PACE

Pathway to a competitive European
Fuel Cell micro-CHP Market

WP4 – The value of flexibility from mCHP systems

Prof. Dr. Christoph Imboden

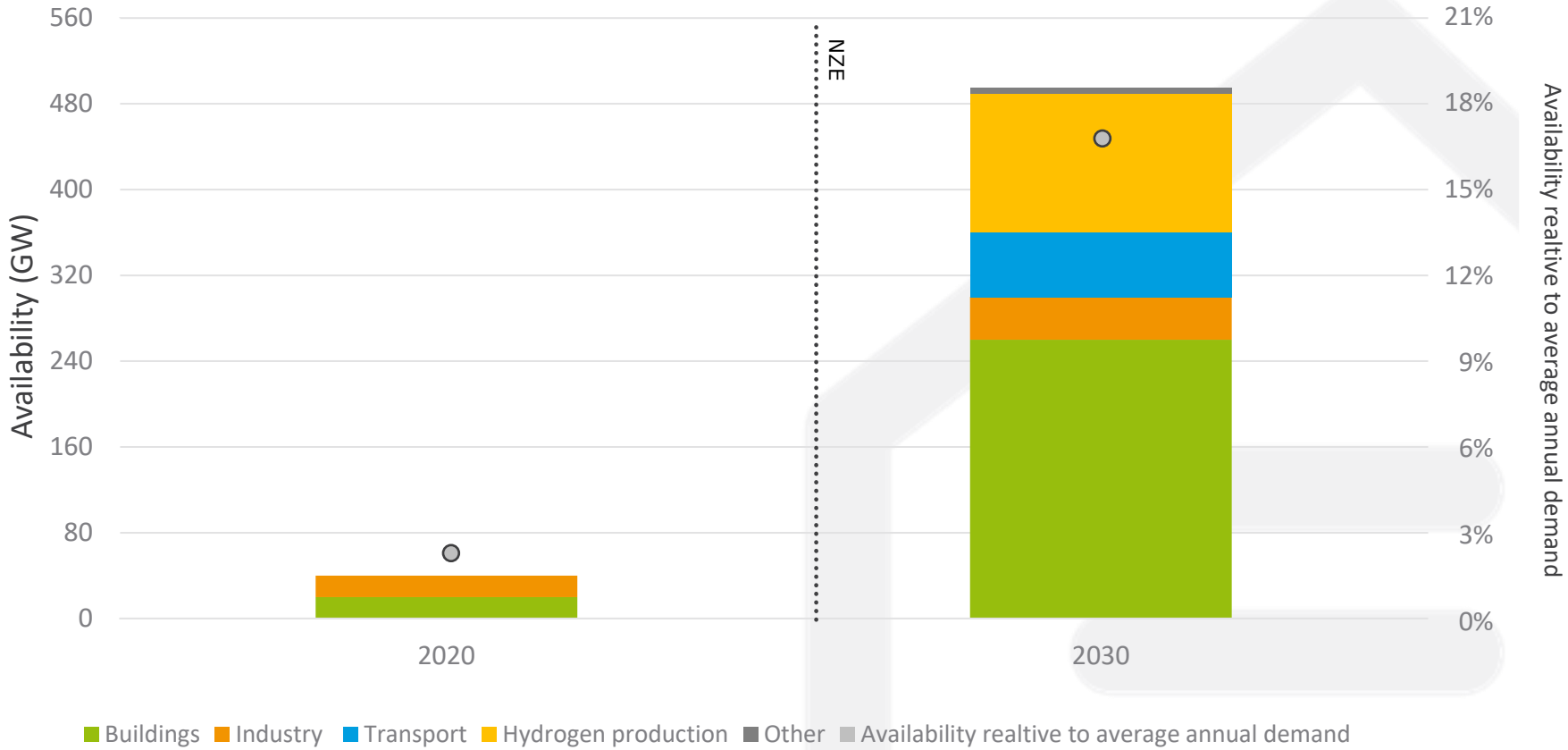
Lucerne University of Applied Sciences and Arts
Institute of Innovation and Technology Management IIT

HSLU

PACE

Pathway to a competitive European Fuel Cell micro-CHP Market

Demand response availability at times of highest flexibility needs and share in total flexibility provision in the Net Zero Scenario, 2020 and 2030



IEA, Demand response availability at times of highest flexibility needs and share in total flexibility provision in the Net Zero Scenario, 2020 and 2030, IEA, Paris https://www.iea.org/data-and-statistics/charts/demand-response-availability-at-times-of-highest-flexibility-needs-and-share-in-total-flexibility-provision-in-the-net-zero-scenario-2020-and-2030, IEA. Licence: CC BY 4.0

HSLU

PACE

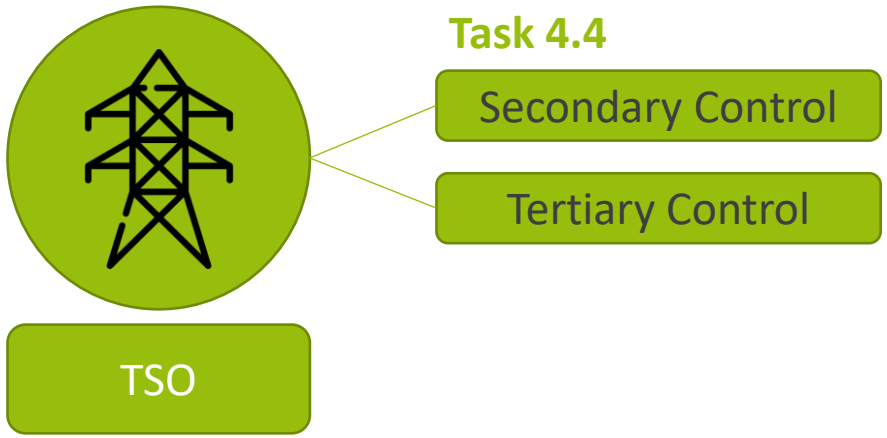
Pathway to a competitive European Fuel Cell micro-CHP Market

Flexibility for the electricity grid

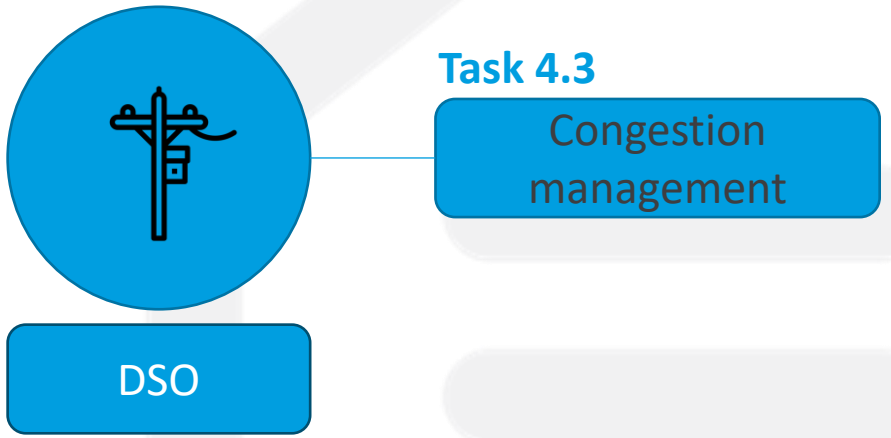
With focus on Germany, Belgium, and the Czech Republic

Analysis conducted within WP4:

Analysis of micro-cogeneration delivering grid service products to the **transmission system operator**



The **potential for infrastructure cost avoidance** in local networks attributable to mCHP



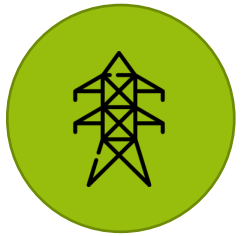
HSLU

PACE
Pathway to a competitive European Fuel Cell micro-CHP Market

Dealing with network growth - DSO Conventional Practices

2019 annual Bundesagentur survey of 815 German DSOs

Most common measures undertaken to optimise and reinforce networks (in descending order)



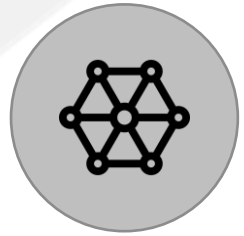
Increasing cable cross-sections

Undergrounding of overhead lines

Increasing transformer capacity

Installation of metering technology

Isolation point optimisation



Changing network topology

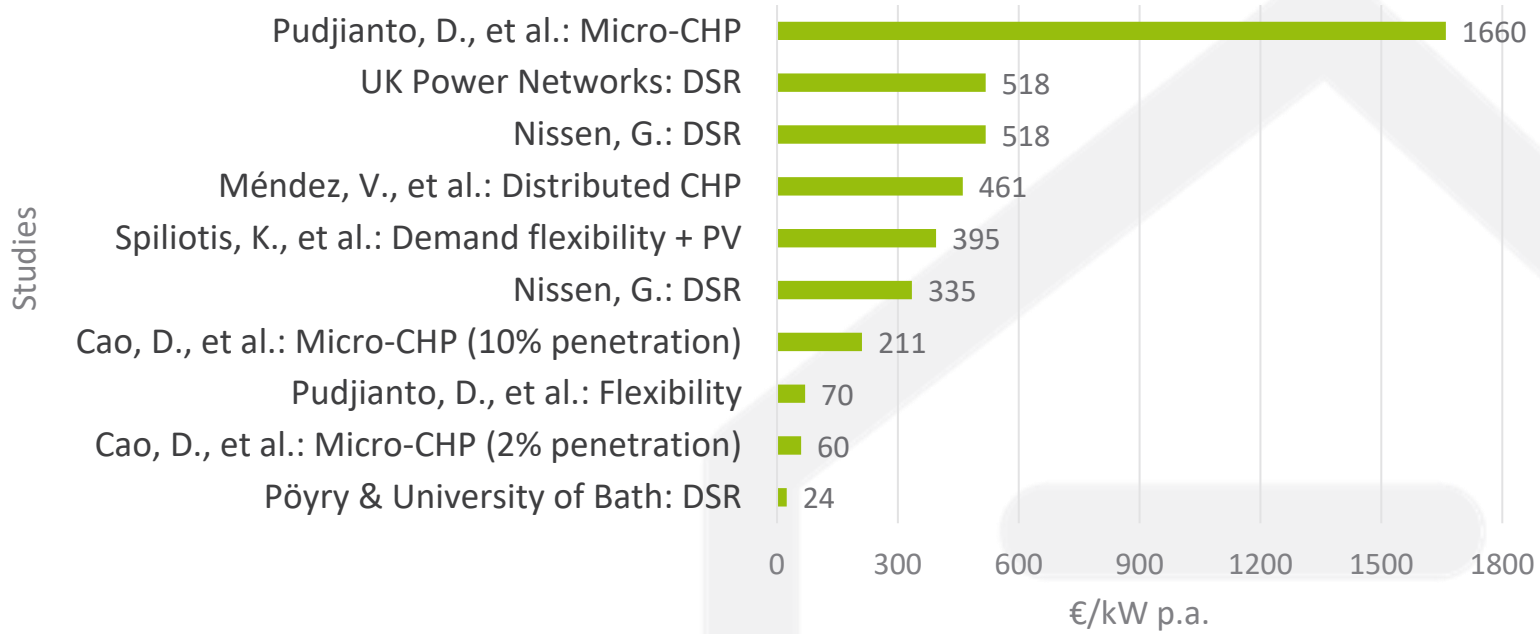
Peak shaving as a network optimisation measure – 6% (49 DSOs)

HSLU

PACE
Pathway to a competitive European Fuel Cell micro-CHP Market

Earned value analysis – avoiding grid extensions using DER

- Literature review to quantify economic benefit to DSO
- Limited previous work on mCHP specifically
- Wider study on demand flexibility was therefore necessary



Demand flexibility estimated benefit is 24 – 1’660 €/kW p.a.

HSLU

PACE

Pathway to a competitive European Fuel Cell micro-CHP Market

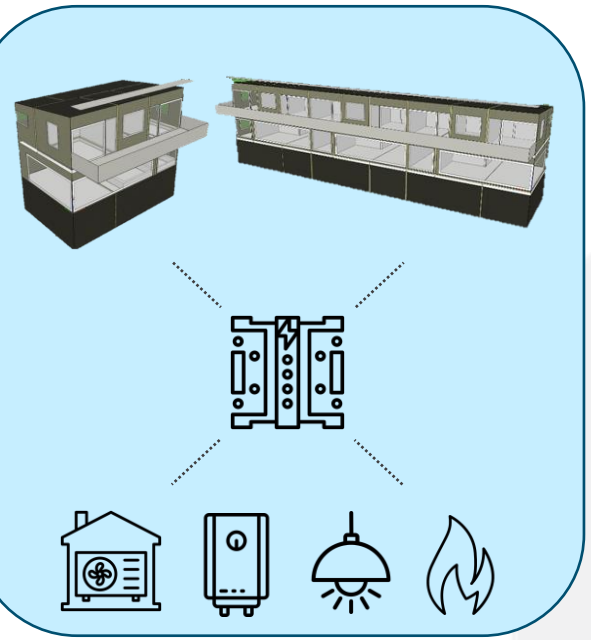
Simulation toolbox

HSLU Distributed Energy Management Suite - DISsuite™

Input

- Energy Prices
- Meteo Data
- Subsidy scheme

Model-based optimisation



Output

- Optimised operation policy
- Energy savings
- CO2 emissions

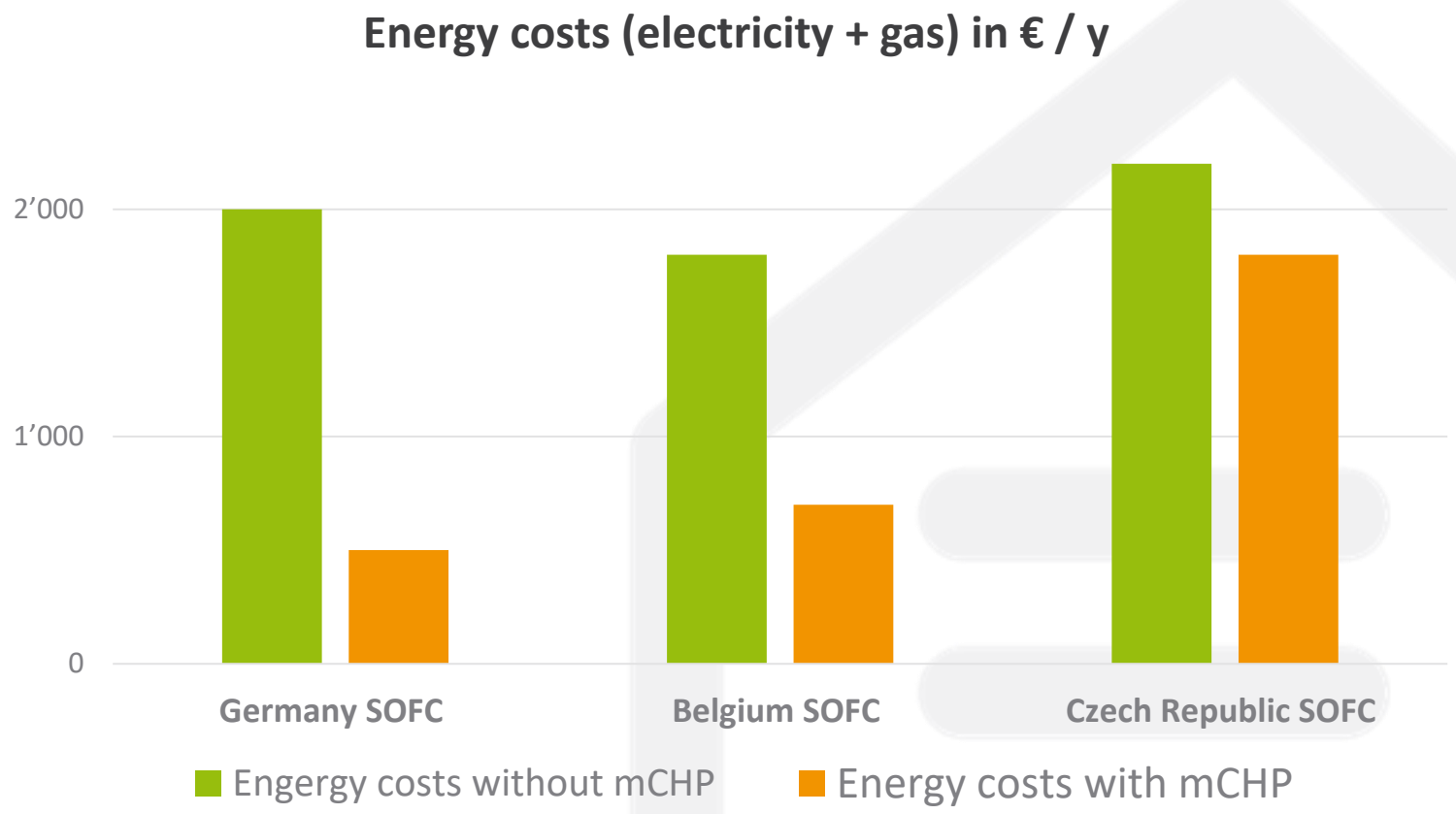
HSLU

PACE
Pathway to a competitive European Fuel Cell micro-CHP Market

Results of self-consumption policy optimisation

Domestic installation in a single family house (SFH)

High savings in annual energy costs are observed in Germany and Belgium due to self-consumption.



HSLU

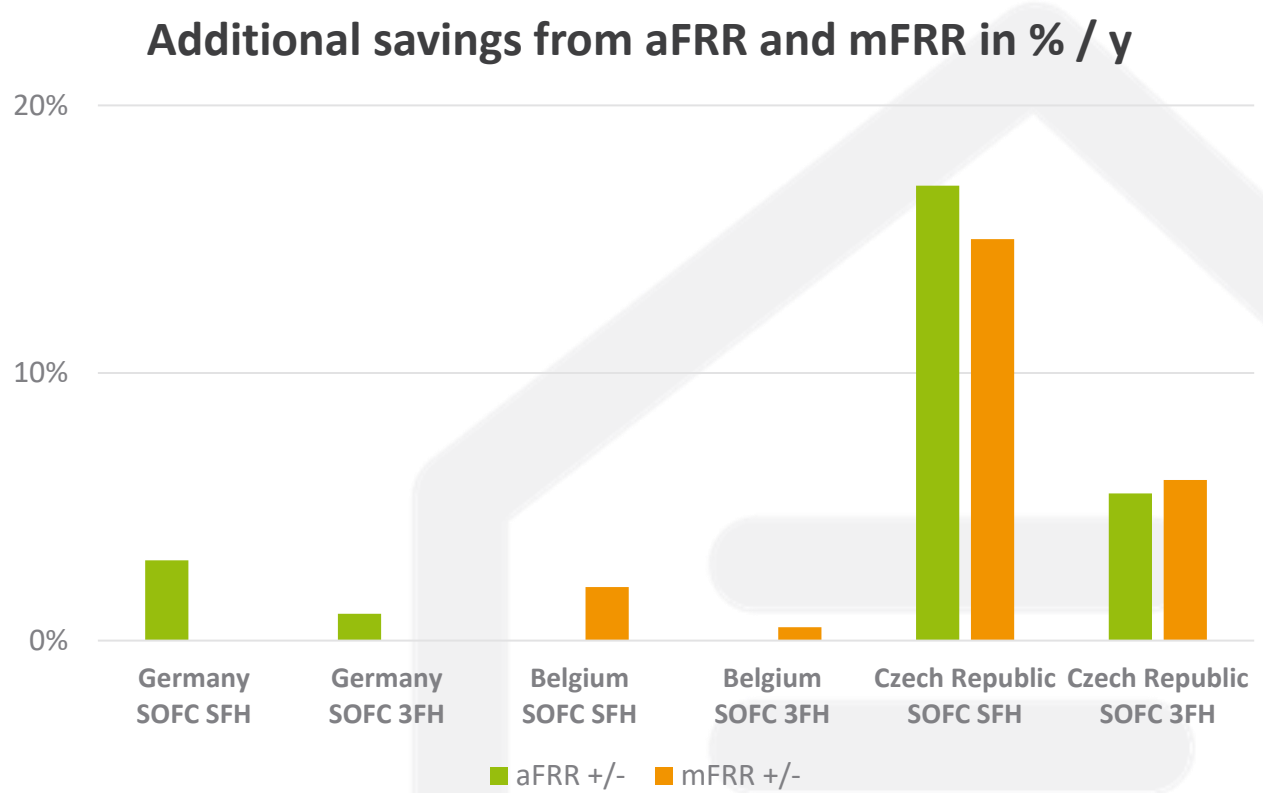
PACE

Pathway to a competitive European Fuel Cell micro-CHP Market

Resulting additional revenues streams from offering TSO grid services

Focus on providing secondary (aFRR) and tertiary (mFRR) reserves

- Two balancing products are investigated:
  - **aFRR** (secondary control reserves): faster response time
  - **mFRR** (tertiary control reserves): longer activation time
  - For both of them, positive (+) and negative (-) balancing is analysed
- The balancing income depends on:
  - Availability income results directly from self-consumption optimisation
  - Market prices for each country
  - Activation probability depending on bidding strategy and market behaviour
  - Subsidy schemes



HSLU

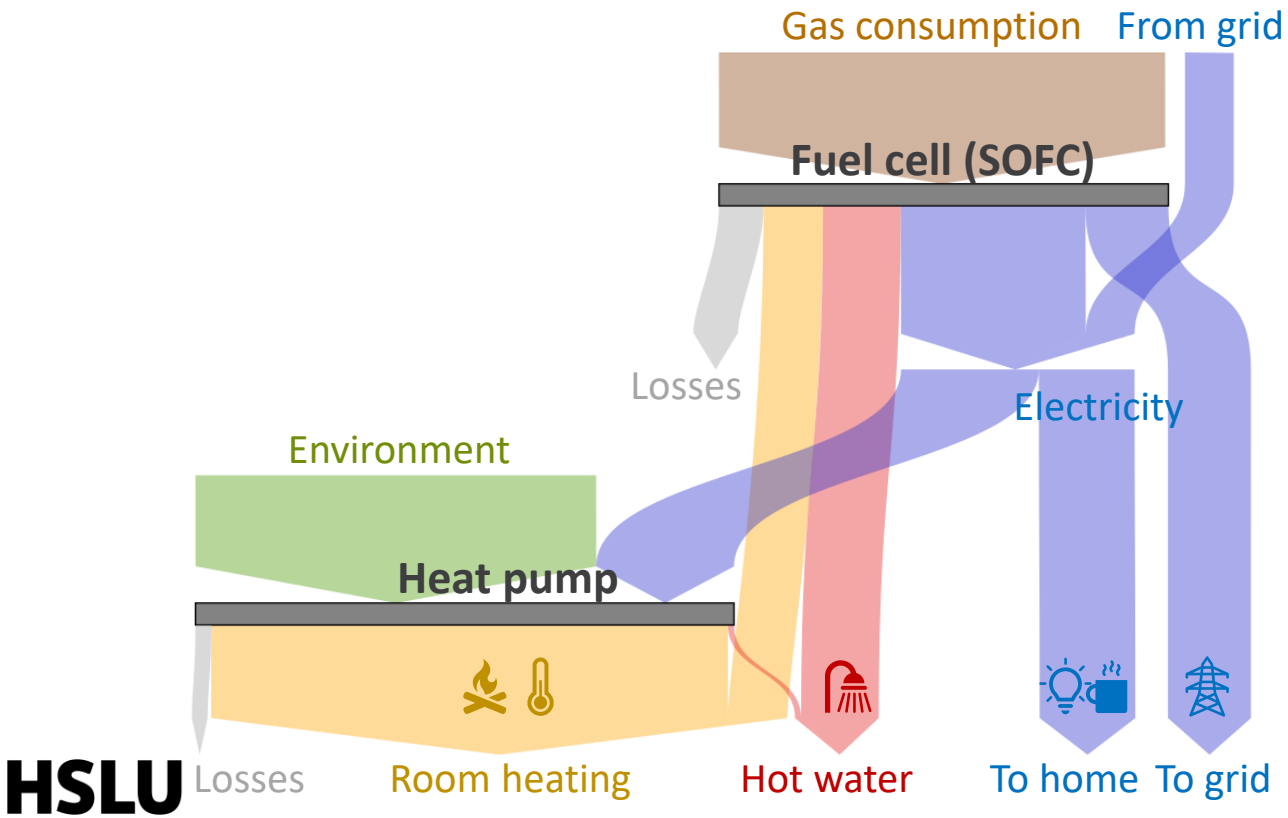
PACE

Pathway to a competitive European Fuel Cell micro-CHP Market

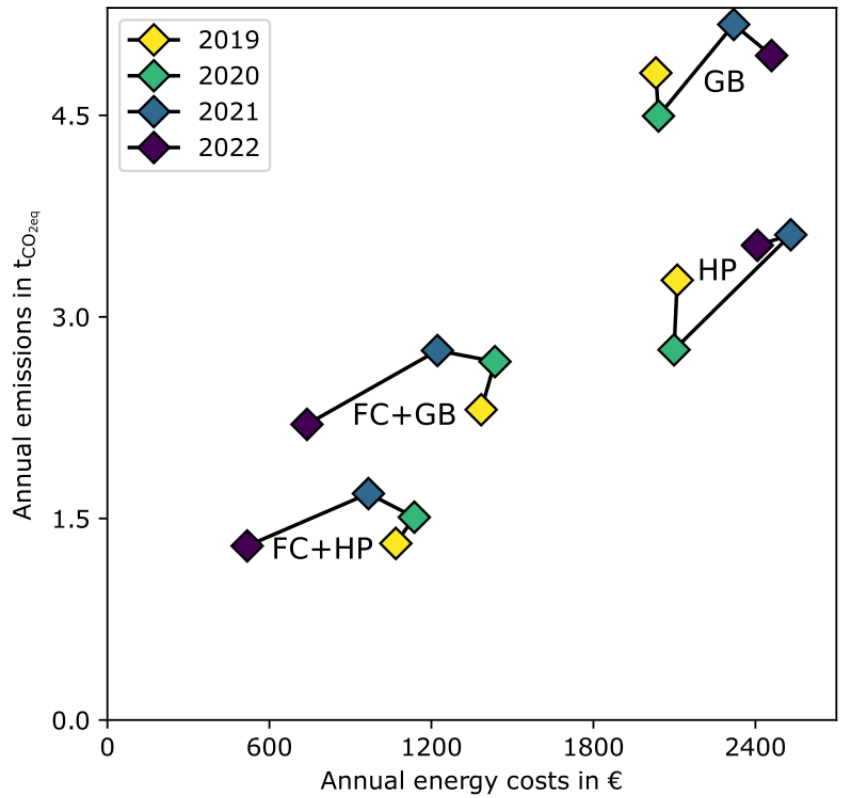
CO2 comparison of different heating systems

Hourly simulation using the German electricity emissions from electricitymaps.com

Example scenario: FC+HP in winter 2022



Comparison of different systems



HSLU

PACE
Pathway to a competitive European Fuel Cell micro-CHP Market

WP4 Key messages

- A combination of fuel cells and heat pumps makes most sense in terms of CO_2 emissions and energy costs
- The greatest financial opportunity for mCHPs comes from maximising self-consumption
- Income from balancing markets is a worthwhile side-case in countries where self-consumption policies are less favourable (e.g. Czech Republic)
- Literature reports that local congestion management and peak shaving could be attractive offerings of mCHP, with benefits of up to 500 €/kW p.a.

HSLU

PACE

Pathway to a Competitive European Fuel Cell micro-CHP Market

Contact:
Prof. Dr. Christoph Imboden
PACE | c/o HSLU
Technikumstrasse 21
6048 Horw
Switzerland
Phone: +41 41 349 37 52
Email: christoph.imboden@hslu.ch

Clean Hydrogen Partnership

This project has received funding from the Fuel Cells and Hydrogen 2 Joint Undertaking (now Clean Hydrogen Partnership) under Grant Agreement No 700339.

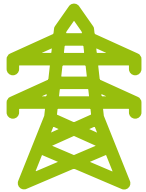
This Joint Undertaking receives support from the European Union's Horizon 2020 Research and Innovation program, Hydrogen Europe and Hydrogen Europe Research.

PACE
Pathway to a competitive European Fuel Cell micro-CHP Market

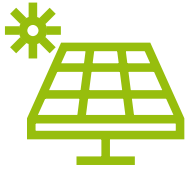
Dealing with network growth – harnessing distributed resources

DSO moving from a passive to an active role

Drivers for the change



New grid needs: need for better peak load and network congestion management



Maturing technologies

Expanding ambitions of market actors e.g. aggregators

Maturing market designs

New business models e.g. energy-as-a-service for smart homes

The techno-economic potential in obtaining grid services from DERs is recognized by DSOs in Europe and is the subject of numerous research and pilot projects