Session 3: Power - gas - heat: quantifying the benefits of a multi-energy approach

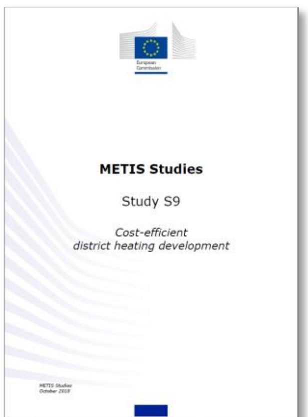
METIS 1 – Dissemination event

20 February 2019

Articulation of the four studies presented today

METIS studies

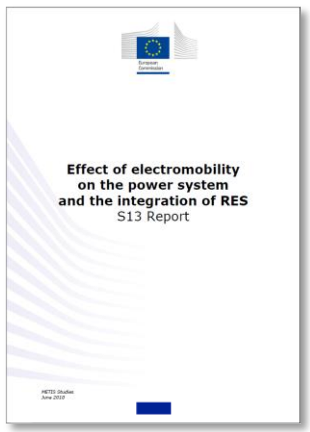
S9


METIS Studies

Study S9

Cost-efficient district heating development

S13

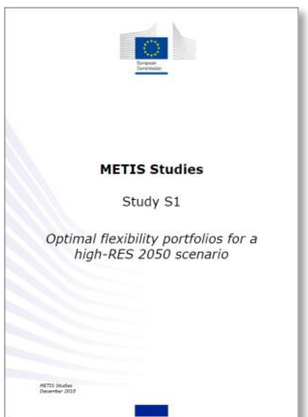

Effect of electromobility on the power system and the integration of RES

S13 Report

Electrification – possibilities and limits

METIS Studies

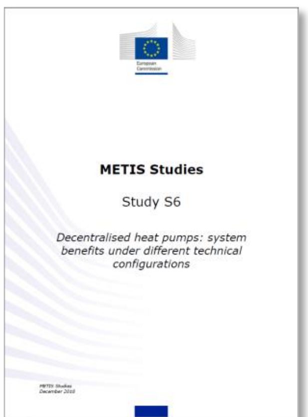
S1


METIS Studies

Study S1

Optimal flexibility portfolios for a high-RES 2050 scenario

S6


METIS Studies

Study S6

Decentralised heat pumps: system benefits under different technical configurations

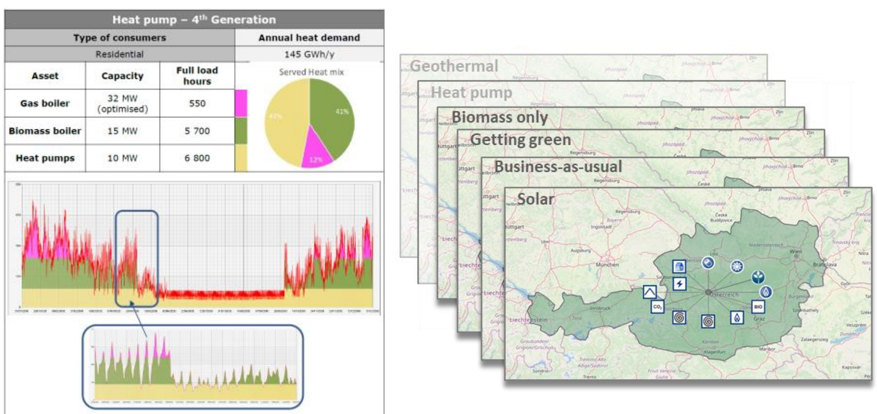
The power-gas nexus

BENEFITS OF THE MULTI-ENERGY APPROACH

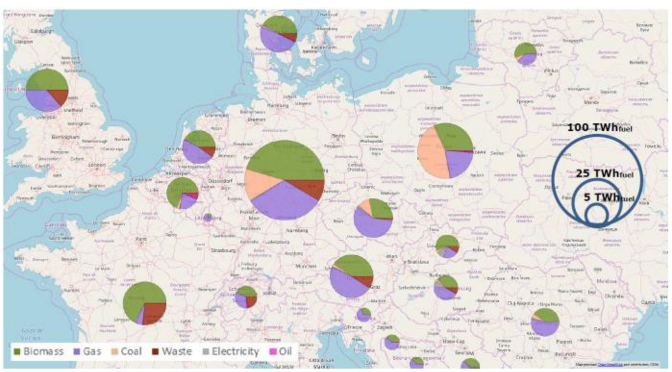
1. **Electrification – possibilities and limits**
2. The power-gas nexus
3. Conclusions

Case 1: Electrifying district heating

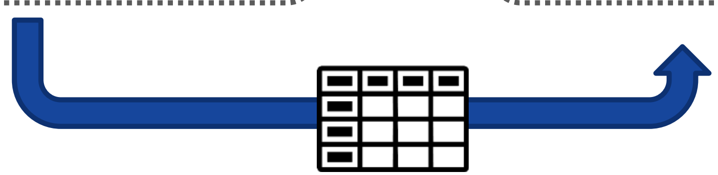
- METIS representation of DH networks by means of archetypes
  - Definition of 12 archetypes based on network survey
    - ↳ differ regarding capacity mix, demand and consumer types
  - Modelling of the hourly dispatch of heat generation and storage assets
    - ↳ takes into account national electricity prices and carbon content
  - Archetypes are combined to represent a country’s future DH mix



Archetype perspective



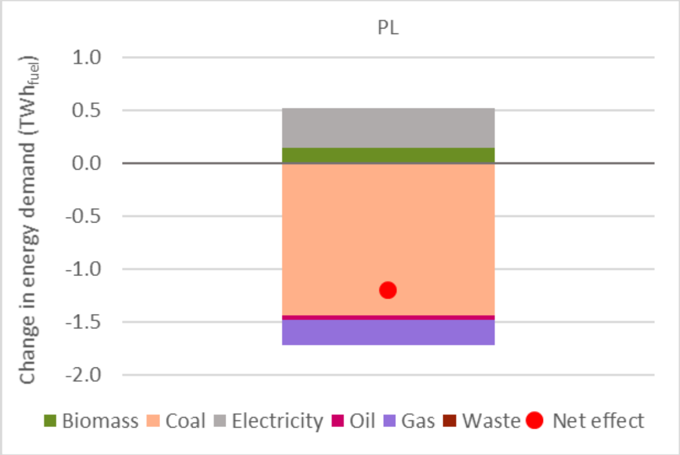
National/EU perspective

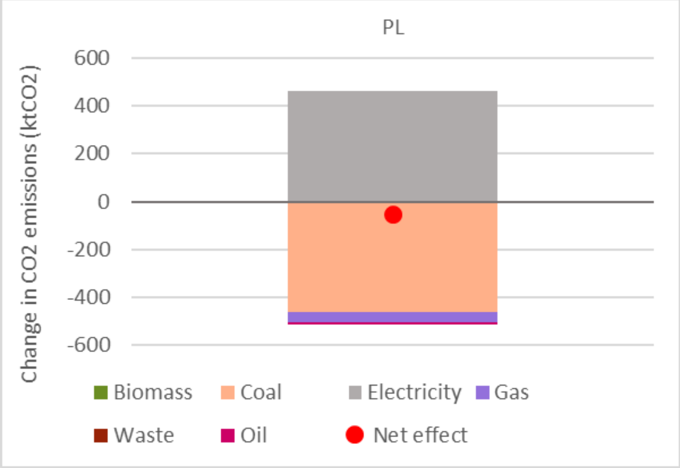


Case 1: Electrifying district heating

S9: "Cost-efficient district heating development"

- **Sensitivity** assessment
  - Impacts of a higher share of residential **heat pump** networks on emissions
- Power **carbon content** is a key factor for emission reduction
  - Effective emission reduction is subject to low carbon content of electricity
  - Displaced DH energy mix must feature a proportionally higher carbon content



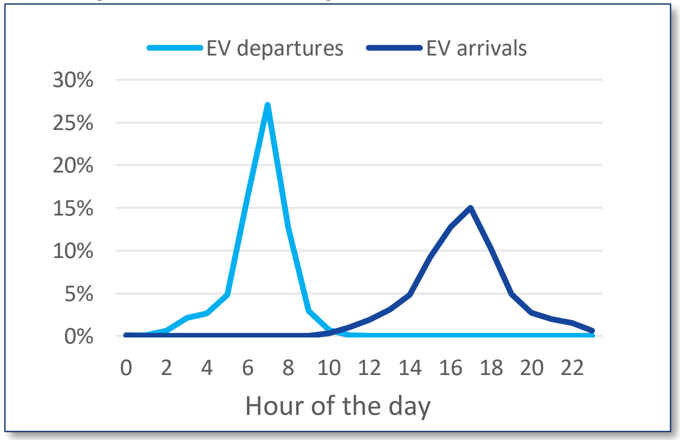


Key message #1: The relative carbon content of electricity is key

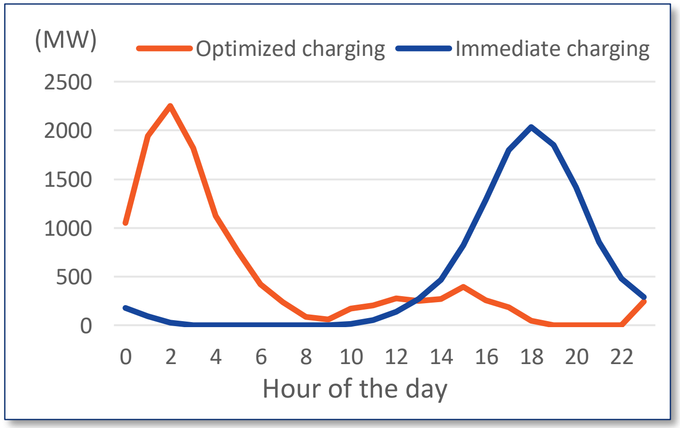
Case 2: Electrifying passenger road transport

- Modelling of EV charging under behavioural constraints (driving patterns)
  - Immediate charging: vehicles charged whenever they get home
  - Time-of-use (TOU) based charging
  - Real time pricing (RTP) based charging
    - **Joint** optimisation of EV charging and power plant dispatch
    - Vehicle-to-grid (V2G) charging

Input: Arrival/departure timeseries



Output: Power demand timeseries



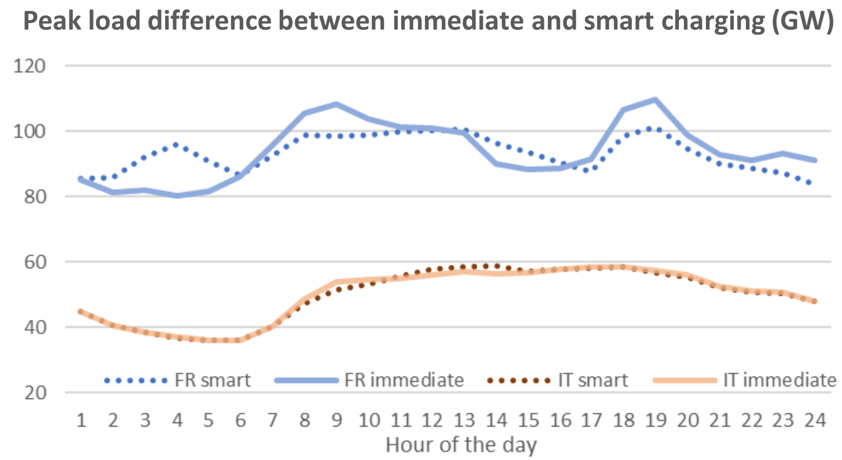
Case 2: Electrifying passenger road transport

S13: "Impacts of EV charging strategies on power systems and RES integration"

- **Immediate** EV charging
  - uncontrolled charging entails significant load peaks

- **Smart** EV integration
  - RTP avoids load peaks and LoL
  - facilitates RES integration
  - enhances utilisation of base load
    - ↳ with effective carbon price signal reduction of carbon emissions

- **V2G** further eases integration of EVs and RES generation

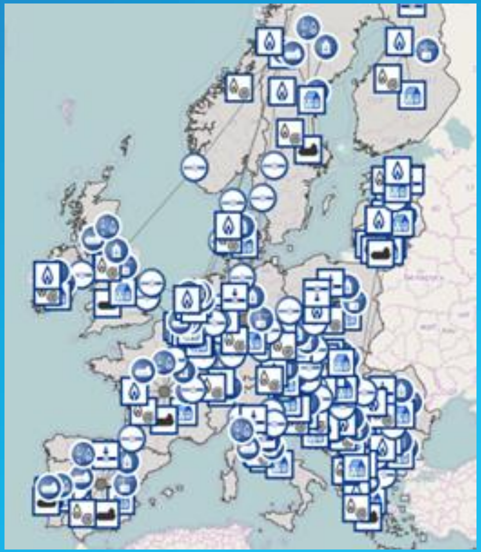


Key message #2: Smart electrification avoids additional power system stress

BENEFITS OF THE MULTI-ENERGY APPROACH

1. Electrification – possibilities and limits
2. **The power-gas nexus**
3. Conclusions

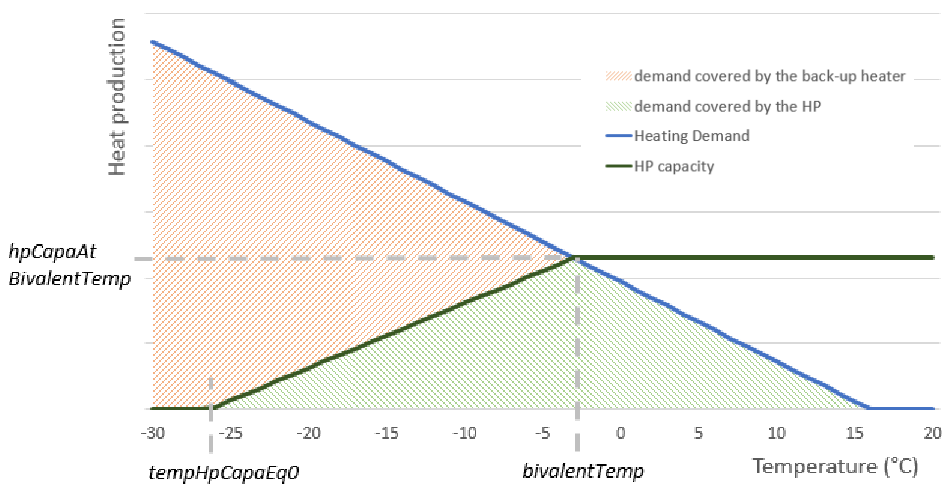
European power model



European gas model

Case 3: Hybridisation of heat pumps

- Modelling of decentralised heat pumps under different operation modes
  - Takes into account thermo-sensitive heat demand (for varying weather years)
- Consideration of different HP configurations
  - Hybrid HPs with electric/gas back-up
  - HP with storage allowing for smart operation

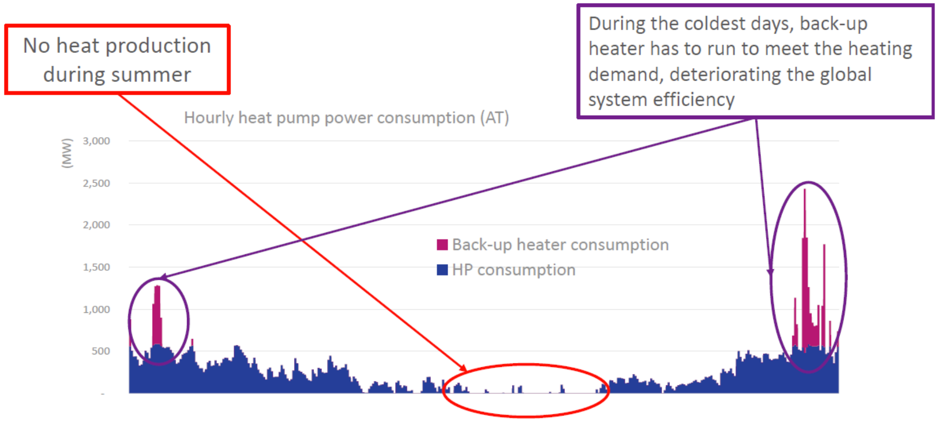


Case 3: Hybridisation of heat pumps

S6: "Decentralised HPs: system benefits under different configurations"

- **Electrification** is a major lever for decarbonisation
  - But tends to generate excessive load peaks, requiring massive investments in peak power capacities
- **Hybridisation** of HPs allows to use low-CAPEX heat capacities (i.e. decentralised gas boilers) during cold hours
  - Marginal increase in emissions
  - Substantial decrease in power system costs

Power demand of HPs and electric back-up, AT, 2030



Key message #3: Hybridisation: lower costs using synergies between power and gas

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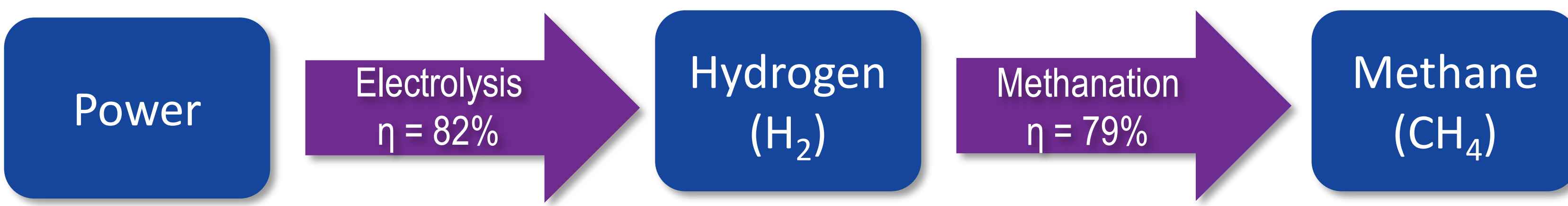
Case 4: The flexibility role of gas in 2050

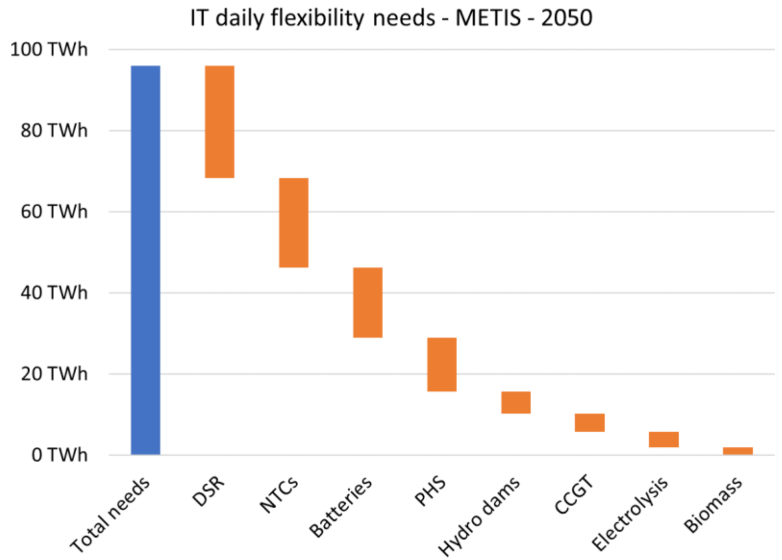
- METIS modelling of power-to-gas: electrolysis and methanation
- Joint optimisation of power system assets and PtX capacities and dispatch
  - Available flexibility solutions subject to optimisation
    - Interconnectors
    - Flexible generation
    - DSR (EVs, HPs)
    - Storage
    - Power-to-Gas



Case 4: The flexibility role of gas in 2050

S1: "Optimal flexibility portfolios for a high-RES 2050 scenario"

- **New flexibility sources** effectively drive down the need for dispatchable gas
  - In terms of power generation, the role of gas is limited to 3% of power generation
  - 200 GW of gas-fired assets to meet power demand peaks and cope with inter-seasonal variations in the residual load



- **PtG** provides additional system flexibility at all time scales, but in particular on the annual level

Key message #4: New flexibility sources reduce gas utilisation. Gas capacity value remains important.

BENEFITS OF THE MULTI-ENERGY APPROACH

1. Electrification – possibilities and limits
2. The power-gas nexus
3. **Conclusions**

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Conclusions

- METIS comes with
  - a **multi-energy modelling** approach, combining power, gas, district heat
  - a library of **new electric end-uses**, considering different consumption behaviours

- **Smart electrification** is key for emission reduction
  - **Electricity needs to be clean**, and thus requires a clear **carbon price s**ignal
  - Market design needs to **incentivize flexible** power consumption
    - ↳ Electrification is a relevant source of additional power system flexibility
  - **Partial electrification** allows to use gas to meet occasional peak demand
  - **Gas** may serve as **capacity backbone** of the power system, in selected situations of peak load or high ramp rates

- **Joint assessment** of power and gas infrastructure is indispensable

Thank you for your attention!

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Interested in further information?

https://ec.europa.eu/energy/en/data-analysis/energy-modelling/metis