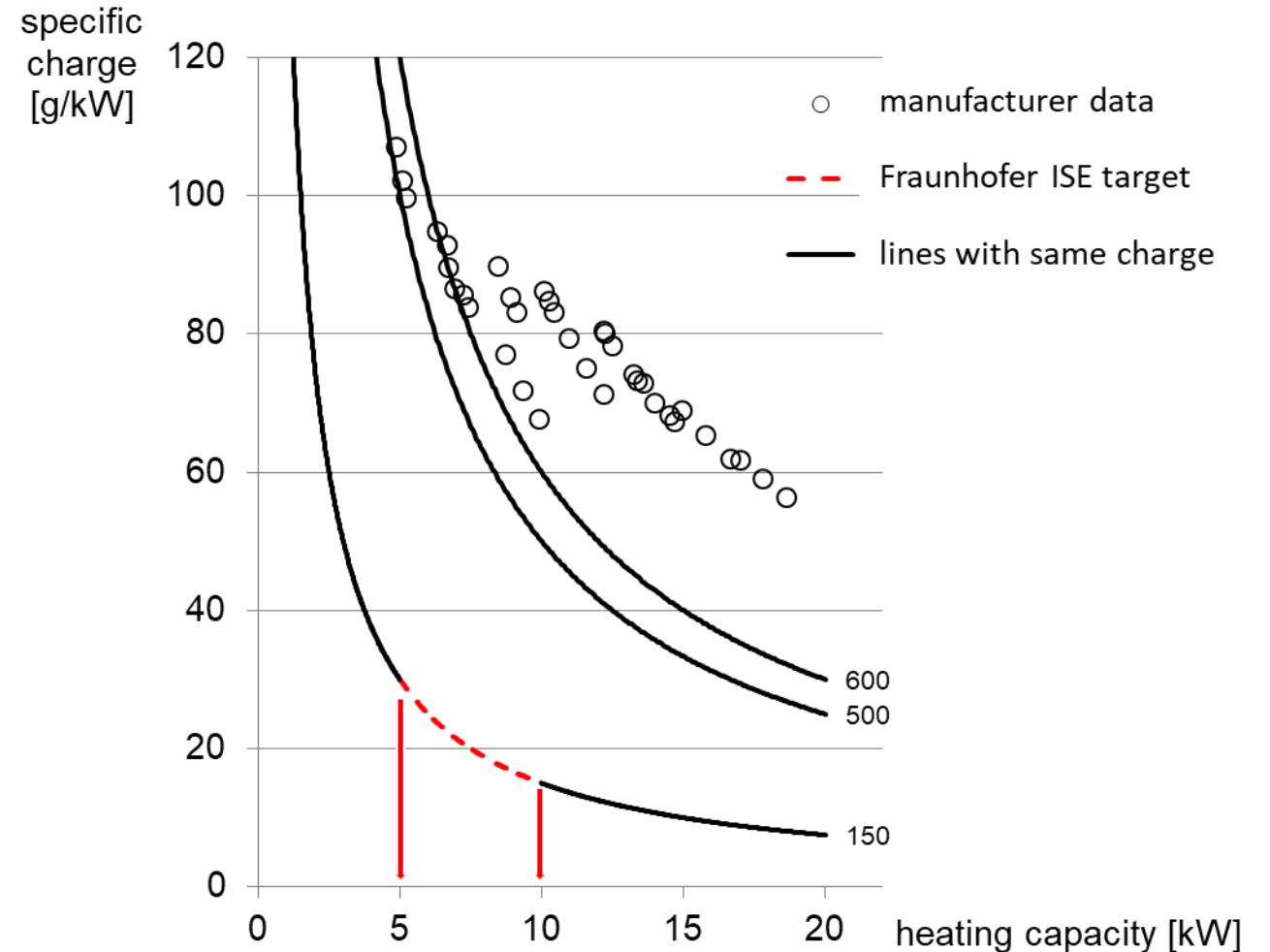
- Use of propane (R290) as refrigerant
- Does not exceed more than 150g of charge
- Providing a heating capacity between 5-10kW
- Use of market available components



# Low Charge Heat Pump Module using 150g of R-290

## Motivation and targets

- Market available brine-to-water heat pumps systems use 60-100 g/kW of refrigerant charge
- 150 g of refrigerant for 5-10 kW heating capacity corresponds to ~20 g/kW

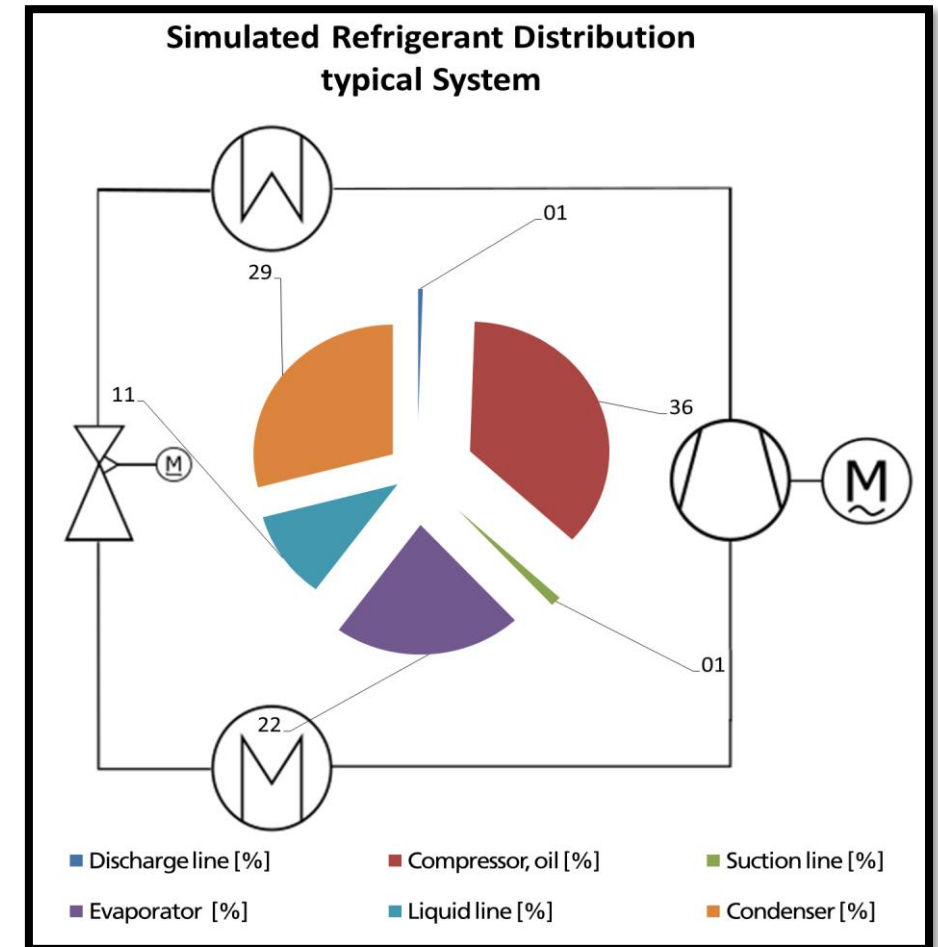


# Low Charge Heat Pump Module using 150g of R-290

## Design of the heat pump module

Addressing the parts with high refrigerant content

- reduced volume due to asymmetric plate heat exchangers
- Reduced diameter and length of piping
- Reduced quantity of oil in cooperation with compressor manufacturer



# Low Charge Heat Pump Module using 150g of R-290

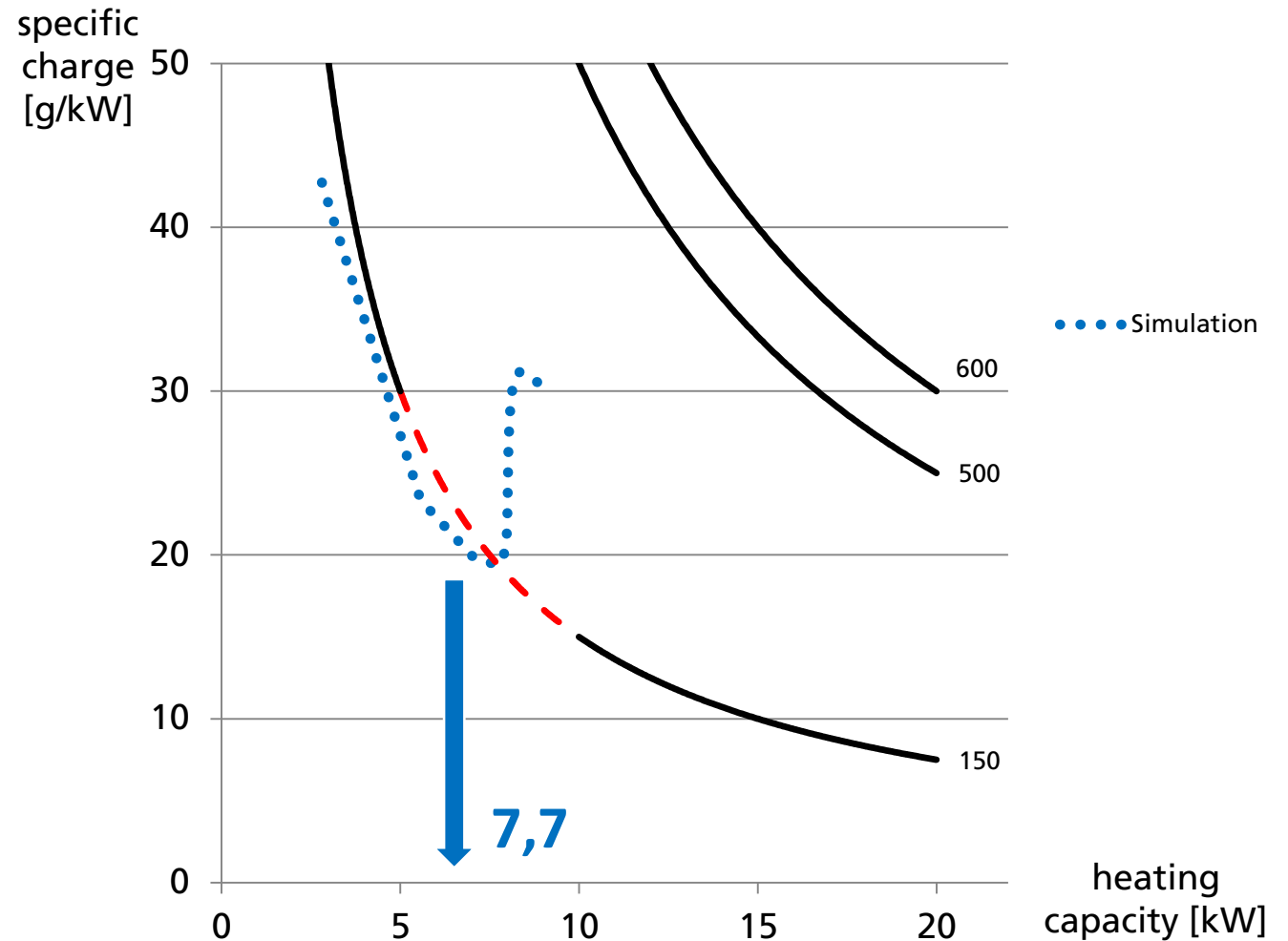
## Design of the heat pump module

Addressing the parts with high refrigerant content

- reduced volume due to asymmetric plate heat exchangers
- Reduced diameter and length of piping
- Reduced quantity of oil in cooperation with compressor manufacturer

➤ Simulation results for B0/W35 @120Hz, SH10K:

- design meets the addressed capacity range, predicted COP 3.3 (120Hz), 3.59 (60Hz)



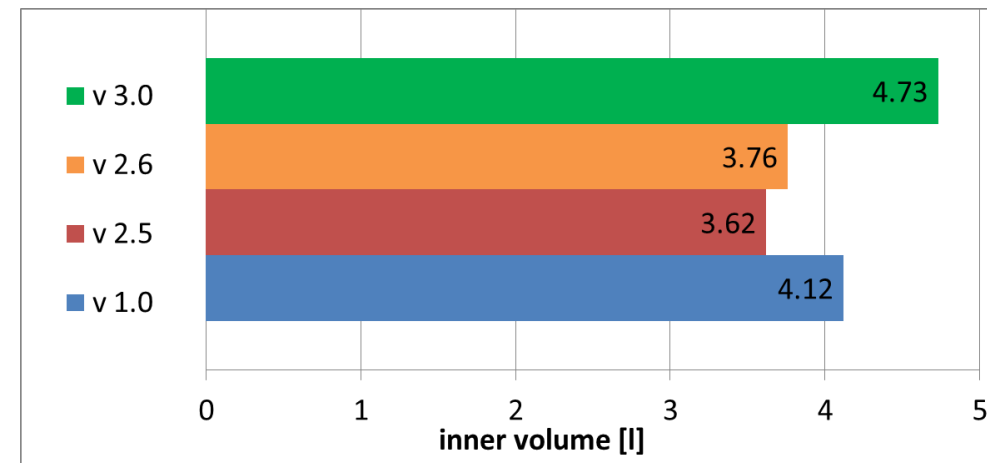


# Low Charge Heat Pump Module using 150g of R-290

## Measurements and results

### Evaluation of four different configurations

- Two different compressor types
- different heat exchanger types



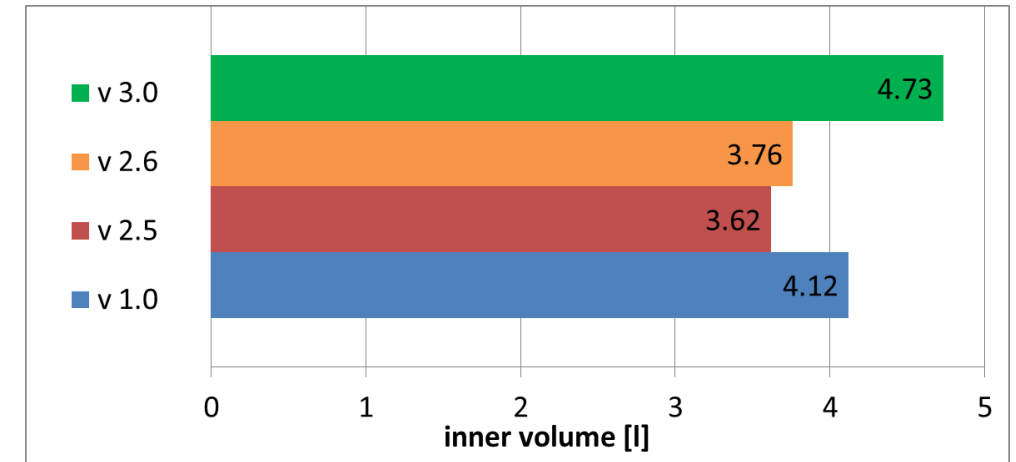
	V 1.0	V 2.5	V 2.6	V 3.0
Compressor	Scroll Manufacturer 1	Rotary v1 Manufacturer 2	Rotary v1 Manufacturer 2	Rotary v1 Manufacturer 2
Condenser	Long Asymmetric 16 Plates	Long Asymmetric 16 Plates	Short Asymmetric 38 Plates	Short Asymmetric 46 Plates
Evaporator	Long Asymmetric 16 Plates	Long Asymmetric 16 Plates	Long Symmetric 16 Plates	Long Symmetric 28 Plates
Piping	Pipes v1	Pipes v1	Pipes v1	Pipes v2

# Low Charge Heat Pump Module using 150g of R-290

## Measurements and results

### Evaluation of four different configurations

- Two different compressor types
- different heat exchanger types

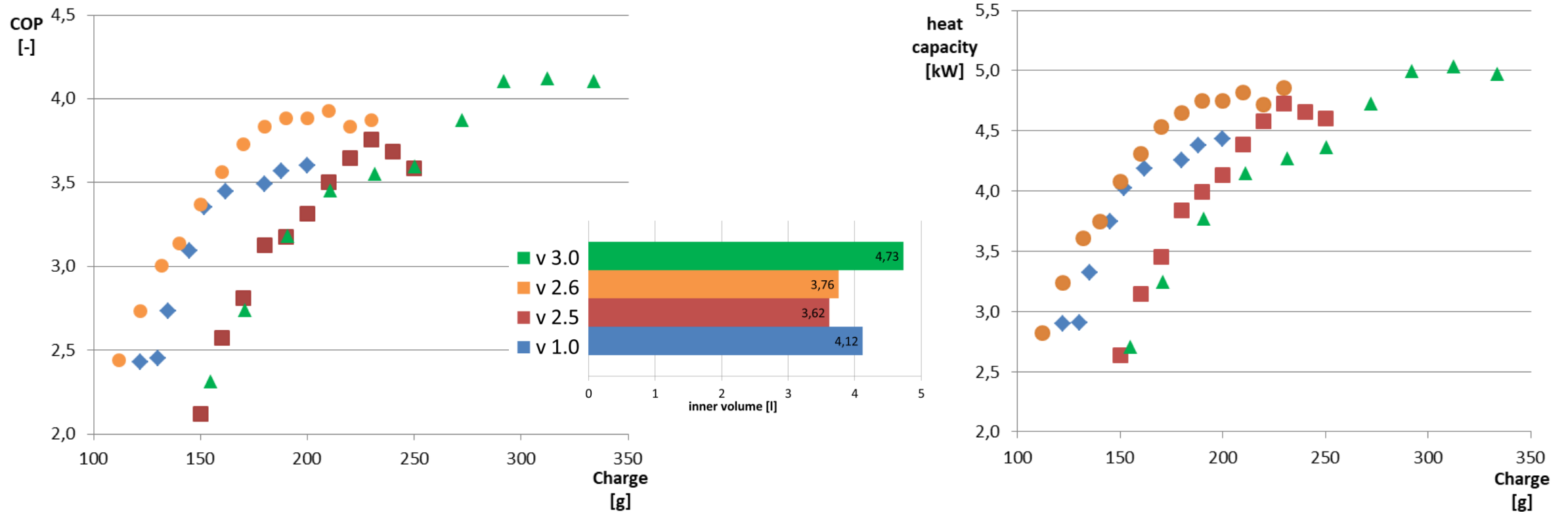


	V 1.0	V 2.5	V 2.6	V 3.0
Compressor	Scroll Manufacturer 1	Rotary v1 Manufacturer 2	Rotary v1 Manufacturer 2	Rotary v1 Manufacturer 2
Condenser	CB65-16AH-F	CB65-16AH-F	CB24-38AH-F	CB24-46AH
Evaporator	ACH72-16AH-F	ACH72-16AH-F	CB62-16H-F	CB62-28H-F
Piping	Pipes v1	Pipes v1	Pipes v1	Pipes v2 (Sammler)

# Low Charge Heat Pump Module using 150g of R-290

## Measurements and results

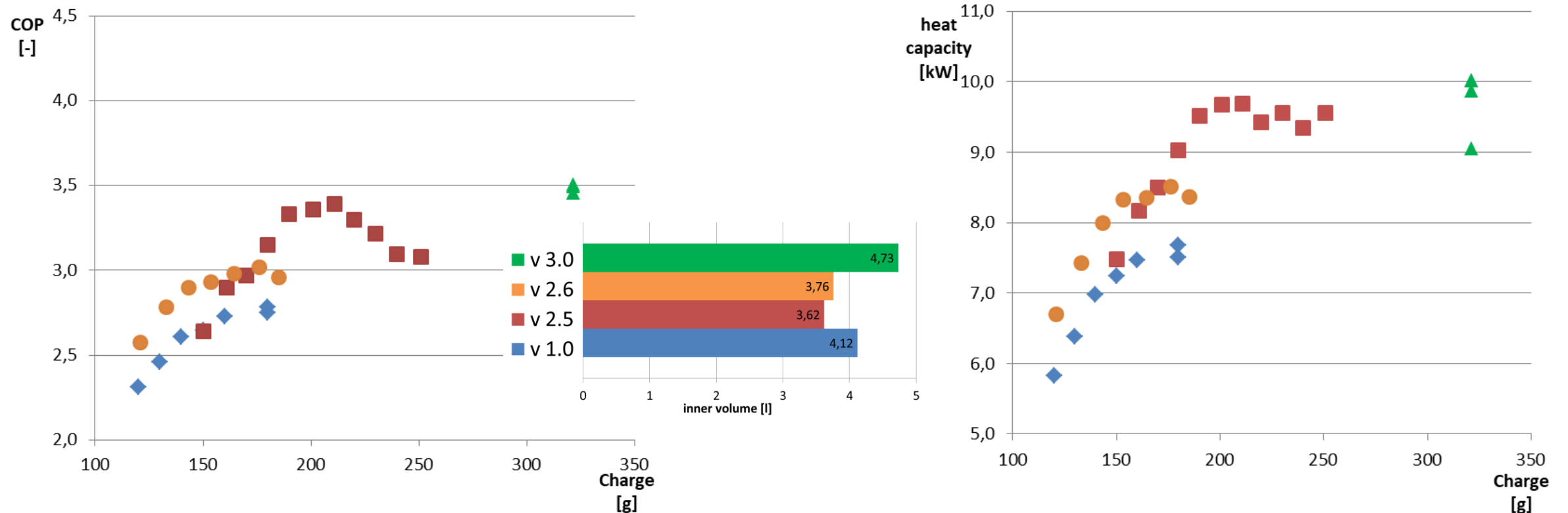
### Results for B0/W35 @60Hz, SH10K



# Low Charge Heat Pump Module using 150g of R-290

## Measurements and results

### Results for B0/W35 @120Hz, SH10K





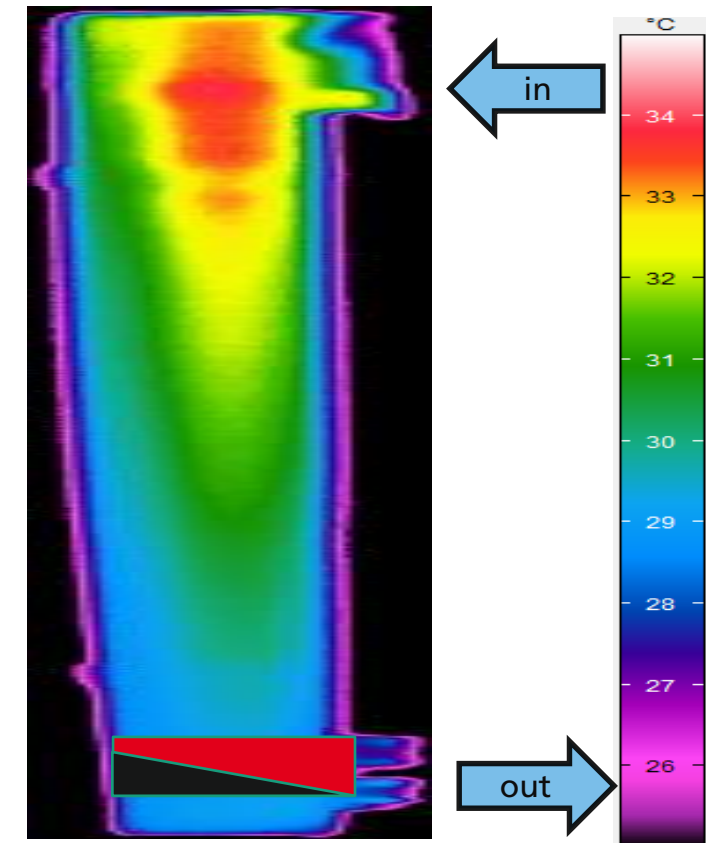
# Low Charge Heat Pump Module using 150g of R-290

## Measurements and results

- Pictures of ice profiles of the evaporator  
→ maldistribution → higher dTs → lower COPs



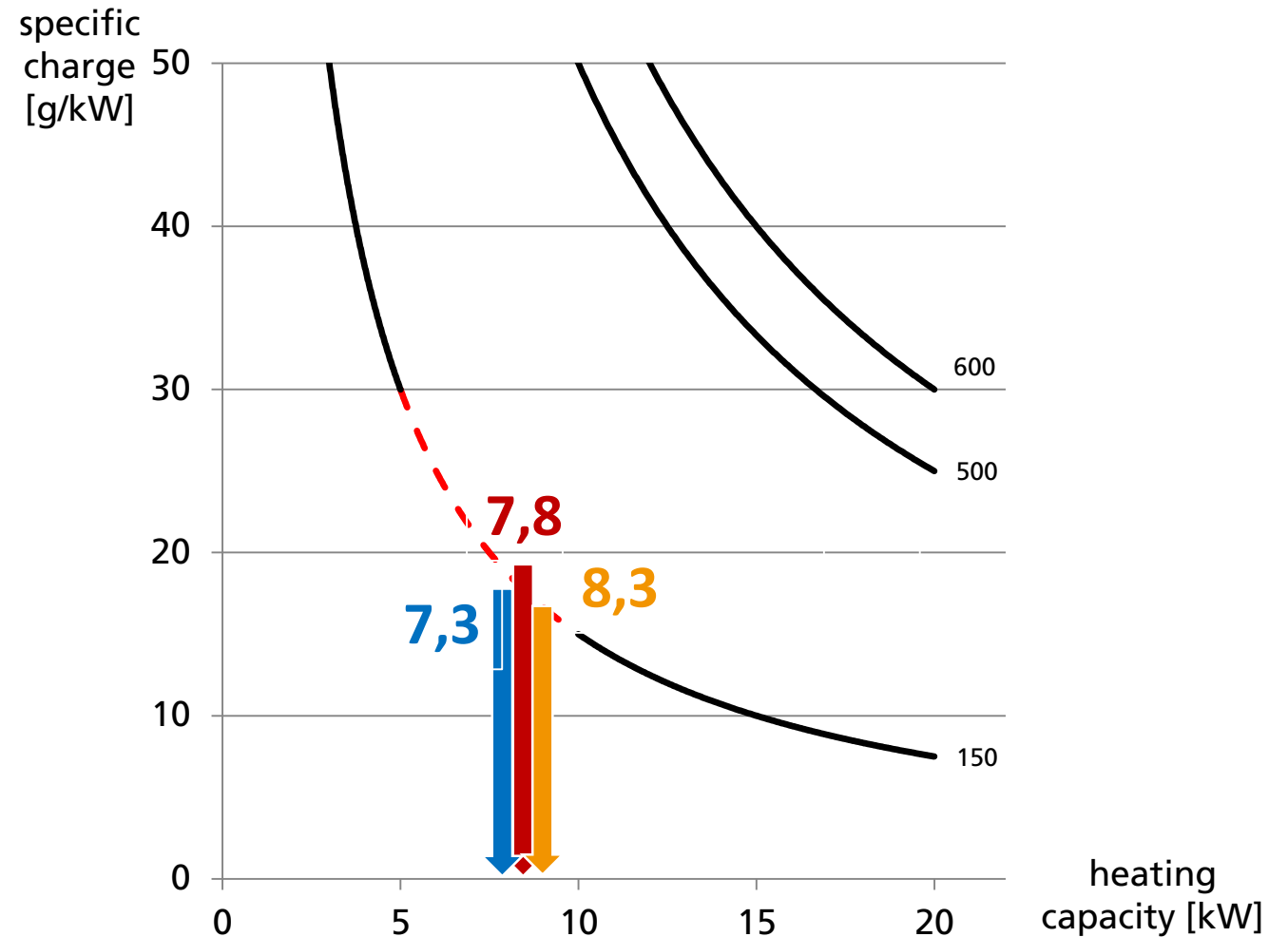
- Thermography pictures of the condenser  
→ maldistribution → higher dTs → lower COPs



# Low Charge Heat Pump Module using 150g of R-290

## summary

- With the Low Charge Heat Pump using 150g propane a heating capacity of ~8kW was achieved with different configurations.
- Combination of components and operation (compressor speed) gives a wide range of enhancing COP and heating capacity.
- COP will be further improved by
  - more equalized flow distribution in heat exchangers,
  - insulation of components,
  - well designed configuration.



# Low Charge Heat Pump Module using 150g of R-290

Project consortium LC150

CHILLVENTA  
eSPECIAL



Steering Committee, definition of requirements, receipt of results and access to IPs



1,2 Mio. € (approx. 1-4 % of total project volume, pro rata market share)



3,6 Mio. €  
(75 % funding rate)  
FKZ 03EN4001A

Supported by:



on the basis of a decision  
by the German Bundestag



## LC150 PLATFORM DEVELOPMENT OF A CHARGE-REDUCED HEAT PUMP MODULE WITH PROPANE

4,8 Mio. € project budget, 2.5 years, 1.10.2020 – 31.03.2023

- Component testing (heat exchangers, compressors, valves etc.) in single component tests and in broad cross evaluation
- Charge reduction and localization of refrigerant
- Operating strategies
- Standardization
- Network and platform for manufacturers

# Low Charge Heat Pump Module using 150g of R-290

## Project consortium LC150

- Vaillant, Kermi GmbH, Bosch Thermotechnik GmbH, Viessmann Werke Allendorf GmbH, BDR Thermea und ait-deutschland GmbH indicated their interest to participate in the advisory board and to cofinance the project
- Kick-off meeting will be in mid of November
- Project is still open for more participants until end of 2020! The participation fee depends on Your turnover with heat pumps.
- Contact:
  - Dr.-Ing. Lena Schnabel/ +49 761 4588-5412/ [lana.schnabel@ise.fraunhofer.de](mailto:lana.schnabel@ise.fraunhofer.de)
  - Lena Schnabel will be available at the virtual Fraunhofer ISE booth this afternoon (13-17 o'clock)
  - Dr.-Ing. Peter Schossig/ +49 761 4588-5130/ [peter.schossig@ise.fraunhofer.de](mailto:peter.schossig@ise.fraunhofer.de)



**Thank you for your  
attention.**

**CONNECTING  
EXPERTS.**

