

EXPERIMENTAL EVALUATION OF A CHARGE REDUCED HEAT PUMP MODULE USING 150G OF PROPANE

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Clemens Dankwerth, Timo Methler, Thore
Oltersdorf, Peter Schossig, Lena Schnabel

Fraunhofer Institute for Solar Energy Systems ISE

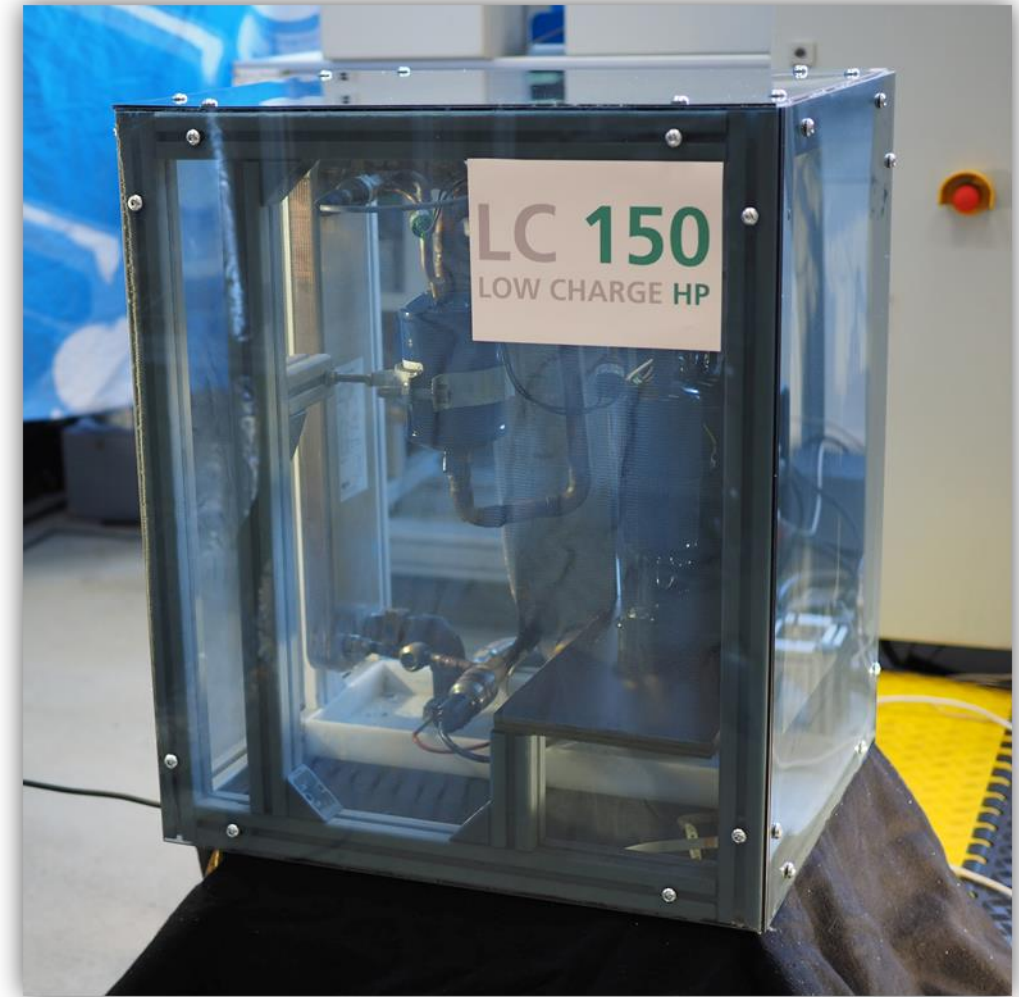
Freiburg/ Japan, 9.12.2020

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

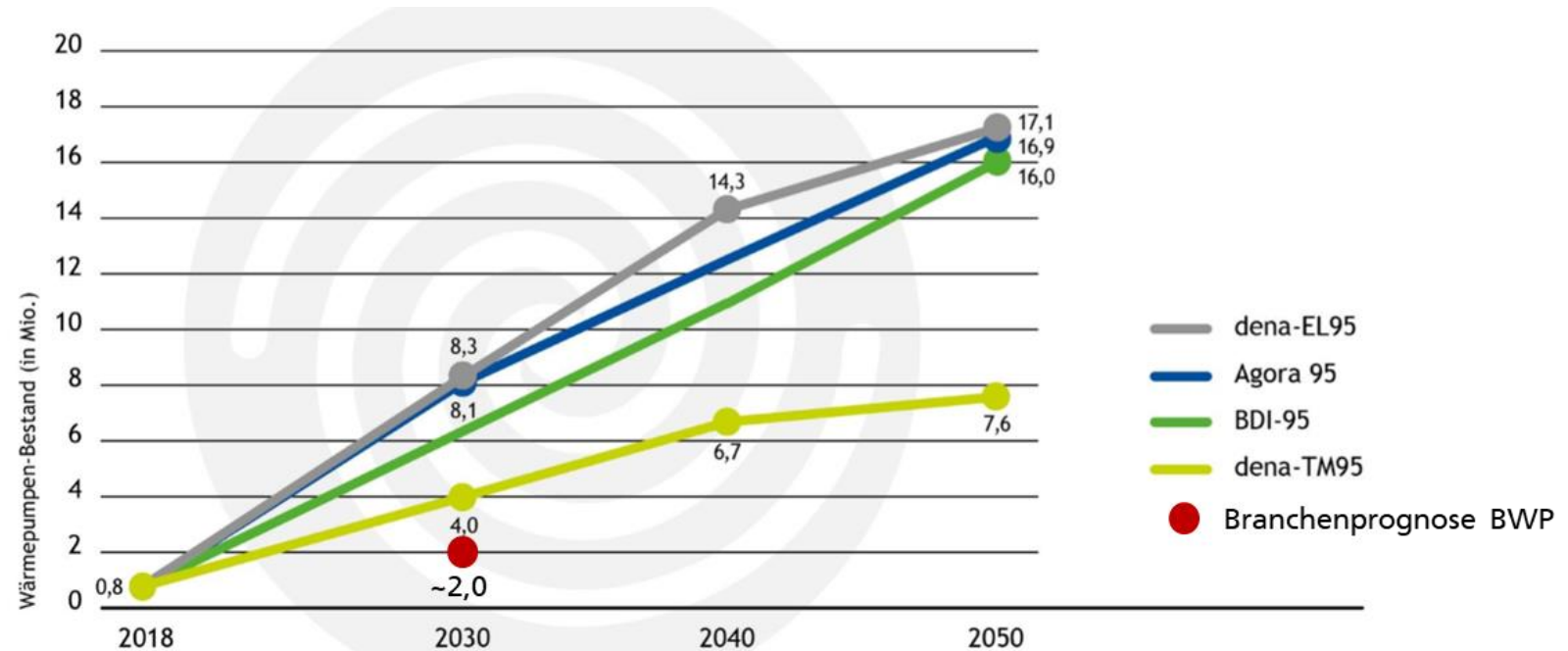
- Motivation and targets of the feasibility study
- Design of the heat pump module
- Measurements and results
- Targets of the LC150 project and consortium



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 be increased drastically in order to reach the needed reductions in CO₂ emissions
- New refrigerant solutions are needed due to F-Gas-Regulation



Quellen: Agora Energiewende: „Wärmewende 2030“
 BDI: „Klimapfade für Deutschland“
 Geea/dena: „Gebäudestudie - Szenarien für eine marktwirtschaftliche
 Klima- und Ressourcenschutzpolitik 2050 im Gebäudesektor“

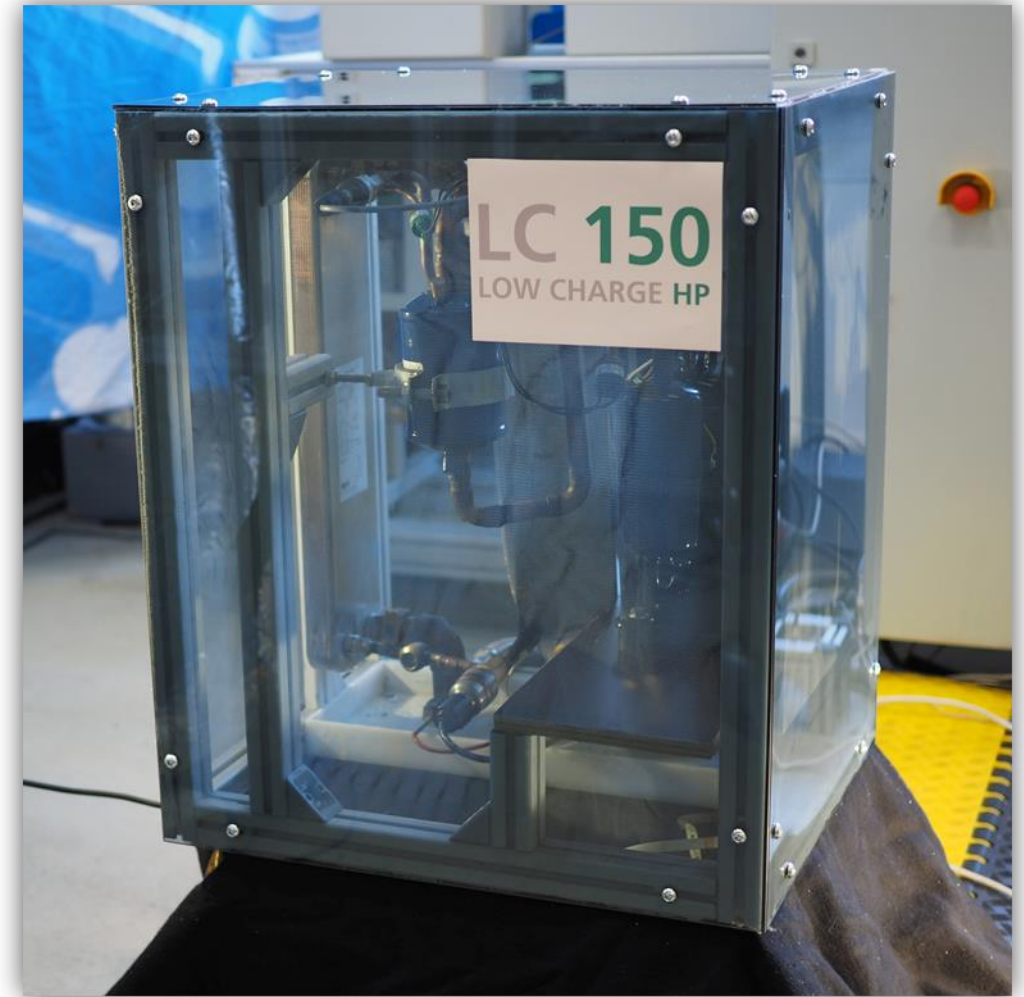
bwp Bundesverband
 Wärmepumpe e.V.

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

motivation and targets

Targets of the feasibility study (10/18 – 09/20)

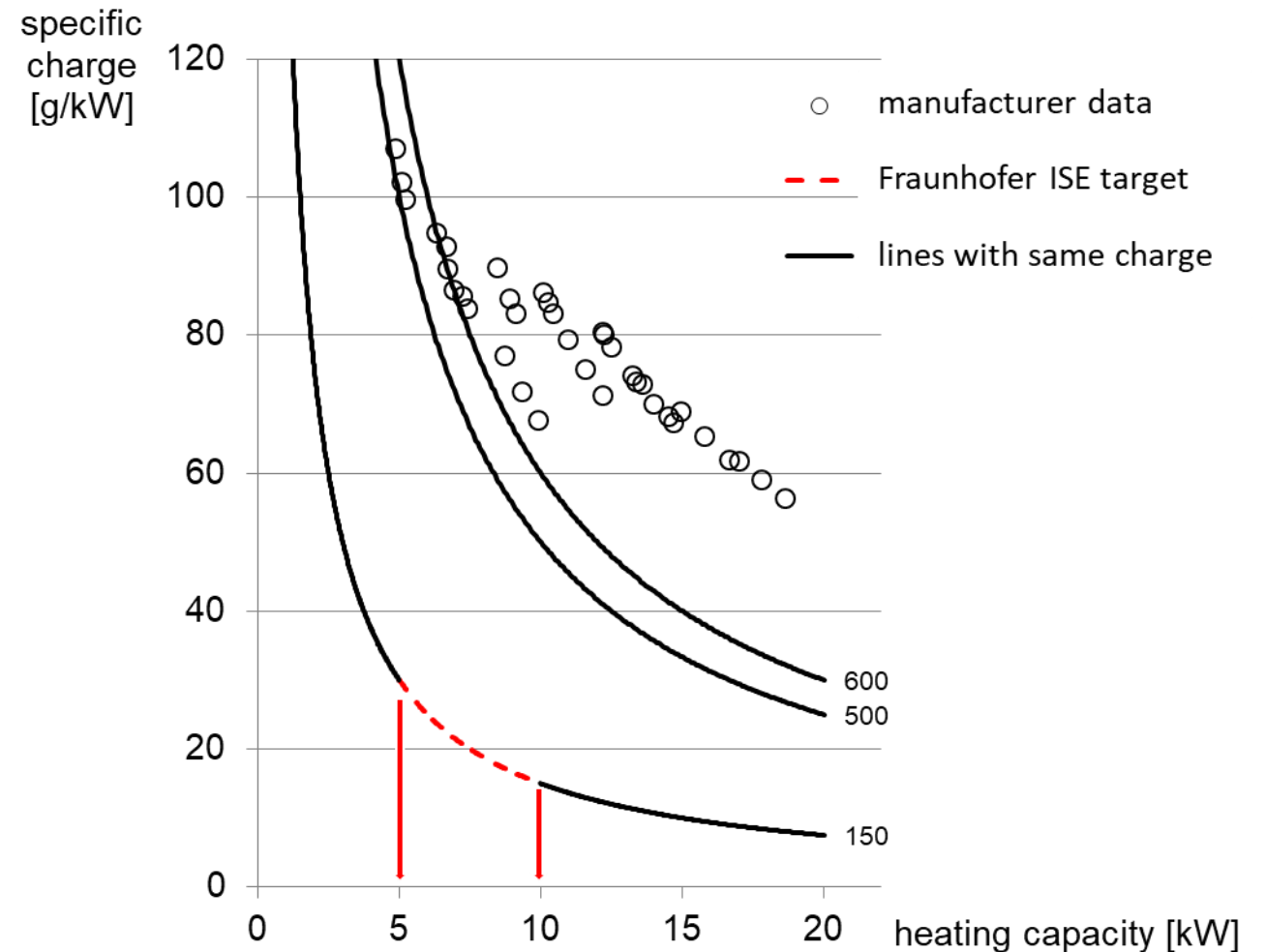
- Use of propane (R290) as refrigerant
- Does not exceed more than 150g of charge
- Providing a heating capacity between 5-10kW
- Use of market available components



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



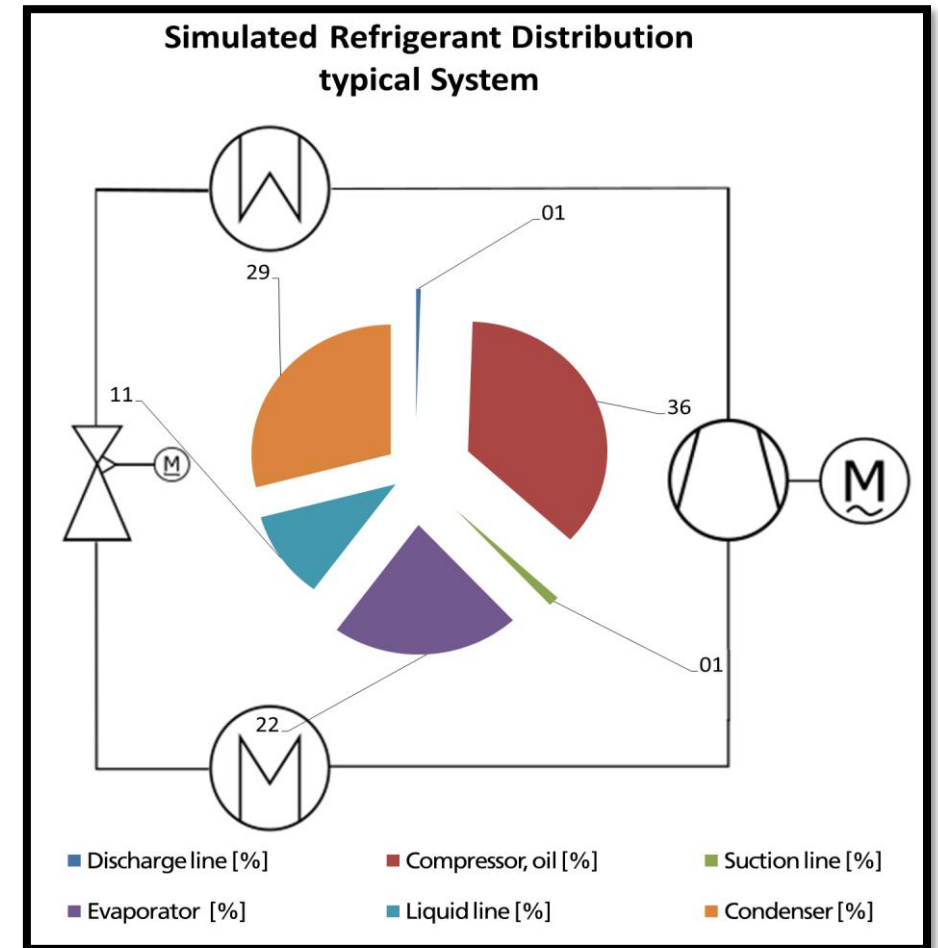
Low Charge Heat Pump Module using 150g of R-290

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



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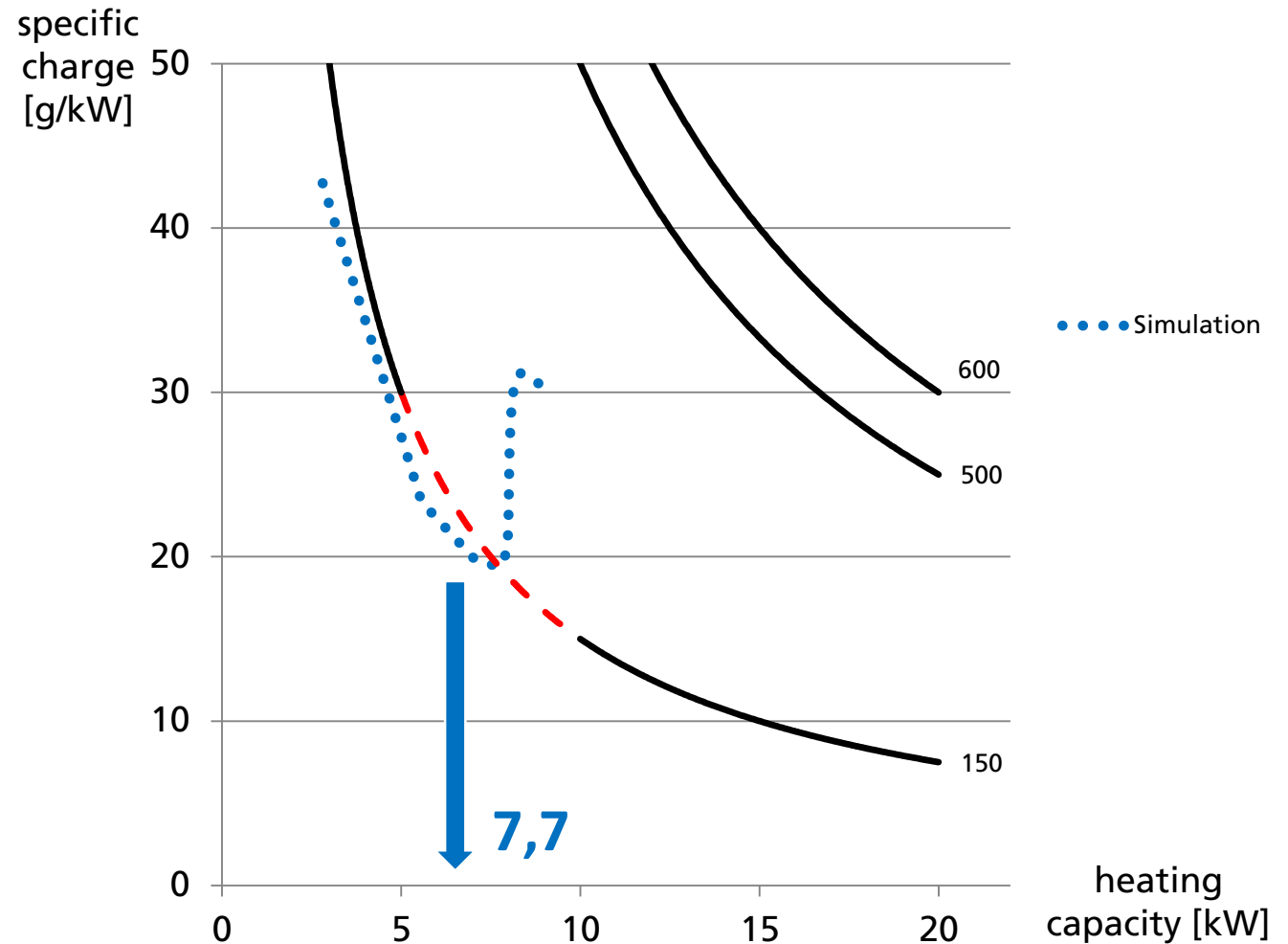
Design of the heat pump module

Addressing the parts with high refrigerant content

- reduced volume due to asymmetric plate heat exchangers
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➤ **Simulation results for B0/W35 @120Hz, SH10K (IMST-Art):**

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



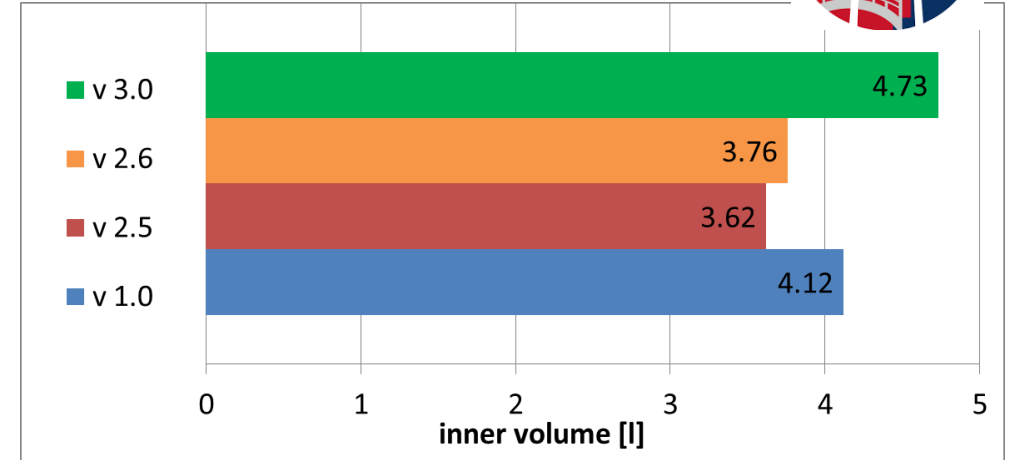
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Measurements and results



Evaluation of four different configurations

- Two different compressor types
- different heat exchanger types
- Variation of temperatures, superheat, compressor speed, refrigerant charge



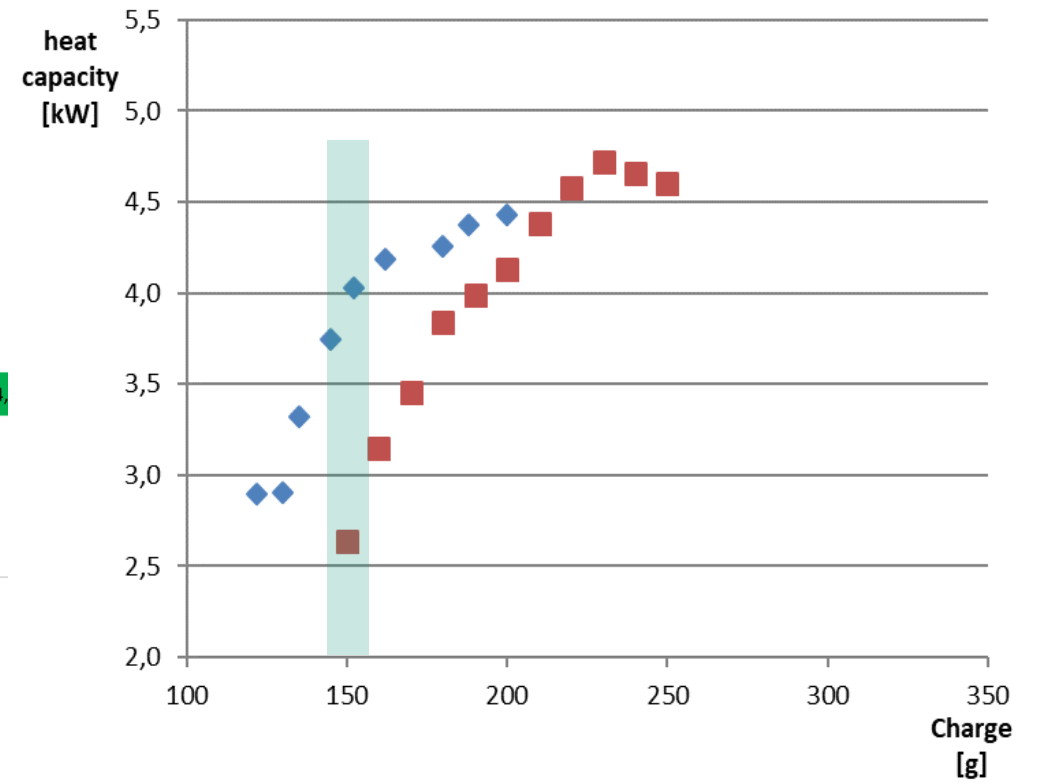
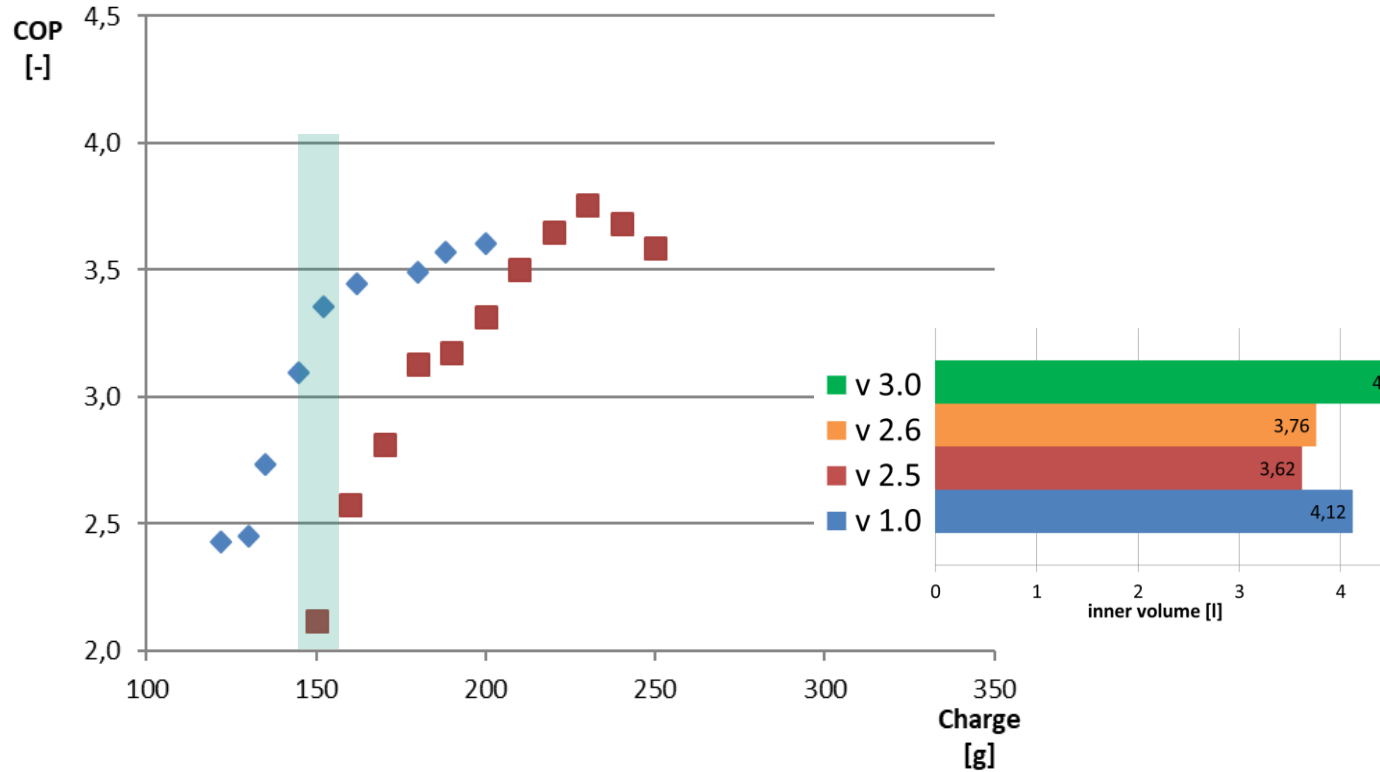
	V 1.0	V 2.5	V 2.6	V 3.0
Compressor	Scroll Manufacturer 1	Rotary v1 Manufacturer 2	Rotary v1 Manufacturer 2	Rotary v1 Manufacturer 2
Condenser	Long Asymmetric 16 Plates	Long Asymmetric 16 Plates	Short Asymmetric 38 Plates	Short Asymmetric 46 Plates
Evaporator	Long Asymmetric 16 Plates	Long Asymmetric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



Results for B0/W35 @60Hz, SH10K





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

Measurements and results

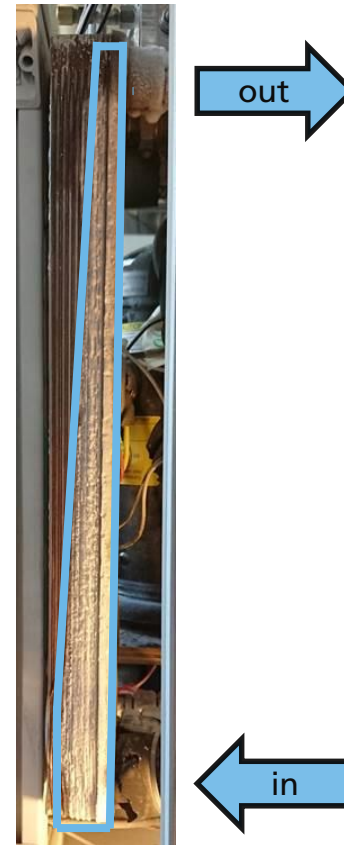
- Max. COP/ heating capacity strongly depends on the refrigerant charge.
- Choice of the compressor system shifted the max. COP/ heating capacity to higher refrigerant charges.

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

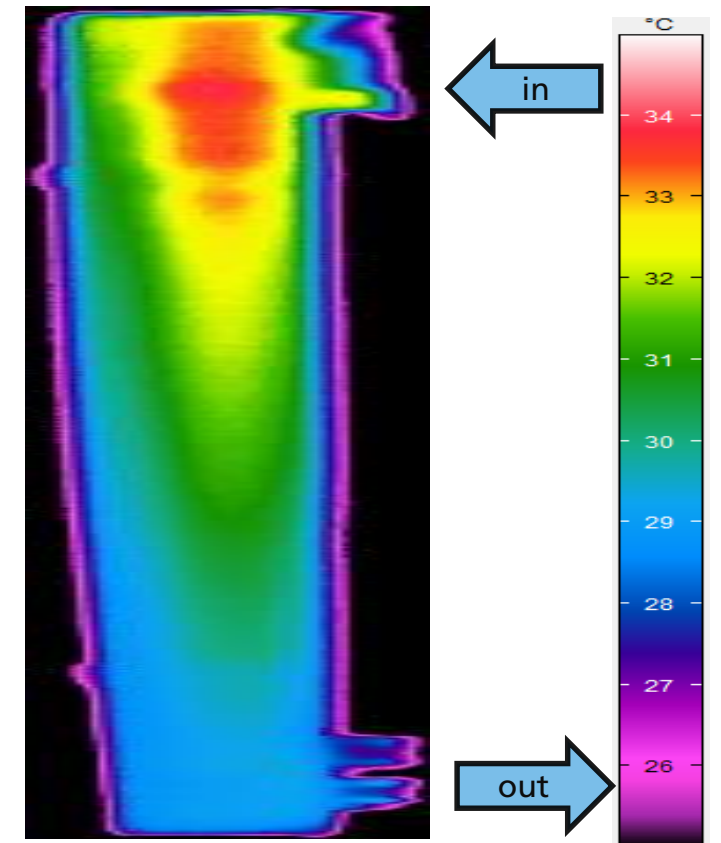
Measurements and results

- Max. COP/ heating capacity strongly depends on the refrigerant charge.
- Choice of the compressor system shifted the max. COP/ heating capacity to higher refrigerant charges.
- Visual analysis of the heat exchangers with pictures of the ice profile and thermography indicates maldistribution.
- Maldistribution leads to higher temperature differences/ reduced COPs.

evaporator



condenser

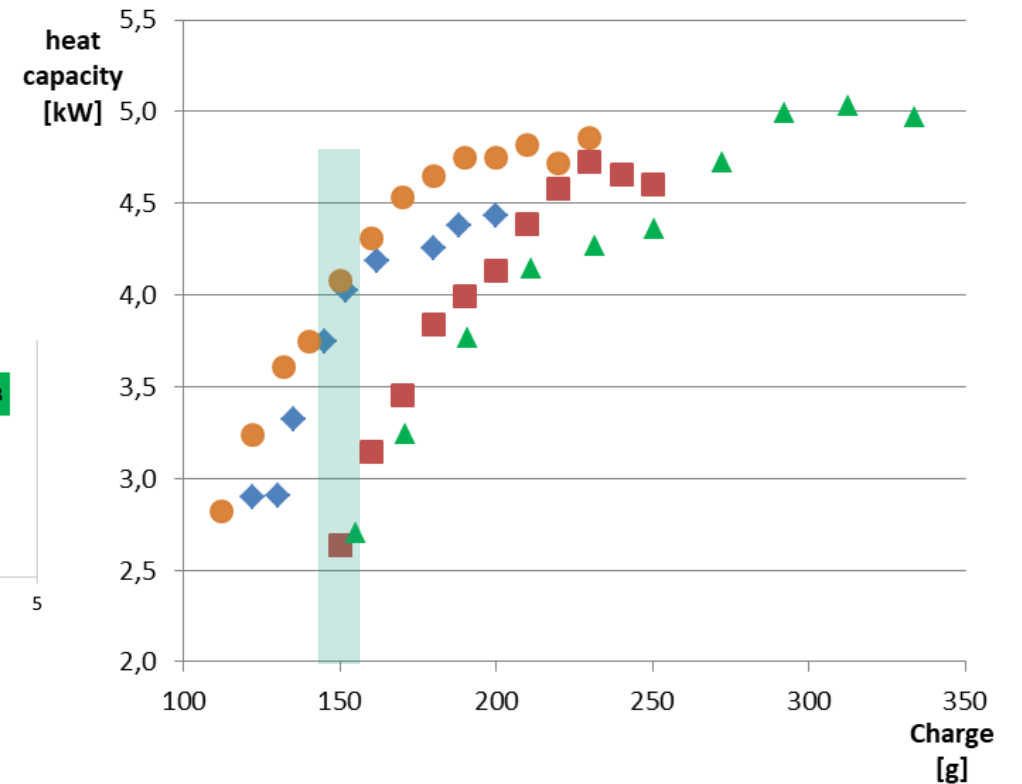
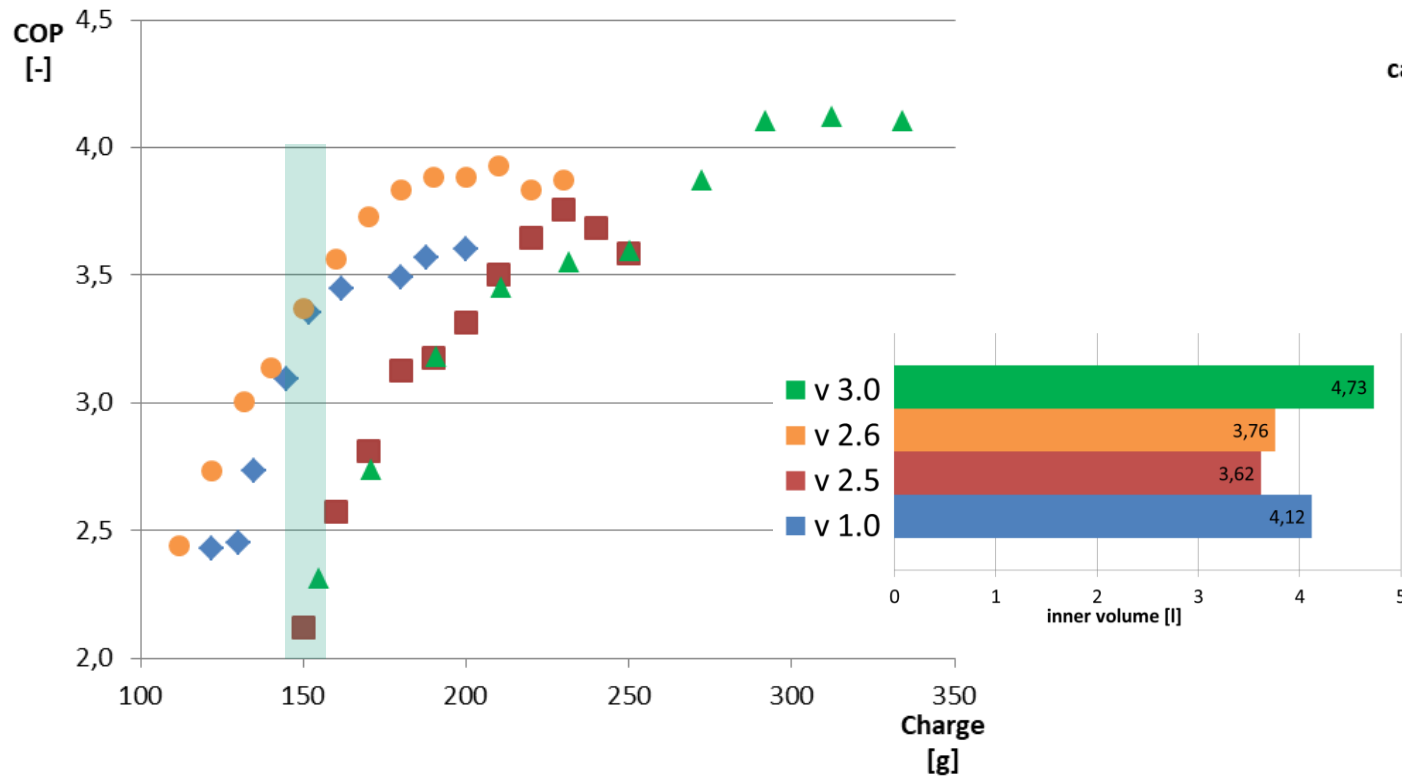


Low Charge Heat Pump Module using 150g of R-290

Measurements and results



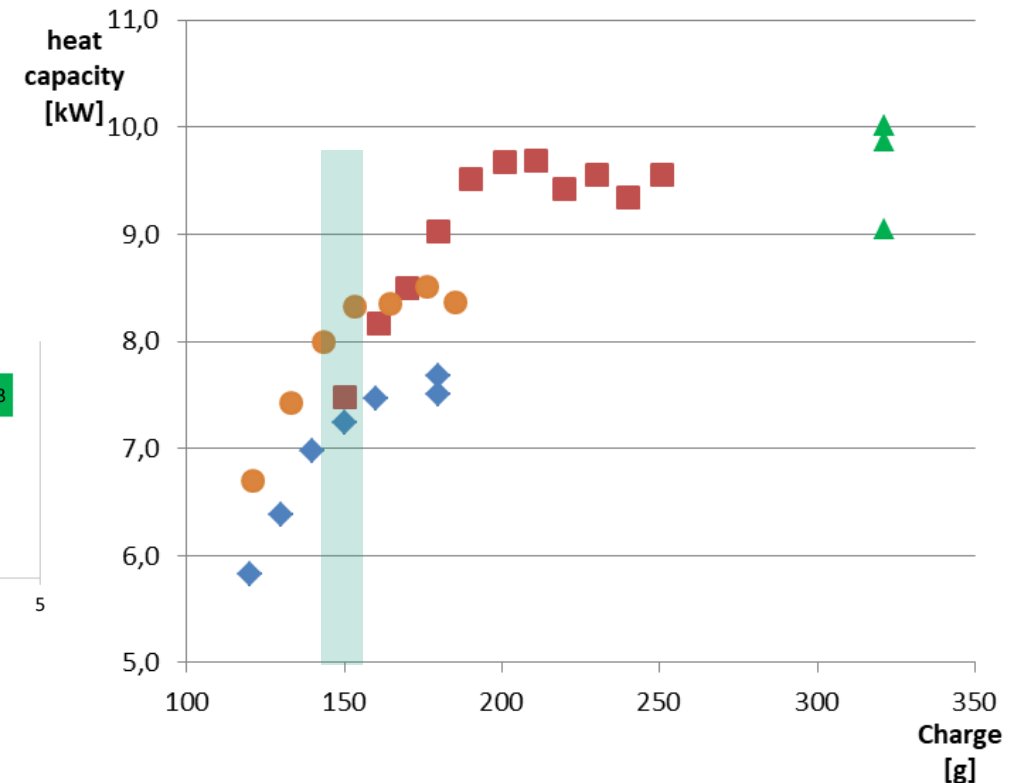
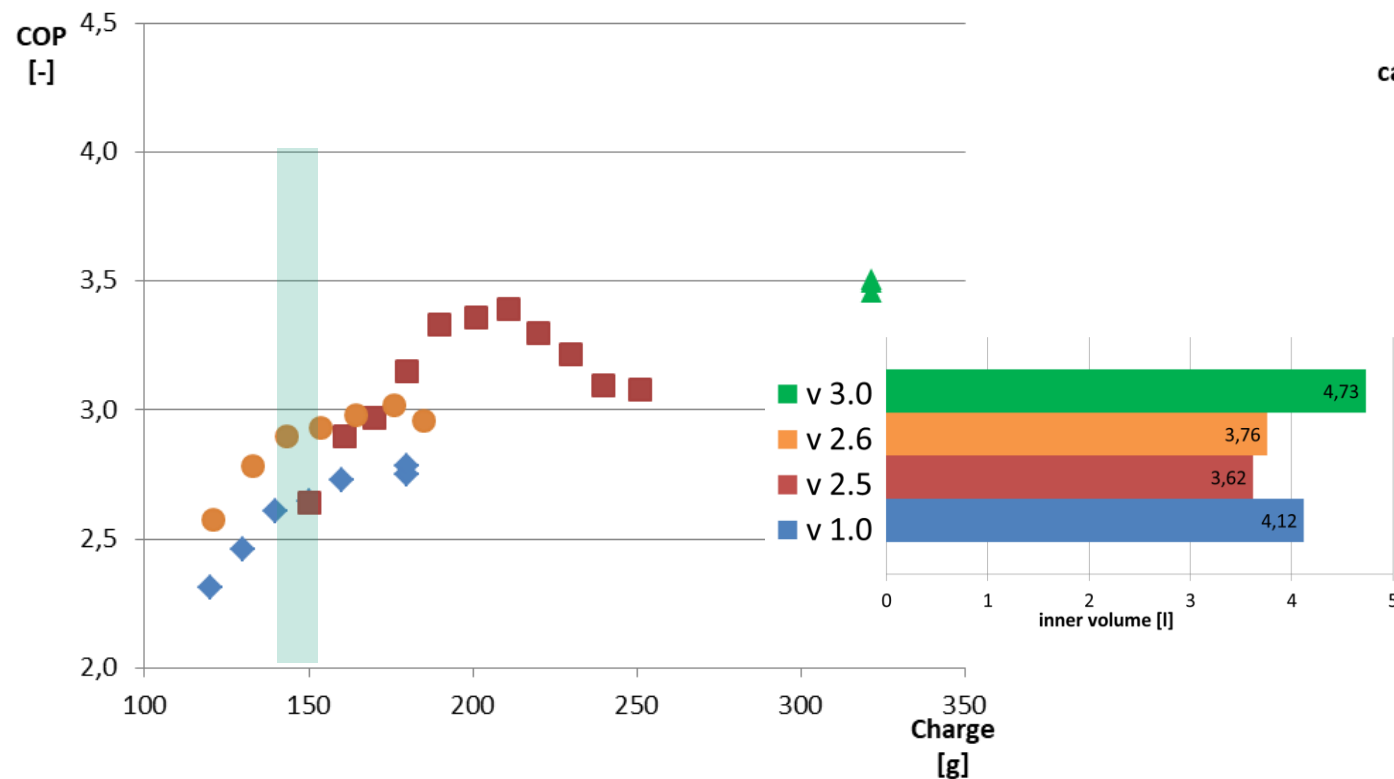
Results for B0/W35 @60Hz, SH10K



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

Measurements and results

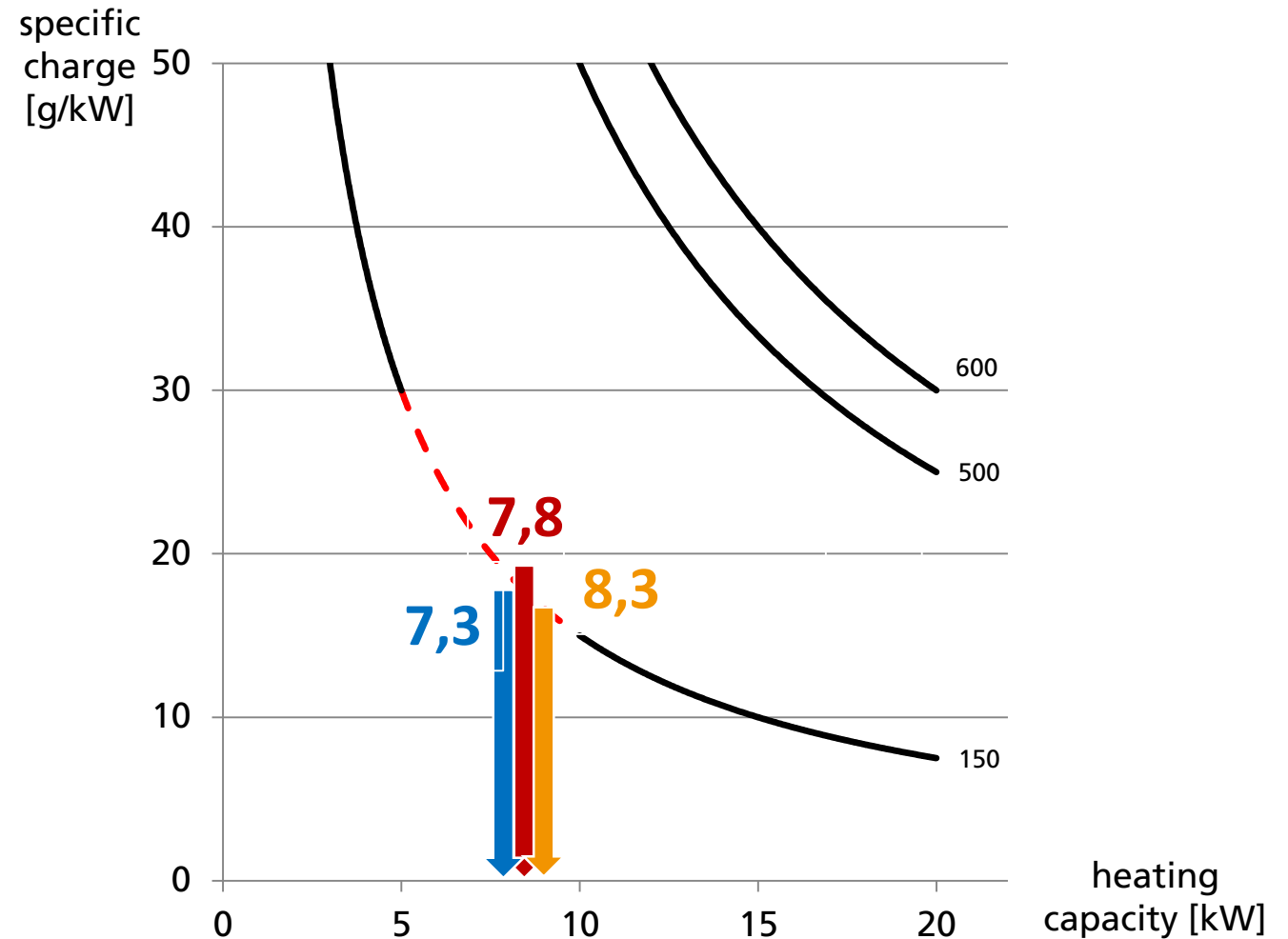
Results for B0/W35 @120Hz, SH10K



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

summary

- Using 150g propane a heating capacity of ~8kW was achieved – corresponding to 75 % charge reduction.
- Combination of components and operation (compressor speed, superheat, different HX designs) gives a wide range of enhancing COP and heating capacity.
- COP can be further improved by
 - more equalized flow distribution in heat exchangers,
 - insulation of components,
 - well designed configuration.



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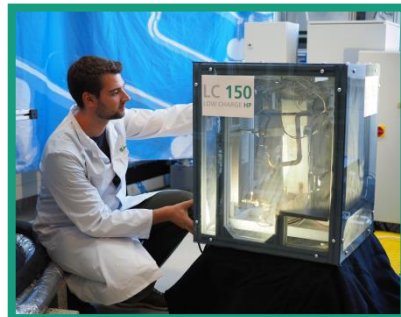
Project consortium LC150



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)



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

- Design rules and Operating strategies by
 - Component testing (heat exchangers, compressors, valves etc.) in single component and module tests and in broad cross evaluation
 - Validation of simulation tools
- Standardization/ simplification/ safety aspects
- Network and platform for manufacturers and component suppliers

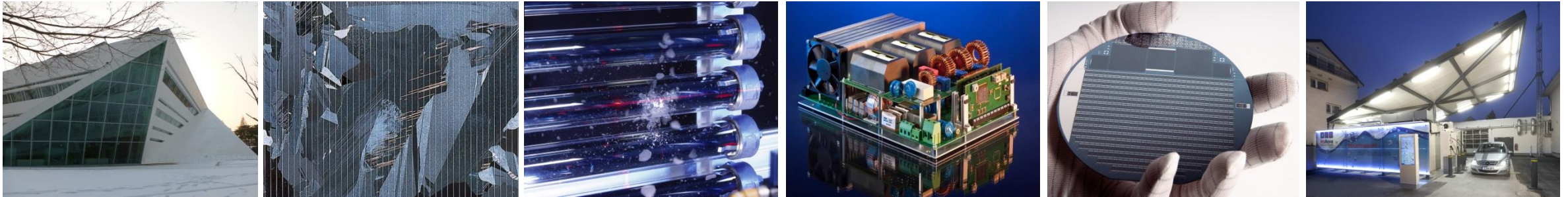
3,6 Mio. €
(75 % funding rate)
FKZ 03EN4001A

Supported by:



on the basis of a decision
by the German Bundestag

Thank you for your Attention!



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Lena Schnabel

www.ise.fraunhofer.de

lana.schnabel@ise.fraunhofer.de