Food industry case study on the influence of CO₂ pricing on the decarbonization and investment strategies into energy supply technologies



Nicolas Fuchs, Jessica Thomsen

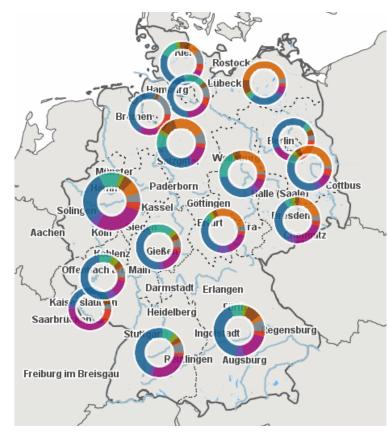
Fraunhofer ISE - Institute for Solar Energy Systems

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

Freiburg, 09. April 2021

Influence of CO₂ 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 CO₂ price development have?



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



Influence of CO₂ pricing on energy supply strategies in a food industry case

Methods – MILP Optimisation

Intrastructure

System & technologies

Economic

Input data

- Installed capacites of energy supply technologies
- Building structures
- Electricity grid
- Heating & cooling grids
- Energy demand per process
- Weather and ground data
- Technology parameters
- RE site potentials
- Limits and targets
- Cost of energy carriers
- Invest- und O&M-costs
- CO₂-certificate / internal prices
- Electricity market prices

Szenario framework

Model

<u>Time resolution:</u>

hourly

Geographic nodal representation:

as single processes and buildings



Energy system optimisation

Case study

Food industry company



<u>Target function</u>: Minimal total system cost

(MILP Optimisation)

Model »DISTRICT«

Results

- Installed capacities new/ decommissiond of supply & flexibility
- Hourly energy balances at temperature levels
- Grid use
- Transmission losses
- Operation scedules
- Demand flexibility
- CO₂-emissions
- Primary energy use
- System cost
- Invest by technology/ grid
- Supply cost
- Emission cost
- Framework effects

Szenario results







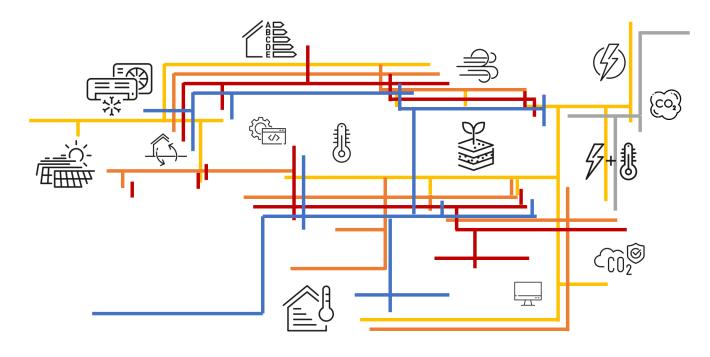






Influence of CO₂ pricing on energy supply strategies in a food industry case Food Industry Case Study

- 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 CO₂ pricing on energy supply strategies in a food industry case

Scenario Framework

Which optimal investment into energy supply technologies?

3 Scenarios

Benchmark Case

CO₂ Price Rise

Production Neutrality

Parameter framework

Energy Demand

CO₂ Price (Certificates + Internal)

Spec. Investment Costs

Techn. Availability is Market Ready

2020

2025

2030

16 GWh

34 GWh

50 GWh

6 €/t CO₂eq

61 €/t CO₂eq

min 66 €/t CO₂eq

Decreasing for PV, HT-HP, H₂-CHP, PtX

Boiler, HP, PV, Gas-CHP Boiler, HP, PV, Gas/H₂-CHP, PtH Boiler, HP, PV, Gas/H₂-CHP, PtH, PtSteam

PV: Photovoltaic HP: Heatpump (HT High Temp) CHP: Combined Heat & Power

PTX: Power-to-X (H-Heat)









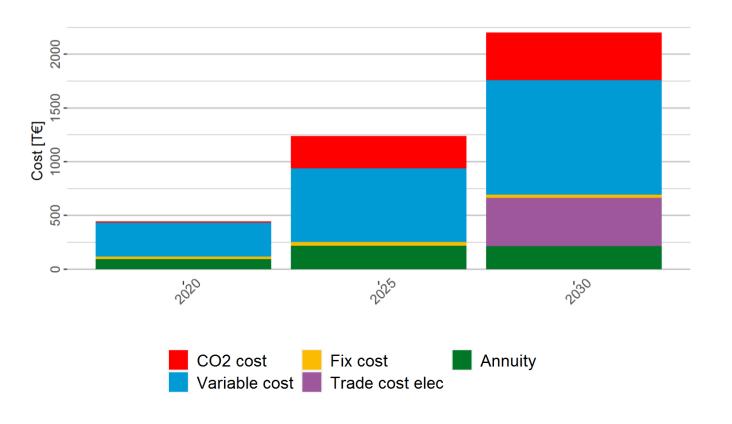






Influence of CO₂ pricing on energy supply strategies in a food industry case Results Benchmark Case

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% H₂

+ External electricity supply









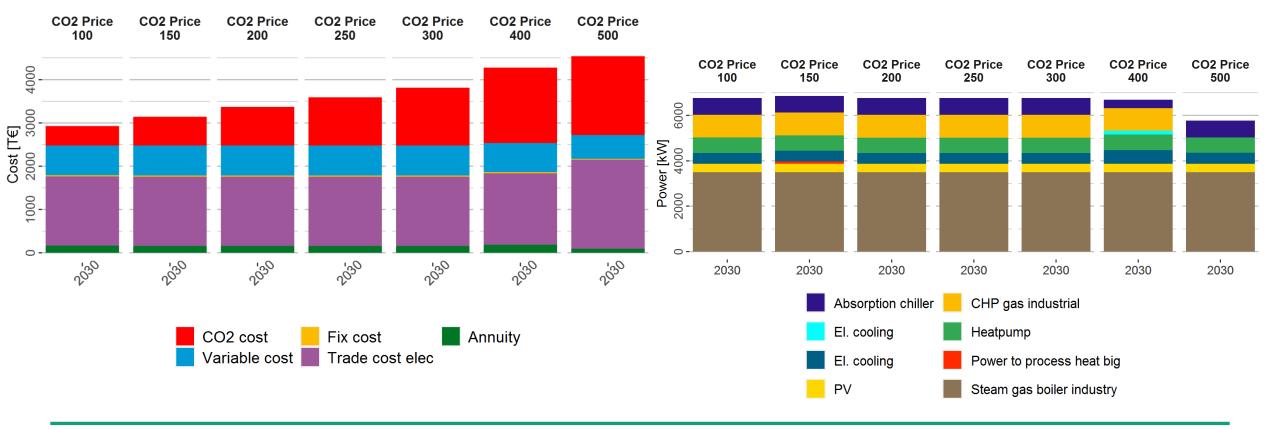




Influence of CO₂ pricing on energy supply strategies in a food industry case Results CO₂ Certificate Price Rise

Total Cost 2030 - CO₂ Price Rise

Installed Capacity New 2030 – CO₂ Price Rise















Influence of CO₂ pricing on energy supply strategies in a food industry case Results Comparison to CO₂ Production Neutrality

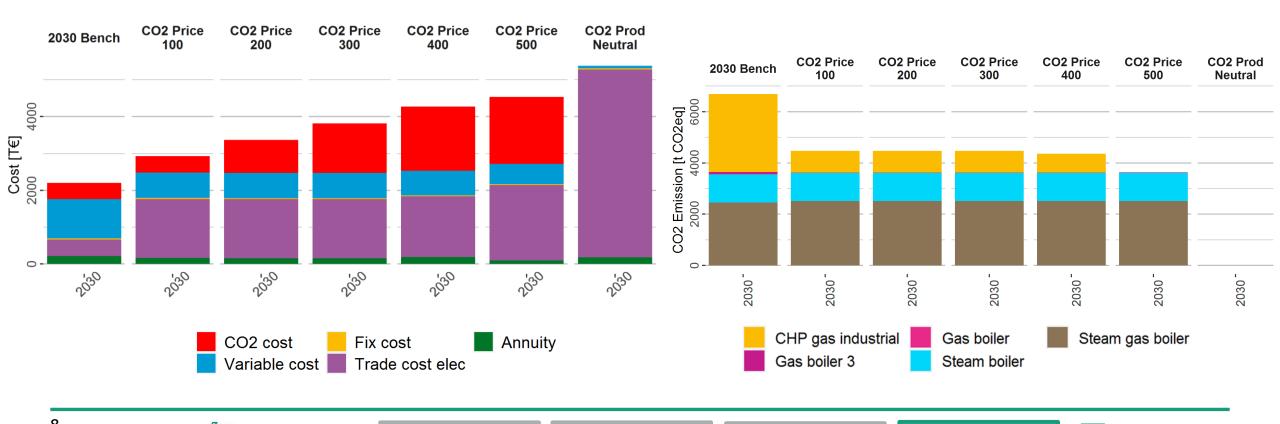
Total Cost Comparison 2030 Scenarios

FHG-SK: ISE-INTERNAL

CO₂ Emission Comparison 2030 Scenarios

Comparison

Fraunhofer



Benchmark

CO₂ Price Rise

Method

Framework

Influence of CO₂ 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_2 price development have?

- 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 CO₂ prices
- The food industry is strongly impacted by the energy transition and must carefully choose their investment strategy and decarbonisation targets

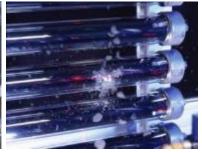


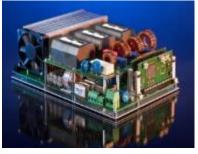


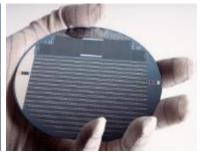
Thank you for your Attention!













Fraunhofer Institute for Solar Energy Systems ISE

Nicolas Fuchs

www.ise.fraunhofer.de nicolas.fuchs@ise.fraunhofer.de FlexGeber: FKZ03EGB0001A









