Climate Recon 2050:
Dialogues on Pathways and Policy

Lukas Emele, Oeko-Institut

Negative emissions in long-term climate scenarios

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DTU Technical University of Denmark

ENEA Agenzia nazionale per le nuove tecnologie, l'energia e lo sviluppo economico sostenibile

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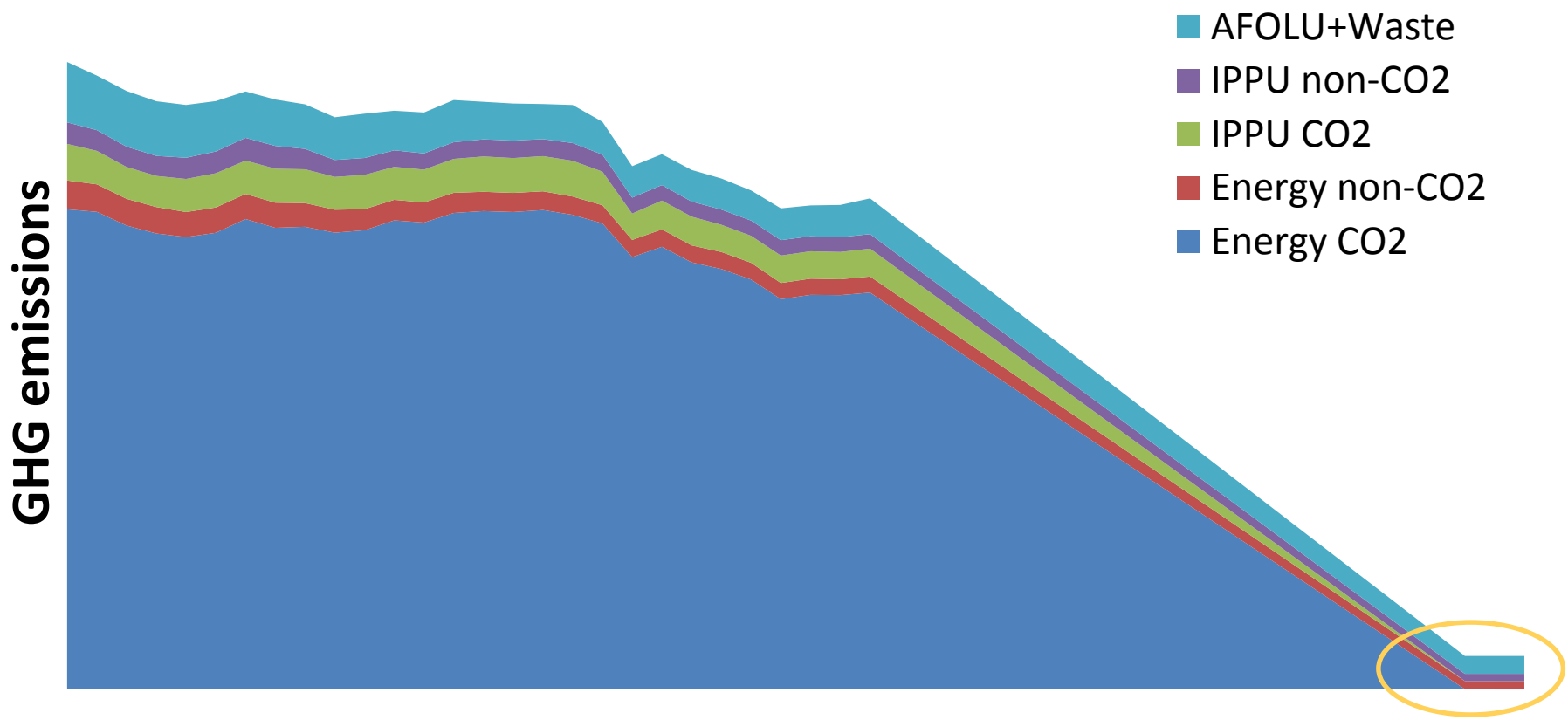
1. Why at we talking about negative emissions all?



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2. Proposed negative emission technologies

NATURAL
FORESTRY / AGRICULTRUE

Afforestation/ Reforestation

Tree growth takes up CO_2 from the atmosphere

Biochar

Partly burnt biomass is added to soil absorbing additional CO_2

Soil carbon sequestration

Land management changes increase the soil carbon content, resulting in a net removal of CO_2 from the atmosphere

Other land-use/ Wetlands

Restoration or construction of high carbon density, anaerobic ecosystems

COMBINED
NATURAL + TECHNOLOGICAL

Bioenergy with Carbon Capture and Storage (BECCS)

Plants turn CO_2 into biomass that fuels energy systems; CO_2 from conversion is stored underground.

TECHNOLOGICAL
ENERGY / INDUSTRY

Accelerated Weathering

Natural minerals react with CO_2 and bind them in new minerals.

Direct Air Capture

CO_2 is removed from ambient air and stored underground.

Ocean Alkalinity Enhancement

Alkaline materials are added to the ocean to enhance atmospheric drawdown and negate acidification

CO_2 to durable carbon

CO_2 is removed from the atmosphere and bound in long-lived materials

Source: UNEP Emissions Gap Report 2017 https://www.unenvironment.org/ar/node/18308

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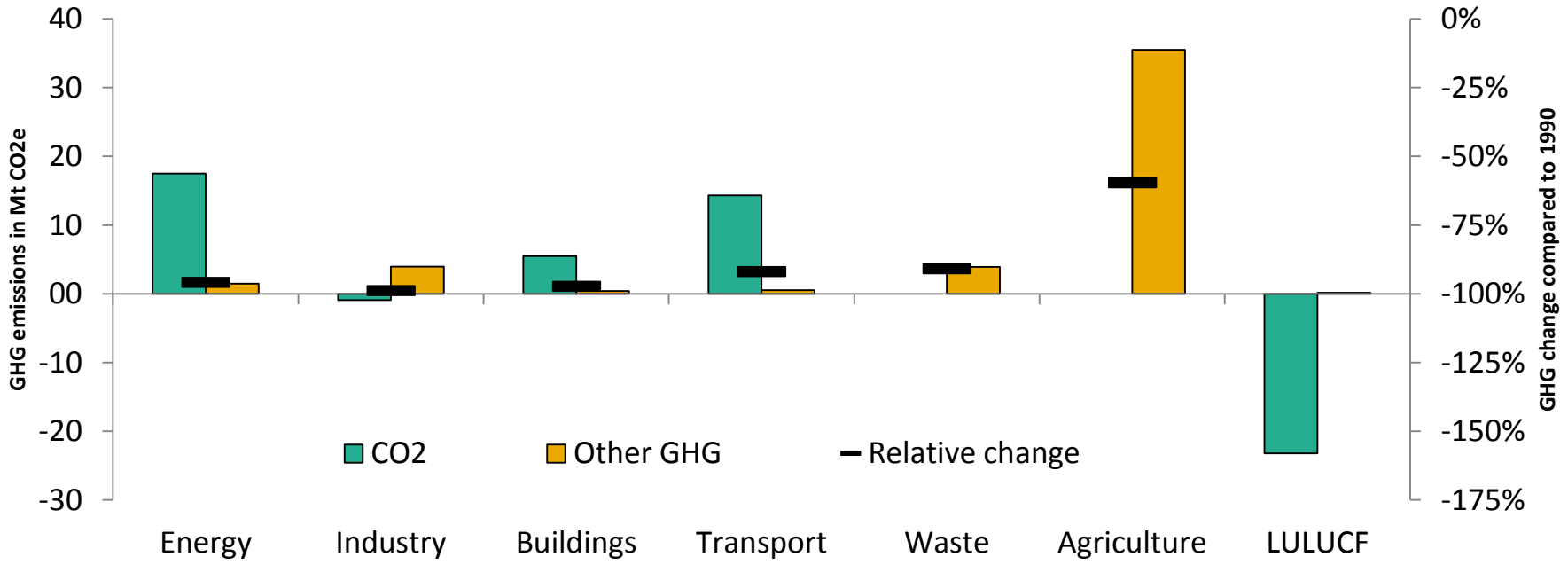
3. Net emissions per sector in a German scenario



- GHG emission reduction potential differs significantly between different sectors
- Almost CO_2 neutral, most net emissions are from non-CO_2 gases
- More than half of remaining emissions from agriculture

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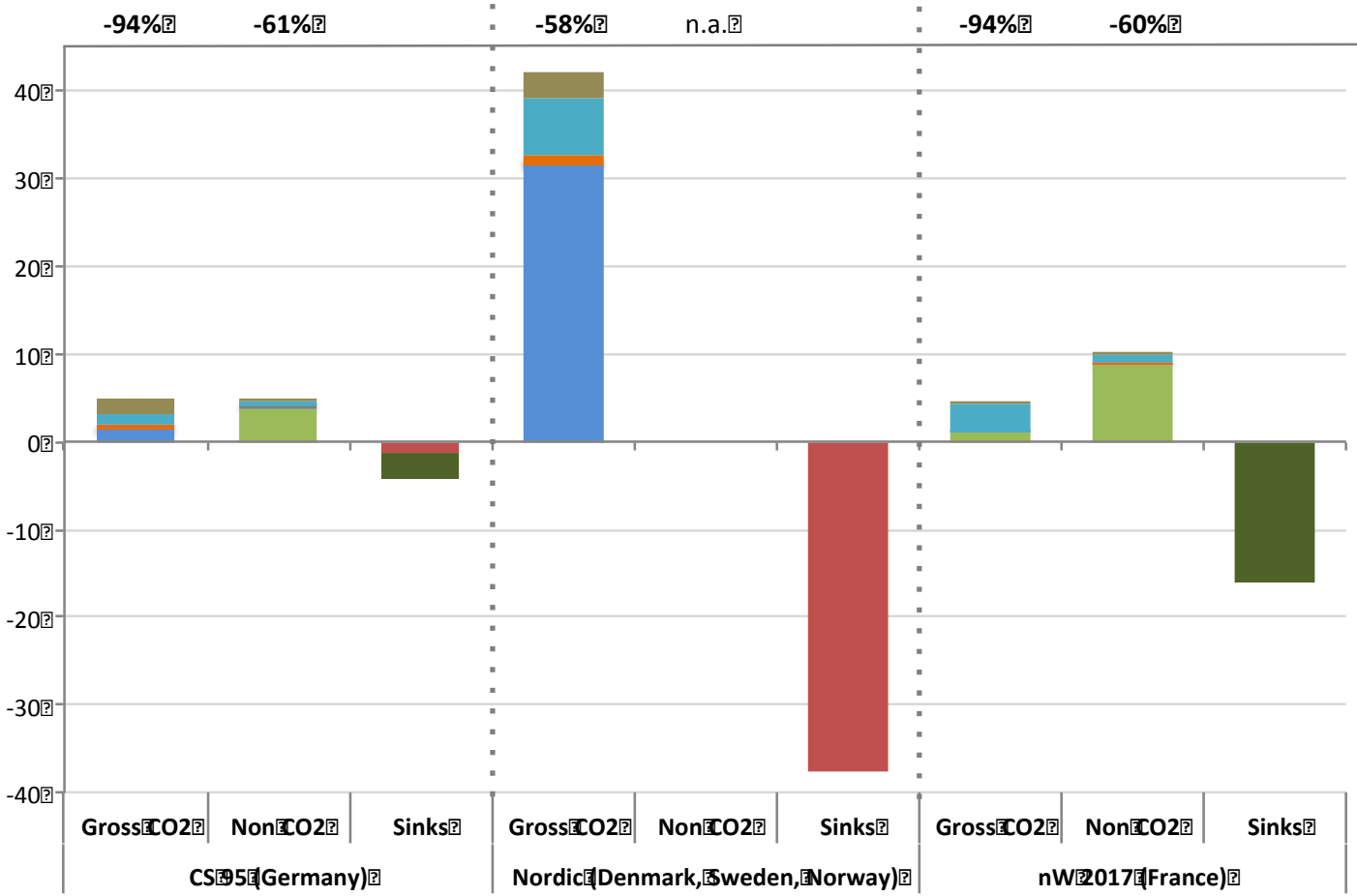
4. Emissions and sinks in national and regional scenarios



Gross CO2, non CO2 emissions & sinks in (almost) neutral year 2050, indexed to gross GHG emissions of the historic year of reference*

- Energy industries incl. fugitive emissions
- Industry incl. process emissions
- Buildings
- Transport incl. international air and maritime
- Waste**
- Agriculture***
- LULUCF (Sink)
- BECCS

*For Nordic, gross CO2 emissions only. The historic reference year is respectively: 2010 (CS95, Nordic), 2015 (nW2017).
**For Nordic, included in energy industries.
***For Nordic, included in industry.

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5. Bio-energy with carbon capture and storage (BECCS)

- **Needs large bioenergy potentials**
  - Either: Sparsely populated countries (e.g. Scandinavia)
  - Or: Large bioenergy imports

- **Strongly interacts with other assumptions in the energy system**
  - BECCS is stationary technology → not useful if bioenergy is allocated mainly in the transport sector
  - Can lower the pressure for renewable energy and energy efficiency

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6. LULUCF sinks

- **More than simply planting trees**
  - Afforestation and reforestation
  - Protection and improvement of soils
- **Strongly interacts with agriculture strategy**
  - Reduced animal numbers → new areas available
  - Agricultural soil can become a carbon sink by changing the agricultural practice
- **LULUCF sinks are very important in holistic approaches (i.e. modeling more than just the energy sector)**

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7. Conclusion

- **General setup and perimeter of modeling strongly determines the choice of negative emission options**
  - Many scenarios use only one negative emission option
  - No result of (cost) optimisation:
    Choice between different negative emission options commonly determined by preferences of modelers and/or country-specifics
  - BECCS is often the only negative emission technology in energy-only approaches
- **Different priorities of negative emission options**
  - Either: equal to other measures (renewables, energy efficiency…)
  - Or: measure of last resort → avoid the last few percentage points of GHG reduction