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WtE and CO_2 Accounting

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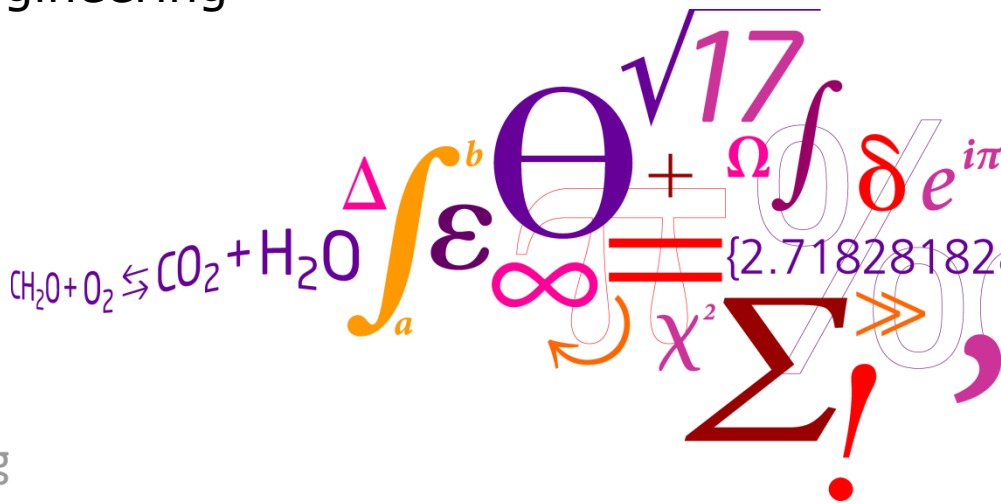


DTU Environment
Department of Environmental Engineering

Discussion about carbon accounting and carbon neutrality

Situation

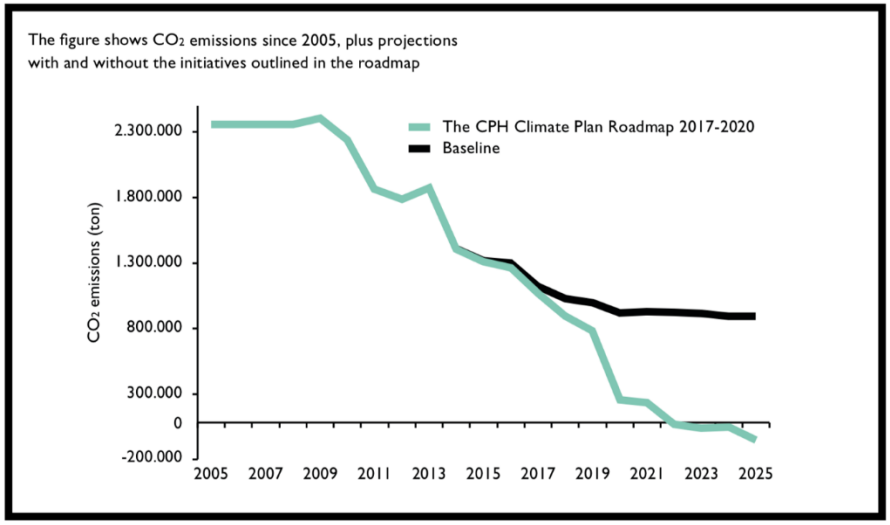
- WtE manages waste
- WtE generates energy
- WtE emits CO_2 – both fossil and biogenic

Challenge

- Fossil CO_2 emissions conflicts with regional carbon emission targets
- Several CO_2 reporting systems exist
- Even biogenic CO_2 emissions may be problematic – over time

”Towards a carbon neutral capital” An example of CO_2 targets for Copenhagen

CO_2 emissions in City of Copenhagen 2005-2025



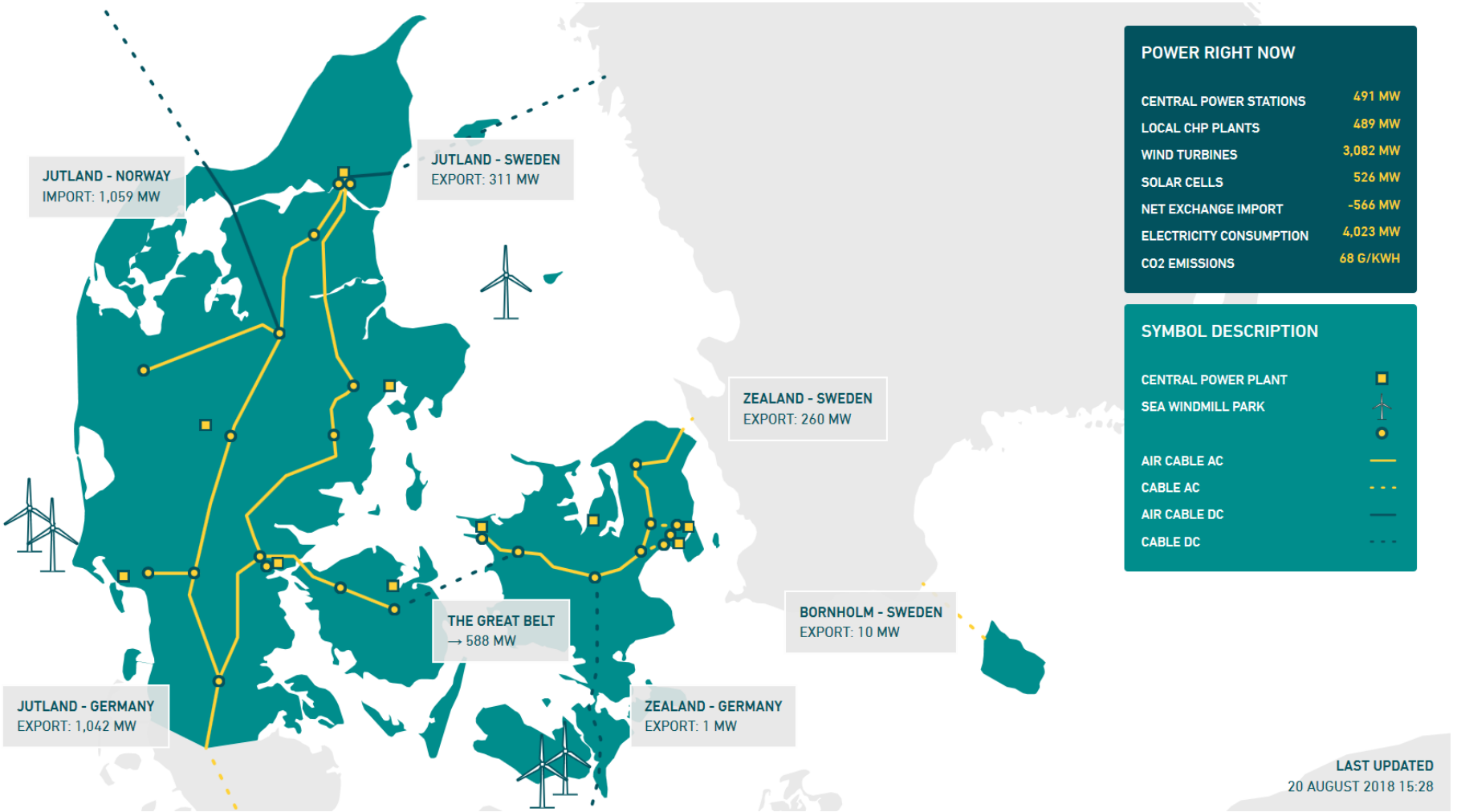
Targets for Energy Production 2025

- District heating in Copenhagen is carbon neutral
- Electricity production is based on wind and biomass and exceeds total electricity consumption in Copenhagen
- Plastic waste from households and businesses is separated
- Biogasification of organic waste

CPH 2025 TOTAL (TONNES OF CO_2)	928,000
Energy Consumption (7%)	66,000
Energy Production (80%)	741,000
Mobility (8%)	78,000
City Administration Initiatives (5%)	43,000

City of Copenhagen (2016)

WtE in the energy system



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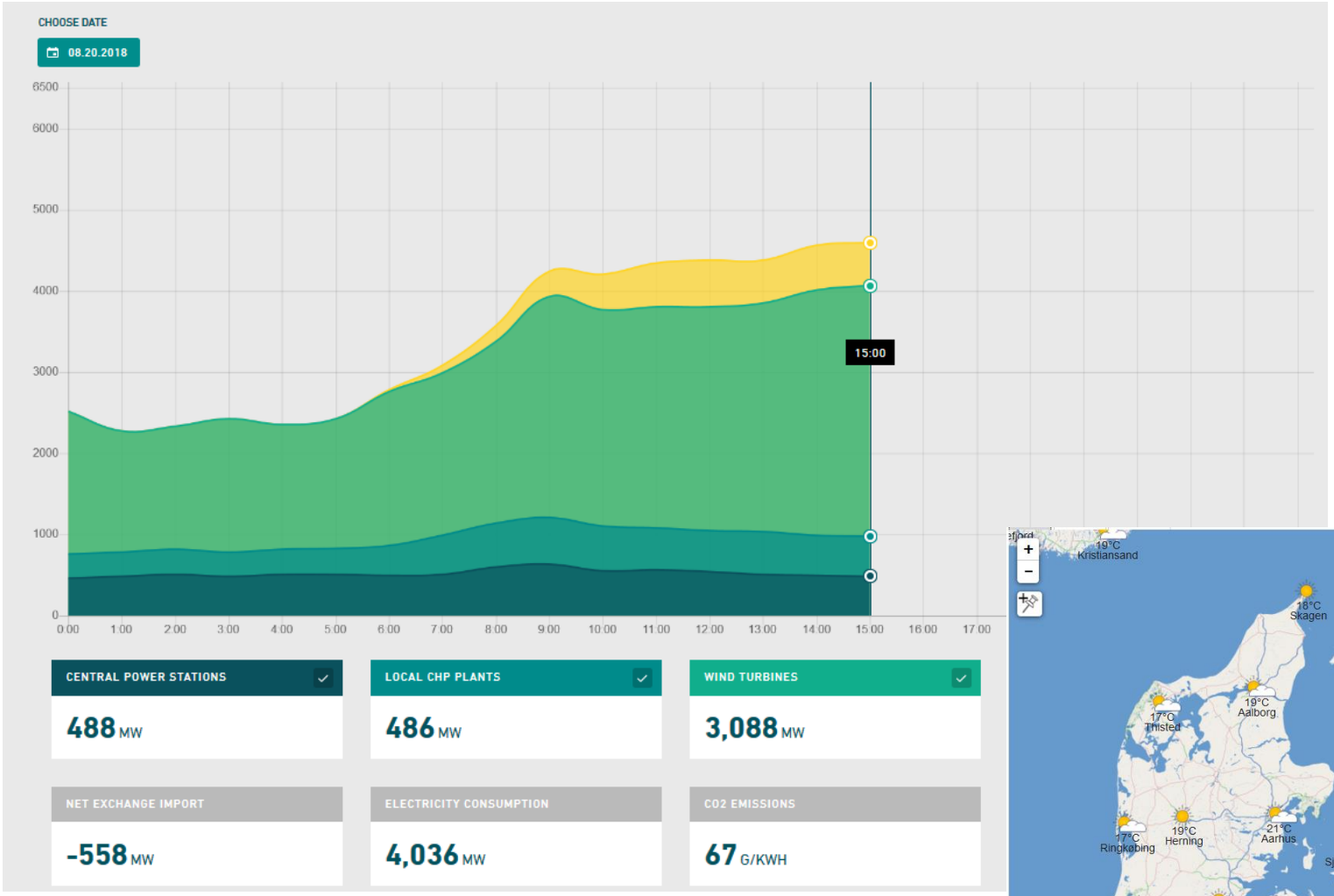

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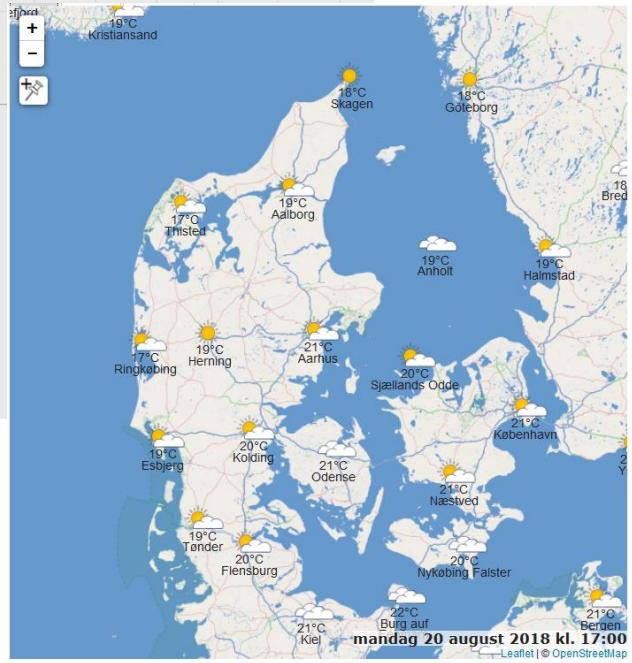
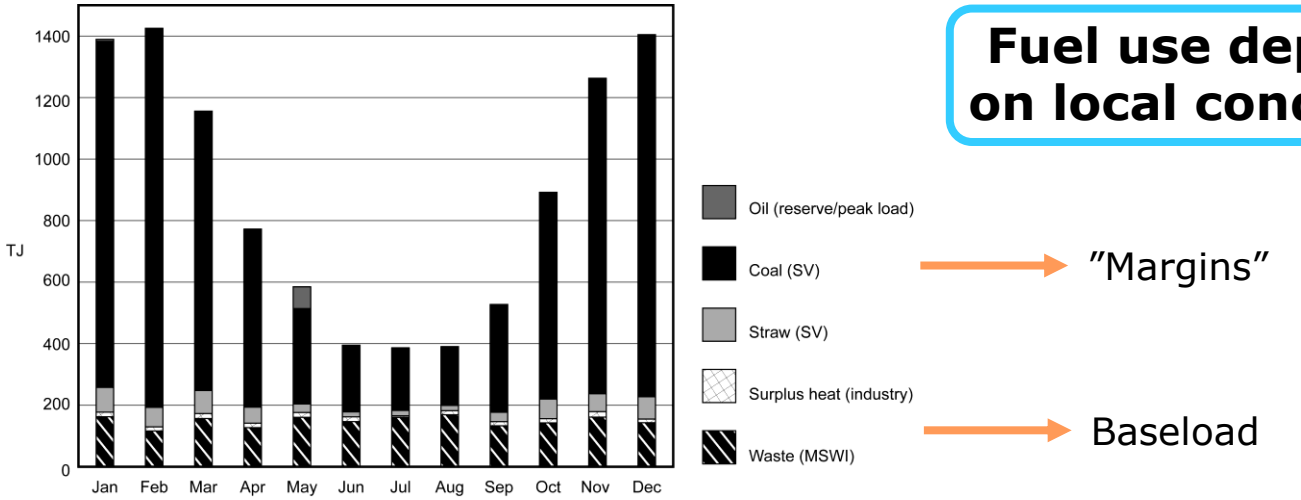


www.dmi.dk

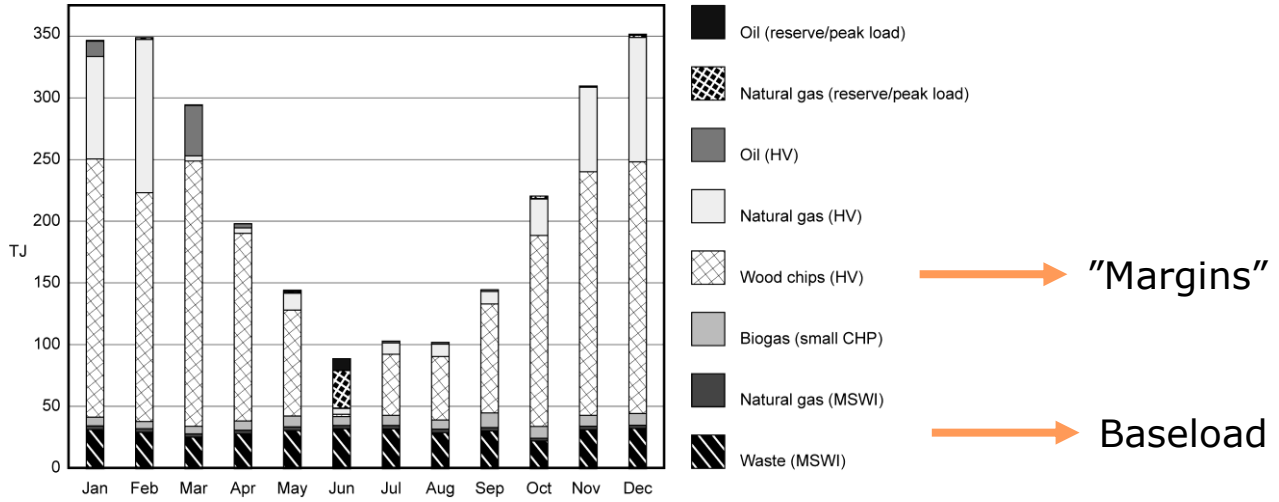
District heating networks (examples)

Fuel use depends on local conditions

Århus

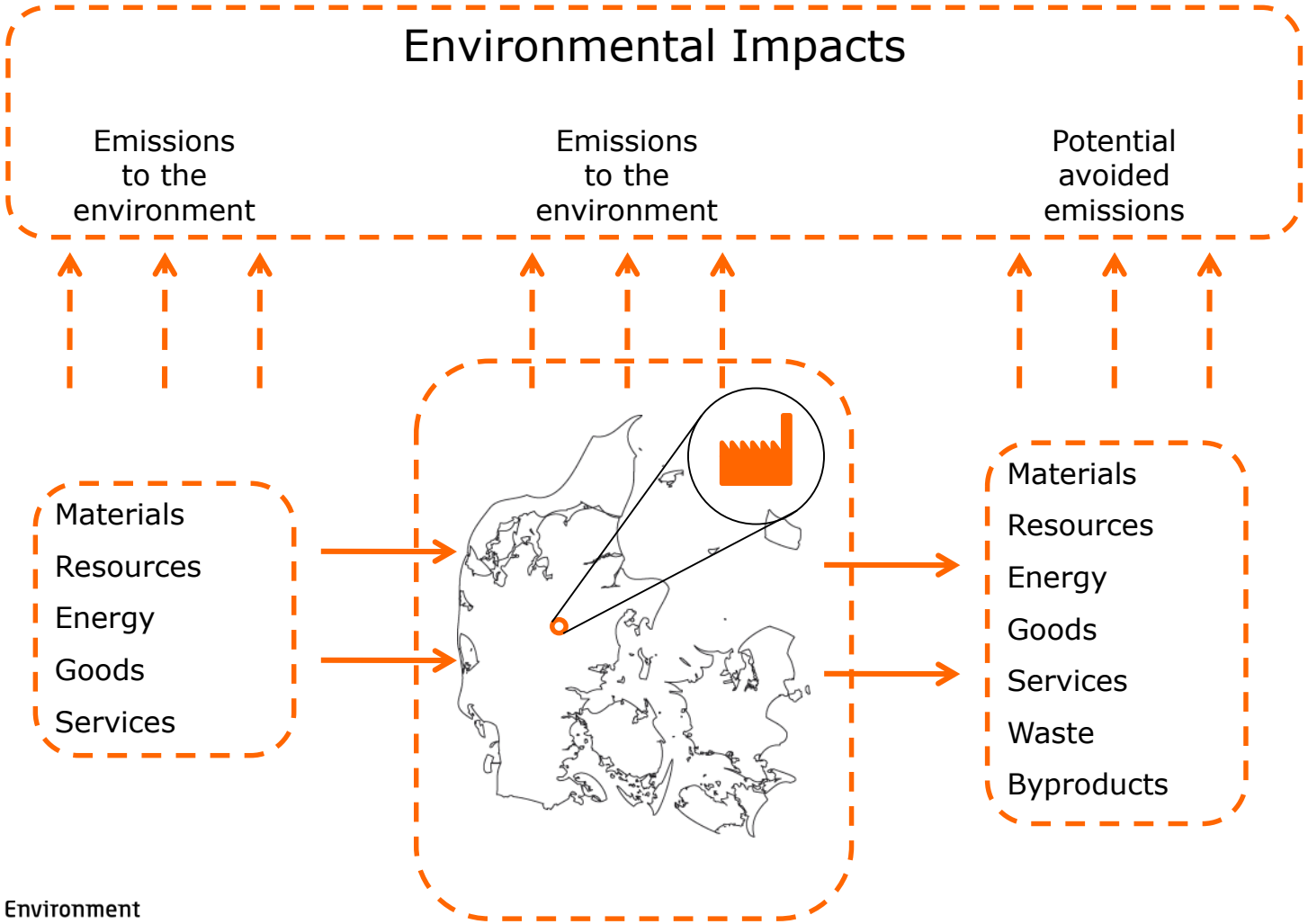


Herning

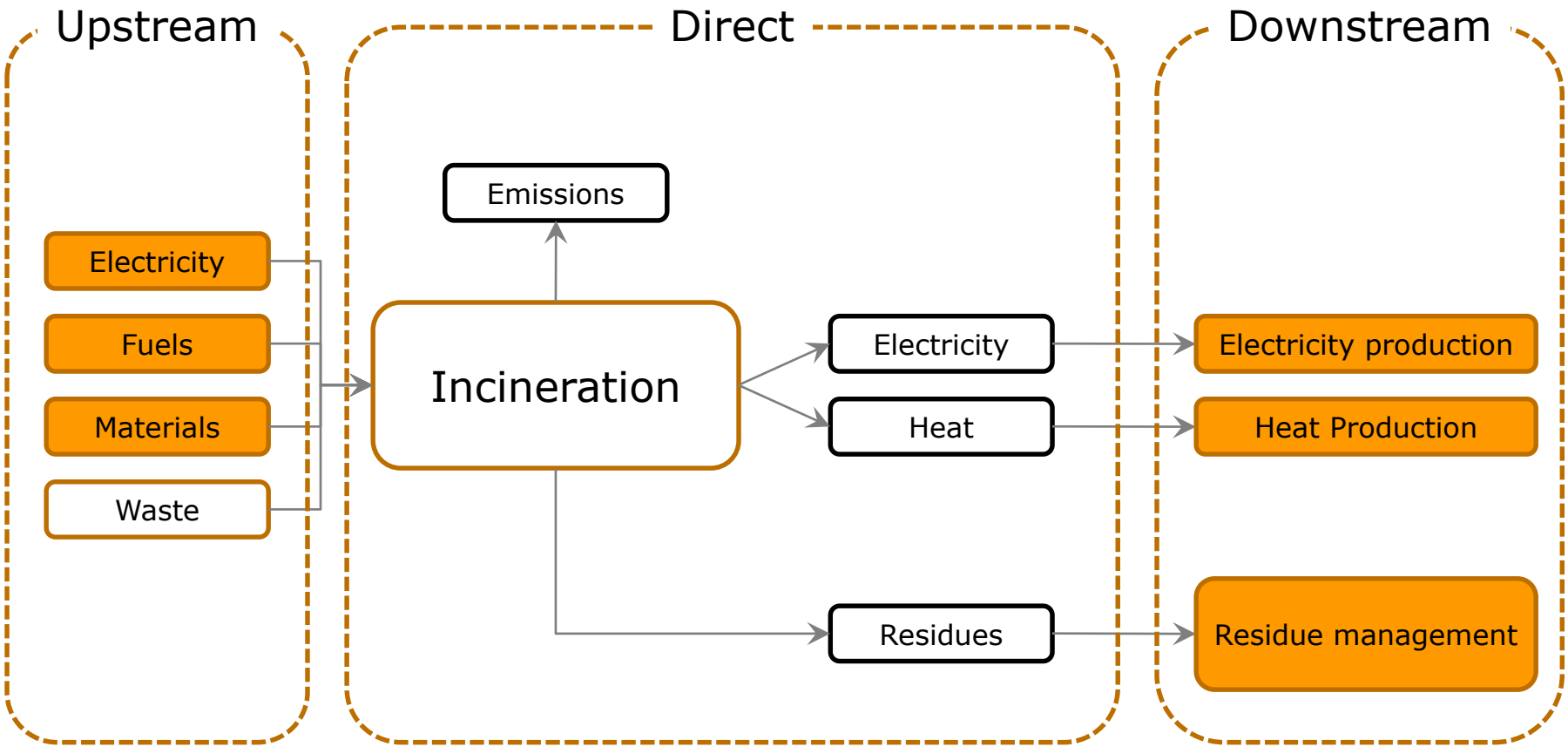


Fruergaard et al. (2010)

How-to be sustainable?



GHG accounting: Waste-to-Energy



Astrup et al. (2009)

Upstream-Direct-Downstream (UDD)

Upstream	Direct	Downstream
Emissions related to production and provision e.g. of: ▪ Fuels ▪ Electricity ▪ Heat ▪ Materials ▪ Resources	Emissions originating directly from the system/technology in question, e.g.: ▪ Combustion of fuels ▪ Combustion of waste ▪ Internal transport	Emissions and savings e.g. related to: ▪ Substitution of energy ▪ Substitution of materials ▪ Management of residues

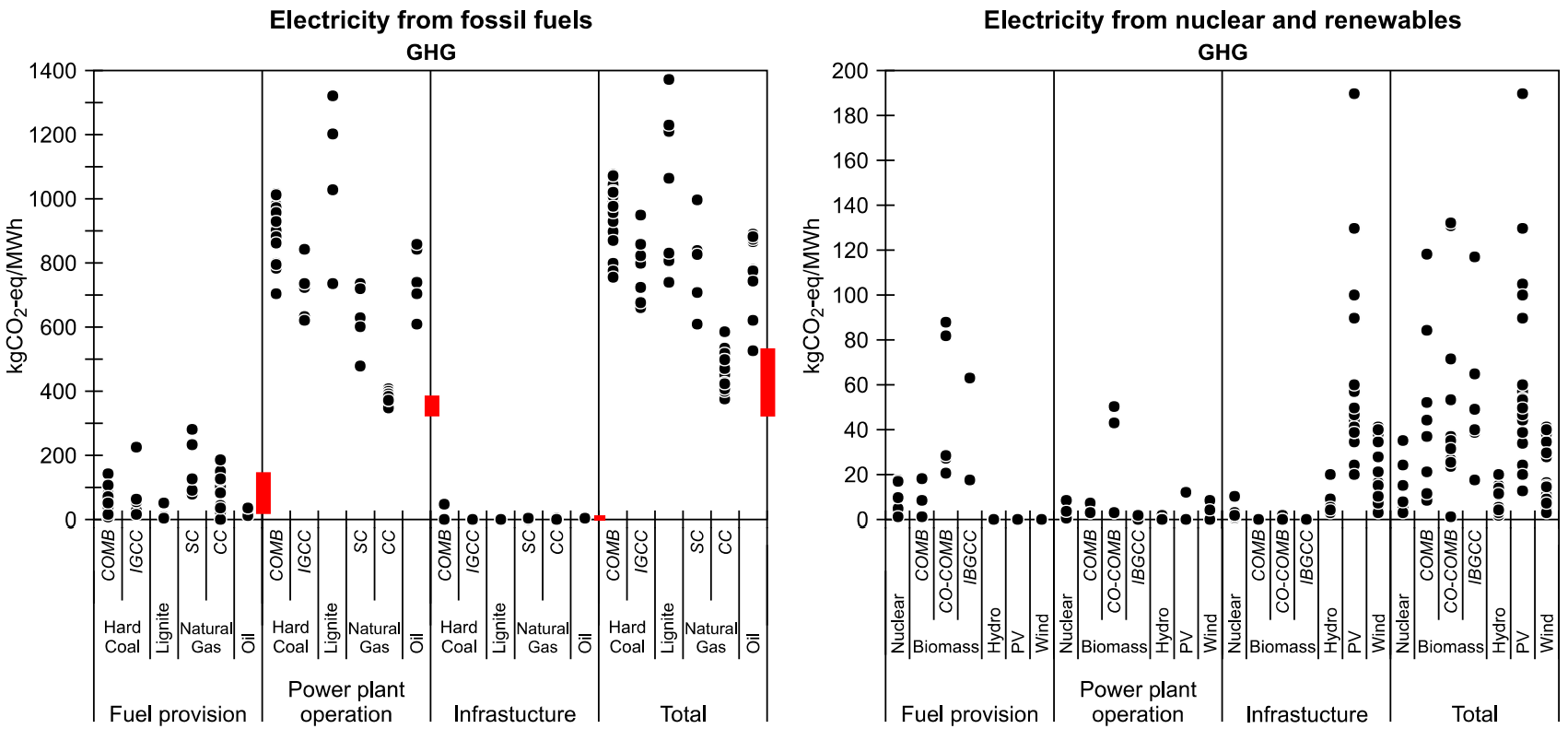
Astrup et al. (2009)

CO_2-accounting EXAMPLE: WtE

Upstream	Direct	Downstream
57 kg CO_2-eq/tonne waste	**374 kg CO_2-eq/tonne waste**	**-910 kg CO_2-eq/tonne waste**
(kg CO_2-eq/tonne waste) Provision of: • Electricity : 50 • Natural gas: 0.6 • Oil: 0.6 • Flue gas cleaning: 6	(kg CO_2-eq/tonne waste) Emission of: • Fossil CO_2 (natural gas): 4.4 • Fossil CO_2 (oil): 2.9 • Fossil CO_2 (waste): 367 • Biogenic CO_2 (waste): 0	(kg CO_2-eq/tonne waste) Substitution of: • Electricity: -347 • Heat: -563 • Residues: 0.5
Included (pr. tonne waste) • Electricity: 100 kWh • Natural gas: 2 Nm^3 • Oil: 1 l • $CaCO_3$: 5 kg • NaOH: 1 kg • NH_3: 1 kg	Included (pr. tonne waste) • Natural gas: 2 Nm^3 • Oil: 1 l • Fossil C in waste: 100 kg • Biogent C in waste: 200 kg	Included (pr. tonne waste) • Elelctricity (25 %): 694 kWh • Heat (75 %): 7500 MJ • Residues: 50 kg

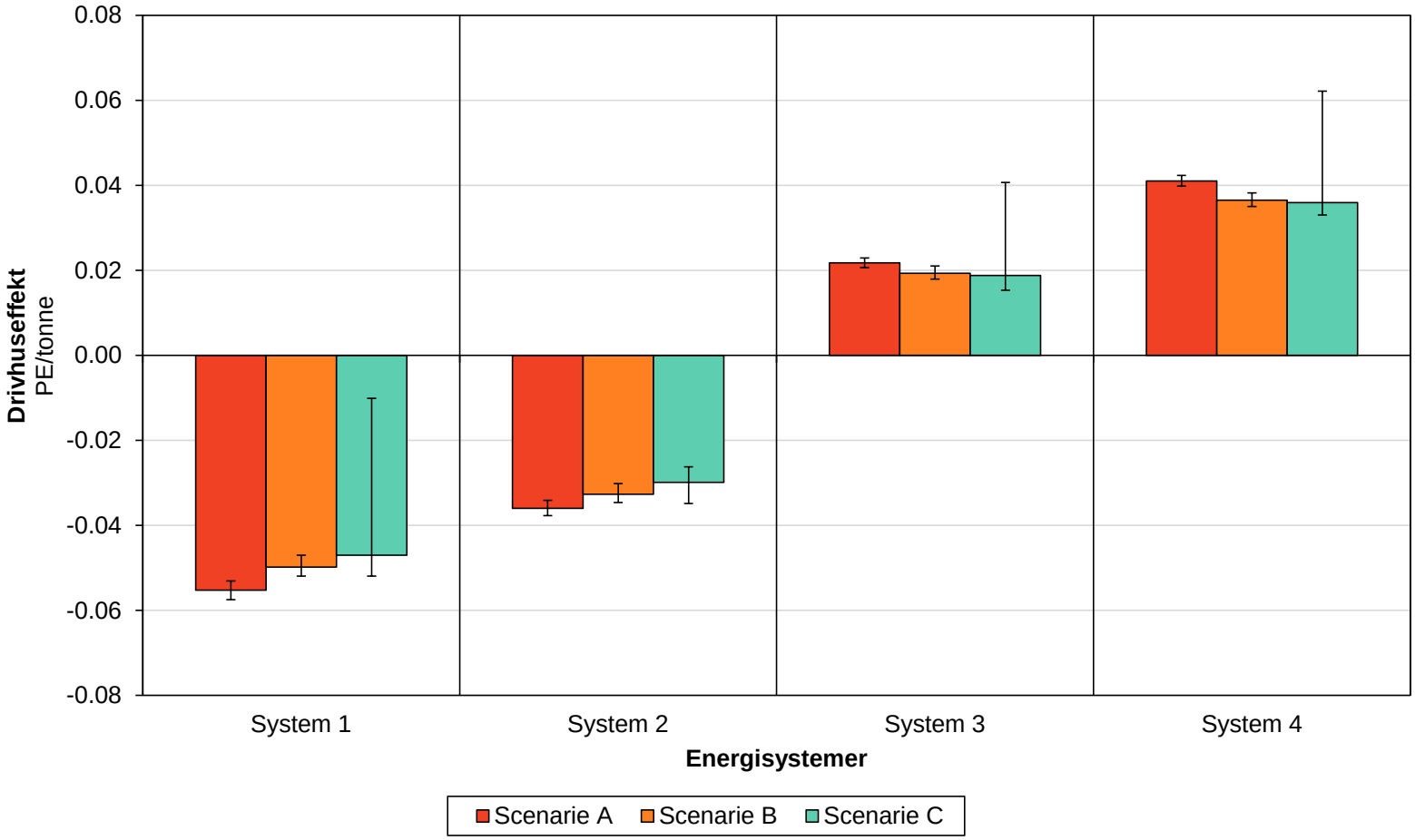
Astrup et al. (2009)

Climate impacts from electricity generation



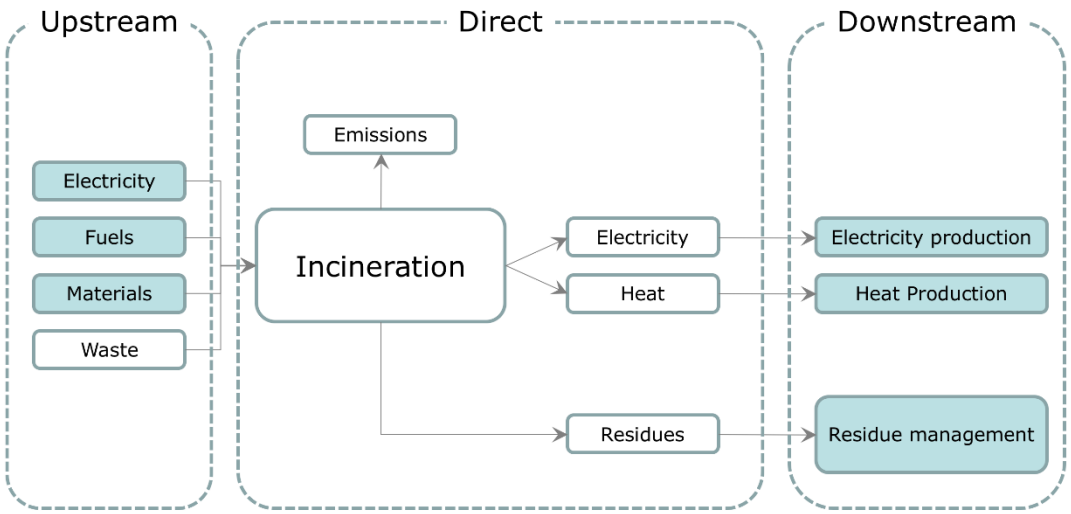
Turconi et al. (2013)

Example: climate impacts and surrounding energy system



Recommendations

- Use an UDD approach to explain the potential benefits of WtE
- The more efficient a plant is, the greater are the benefits
- Be aware of situations where WtE is not the environmentally preferable solution



References

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- Turconi, R., Boldrin, A., & Astrup, T. F. (2013). Life cycle assessment (LCA) of electricity generation technologies: Overview, comparability and limitations. *Renewable and Sustainable Energy Reviews*, *28*, 555-565.