Diversity of biomass usage pathways to achieve emissions targets in the European energy system

Markus Millinger | OpenMod conference

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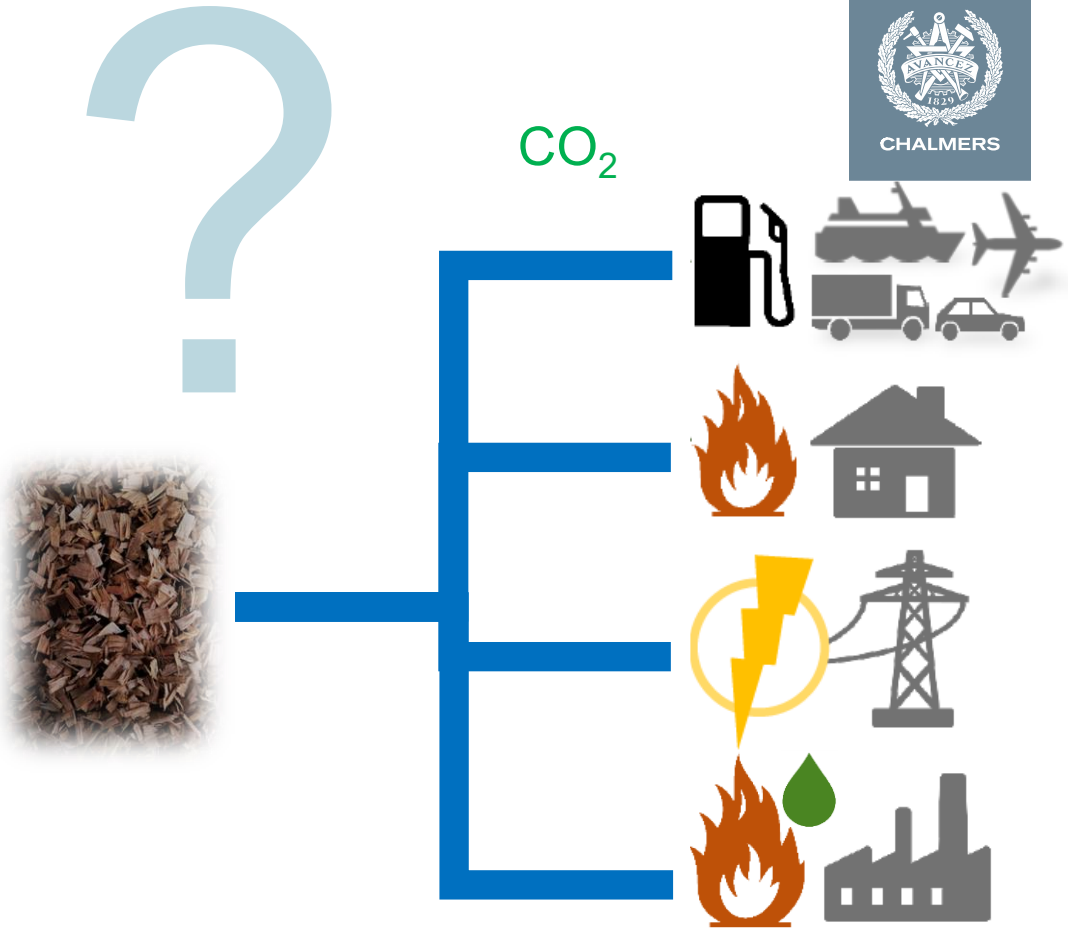
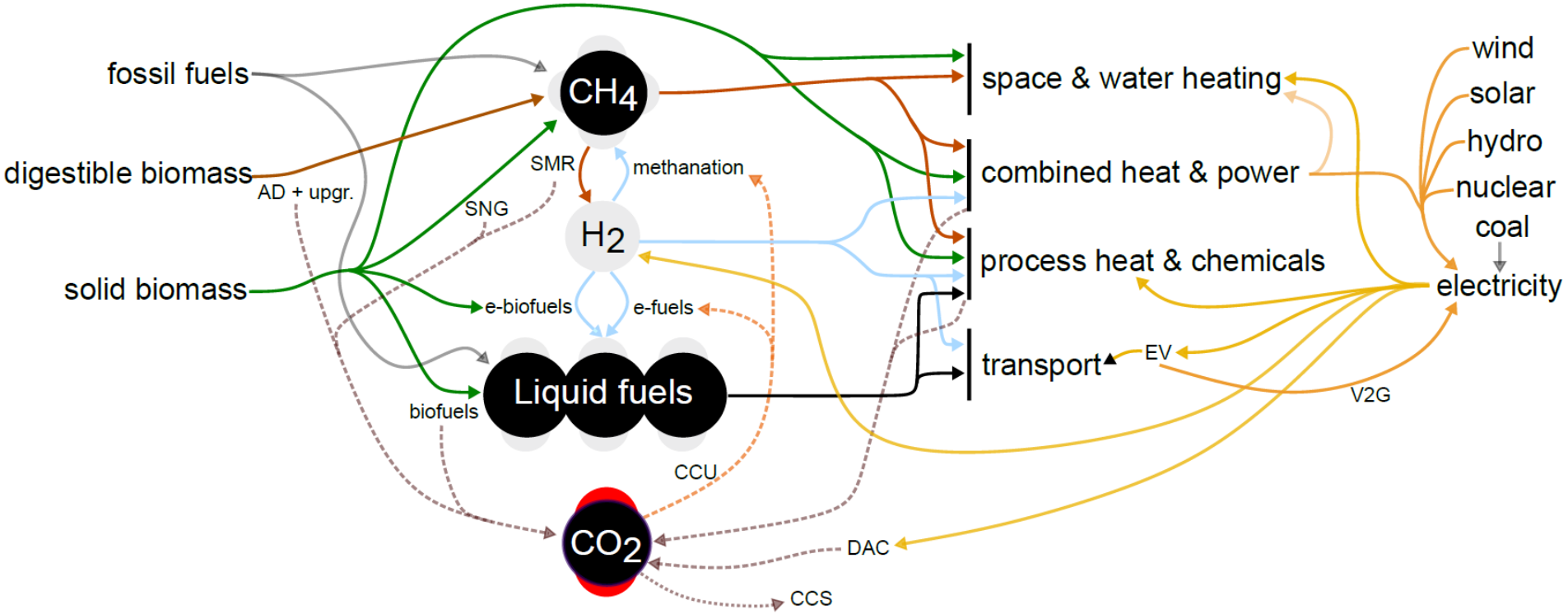
Biomass

- Limited resource with trade-offs
- RED III proposed to exclude forest residues
- Cost-effective use of biomass residues in the energy system?
  - Fuels?
  - Variation management / firm generation?
  - Industry?
  - Negative emissions?



Millinger et.al. 2021:
https://doi.org/10.1039/D0SE01067G

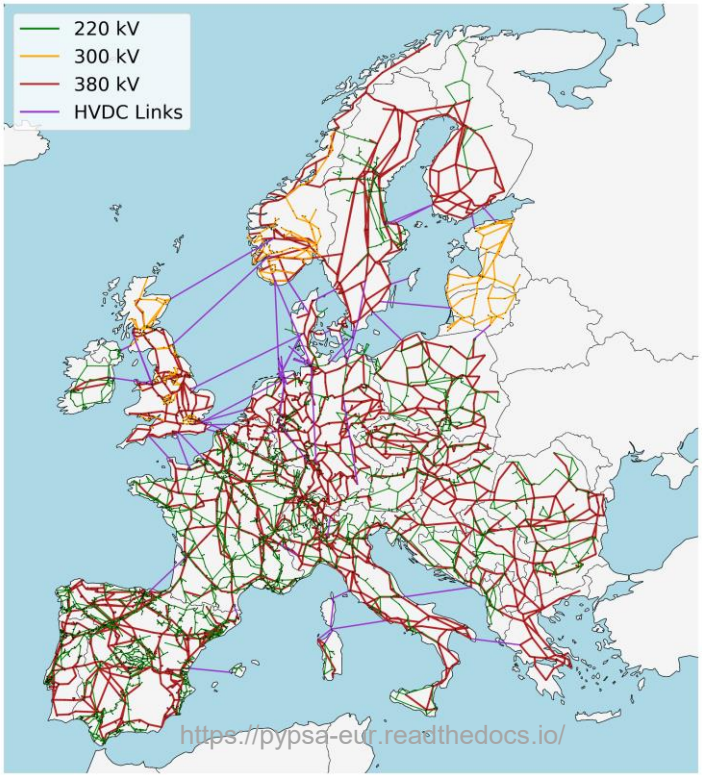

fossil fuels
digestible biomass
AD + upgr.
solid biomass
CH4
SMR
methanation
SNG
H2
e-biofuels
e-fuels
Liquid fuels
biofuels
CCU
CO2
DAC
CCS
space & water heating
combined heat & power
process heat & chemicals
transport
EV
V2G
wind
solar
hydro
nuclear
coal
electricity

Model

- **PyPSA**-Eur-Sec. Optimisation of capacity and dispatch across all sectors. Open source.

Set-up:

- Europe in 37 nodes, 5H temporal resolution, **overnight**
- **Net-negative** (-110%) CO_2 emissions vs 1990, with limited carbon storage
- Biomass competes with electricity- and fossil-based options in all sectors
- Energy penalties for carbon capture



Conclusions

- Removing biomass residues results in **~20%** higher energy system cost
- Main value of biomass is **carbon provision** for further utilisation or negative emissions. Carbon capture and e-biofuels enhance carbon efficiency to provide negative emissions or for production of fuels
- Dispatchable bioelectricity covering 1% of total electricity generation strengthens supply reliability. Otherwise, it is **not crucial what biomass is used** for as long as carbon content is utilised to a high extent
- Renewable chemicals and **liquid fuels most challenging** part of the energy system