



WIR SCHAFFEN WISSEN – HEUTE FÜR MORGEN

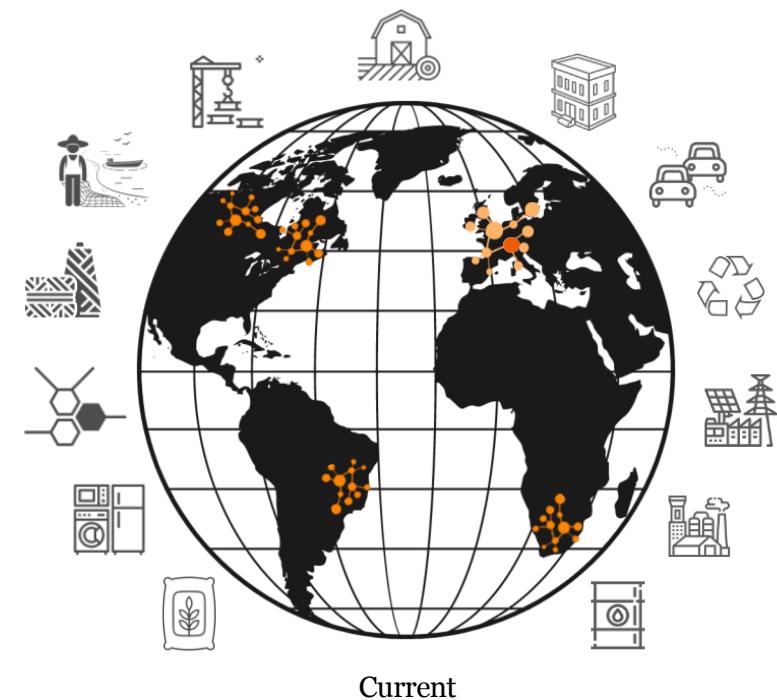
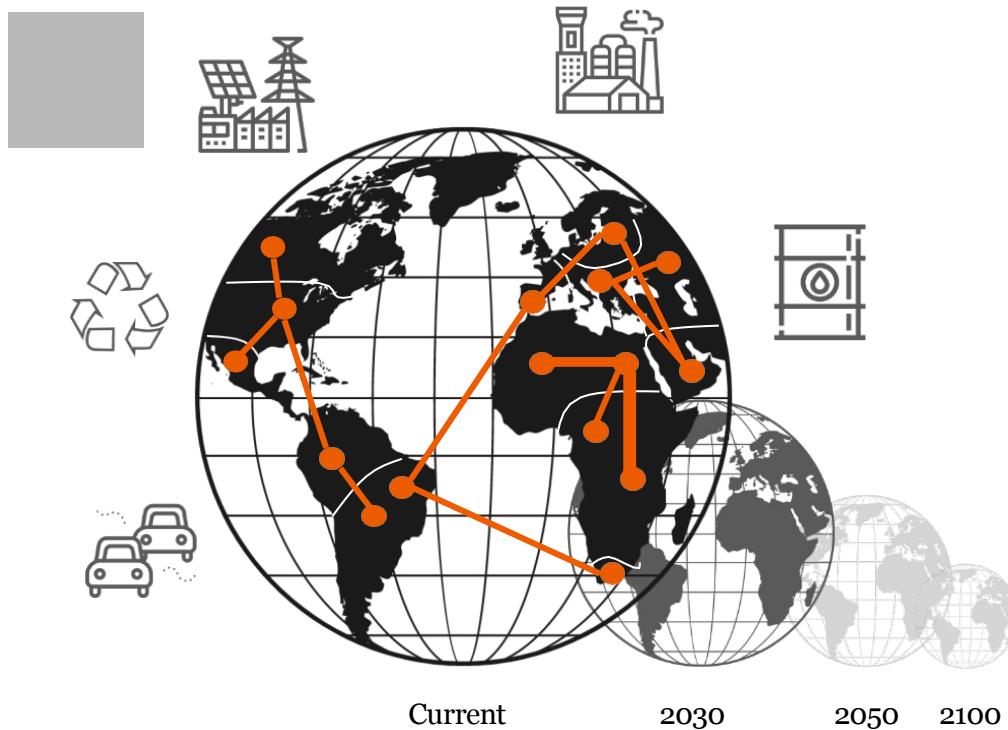
Romain Sacchi :: Postdoctoral researcher :: Technology Assessment :: Paul Scherrer Institut

# Prospective life-cycle assessment: environmental footprint of products and services across transition scenarios

21.08.2023



## IAM/ESM world vs. LCA world



# Integrated Assessment Model

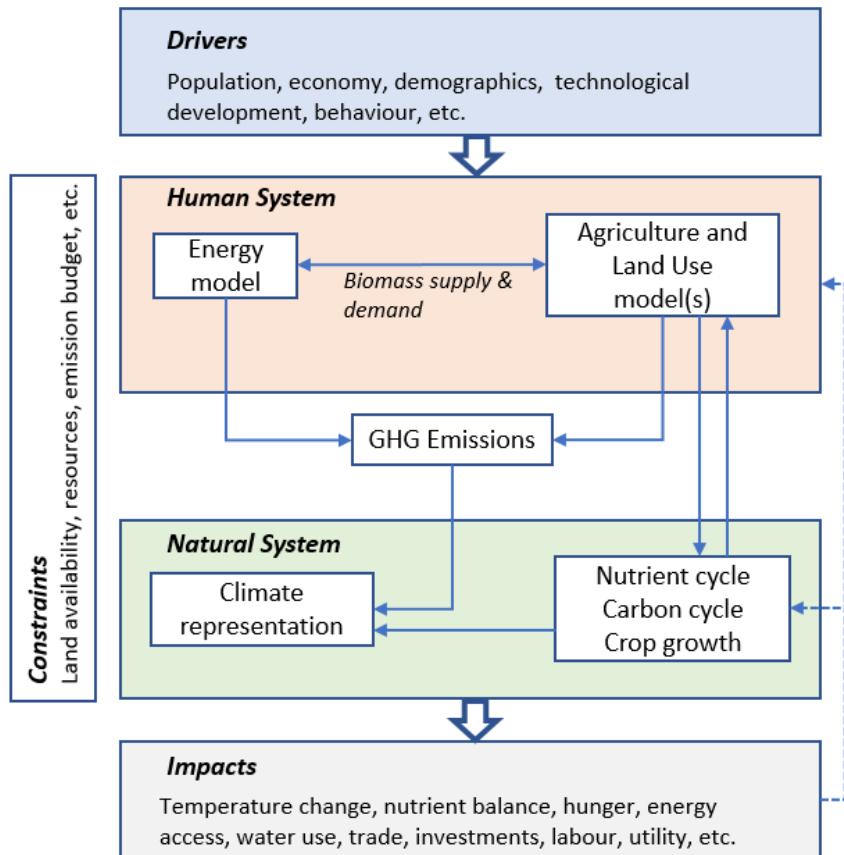
Integrated Assessment Models (IAMs) assess the interactions between **human** and **natural** systems

Contain stylized representations of

- Energy system
- Agricultural economy
- Climate
- Land system

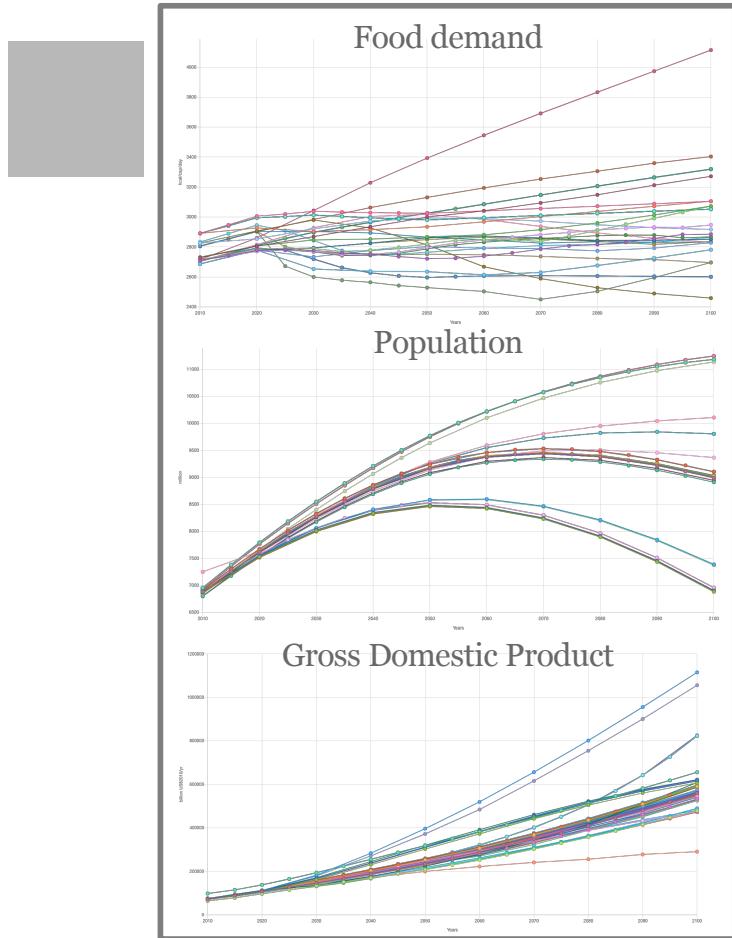
Bridge the Science/Policy interface

- Scenario Analysis: *What if?*
- What are the drivers or constraints of change?
- How do technology and policy choices lead to different outcomes?
- Uncertainties? Sensitivities?

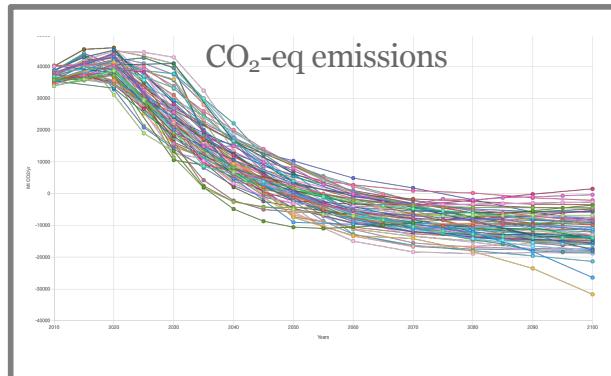


# The IAM world

## Socio-economic constraints (SSP)



## Climate constraints (RCP)

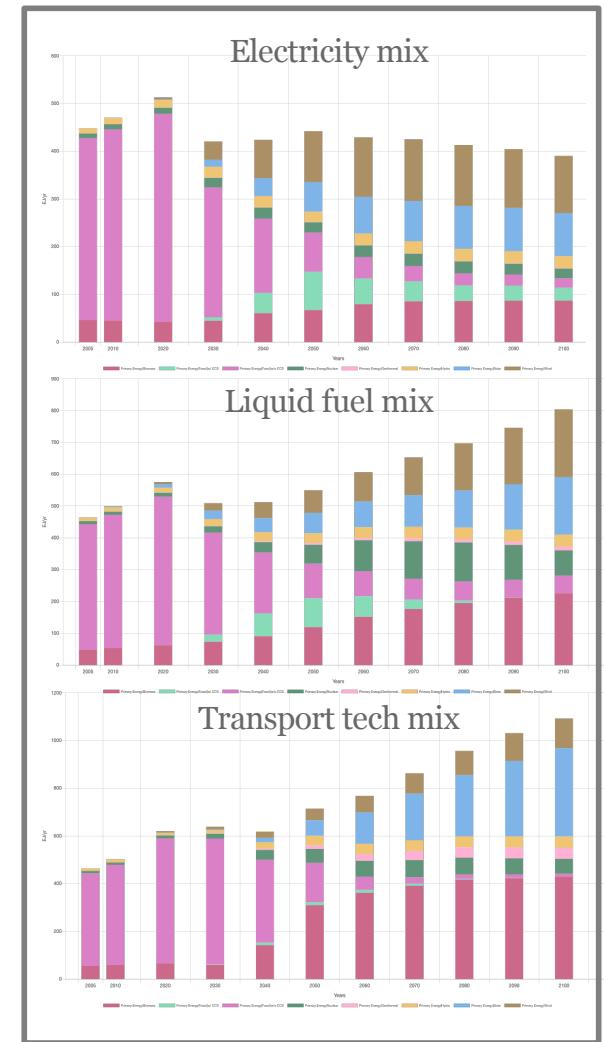


## Mitigation challenges

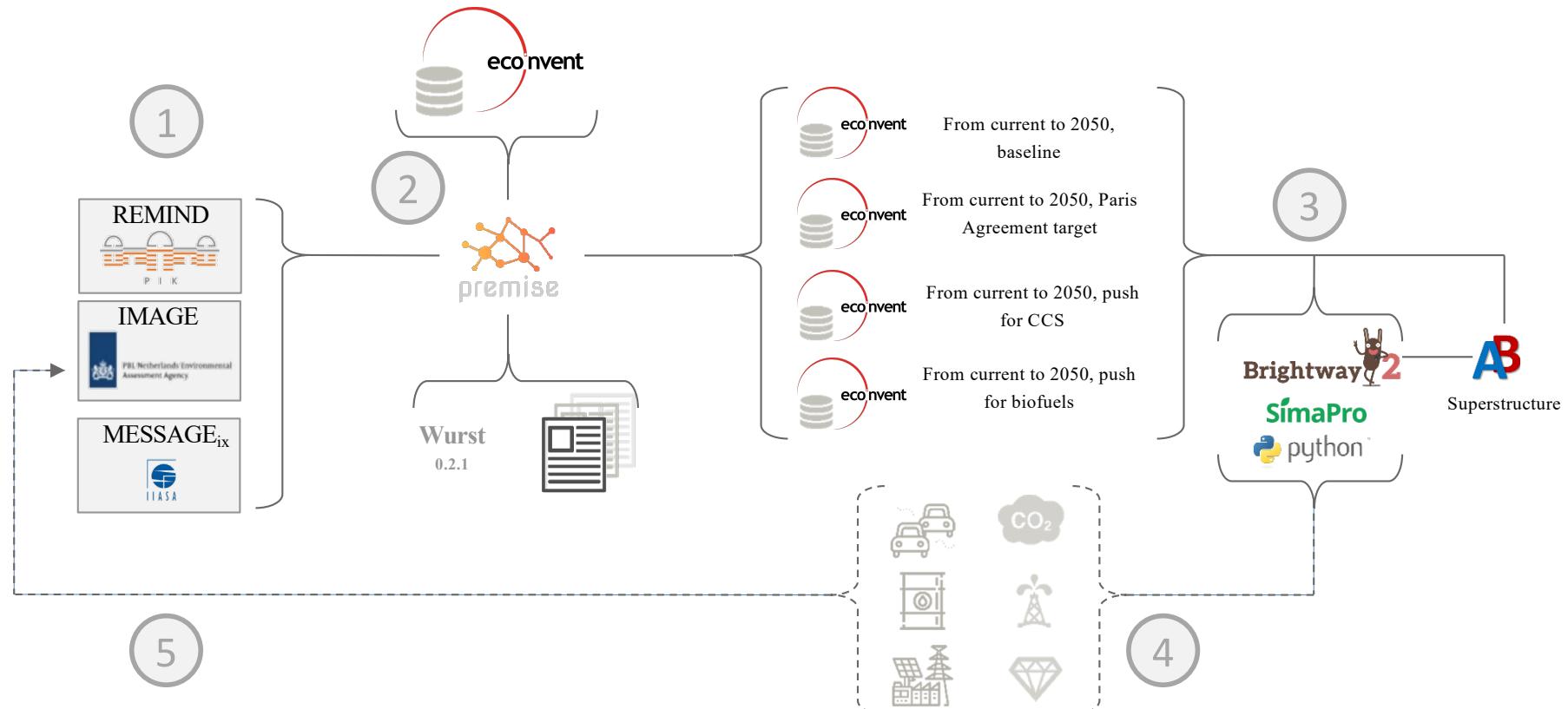


SSP = Shared Socioeconomic Pathway. Source: Rogelj et al (2018).  
<https://www.carbonbrief.org/explainer-how-shared-socioeconomic-pathways-explore-future-climate-change> CB

## Techno-economic solutions



# Tool kit

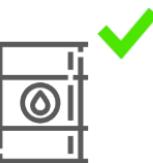


# What does *premise* (try to) do?



## Power

Create regional electricity markets  
Adjust power plant efficiency



## Fuels

Create regional fuel markets  
Add new production pathways  
(synthetic fuels)



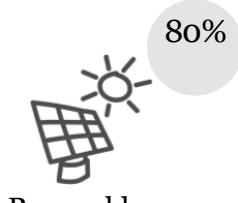
## Metals recycling

Adjust future recycled content



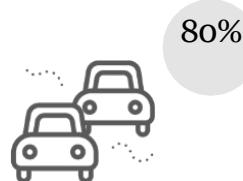
## Hot pollutant emissions

Adjust hot pollutant emission  
from GAINS



## Renewables

Adjust solar PV and windturbines  
efficiency



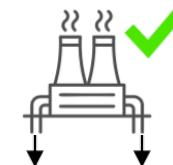
## Transport

Create market for passenger  
and freight road transport



## Industry

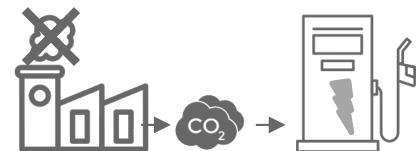
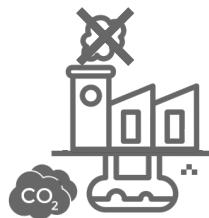
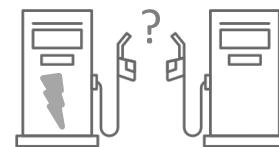
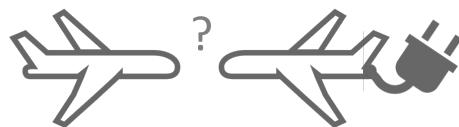
Adjust efficiency for cement  
and steel production (fuel  
mix, process efficiency,  
material composition, etc.)



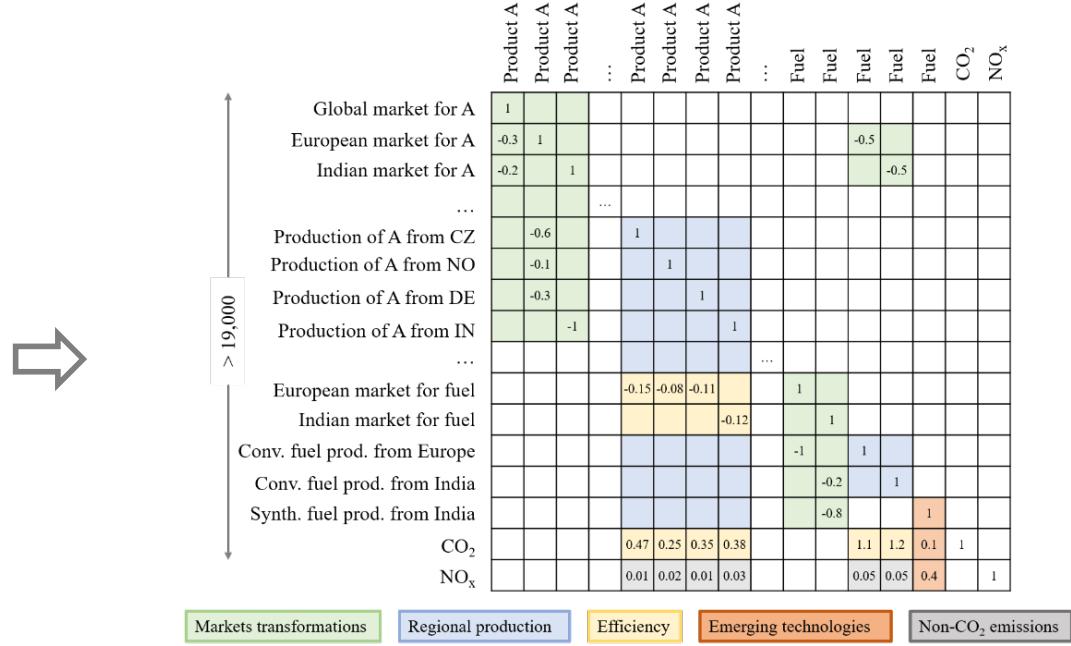
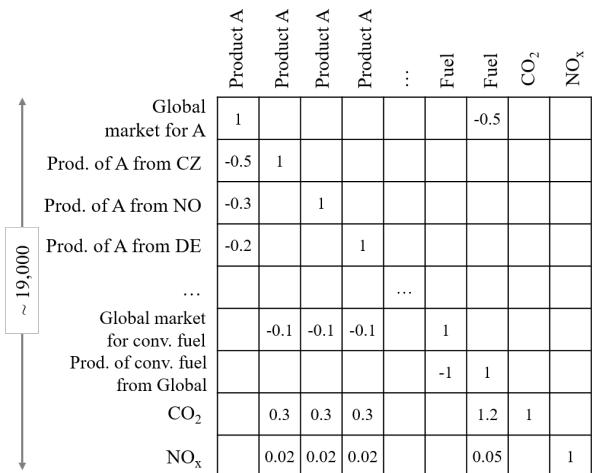
## Carbon capture and storage

Add carbon capture and  
storage where needed

## Cases using premise databases



# Database manipulation

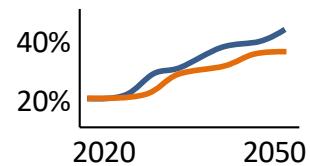


# Example of transformation

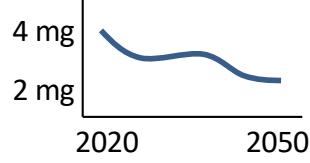
## Power generation

IAM → LCA

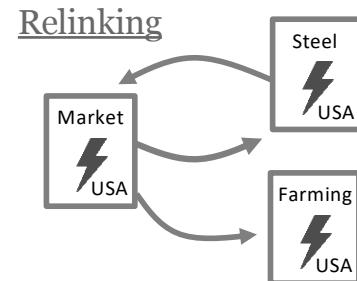
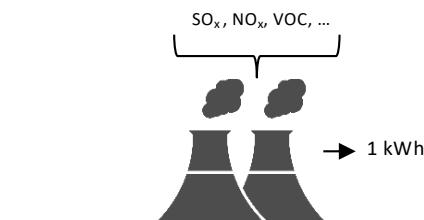
Efficiency



Pollutants



Market mixes



## Transport

LCA

Modelling new vehicles



IAM → LCA

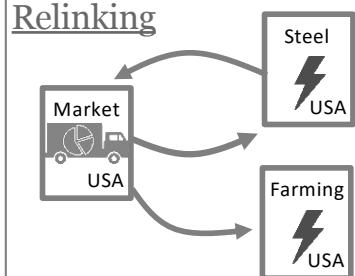
Adjust fuel mixes



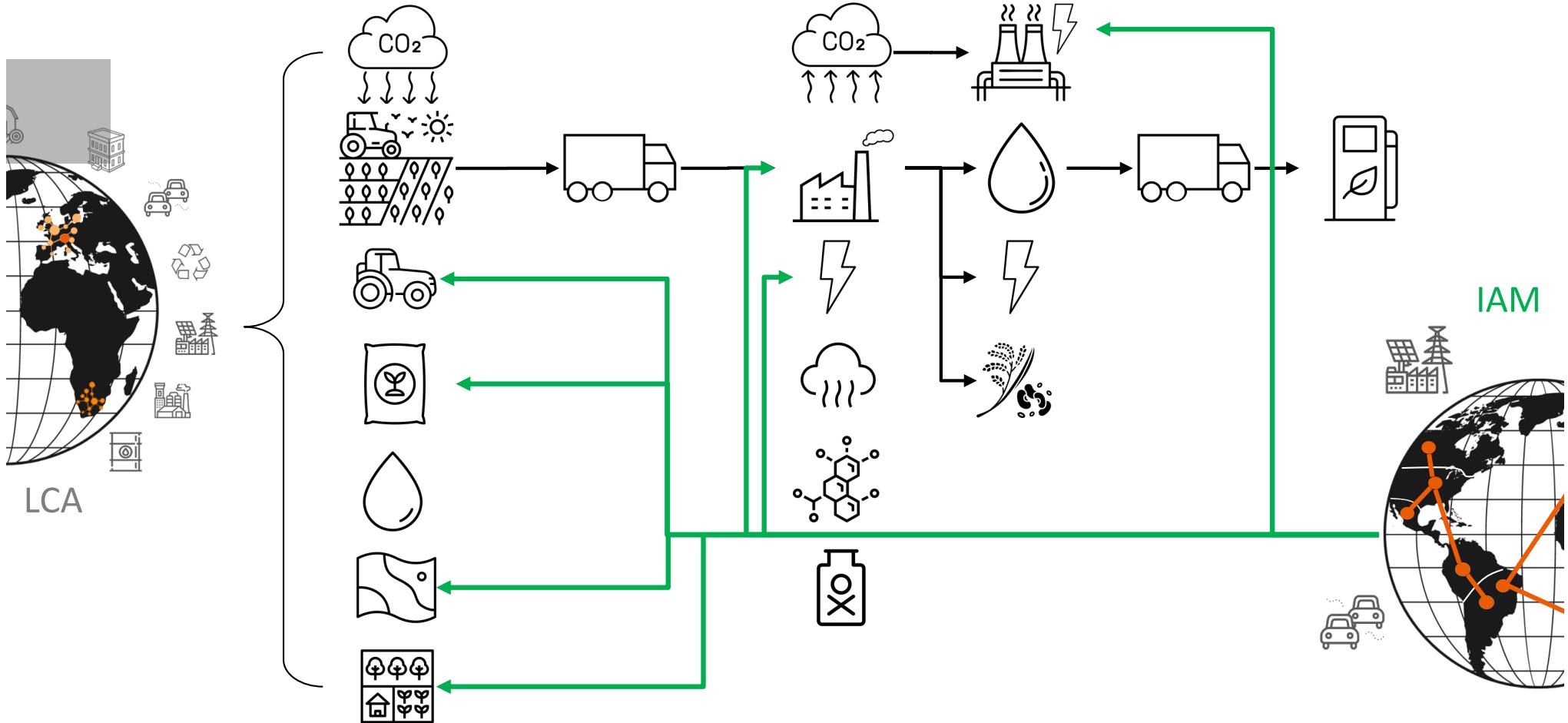
Market mixes



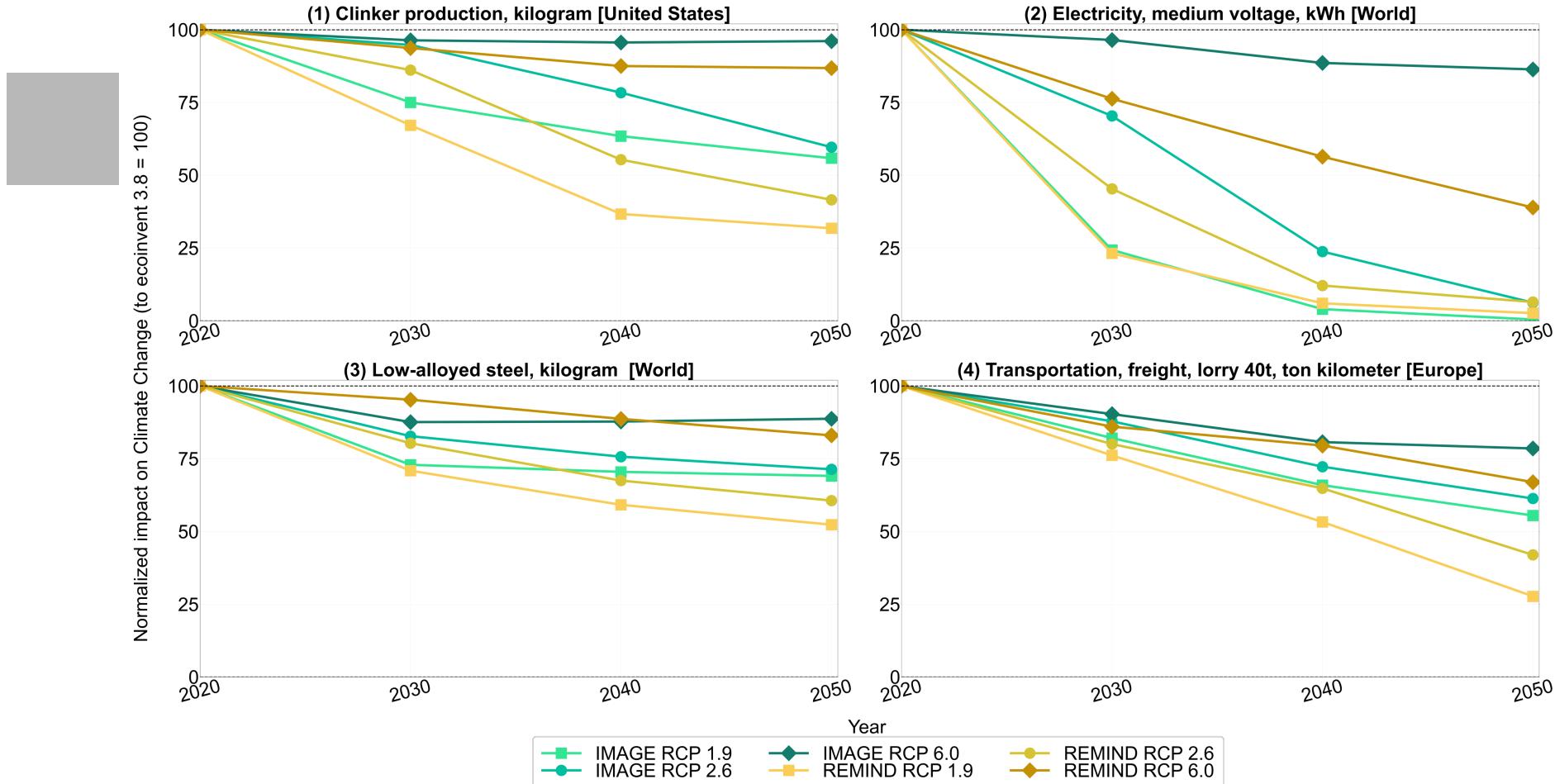
Relinking



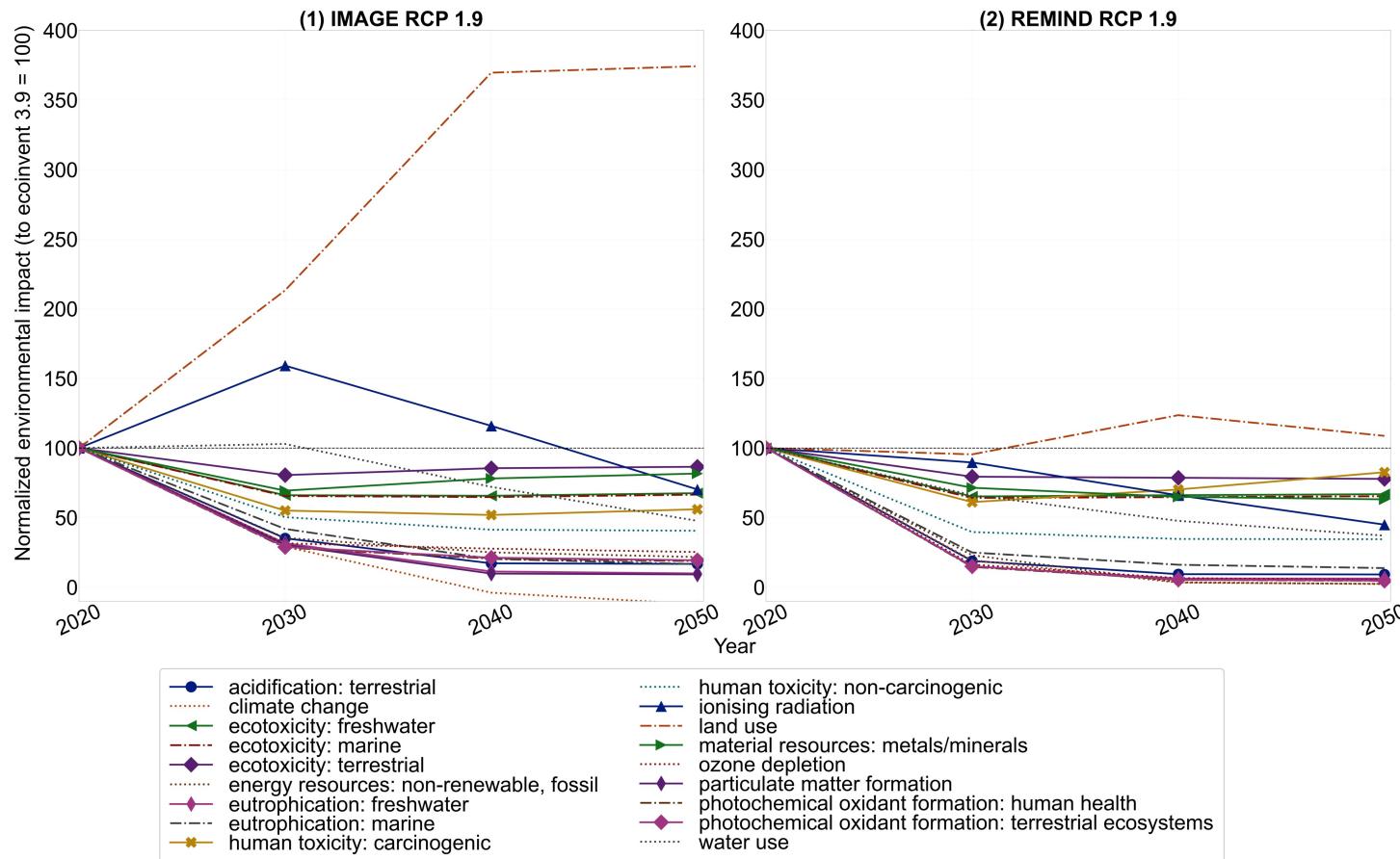
# Biofuels



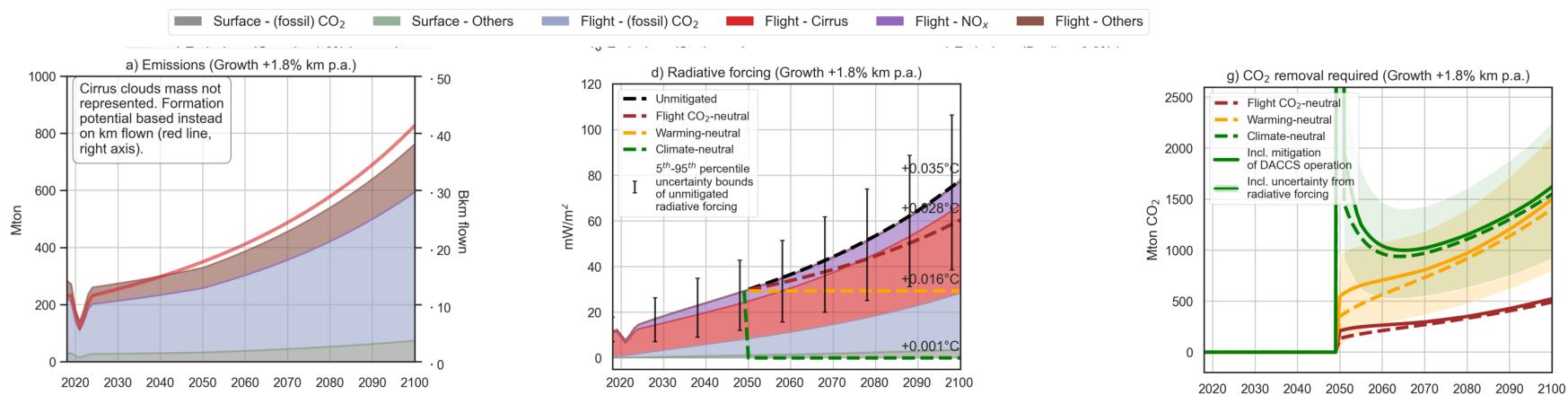
# Efficiency change across time and scenarios



# Indicators evolution across time and scenarios

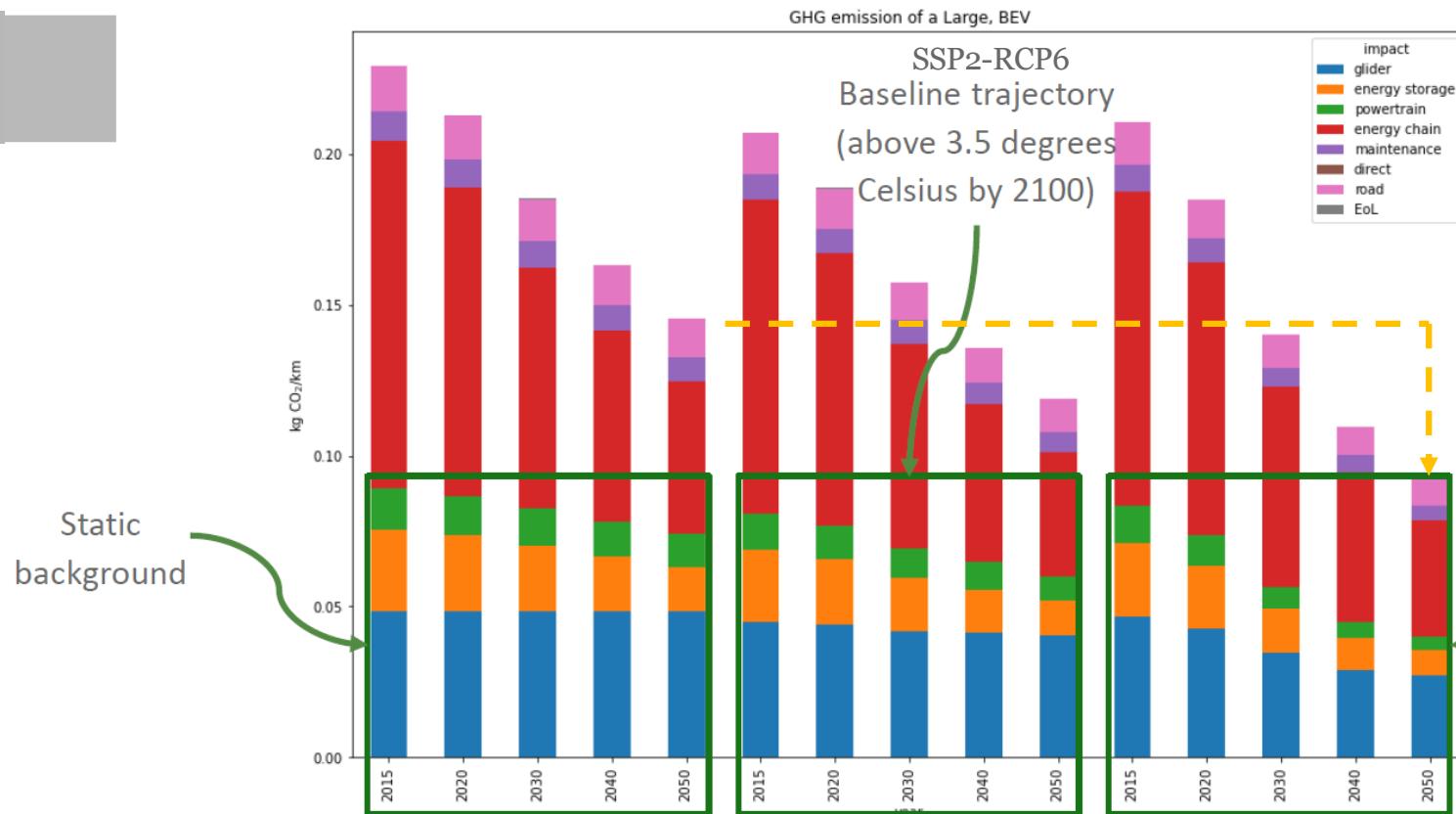
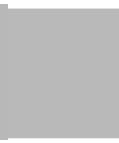


- Simplified aircraft LCA model
- Linked to premise database for every year between 2018 and 2100
- Climate impact of EU fleet until 2100



Romain Sacchi, Viola Becattini, Paolo Gabrielli et al. Climate-neutral aviation: will it fly?, 16 November 2022, PREPRINT (Version 1) available at Research Square [<https://doi.org/10.21203/rs.3.rs-2185970/v1>]

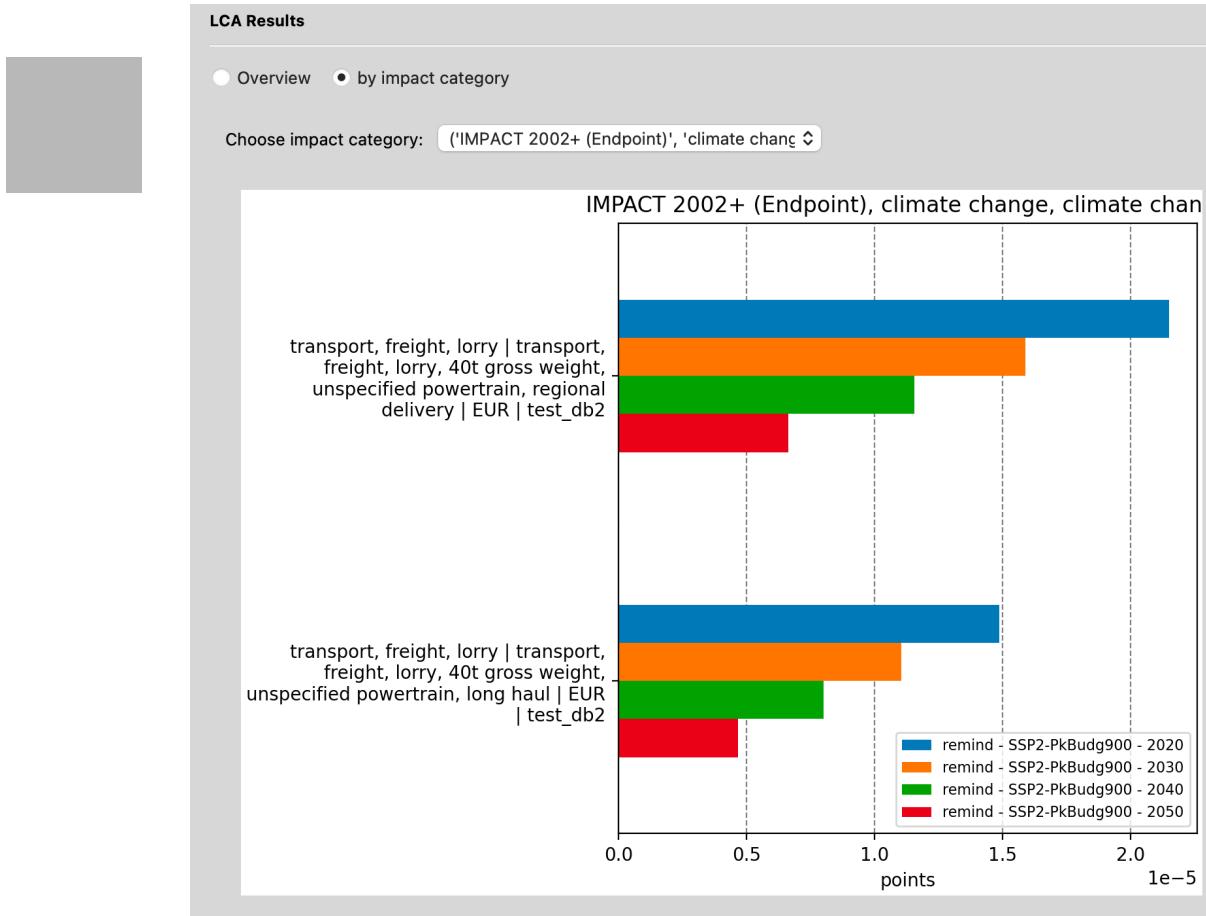
# Battery electric cars



Example for a large size battery electric car operated in Europe, using various REMIND energy scenarios.

SSP2-RCP1.9  
Well below 2  
degrees Celsius by  
2100

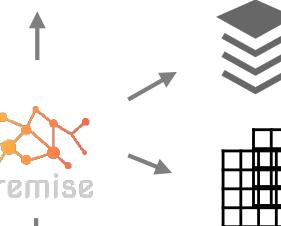
# Integration in LCA software



premise's outputs play nicely with *Activity-browser*, using superstructure databases

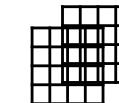
Ideal for beginners.

**SimaPro**



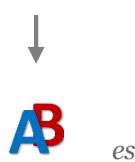
Data packages, using unfold.

**premise**



Total freedom. Can be used to inform other models.

**Brightway2**



Python environment. Ideal for fast stochastic analyses. Harness the power of BW. Can connect to other Python models.

**BW**

Easy and powerful way to browse through results, especially using superstructure databases.

# What's coming?

- Heat integration
  - Currently, only mobile heat generators decarbonize (via fuel blend modification)
- Metals tracking
  - Mining inventories for ~80 specialty metals
  - MFA → recycling rates, ore degradation
- Scenarios from three additional IAMs
  - Message-ix, Ti-IAM, GCAM
- *pathways*
  - A new library for scenario- or sector-wide LCA

# Open source tools

- *Brightway2* (LCA framework): <https://github.com/brightway-lca>
- *Activity-Browser* (GUI for Brightway2): <https://github.com/LCA-ActivityBrowser/activity-browser>
- *Brightway-superstructure* (multiple-scenario database): <https://github.com/LCA-ActivityBrowser/brightway-superstructure>
- *premise* (IAM-LCA coupling): <https://github.com/polca/premise>
- *wurst* (fast handling of LCA databases): <https://github.com/polca/wurst>

# Wir schaffen Wissen – heute für morgen

Technology Assessment Group  
<https://www.psi.ch/en/ta>

Questions?



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