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European-wide field trials for residential fuel cell micro-CHP

Impact of widespread deployment of micro-CHP in European electricity systems

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Objective

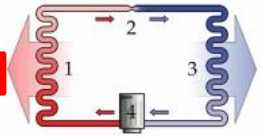
- The macroeconomics and macro-environmental impact of widespread deployment of fuel cell micro-CHP in Europe
  - System benefit of micro-CHP
  - Impact on the capacity of primary sources and electricity production
  - Benefits in reducing carbon emissions
  - Synergies between HP and micro-CHP operation

Approach

Reference scenario

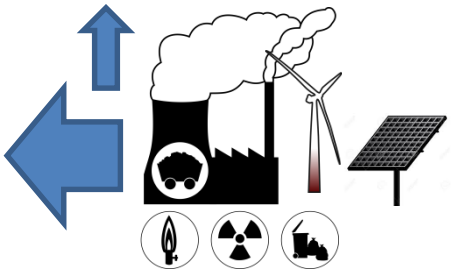
Heat

Other heat sources:
gas boiler, resistive heating, etc.



HP

Electricity

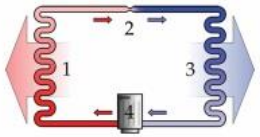


VS

micro-CHP scenario

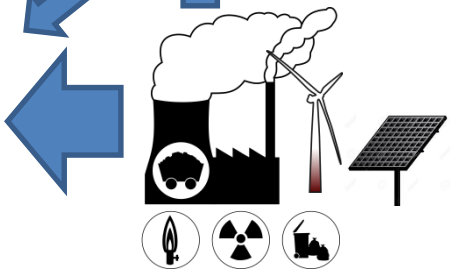
Heat

Other heat sources:
gas boiler, resistive heating, etc.



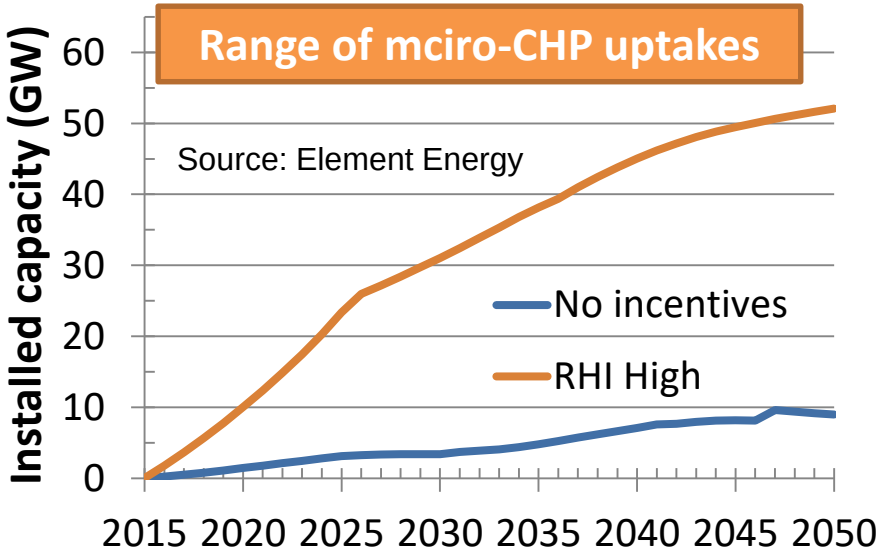
HP

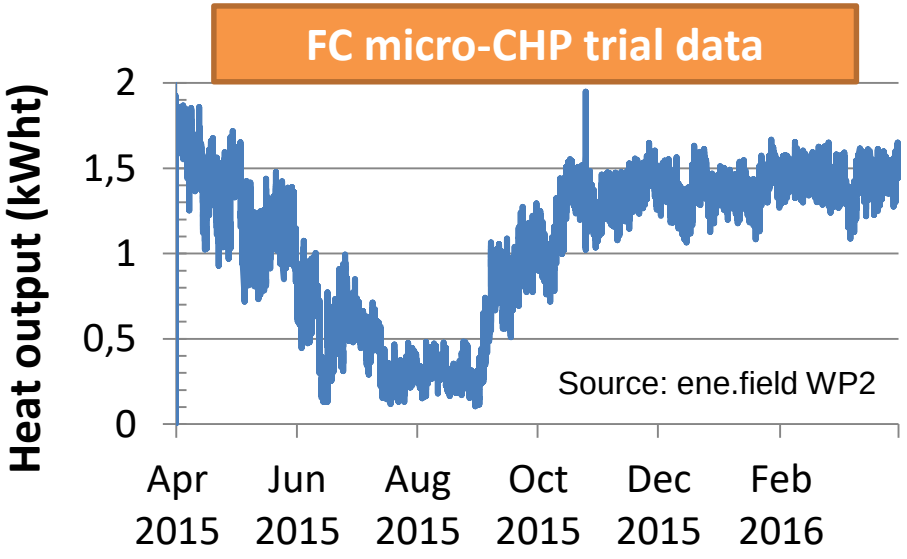
Electricity

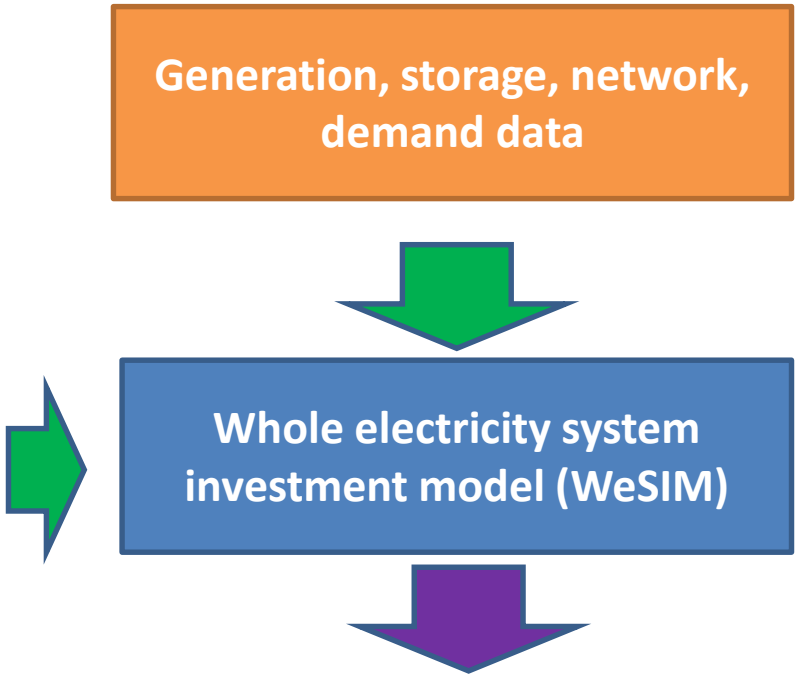


System benefits of micro-CHP

Optimisation model for generation, and network investment problems

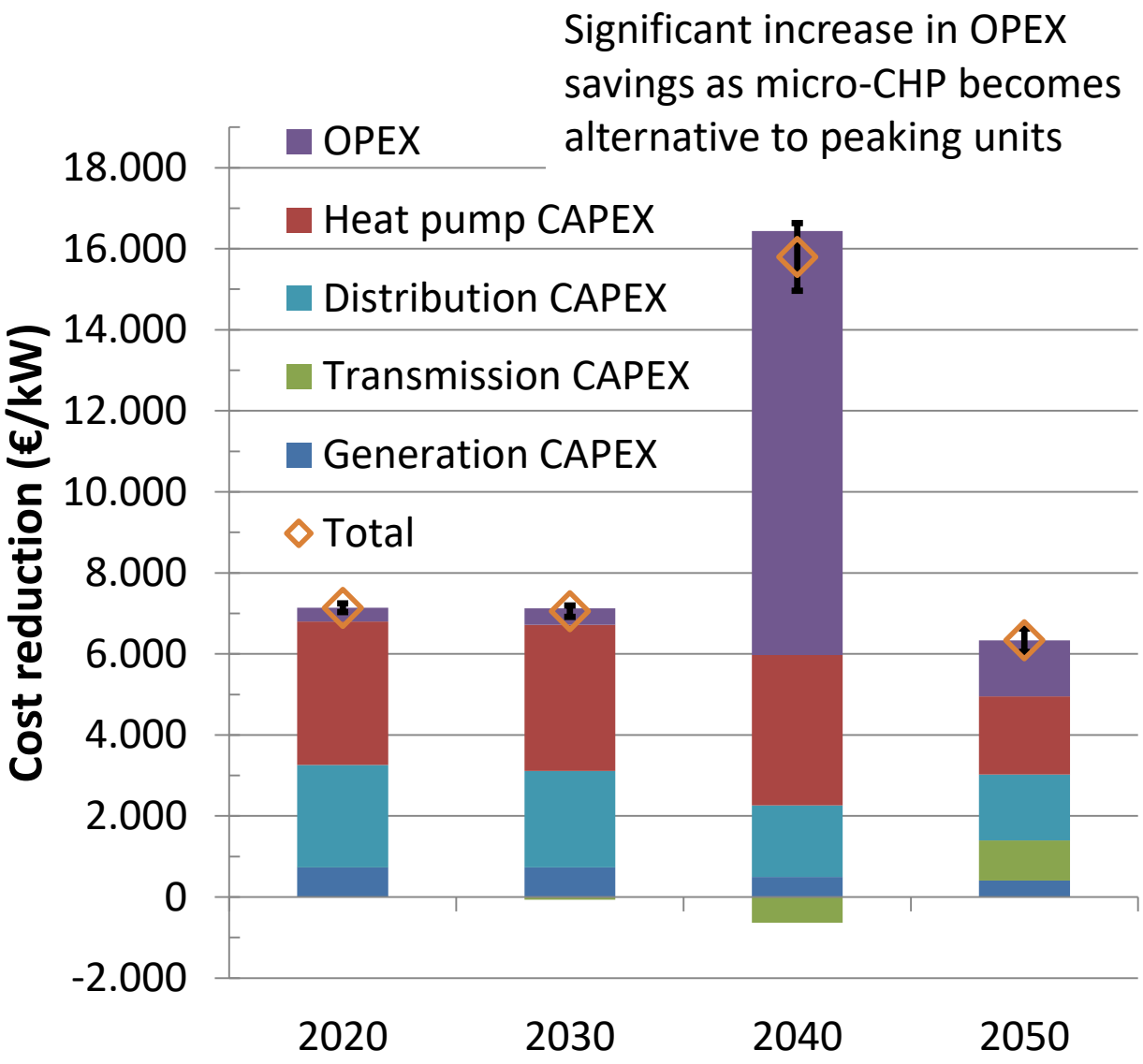






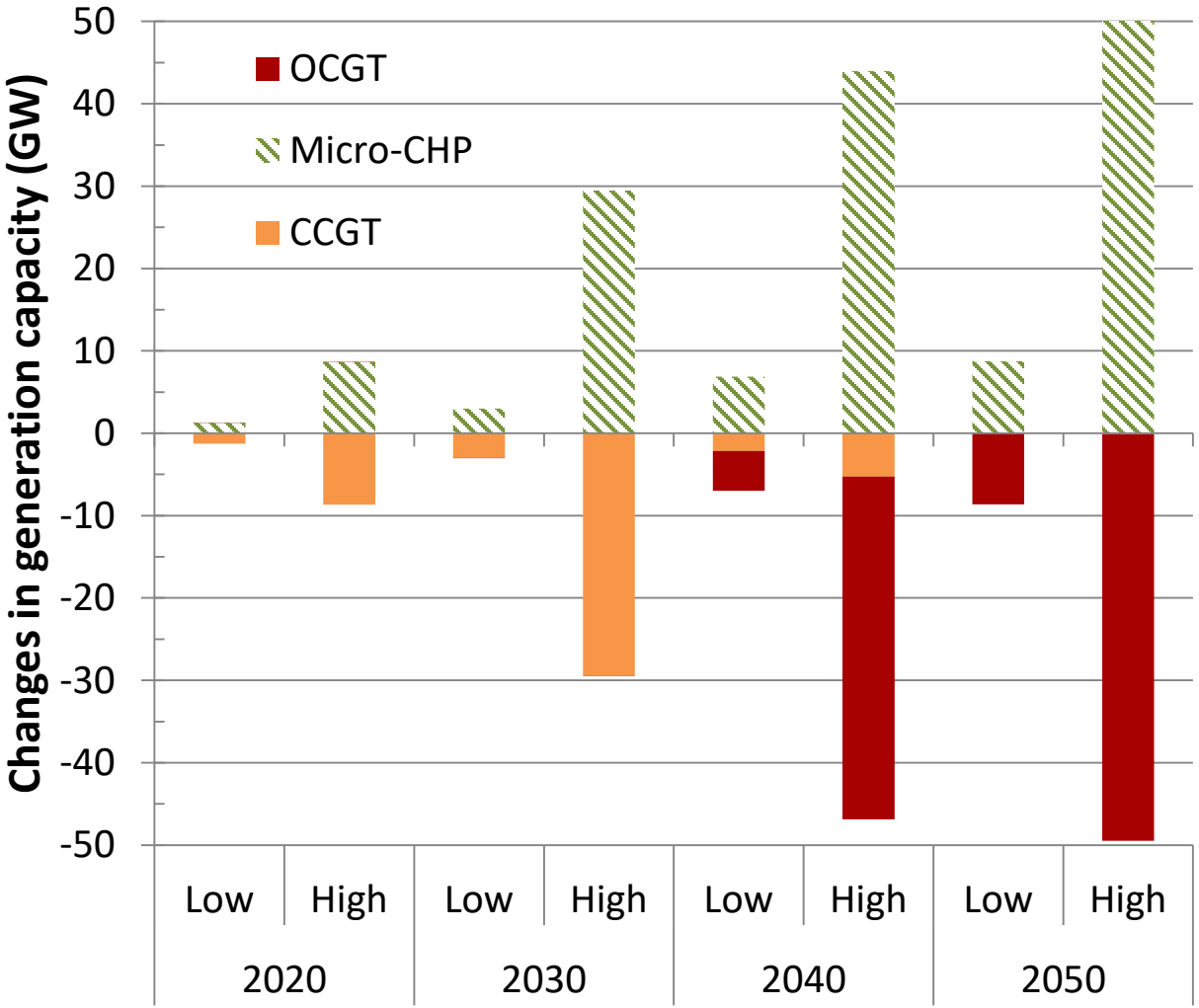
Investment decisions: CAPEX (generation, transmission and distribution network, HP)
Operating decisions: OPEX, CO_2 emissions, generation dispatch including RES and storage, demand response, and power flows

Benefits of µCHP



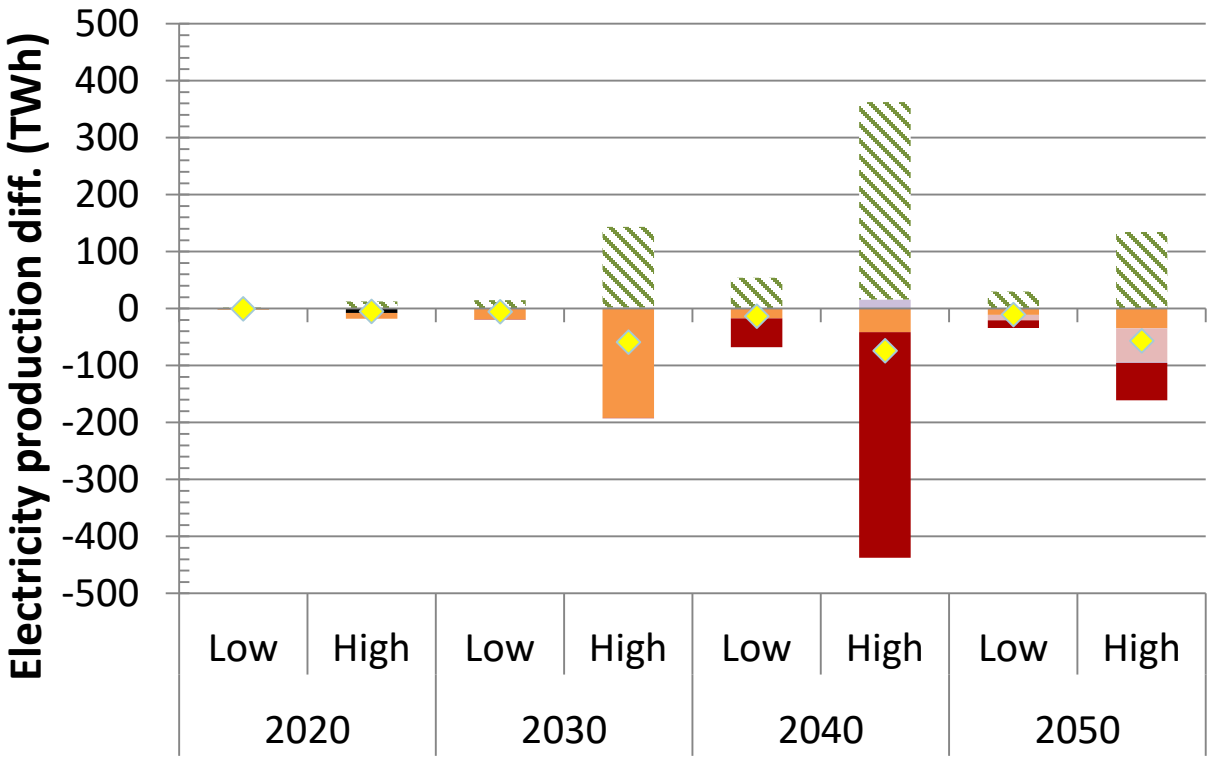
- Deferred infrastructure investment and reduced operating cost are more than €6,000 per kW of installed micro-CHP
- It is relatively stable within market projection range but it is system specific
  - Higher when micro-CHP displaces output from peaking plant (e.g. 2040)
  - Lower in systems with higher RES (e.g. 2050)

Impact on the capacity of primary sources



- In the short-term, micro-CHP displaces mid-merit CCGT but in the long-term, with large amount of renewables, it displaces peaking capacity (OCGT)
- Capacity value of micro-CHP (combined electricity and heat led operation mode) is comparable (firm) with conventional plant assuming it provides: ancillary services and capacity for security

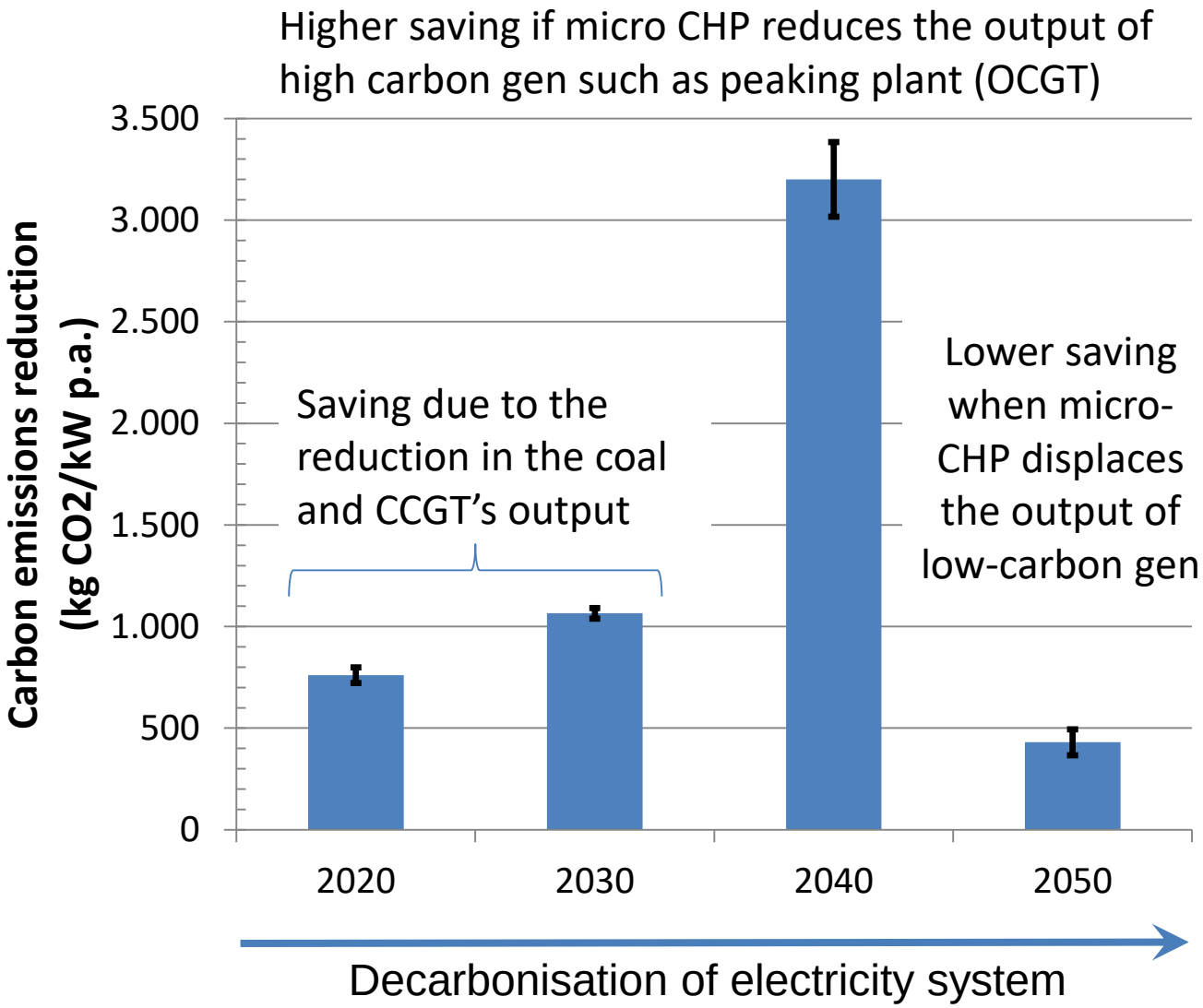
Impact on the electricity production



Capacity factor of micro-CHP	55%	90%	35%
Operational drivers	Heat led	Heat and electricity led	

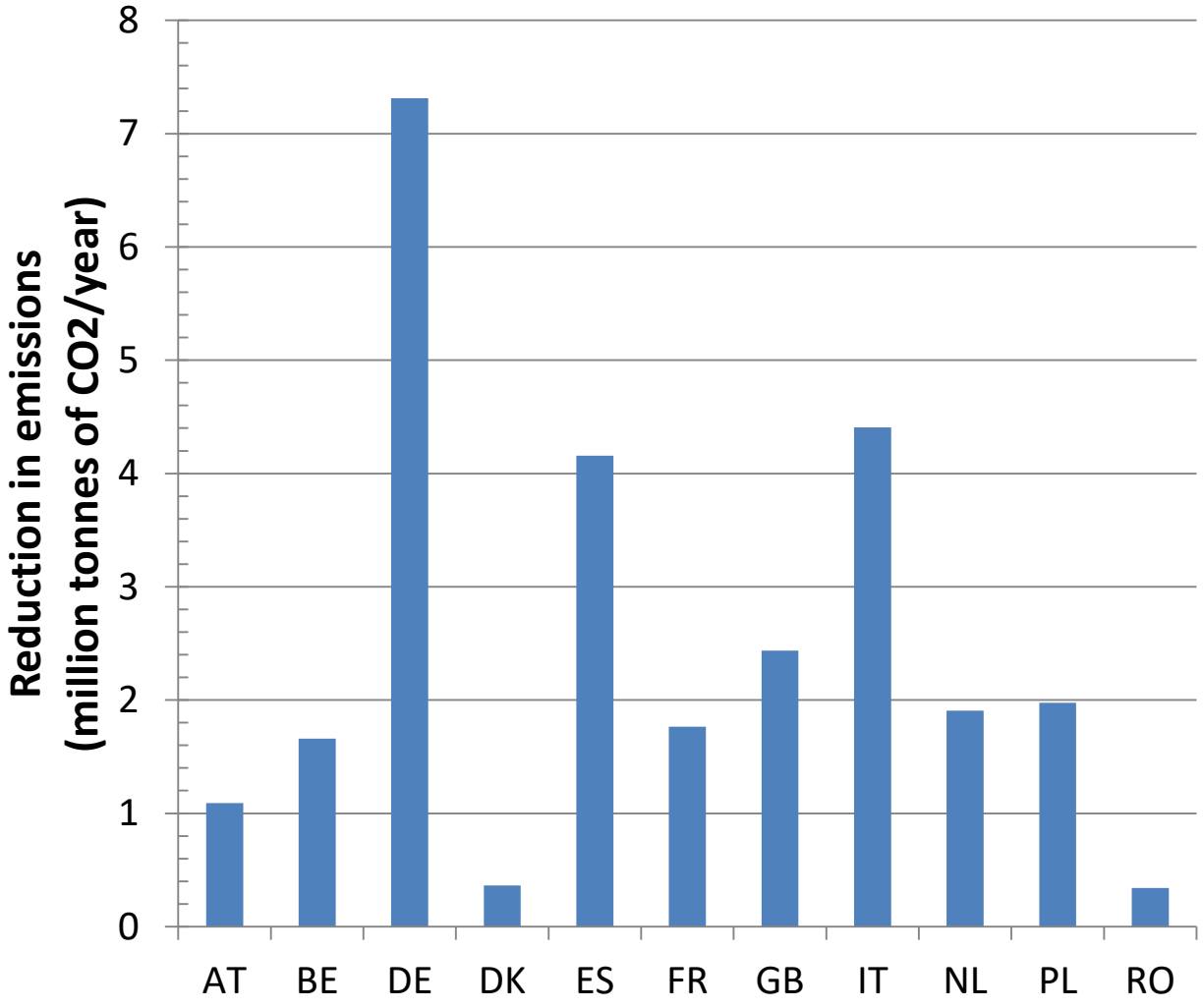
- The output of micro-CHP displaces the output of marginal generation
- Micro-CHP produces both electricity and heat (higher energy efficiency)
- **Micro-CHP is a cost-effective solution of utilising gas to generate both heat and electricity at domestic level and it improves energy efficiency and reduces system consumption**

Benefit of mCHP in reducing carbon emissions



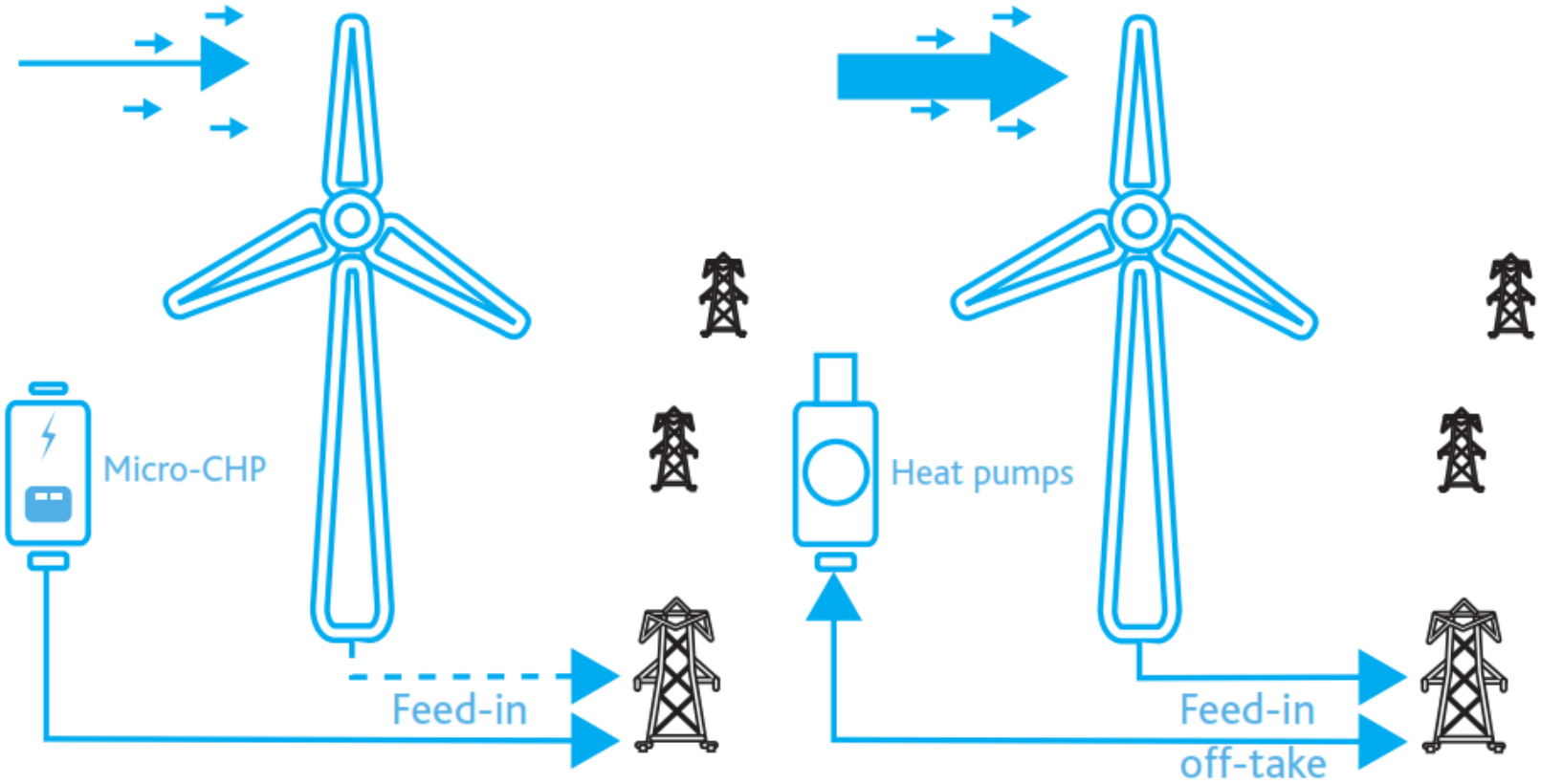
- Depending on what primary sources have been displaced by µCHP, the benefit of µCHP in reducing carbon emissions varies
- It is likely that the benefit is larger in the short term when the grid carbon intensity is high (i.e. supply of electricity is still dominated by coal/gas-fired plant)

Carbon emissions reduction in 2030



Across Europe, the total CO2 reduction is more than 32 million tonne per year in 2030
Equivalent to 25% of Belgium's carbon emissions in 2015)

Synergies between µCHP and HP /1

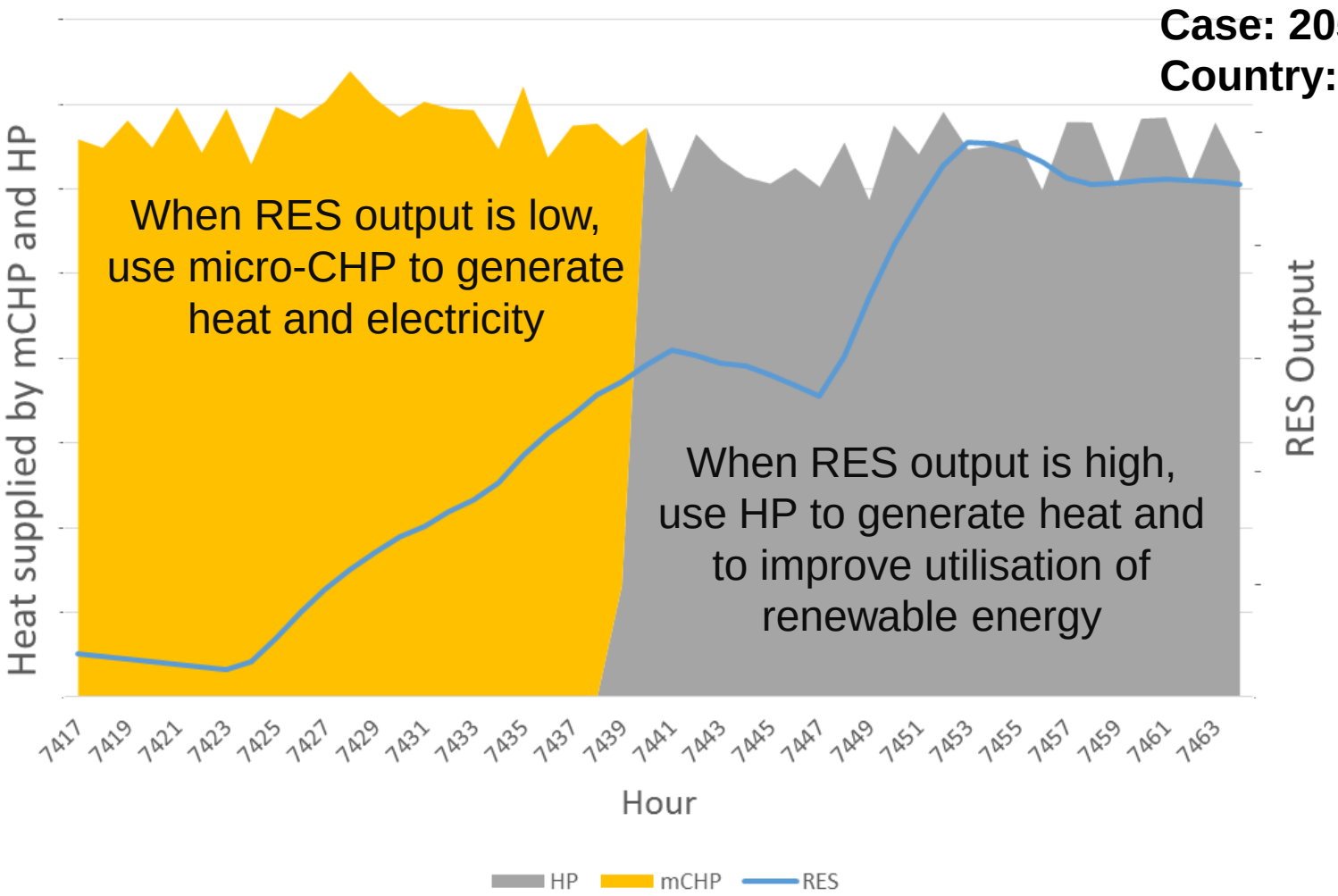


Source: Delta-ee and COGEN Europe, the benefits of µCHP

Micro-CHP operates when the output of renewables is low

HP operates when the output of renewables is high

Synergies between micro-CHP and HP /2



In electricity systems with high RES penetration, a mix of HP and micro-CHP will optimise cost-efficiency and environmental outcomes.

Conclusions

- The main system benefits of micro-CHP are:
  - displacing conventional generation capacity especially peaking/backup capacity
  - substituting other heat sources such as HP in the near/mid-term
  - reducing network capacity need
  - improving efficiency of system operation and reducing OPEX
  - reducing carbon footprint
- Benefits are between 6,000 and 7,300 €/kWe of micro-CHP
  - Benefits are higher for the 2040 case but this is an exception as the generation mix in this case is not balanced.
- Heat-led operation is optimal in the short-term
- In systems with higher share of renewables or when there is a scarcity in the generation system, a combination of heat and electricity led operation is needed

To read the full report on the impact of widespread deployment of micro-CHP in European electricity systems, please follow this link: Benefits of Widespread Deployment of Fuel Cell micro-CHP in Securing and Decarbonising the Future European Electricity System