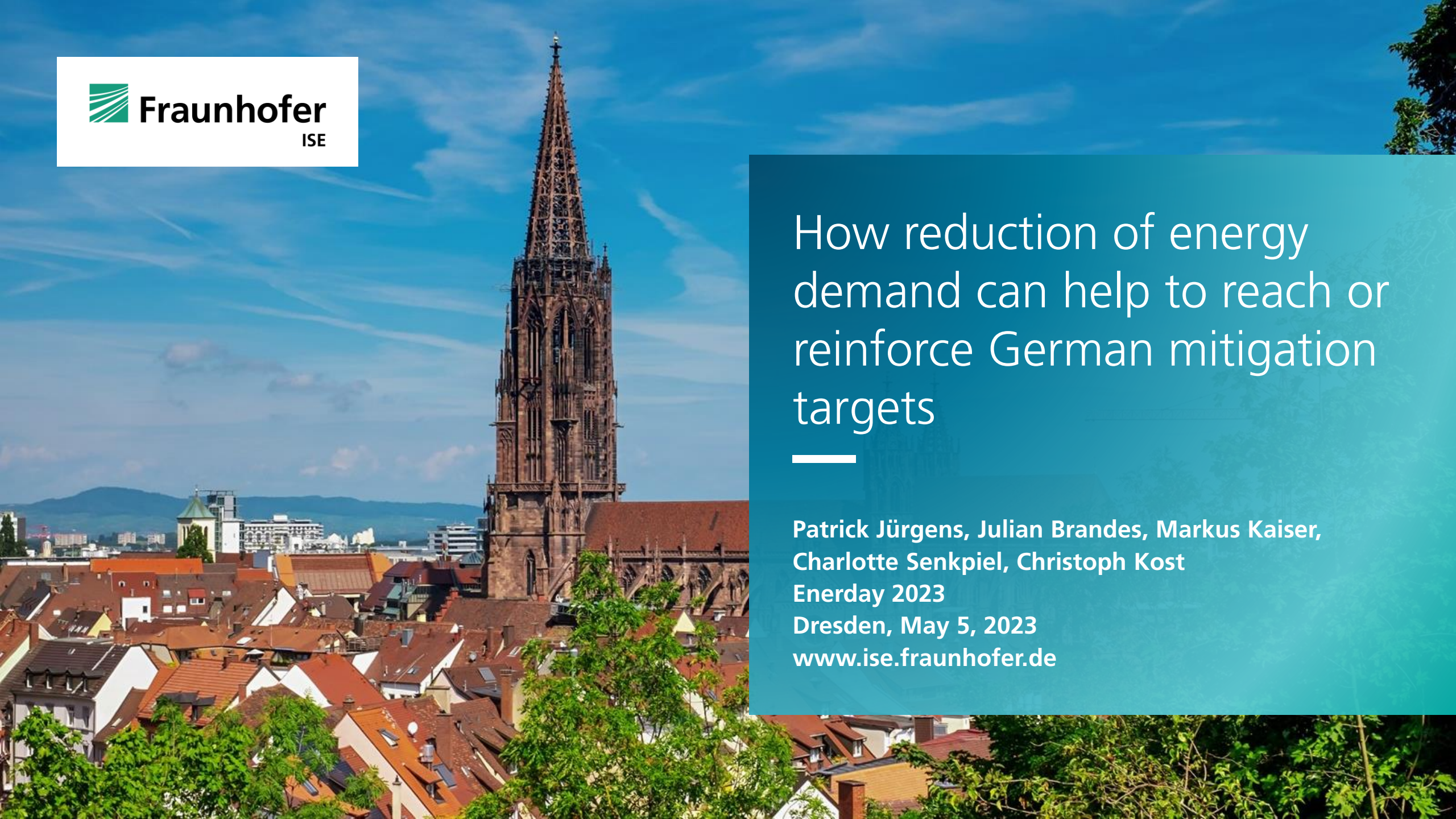

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How reduction of energy demand can help to reach or reinforce German mitigation targets

Patrick Jürgens, Julian Brandes, Markus Kaiser, Charlotte Senkpiel, Christoph Kost

Enerday 2023
Dresden, May 5, 2023
www.ise.fraunhofer.de

The energy system model REMod

Modeling approach and scope

Geographical scope

- Germany as one node

Conversion and consumption sectors

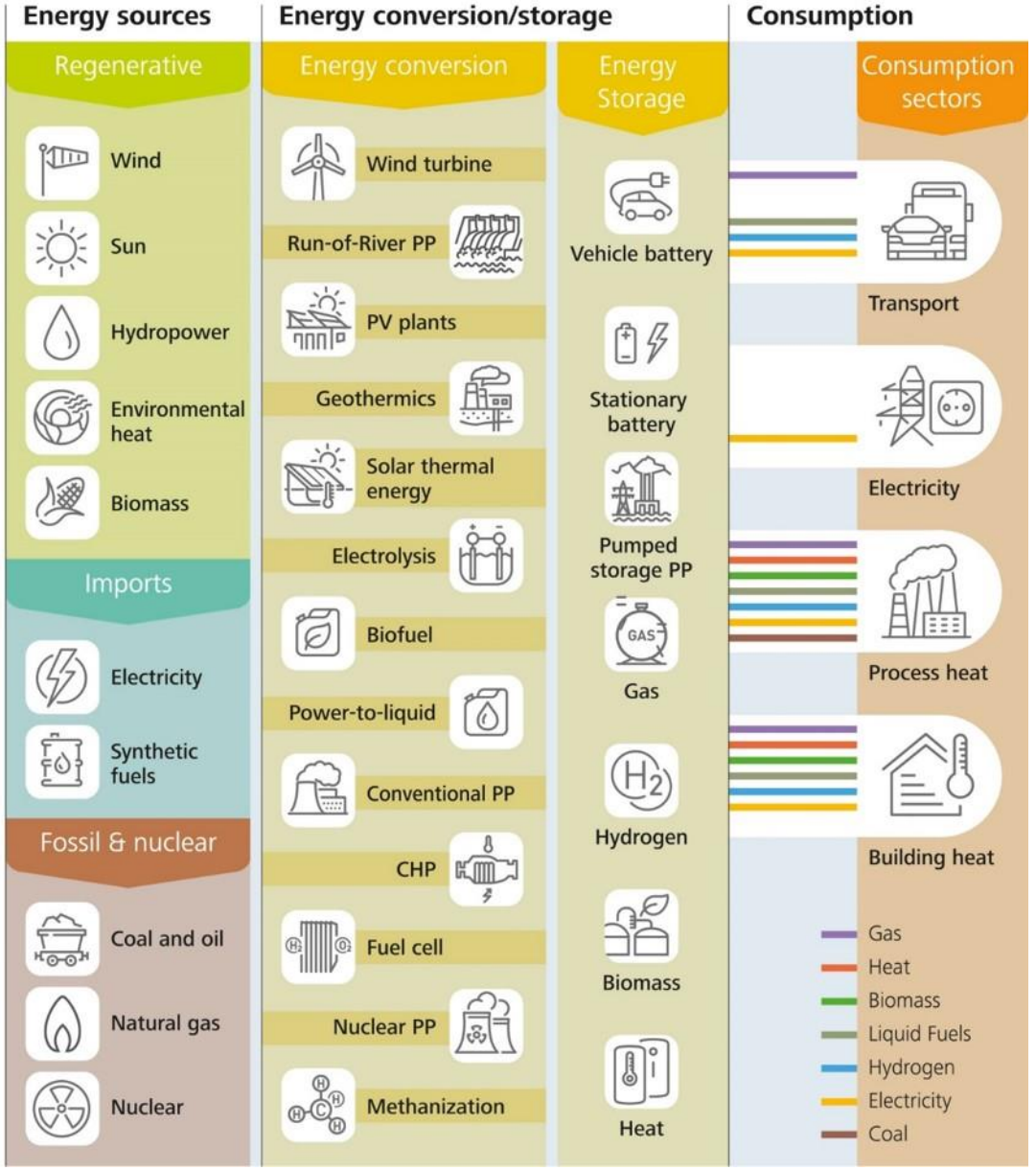
- Inclusion of all consumption sectors
- Multiple technologies are optimized separately
- Detailed integration of sector coupling effects

Optimization

- Minimization of transformation costs
- Non-linear „Black box“ optimization of transformation path on yearly basis

Simulation

- Simulation of operation on hourly basis
- Including historic timeseries (demand, weather) of five years



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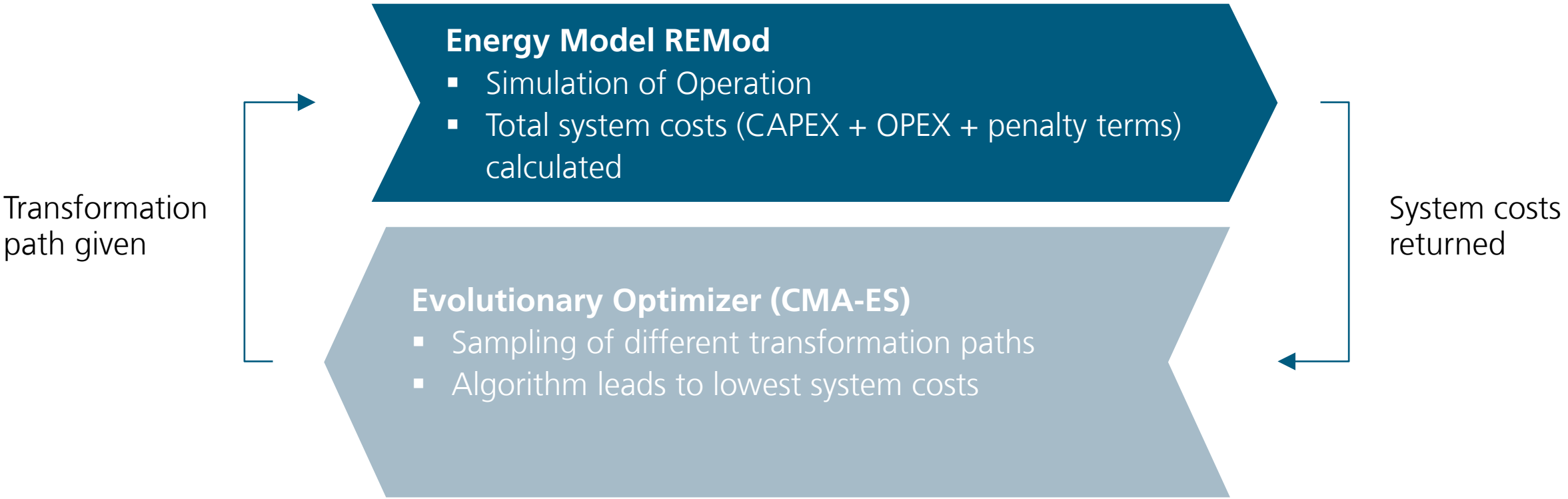
The energy system model REMod

Simulation and Optimization



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Reduction of energy demand

Change of lifestyle based on GreenSupreme-Scenario (UBA)

1 

Transport: modal shift and electrification of rail
→ -47% private transportation, -40% road freight transport, -100% combustibles for rail, -60% aviation and navigation

2 

Buildings: reduction of room temperature, sustainable forms of living
→ -10% space heating

3 

Industry: circular economy, sustainable consumption
→ -33% industrial process heat

4 

Classical power applications: efficiency, sustainable use of devices (e.g. air-conditioning, tumble dryer)
→ -45% demand of classical electricity

Methodology

Development of scenarios

1

Reference
Projected energy demand
German climate targets (net-zero 2045)
Optimized pathway

2

Sufficiency
Reduction of energy demand
German climate targets (net-zero 2045)
Optimized pathway

3

Sufficiency – CO_2-reduction
Reduction of energy demand
Transformation pathway of reference scenario
→ Reinforcement of CO_2-mitigation

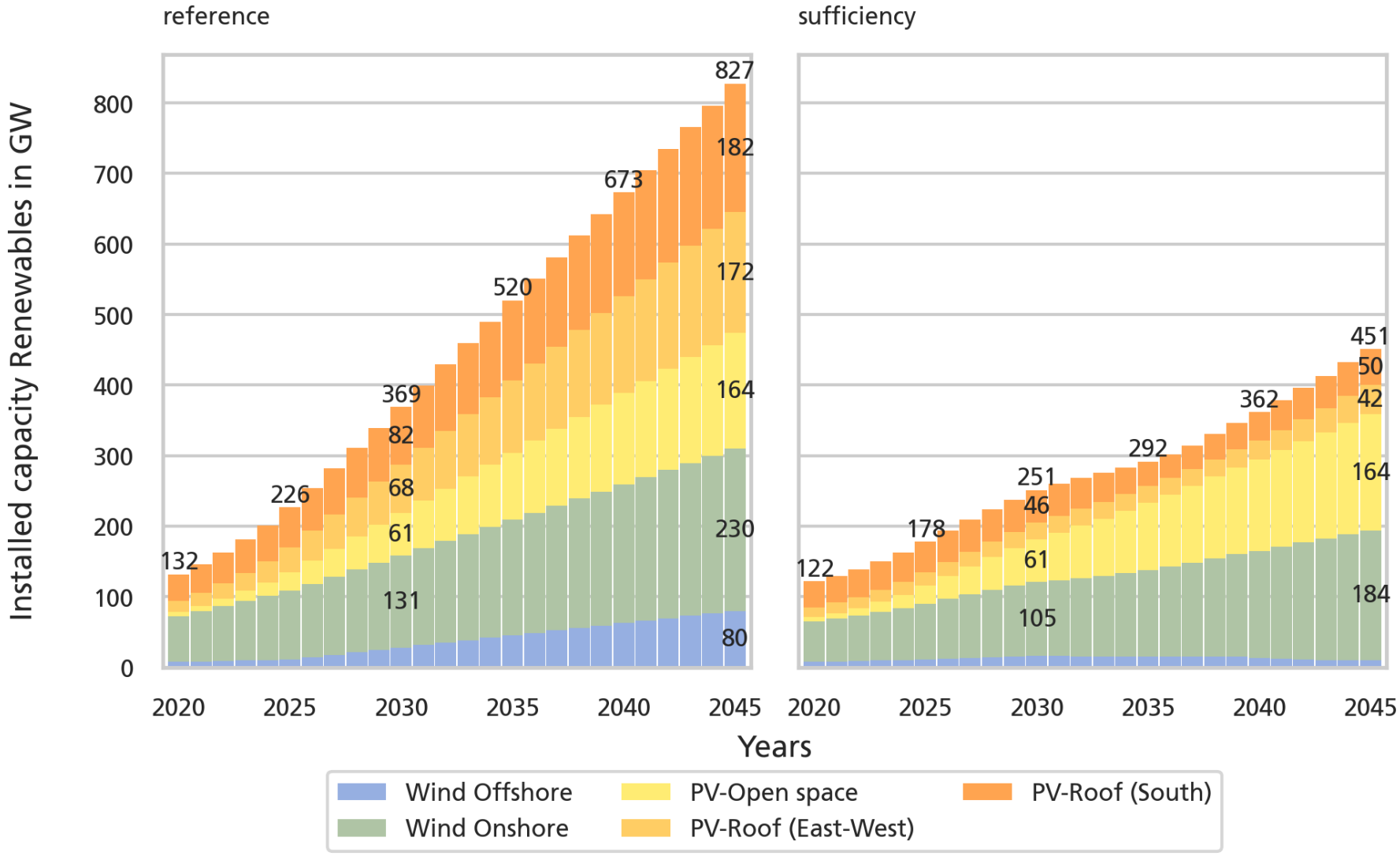
Parameters of the different scenarios

Energy demand
- Projected
- Reduction by sufficiency measures

Climate targets
- German climate targets (net-zero 2045, given CO2-budget)
- Reinforced mitigation

Optimization
- Transformation path optimized with given parameters
- Simulated with given transformation path

Fluctuating Renewable Energies



Reference

- PV: 210 GW (2030), 520 GW (2045)
- Wind: 160 GW (2030), 310 GW (2045)

Sufficiency

- PV: 130 GW (2030), 260 GW (2045)
- Wind: 120 GW (2030), 190 GW (2045)

→ Mitigation targets can be reached with less capacity additions

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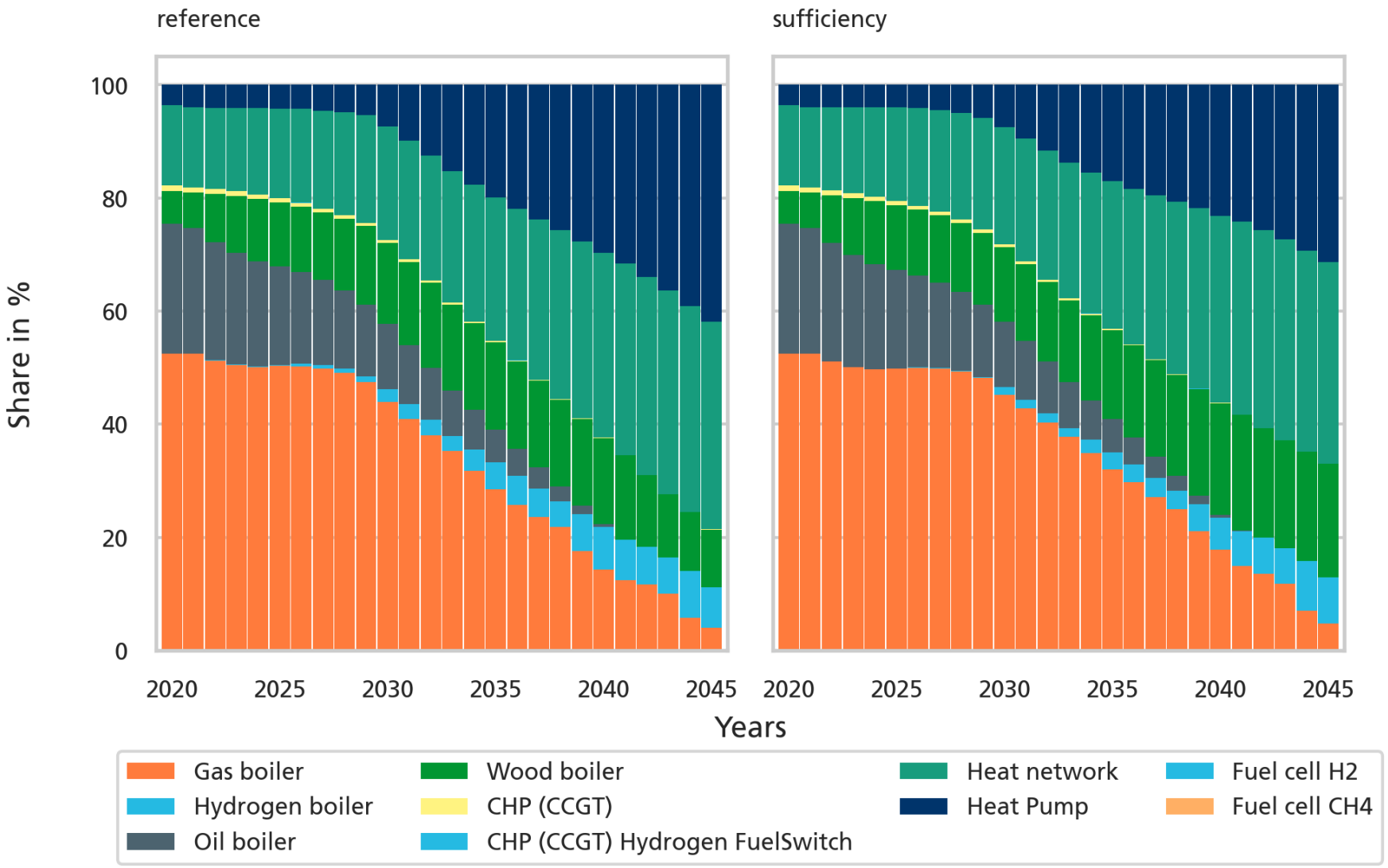
Transformation in demand sectors

Buildings: Space and Water heating



→ Mitigation targets can be reached with lower share of heat pumps

→ Delayed transformation in demand sectors can be compensated

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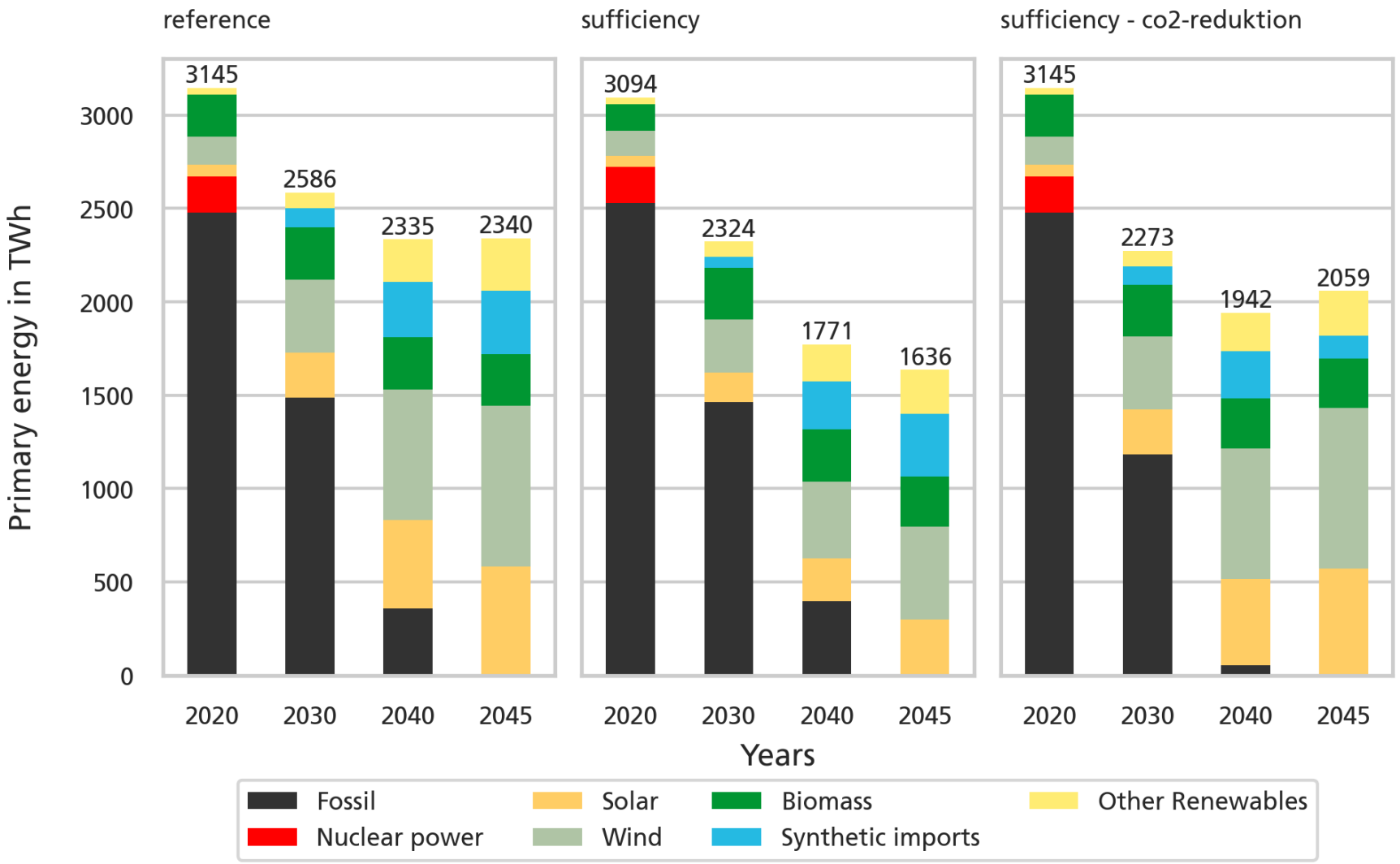
Primary Energy Demand



Primary energy demand

→ highest in reference, lowest in sufficiency scenario

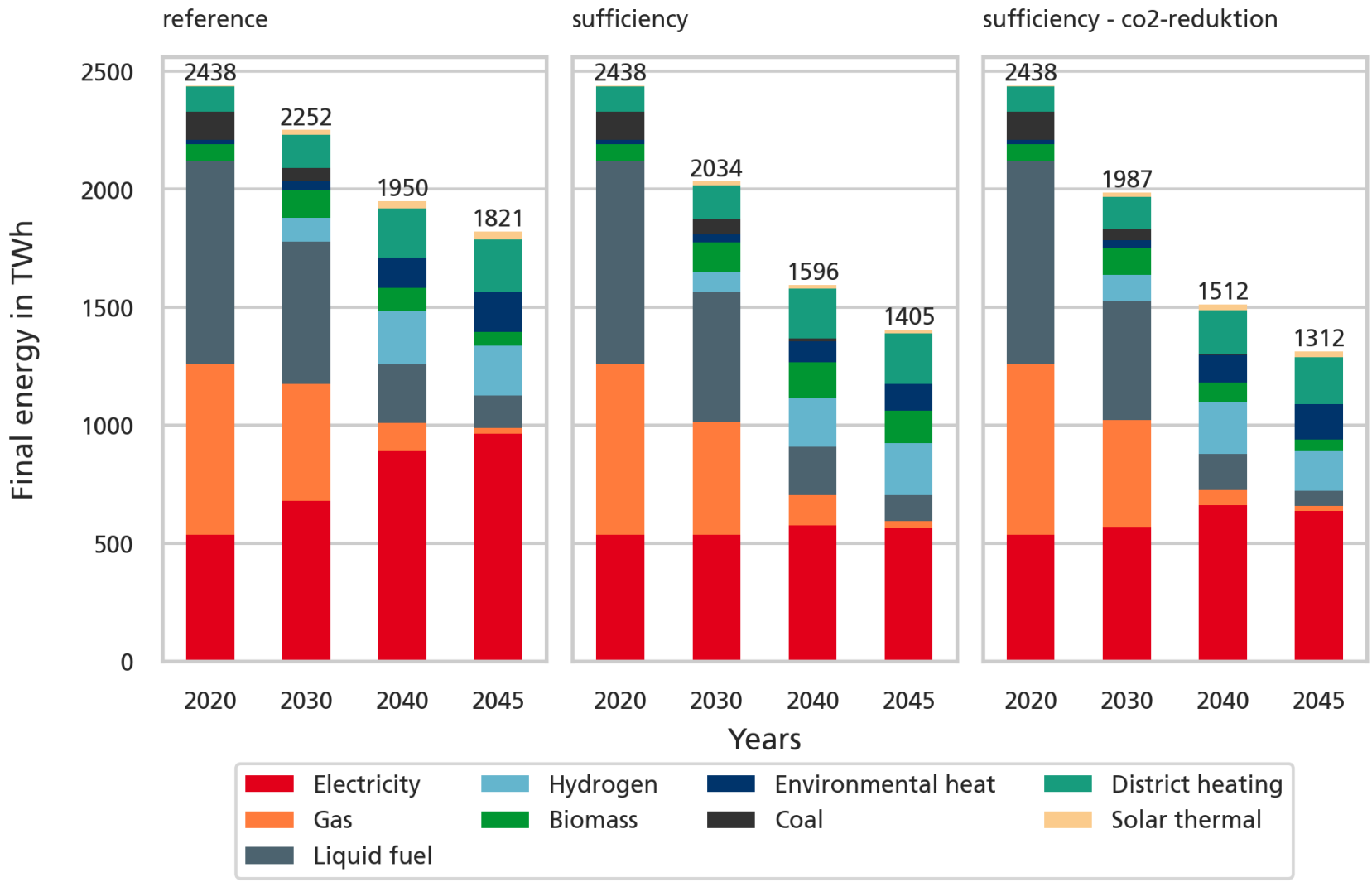
Sufficiency – CO2-reduction

→ earlier phase out of fossil energy

→ Higher primary energy compared to sufficiency, lower efficiency of the system

Final Energy Demand

By energy carrier



→ Demand highest in reference, lowest in CO2-reduction scenario

→ Electricity demand highest in reference scenario

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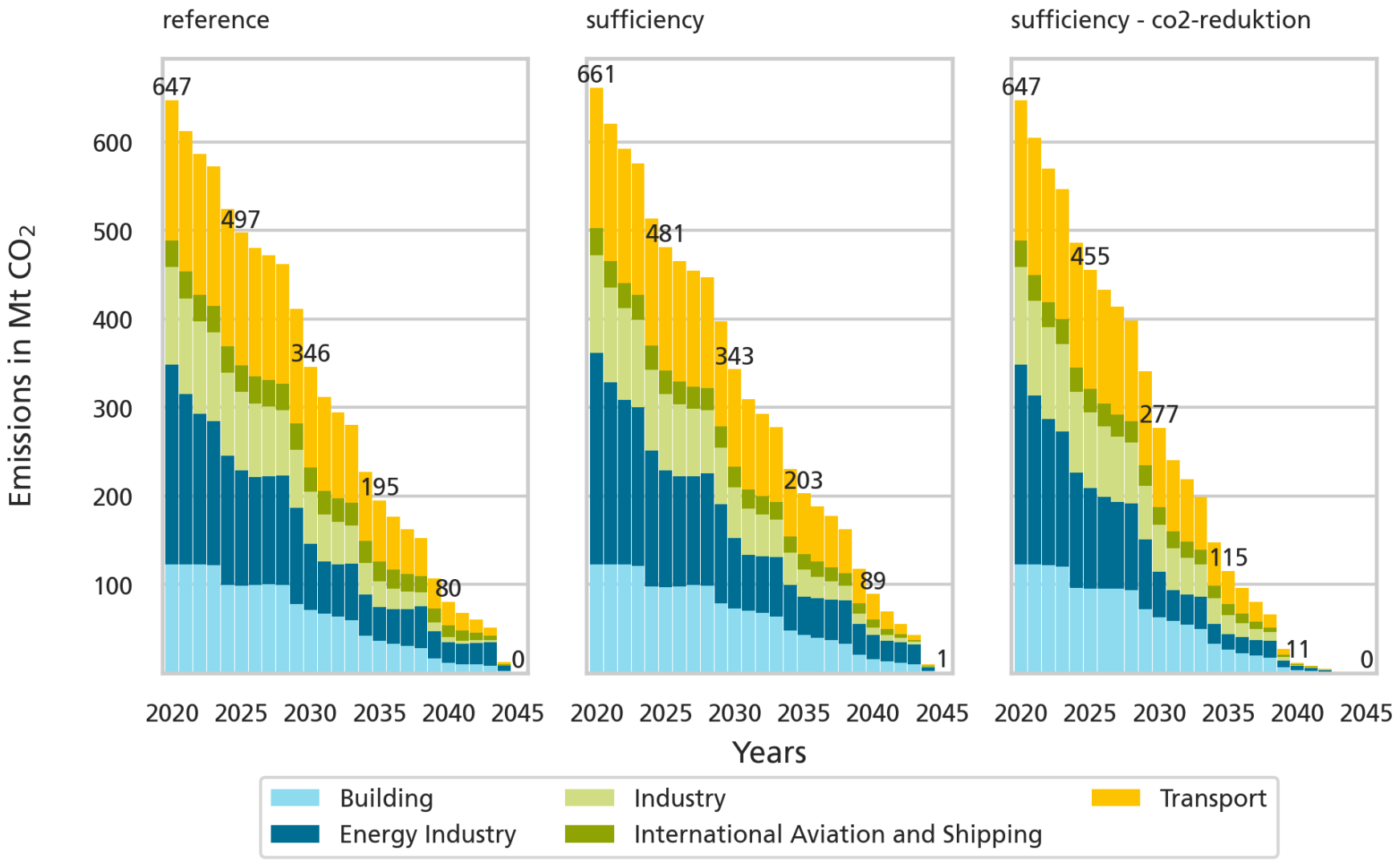
CO2-Emissions



→ Mitigation reinforced in CO2-reduction-scenario

Cumulated fossil primary energy demand and CO2 emissions

Variable	Unit	Scenario Reference	Scenario CO2-reduction	Savings
CO2-emissions	Mt	7 790	6 390	1 400
Natural Gas	TWh	15 540	12 250	3 290
Hard Coal	TWh	1 850	1 740	110
Lignite	TWh	1 570	1 530	35
Oil	TWh	13 570	10 840	2 730

Conclusion

Advantages of reduction of energy demand

1. **Transformation of energy sector**
   Mitigation targets can be reached with less capacity additions

2. **Transformation of demand sectors**
   Delayed transformation in demand sectors can be compensated

3. **CO_2-emissions**
   1.4 Gt CO2 can be saved, mainly by savings of Natural Gas (3 290 TWh) and Oil (2 730 TWh)

Thank You for Your Attention!

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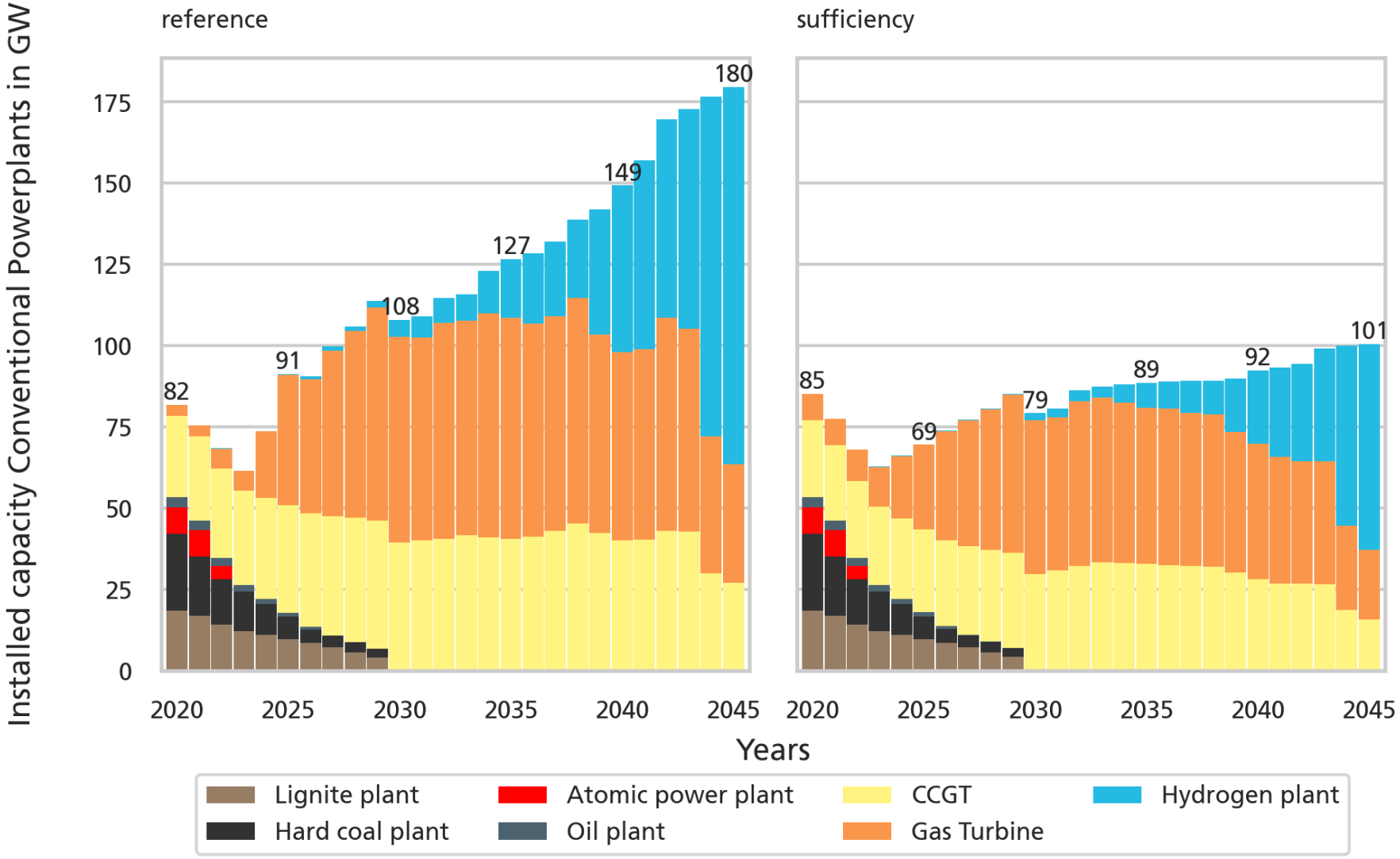
Conventional Powerplants



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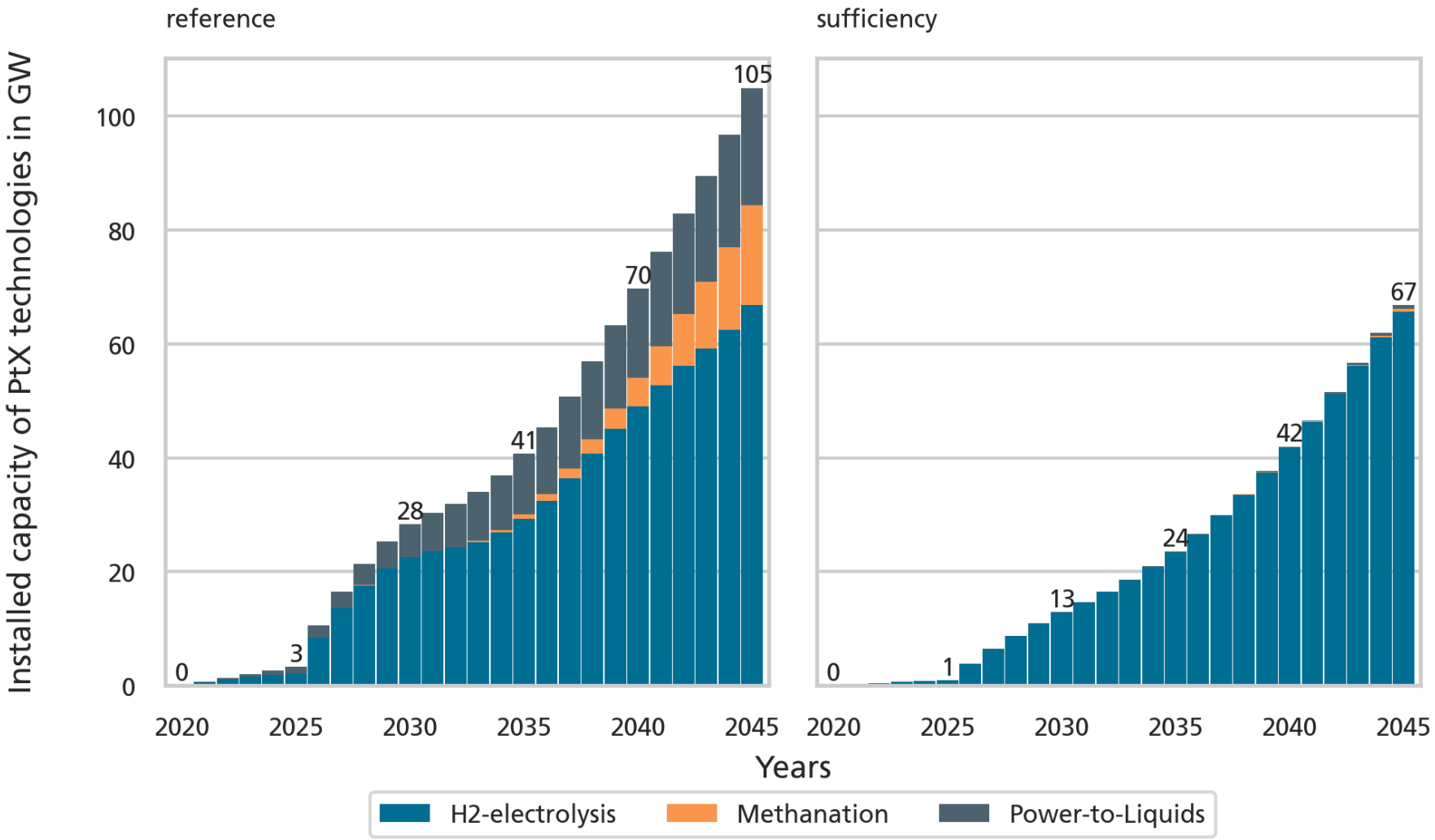
PtX-technologies



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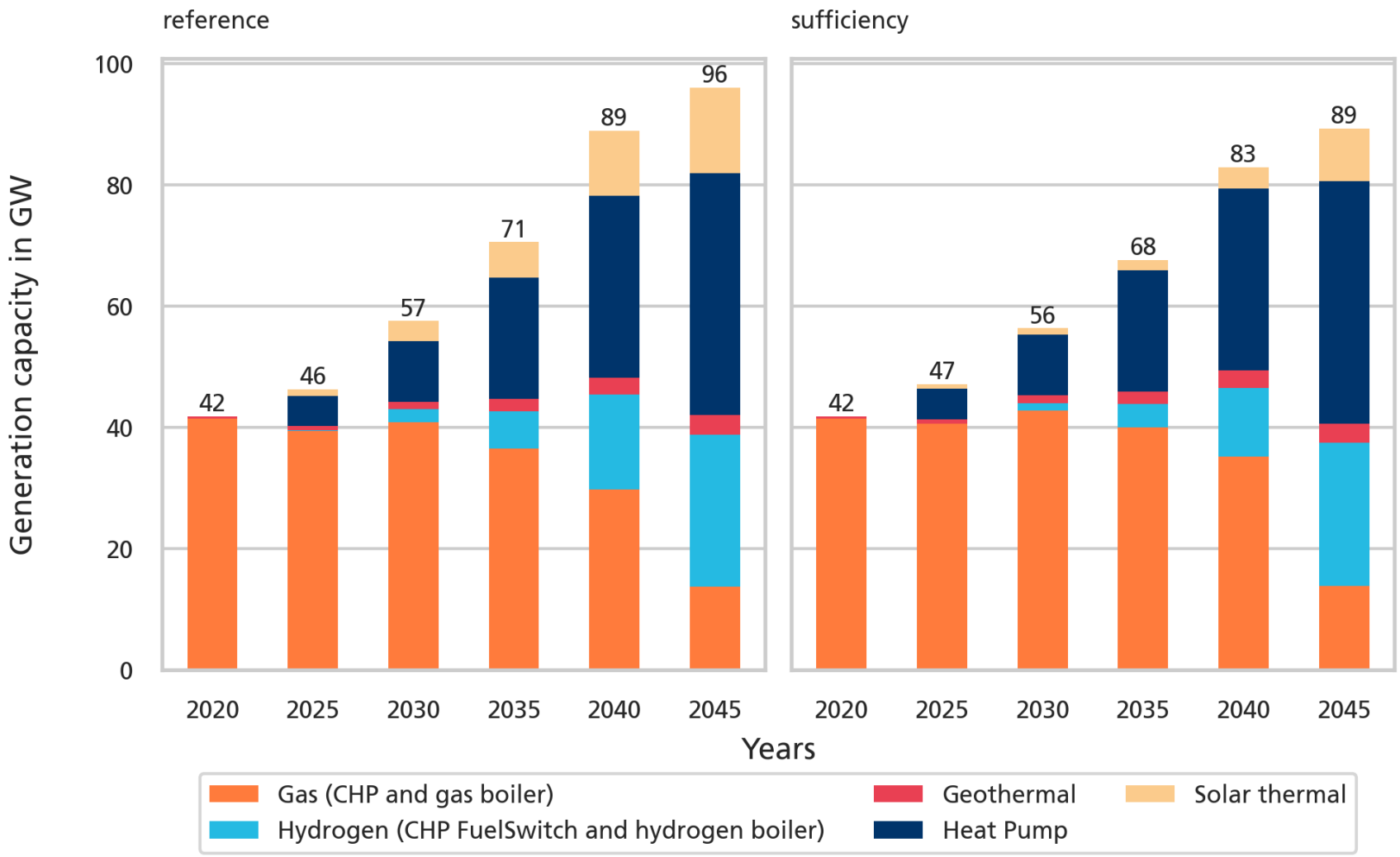
District heating



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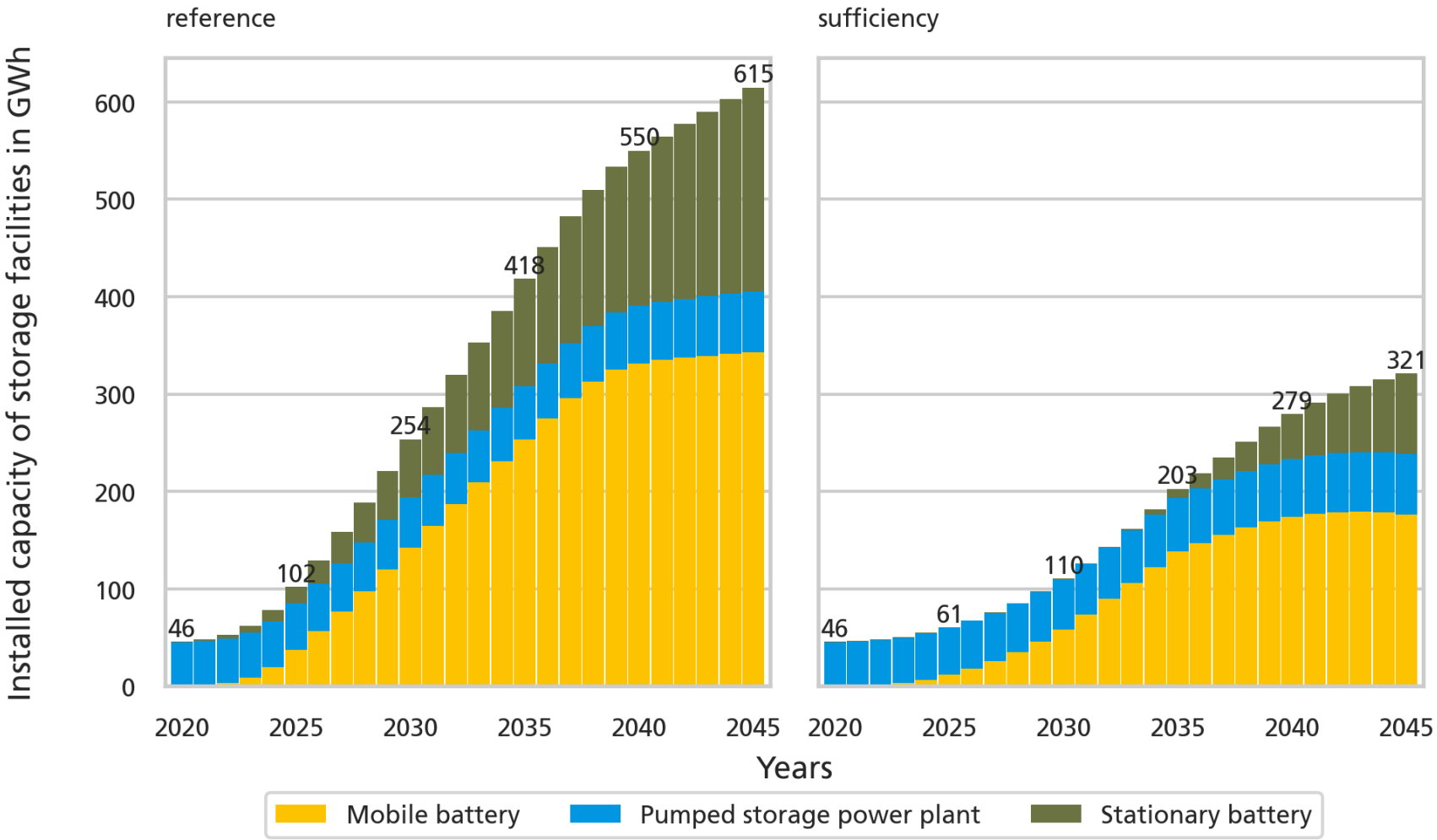
Storage Reservoir



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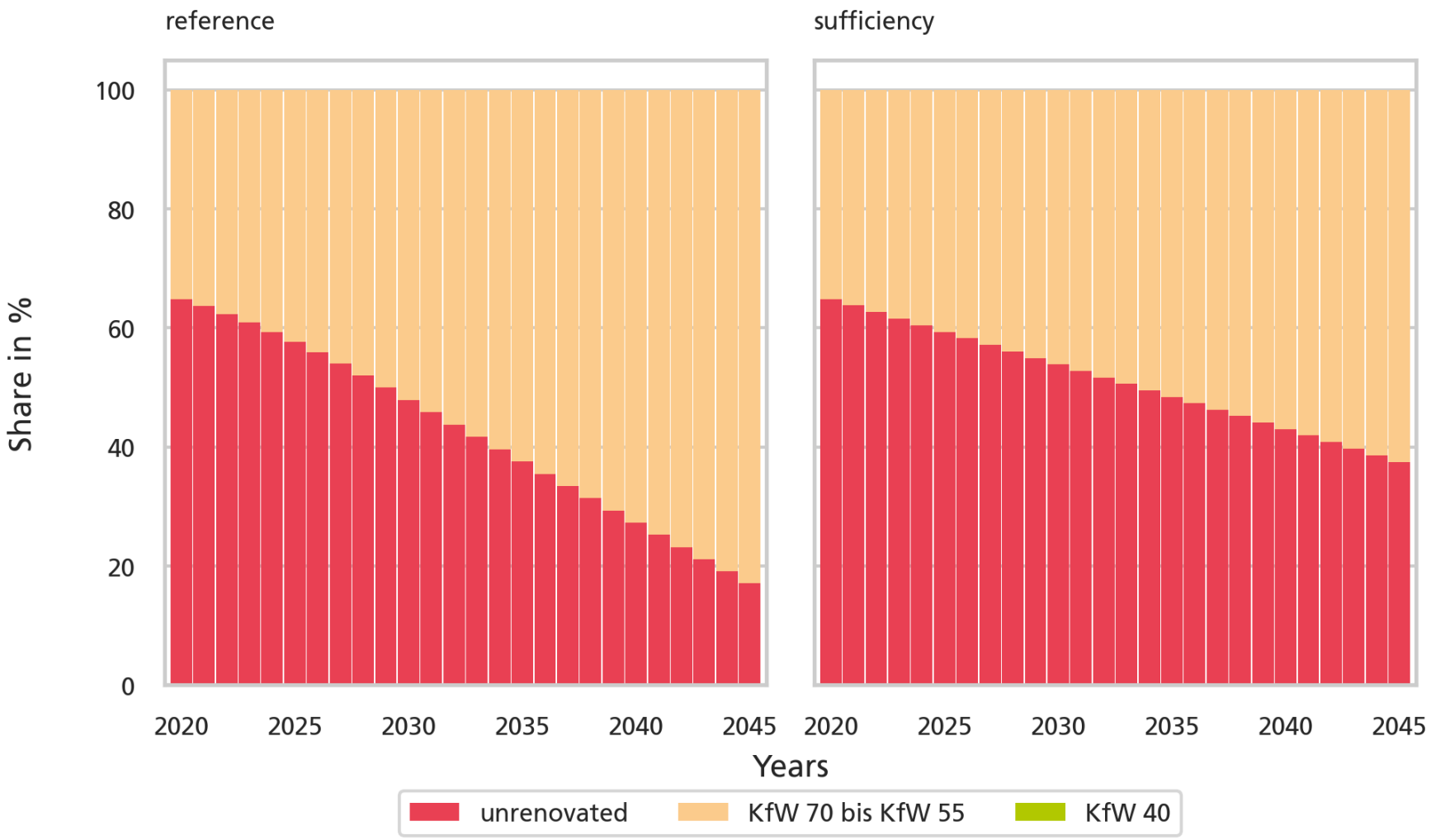
Transformation in demand sectors

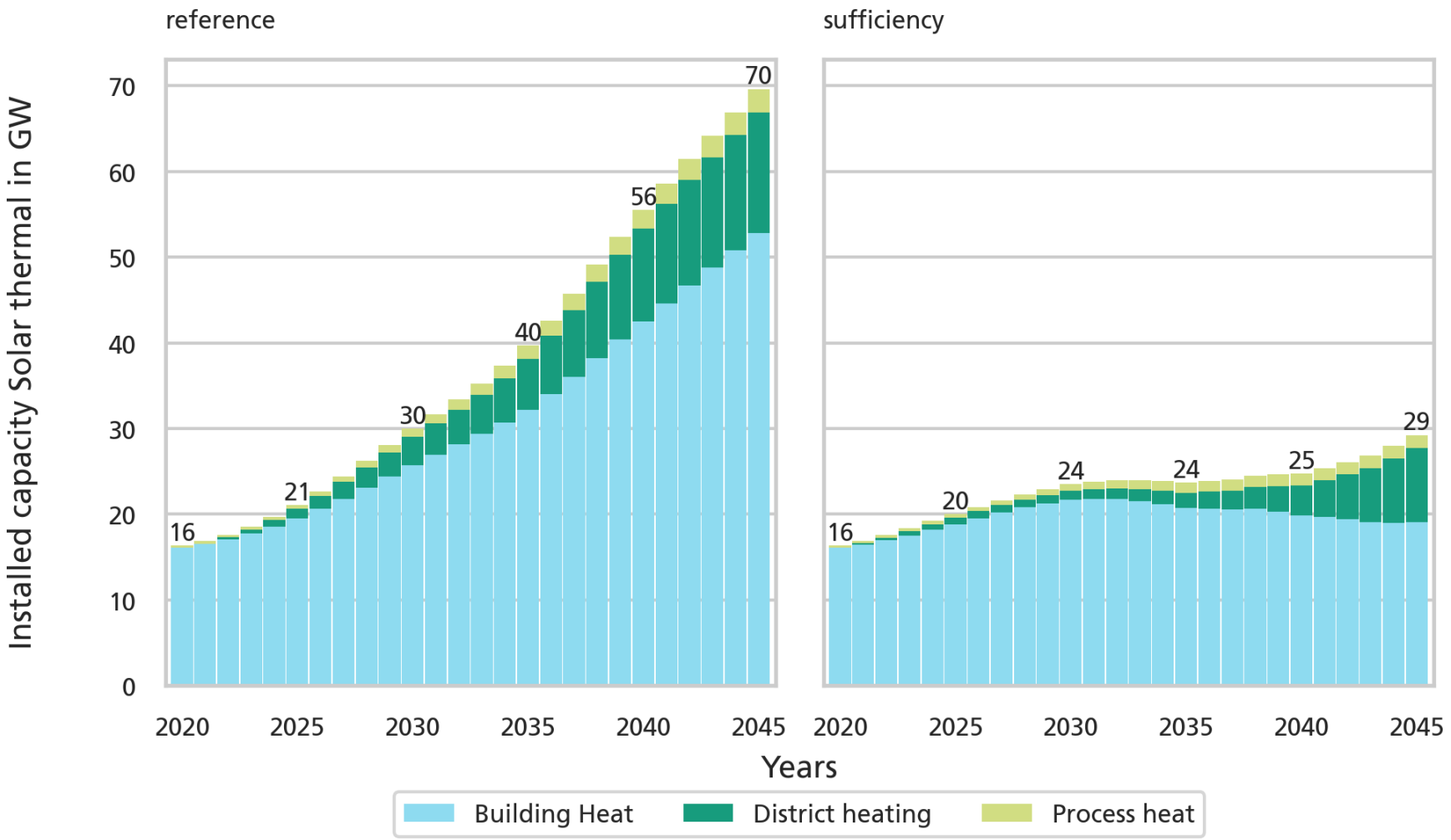
Buildings: renovation rate



→ Mitigation targets can be reached with slower transformations

Transformation in demand sectors

Solar thermal



→ Mitigation targets can be reached with slower transformations

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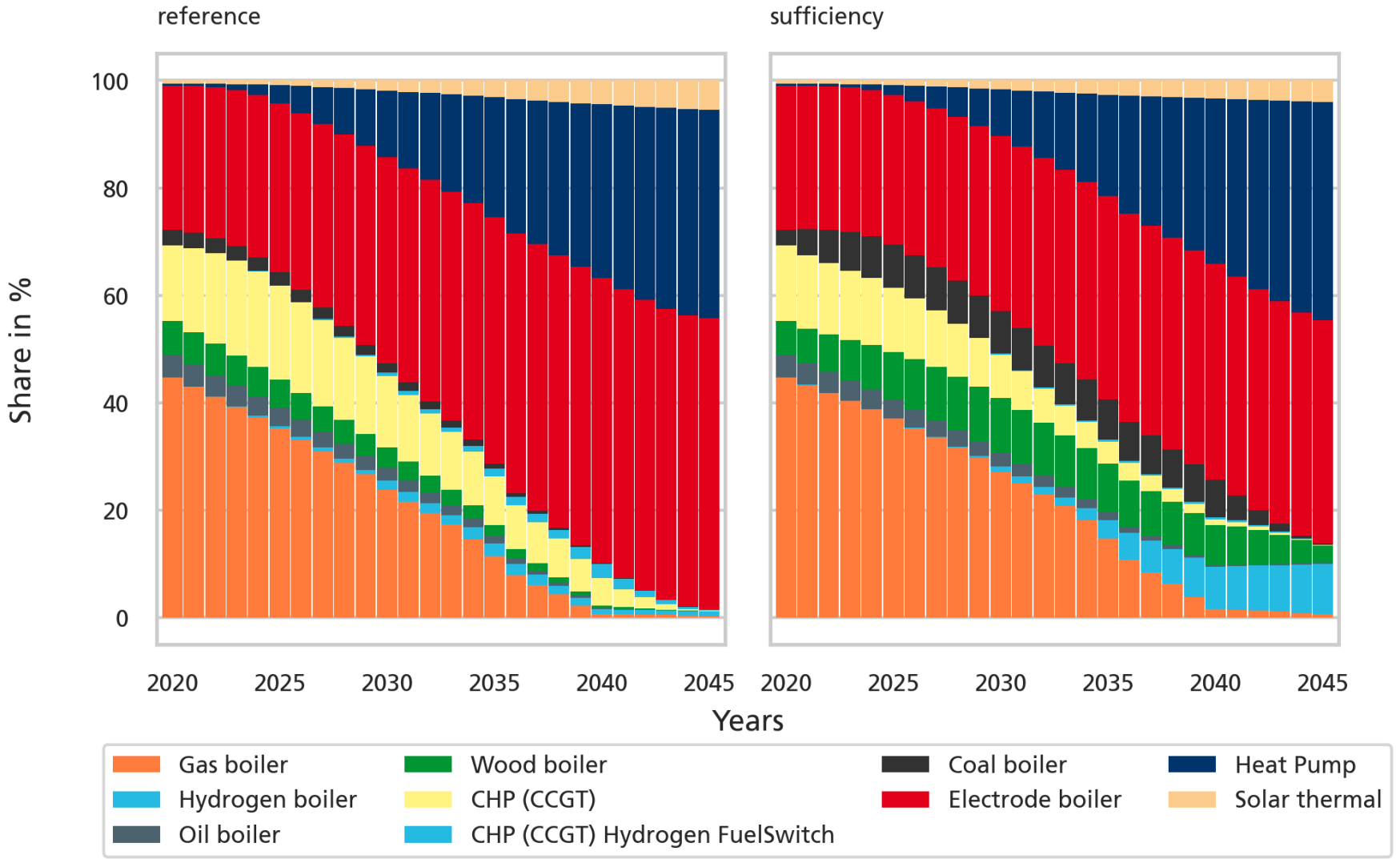
Transformation in demand sectors

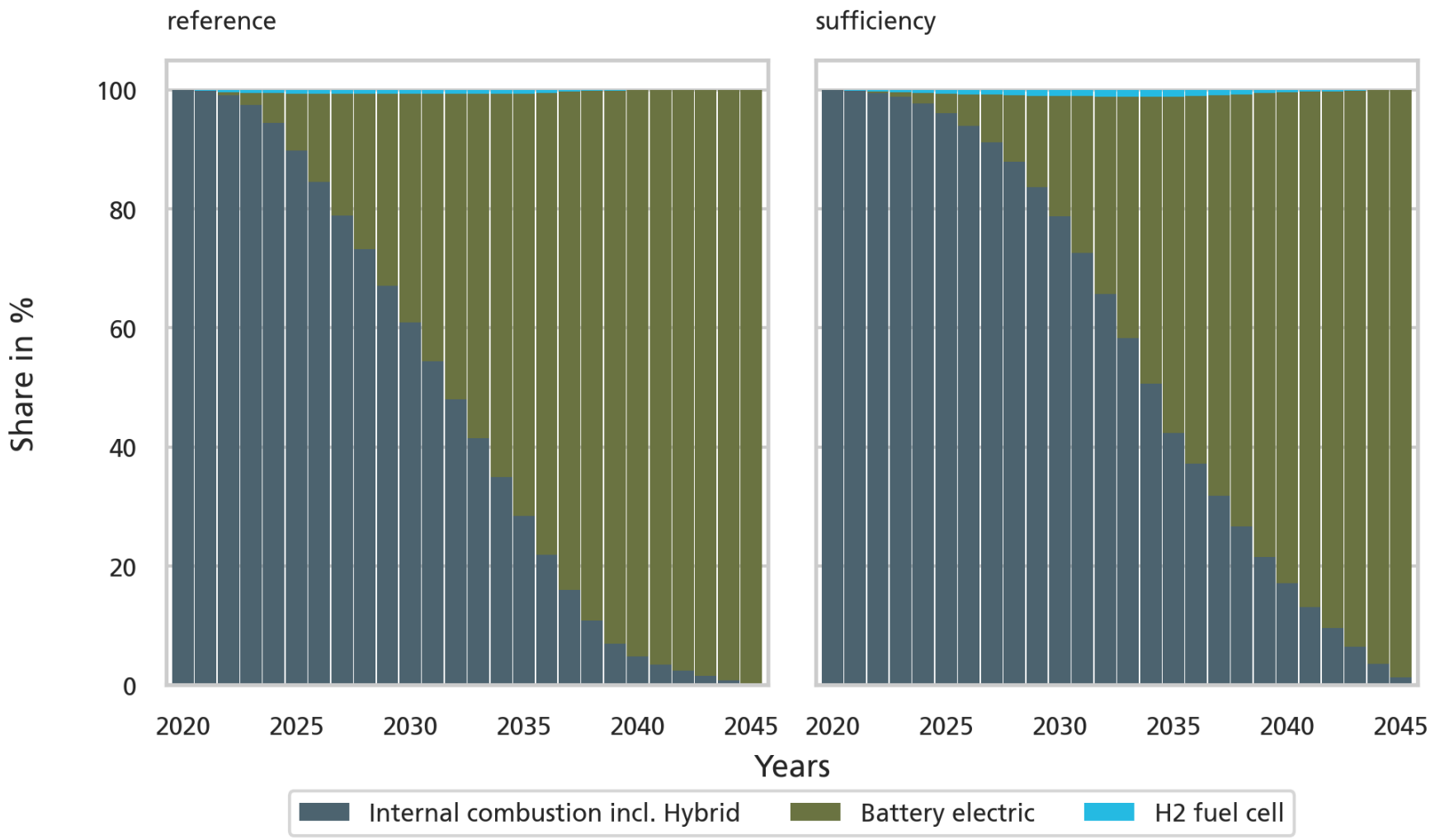
Industry: industrial process heat



→ Mitigation targets can be reached with slower transformations

Transformation in demand sectors

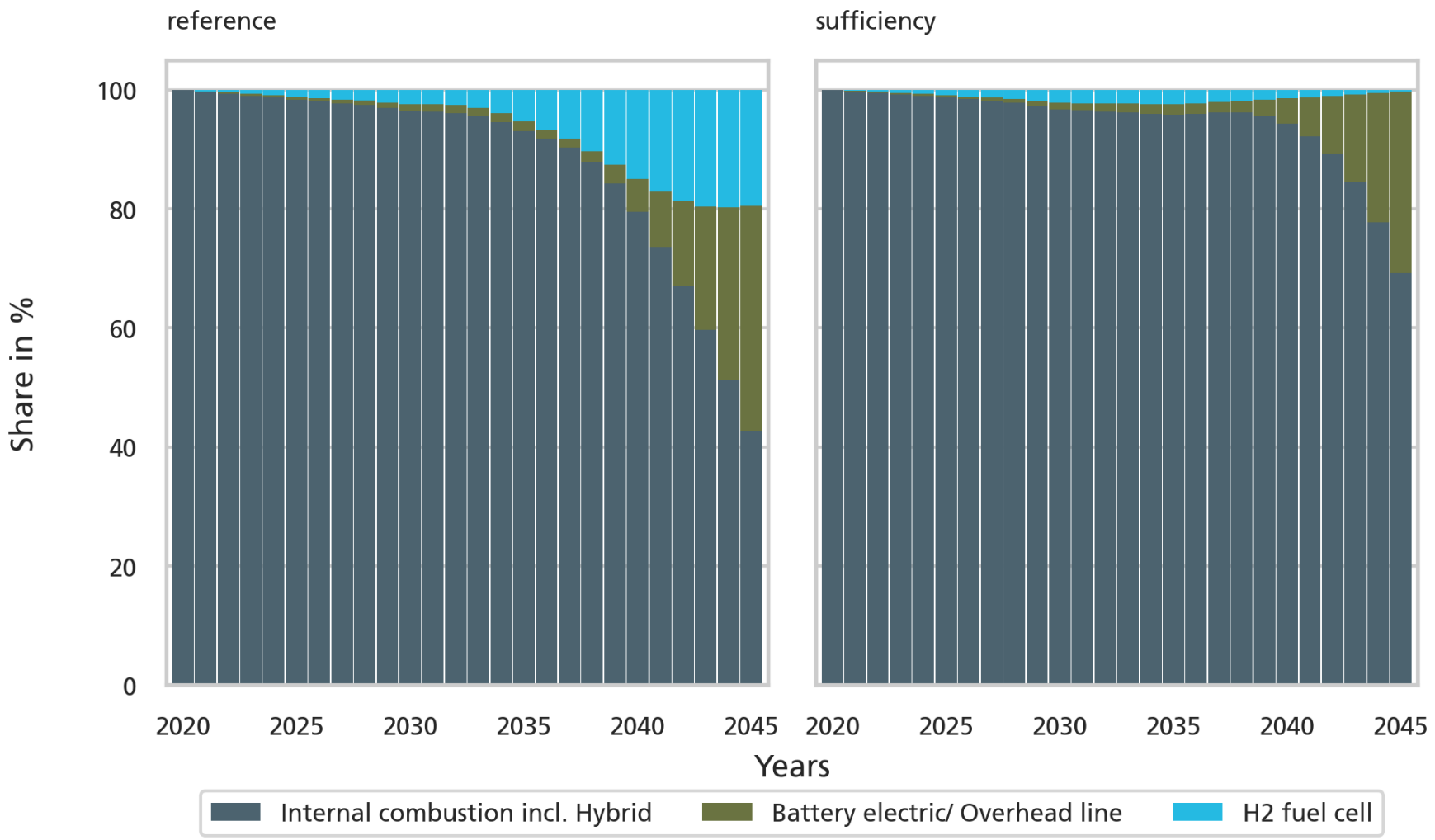
Transport: LDVs



→ Mitigation targets can be reached with slower transformations

Transformation in demand sectors

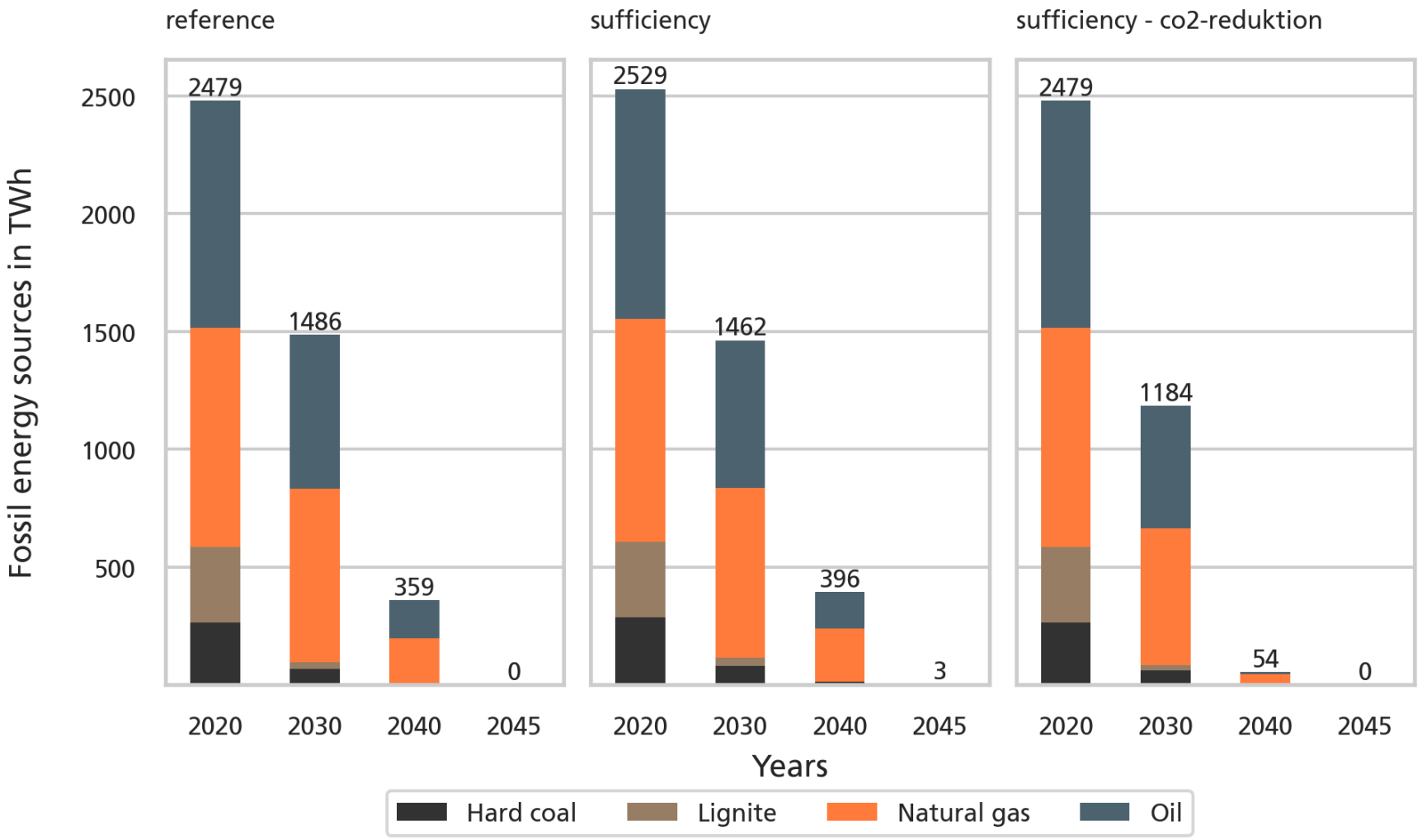
Transport: Trucks



→ Mitigation targets can be reached with slower transformations

Primary Energy Demand

Fossil energy sources



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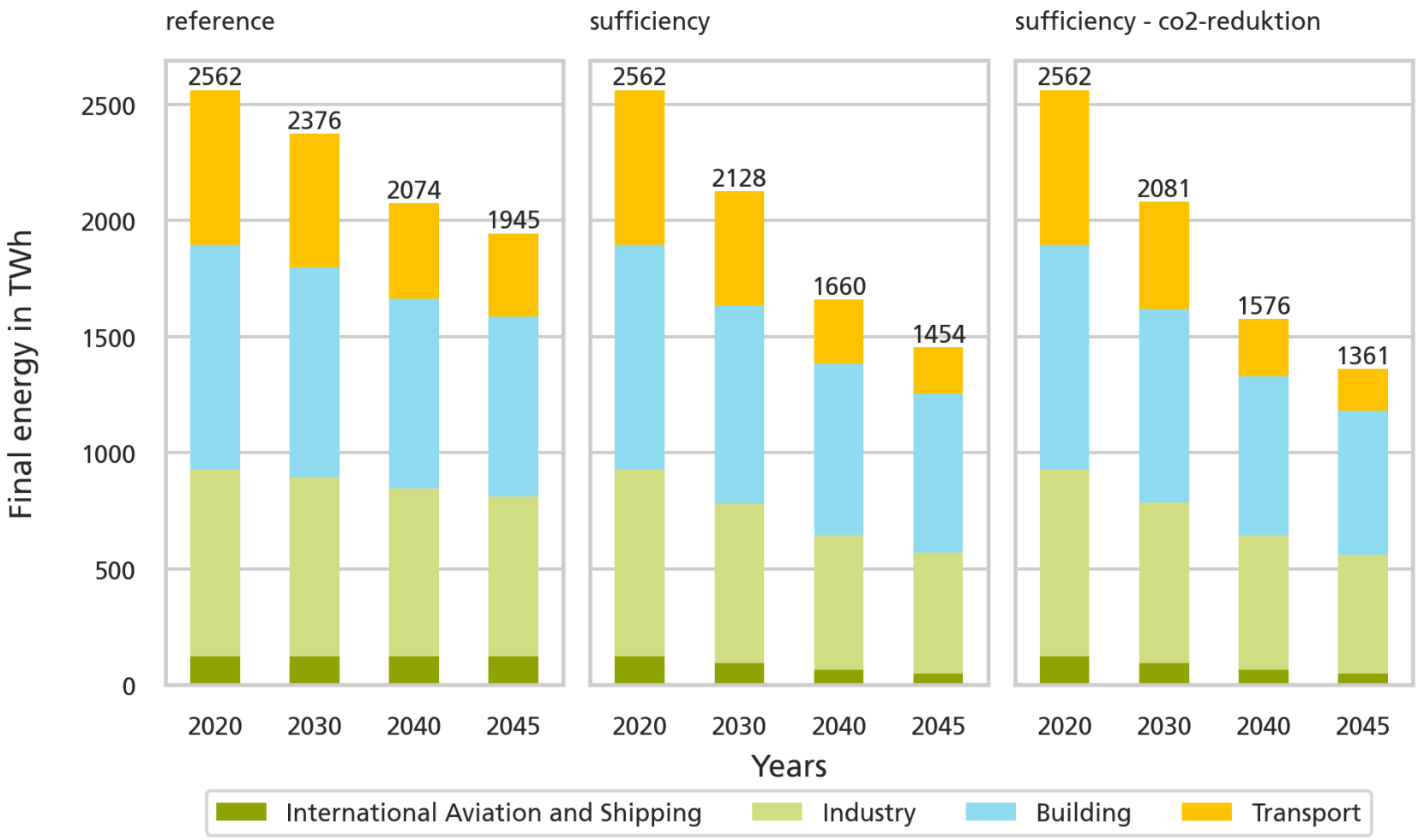
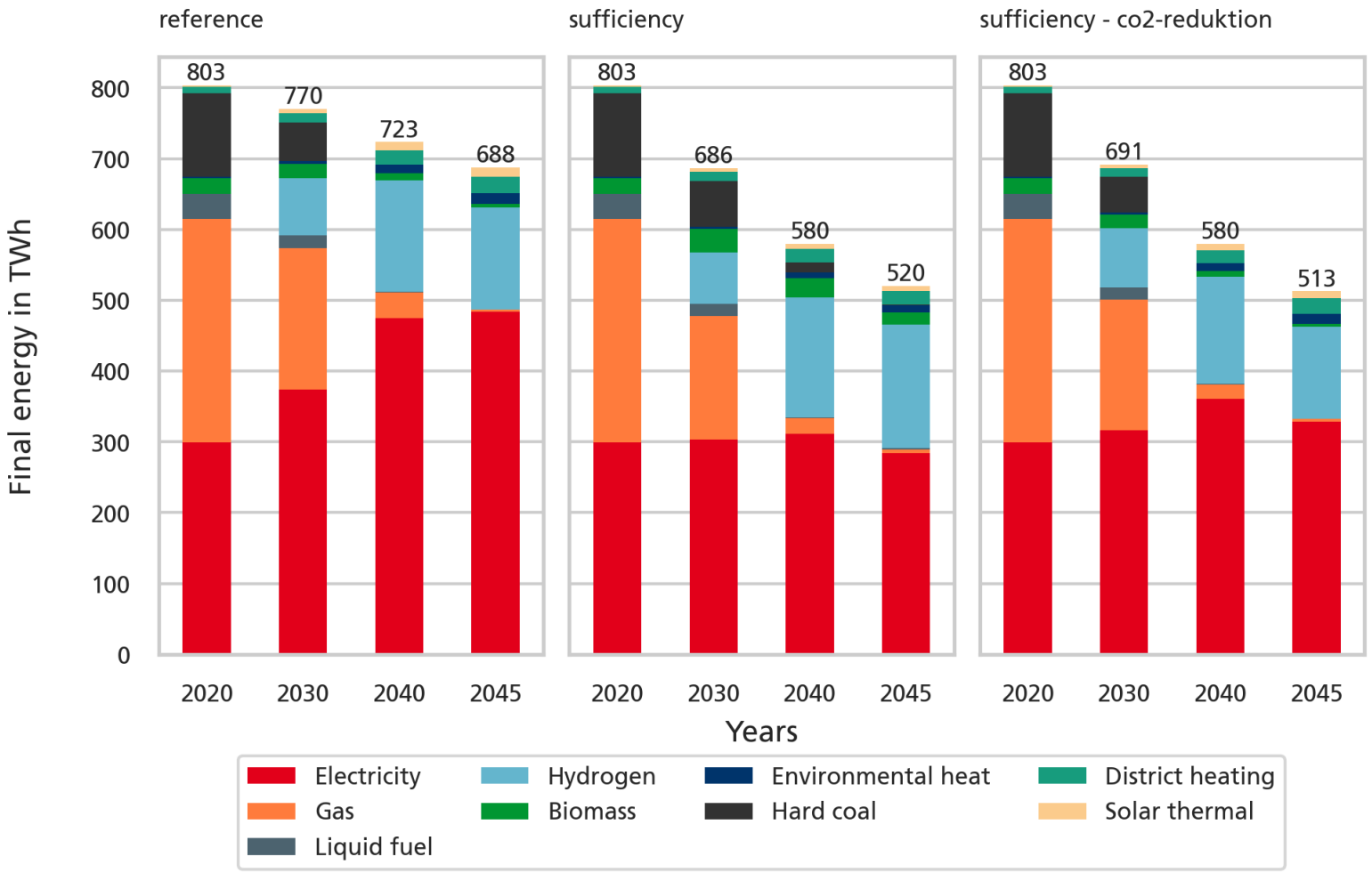
Final Energy Demand

By sector



Final Energy Demand

Industry



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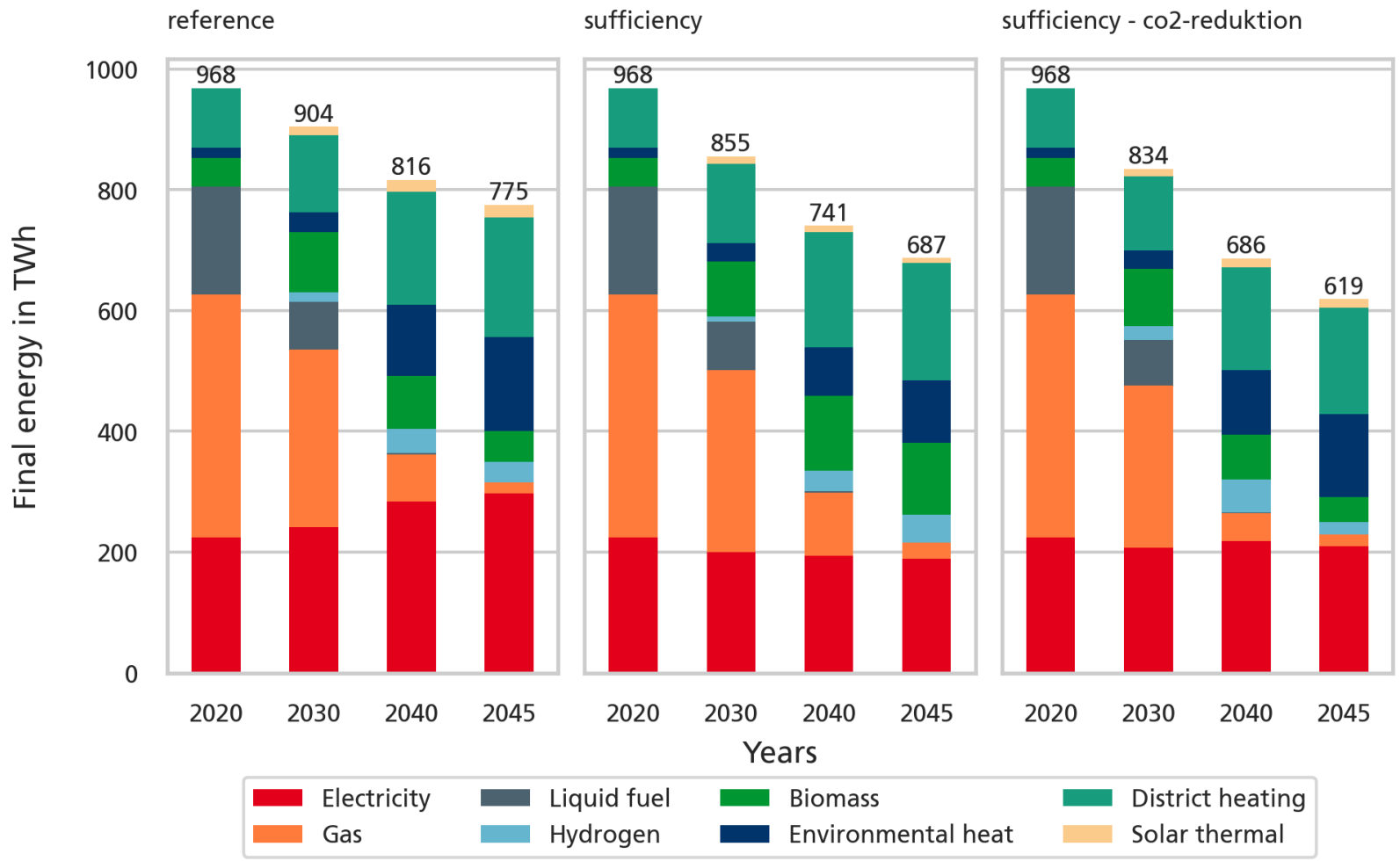
Final Energy Demand

Residential and Commercial



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Final Energy Demand

Transportation