

---

# Food industry case study on the influence of CO<sub>2</sub> pricing on the decarbonization and investment strategies into energy supply technologies

---



Nicolas Fuchs, Jessica Thomsen

Fraunhofer ISE - Institute for Solar Energy Systems

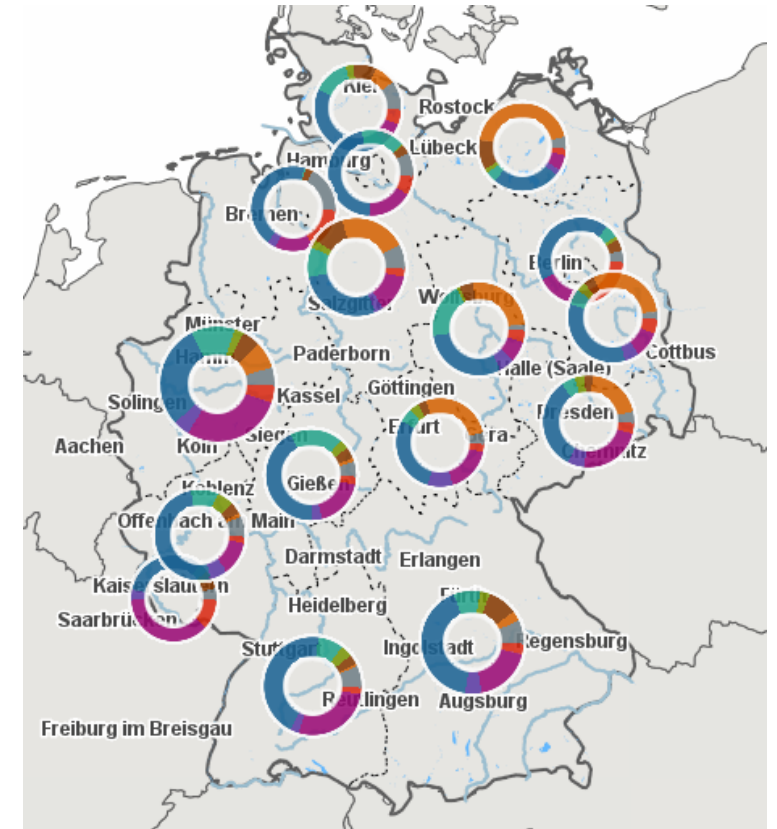
Enerday 2021 - 15th International Conference on Energy Economics and Technology – online

Freiburg, 09. April 2021

# Influence of CO<sub>2</sub> pricing on energy supply strategies in a food industry case

## Motivation

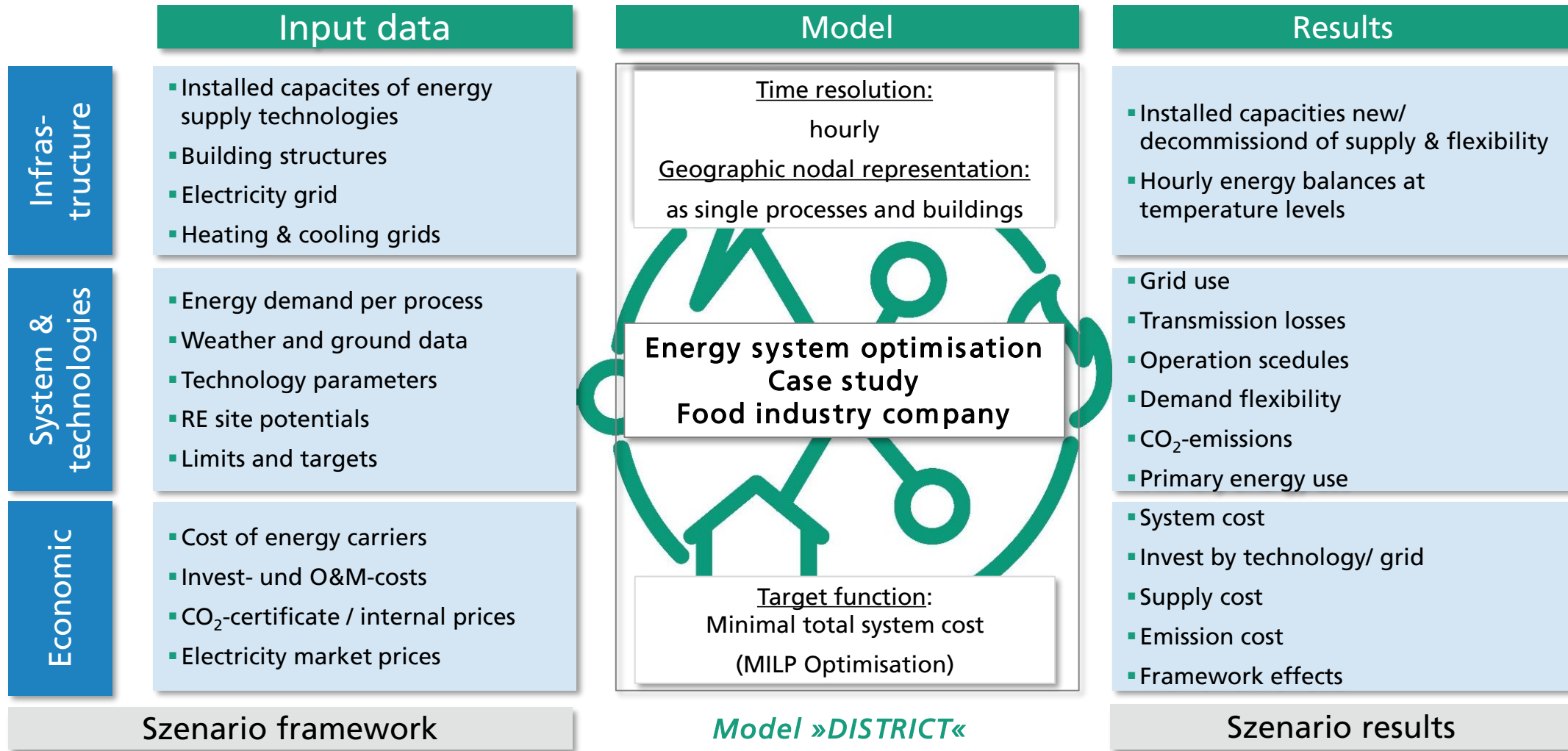
- Case Study
  - High demand for process heat, cooling and steam
  - Goal of production neutrality within Scope 1+2
  - Production expansion
  - Need for investment decisions into energy supply
- What would be the best **decarbonization and investment strategy** and what influence does the **CO<sub>2</sub> price development** have?



German Industry Structure with food industry at 8% (dark brown), Source: Thru.de

# Influence of CO<sub>2</sub> pricing on energy supply strategies in a food industry case

## Methods – MILP Optimisation



# Influence of CO<sub>2</sub> pricing on energy supply strategies in a food industry case

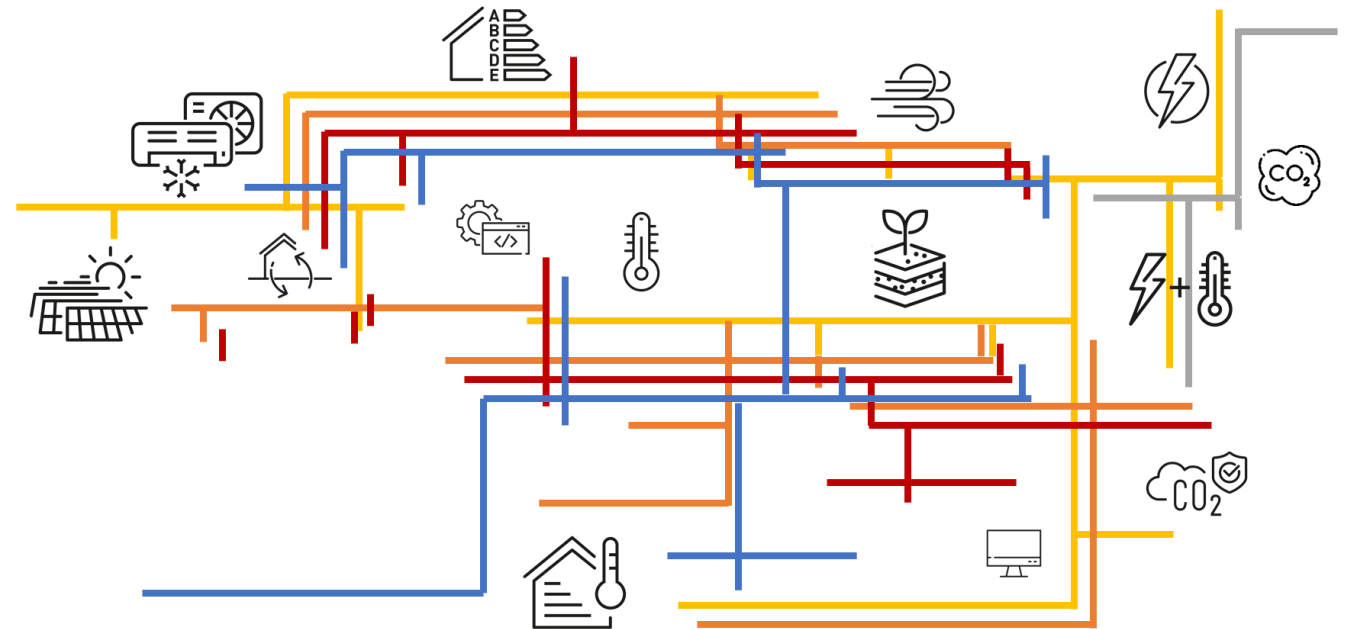
## Food Industry Case Study

### ■ Heat Supply Technology:

- Gas boilers
- Ground water heat pump

### ■ Measured processes:

- Electric - 55
- Gas - 5
- Heat
  - Process - 14
  - Steam - 6
  - Cooling - 17
  - Building / Hot Water - 21

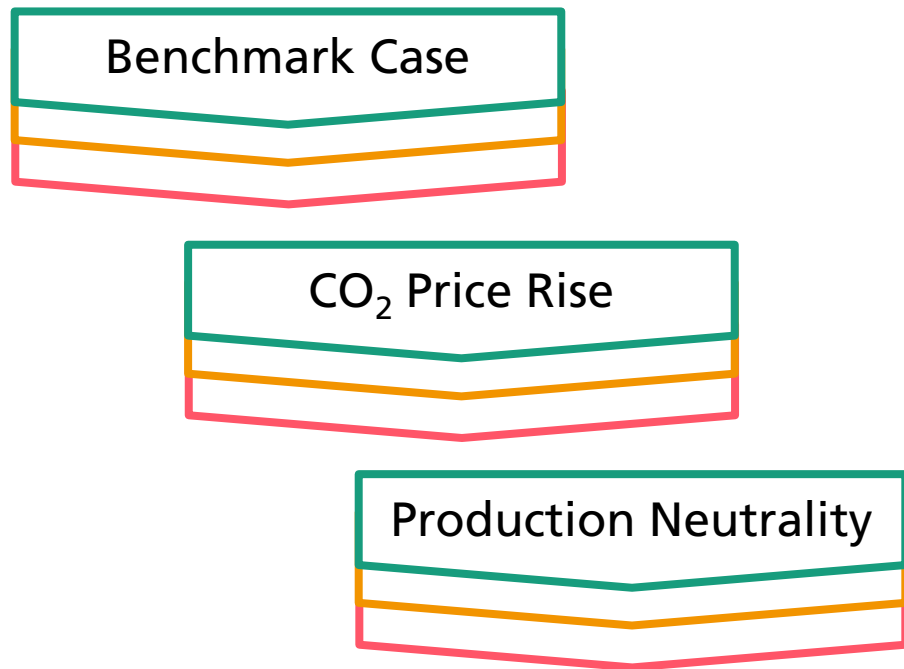


Schematic overview of the energy systems

# Influence of CO<sub>2</sub> pricing on energy supply strategies in a food industry case

## Scenario Framework

- Which optimal investment into energy supply technologies?
- 3 Scenarios



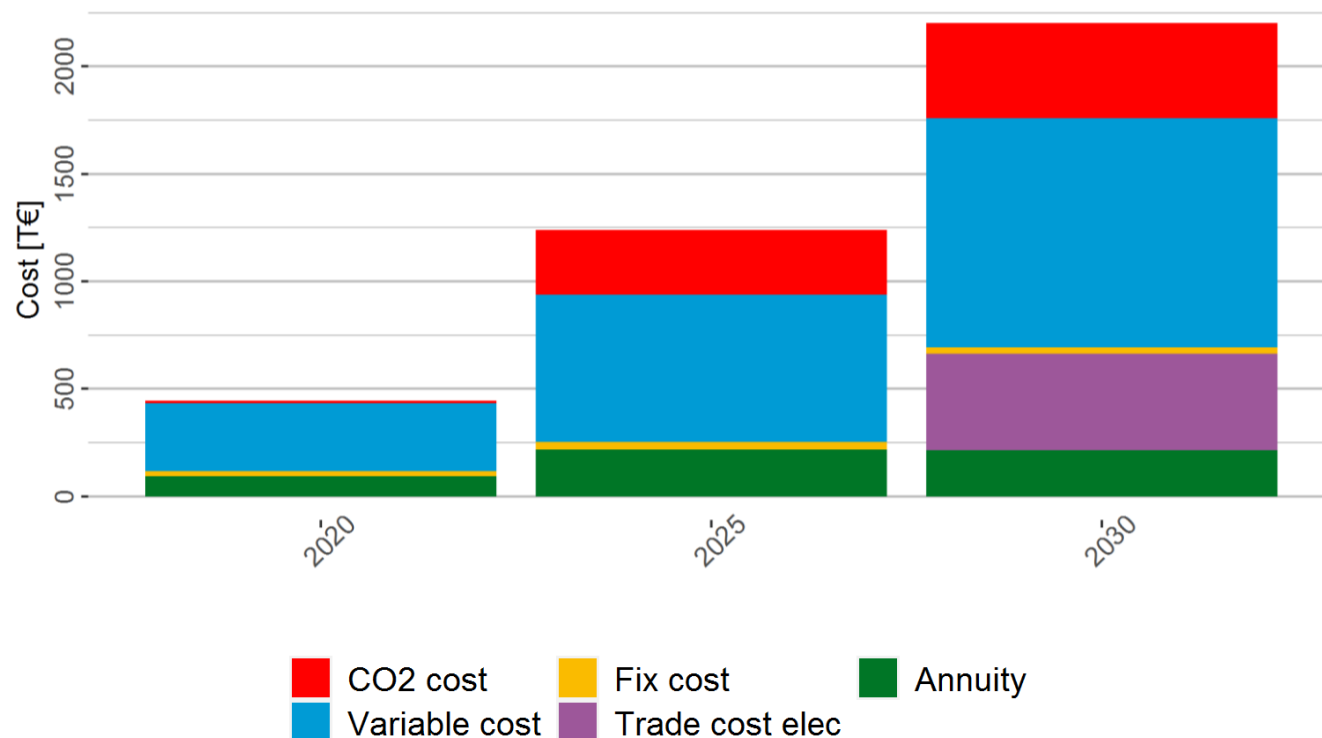
Parameter framework	2020	2025	2030
Energy Demand	16 GWh	34 GWh	50 GWh
CO <sub>2</sub> Price (Certificates + Internal)	6 €/t CO <sub>2</sub> eq	61 €/t CO <sub>2</sub> eq	min 66 €/t CO <sub>2</sub> eq
Spec. Investment Costs	Decreasing for PV, HT-HP, H <sub>2</sub> -CHP, PtX		
Techn. Availability is Market Ready	Boiler, HP, PV, Gas-CHP	Boiler, HP, PV, Gas/H <sub>2</sub> -CHP, PtH	Boiler, HP, PV, Gas/H <sub>2</sub> -CHP, PtH, PtSteam

PV: Photovoltaic  
 HP: Heatpump (HT High Temp)  
 CHP: Combined Heat & Power  
 PTX: Power-to-X (H-Heat)

# Influence of CO<sub>2</sub> pricing on energy supply strategies in a food industry case

## Results Benchmark Case

### Total Cost Change – Benchmark



### Supply Capacity – Benchmark

All steam >130°C supplied by 3 MW gas boilers

Maximum PV capacity installed on-site

#### 2020 / 2025:

Combined Heat & Power 0,7/ 3 MW +  
Absorption Cooler 370 kW

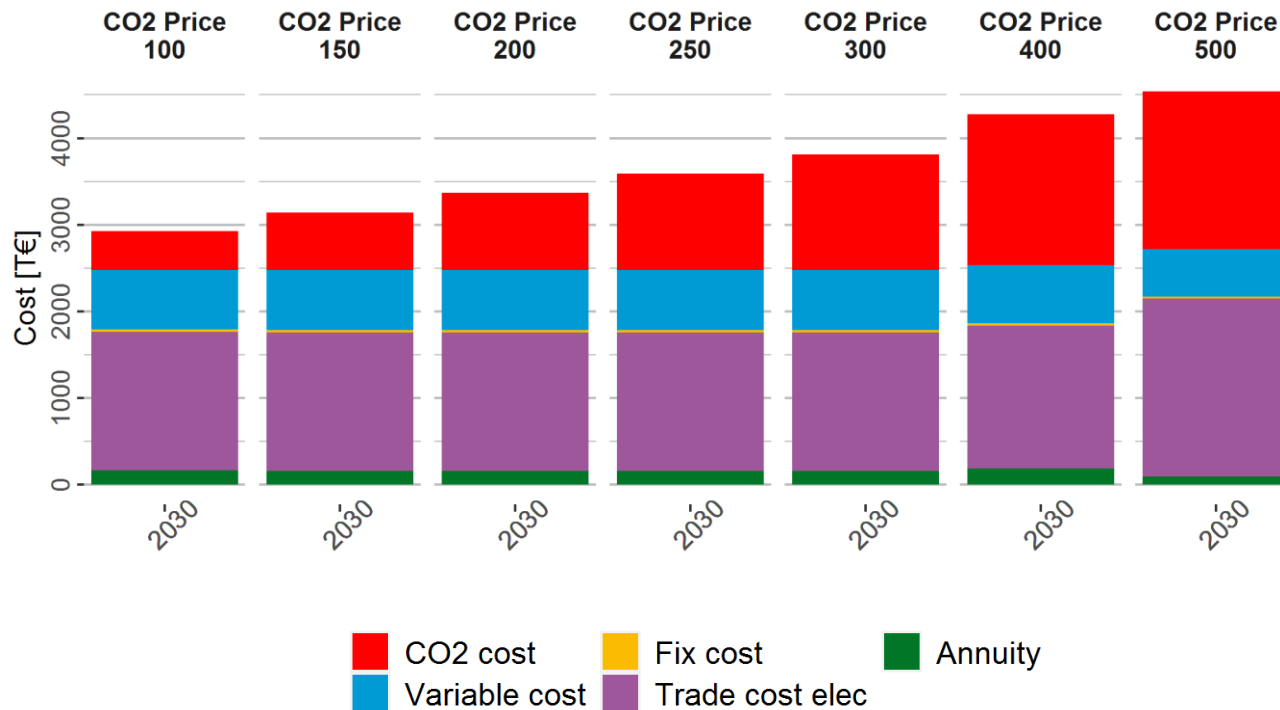
#### 2030:

CHP with up to 20% H<sub>2</sub>  
+ External electricity supply

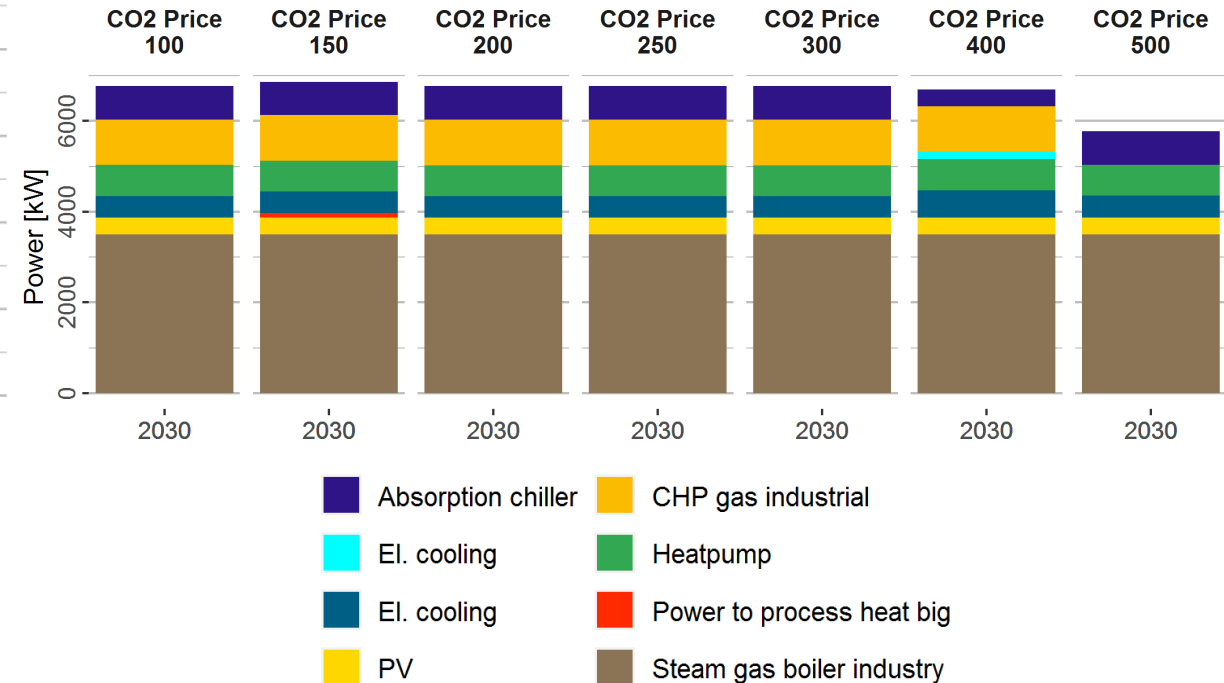
# Influence of CO<sub>2</sub> pricing on energy supply strategies in a food industry case

## Results CO<sub>2</sub> Certificate Price Rise

### Total Cost 2030 – CO<sub>2</sub> Price Rise



### Installed Capacity New 2030 – CO<sub>2</sub> Price Rise



■ CO<sub>2</sub> cost    ■ Fix cost    ■ Annuity  
■ Variable cost    ■ Trade cost elec

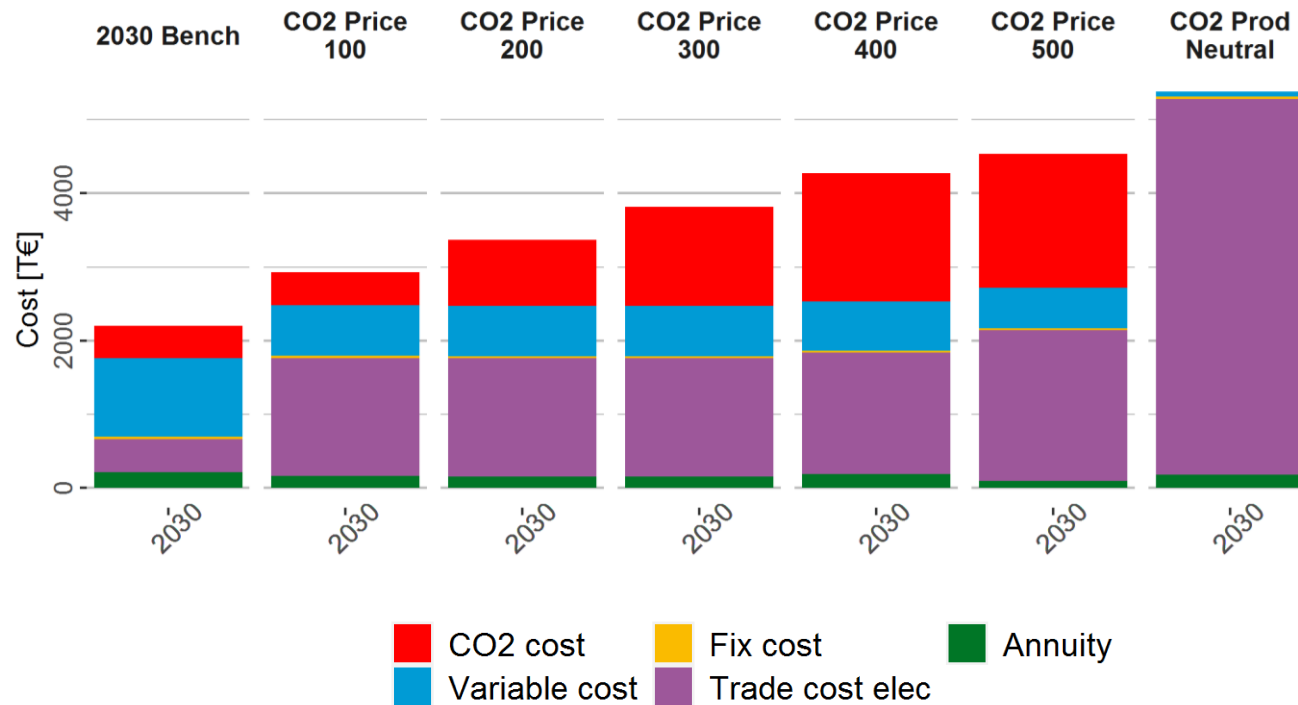
■ Absorption chiller    ■ CHP gas industrial  
■ El. cooling    ■ Heatpump  
■ El. cooling    ■ Power to process heat big  
■ PV    ■ Steam gas boiler industry



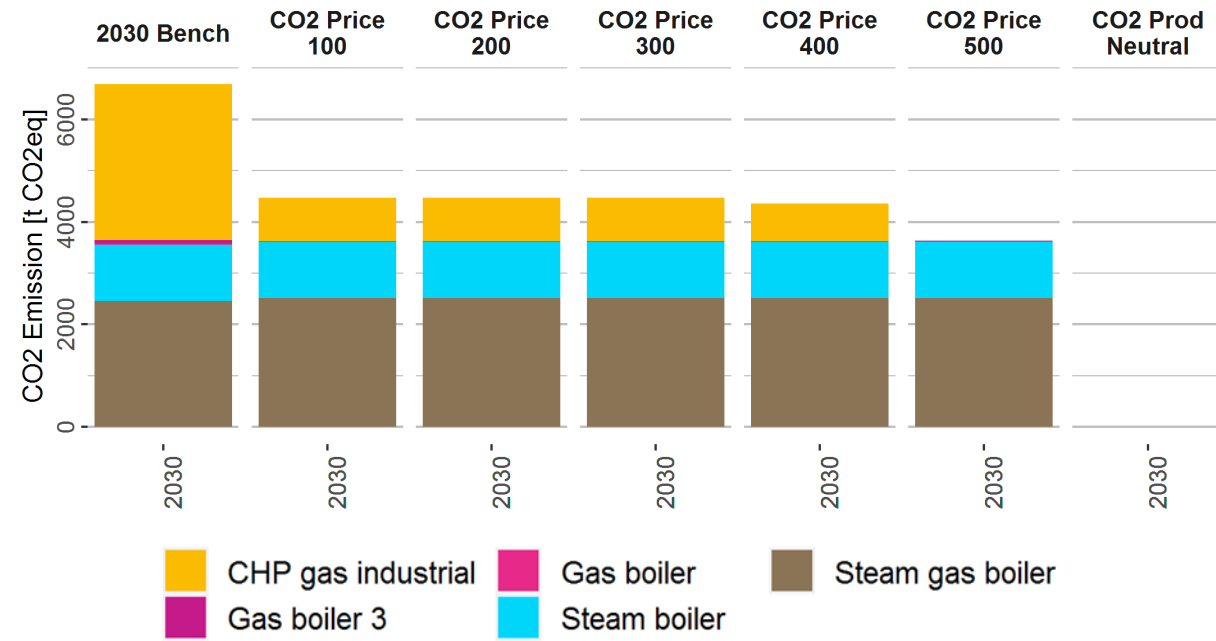
# Influence of CO<sub>2</sub> pricing on energy supply strategies in a food industry case

## Results Comparison to CO<sub>2</sub> Production Neutrality

### Total Cost Comparison 2030 Scenarios



### CO<sub>2</sub> Emission Comparison 2030 Scenarios





# Influence of CO<sub>2</sub> pricing on energy supply strategies in a food industry case

## Conclusion

---

**Issue:** What would be the best decarbonization and investment strategy and what influence does the CO<sub>2</sub> price development have?

1. Available current and projected renewable heat & steam supply technology is **not price competitive** to fossil fuel based

*It is economic to shift to CHP with mixed gas-hydrogen based heat supply*

2. Production neutrality is achievable only with **green electricity supply**

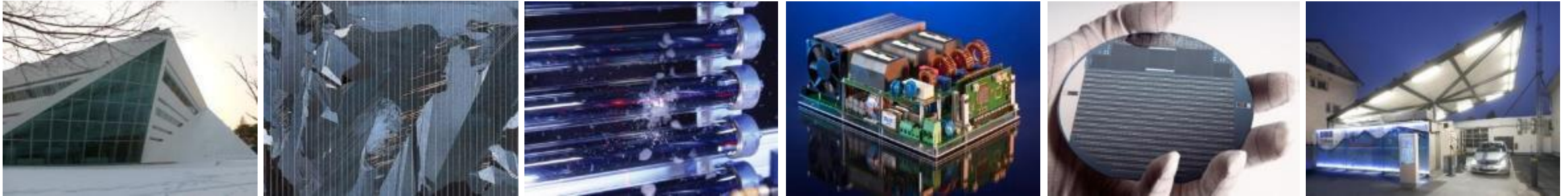
*And an industry shift to power-to-heat and high temperature heat pumps requires lower investment prices & wide availability*

3. Shift to full electrification technologies **doubles the cost**

*It shows strong external dependency on electricity, gas and CO<sub>2</sub> prices*

- The food industry is strongly impacted by the energy transition and must carefully choose their investment strategy and decarbonisation targets

# Thank you for your Attention!



Fraunhofer Institute for Solar Energy Systems ISE

Nicolas Fuchs

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

[nicolas.fuchs@ise.fraunhofer.de](mailto:nicolas.fuchs@ise.fraunhofer.de)

FlexGeber: FKZ03EGB0001A



Bundesministerium  
für Wirtschaft  
und Technologie

