

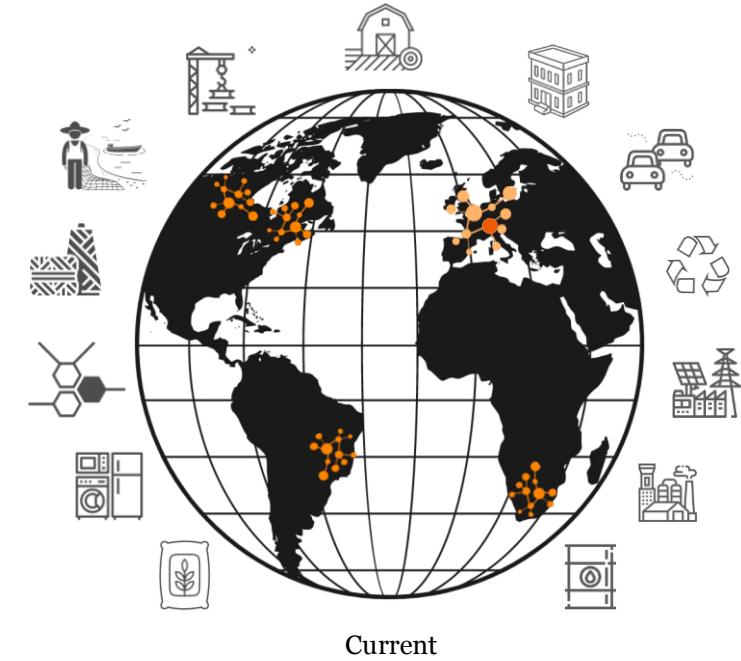
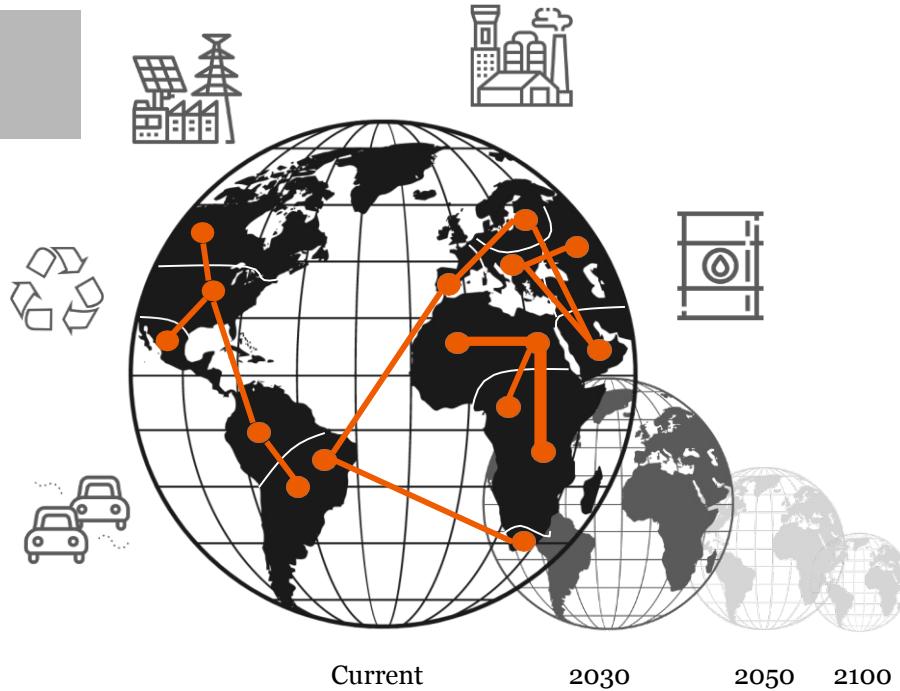


Romain Sacchi :: Postdoctoral researcher :: Technology Assessment :: Paul Scherrer Institut

# 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

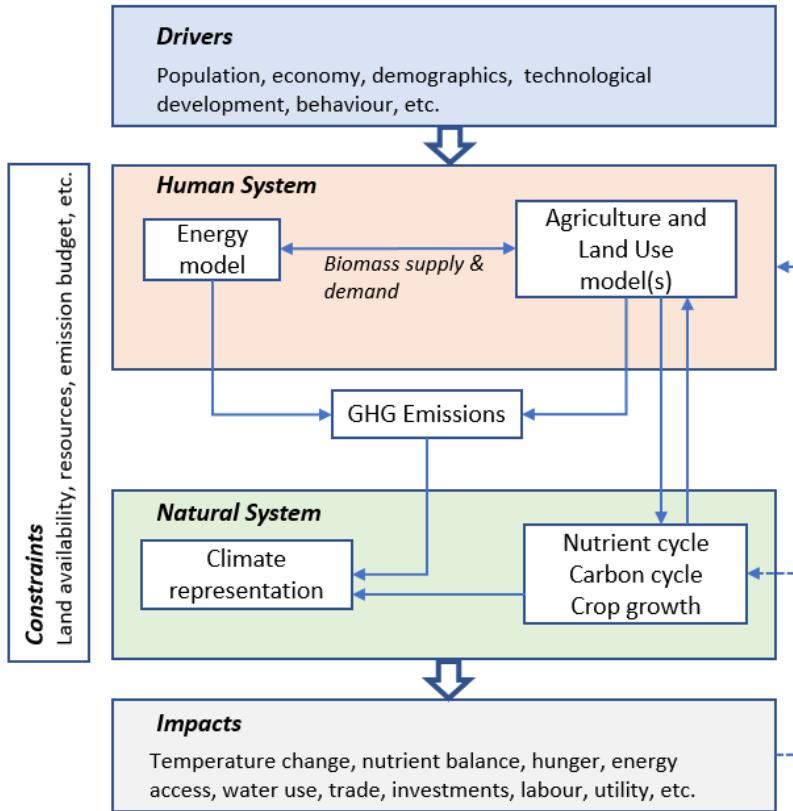
Integrated Assessment Models (IAMs) assess the interactions between **human** and **natural** systems

Contain stylized representations of

- Energy system
- Agricultural economy
- Climate
- Land system

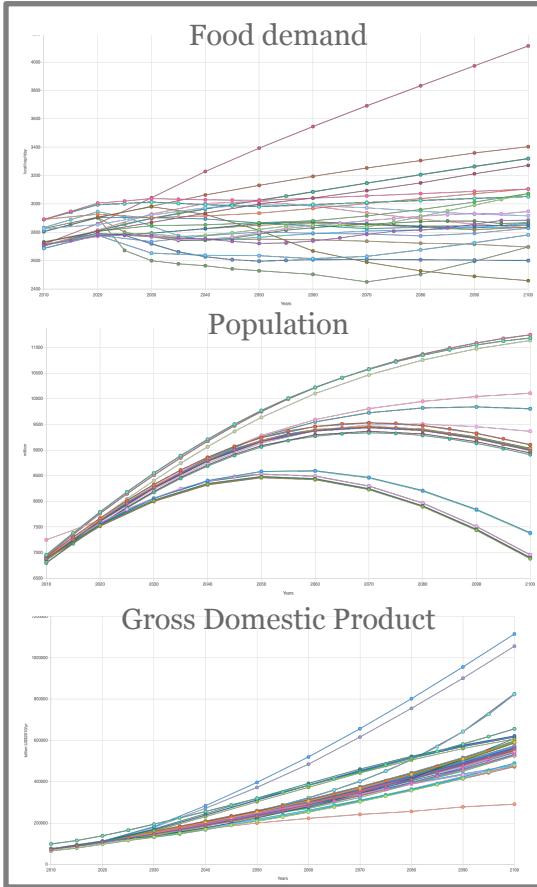
Bridge the Science/Policy interface

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

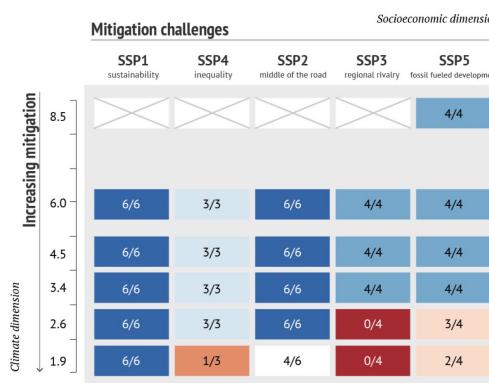
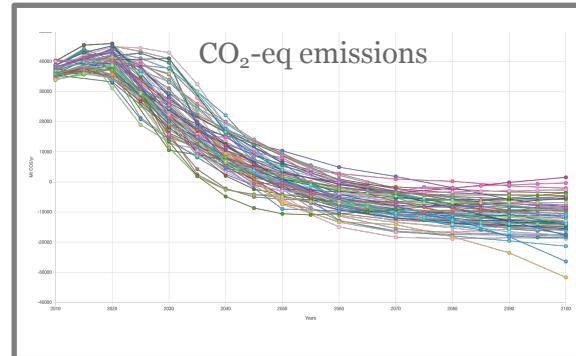


# The IAM world

## Socio-economic constraints (SSP)



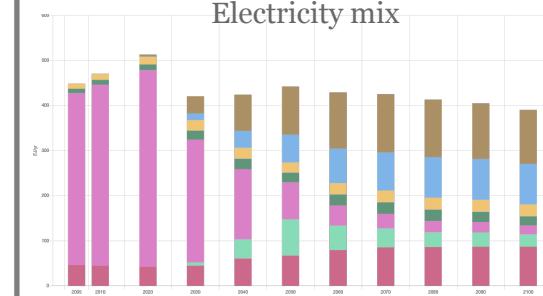
## Climate constraints (RCP)



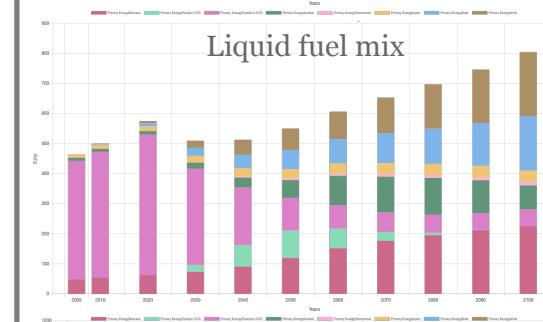
SSP = Shared Socioeconomic Pathway. Source: Rogelj et al (2018).  
<https://www.carbonbrief.org/explainer-how-shared-socioeconomic-pathways-explore-future-climate-change>

## Techno-economic solutions

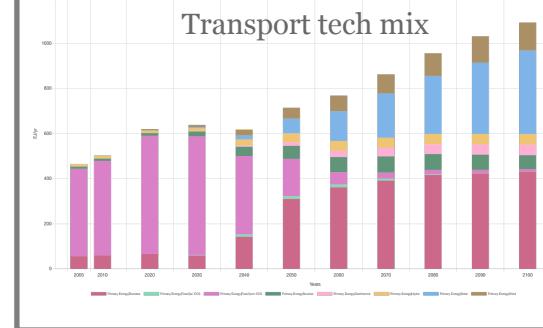
### Electricity mix



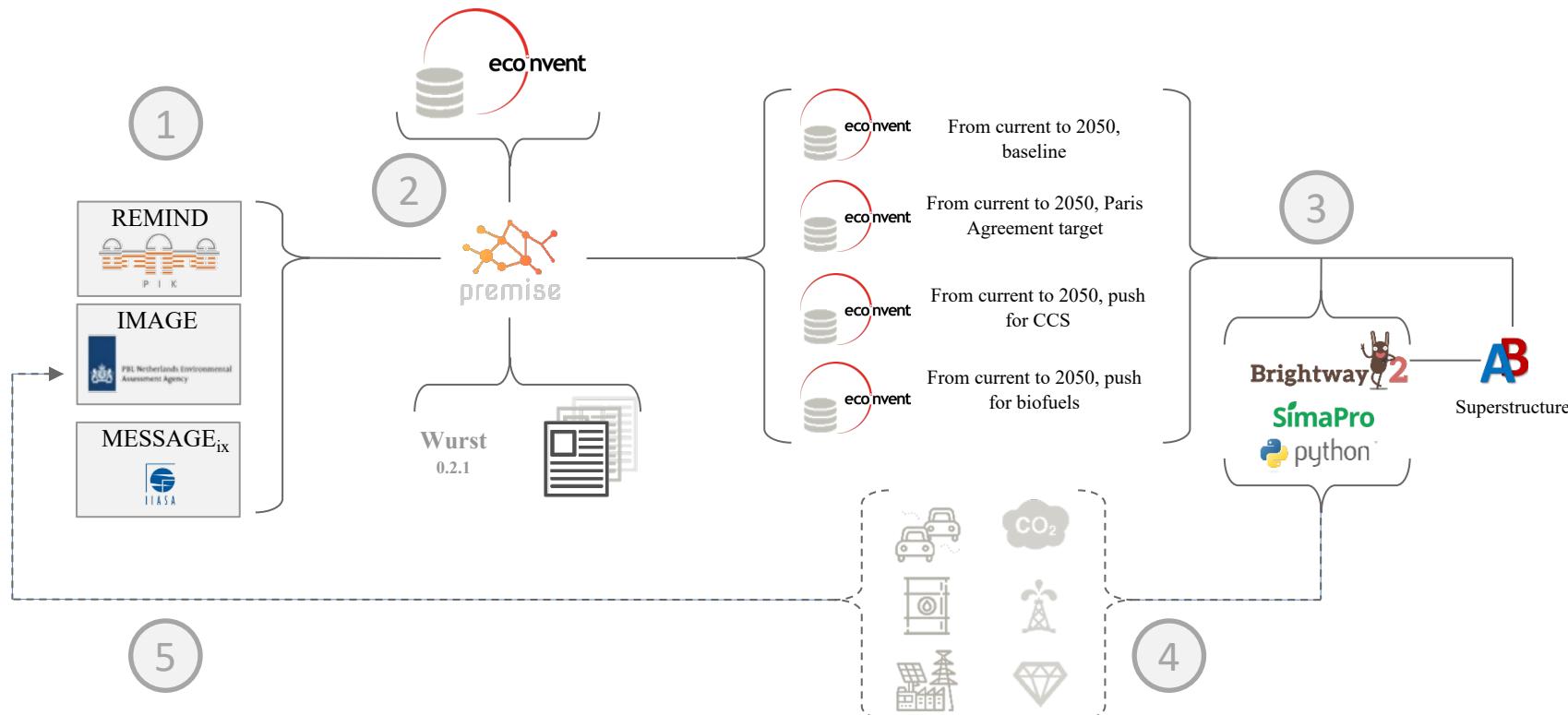
### Liquid fuel mix



### Transport tech mix



# 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



80%

## Renewables

Adjust solar PV and wind turbines  
efficiency



80%

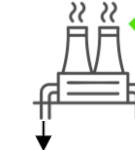
## Transport

Create market for passenger  
and freight road transport



## Industry

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

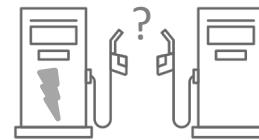


## Carbon capture and storage

Add carbon capture and  
storage where needed



# Cases using premise databases



# Database manipulation

	Product A			Product A			Product A			Product A			...			Fuel	Fuel	CO <sub>2</sub>	NO <sub>x</sub>
	1												-0.5						
Global market for A																			
Prod. of A from CZ	-0.5	1																	
Prod. of A from NO	-0.3		1																
Prod. of A from DE	-0.2			1															
...																			
Global market for conv. fuel from Global		-0.1	-0.1	-0.1				1											
Prod. of conv. fuel from Global								-1	1										
CO <sub>2</sub>	0.3	0.3	0.3							1.2	1								
NO <sub>x</sub>	0.02	0.02	0.02							0.05		1							

19,000 ↗



	Product A	...	Product A	...	Fuel	Fuel	Fuel	Fuel	Fuel	Fuel	CO <sub>2</sub>	NO <sub>x</sub>																	
	1																				-0.5								
Global market for A																													
European market for A	-0.3	1																											
Indian market for A	-0.2		1																										
...																													
Production of A from CZ		-0.6								1																			
Production of A from NO		-0.1									1																		
Production of A from DE		-0.3										1																	
Production of A from IN			-1										1																
...														...															
European market for fuel														-0.15	-0.08	-0.11				1									
Indian market for fuel																-0.12				1									
Conv. fuel prod. from Europe																				-1	1								
Conv. fuel prod. from India																				-0.2	1								
Synth. fuel prod. from India																				-0.8		1							
CO <sub>2</sub>														0.47	0.25	0.35	0.38					1.1	1.2	0.1	1				
NO <sub>x</sub>														0.01	0.02	0.01	0.03					0.05	0.05	0.4	1				

Markets transformations

Regional production

Efficiency

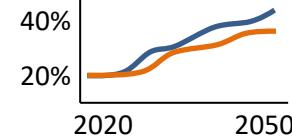
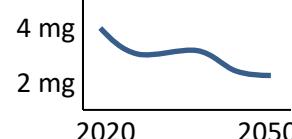
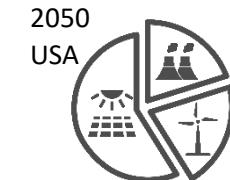
Emerging technologies

Non-CO<sub>2</sub> emissions

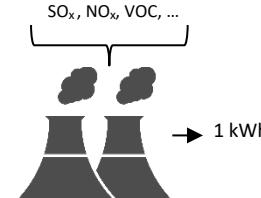
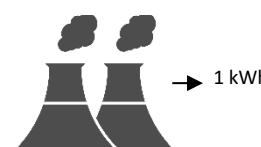
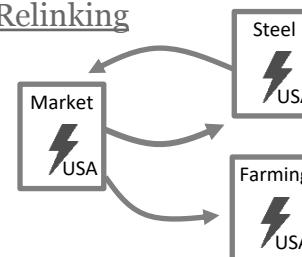
# Example of transformation

## Power generation

IAM

EfficiencyPollutantsMarket mixes

LCA

Hard coal  
Lignite  
Natural gas  
Fuel oil  
...Relinking

## Transport

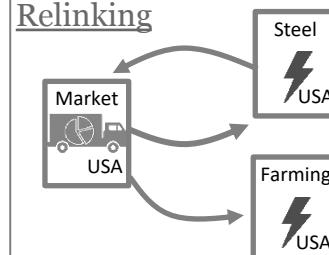
LCA

Modelling new vehicles

IAM

Adjust fuel mixes

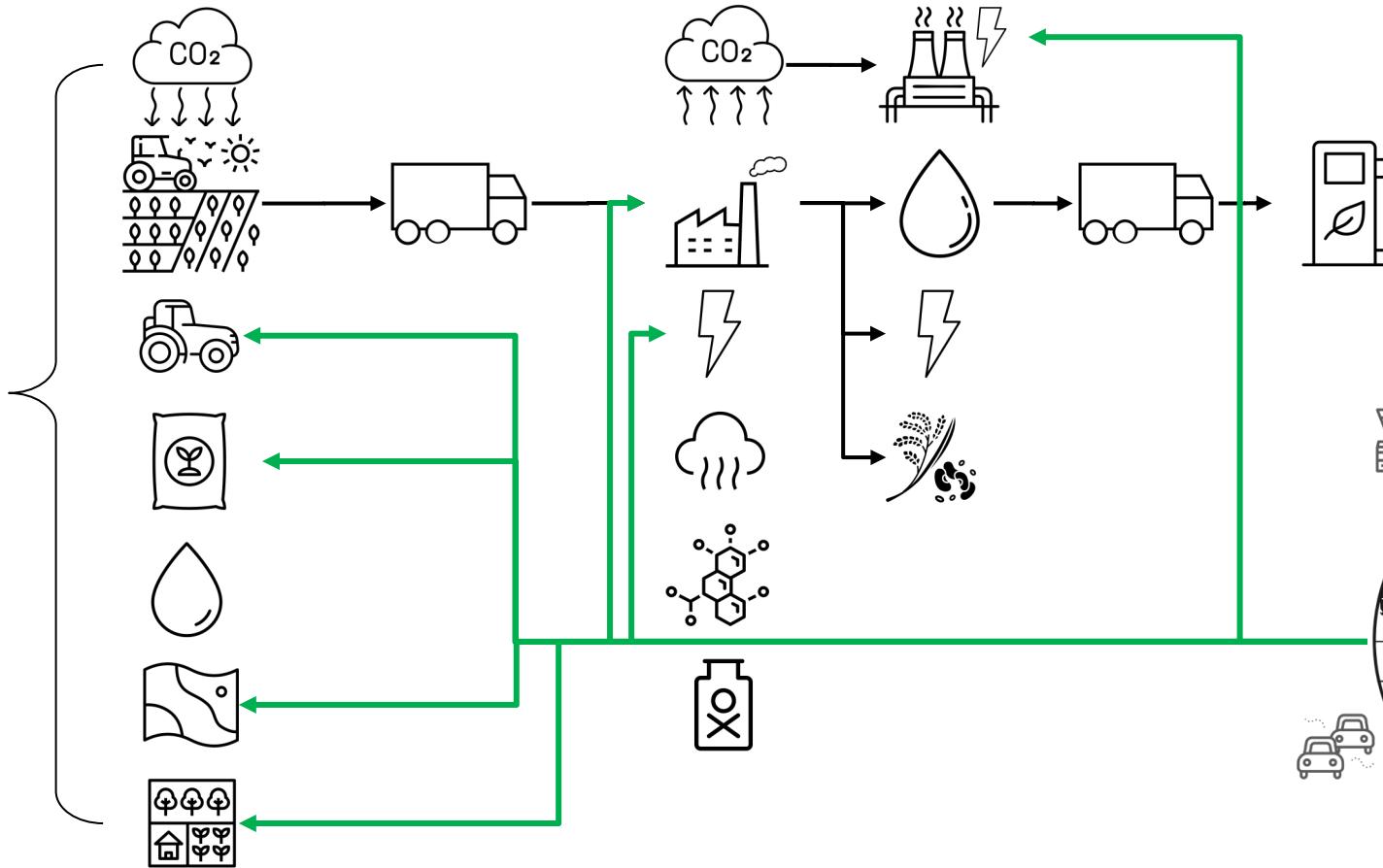
LCA

Market mixesRelinking

# Biofuels



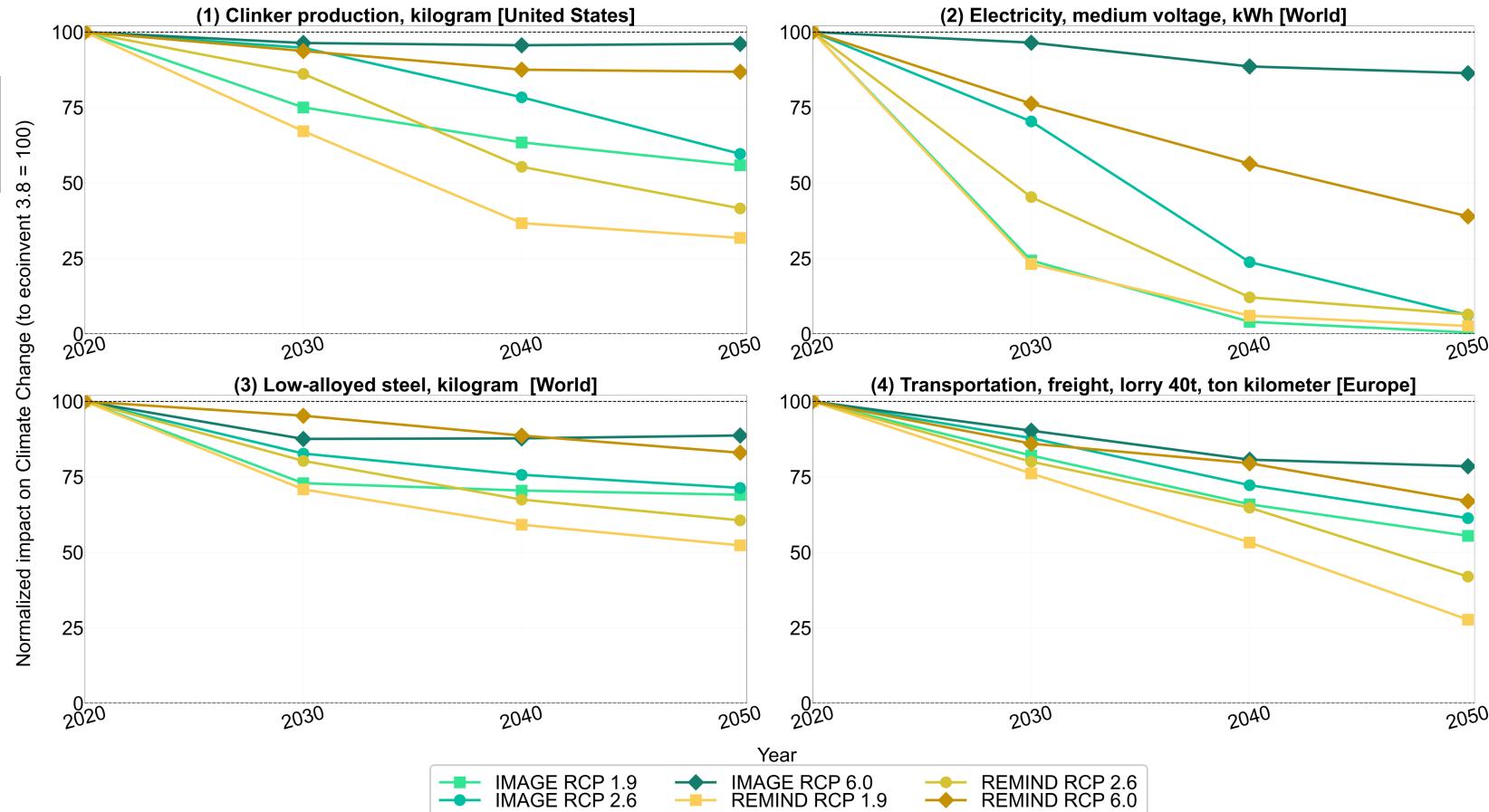
LCA



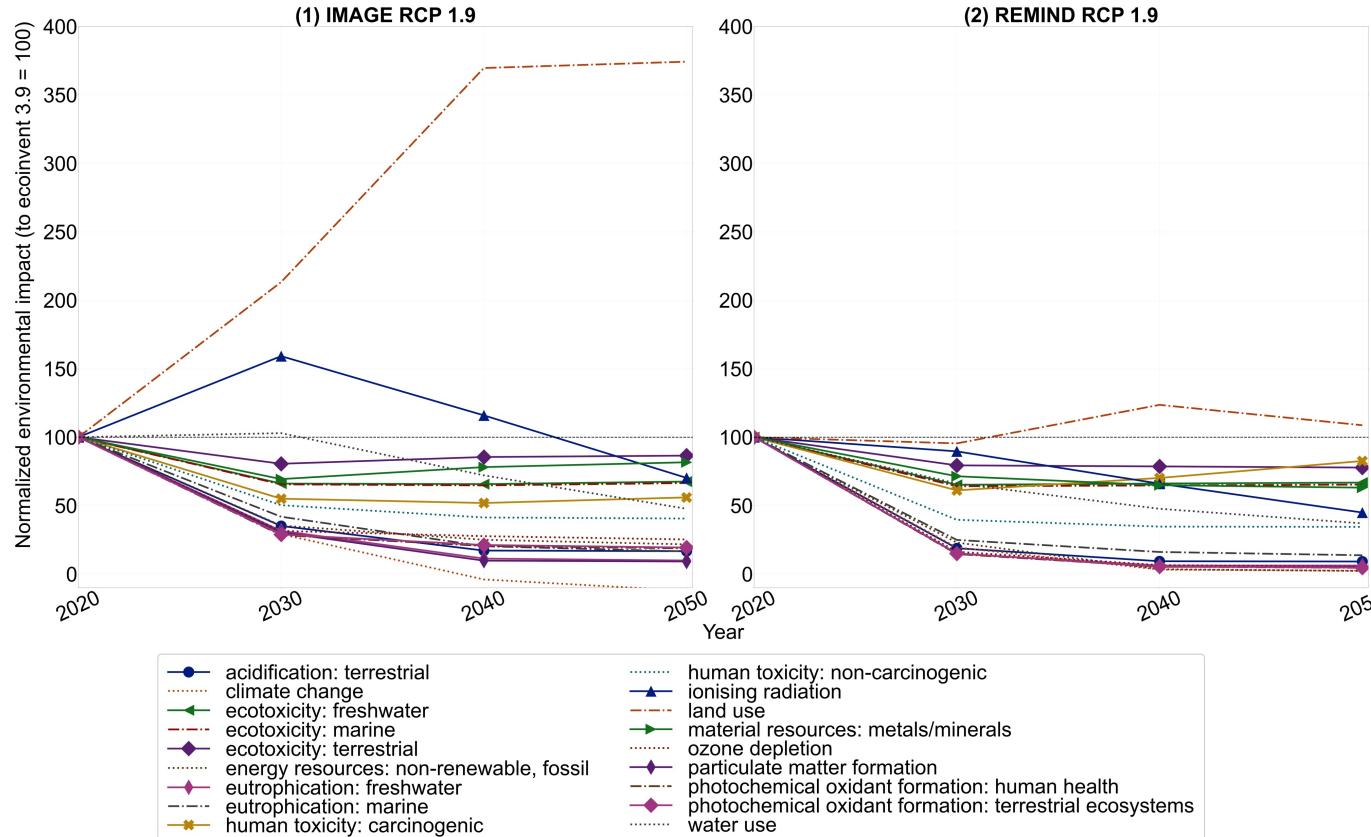
IAM



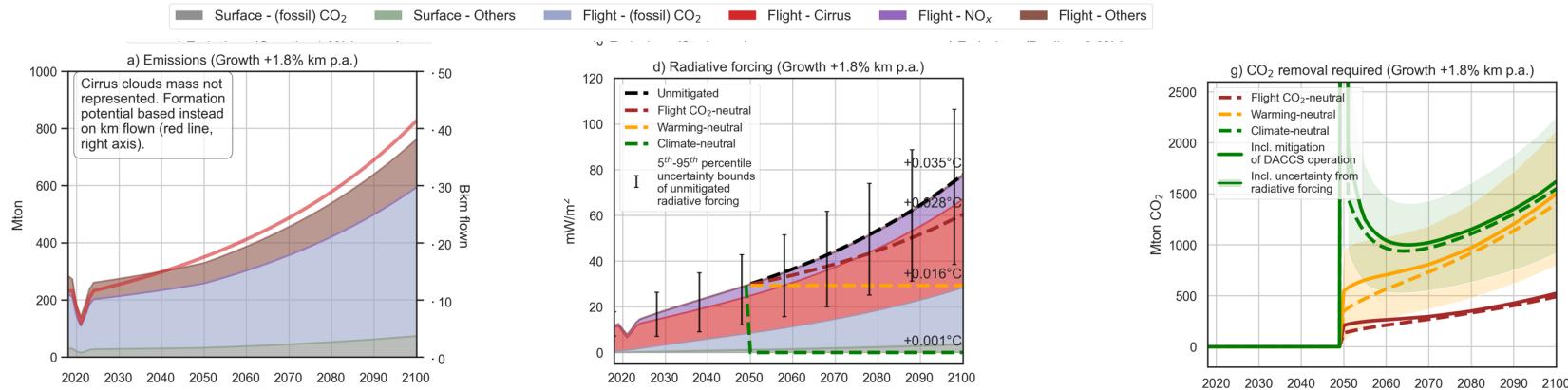
# Efficiency change across time and scenarios



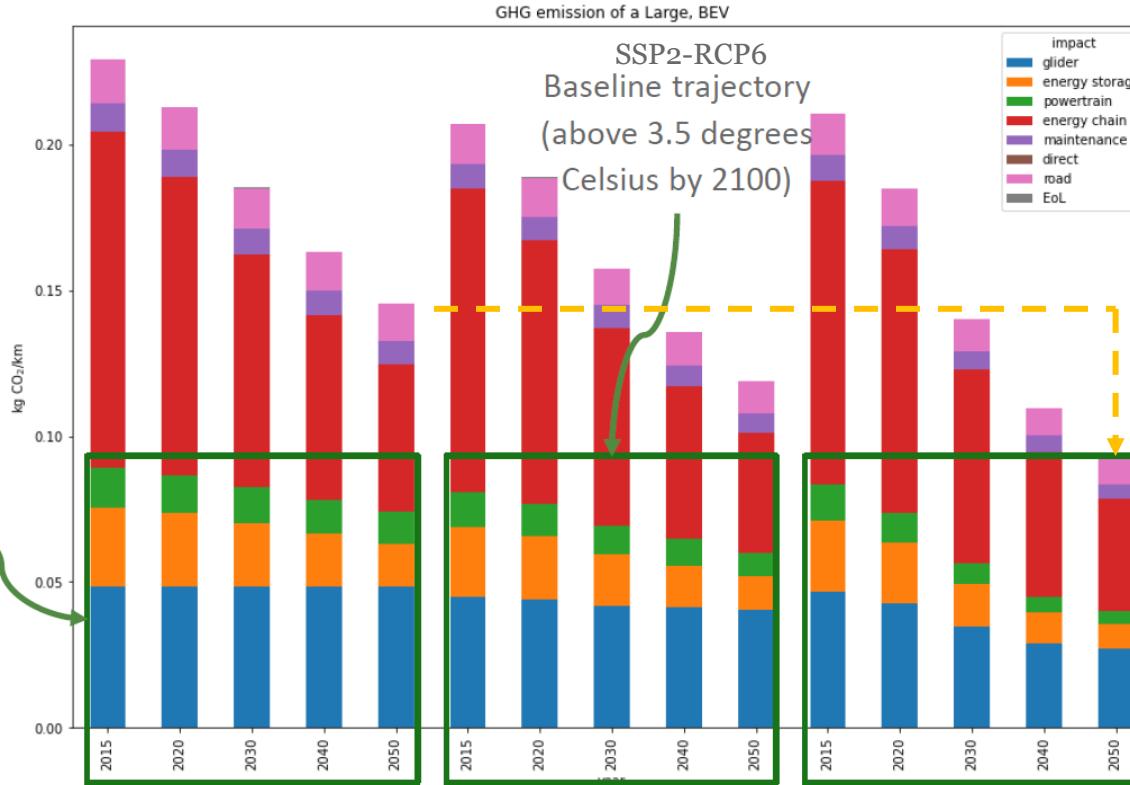
# Indicators evolution across time and scenarios



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



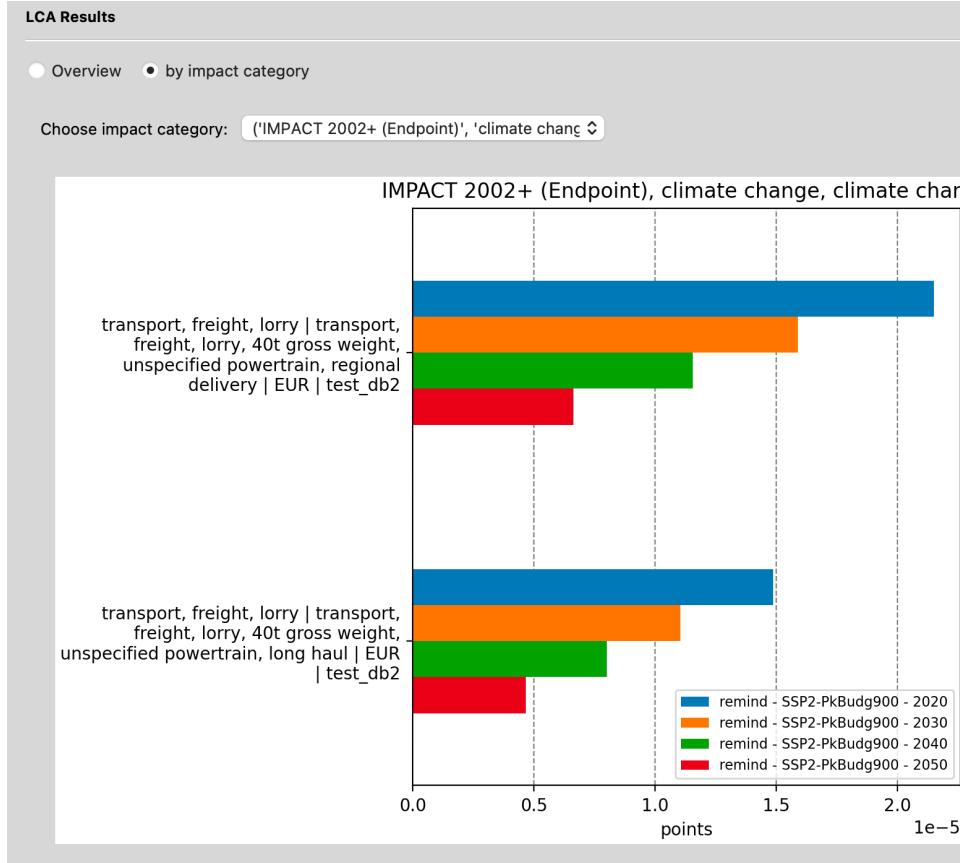
# Battery electric cars



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

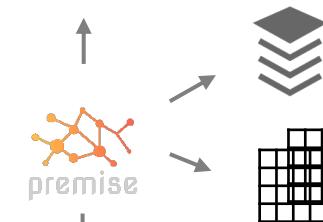
# Integration in LCA software



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

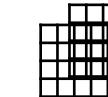
Ideal for beginners.

**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.

**AB**

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

# 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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[romain.sacchi@psi.ch](mailto:romain.sacchi@psi.ch)

