# снициента



NürnbergMesse, Arbeitstitel, Datum

Hall 9



# Energy efficient heat pumps with Opteon™ XL low GWP HFO refrigerants for buildings' renovation

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#### Introduction

- European Green Deal (EC in 2020): 2030 GHG gas emission reduction >55% compared to 1990!
- Heating + cooling in buildings = 40% of EU final energy consumption.
- Energy Performance of Buildings Directive (EPBD) (2010/31/EU + 2018/844/EU): Energy renovation of existing buildings + Nearly Zero Energy Buildings.
- Heat Pumps to become enabler in reduction of energy consumption!
- Besides refrigerant's low GWP the energy efficiency plays major role!





# CO<sub>2</sub> savings by heat pump technology:

	Heat	Pump	G	as	Oil		
Building Type	new	renovation	new	renovation	new	renovation	
Annual Heating Capacity (thermal) (kWh/a)	5000	20000	5000	20000	5000	20000	
SCOP	3.5						
CO <sub>2</sub> Equivalent per kWh (kgCO <sub>2</sub> e/kWh)	0.3 (electricity)		0.22		0.32		
Annual Indirect Emissions (TCO <sub>2</sub> e)	0.429	1.714	1.1	4.4	1.6	6.4	
10 years Indirect Emissions (TCO <sub>2</sub> e)	4.29 17.14		11	44	16	64	
CO <sub>2</sub> Reduction by HP vs. Gas/Oil	uction by HP vs. Gas/Oil		-61%		-73%		



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## **Special Needs for Building Renovation**









## **Special Needs for Building Renovation**



Source: Breitkopf, Wohnungsbau - Struktur nach Art der Bauleistung in Deutschland bis 2019, 08.12.2020, Statista.com





## **Special Needs for Building Renovation**

Heating Capacity and Temperature Level Needs						
	New Building	<b>Renovation Building</b>				
Relative heating capacity	35 W/m²	100-150 W/m <sup>2</sup>				
Absolute heating capacity, incl. Sanitary hot water	5 - 8 kW	10 - 15 kW				
Sanitary Hot Water Temperature	60°C	60°C				
Radiator / HX flow temperature	35°C	55°C				
Max. Temperature Lift, Sanitary hot water	-25°C/+60°C	-25°C / +60°C				
Max. Temperature Lift, space heating system	-25°C/+35°C	-25°C / +55°C				
Share of buildings / projects (Germany 2019)	31%	69%				





## **Refrigerants - Performance Comparison**

Refrigerant	R-410A	R-452B	R-454B	R-454C	R-32
Chemours Product	Freon <sup>™</sup> 410A	Opteon <sup>™</sup> XL55	Opteon <sup>™</sup> XL41	Opteon <sup>™</sup> XL20	
Ref. Type	HFC	HFO / HFC	HFO / HFC	HFO / HFC	HFC
Components	R-32 / R-125	R-32 / R-125 / R-1234yf	R-32 / R-1234yf	R-32 / R-1234yf	
ASHRAE safety class	A1	A2L	A2L	A2L	A2L
GWP (AR4)	2088	698	466	148	675
GWP (AR5)	1924	676	467	146	677





## **Refrigerants - Performance Comparison**



Comparison Results from Calculation Tool:







Direct Emissions (based on GWP):

Refrigerant	R-4	10A	R-4	52B	R-4	54B	R-4	54C	R-	32	
Chemours Product name Freon <sup>TM</sup> 410A		XL55 XL41		XL20							
GWP (AR4) 2088		698 466		148		675					
Annual Leakage Rate (%)	3	3.5		3.5		3.5		3.5		3.5	
Building Type	New	Renovation									
Heating Capacity (kW)	5 - 10	10 - 20	5 - 10	10 - 20	5 - 10	10 - 20	5 - 10	10 - 20	5 - 10	10 - 20	
Refrigerant Charge (kg)	2	3	2	3	2	3	2	3	2	3	
10 years Direct Emissions (TCO <sub>2</sub> e)	1.46	2.19	0.49	0.73	0.33	0.42	0.09	0.16	0.47	0.71	
10 years Direct Emissions vs. R-410A (%)	100%	100%	34%	33%	23%	19%	6%	7%	32%	32%	





#### Indirect Emissions:

Building Type	new	renovation			
Annual Energy Consumption (thermal) (kWh/a)	5000	20000			
SCOP	3.5				
CO <sub>2</sub> Equivalent of Electricity (kgCO <sub>2</sub> e/kWh)	0.3				
Annual Indirect Emissions (TCO <sub>2</sub> e)	0.429 1.714				
10 years Indirect Emissions (TCO₂e)	4.29	17.14			







#### 10 years Emissions (R-454C vs. R-410A):













## Ways to success

- Theoretical calculations have shown high potential of A2L HFO based refrigerants for efficient solutions in HP applications
- Components of refrigeration circuits must be adopted to refrigerant properties. (Drop-In is not a solution!)
- Adaption of refrigeration circuit design to the fluid properties may help increasing capacity and efficiency.
- Especially R-454C enables highly efficient solutions at high temperature lift. (At most critical conditions for a HP!)





#### Ways to success





# Conclusion / Summary

- Heat Pumps can help reducing CO<sub>2</sub> emissions for heating by more than 70% versus fossil fuel boiler technology.
- Low GWP HFO based refrigerants like R-454C will reduce direct emissions ratio to as little as 1%. (In newer/tighter systems even less.)
- All components of a refrigeration circuit must be adapted to the refrigerant's properties.
- Using renewable electricity will even improve the Heat Pumps' environmental footprint.





# THANK YOU FOR YOUR KIND ATTENTION

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