Low-GWP Refrigerants in Heat Pumps

Institute for Energy Efficient Buildings and Indoor Climate, RWTH Aachen University

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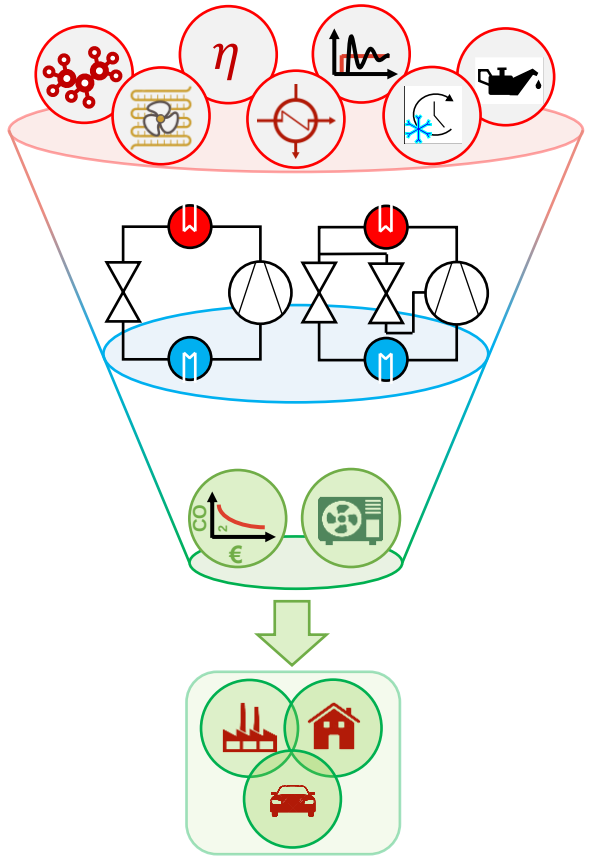
Team Refrigeration Cycle

Our vision is energy-efficient and sustainable heat supply through systematic development of the refrigeration cycle process - from the molecule to the operating strategy



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Research topics: *From* fluid selection *to* the heat pump controller

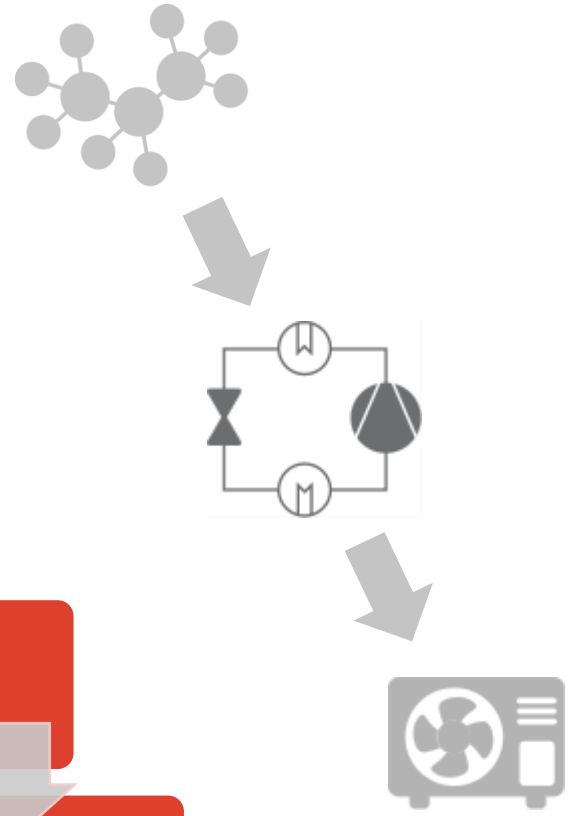
Refrigerant selection

Refrigerant cycle tayloring

Component design

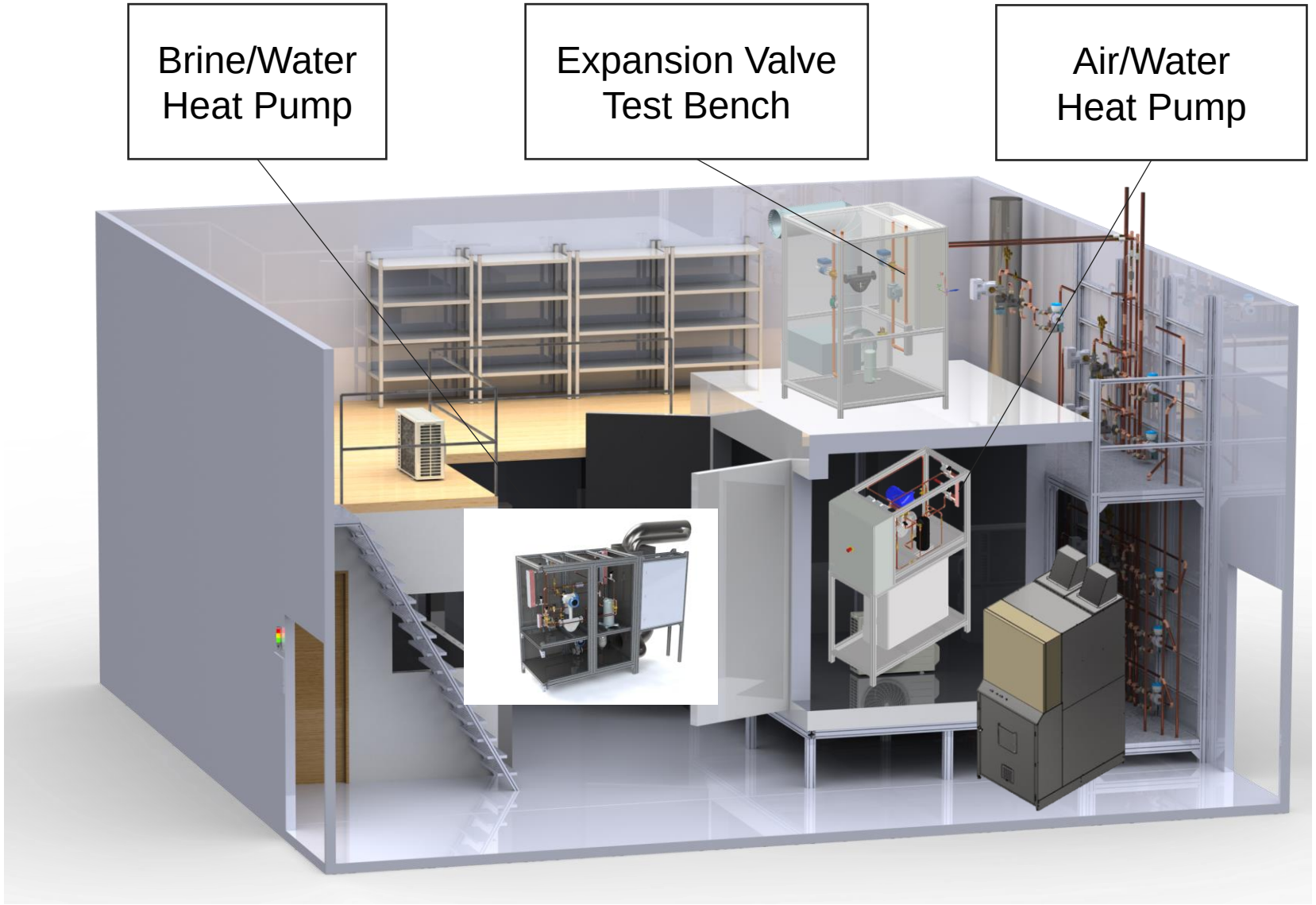
Operation optimization

System integration



Refrigerant Lab
Field test in the Lab environment for flammable refrigerants

- Emulation of dynamic test conditions
  - Hardware-in-the-loop
  - Dynamic source and sink
- Safe test environment
  - Flammable refrigerants
  - Exhaust air system
- Integrated test benches
  - Compressor
  - Expansion valve
  - Brine/Water heat pump
  - Air/Water heat pump



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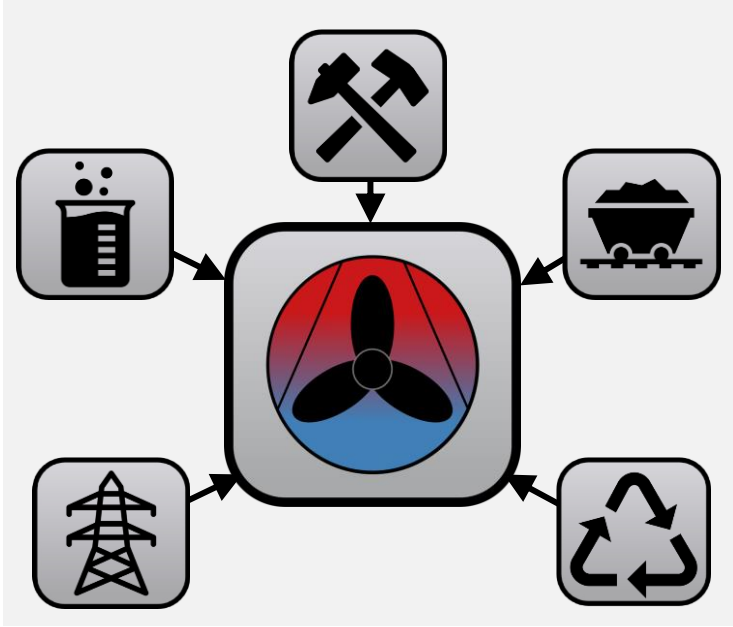
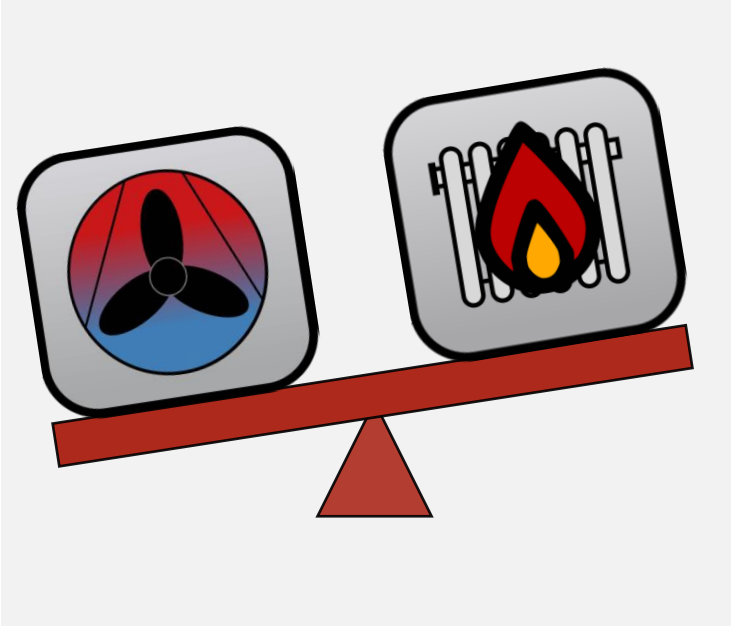
Heat Pump vs. Boiler

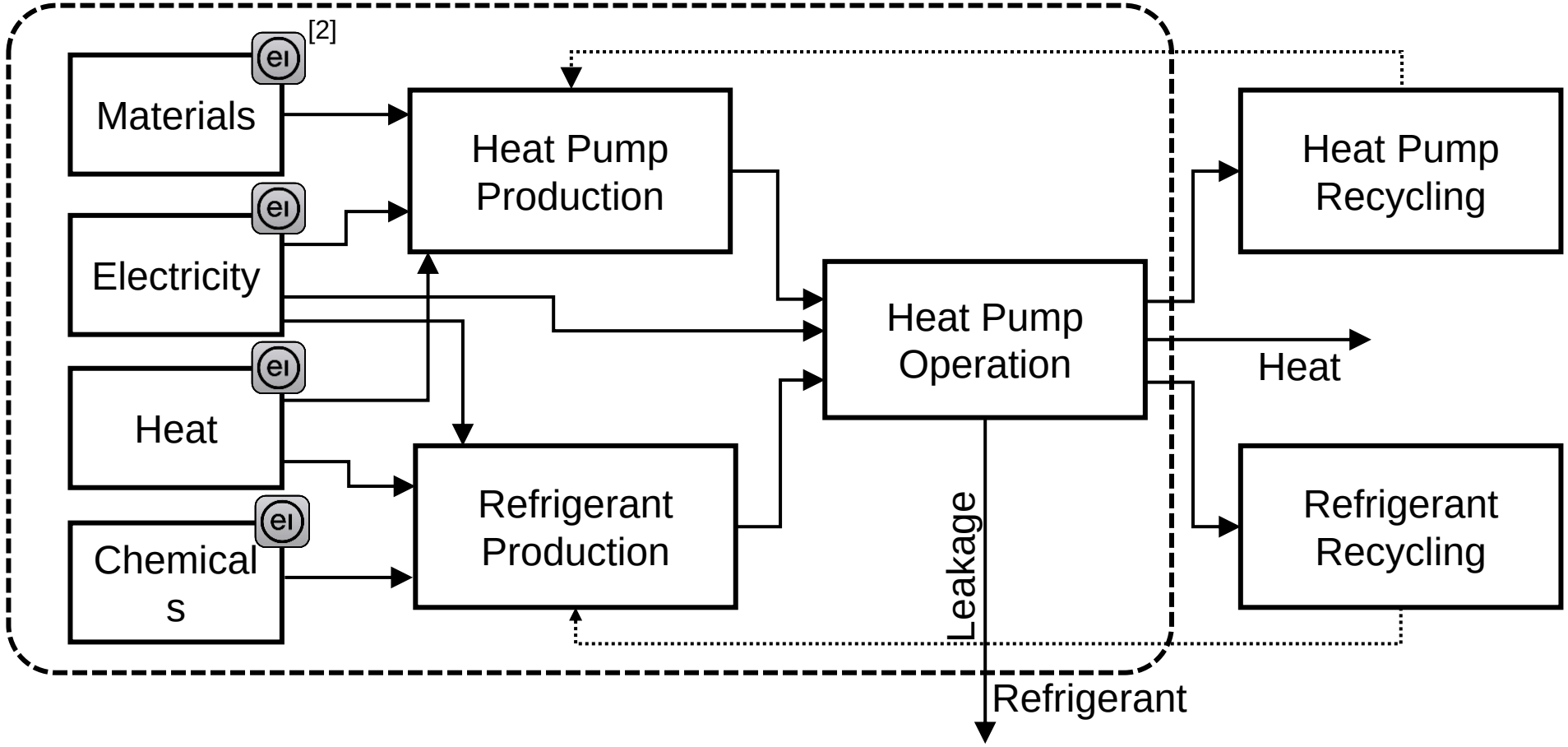
1 Life Cycle Assessment



2 Heat Pump vs. Gas Boiler



Life Cycle Assessment



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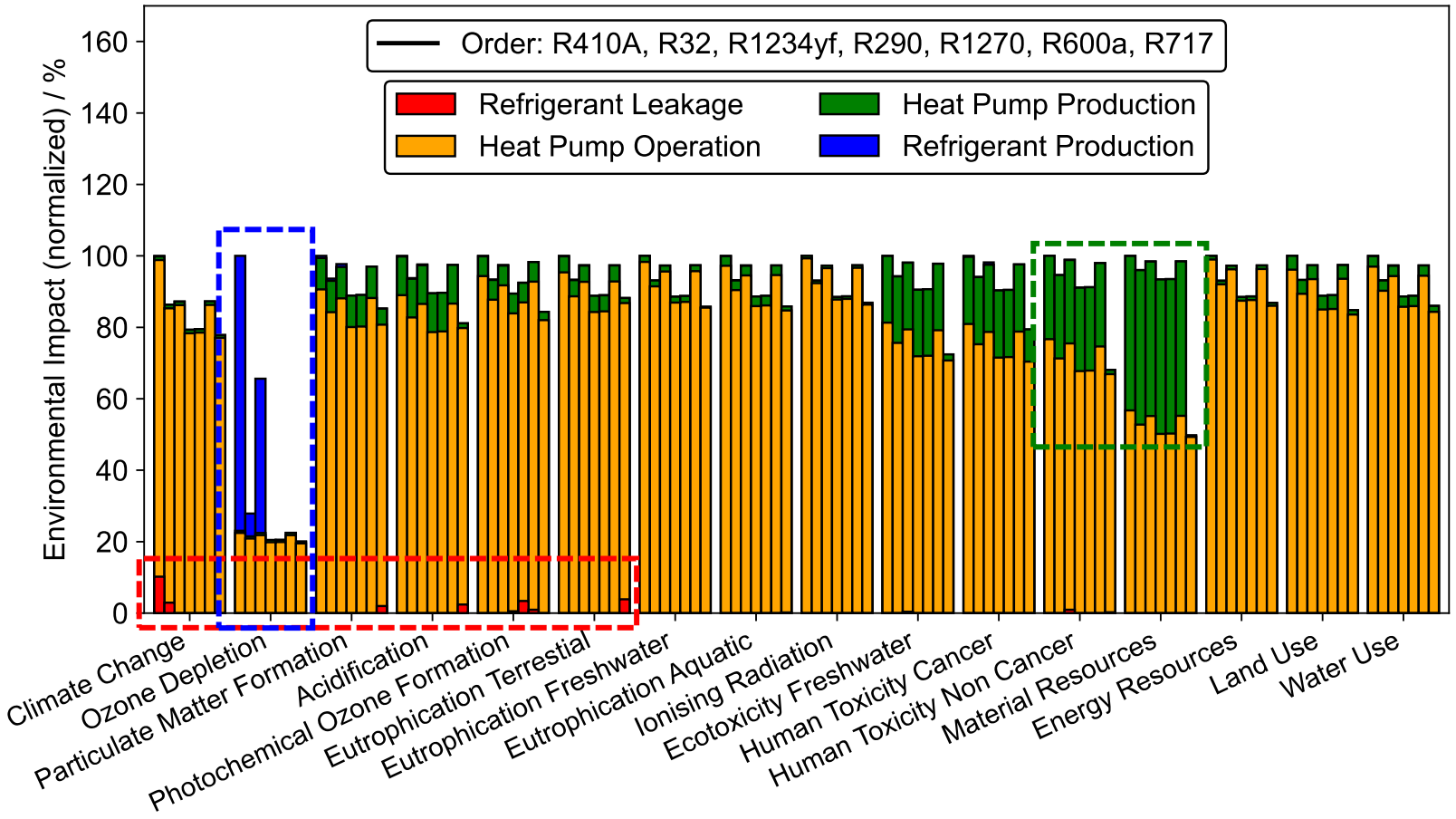
Results: Environmental Impacts of a Heat Pump



Findings

- Electricity demand biggest influencing factor
- Heat pump efficiency most important evaluation criterion
- Other life cycle stages only secondary influence

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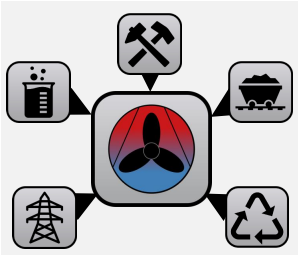
Discussion: Gas Condensing Heating System vs Air-to-Water Heat Pump

	GE	SDS
Climate Change	-30 %	-79 %
Ozone Depletion		
Particulate Matter Formation		
Acidification		
Photochemical Ozone Formation		
Eutrophication Terrestrial		
Eutrophication Freshwater		
Eutrophication Aquatic		
Ionizing Radiation		
Ecotoxicity Freshwater		
Human Toxicity Cancer		
Human Toxicity Non Cancer		
Material Resources		
Energy Resources		
Land Use		
Water Use		

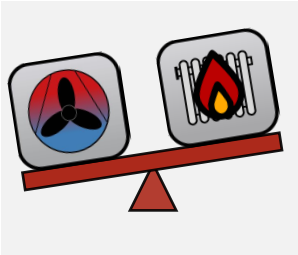
Findings

- Use of a heat pump leads top GHG emission reduction
- **But** Burden-Shifting towards other environmental categories
- Change in electricity mix reduces environmental impact
  - Burden-Shifting is inevitable

Conclusion and Outlook



- Electricity demand during operation is the main influencing factor
- Efficiency of the HP most important evaluation criterion
- Other phases have only a secondary influence



- GHG reduction when switching to HP is possible
- **But:** Burden shifting towards other environmental categories

- Investigation of environmental categories affected by burden shifting
- Include modelling of recycling process

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