



Universität Stuttgart

IER Institut für Energiewirtschaft
und Rationelle Energieanwendung



**Energy-Water-Land Use
Nexus in Germany:
A case study**

**Vera
Sehn**

1. Introduction

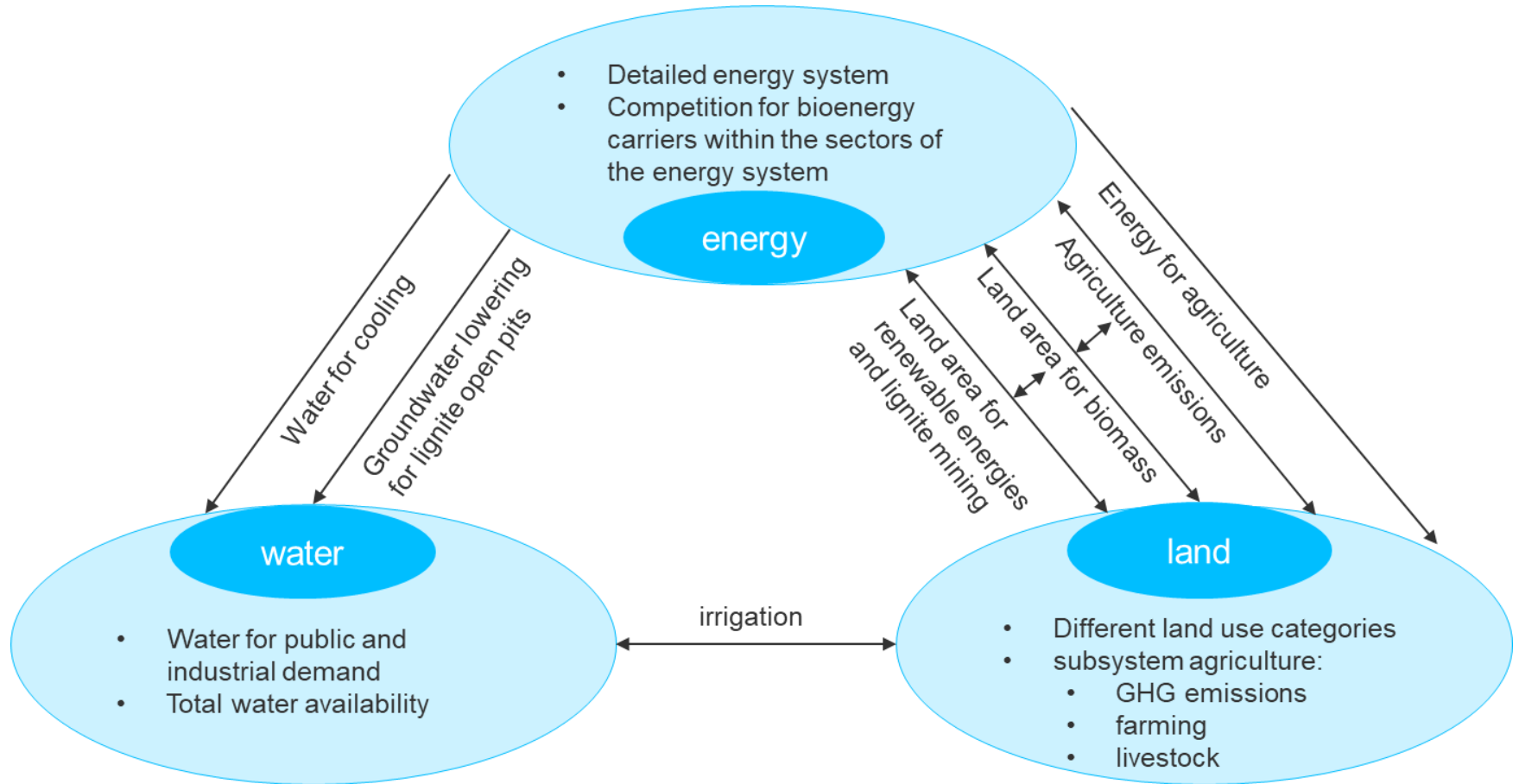
Literature

Previous publications on the Nexus:

- Without methodology:
 - Conceptualization of the energy-water land/food nexus (70% of the 245 articles examined by Albrecht et al. 1))
- With methodology and scenario analysis:
 - Coupling of several sub-models
 - No energy system model with integrated water and land use interactions

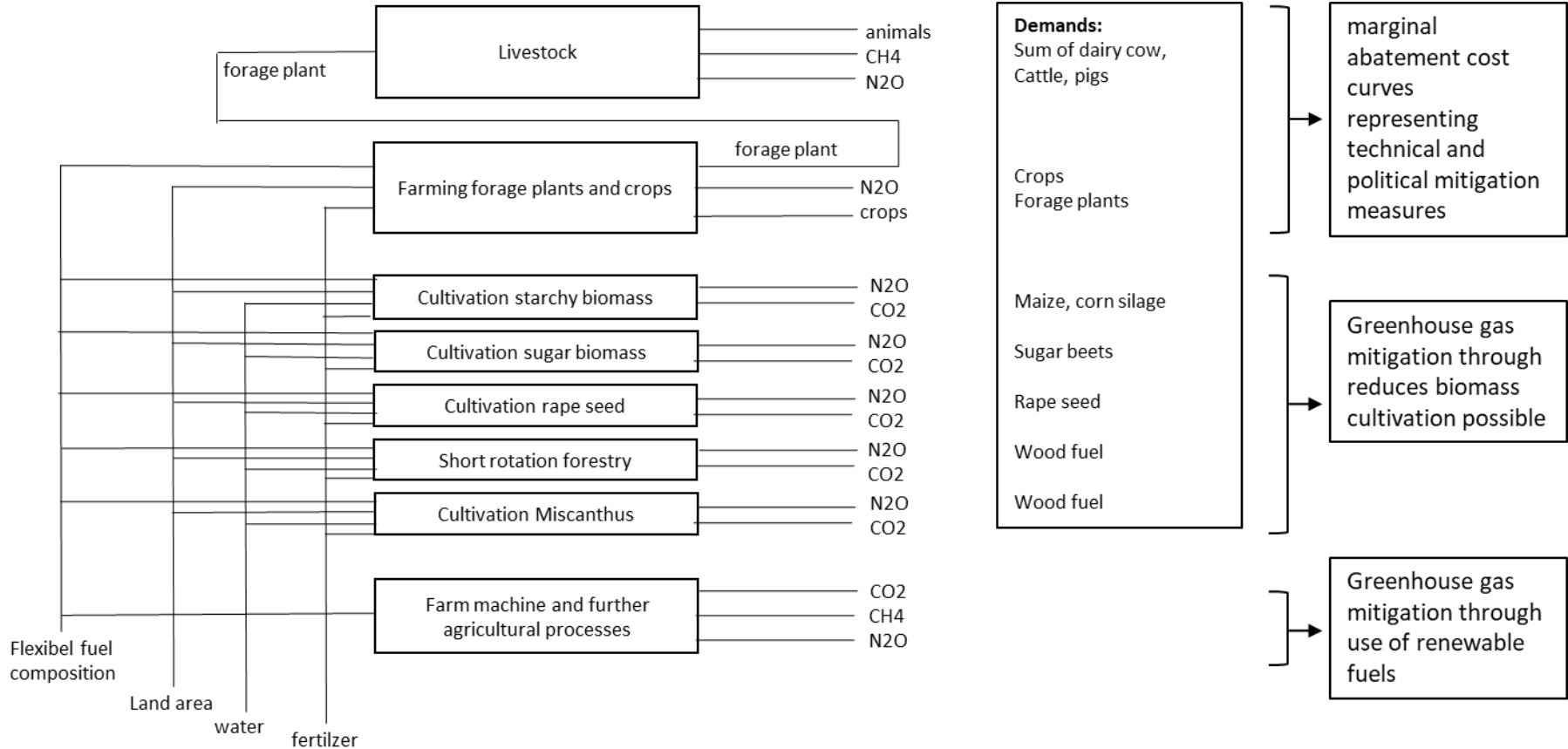
¹ T. R. Albrecht, A. Crootof, and C. A. Scott. 2018: The Water-Energy-Food Nexus : A systematic review of methods for nexus assessment The Water-Energy-Food Nexus : A systematic review of methods for nexus assessment, *Environ. Res. Lett.*.

2. Methodological development in TIMES PanEU



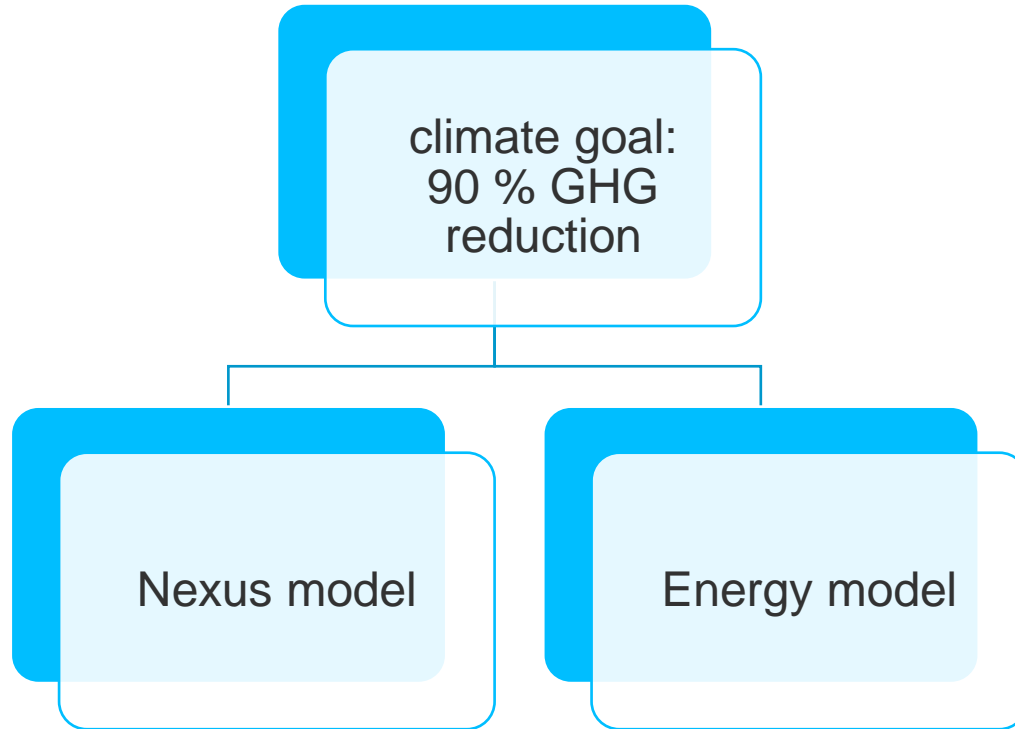
2. Methodological developments

Dissaggrigation of the agricultural sector in TIMES PanEU



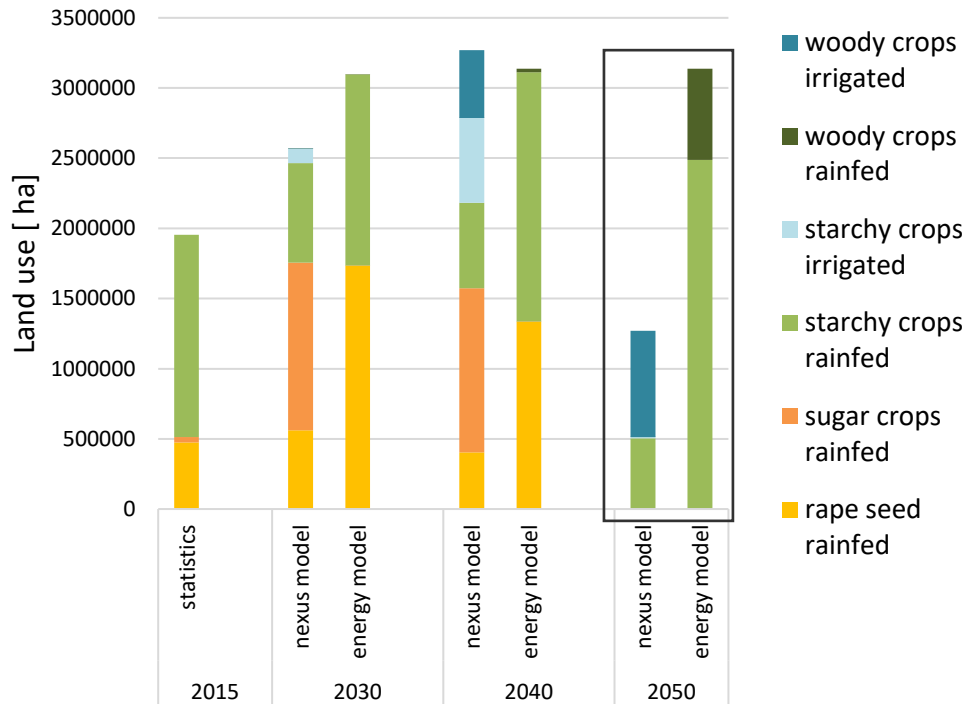
2. Methodological development

Scenario definition



3. Results

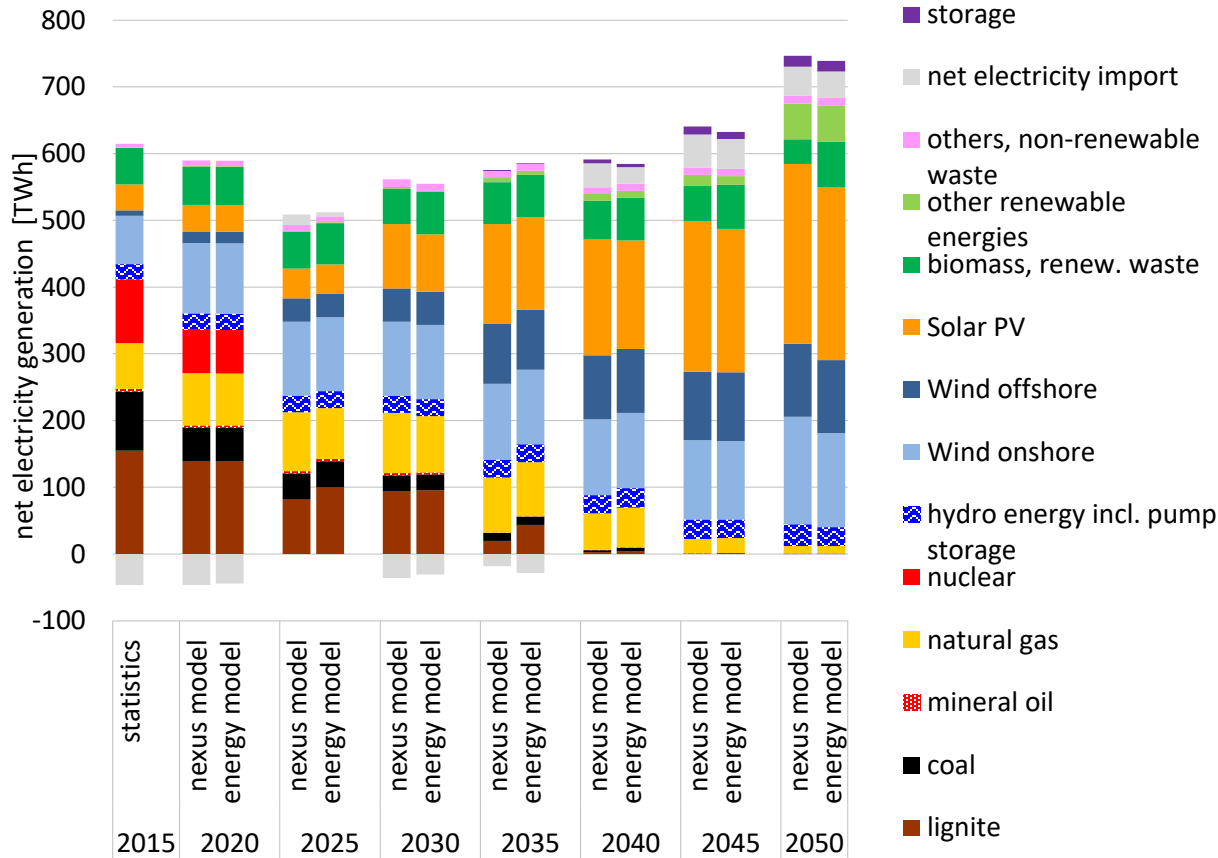
Bioenergy crop cultivation



- **Nexus modelling includes fertilizer emissions → leads to less biomass demand**
- Biomass cultivation potential is not used due to additional nitrous oxide emissions
- Medium-term: sugar beet cultivation involves less specific nitrous oxide emissions than rapeseed cultivation
- Long-term: woody crops favoured biomass type, as there are hardly any specific nitrous oxide emissions
- Irrigation is applied

3. Results

Net electricity generation (public and non public)

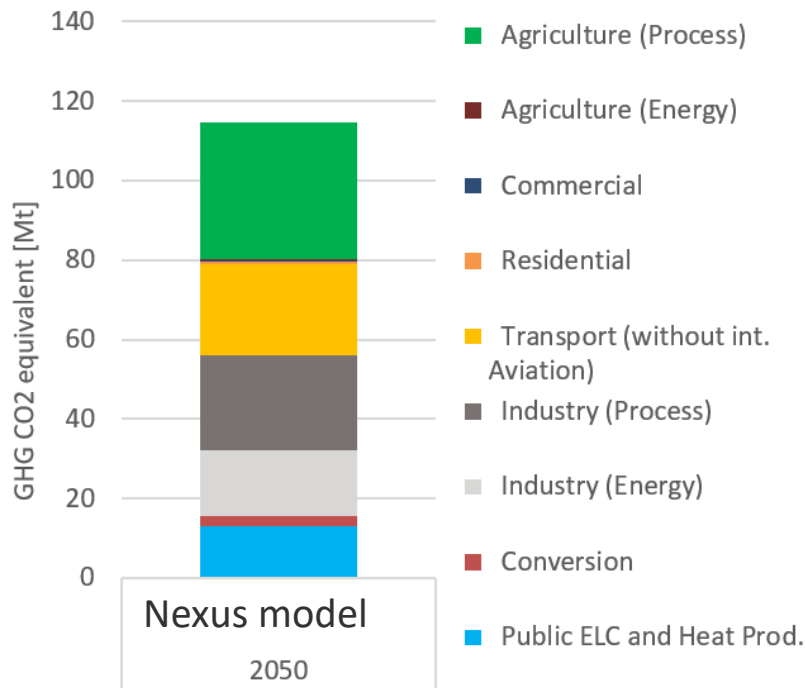


Nexus extensions lead to

- more wind and solar energy use
- less bioenergy use
- slightly faster decarbonization

3. Results

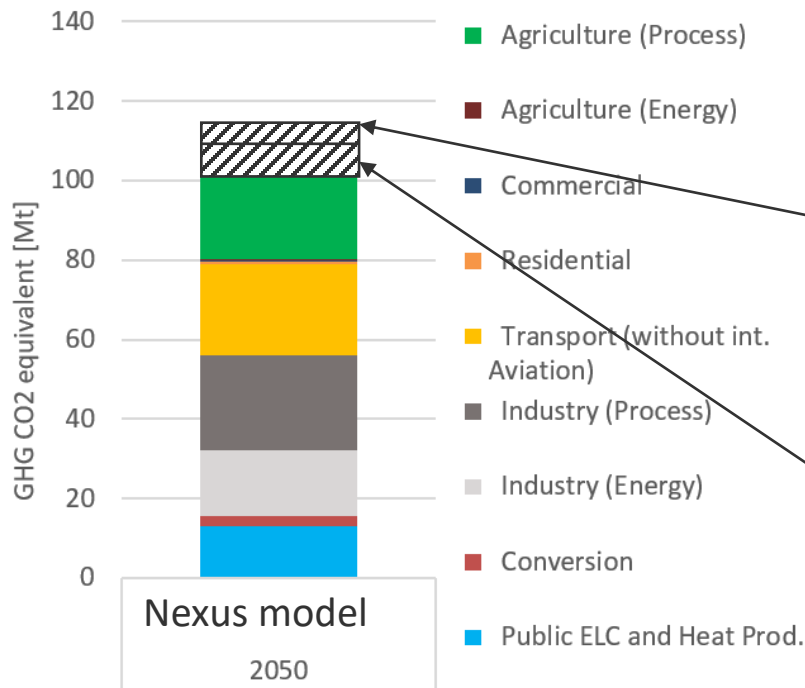
Remaining GHG emissions of all sectors in 2050 (90% GHG reduction, without any CCS or CCU)



- Agricultural sector has the most unavoidable process emissions of the entire energy system
- Further reduction measures through a change in demand are imaginable:

3. Results

Remaining GHG emissions of all sectors in 2050 (90% GHG reduction, without any CCS or CCU)

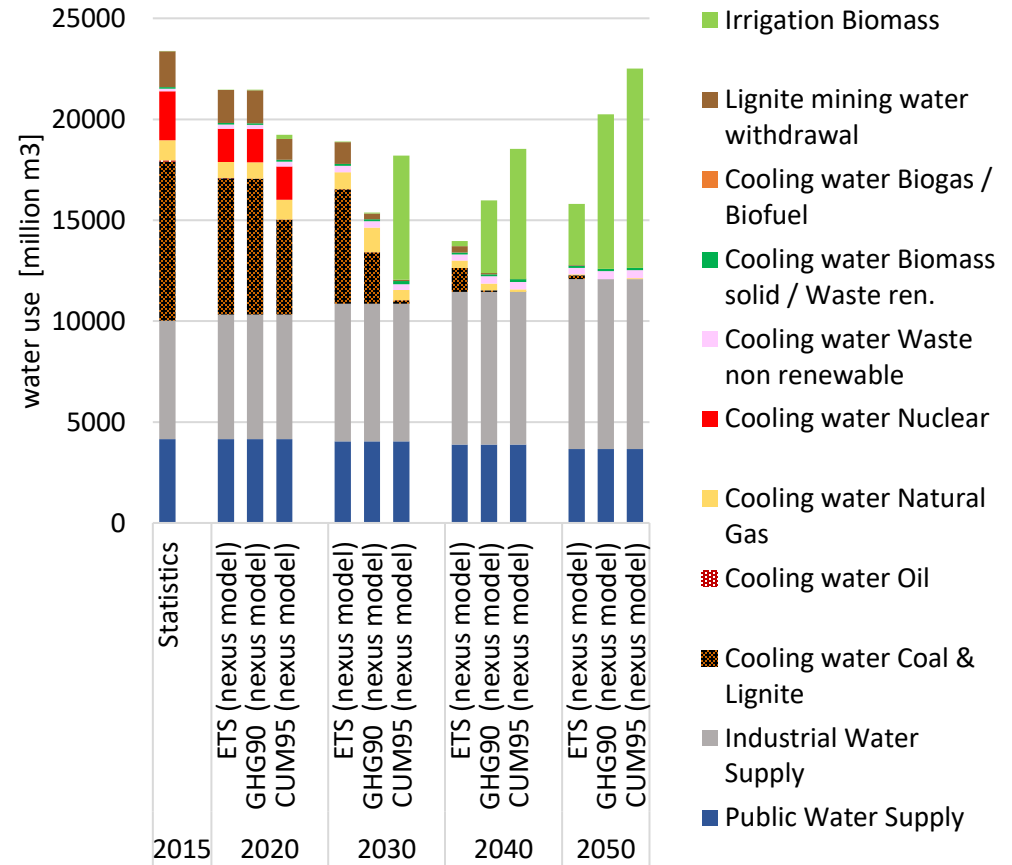


- Agricultural sector has the most unavoidable process emissions of the entire energy system
- Further reduction measures through a change in demand are imaginable:
 - Food waste prevention measure (14 % of the total food demand according to ISWA study) could save 4.5 Mt CO₂-eq and 2.3 million ha of land
 - Meat innovation measure (laboratory meat and innovative alternative products (development according to ATKearney study)) could save 9.1 Mt CO₂-eq and 4.9 million ha of land area

3. Results

Total water demand from all sectors with variation of the climate target

- The stricter the climate target, the more biomass is used and the higher the demand for irrigation water/total water demand
- Measure Water Resource Efficiency: Reuse of waste water for irrigation of woody crops



4. Summary

Water point of view

- The higher the GHG reduction target, the higher the demand for irrigation water/total water demand
- Reuse of waste water for irrigation of woody crops
- Water price is a functional incentive to avoid biomass irrigation in an optimization environment
- Climate change forecasts of water availability vary greatly from region to region

Land use point of view

- Less use of agricultural biomass (due to fertilizer emissions)
- Woody crops future preferred biomass type
- Measures to change the demand for agricultural products could save up to 7 million hectares of land without changing essential nutritional habits
- New potential for renewable energies or GHG sinks? More cooperation between the agricultural and energy sectors

Sources

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Thank you for your attention!



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