Strategies to overcome the dilemma in renovating and integrating HPs and RE into the building stock

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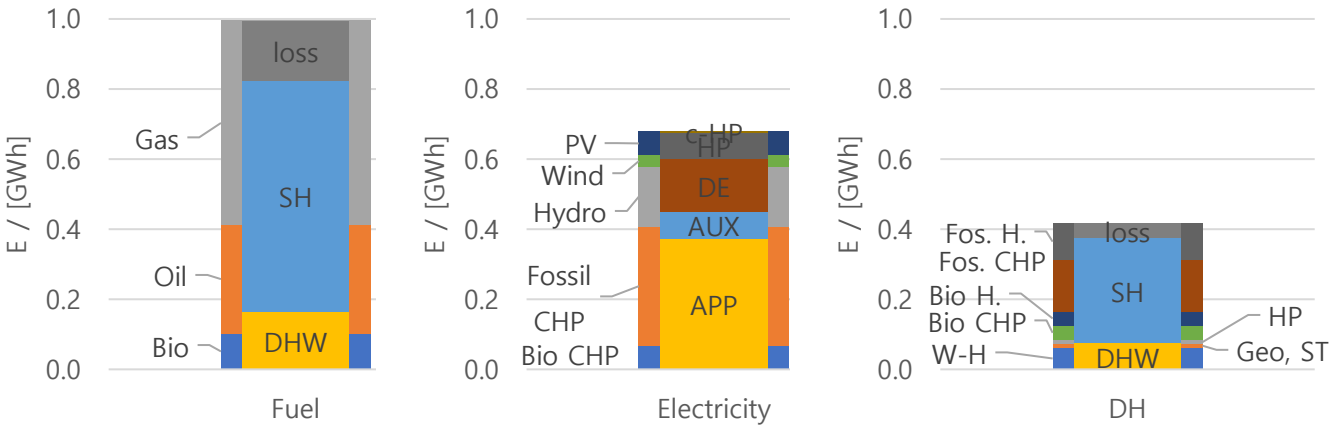
- Results – Why do we need Deep Thermal Renovation?
  (and HPs and DH with HPs)
- Outlook – Gaps

Decarbonisation - Dilemma



Example of the energy mix of a building stock

- Fuel
- Electricity
- District Heating (DH)

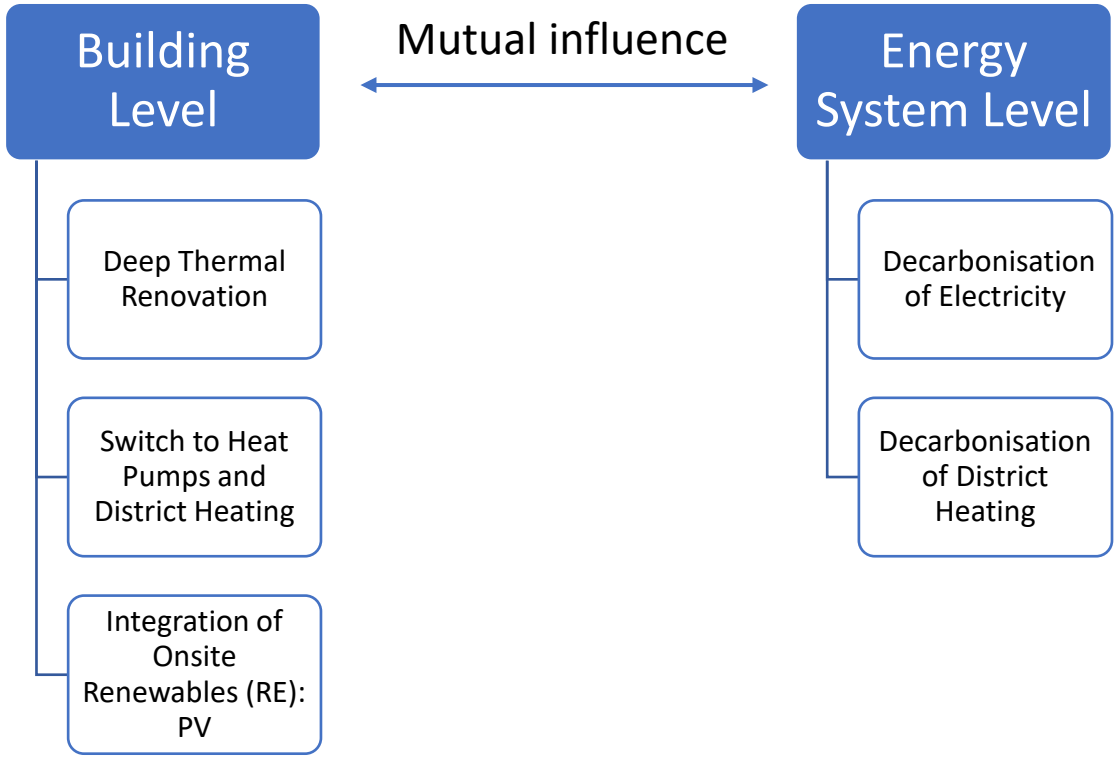
Decarbonisation on Energy System Level only with massive improvement of the building stock

- Deep Thermal Renovation (decrease of Electricity Demand)
- Switch to HP and DH (phase-out of fossil heating systems)
- Integration of PV (increase share of renewable electricity)

Decarbonisation of the Energy System leads to reduced motivation to

- Deep Thermal Renovation (instead switch to DH with renewable heat or HP or DE, with renewable electricity)
- Switch to HP (instead of DE)
- Integrate PV (as electricity is becoming renewable)

Decarbonisation - Dilemma



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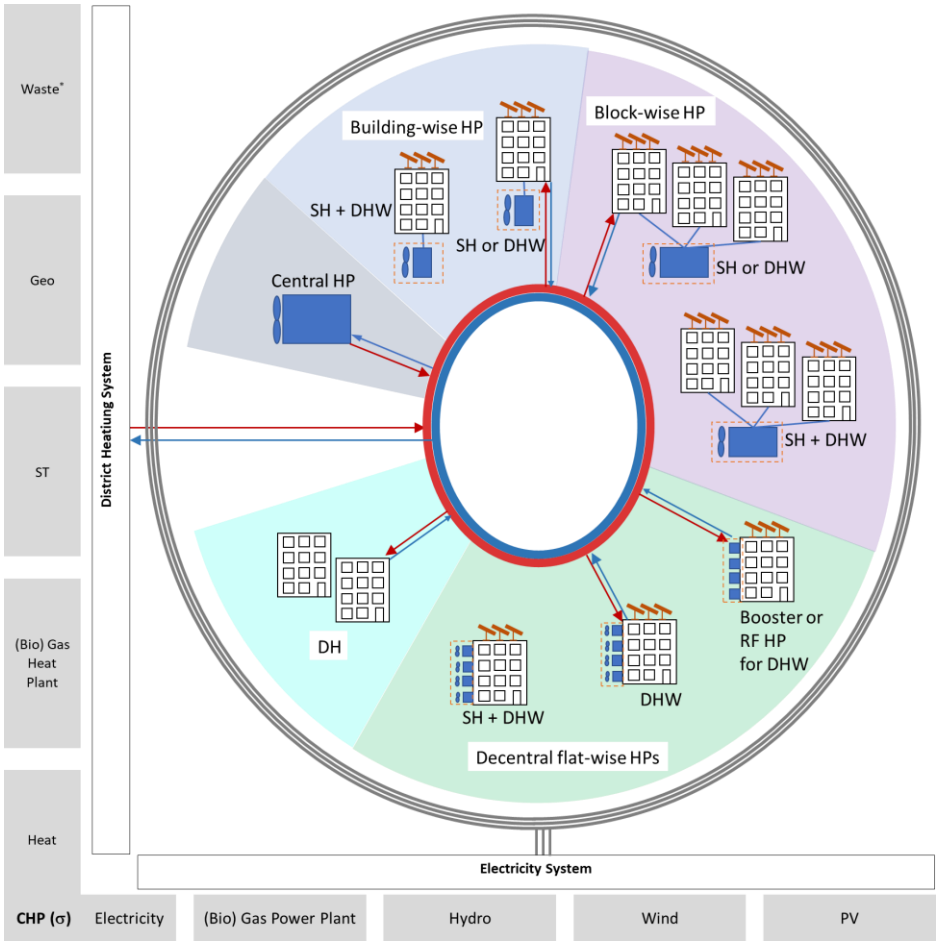
Integration of HP

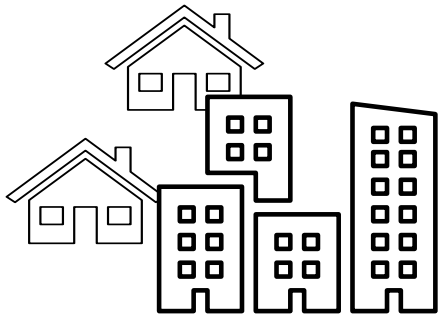
- Integration on Level of
  - DH
  - Blocks
  - Buildings
  - Flats
- Micro-Economic Perspective
  - Building owner/operator
  - DH operator
- Macro-Economic Perspective
  - Scalability
  - Sector Coupling
  - Energy strategy/policy



Ochs et al., 2022, modified

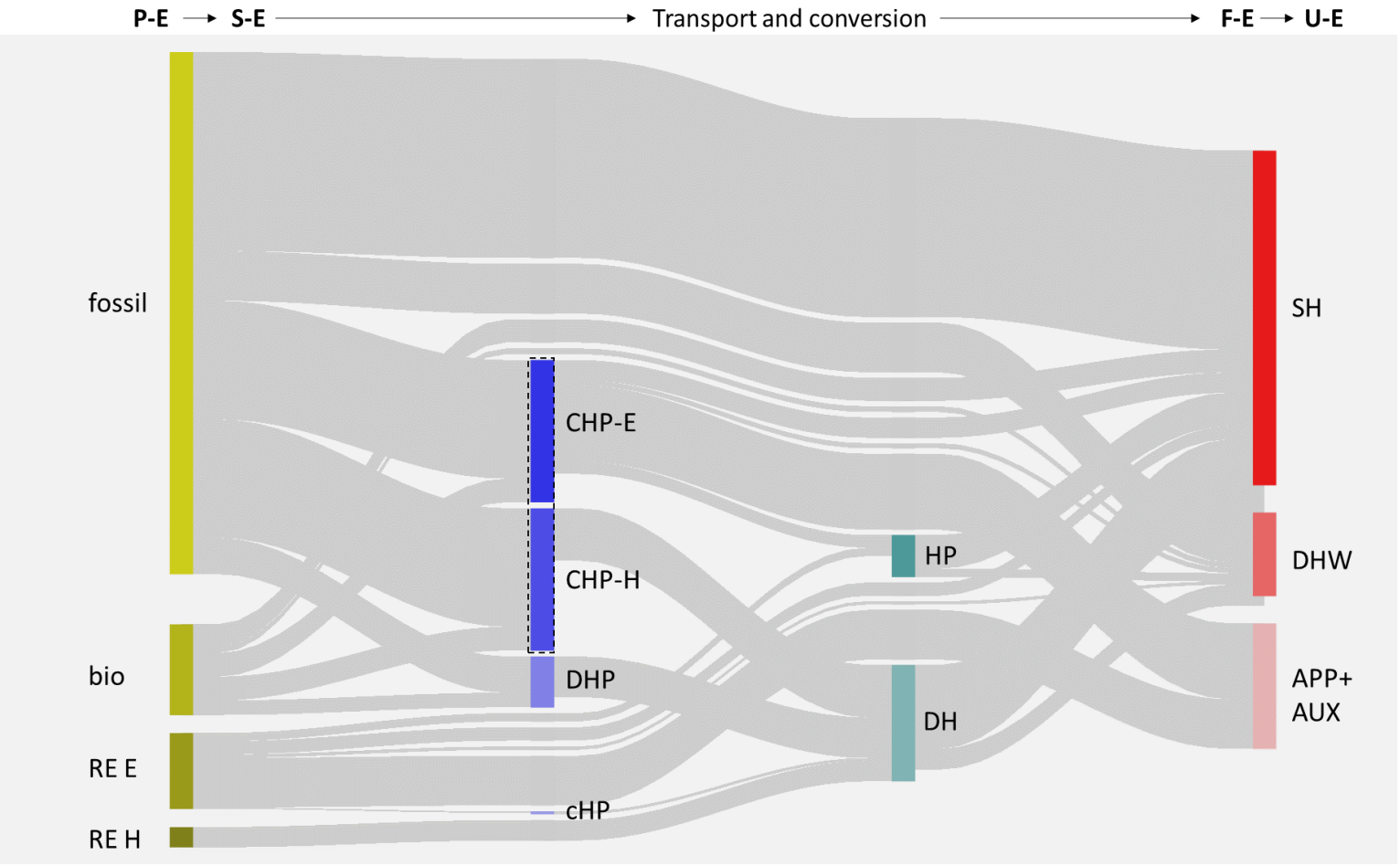
Building Stock Model (generic)

Building Stock (BS)
with average building



	BAU	IMPROVE	AMBITION
Space Heating Demand SH / kWh/(m² a)	80	55	30
Domestic Hot Water Demand DHW / kWh/(m² a)		15 + 5	
Appliances and auxiliaries / kWh_{el}/(m² a)		20 + 5	

Sankey Diagram of the Baseline



- **demand**, i.e. the useful energy (UE): space heating (SH), domestic hot water (DHW) as well as appliances and auxiliaries,
- **heating systems**: fuels (oil, gas, biomass), direct electric (DE) heating, heat pump (HP) and district heating (DH) and
- **energy system** consisting of combined heat and power (CHP) and district heating plants (DHP).

Decarbonization Scenarios

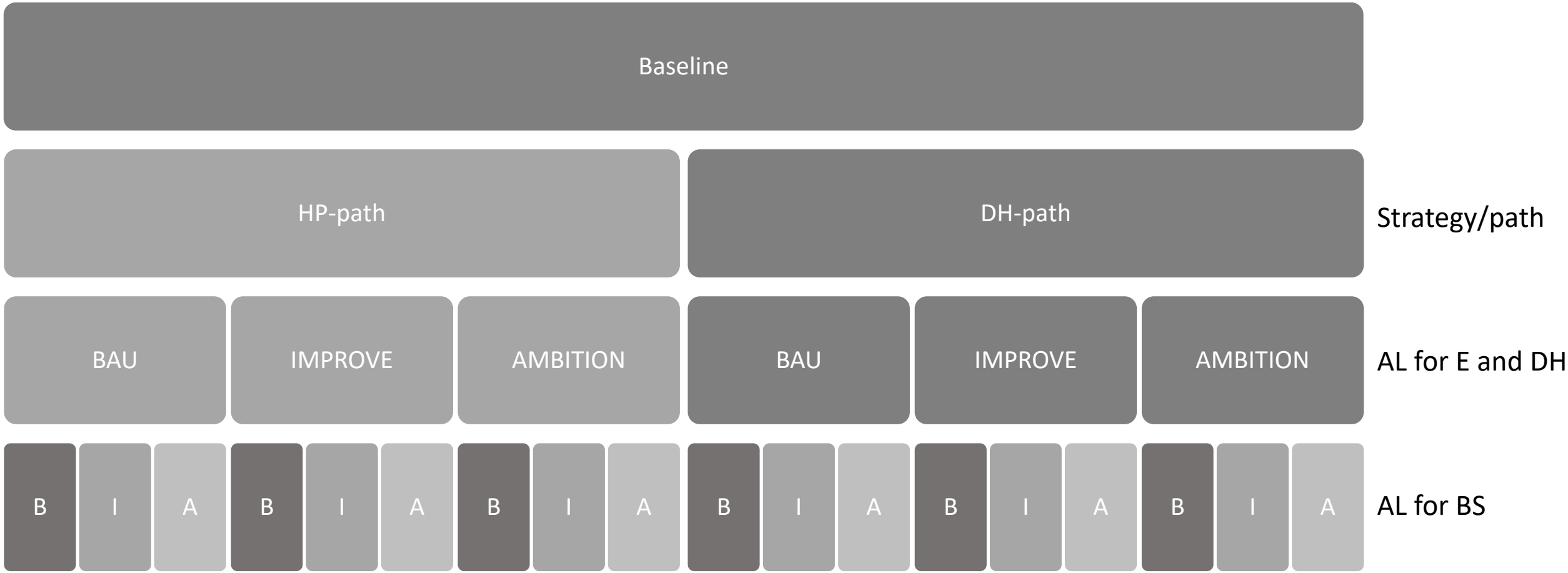
Ambition Level (AL)

- Const (= BAU)
- IMPROVE
- AMBITION

Measures

- Building Level – Building Stock (BS)
  - Deep Thermal Renovation (TR)
  - Heat Pumps (HP)
  - District Heating (DH)
- Energy System
  - Decarbonisation of Electricity by integrating RE
  - Decarbonisation of DH by integrating HP and RE

Overview of Scenarios (transition paths)

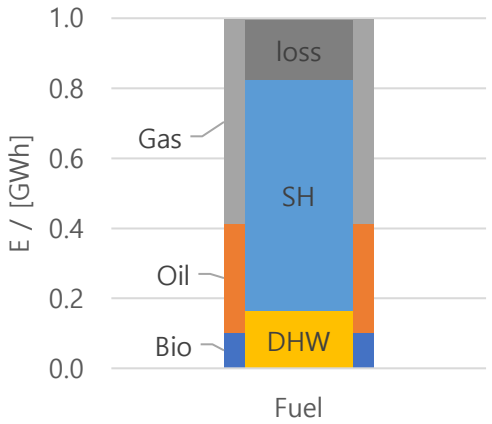


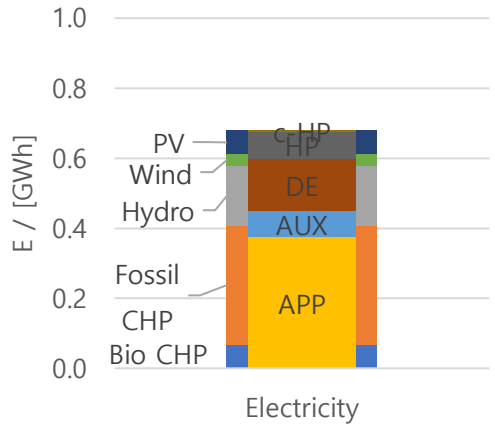
Constraints

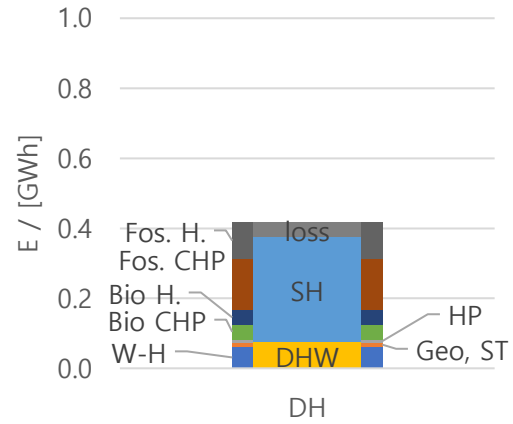
- limited Biomass potential (CHP only)
- Limited RE imports
- No nuclear power

Transition from fuel-based heating to HP and DH

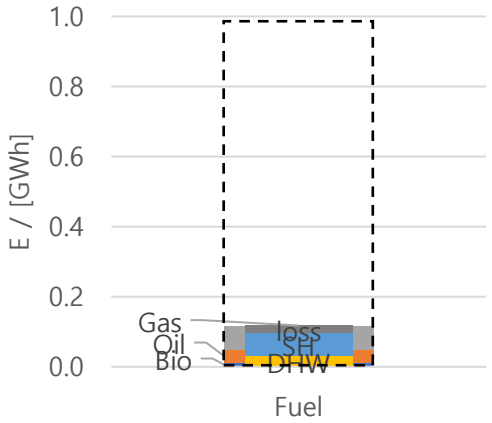
BASELINE

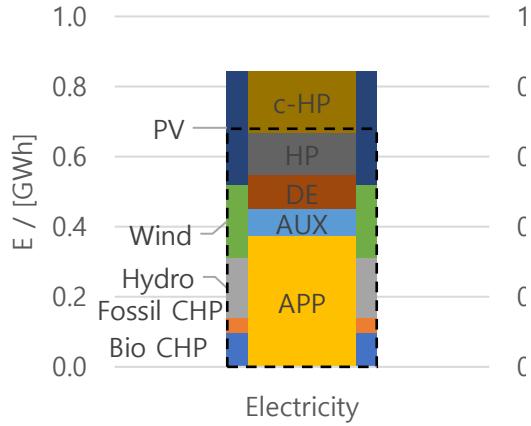


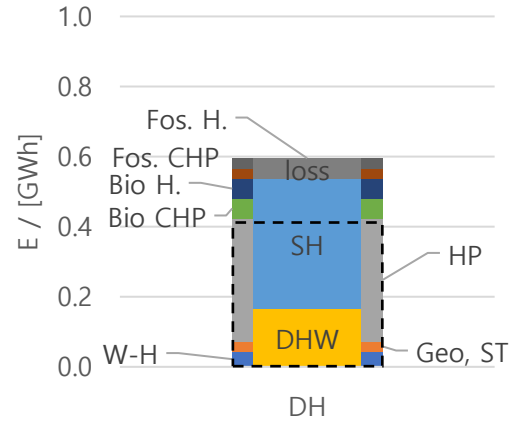




AMBITION

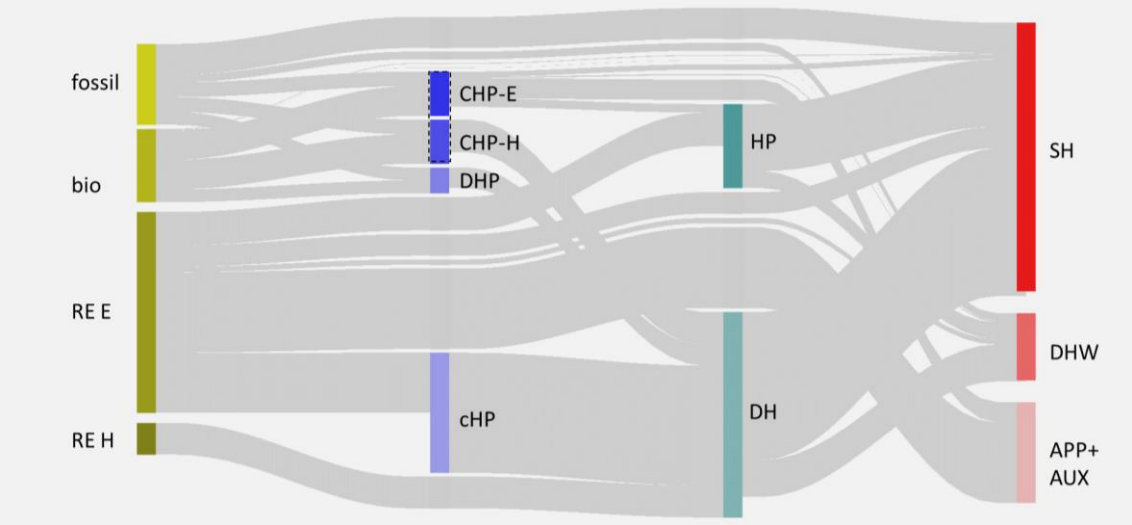




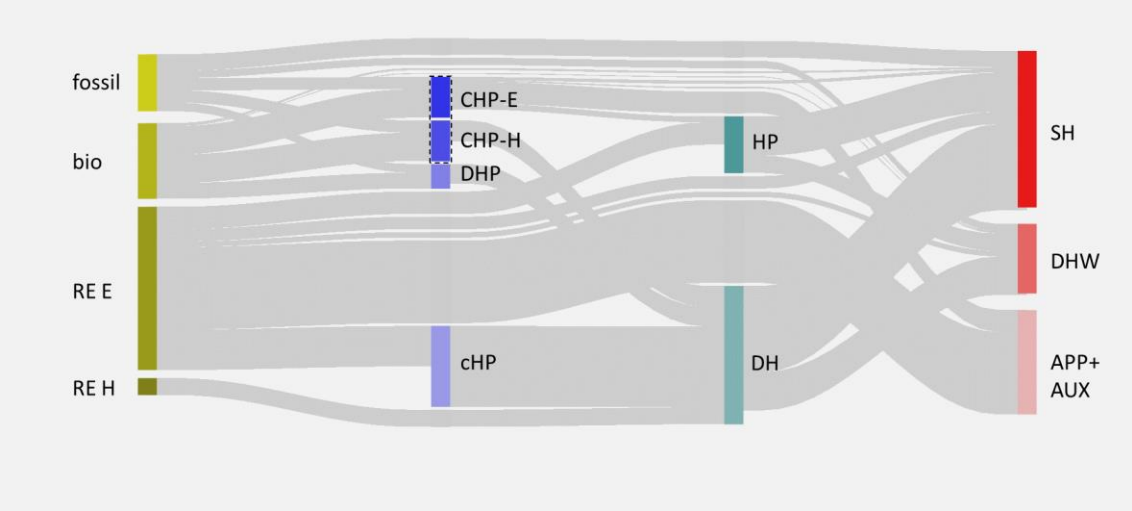


Ambition Levels – BAU, IMPROVE, AMBITION

BAU



IMPROVE



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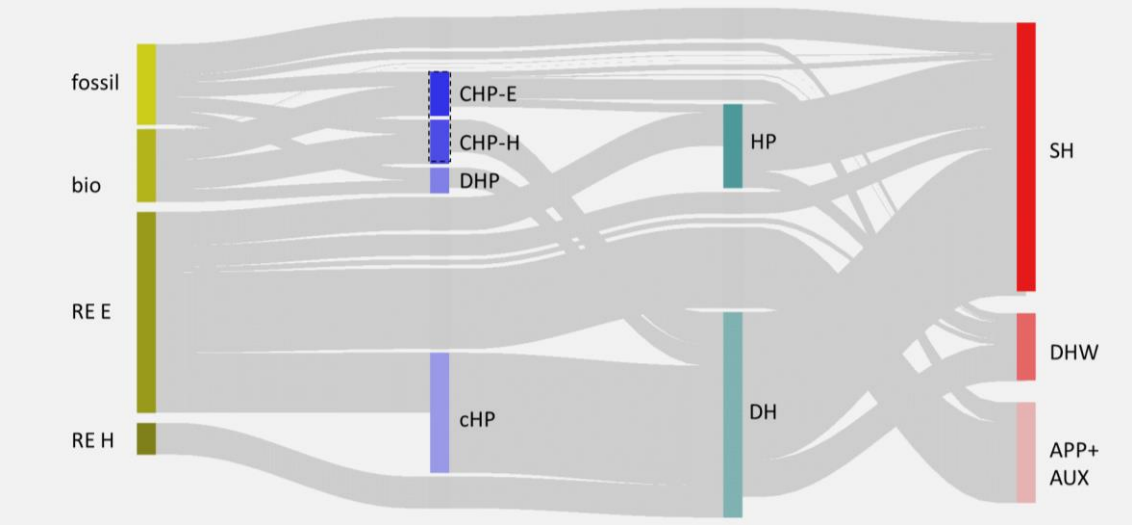

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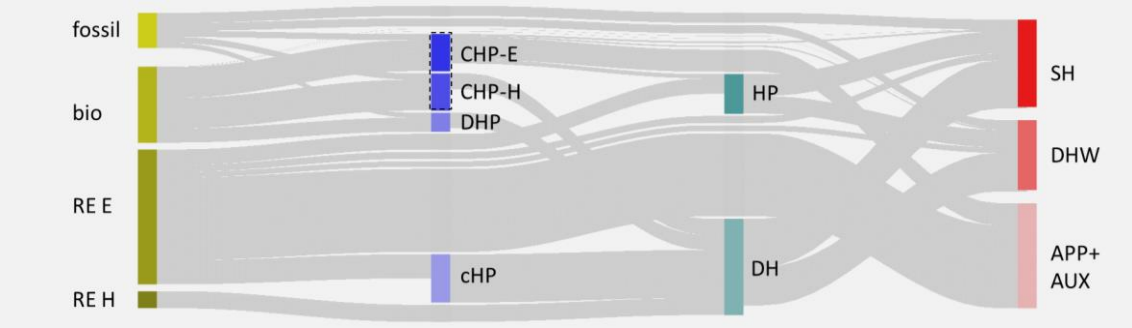
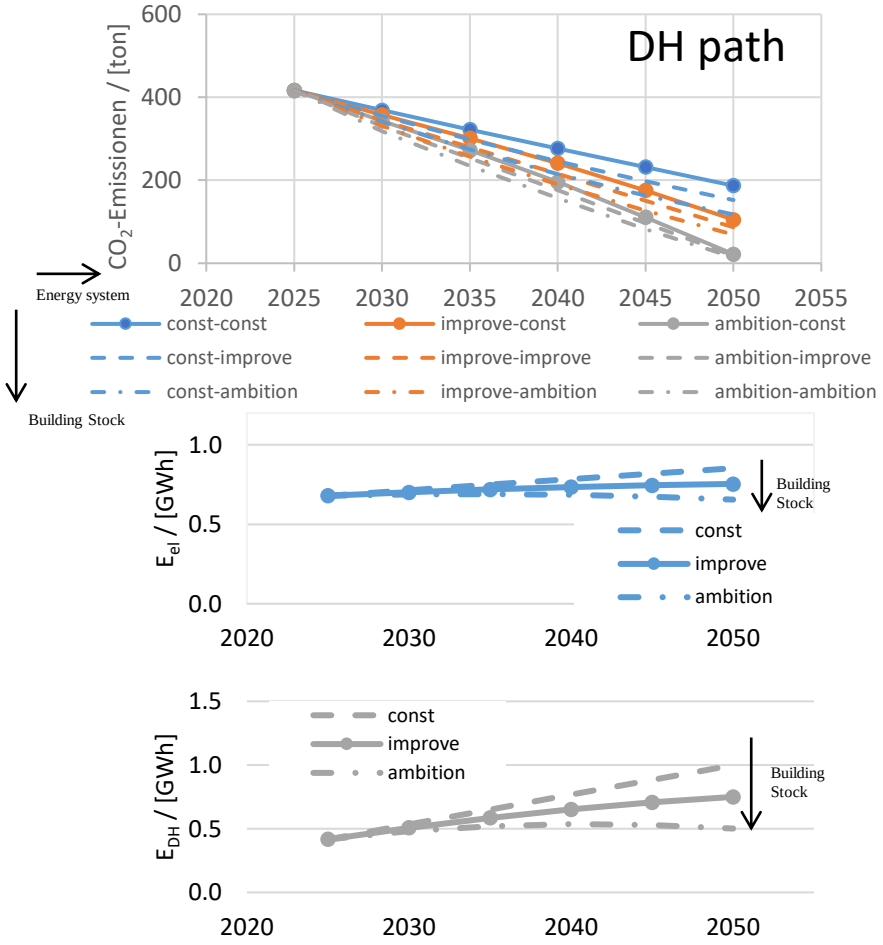
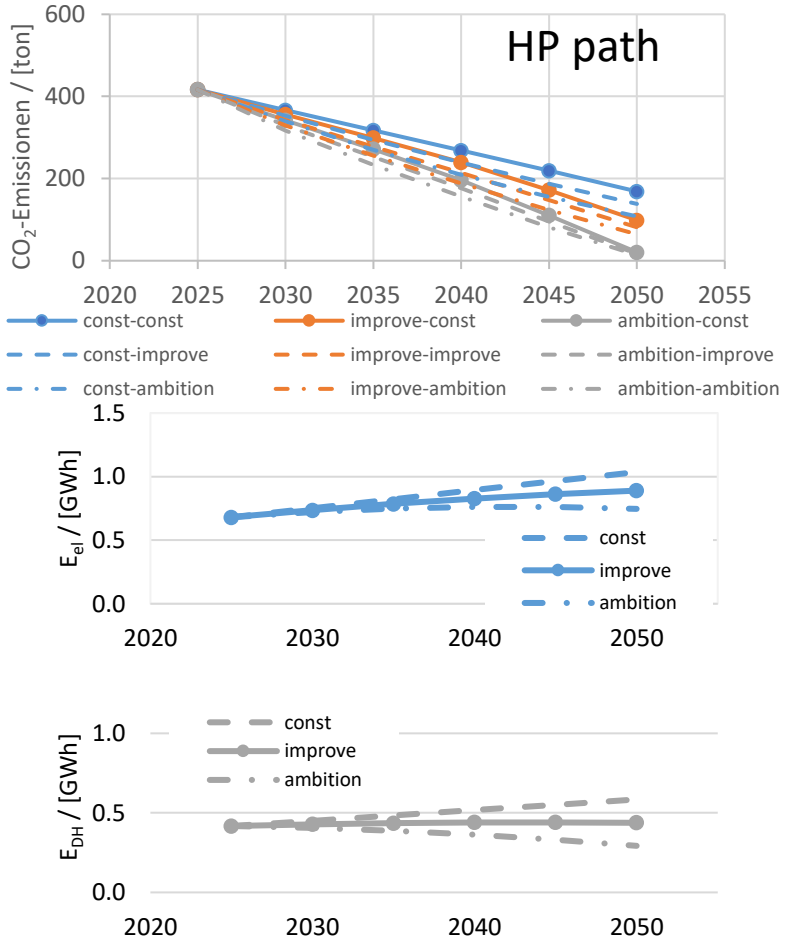


Results – Development depending on Path





Ambition Level

- BAU (const)
- improve
- ambition

Low ambition level in Building Sector
→ Need for massive extension of PV
→ Winter gap

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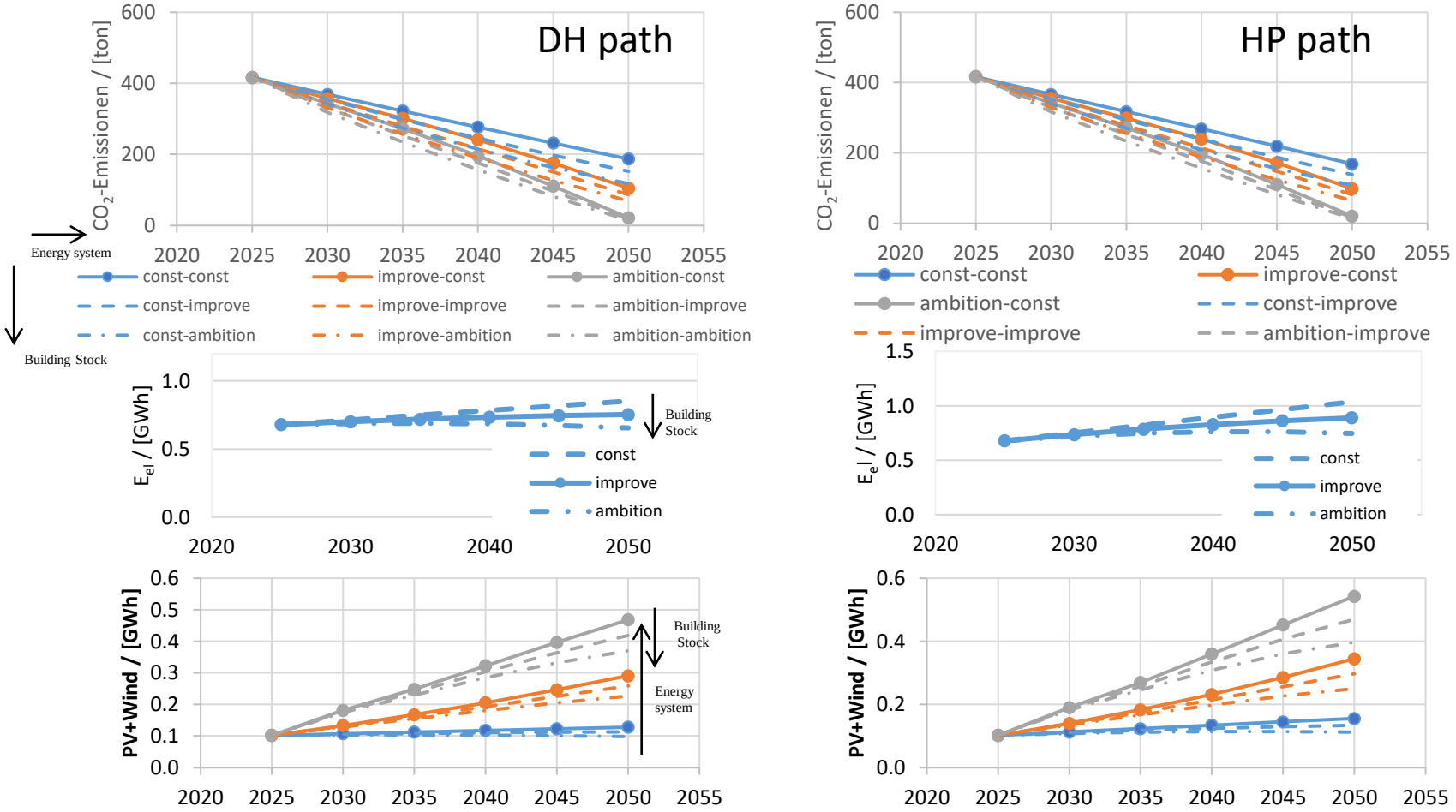

Ambition Level

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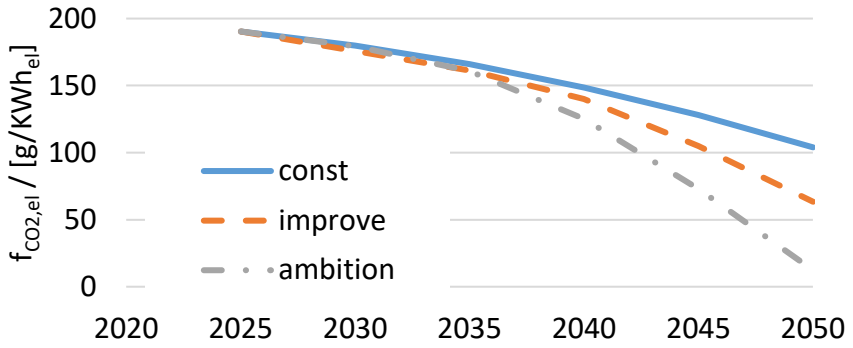
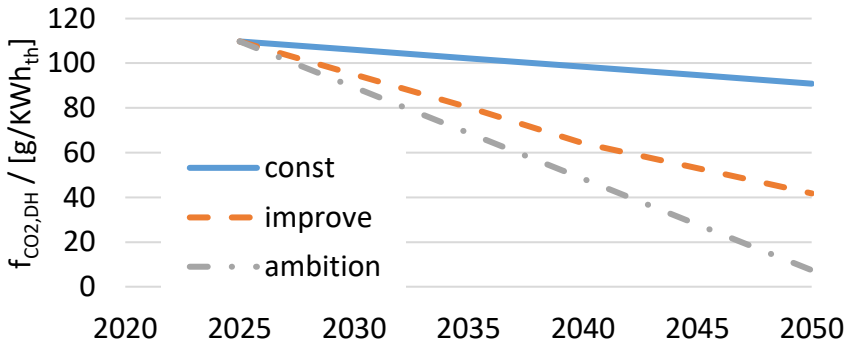
Single Building Perspective – f_{CO2}

CO_2 conversion factors f_{CO2} for Electricity and DH

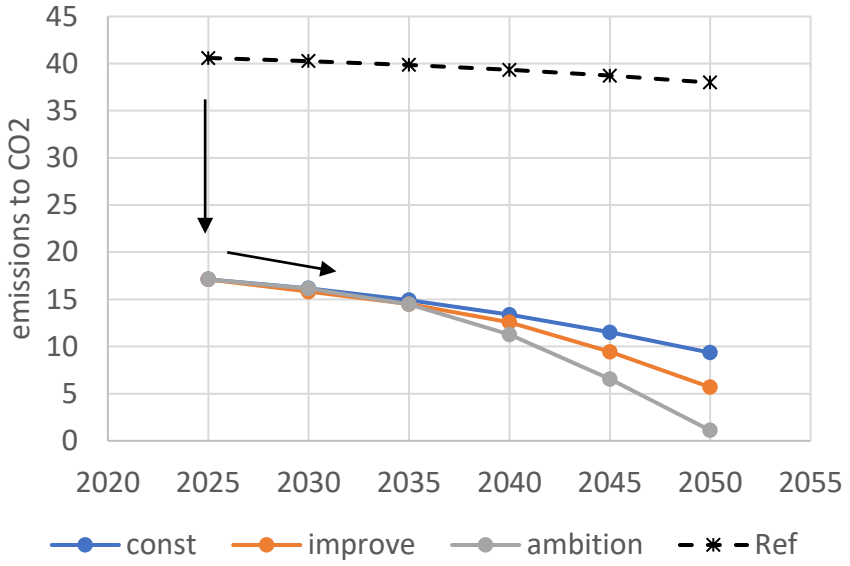


Electricity: DH-path and HP-path

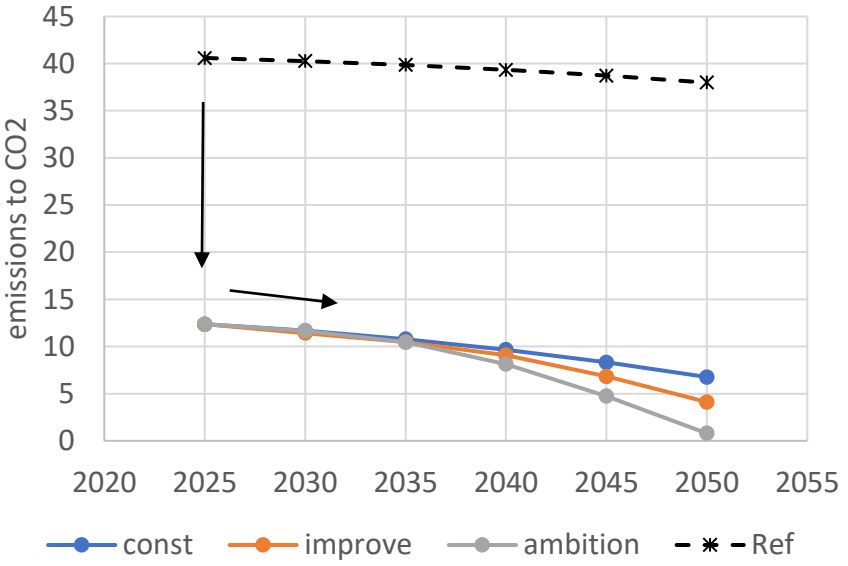


DH: DH-path and HP-path

Single Building Perspective – CO_2 Emissions

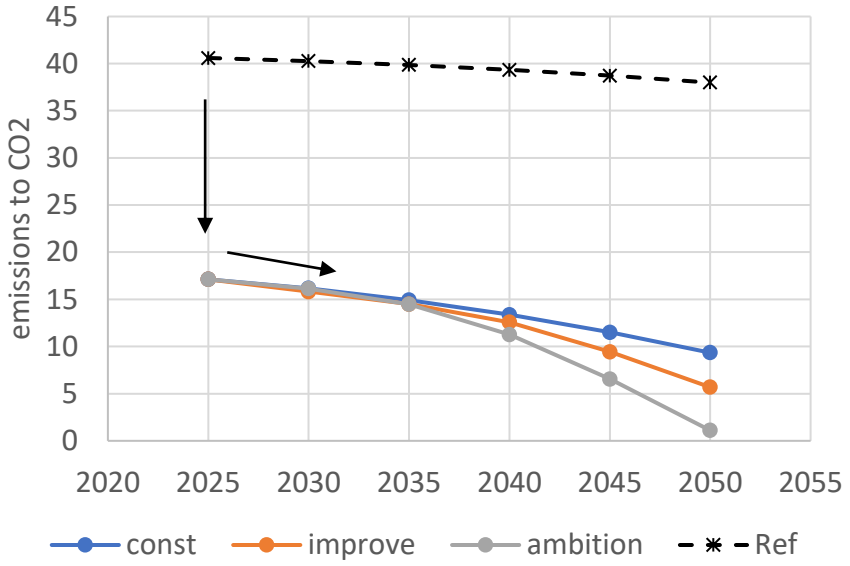


Switch to HP



Thermal Renovation + Switch to HP

Single Building Perspective – CO_2 Emissions



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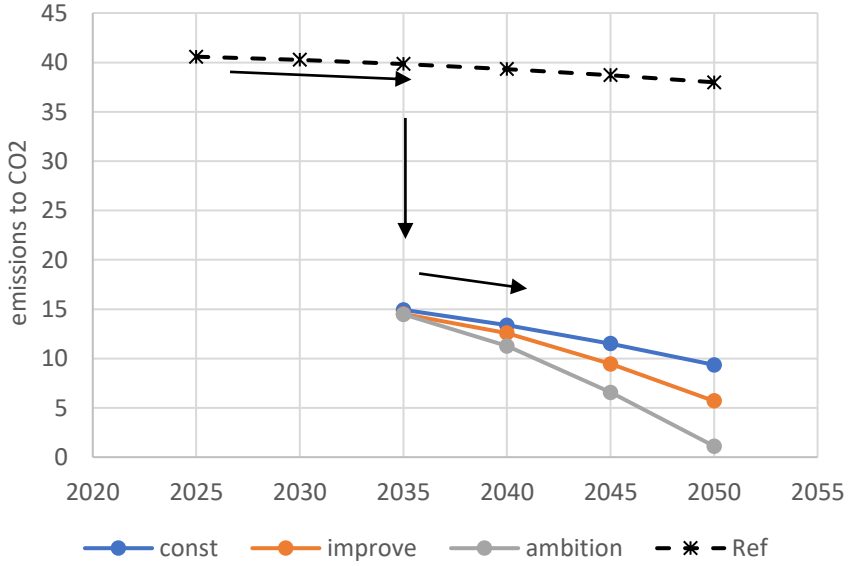

Switch to HP 10 yrs. Later …

Conclusions

- Increasing share of RE in future electricity and DH system will lead to a significant reduction of the CO_2 conversion factor for electricity DH (in particular when HPs are involved).
- **Dilemma**
  - high ambition level (deep TR, integration of onsite RE, coupled to HPs) will not significantly influence the CO_2 emissions on building level in such a future energy system.
  - high ambition on building level and massive onsite PV required to reach the goal of the phase-out of fossils
- **Energy policy approach** required instead of market initiatives
- Insufficient ambition goals on building level lead to the so-called lock-in
- Micro-economic focused approach will inevitably lead to fail
- **Building stock is the important player in the energy system**
- Transparent and long-term policy

Strategies

- Develop a clear and transparent energy policy that includes the building stock as a major column;
- Evaluate measures in the building stock from the macro-economic instead of from the micro-economic perspective;
- Identify lock-in effects and avoid/prevent all measures that lead to lock-ins;
- Focus on energy efficiency in the building stock first, then renewables;
- Restrict direct electric heating (neither for SH nor for DHW);
- Set absolute limit for final energy for electricity (or heat in case of DH) for buildings;
- Direct fundings/subsidies in-line with the overall climate and energy policy goals. Cancel all contra-productive fundings/subsidies;
- Balance investments in the building sector with reduced need to invest in the energy system (PV, wind, energy storage);
- Develop a clear long-term strategy for the extension of DH and define dedicated districts;
- Set a CO_2 budget (per person) instead of a CO_2 long term target.

Thank you …

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