Power-to-hydrogen for field operations on farm

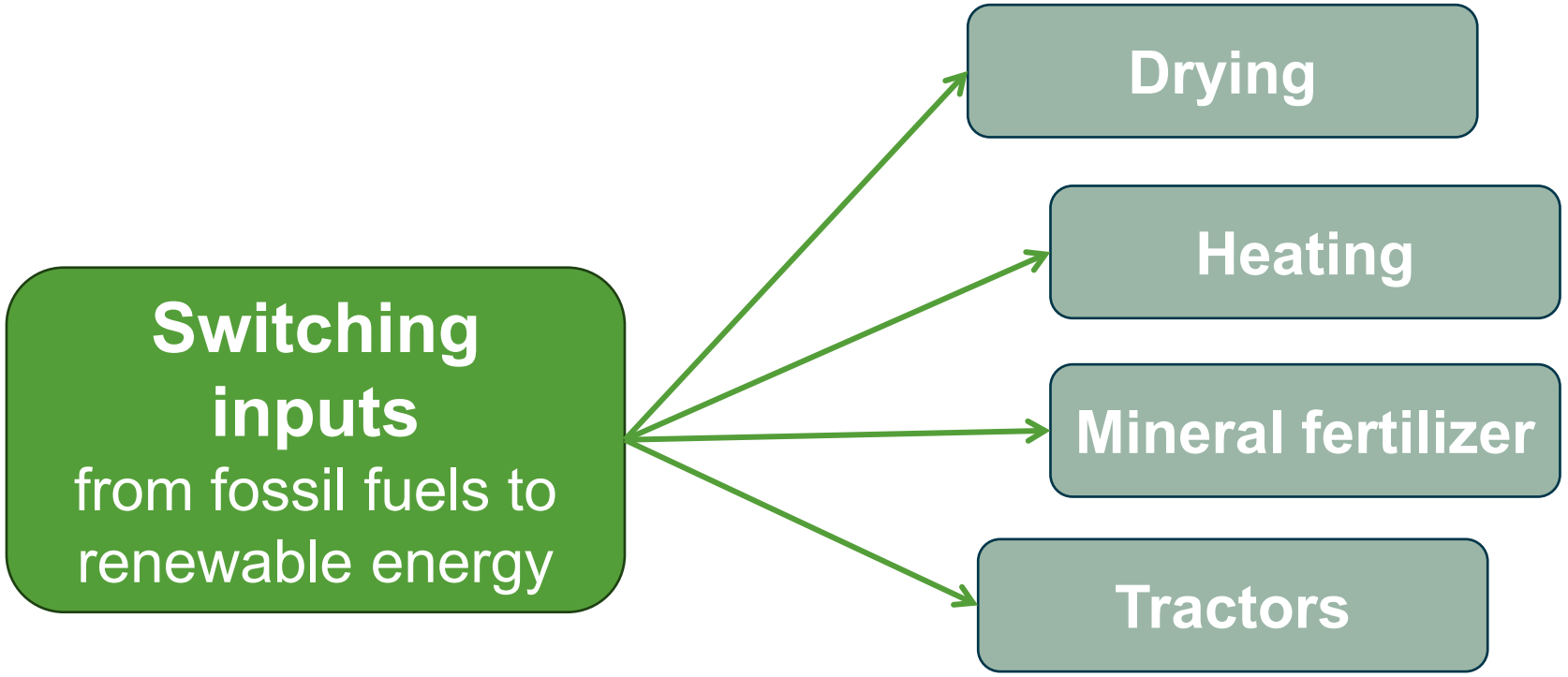
Authors: Ashkan Tayebi, Linus Engstam, Gunnar Larsson, Åke Nordberg, Per-Anders Hansson

STandUPforENERGY

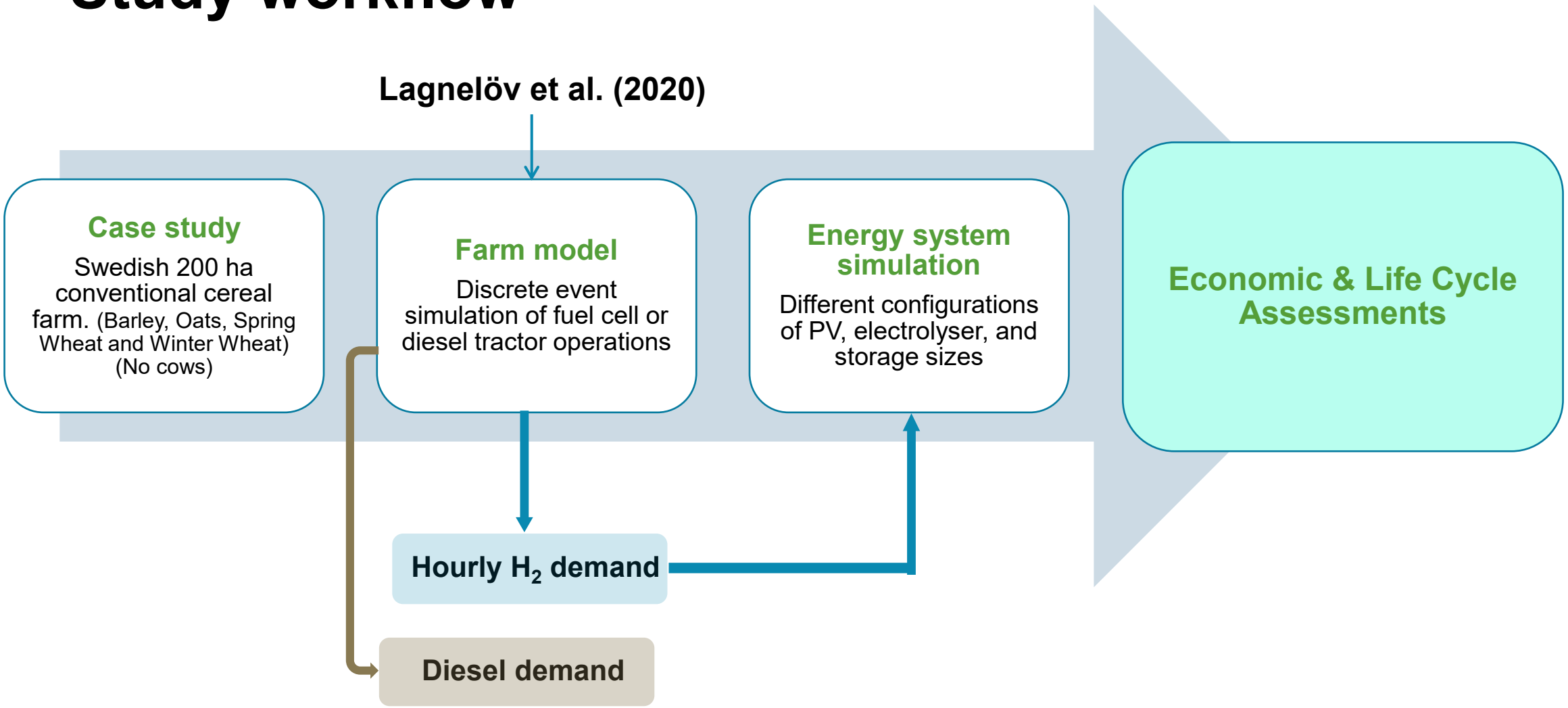
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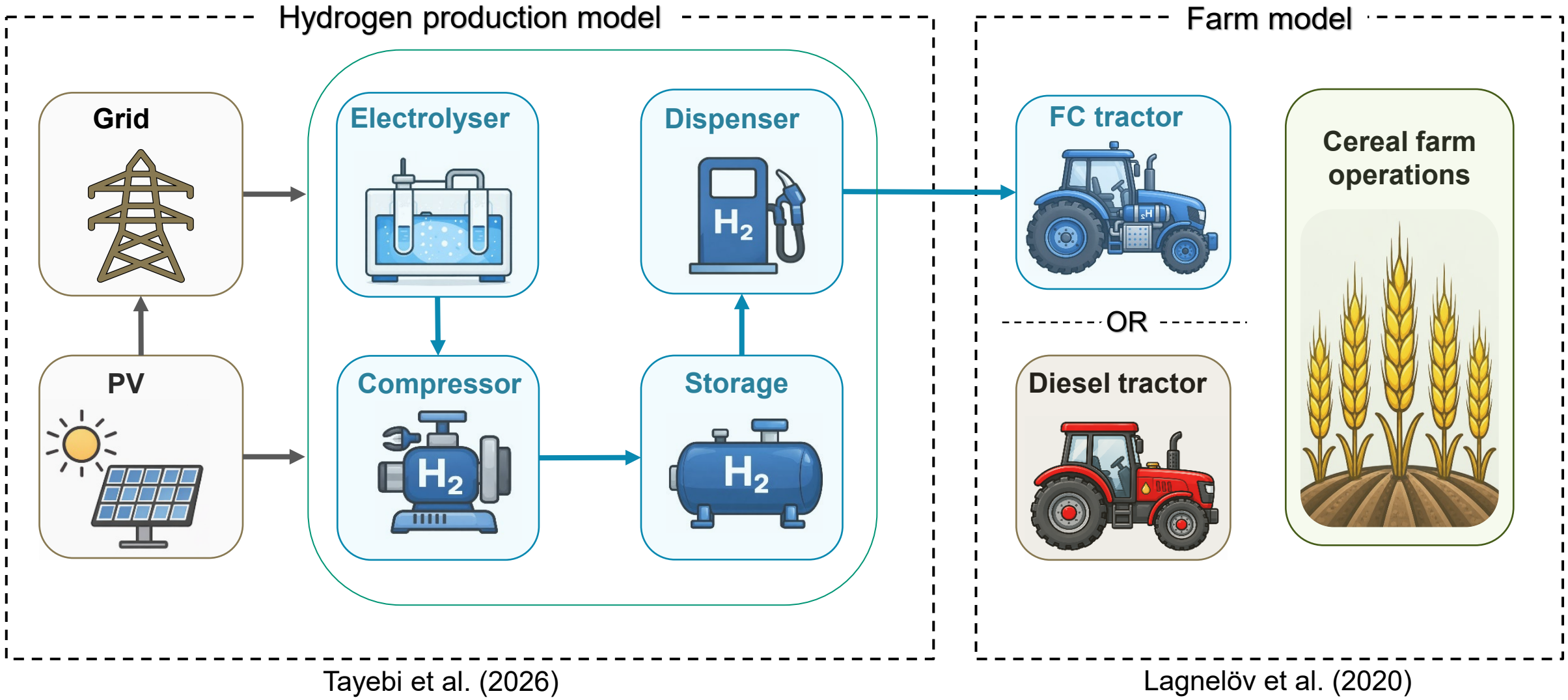
Background

- Organic farming
- Peak Oil
- Climate change
- Energy security



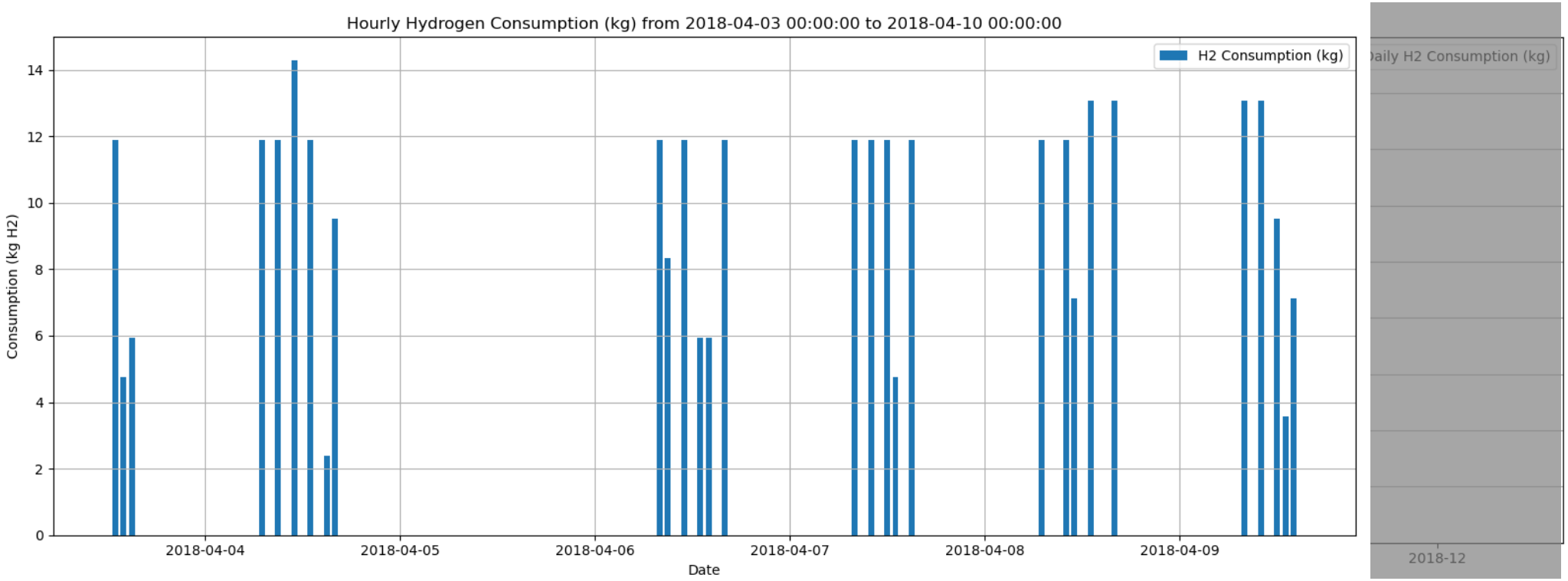
Study workflow



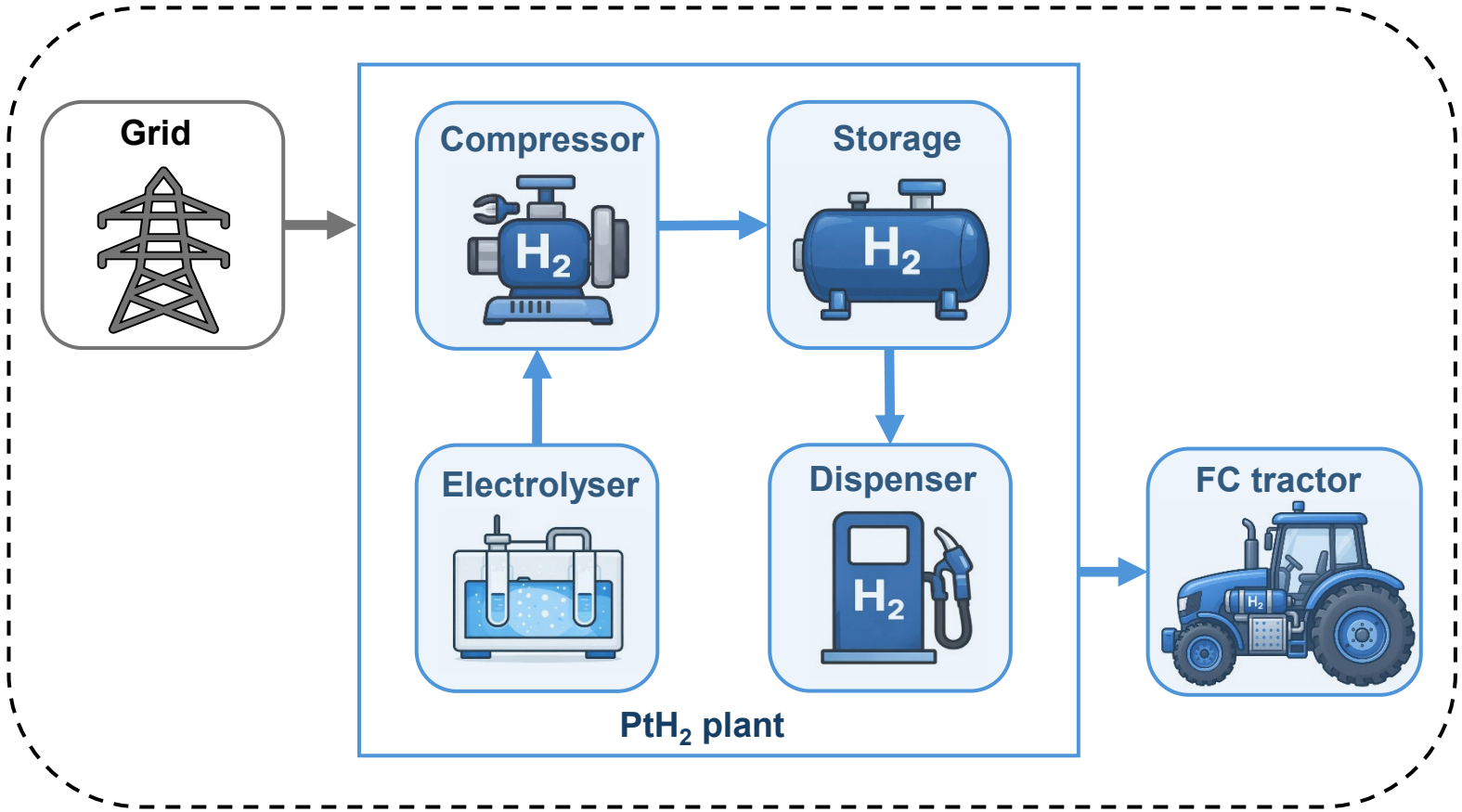

Hydrogen production model
Farm model
Grid
PV
Electrolyser
Compressor
Storage
Dispenser
H_2
H_2
H_2
FC tractor
OR
Diesel tractor
Cereal farm operations
Tayebi et al. (2026)
Lagnelöv et al. (2020)
H_2 flow
Electricity flow

Farm model: Energy demand of the farm

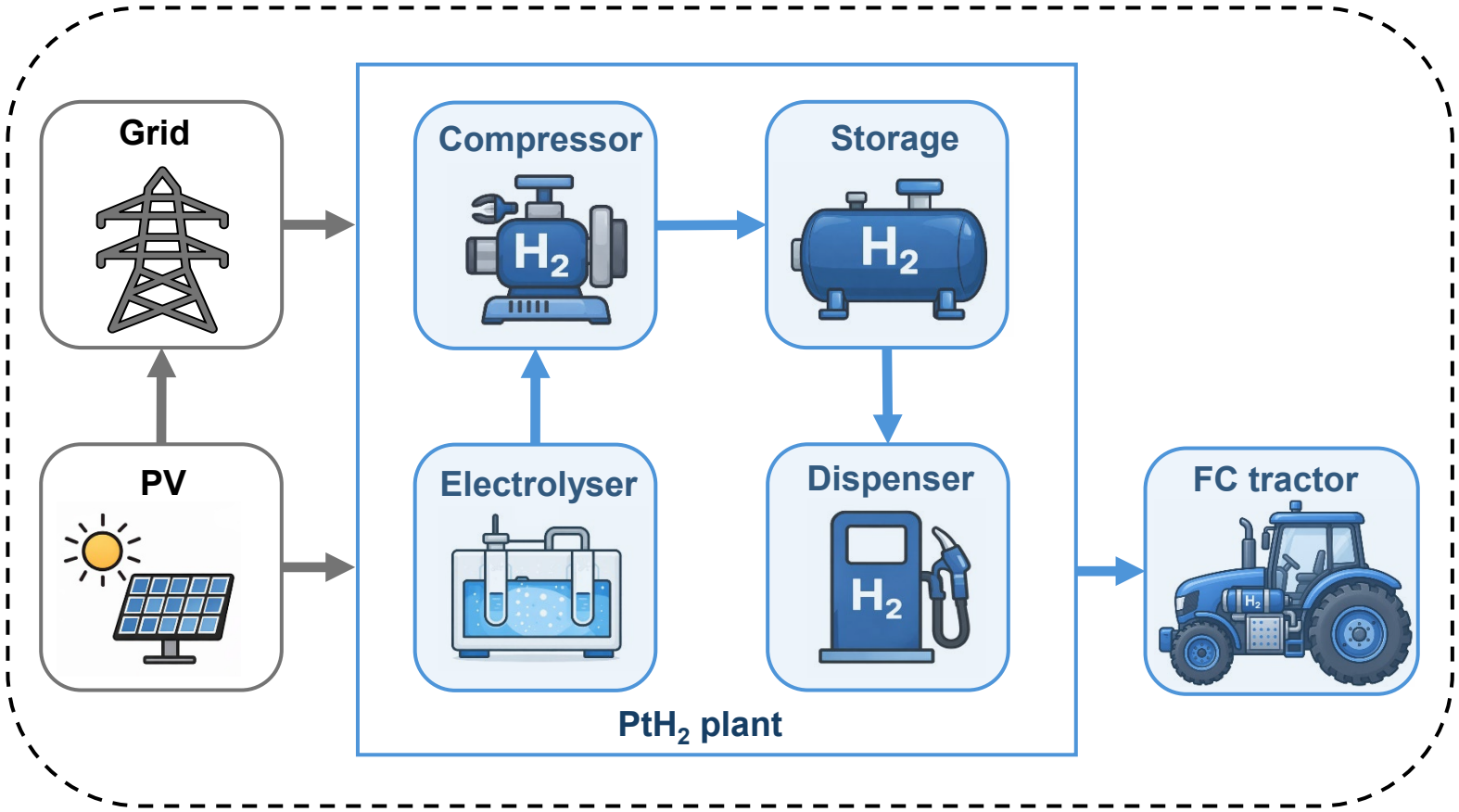
Fuel	Average annual demand	
Diesel	18774 liters	187 MWh
Hydrogen	3430 kg	113 MWh



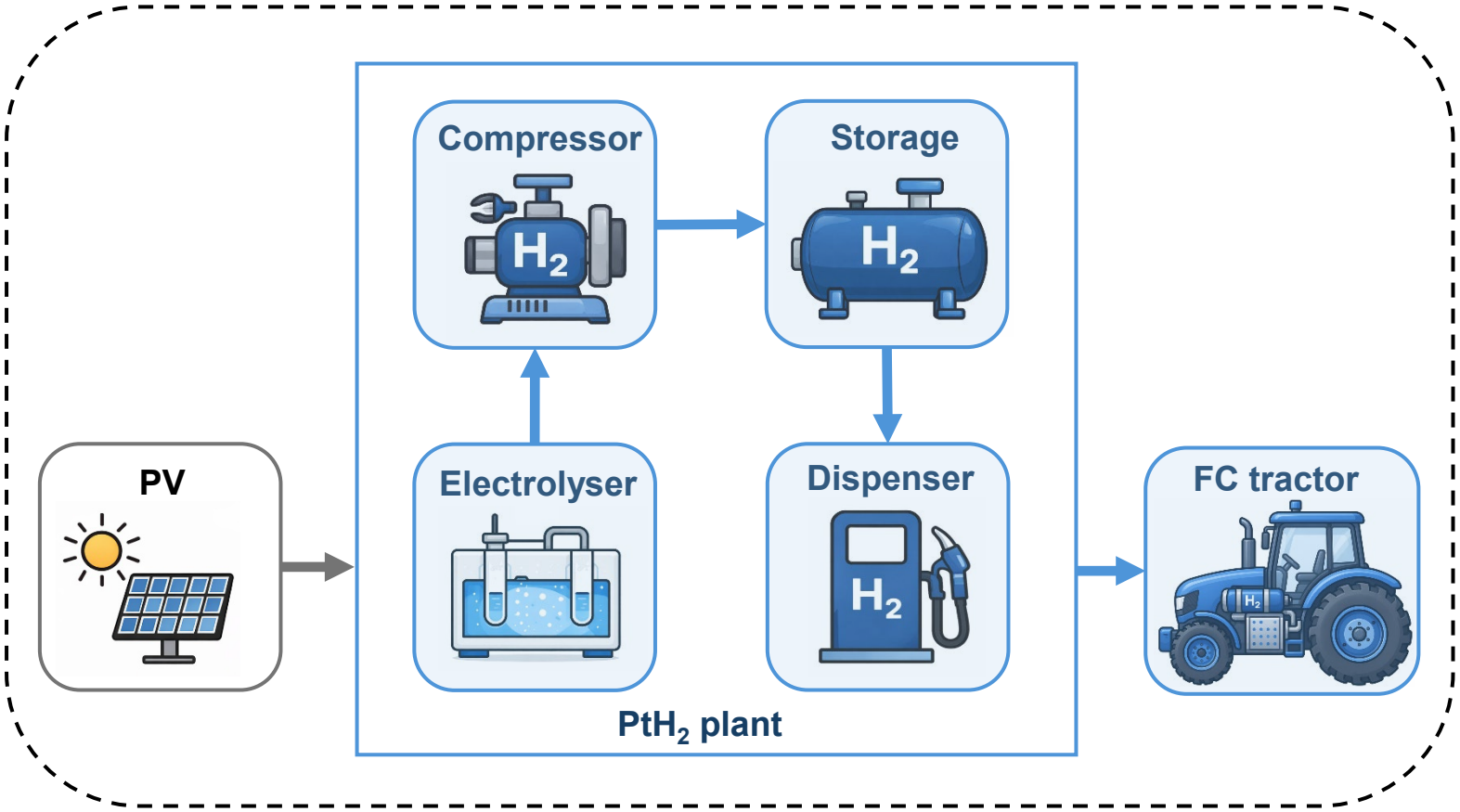
Grid Supply


Grid
Compressor
H_2
Storage
H_2
Electrolyser
Dispenser
H_2
FC tractor
PtH_2 plant

Balanced Supply



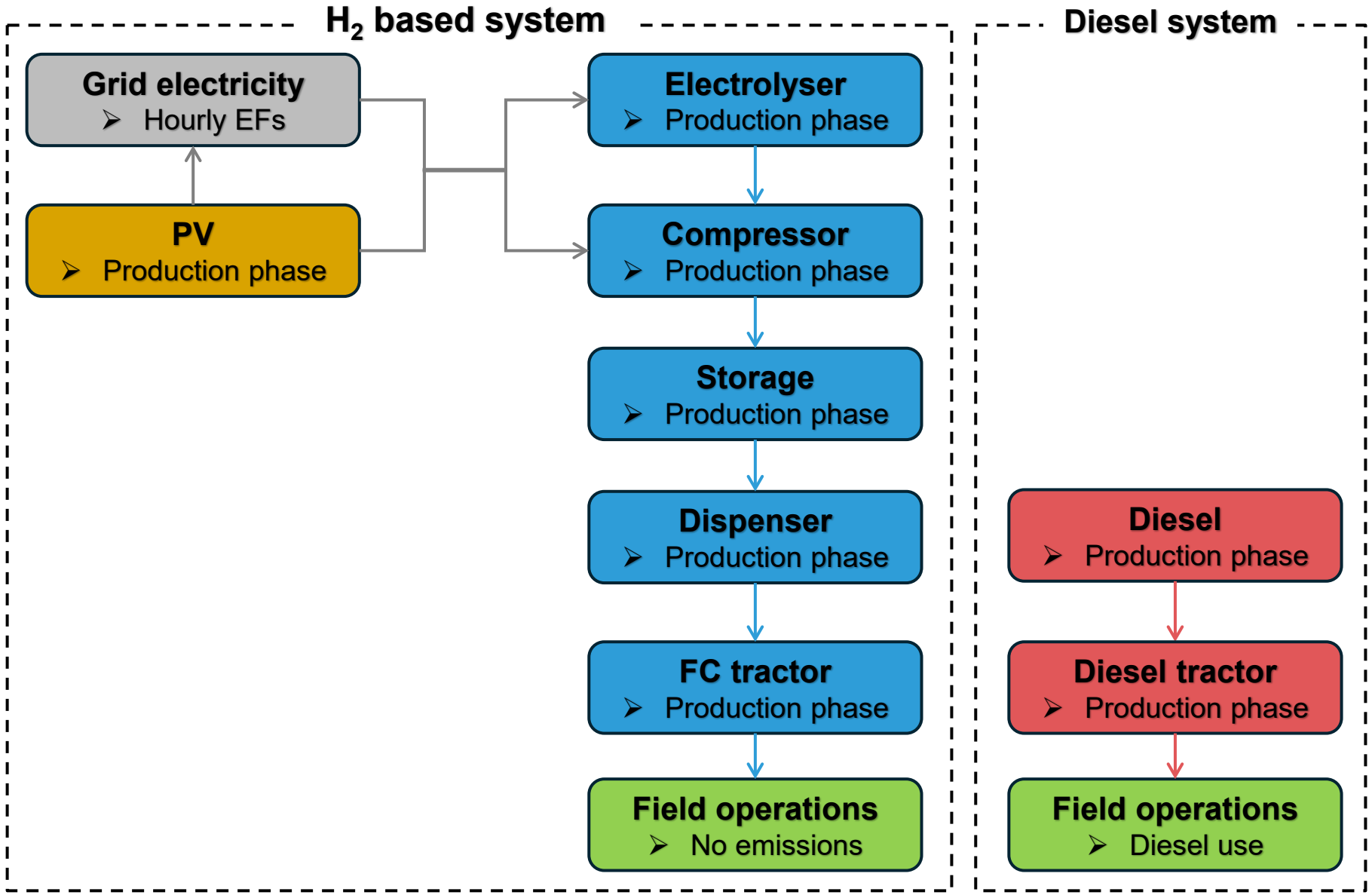
Island Operation



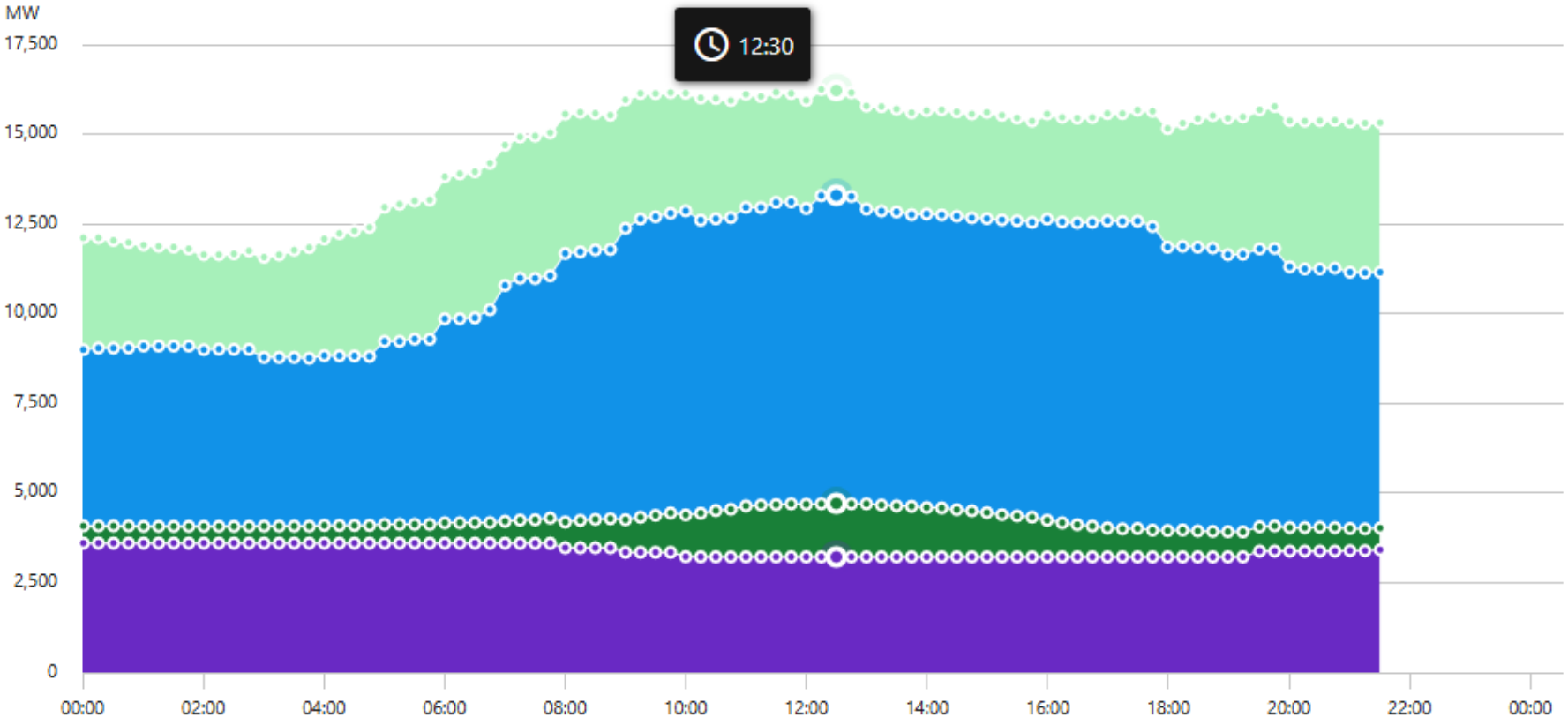
Climate impact of different scenarios

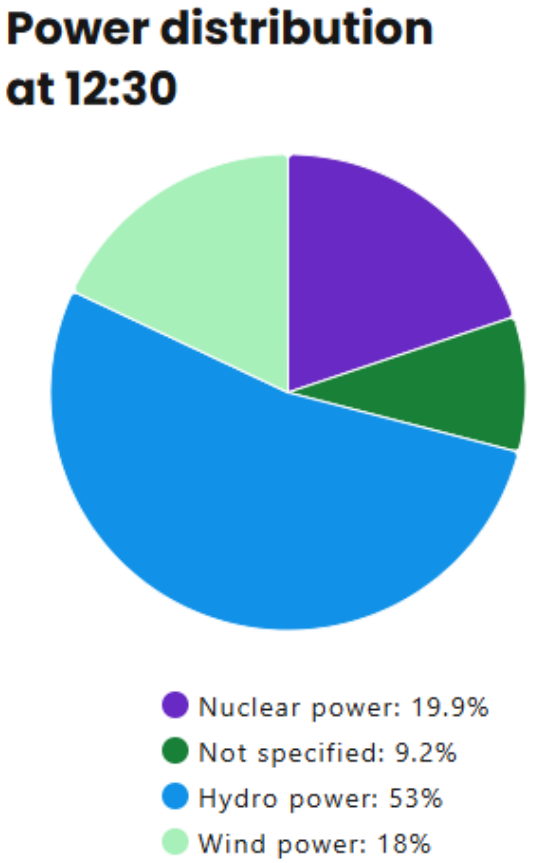
System boundary:

- Production phase
  - All the equipment
- Use phase
  - Grid electricity
  - Surplus PV electricity
  - Diesel



Average generation in the Swedish power system

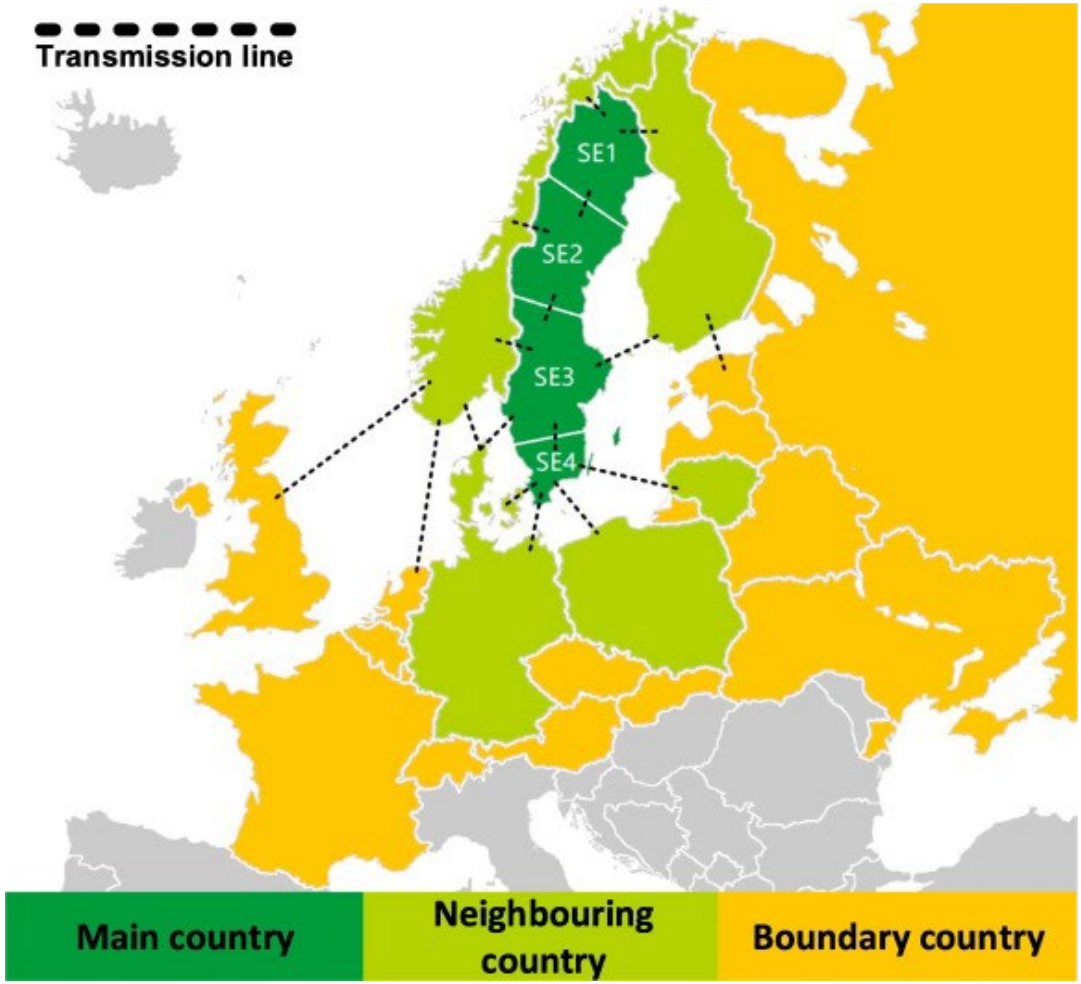




Source: Svenska Kraftnät

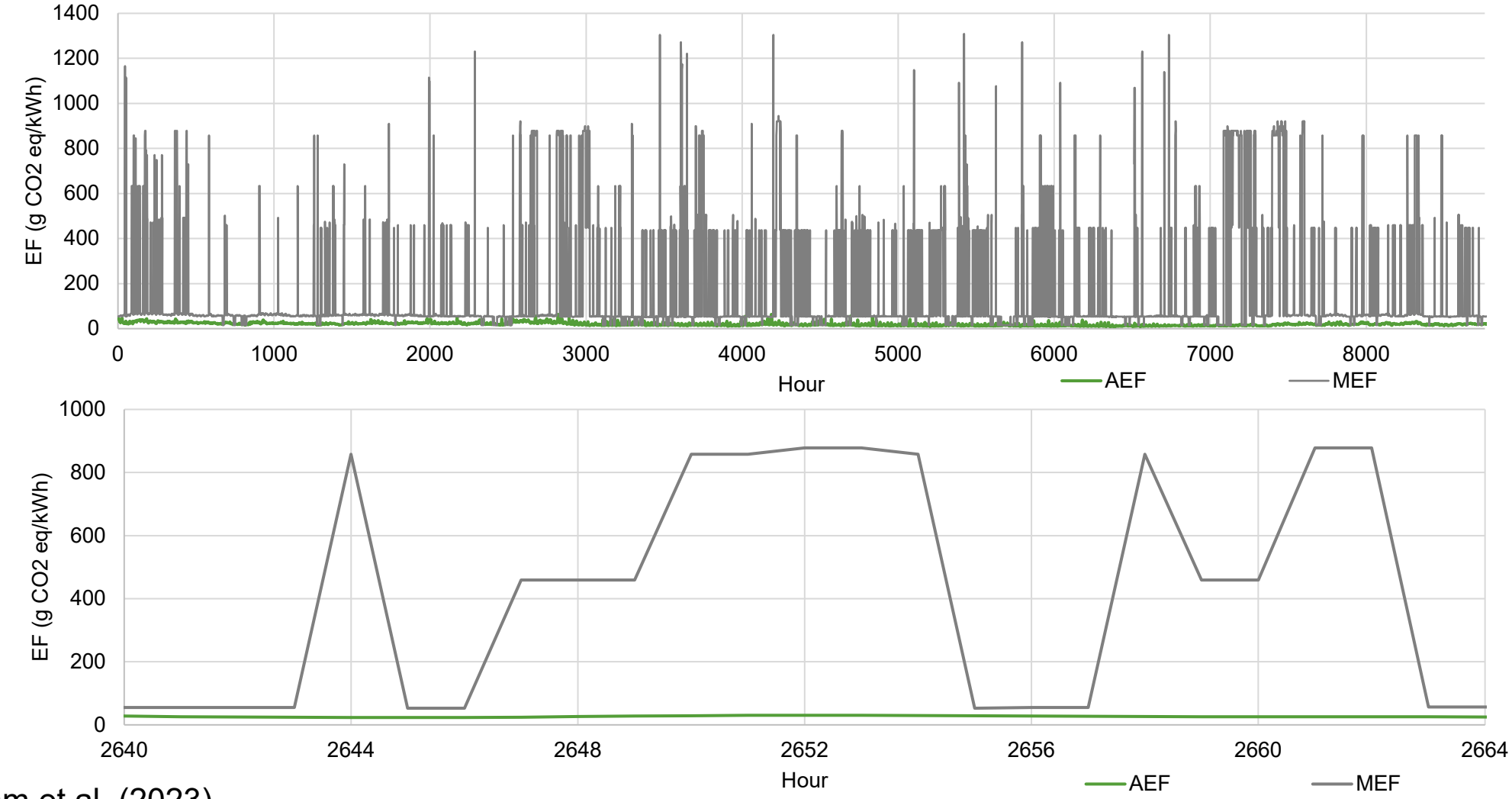
Marginal generation in the Swedish power system

Technology	Carbon intensities [gCO_2eq/kWh]	Marginal technology
Wind	13.3 - 20	If price < 0
Solar PV	83 - 118	No
Hydro	4.4 - 51.4	No
Nuclear	4.4 - 12.9	Germany only
Biomass	46.7 - 63.7	Denmark only
Waste	367	No
Gas (open cycle)	565.5 - 733.1	Yes
Gas (combined cycle)	410.5 - 473.1	Yes
Lignite	906.1 - 1257.8	Yes
Hard coal	826.7 - 1114.0	Yes
Oil	783.1 - 958.9	Yes



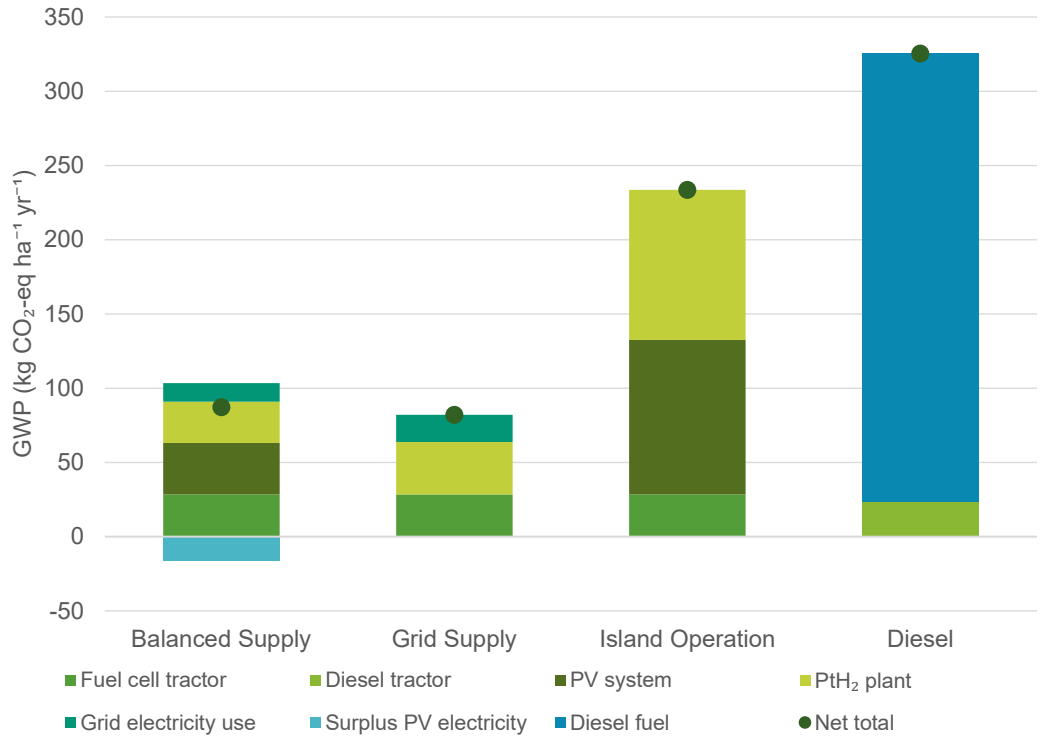
Engstam et al. (2023)

Grid electricity: Marginal vs. Average emission factors

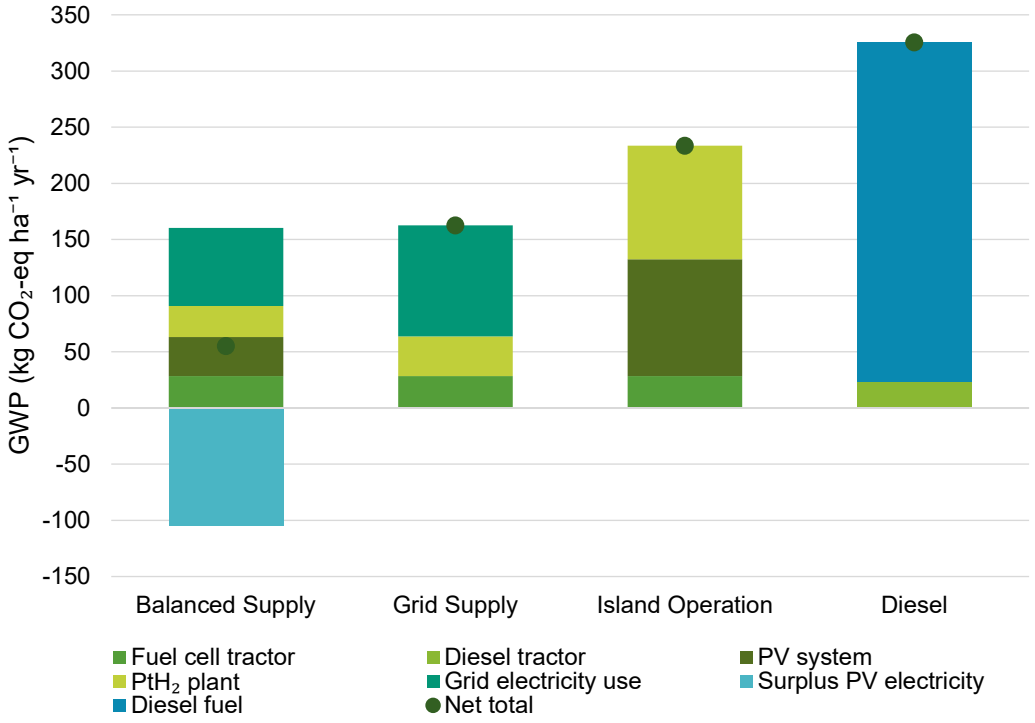


Engstam et al. (2023)

GWP of main scenarios (kg CO_2-eq ha^{-1} yr^{-1})



GWP using AEFs



GWP using MEFs


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