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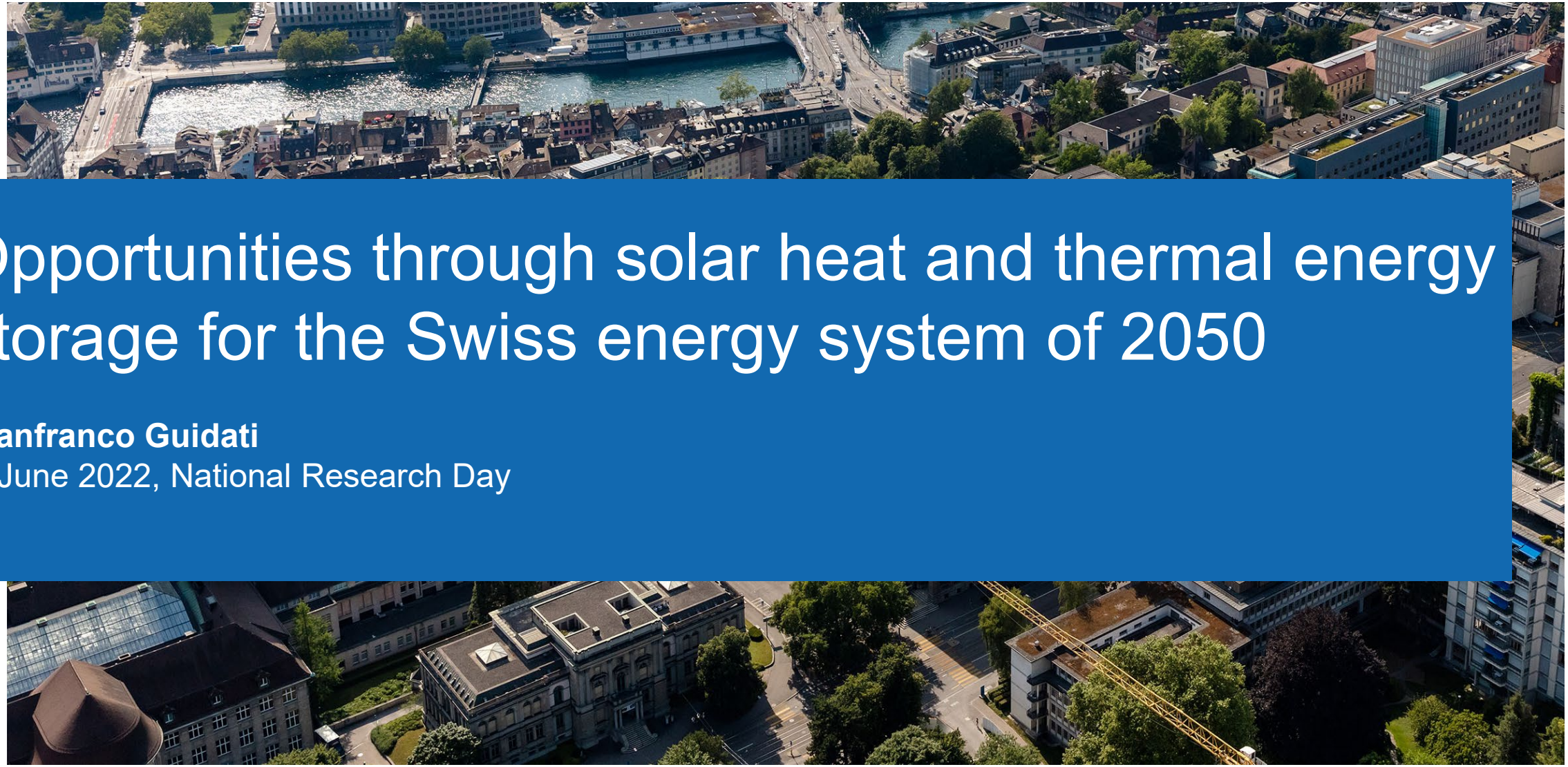


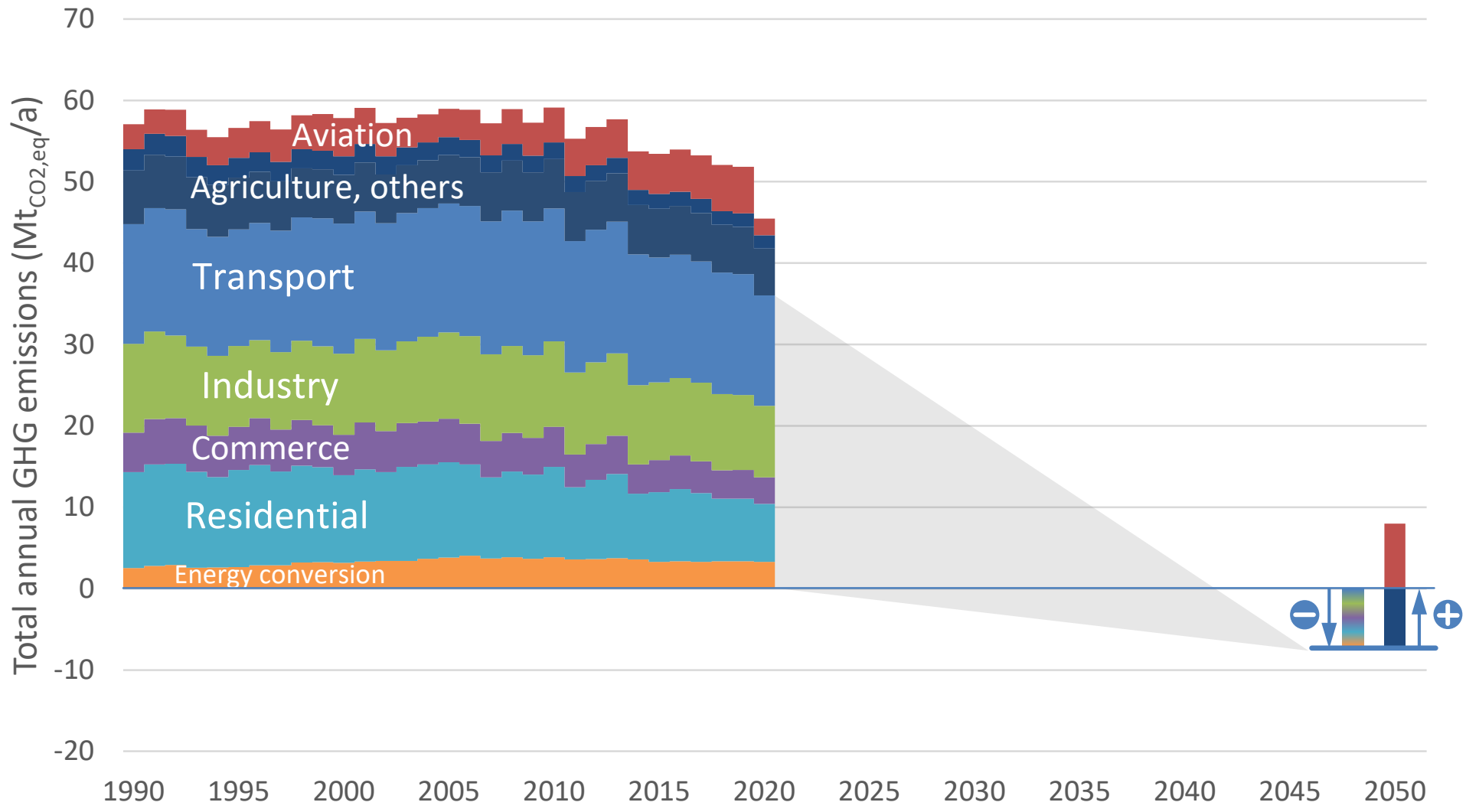
Opportunities through solar heat and thermal energy storage for the Swiss energy system of 2050

Gianfranco Guidati

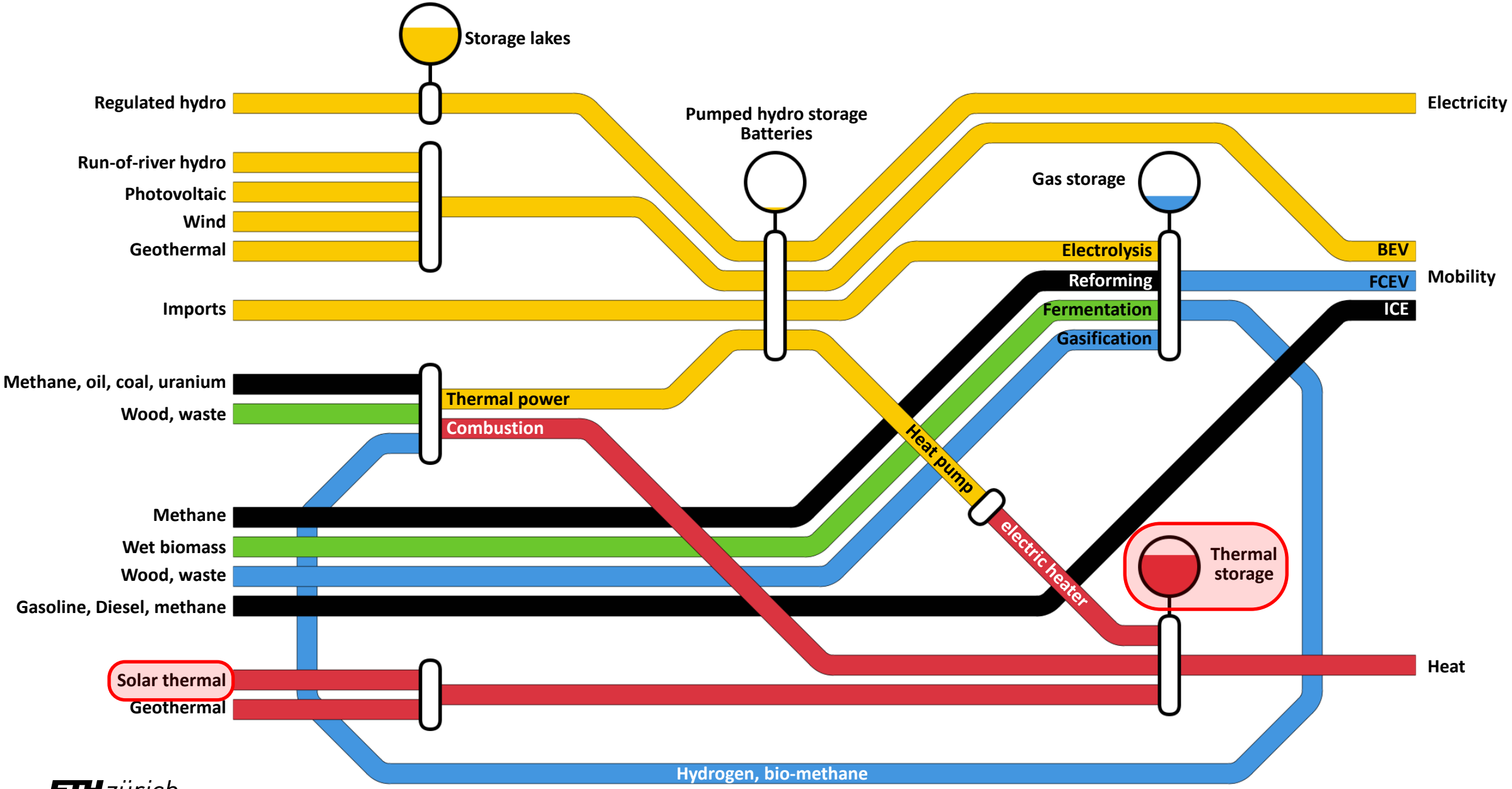
1. June 2022, National Research Day

The SolTherm2050 project

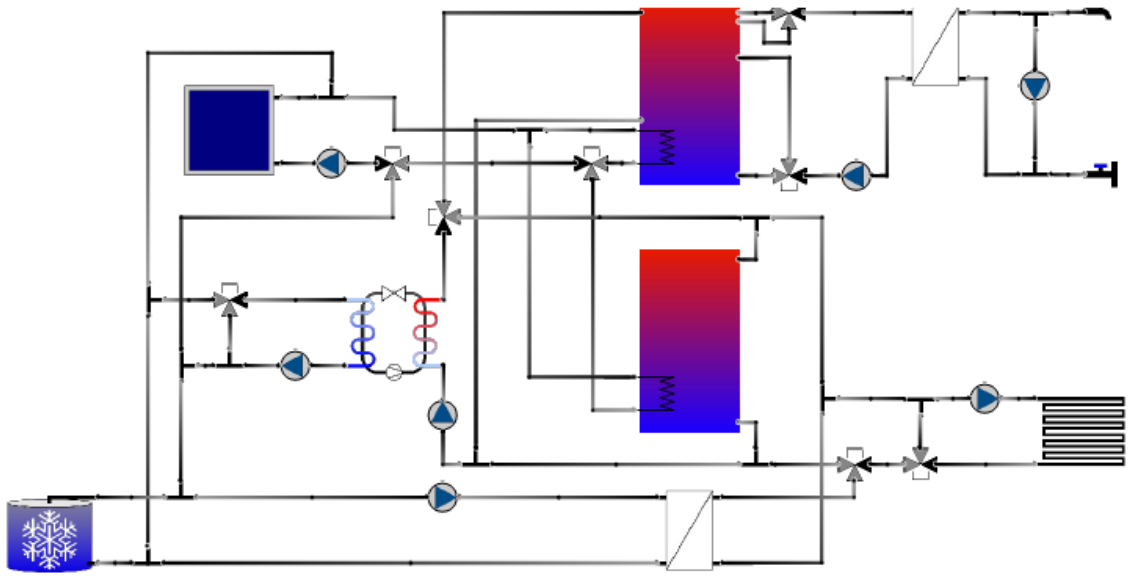
The net-zero target



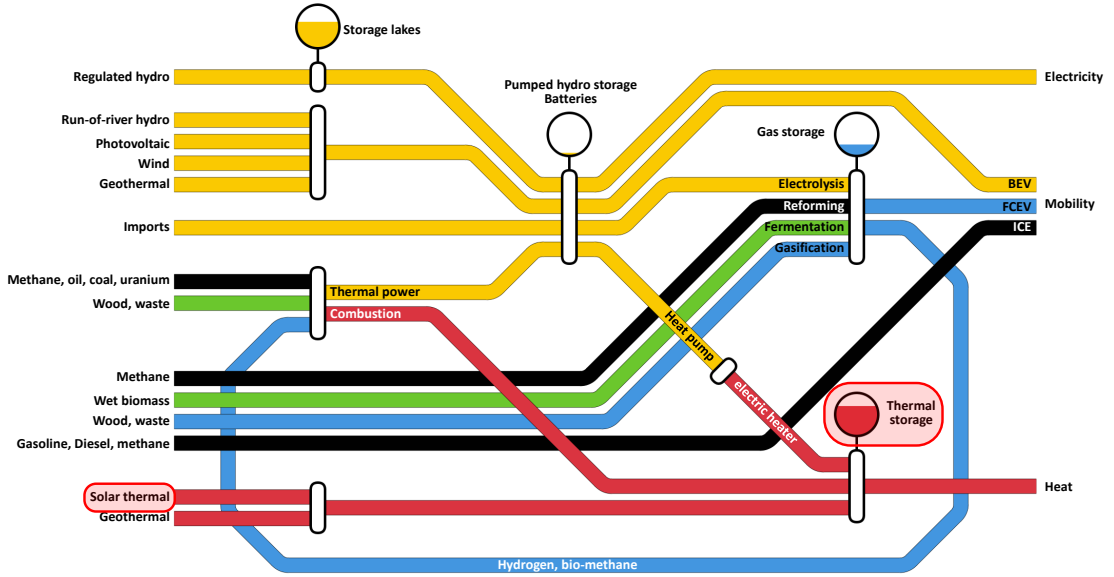
The energy system



Bring together the micro- and macro-world



Detailed process models

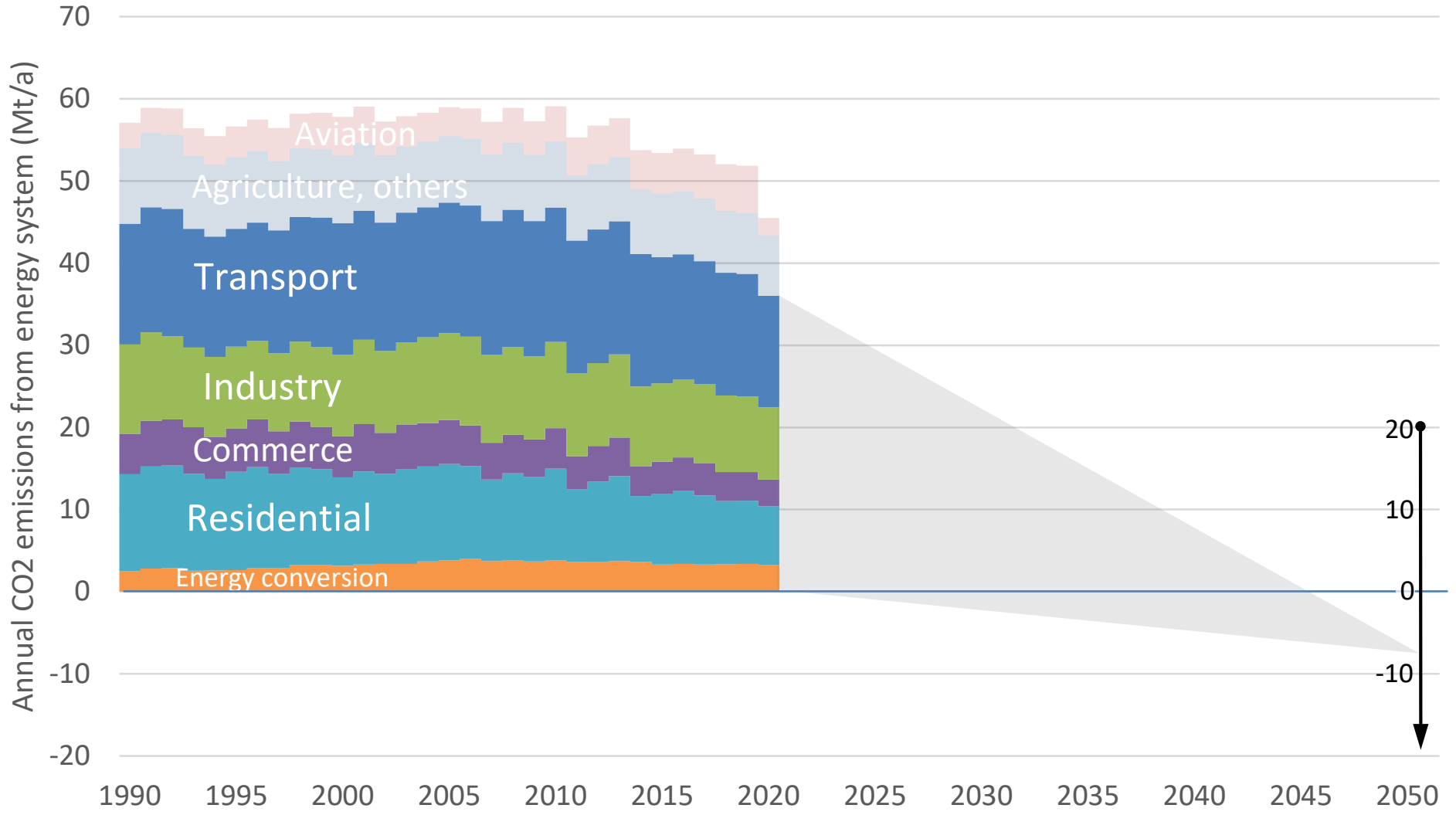


Full energy system model

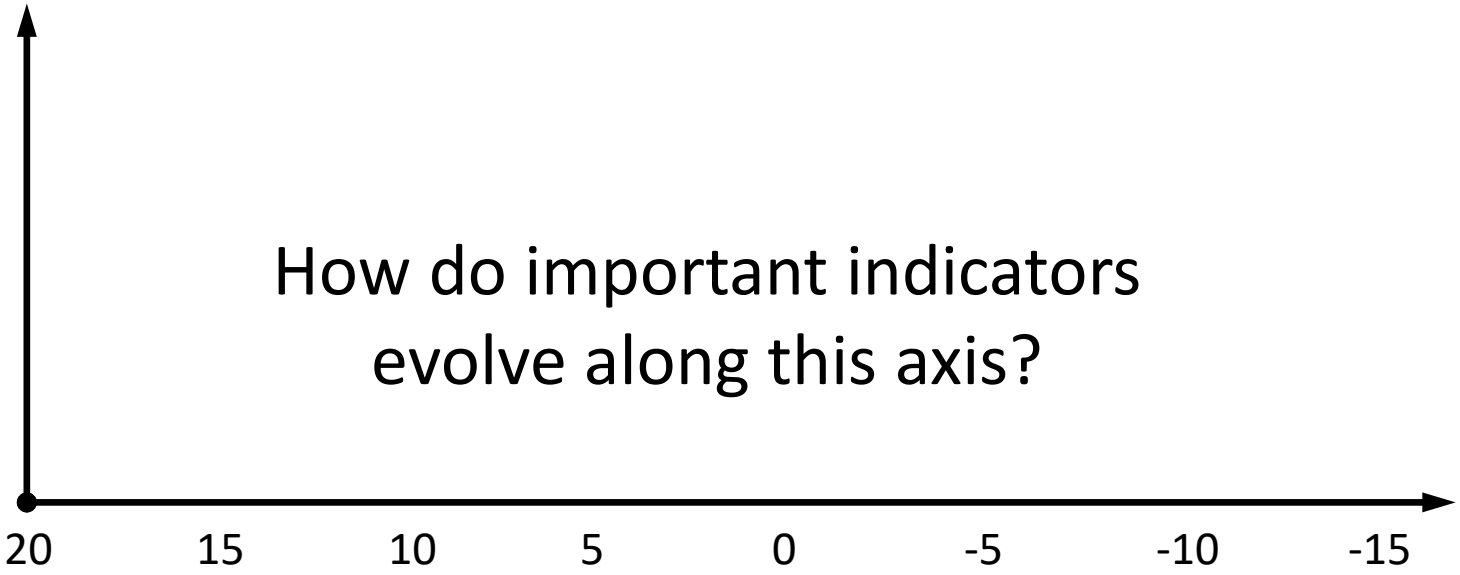
Energy system model

- Balances energy and CO_2 streams between the various elements of the energy system
- Results were generated with Swiss Energyscope (ETH-version, originally developed at EPFL)
  - No spatial resolution (one PV-panel, one pellet boiler, one heat pump, etc)
  - Year is represented by 24 typical days
  - Intra-day clustering into eight 3-hour blocks (see https://sccer-jasm.ch/JASMpapers/JASM_results_ses_eth.pdf)
- Linear optimizer optimizes design of energy system and its operation throughout the target year 2050
- Total system costs (operation and annualized investment) are minimized for a given CO_2 target for the overall energy system
- This CO_2 target is varied between +20 Mt/a and -15 Mt/a
- Uncertainty of drivers such as population, technology costs, etc are considered by a Monte Carlo analysis

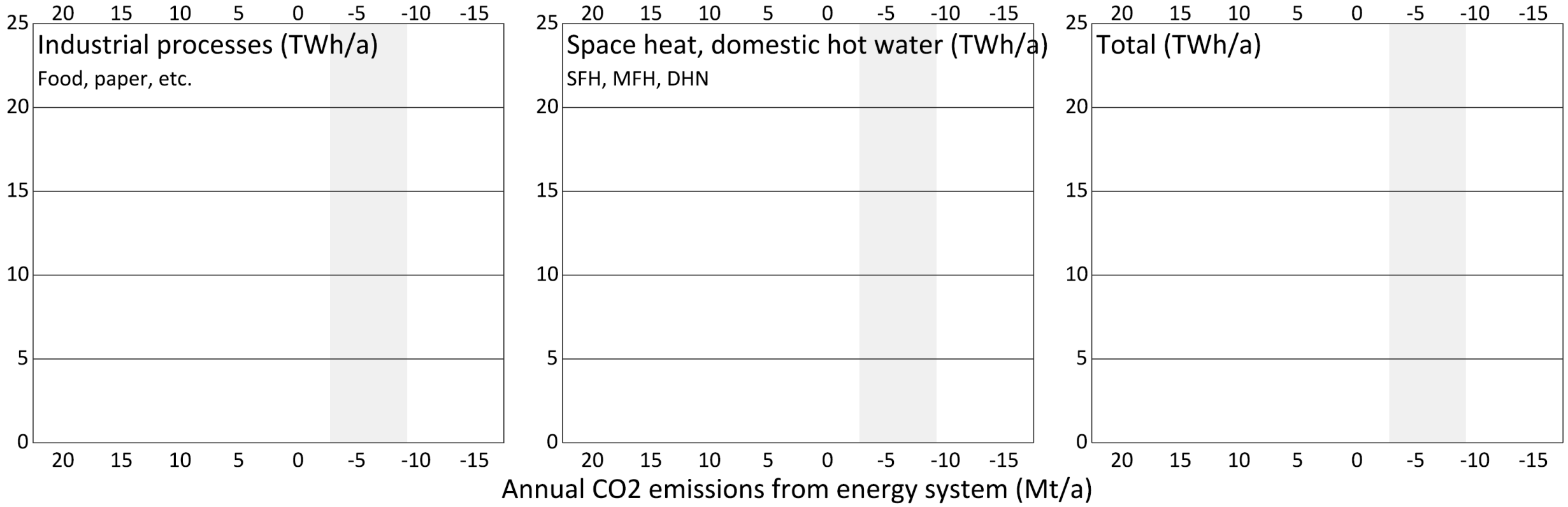
CO_2 emissions from energy system



CO_2 emissions from energy system



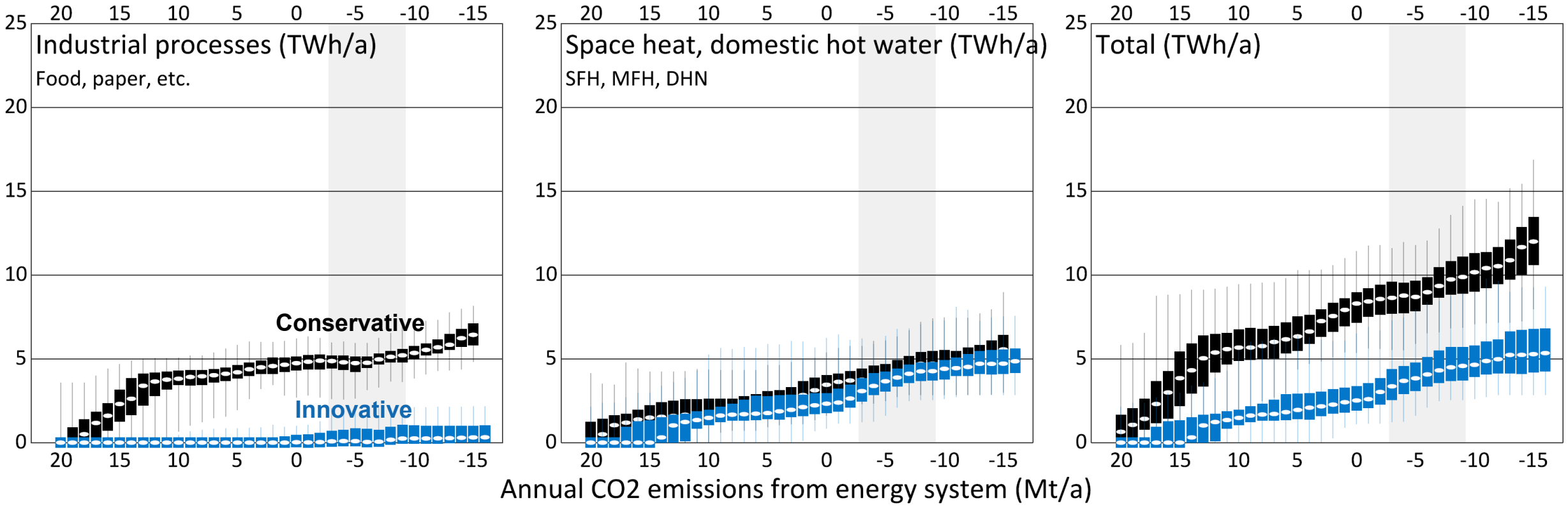
How much solar thermal can be found in the optimal mix in 2050?



Scenario variants: “conservative” vs. “innovative”

	Conservative	Innovative
Hydro power	< 33.6 TWh/a	< 37.1 TWh/a
Hydro storage lakes	< 6.5 TWh	< 8.5 TWh
Wind power	< 0.9 GW	< 2.1 GW
Alpine photovoltaics	No	< 4 GW
Centralized processing of manure	No	Yes
Pyrolysis of digestate	No	Yes
Seasonal hydrogen storage	No	Yes
Deep geothermal energy	No	< 10 TWh/a
Seasonal thermal energy storage	No	Yes

How much solar thermal can be found in the optimal mix in 2050?



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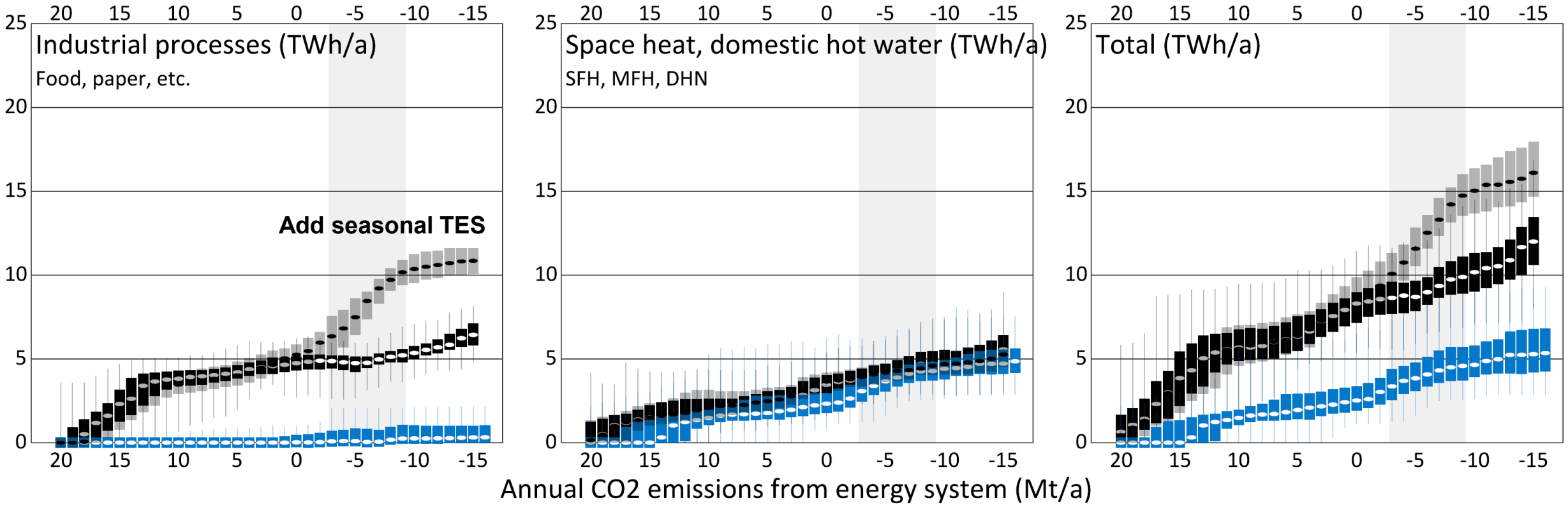

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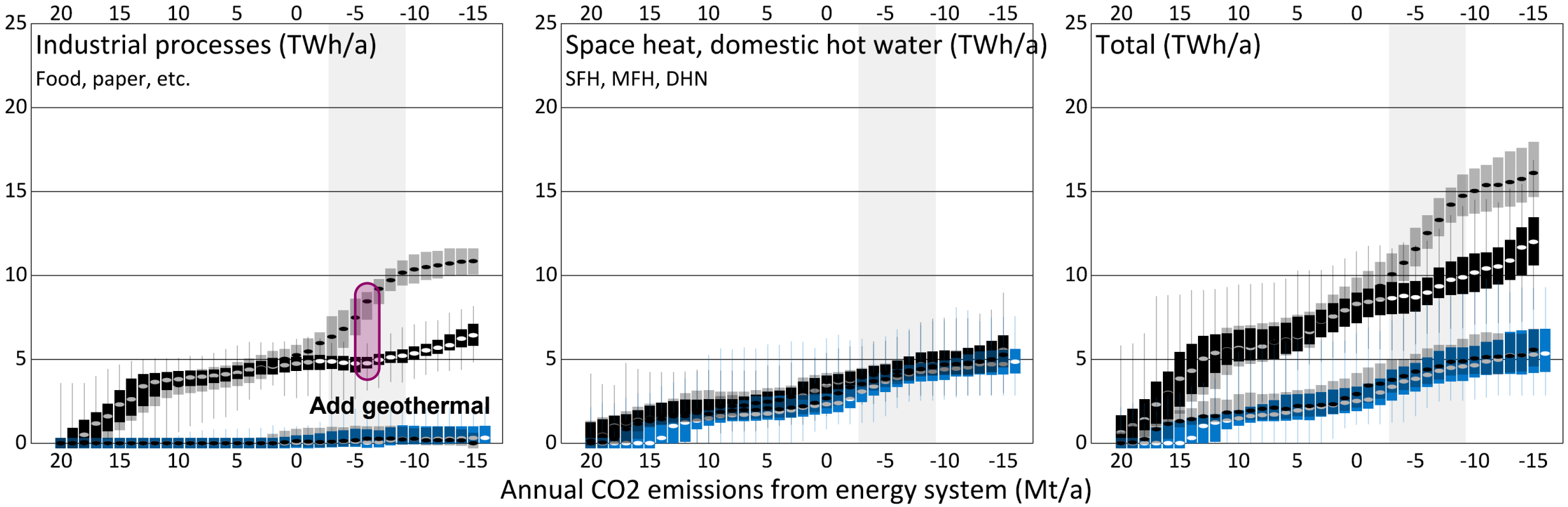
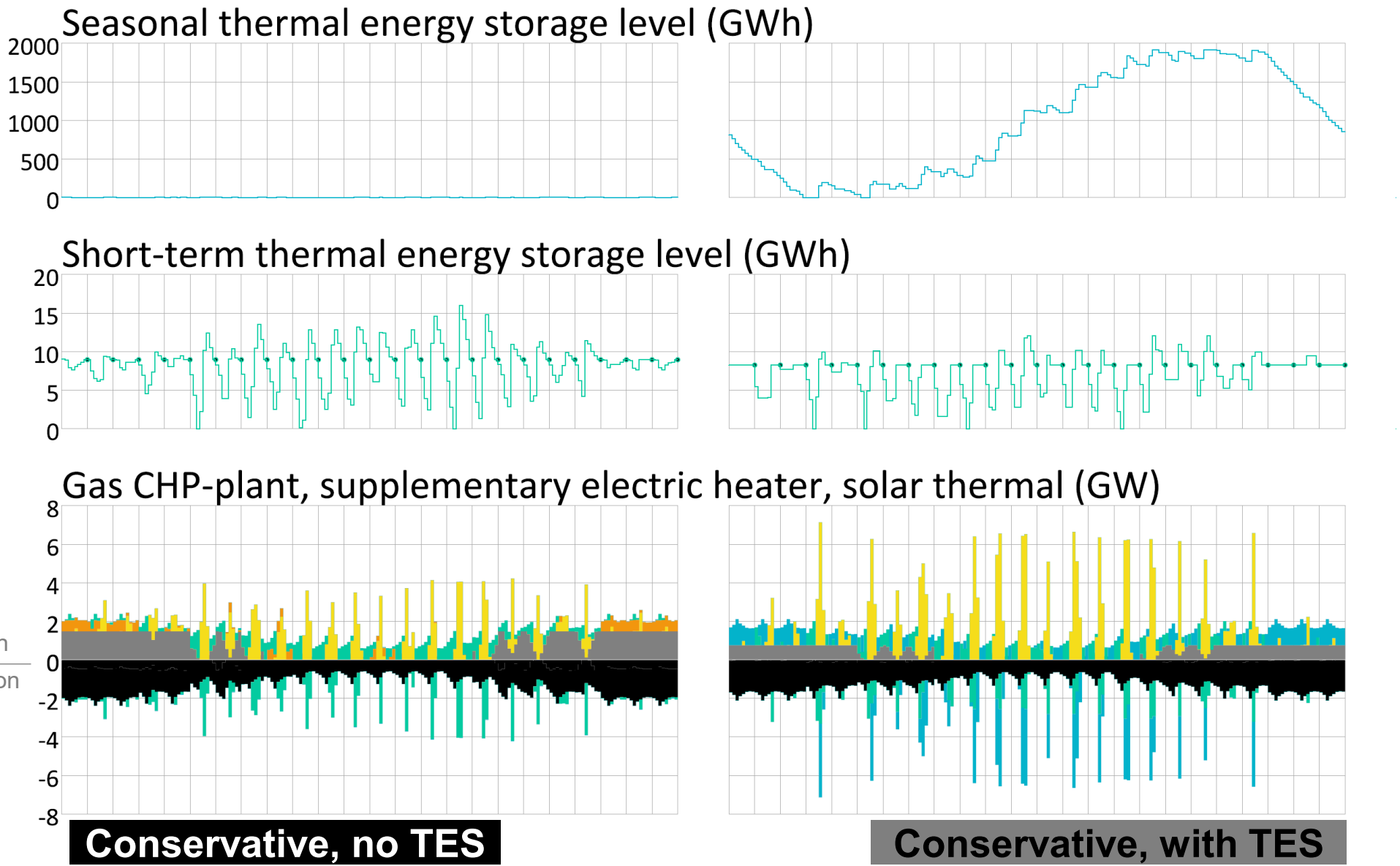


Use in industrial processes depends strongly on other drivers

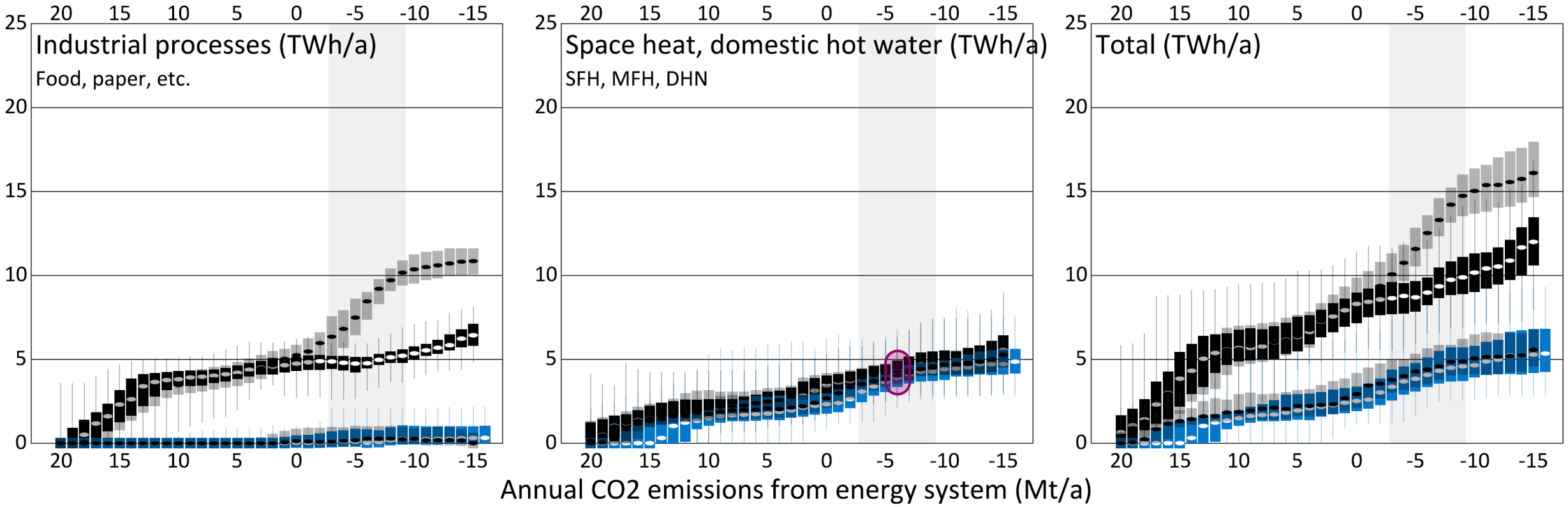
Stable contribution for space heat and DHW in residential sector

Example: industrial Gas-CHP plant with solar thermal

Target year 2050, 24 typical days, net-zero scenario at –6 Mt_{CO2}/a



How much solar thermal is cost-effective in 2050?

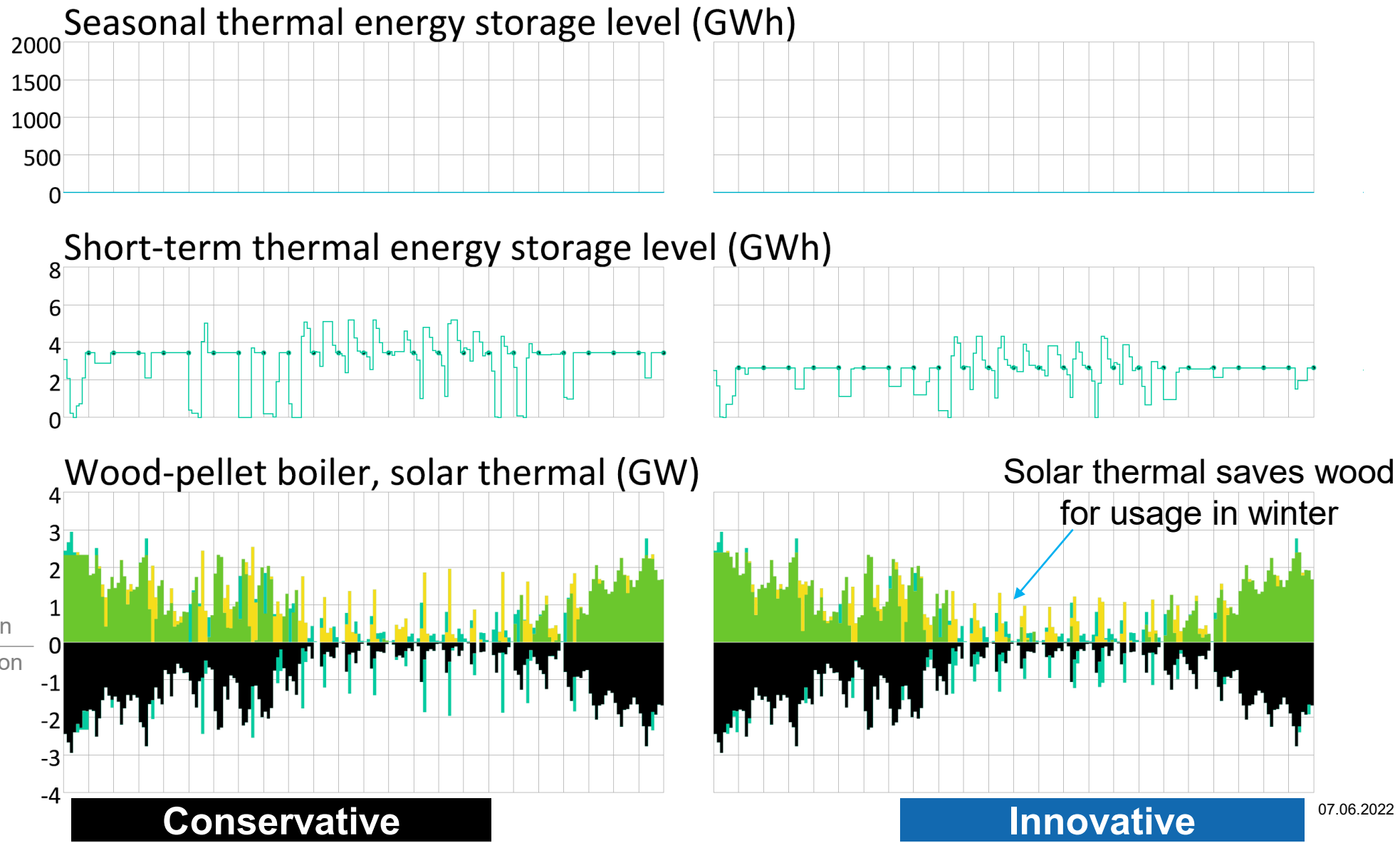


Use in industrial processes depends strongly on other drivers

Stable contribution for space heat and DHW in residential sector

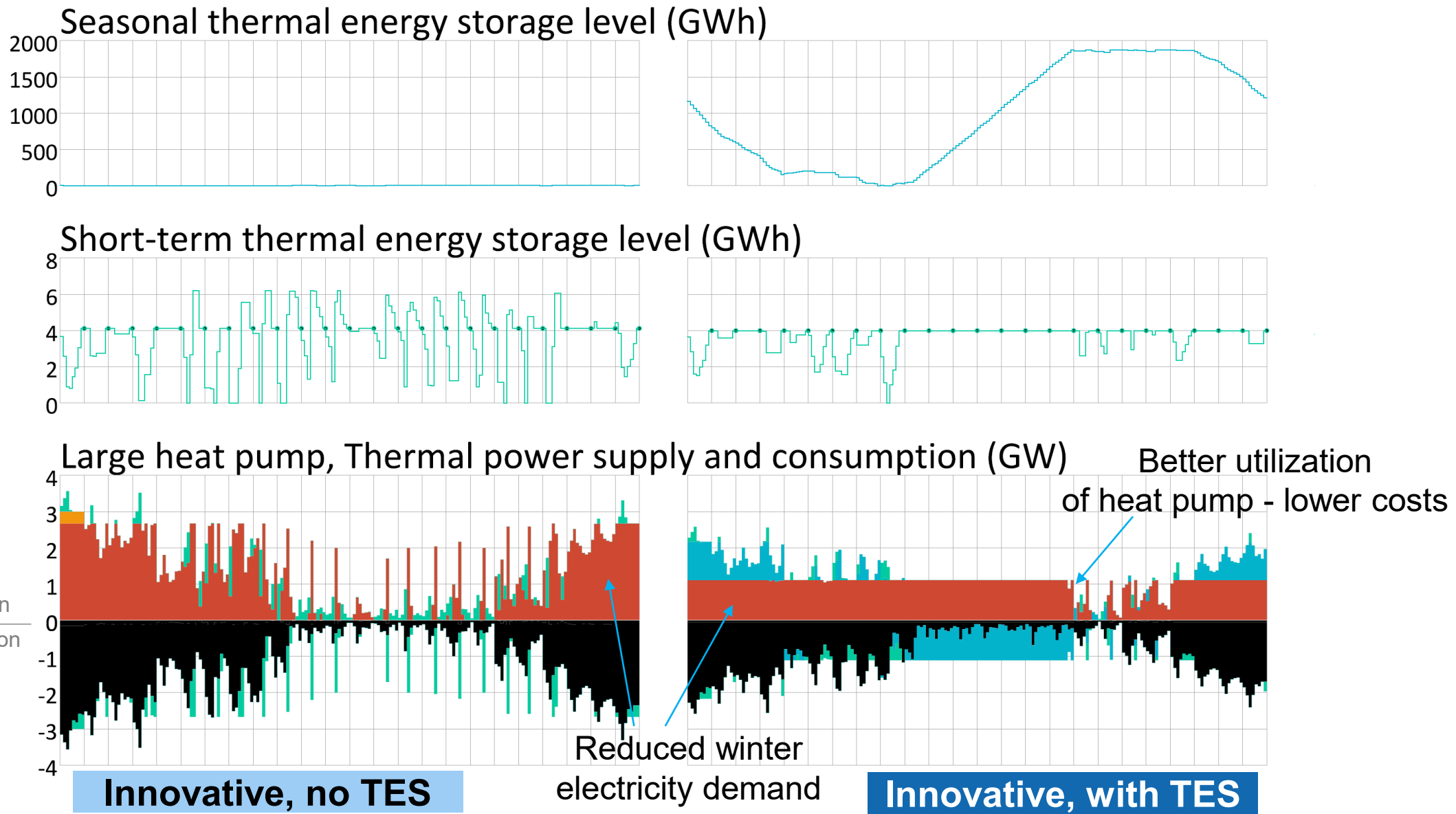
Example: Wood pellet boiler with solar thermal

Target year 2050, 24 typical days, net-zero scenario at –6 Mt_{CO2}/a



Example: large heat pump connected to district heating network

Target year 2050, 24 typical days, net-zero scenario at –6 Mt_{CO2}/a



Conclusions

- Solar thermal energy may seem to be an „old-fashioned“ technology – but is has its place in a future net-zero energy system
- It is used in combination with other technologies, saving valuable resources such as wood or gas
- The use in industrial processes is subject to drivers such as the availability of seasonal thermal energy storage and geothermal energy
- Large scale seasonal thermal energy storage is very interesting to be applied in combination with large heat pumps – it can improve the economics of the heat pumps and reduce winter electricity demand
- Other applications are in waste-to-energy plants
- Having solar thermal and seasonal thermal energy storage available can reduce the total annual system costs by a few 100 mio CHF

ETH zürich

Dr. Gianfranco Guidati
Projektmanager
Gianfranco.guidati@esc.ethz.ch

ETH Zürich
Energy Science Center
Sonneggstrasse 28
8093 Zürich

www.esc.ethz.ch