LCI of future electricity supply systems

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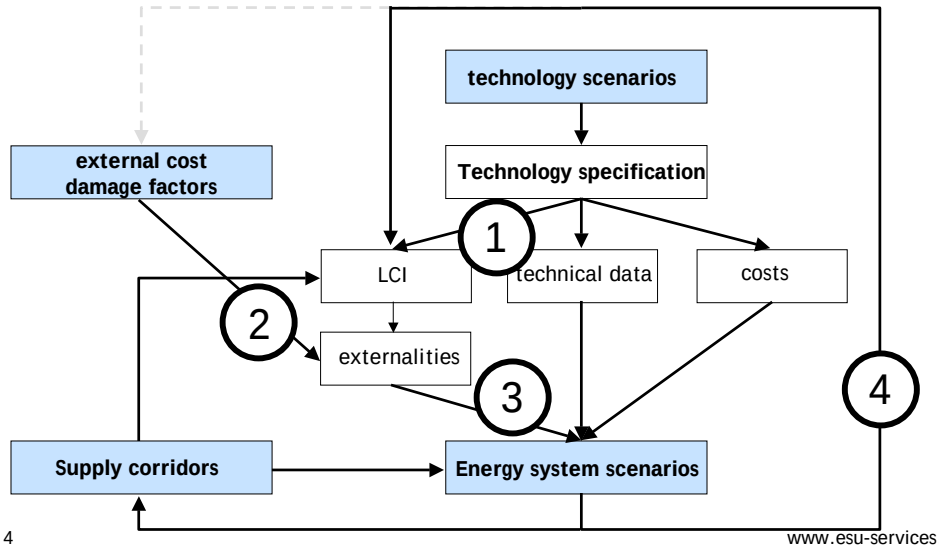
Outline

- The challenge of technology assessment
- Far future LCI modelling
- Results
- Conclusions

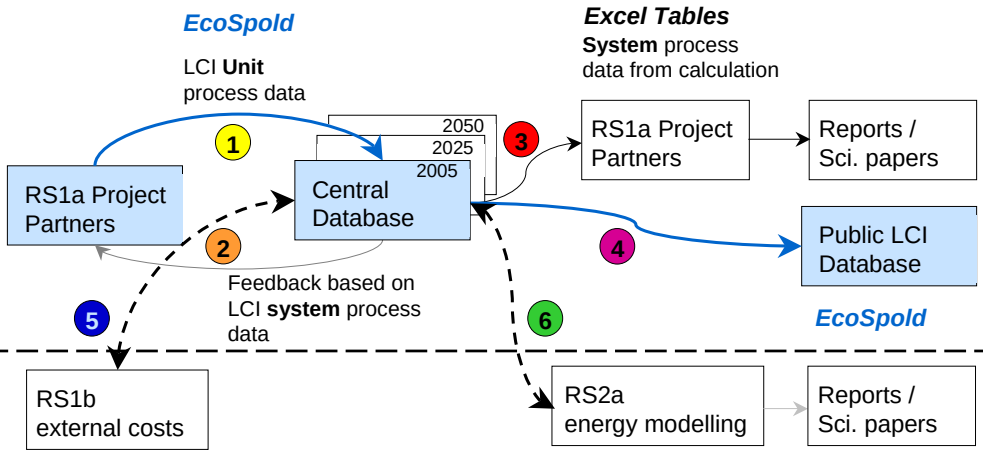
The challenge of technology assessment

- We know the environmental impacts of today's electricity production
- We can quantifiy external costs of pollution
- We can model the optimal energy supply situation in Europe under given constrains
- We have reference LCI data available (e.g. Japanese database or US database)
- How to combine this knowledge for environmental sustainability assessment of the European energy supply?

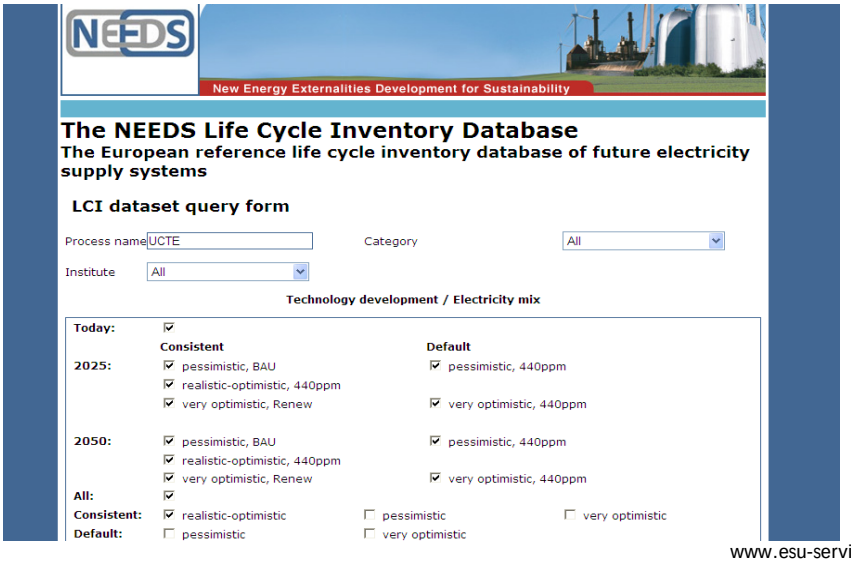
Interactions between the disciplines



Work flow and products



NEEDS LCI database



Advanced Fossil (including CCS)

Fossil fuel power plants:

- Hardcoal (350W / 600MW / 900MW)
- Lignite (950MW)
- Natural gas (50MW / 500MW)

Carbon **C**apture and **S**torage **(CCS):**

- Capture: post-combustion and oxy-fuel combustion processes
- Storage: in depleted gasfields or aquifer, different transport-distances (200km / 400km)

Photovoltaic

c-Si technologies

- sc-Si (plant size / integrated roof)
- c-Si ribbon (plant size / integrated roof)

Thin films

- Cadmium Telluride (CdTe)

New concept devices

- GaInP/GaAs Concentrators

Conditions and scope

- Southern Europe vs. Central Europe
- Includes the **B**alance of **S**ystem (e.g. converter, standing, cable, etc.)

DONG energy

Wind offshore

Capacity

- today: 2 MW
- future: up to 32 MW

Construction

- Steel tower / concrete tower
- Combined with waterturbine, wave generator or similar - with shared cable to continent

Background data

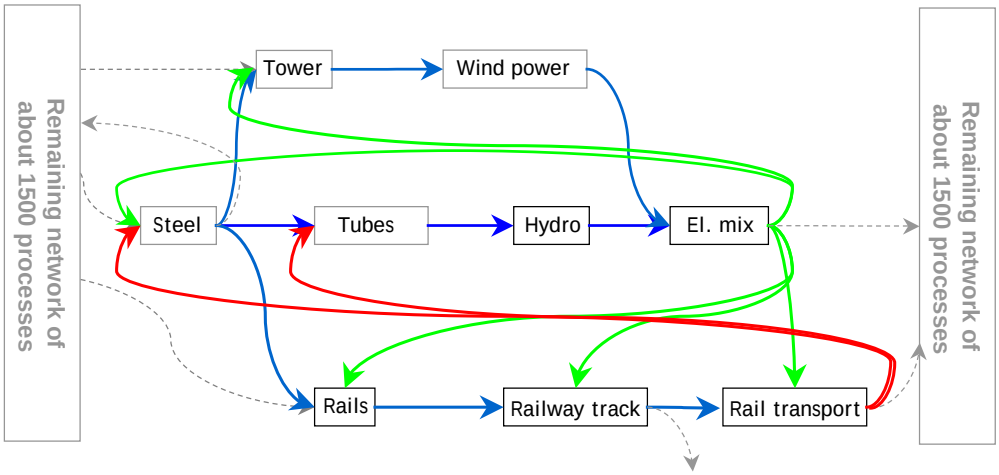
- **Background Data**
  - *year 2000:*
    ecoinvent data v1.3 (ca. 2700, quality controlled Datasets)
  - *years 2025 and 2050 :*
    ecoinvent data including modified LCIs of selected datasets
- **Modified Datasets in future scenarios**
  - metals, mineral building materials, transports, electricity mixes

Consistent environmental sustainability assessment

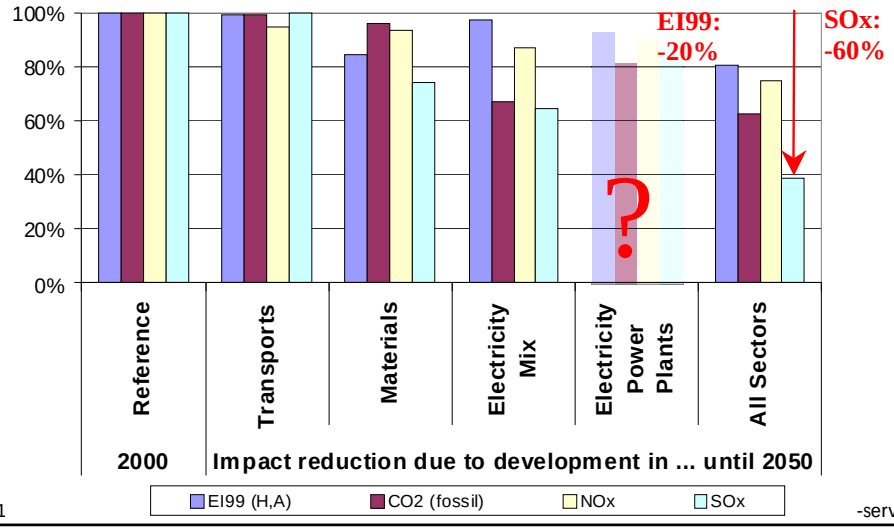
- NEEDS processes are linked to each other:
  Unit process level required
- Interdependency of energy generation, material production and transport technologies
  ⇒ one single change affects all other systems
- consistent modelling of possible futures (scenarios):

electricity mix	**technology development**
business as usual	pessimistic
CO_2 cap at 440ppm	realistic optimistic
Renewables	very optimistic

The advantage of unit process databases:
Interdependency & Feedback-Loops



Impacts are reduced due to …



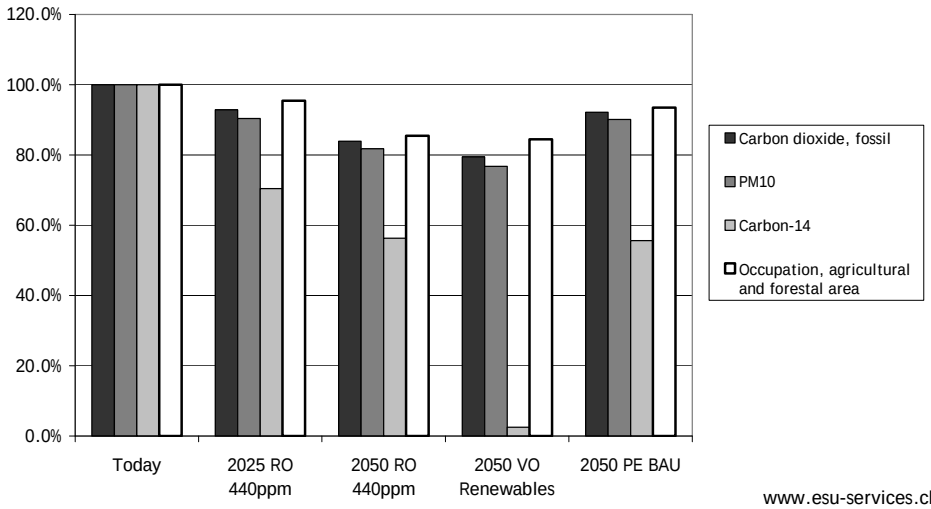
LCI Results

- Electricity generating technologies, based on non renewable and renewable primary energy sources
- Elementary flows shown:
  - Carbon dioxide, fossil, to air
  - particulate matter, to air
  - Carbon-14, to air
  - land use (agricultural and forestal)
- Development within technologies
- Comparison between technologies

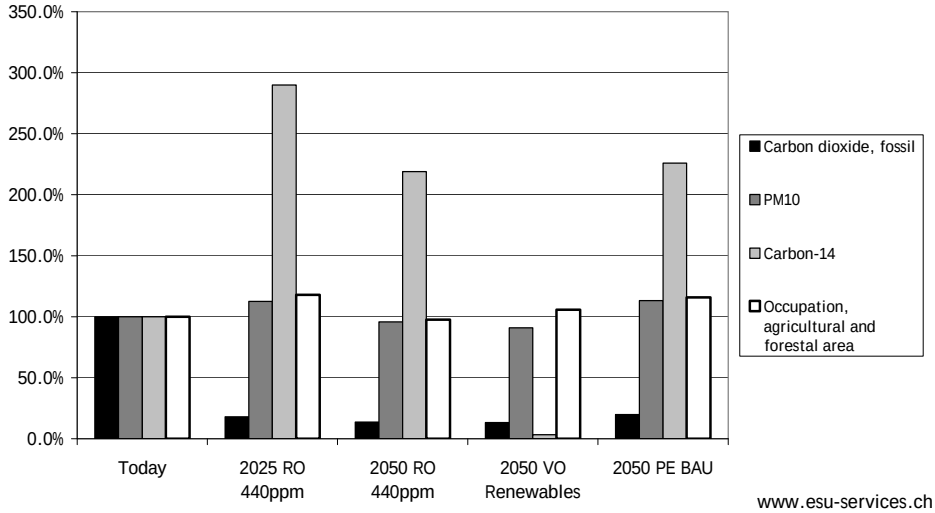
Scenarios shown

Name	Time	Technology development	electricity mix
TODAY	**2000**	**current state**	**current European electricity mix (UCTE)**
2025 RO, 440ppm	**2025**	**realistic optimistic**	**440ppm CO_2 cap**
2050 RO, 440ppm	**2050**	**realistic optimistic**	**440ppm CO_2 cap**
2050 VO, RENEW	**2050**	**very optimistic**	**increased renewables and energy efficiency**
2050 PE, BAU	**2050**	**pessimistic**	**business as usual**

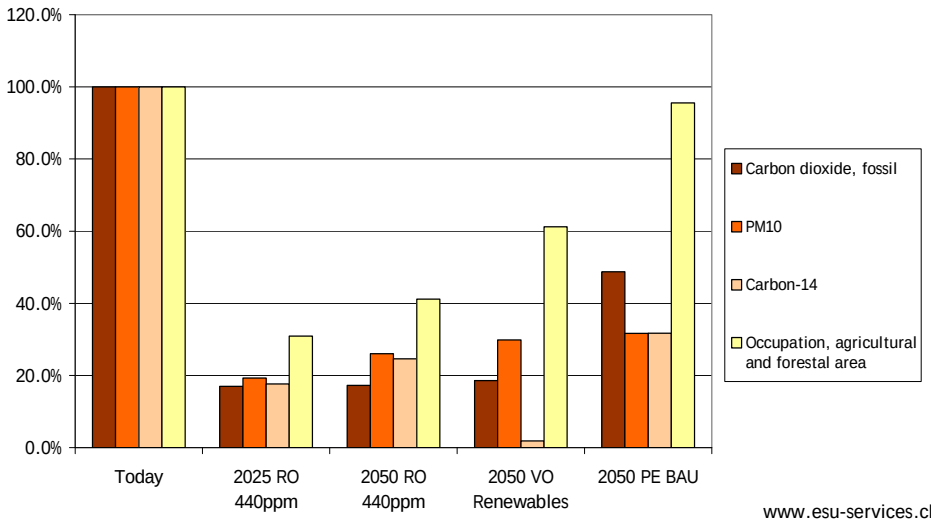
Hard coal power plant, 800 MW



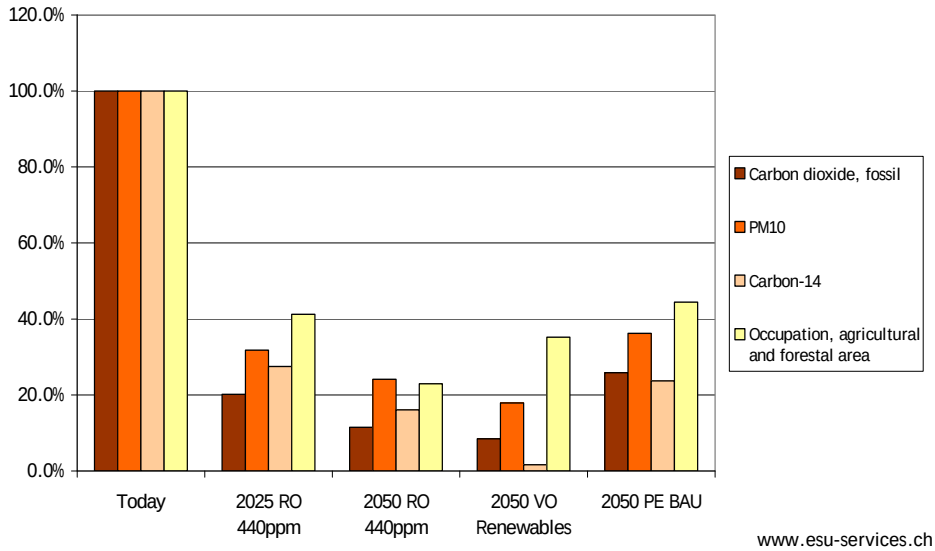
Hard coal power plant, 500 MW, post CCS, 200km, 2500m, gasfield



Offshore wind park, 2MW to 20MW



PV, c-Si, ground mounted, Central Europe



Observations

- each technology has his environmental Achilles' heel
- improvement potential until 2050 between 20% to >90%
- operation intensive systems show less improvement potentials, unless end of pipe technologies are installed (e.g. Carbon Capture and Storage)
- With time, some technologies outperform others (e.g. PV vs. wood)
- In some cases (wind power) increase in emissions after 2025 due to change in design
- excluding electricity mix developments leads to substantially different results

Conclusions

- Life cycle thinking is indispensible in energy policy
- Technology development in LCA background matters
- Energy policy and environmental sustainability assessment should consider possible future situations
- The NEEDS LCI project results provides relevant knowledge
- Transparent unit process LCI databases are one important prerequisite to provide policy relevant answers

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Thank you very much for your attention!

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