



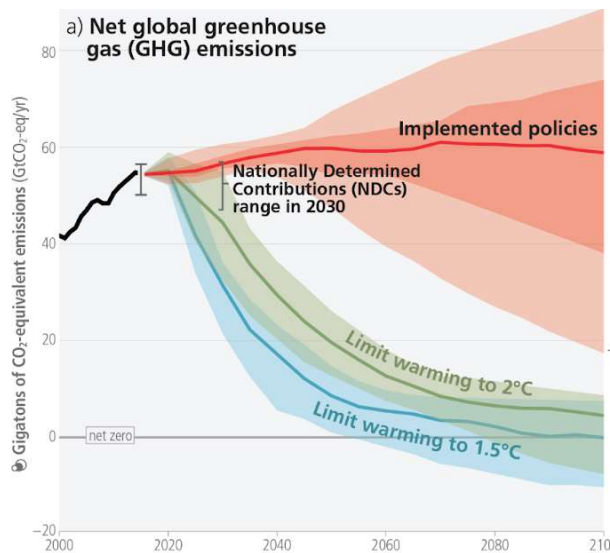
IAMs and long-term scenarios to support the IPCC Climate Change assessment

Detlef van Vuuren

 @IMAGE_PBL

Quick introduction

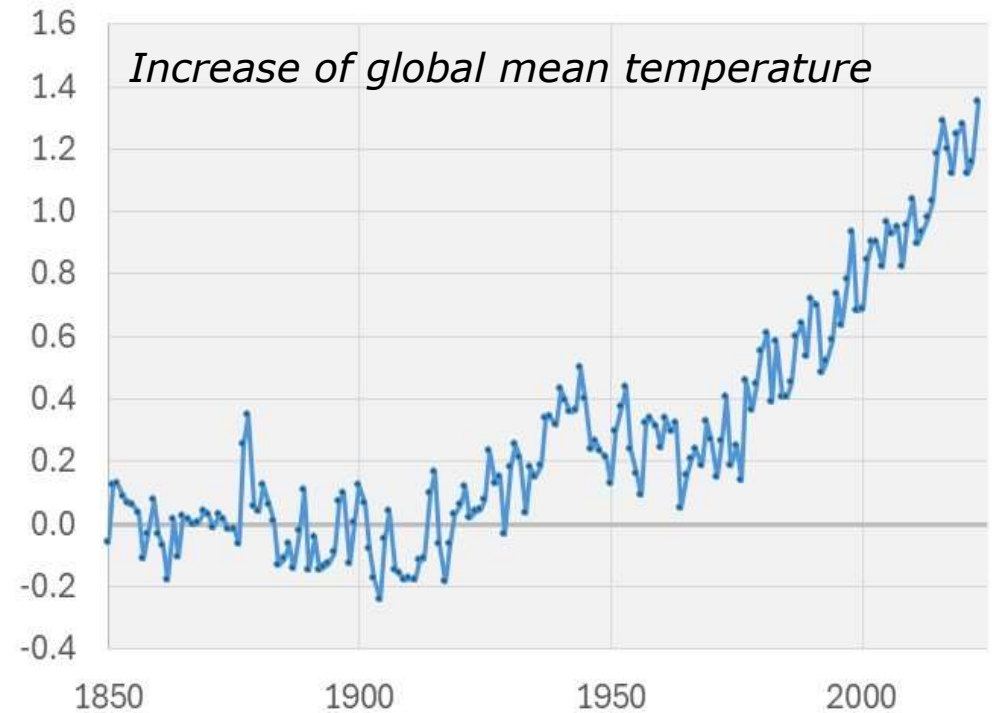
News: Climate researchers : 1.5-target is getting rapidly out of reach, rapid – deep and immediate action necessary.



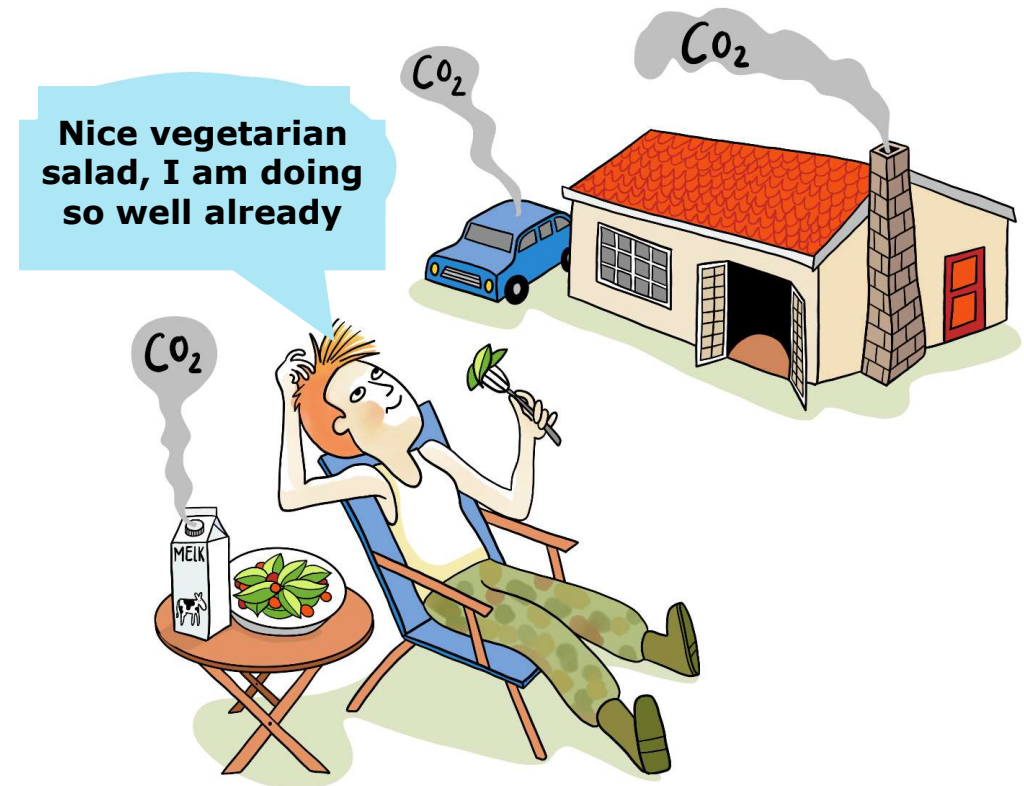
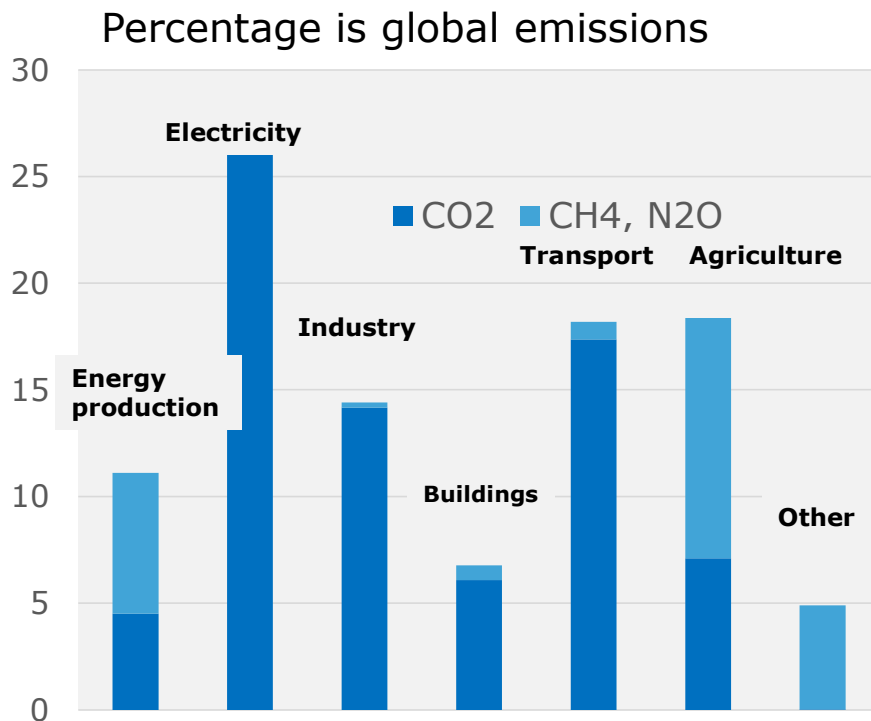
Detlef van Vuuren
Senior researcher PBL
Professor Universiteit Utrecht
Lead Author IPCC reports

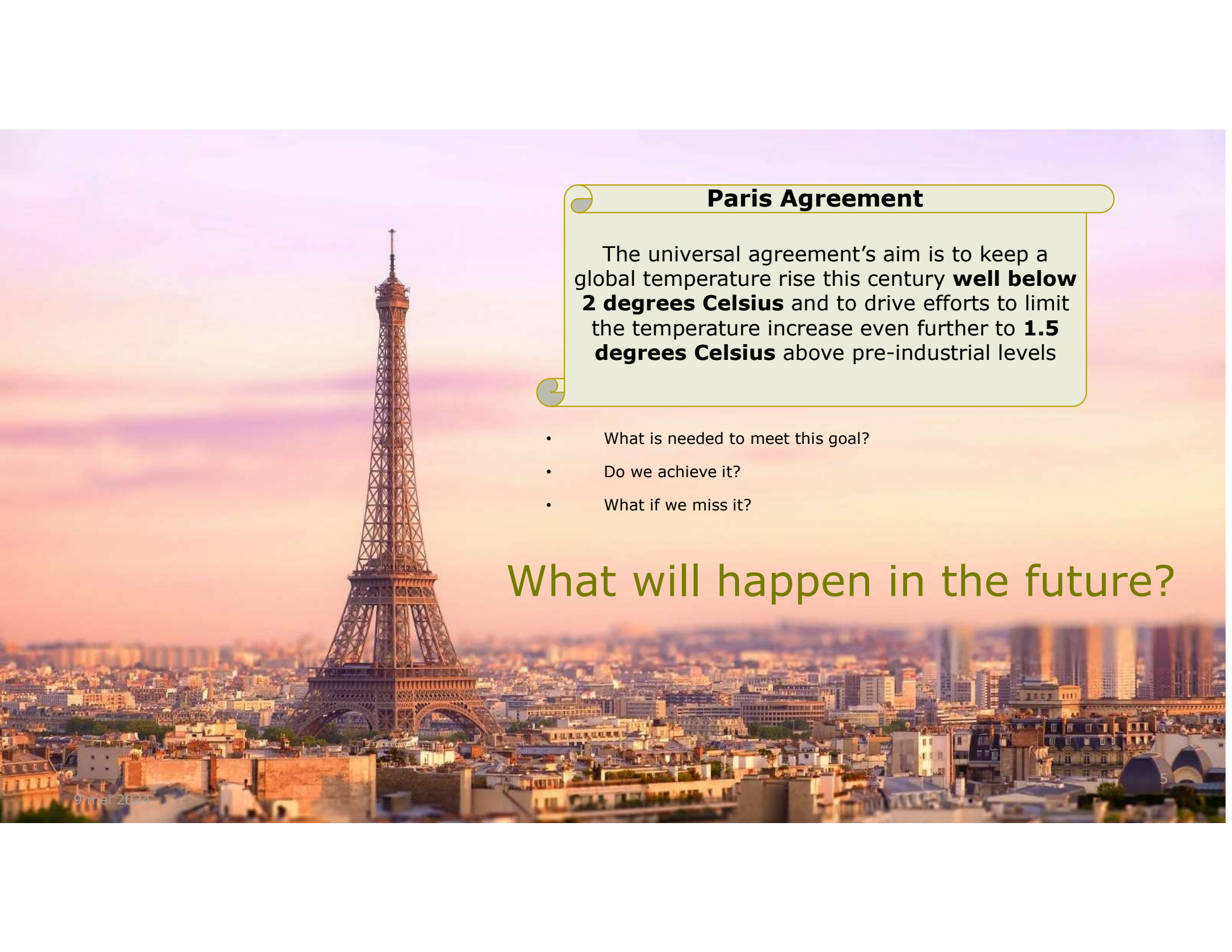


Climate change is clearly visible



And emissions are related to everything we do





Paris Agreement

The universal agreement's aim is to keep a global temperature rise this century **well below 2 degrees Celsius** and to drive efforts to limit the temperature increase even further to **1.5 degrees Celsius** above pre-industrial levels

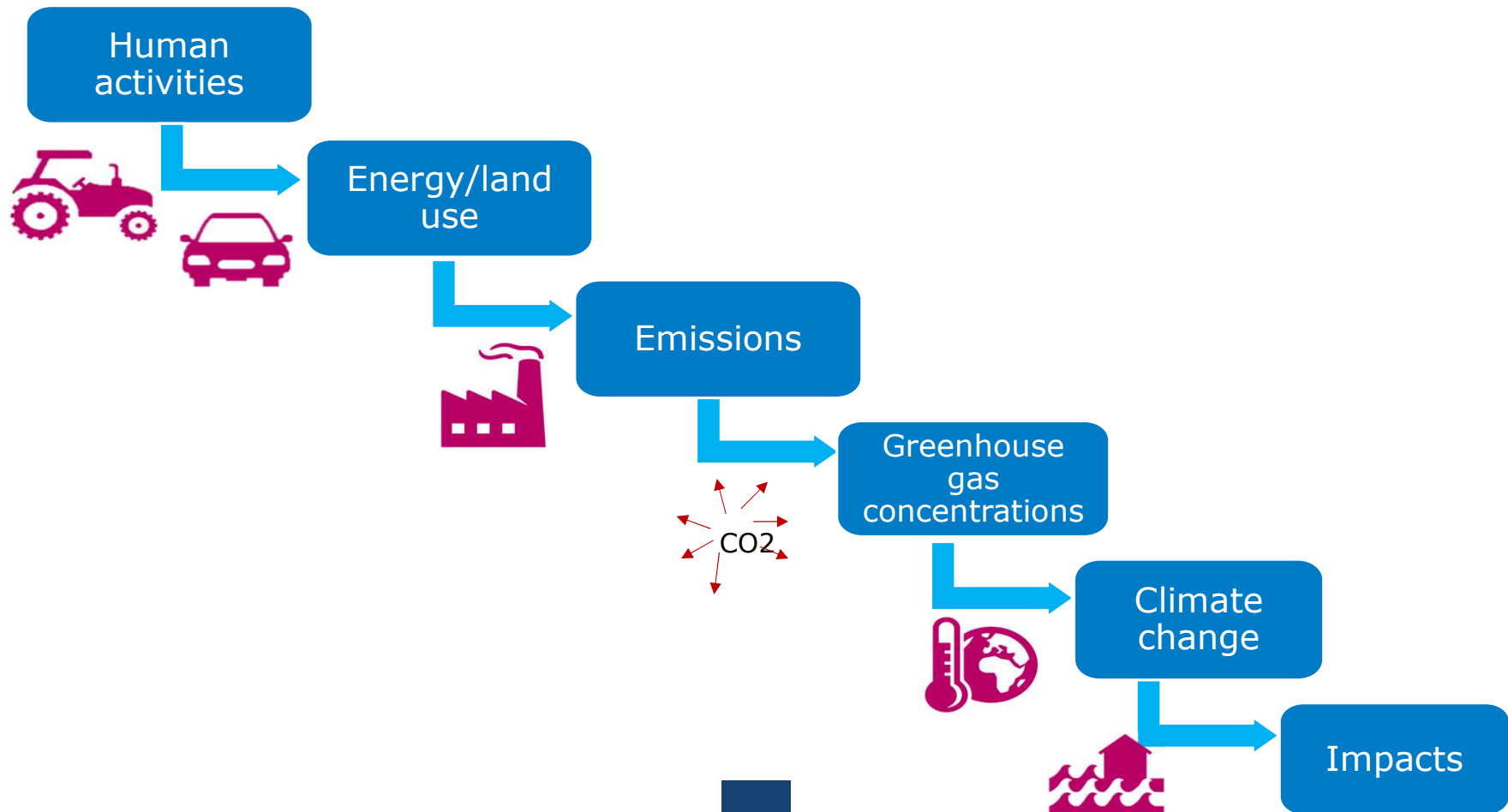
- What is needed to meet this goal?
- Do we achieve it?
- What if we miss it?

What will happen in the future?



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What will happen in the future?



Human system



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Earth system

Energy/
Land use

Emissions

Greenhouse gas
concentrations

Climate change

Impacts

Population

**Socio-economic
development**

Technology

Political change

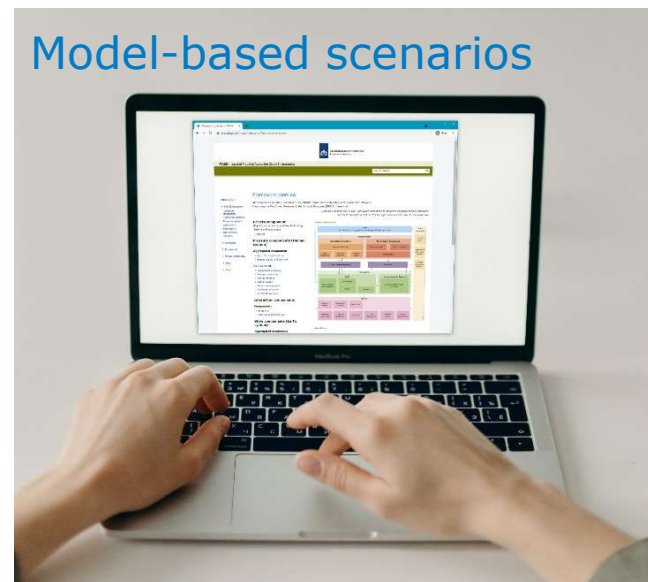
Policy

**Demand for food,
energy and water**

Environmental problems
Climate change
Scarcity

Different scales
Different time periods
Uncertainty

Model-based scenarios



Model-based scenarios



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Energy/
Land use

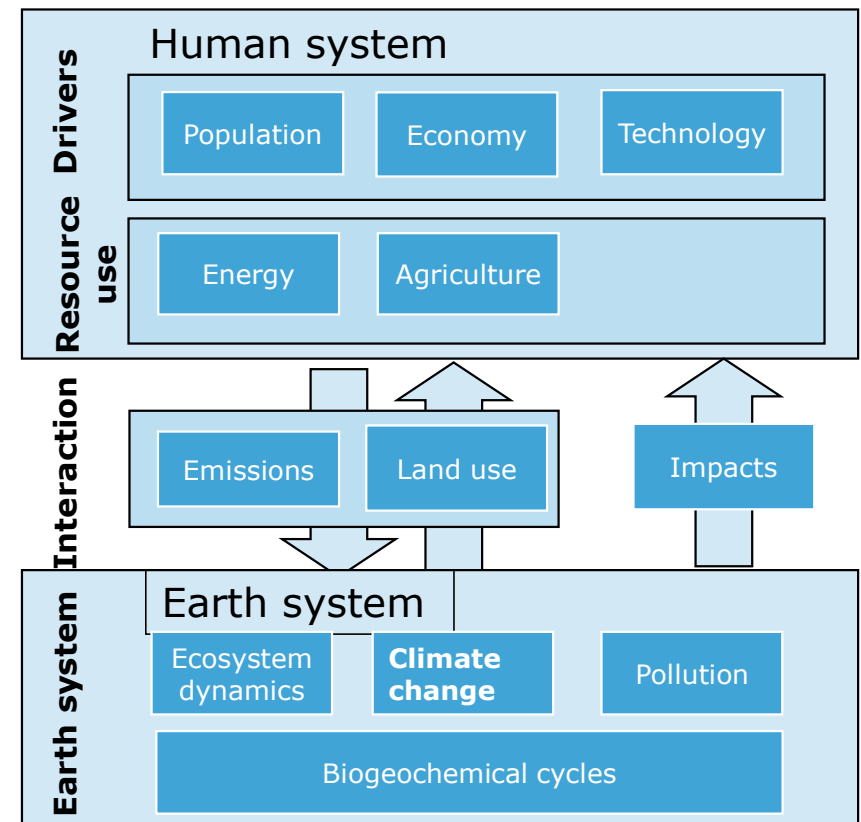
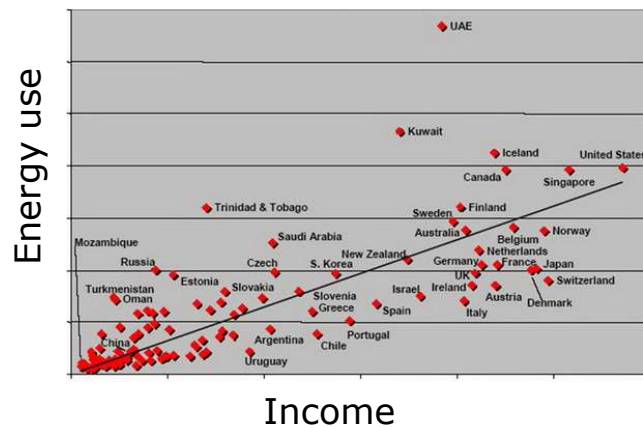
Emissions

Greenhouse gas
concentrations

Climate change

Impacts

- Interaction of human system and environmental system
- Integration across different issues
- Focused on decisions processes (assessment)



Model-based scenarios

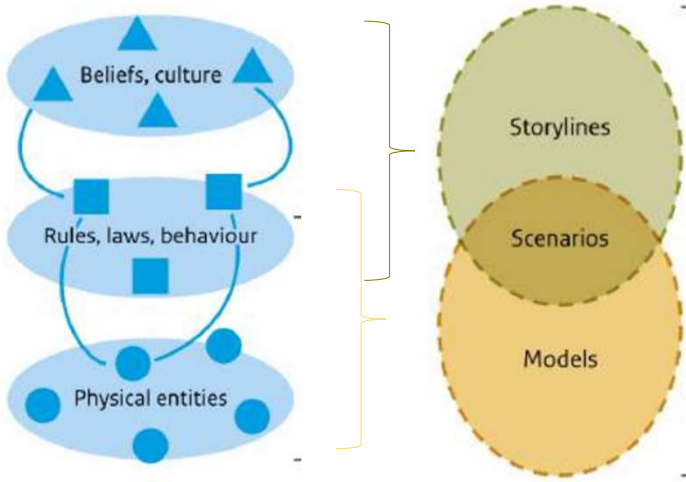


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Describe evolution of future systems

Available tools



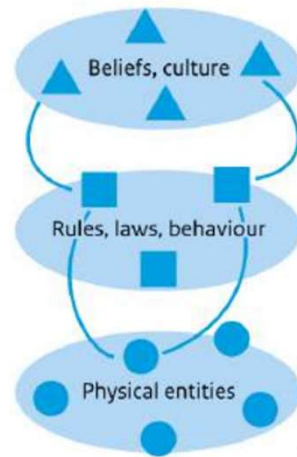


Model-based scenarios

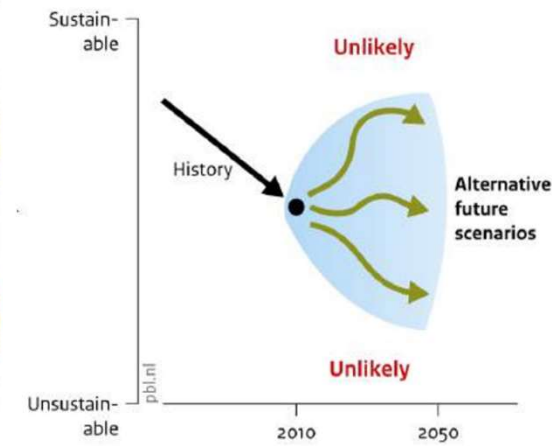
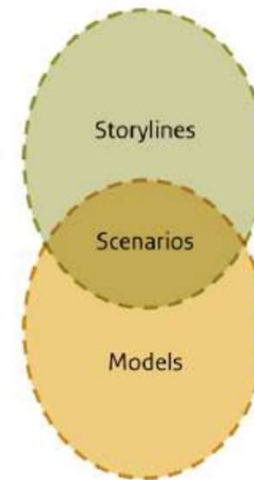
Scenarios:

- Combination of narratives and modelling
- Modelling where there is enough knowledge to define quantitative relationships
- Narratives where there is need for complexity and flexibility

Describe evolution of future systems



Available tools



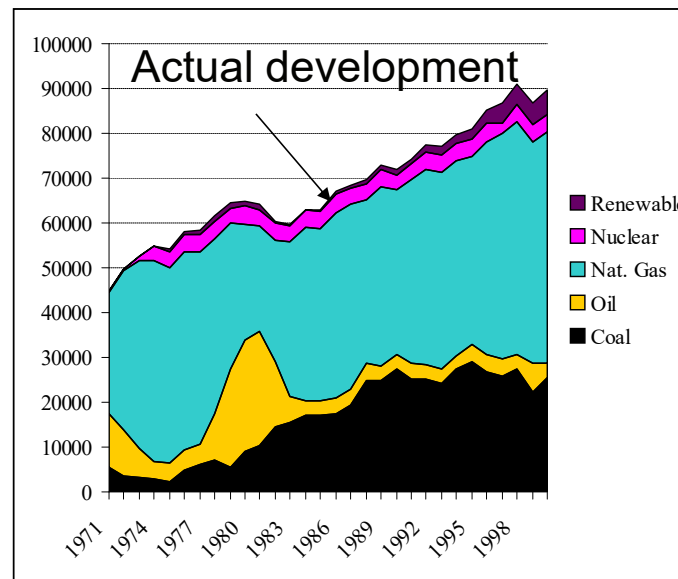


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Model-based scenarios

31 Maart 1972

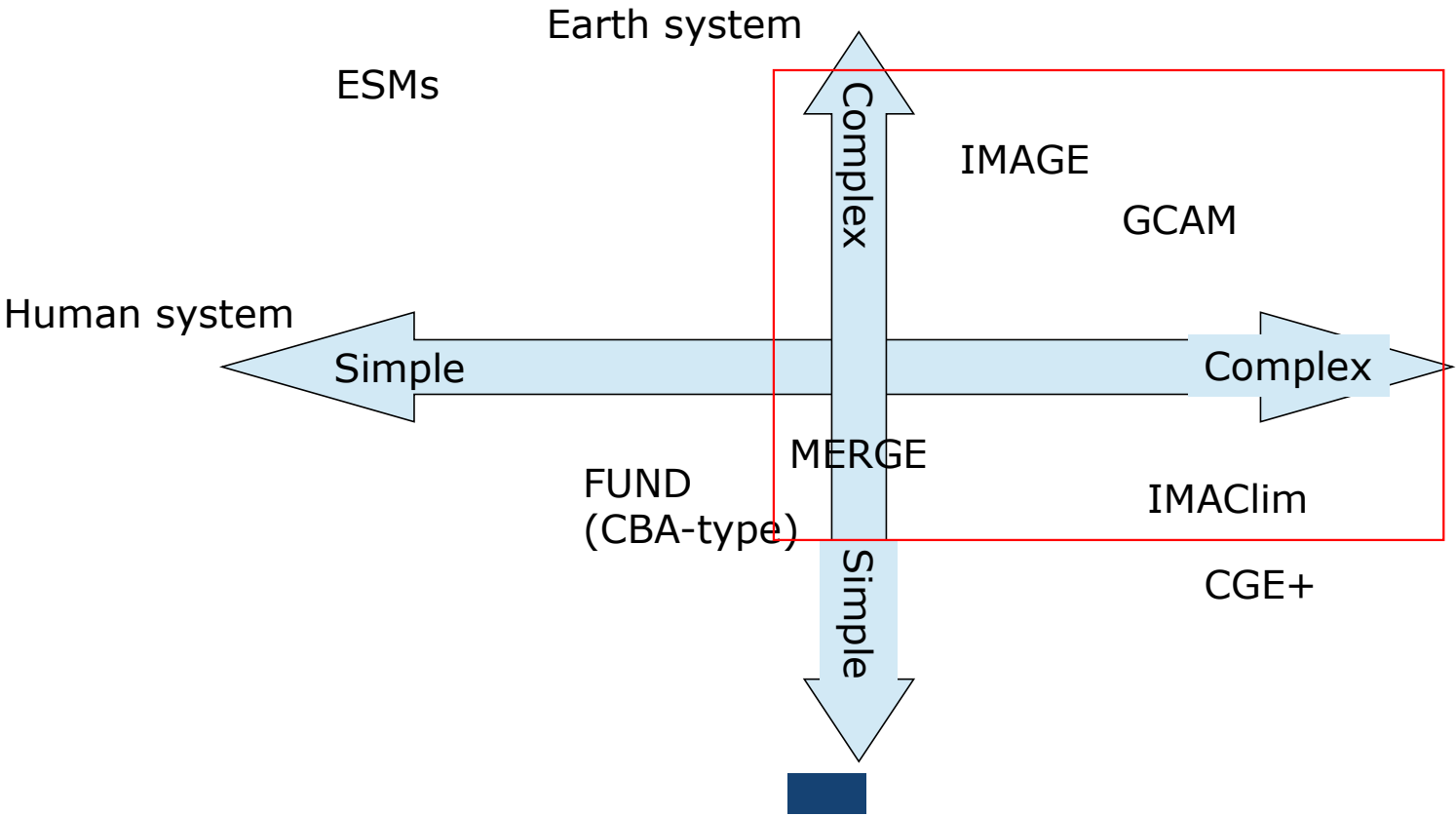
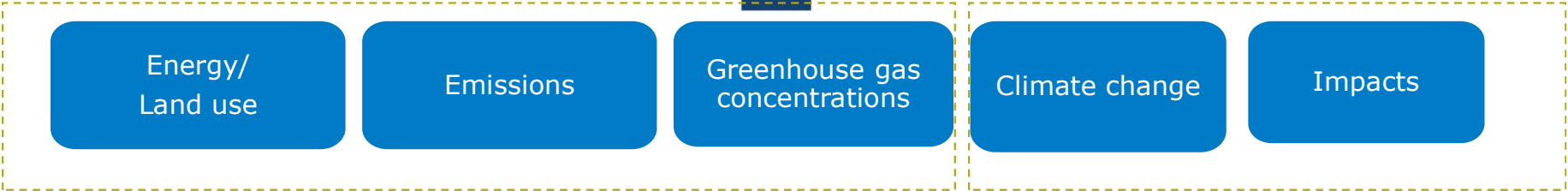


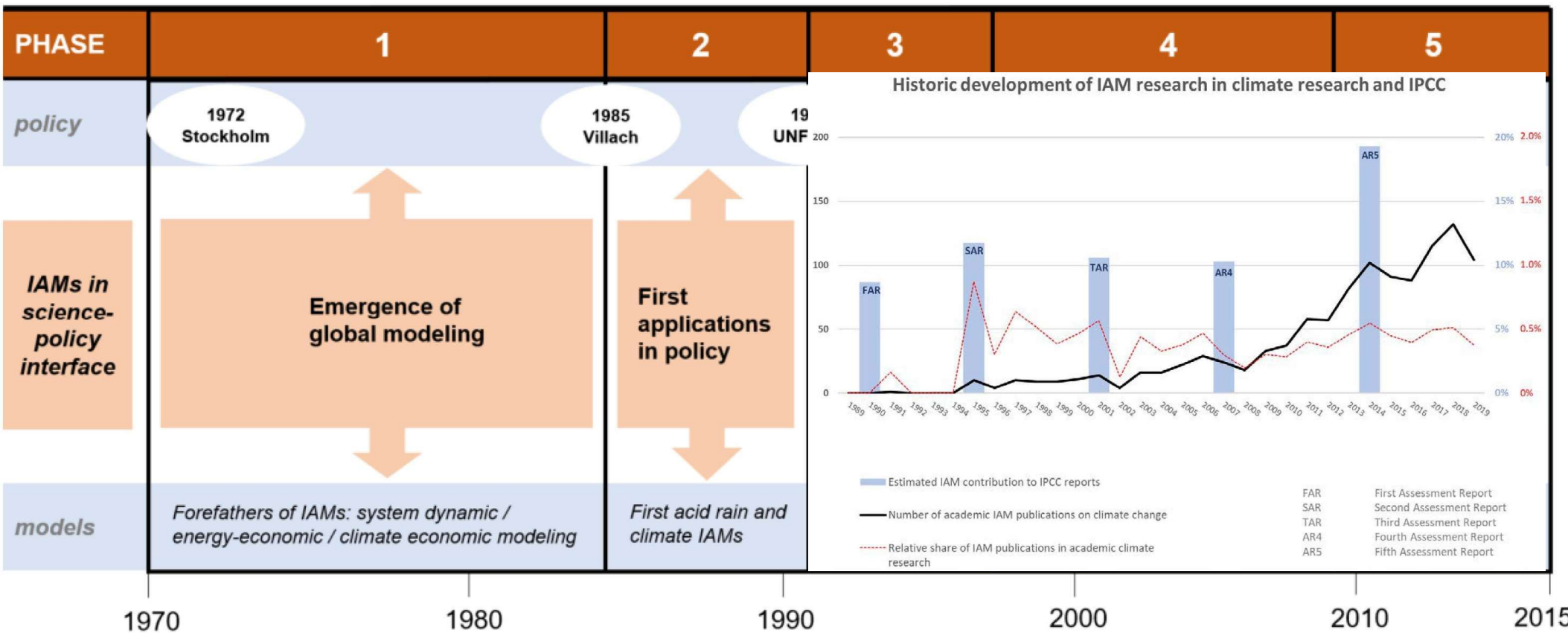
This wrong prediction influenced energy policy in the Netherlands to try to sell out natural gas in avoid getting stuck with it in the ground.

Model-based scenarios

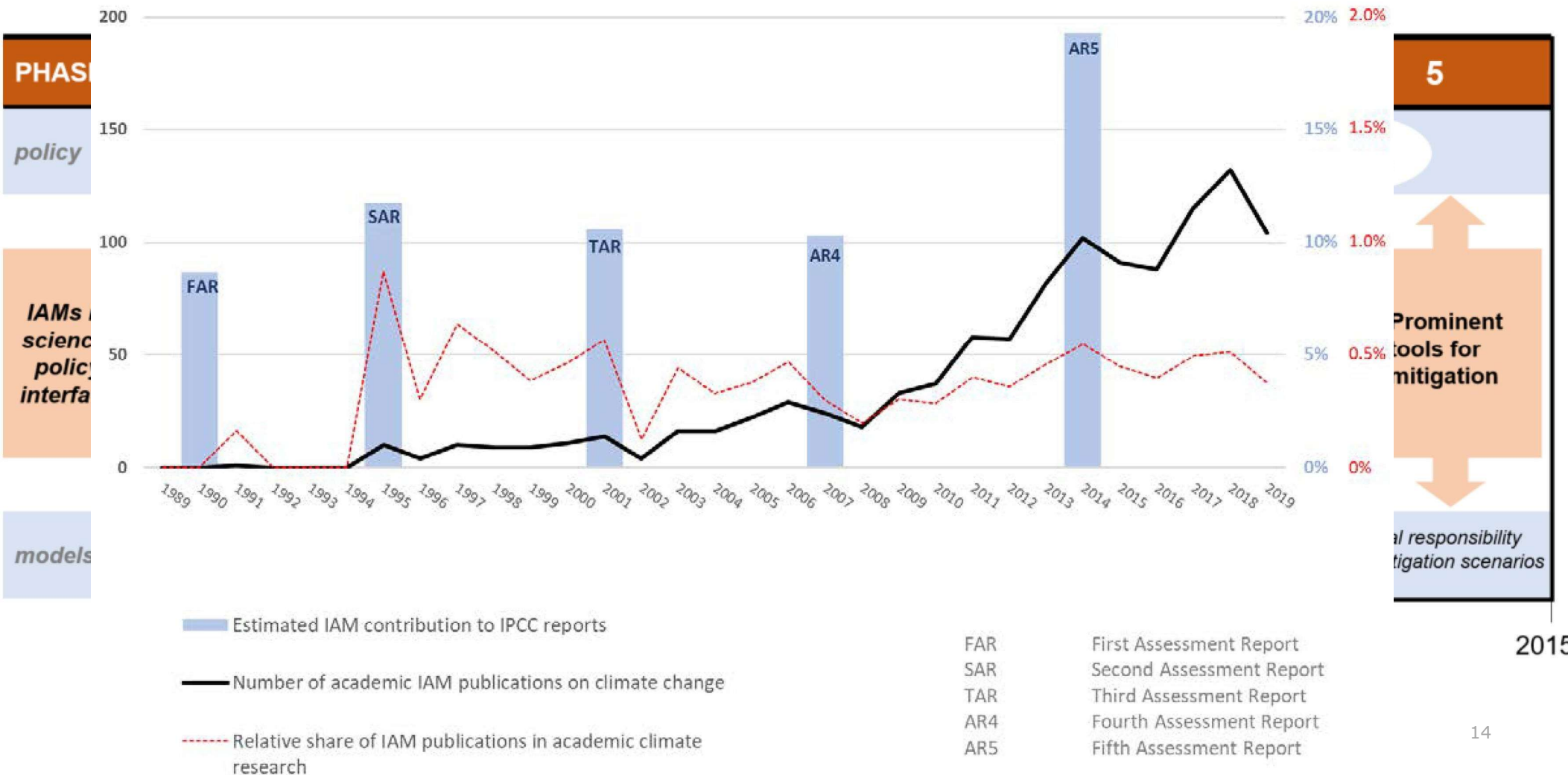


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Historic development of IAM research in climate research and IPCC





Model-based scenarios

Meadows – 1972: If the present growth trends continue unchanged, the limits to growth on this planet will be reached sometime within the **next one hundred years**.

Meadows – 2005: In 1972 the model showed a time of crises 50-70 years into the future; now the crises appear **10-30 years** in the future.



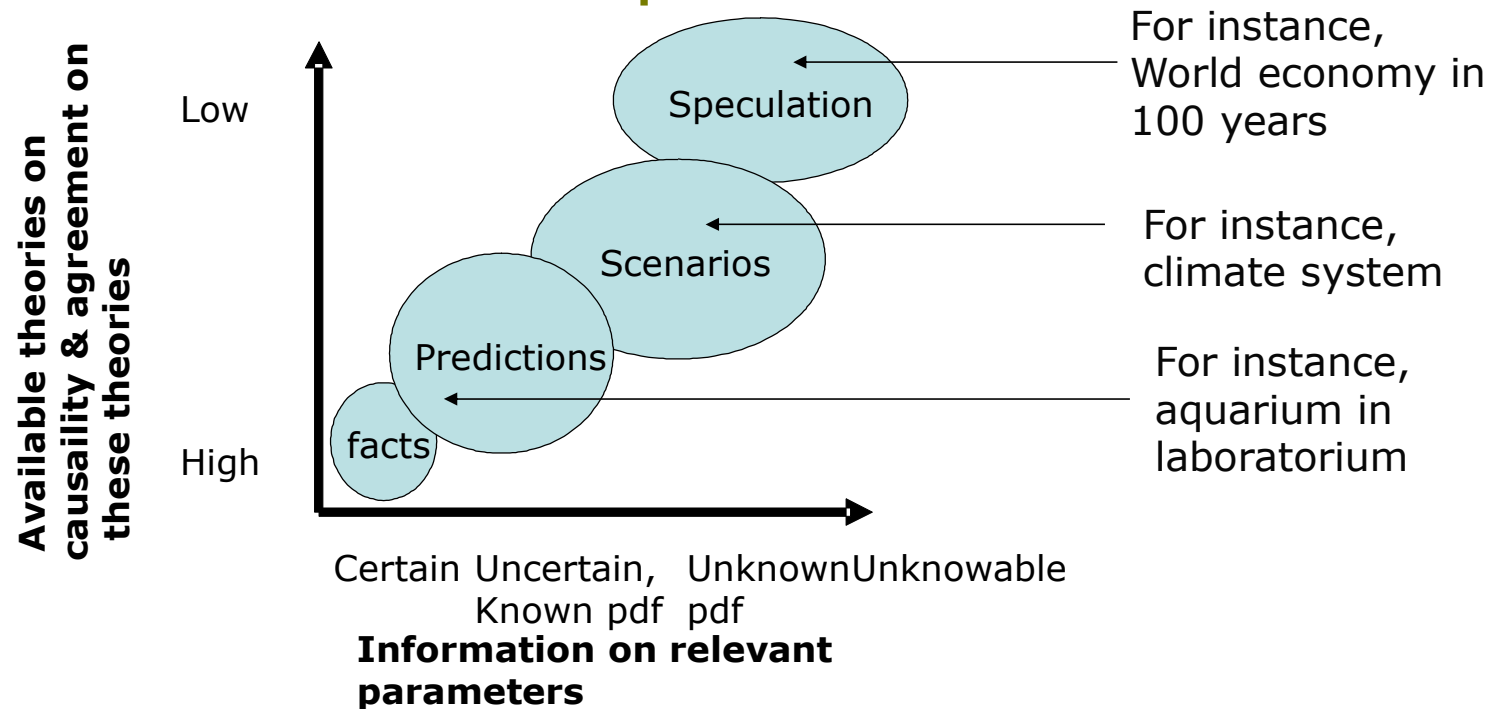
There are no limits to the growth of energy consumption, although present systems are clearly finite. I do not fear a lack of sources to complete this journey unscathed

(Willems
– Shell Oil)





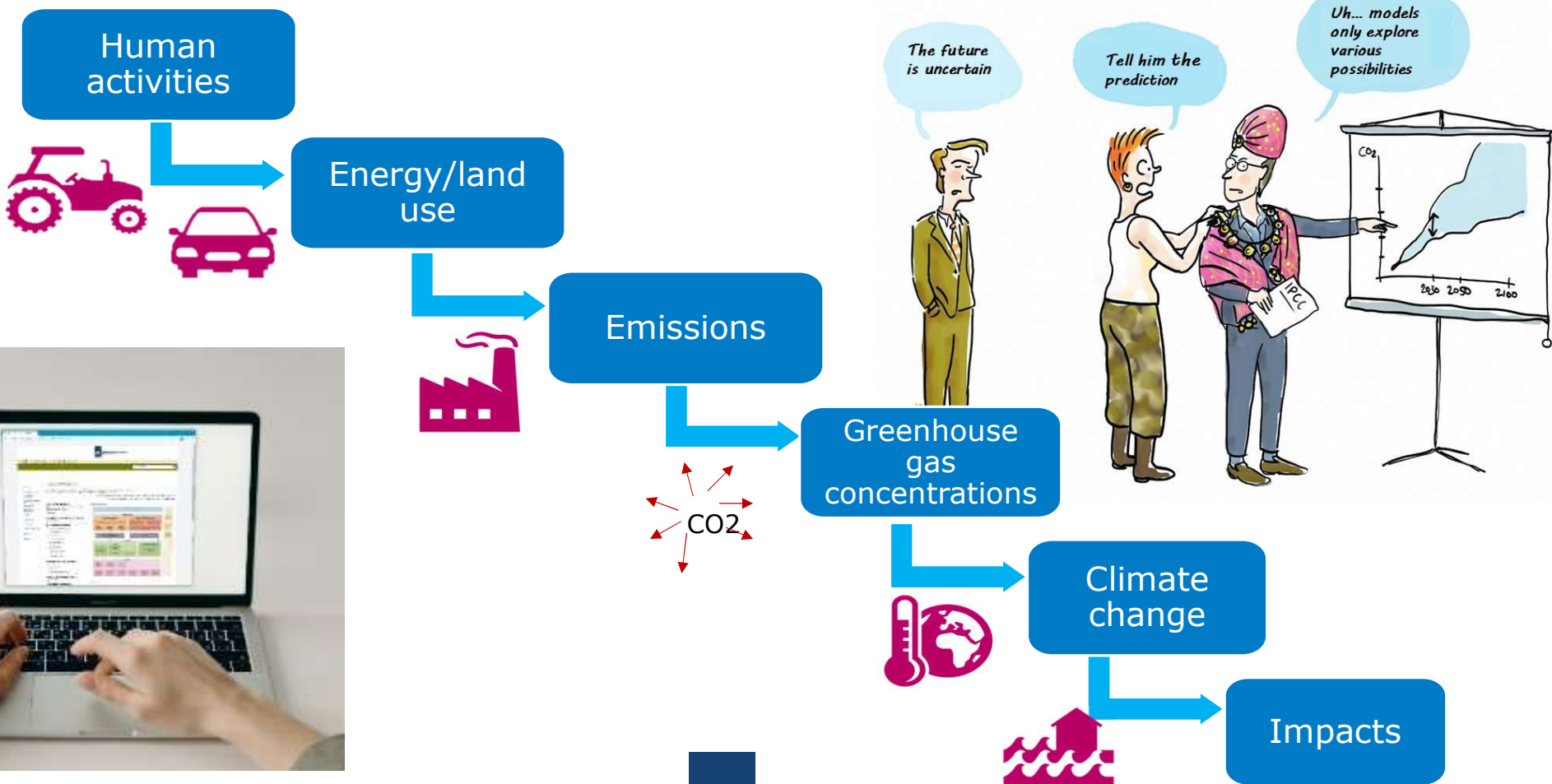
Different tools to explore the future





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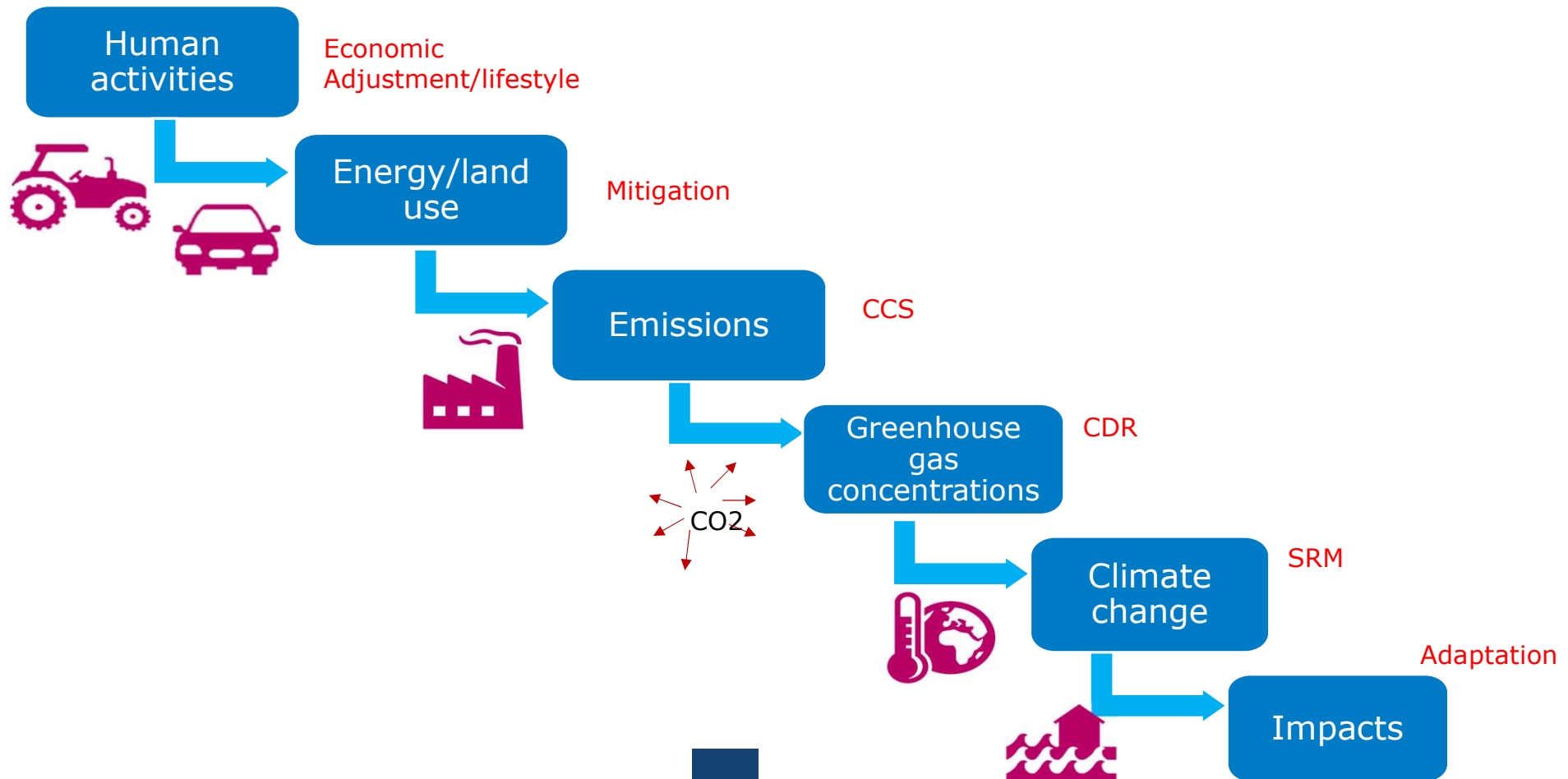
What will happen in the future?





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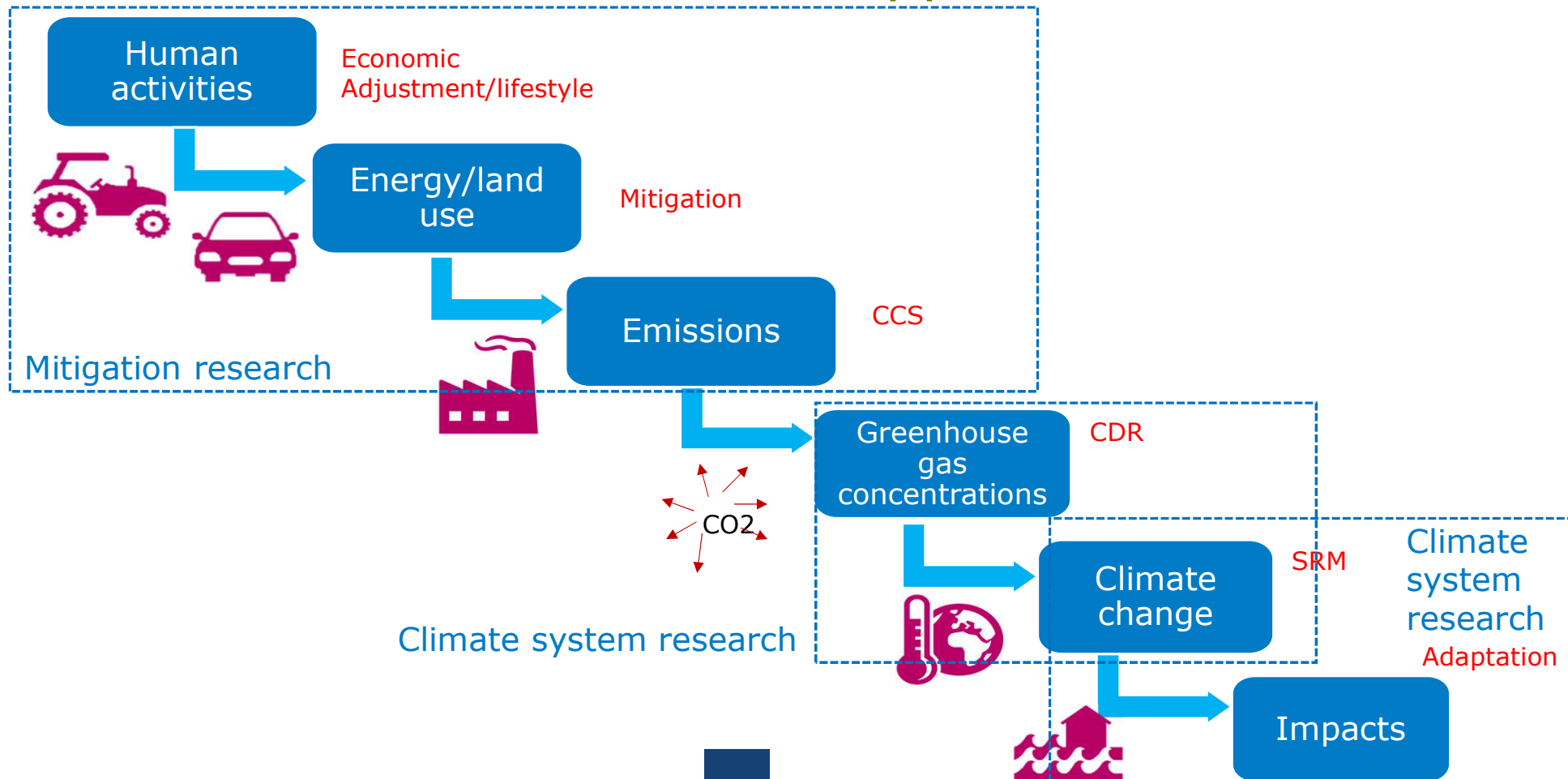
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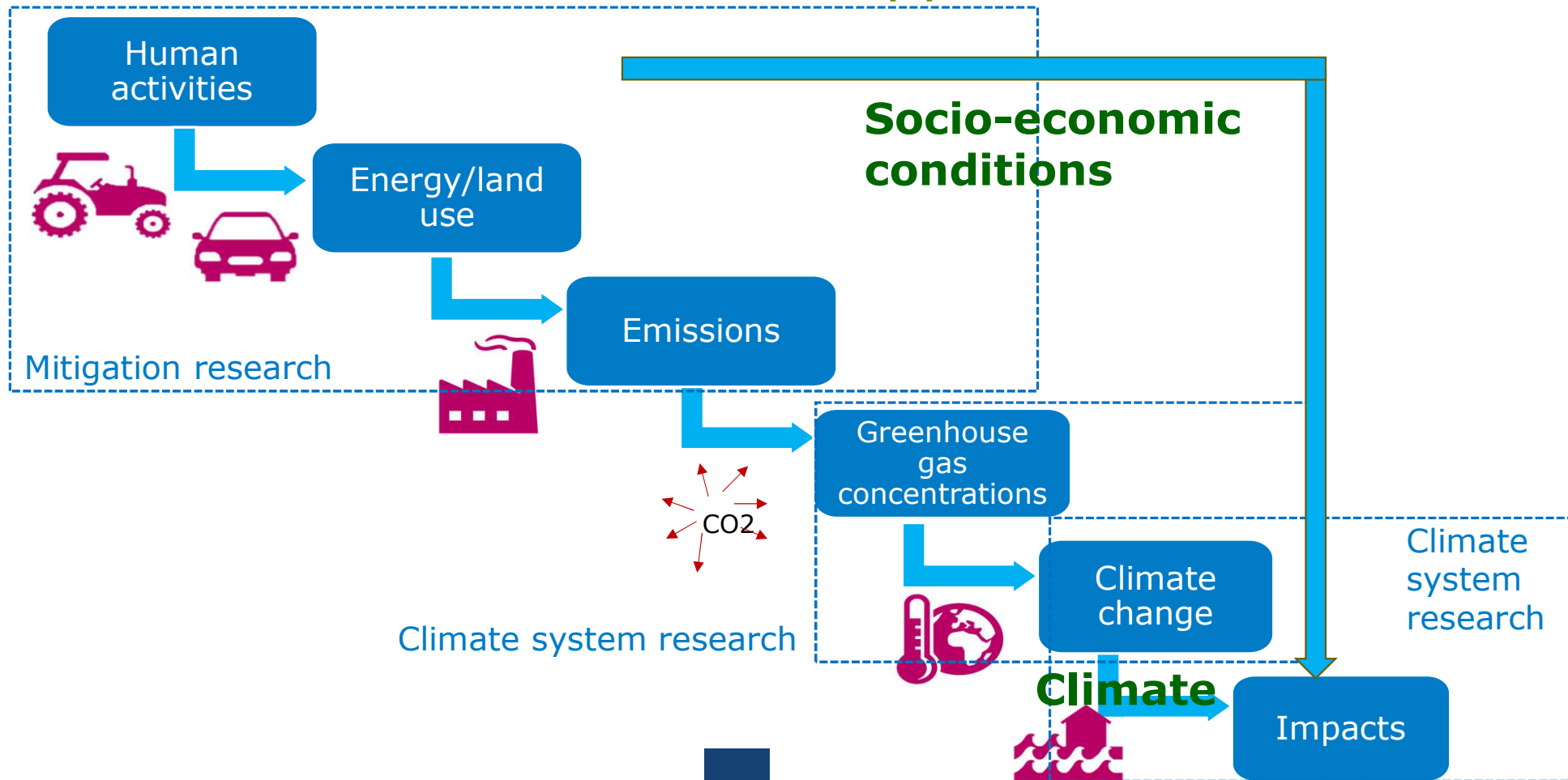
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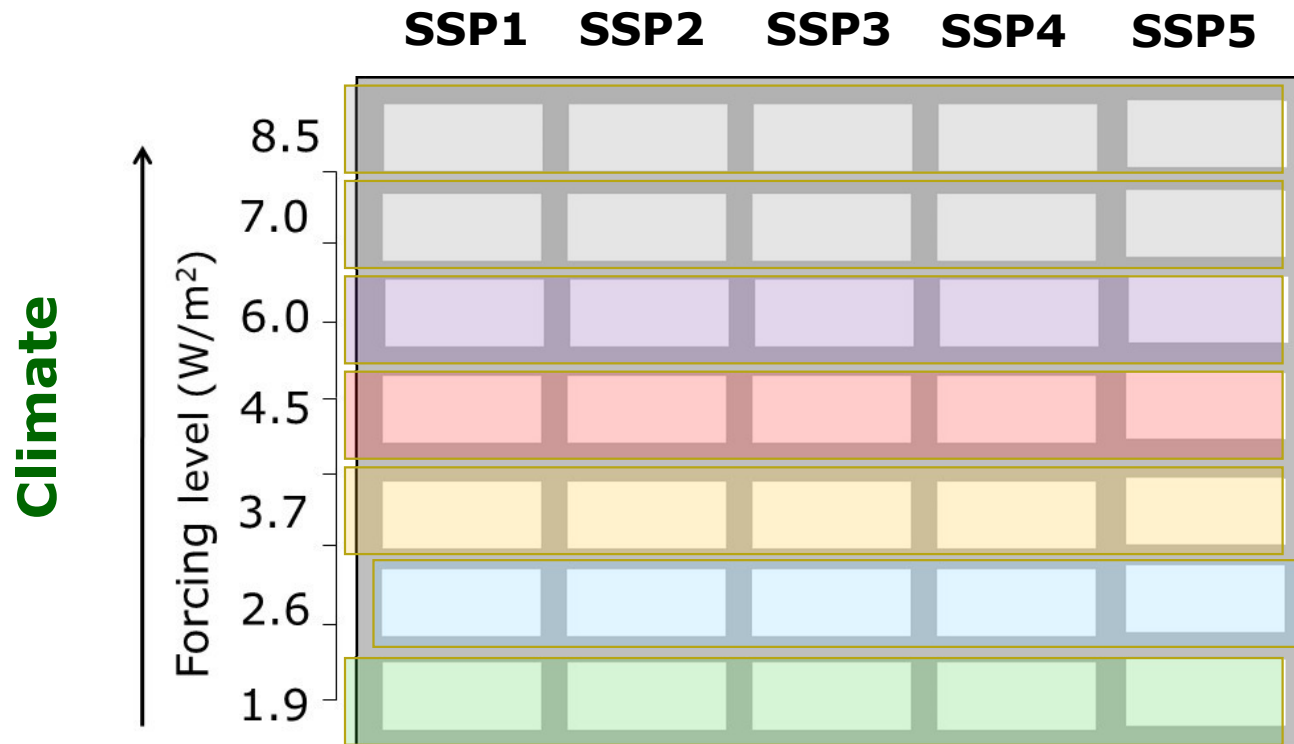
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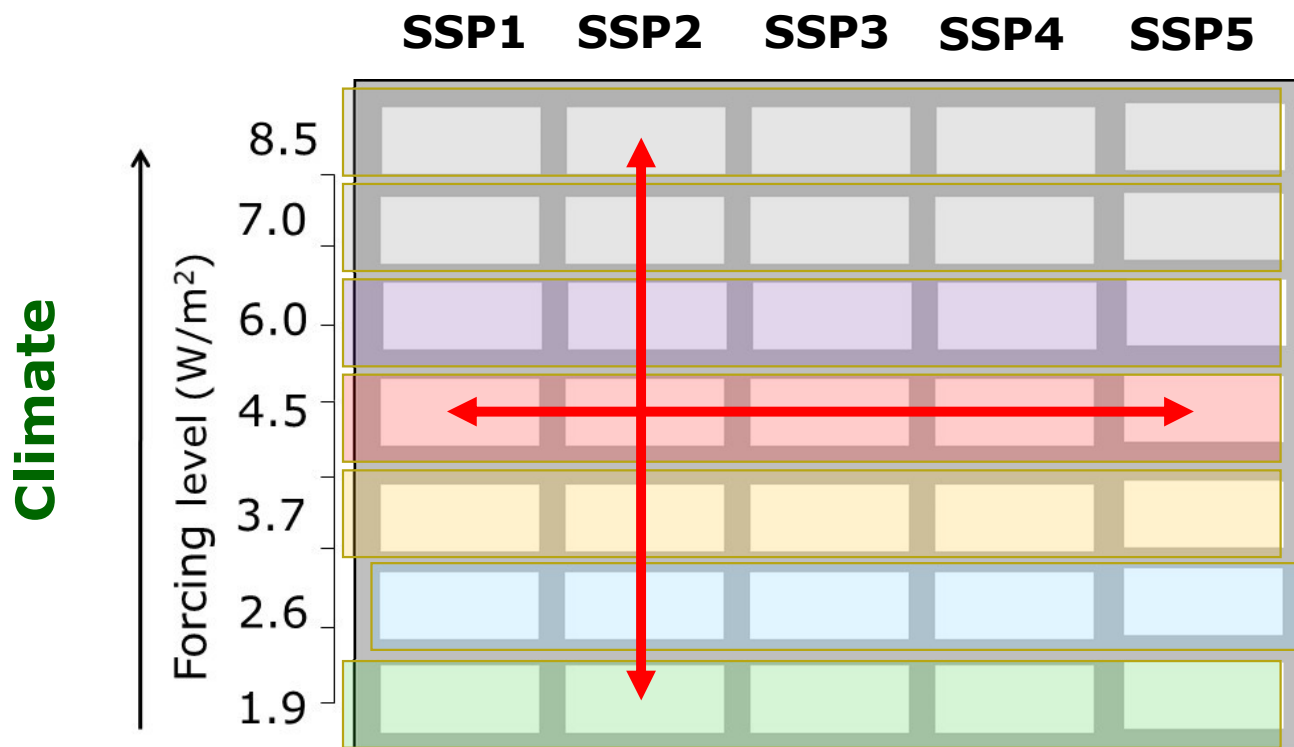
Socio-economic conditions

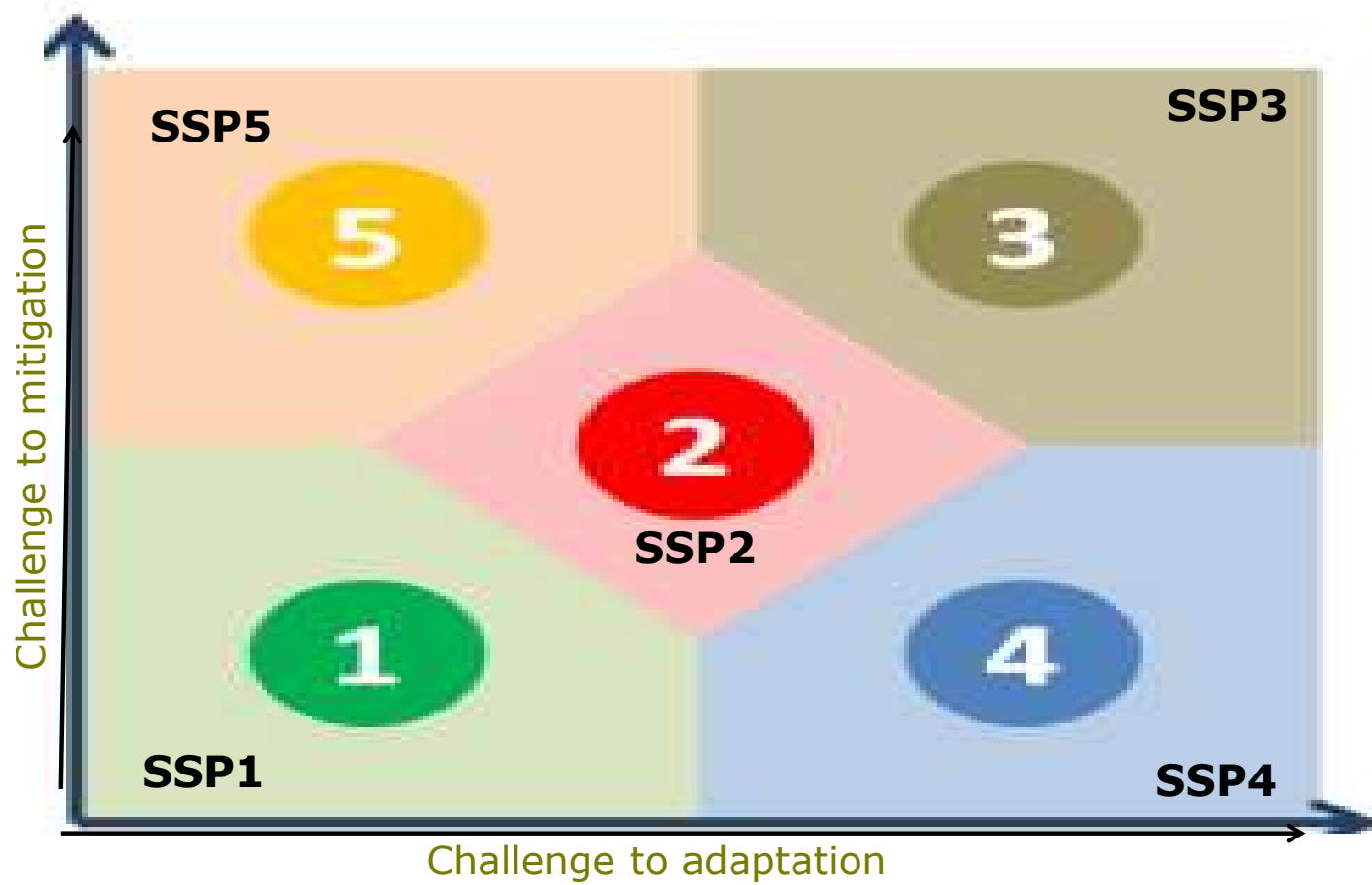




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Socio-economic conditions







Shared Socio-economic Pathways: 5 possible stories about the future

SSP5: Fossil fuel-ed development

- Rapid growth, free trade
- High technology development,
- Environment and social goals not a priority: adaptive, technology-fix
- Focus on economic growth



Markets first



Clash of civilisations

SSP3: Regional rivalry

- Competition among regions
- Low technology development
- Environment and social goals not a priority
- Focus on domestic resources
- High population growth
- Slow economic growth dev. countries

SSP1: Green growth

- Global cooperation
- Rapid technology dev.
- Strong env. policy
- Low population growth
- Low inequity
- Focus on renewables and efficiency
- Dietary shifts
- Forest protection



UN world

SSP2: Middle of the Road



Have's and have not's

SSP4: Inequality

- Inequality across and within regions
- Low technology development
- Environment priority for those that can afford
- Limited trade



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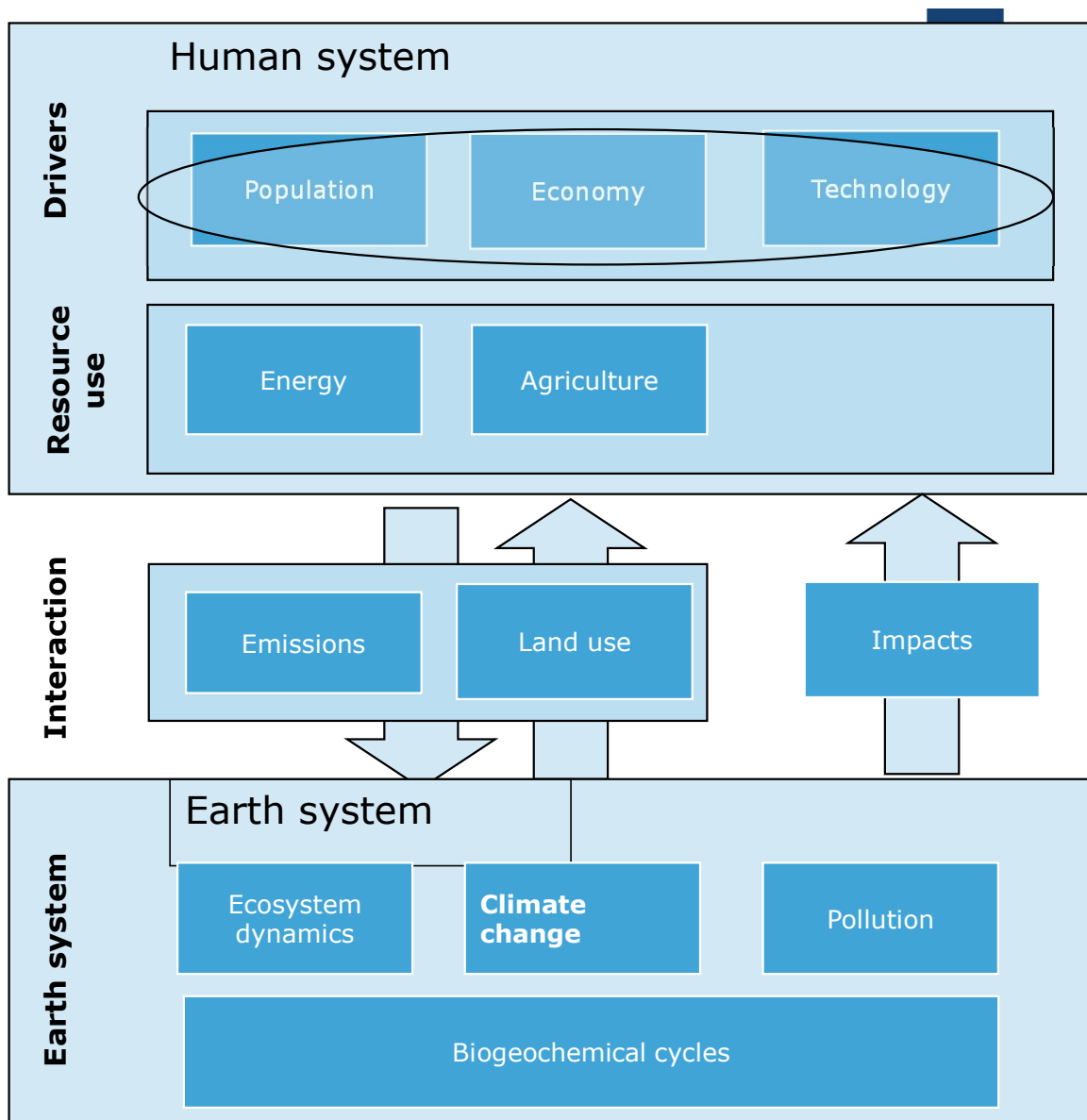


NEW SSP Pop & GDP

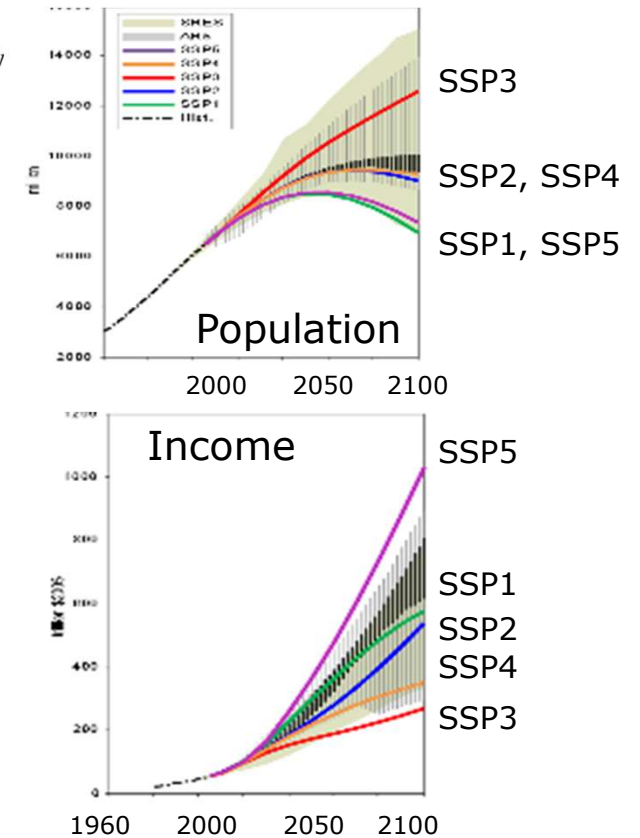
Technology

SPAs

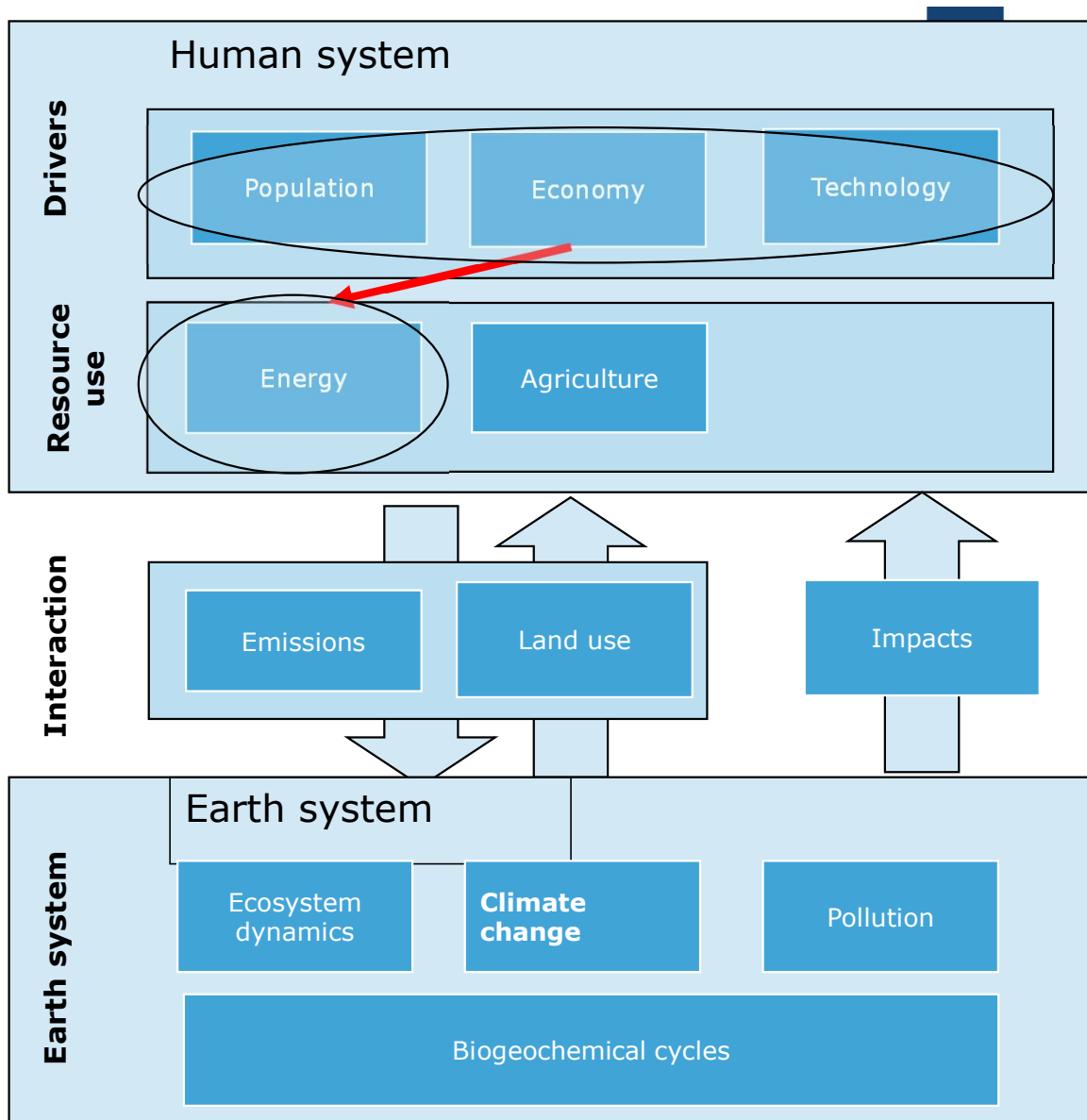
	SSP1 Sustainability	SSP2 Middle of the Road	SSP3 Fragmentation	SSP4 Inequality	SSP5 Development First
2100 Population [billion] (IIASA)	Low (5 th)	Middle (3 rd)	High (1 st)	Middle (2 nd)	Low (4 th)
2100 GDP [trillion 2005 USD, PPP] (OECD)	High (2 nd)	Middle (3 rd)	Low (5 th)	Low/middle (4 th)	Very high (1 st)
Energy Service Demands	Low	Medium	High	Medium	High
End-Use Technology	High	Medium	Low	Low / High	Medium
Nuclear / CCS	Low	Medium	Medium	Mixed	Medium
Renewable Technology	High	Medium	Low	High	Medium
Fossil Fuel Extraction	Low	Medium	High	Medium	High
Crop Yield Improvement	High	Medium	Low	Low / Medium	High
Accession to Carbon Market	All Instantaneous	Delayed	Delayed	Delayed	Delayed
Coverage of Carbon Tax	Universal	Universal	Fragmented	Fragmented	Universal



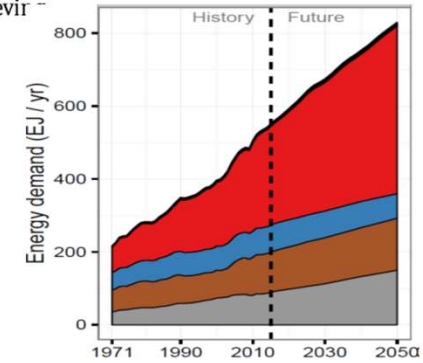
Water voor de Leefomgeving



- SSP1: Sustainable development
- SSP2: Middle of the road
- SSP3: Increasing competition
- SSP4: Divided world
- SSP5: Rapid growth



Levenswijze voor de Leefomgeving

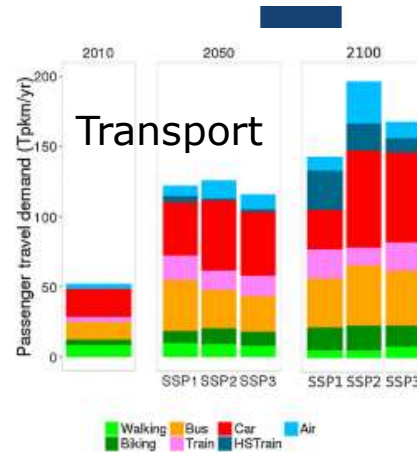
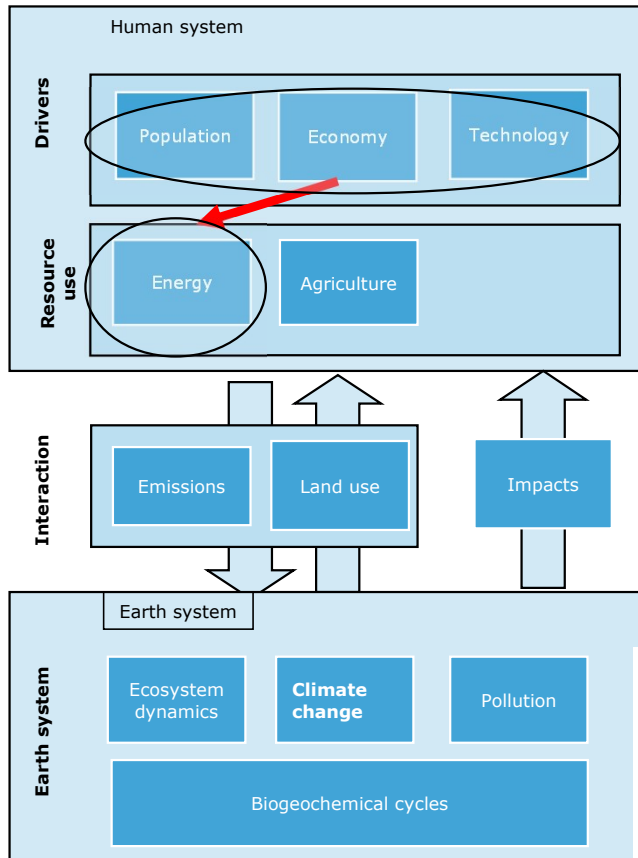


Electricity

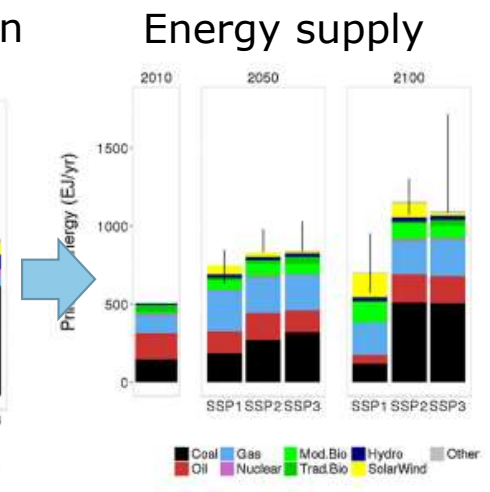
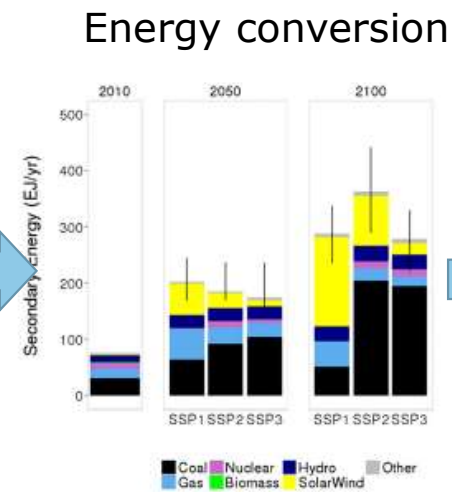
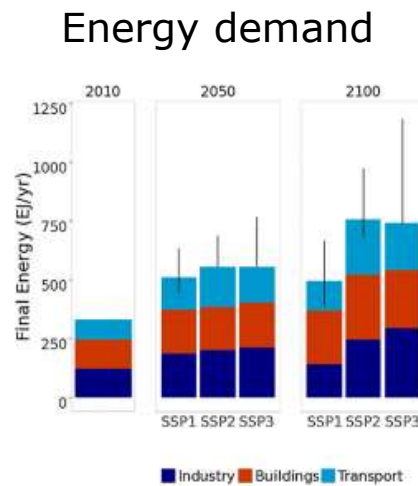
Buildings

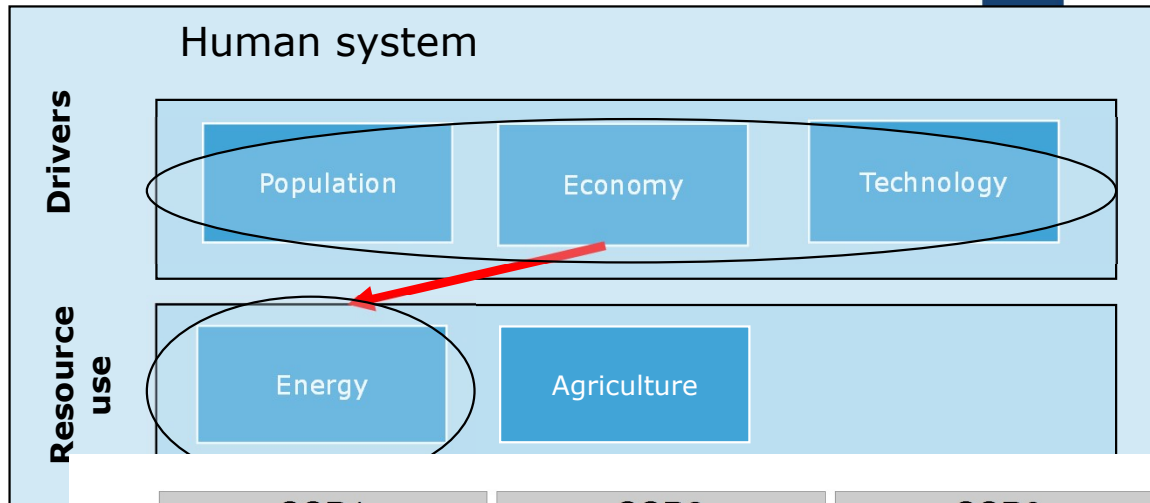
Industry

Transport

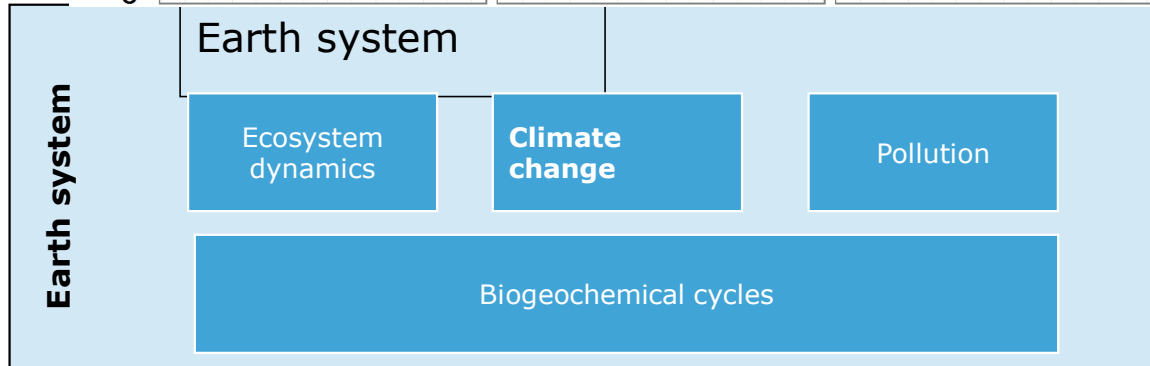
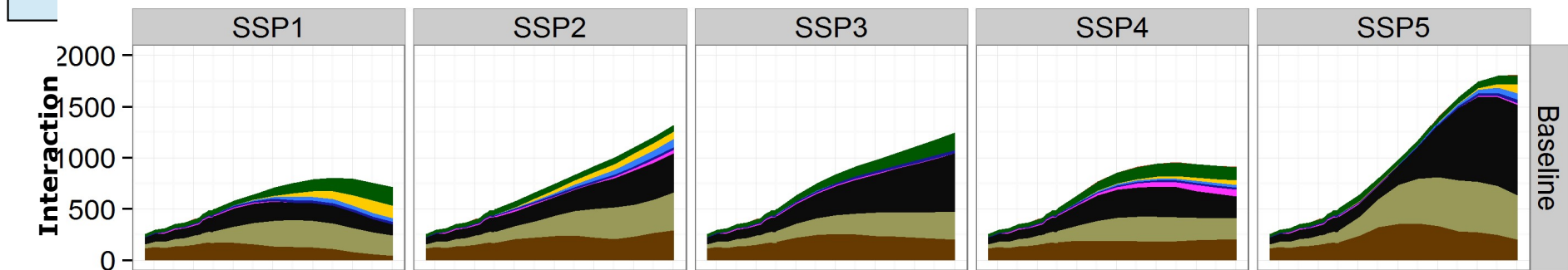
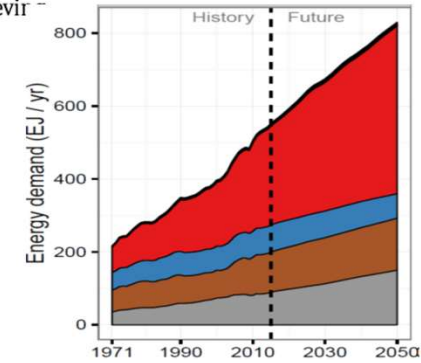


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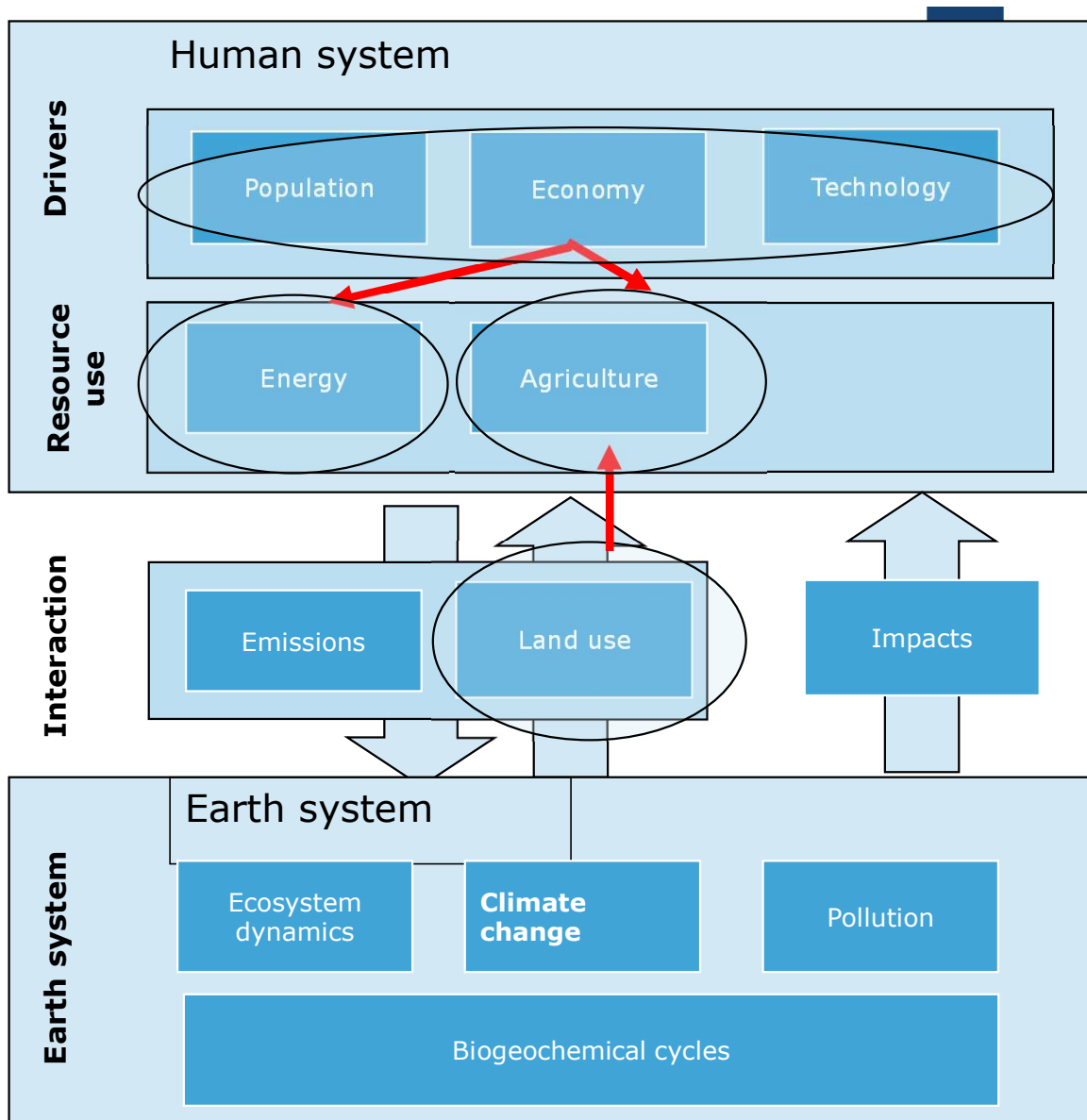




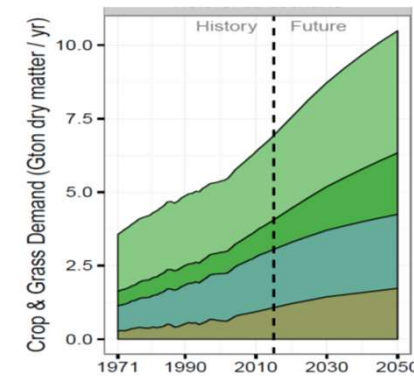
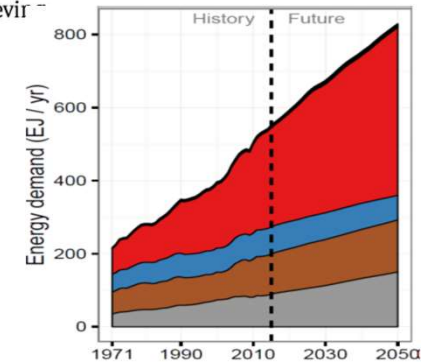
Levenswijze voor de Leefomgeving



- As a result, in all 5 stories without stringent climate policy:
 - further increase in global energy use
 - Fossil fuels continue to be important
 - Thus increasing greenhouse gas emissions



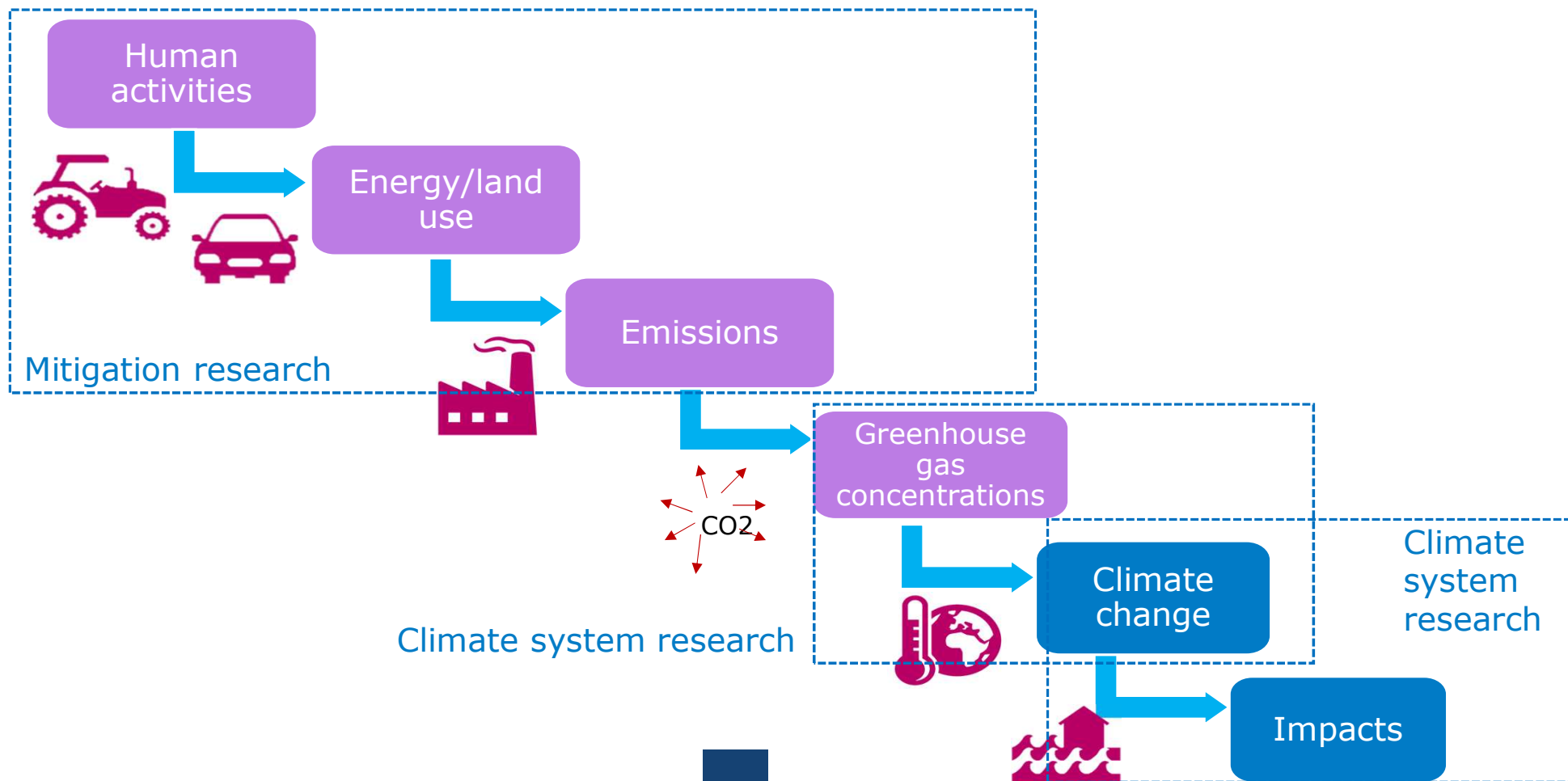
Levenswijze voor de Leefomgeving



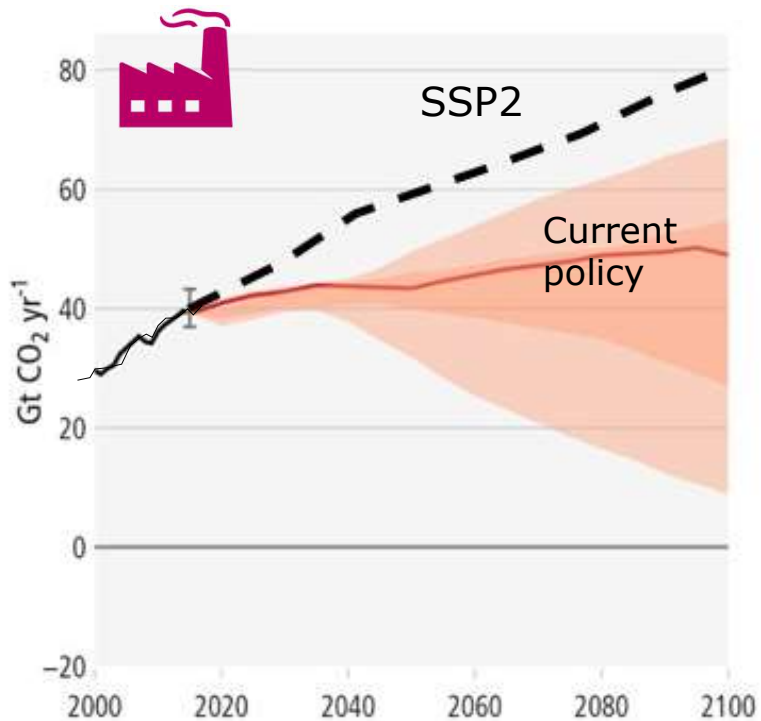
Interaction demand / supply

Allocation based on prices and preferences

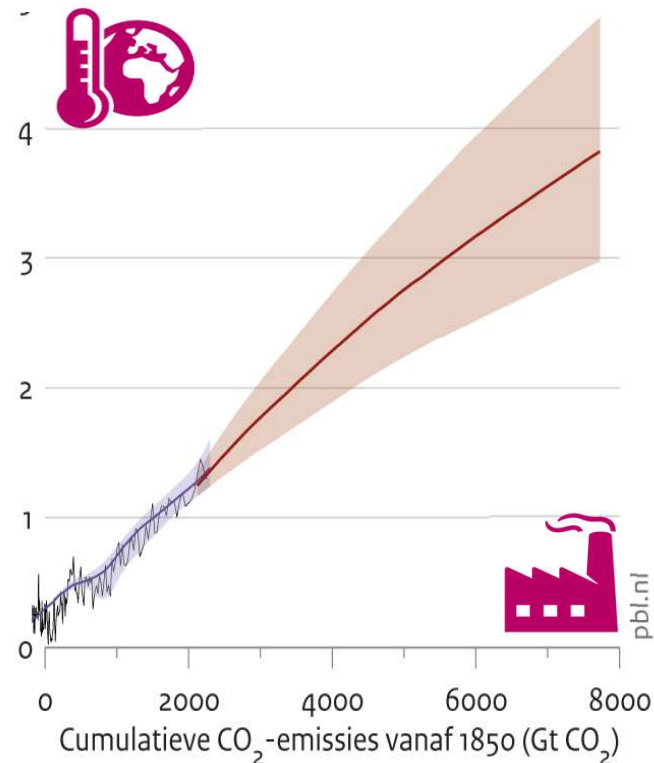
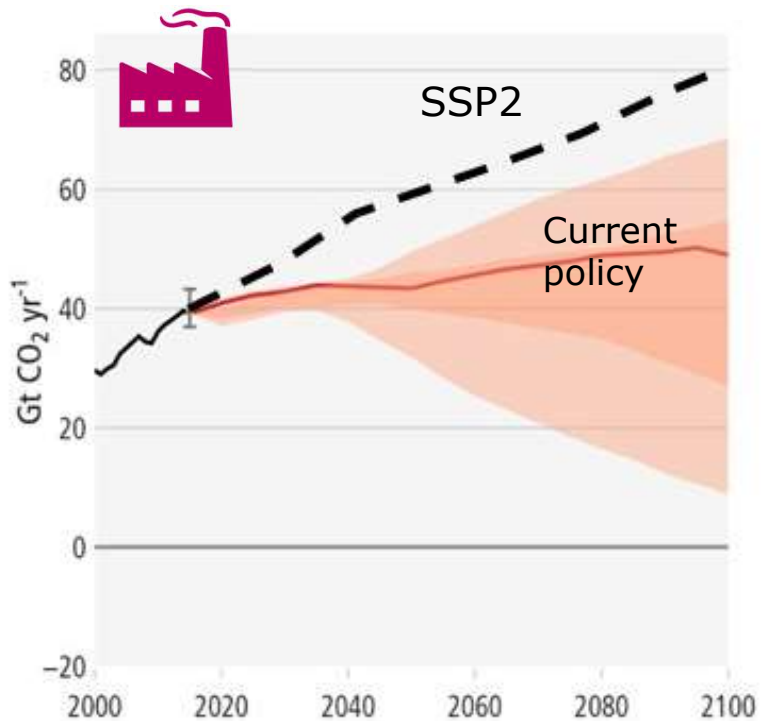
Detailed representation of processes (technology development, depletion) and sectors (e.g. transport)



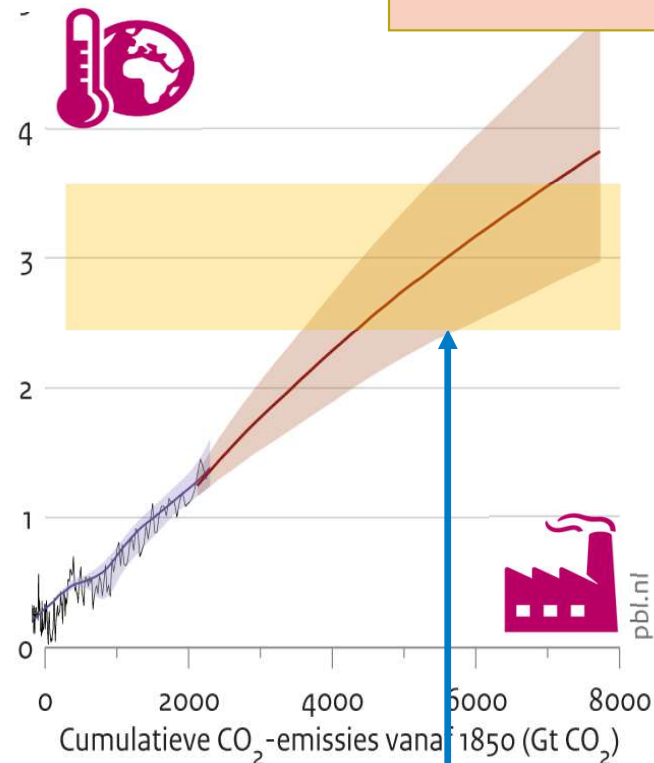
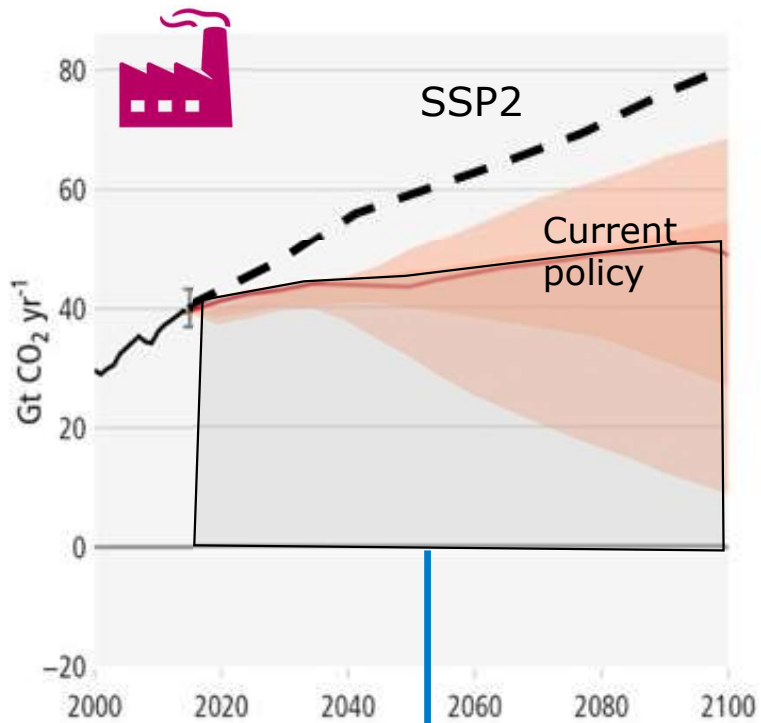
IPCC-2023: IAMs show that current policies could slow down emission growth, but won't lead to fundamental transition



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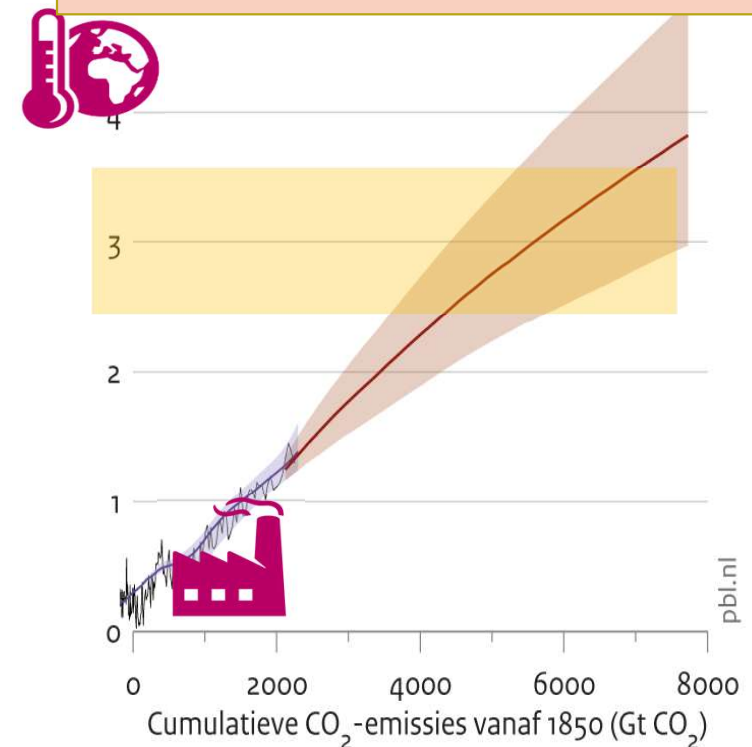


Increase of 2.2-3.5°C in 2100

IPCC-2023: IAMs show that current policies could slow down emission growth, but won't lead to fundamental transition

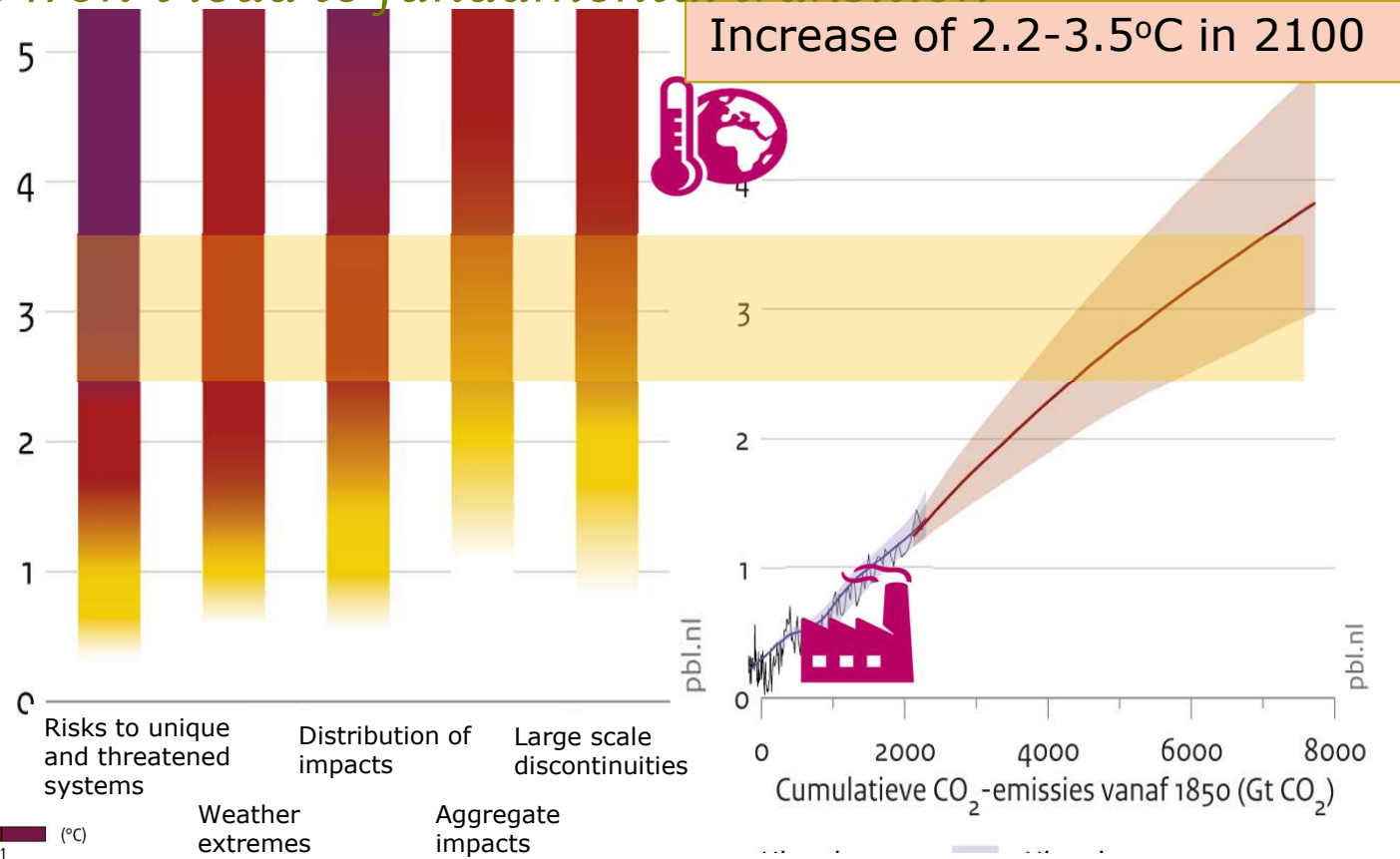
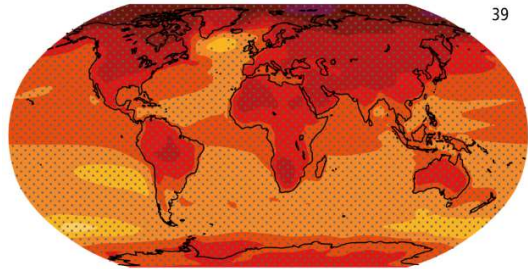
4 deg C

Increase of 2.2-3.5°C in 2100



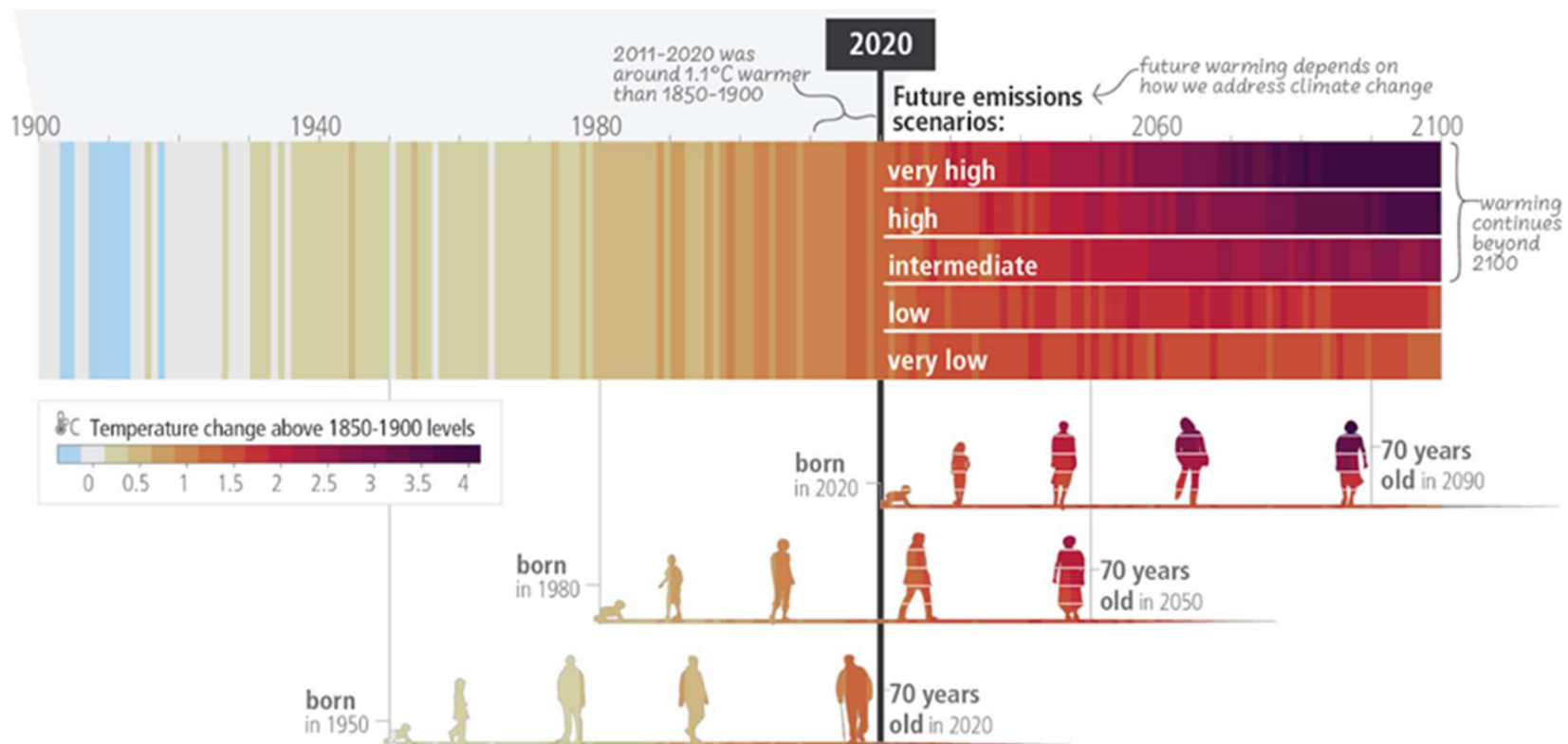
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4 deg C

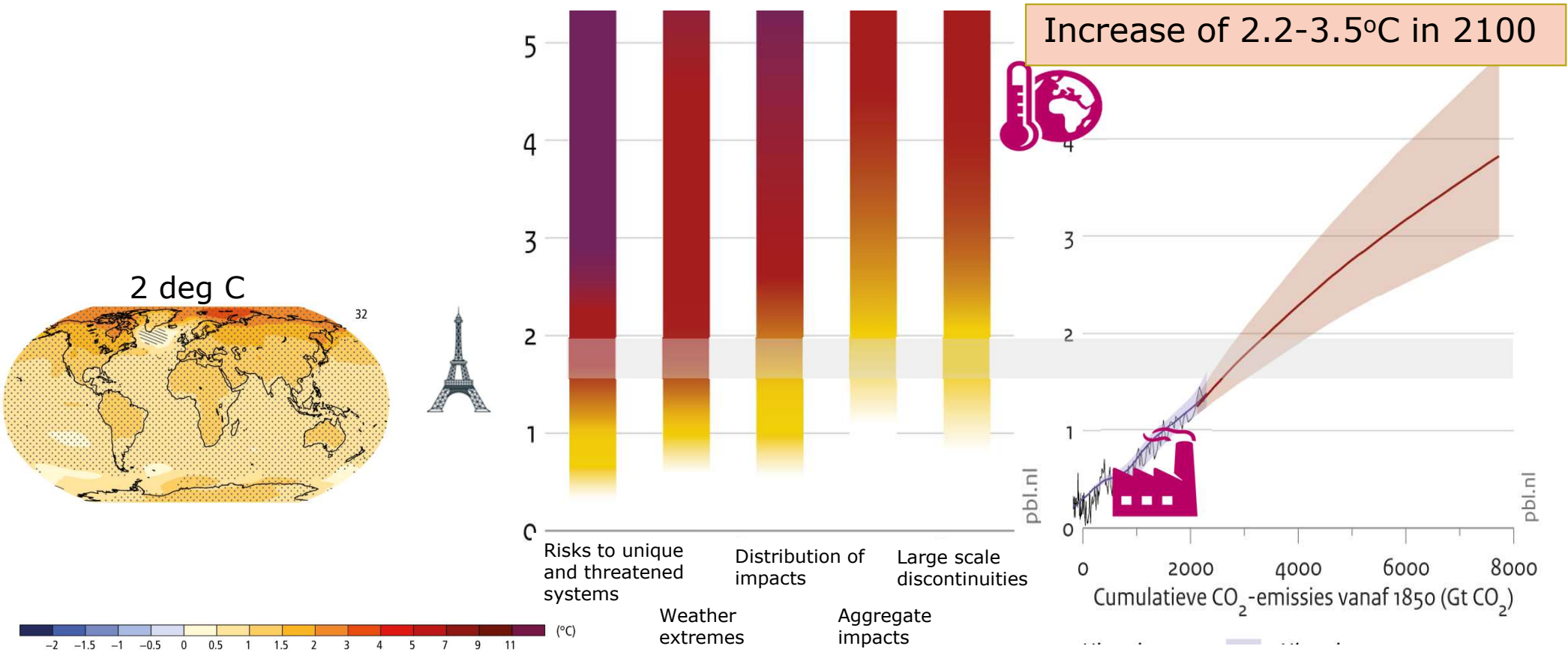


-2 -1.5 -1 -0.5 0 0.5 1 1.5 2 3 4 5 7 9 11 (°C)

Our choices determine the climate future



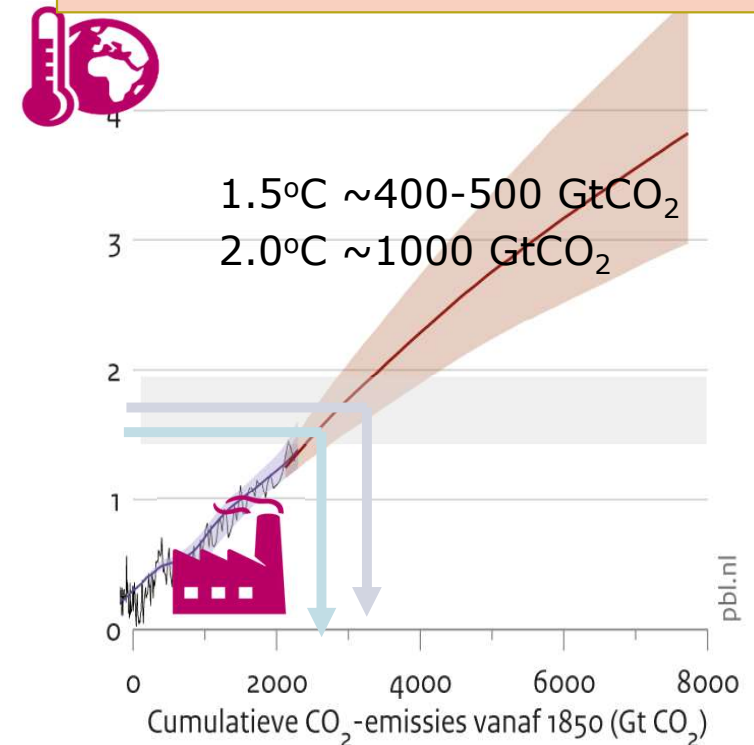
Paris-agreement



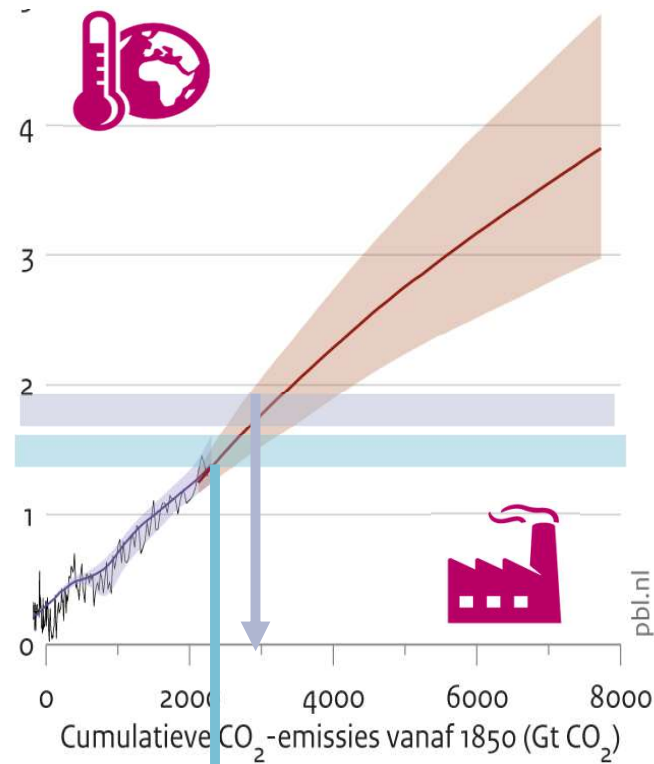
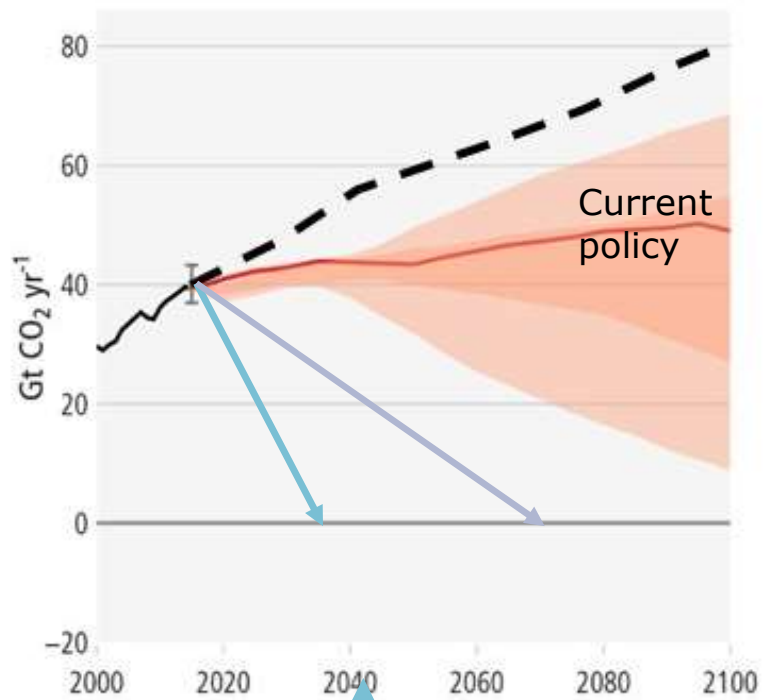
Paris-agreement



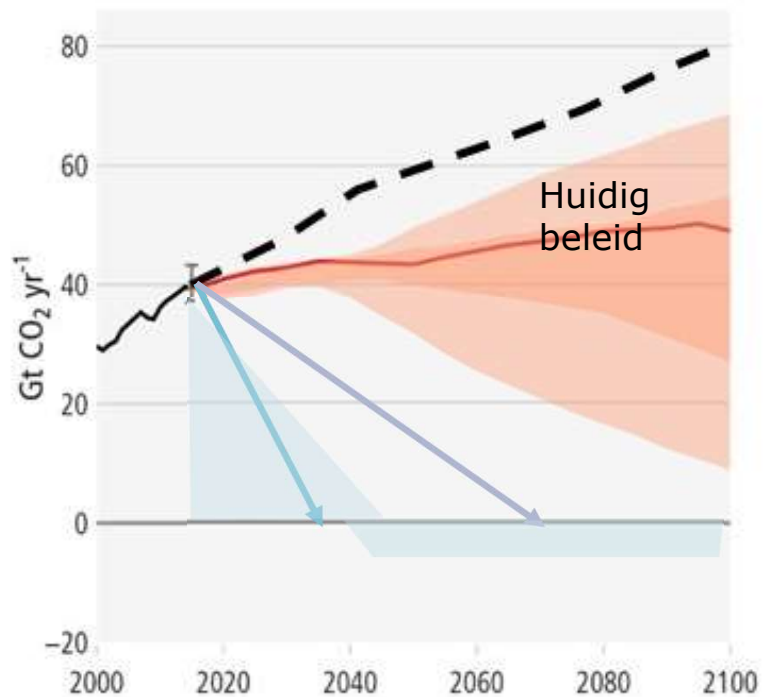
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Paris-agreement



Paris-agreement



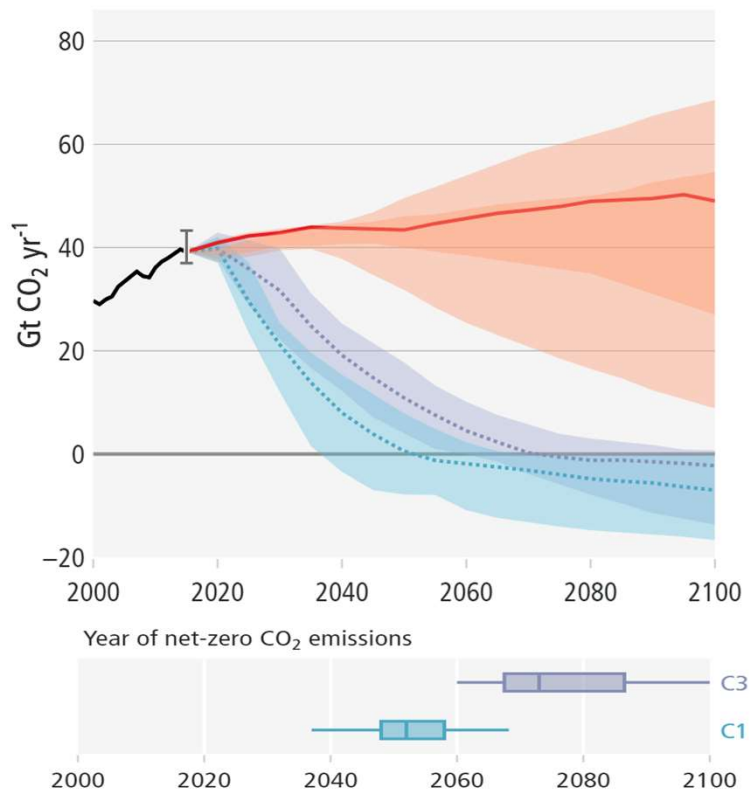
Negative emissions:

- Reforestation
- Bio-energy with CCS
- Direct air capture
- Nature-based solution (e.g. soil carbon)
- ...

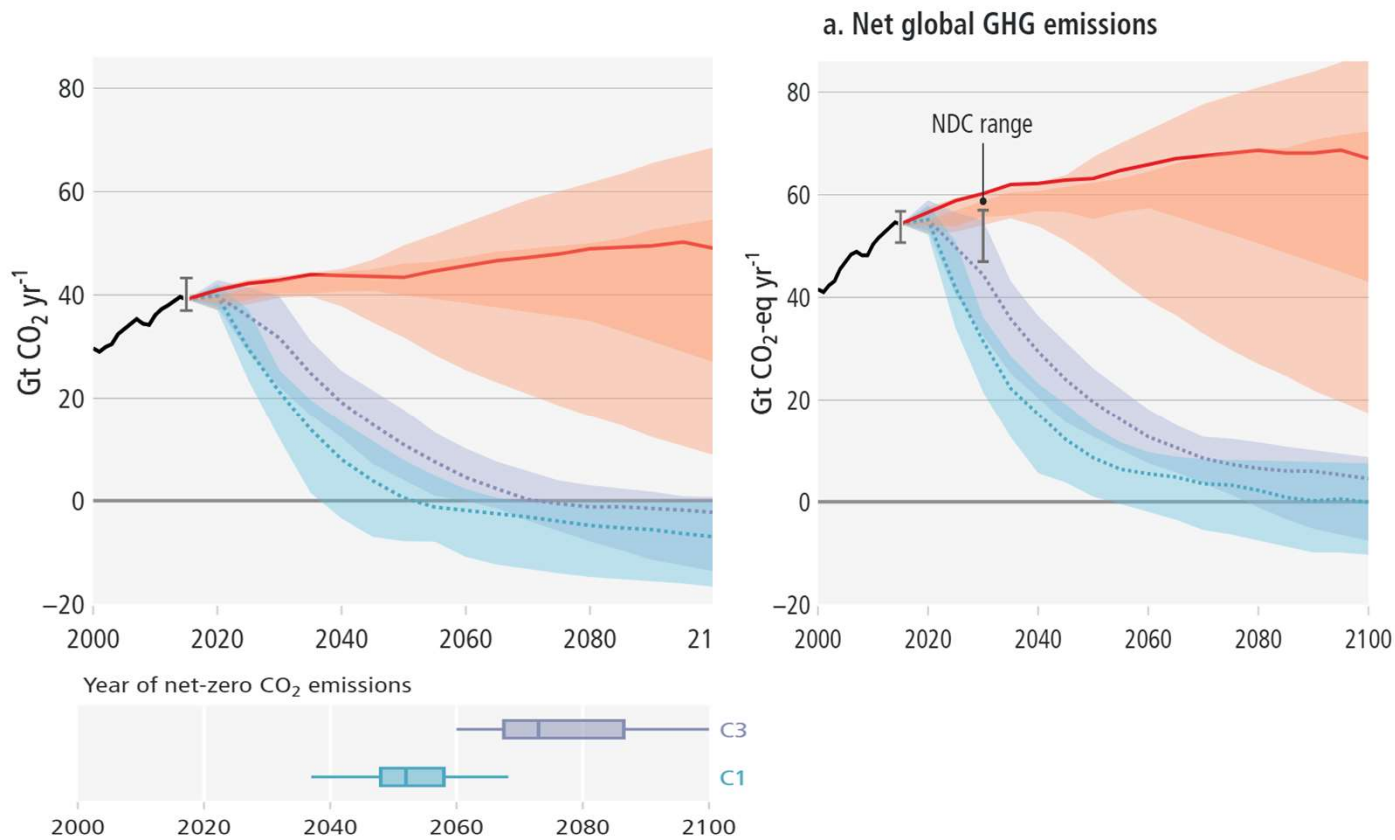
Could help, but

- Temporary overshoot temperature target
- Possible negative impacts on land use
- Limit potential

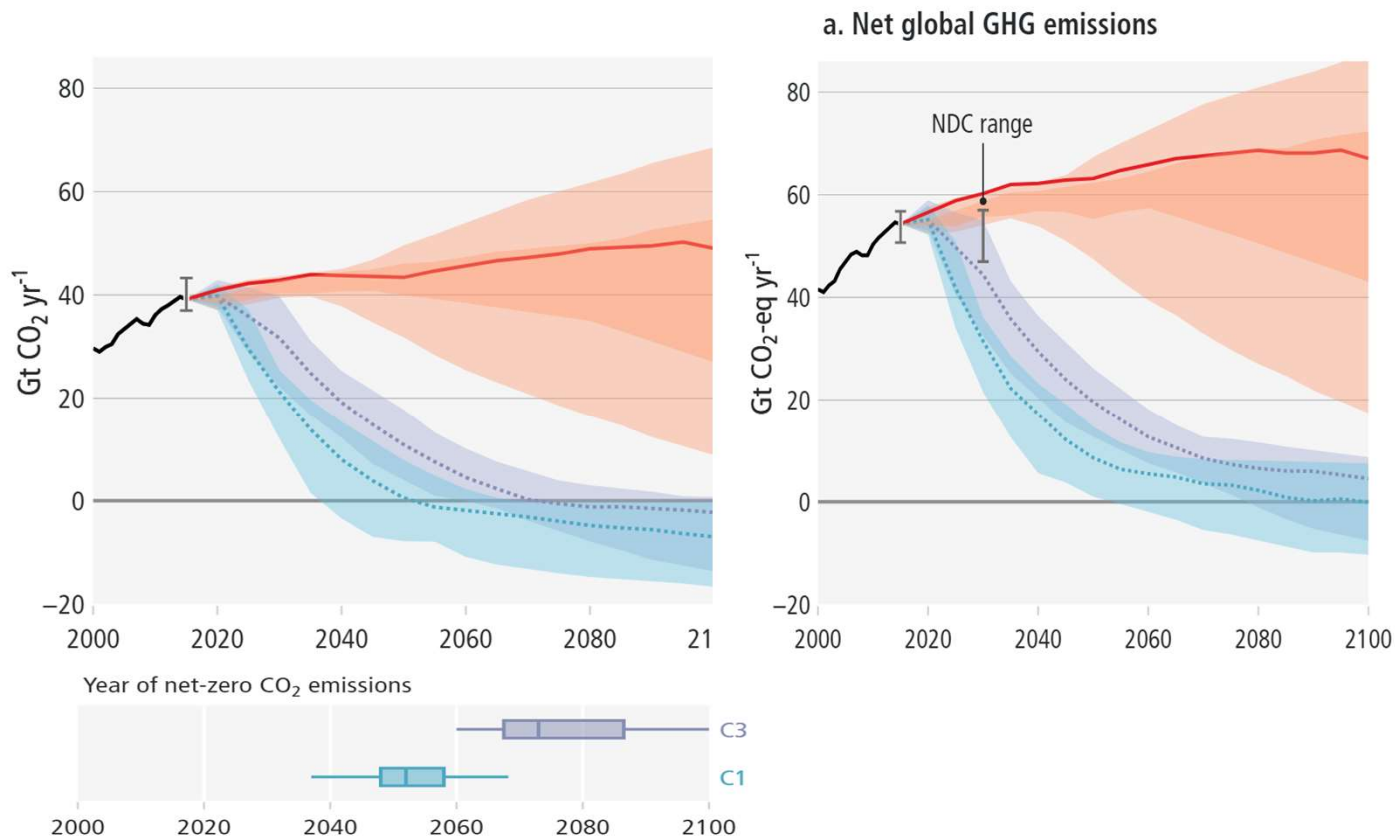
Paris-agreement



Paris-agreement



Paris-agreement

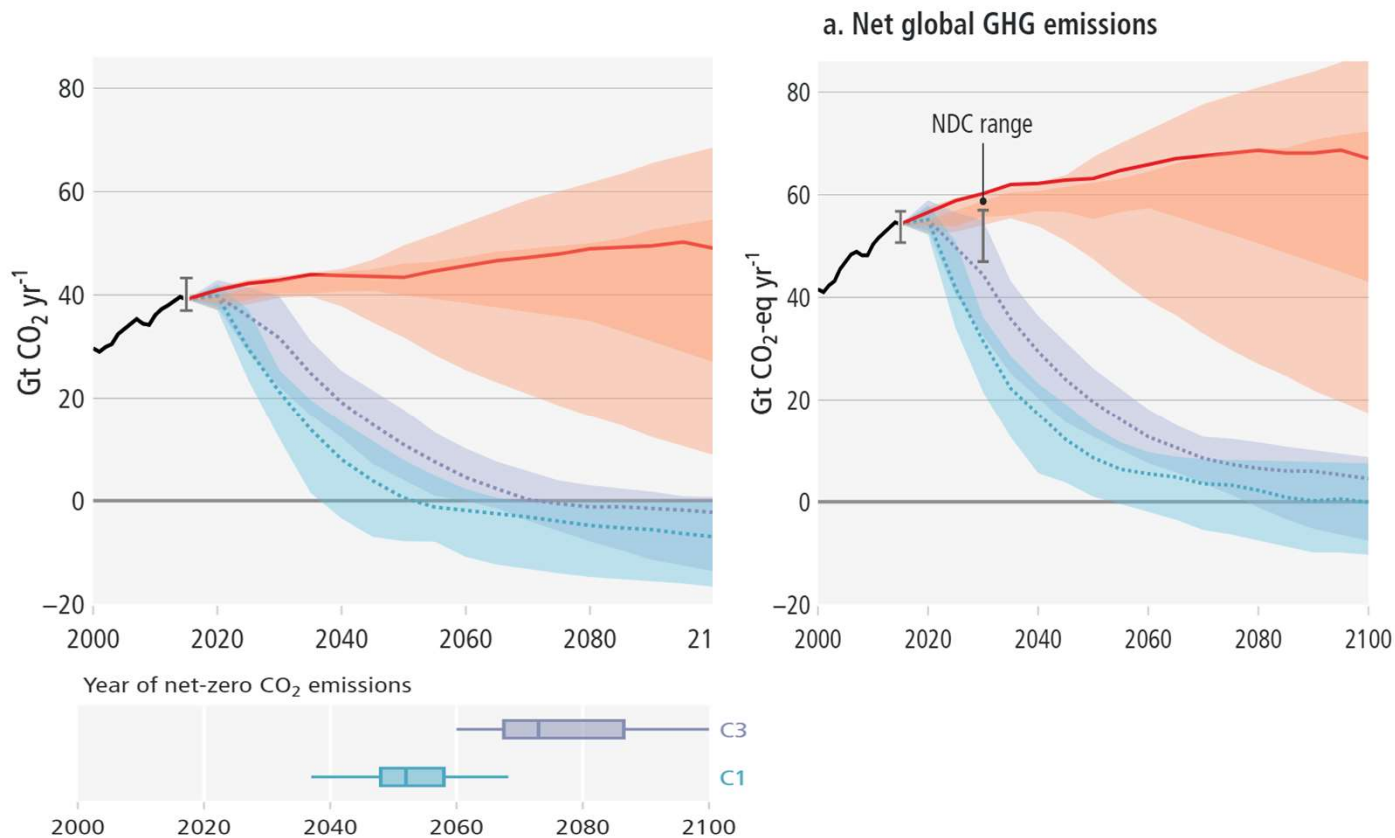


1.5 degrees target:

- Emissions peak before 2025
- 43% reduction in 2030
- Net zero around 2050



Paris-agreement



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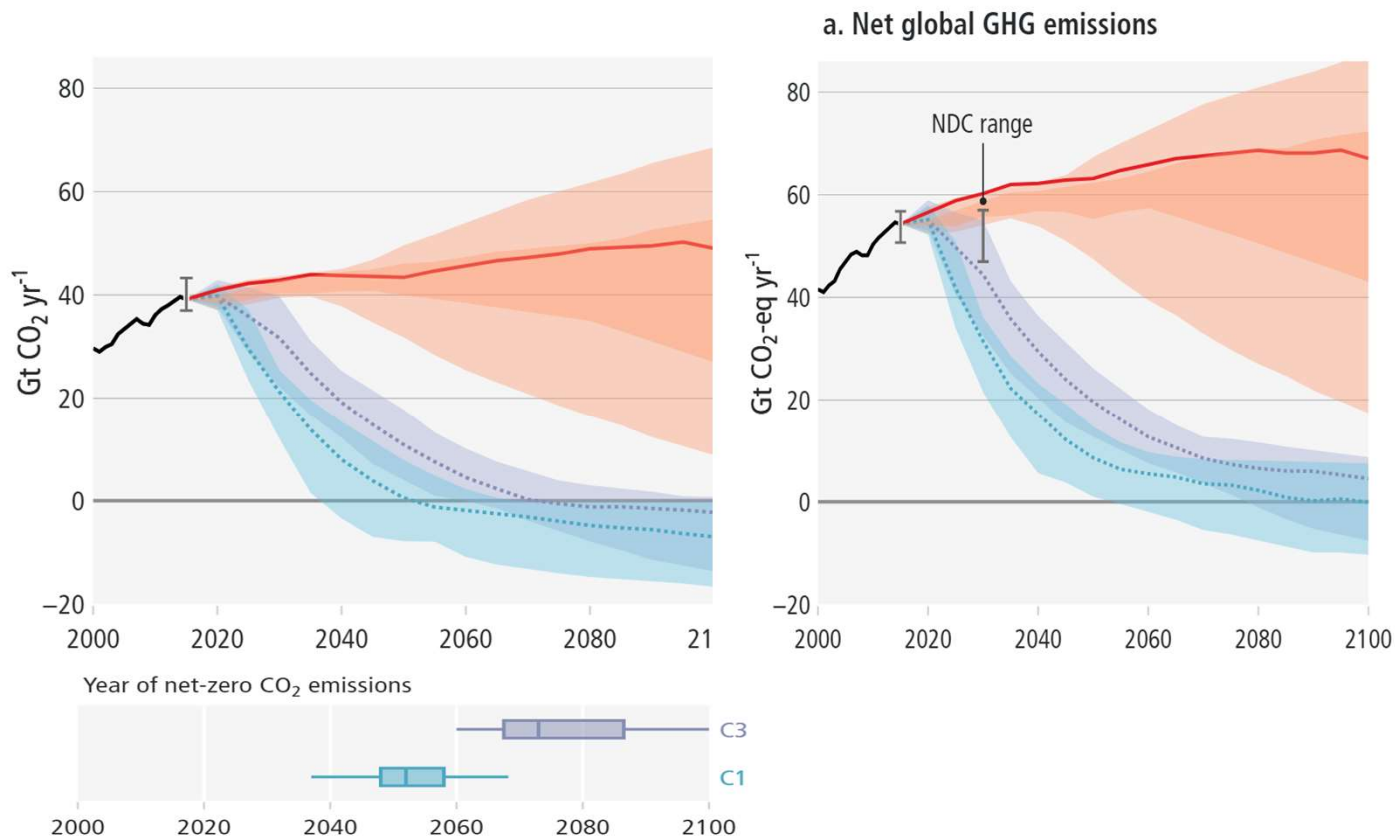


2 degrees target:

- 2070 net zero... but only if emissions are reduced in short-term



Paris-agreement



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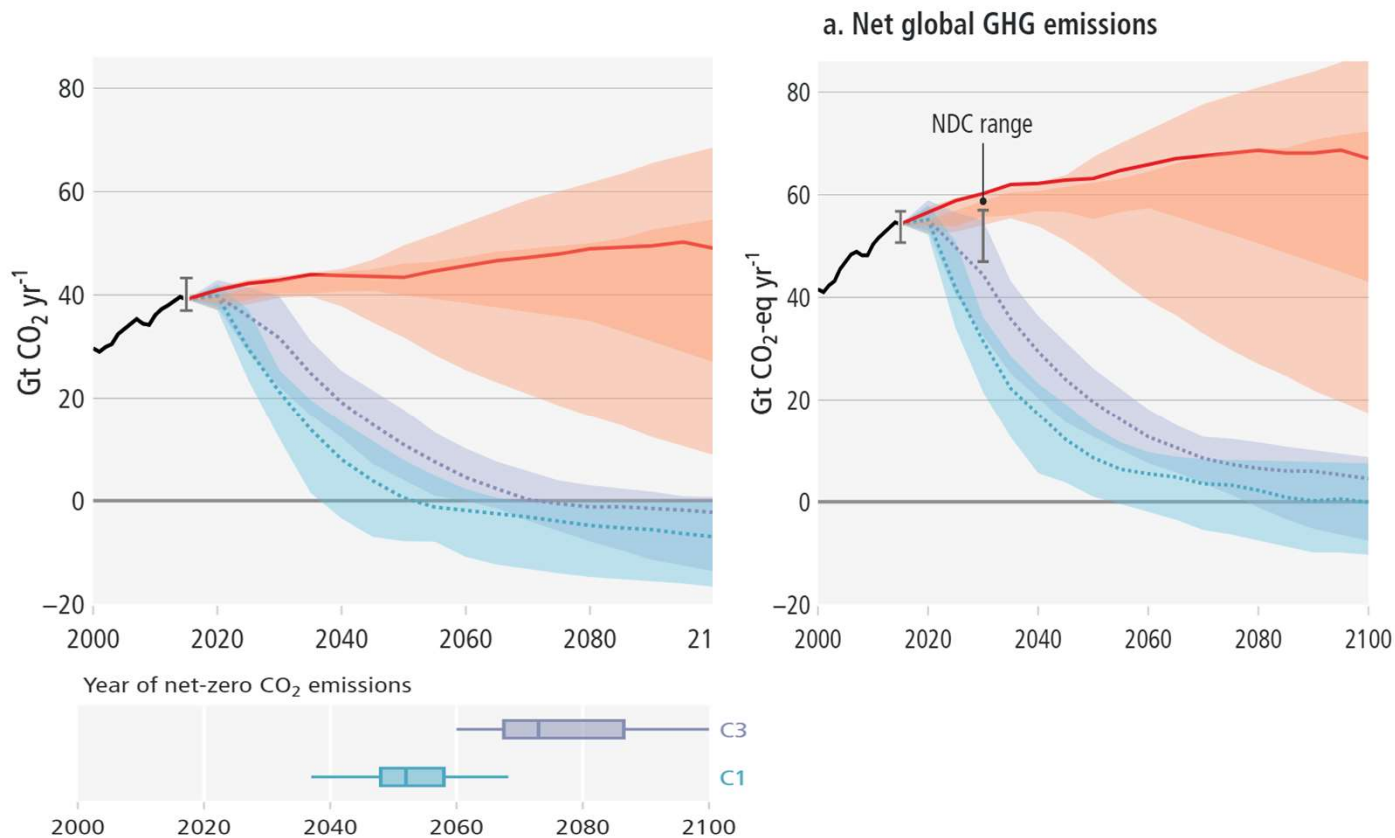
2 degrees target:

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- Net-zero year slightly later (consequence of less net negative emission scenarios)
- Not all 1.5°C reach net-zero GHG

Paris-agreement



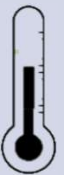
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2 degrees target:

- 2070 net zero... but only if emissions are reduced in short-term



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Gap from NDCs:

<<2°C ~ 10-13 GtCO₂
 <1.5°C ~ 20-23 GtCO₂
 +Gap implemented policy to NDC:
 ~5 GtCO₂



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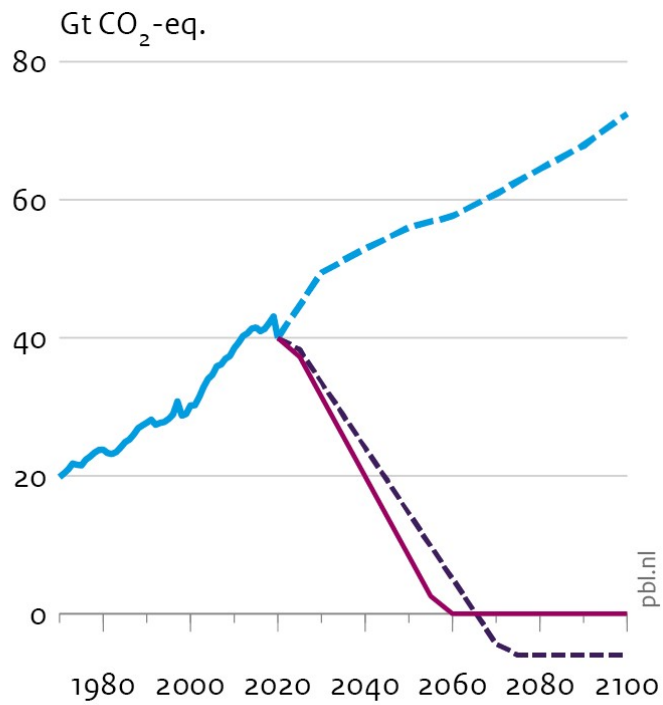
How do we get there?





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How do we get there?



Energy/land use

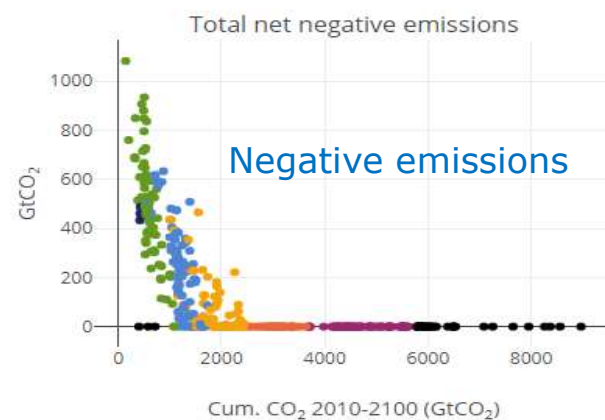
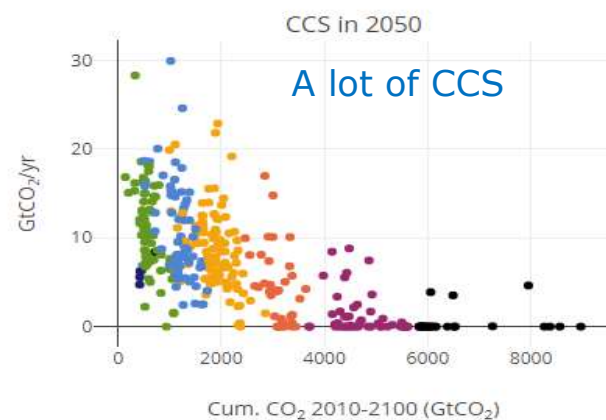
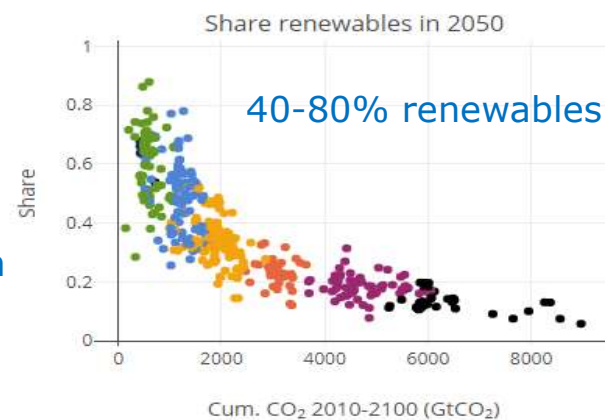
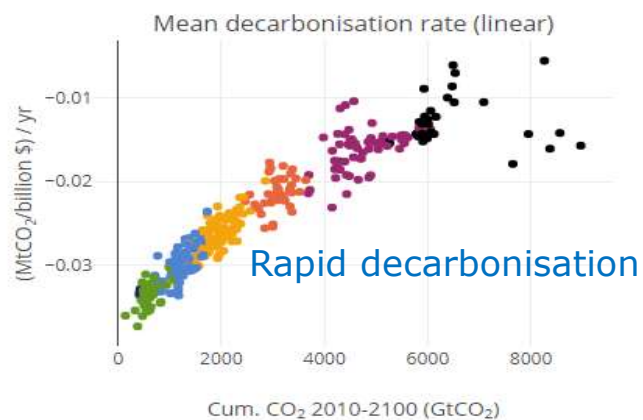
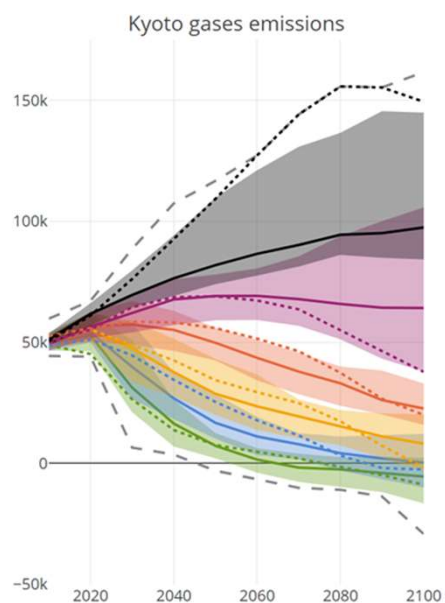
Emissions

Greenhouse gas concentrations

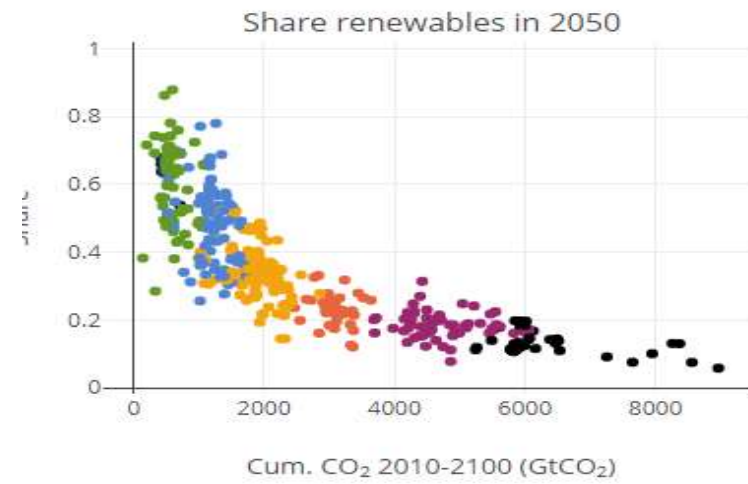
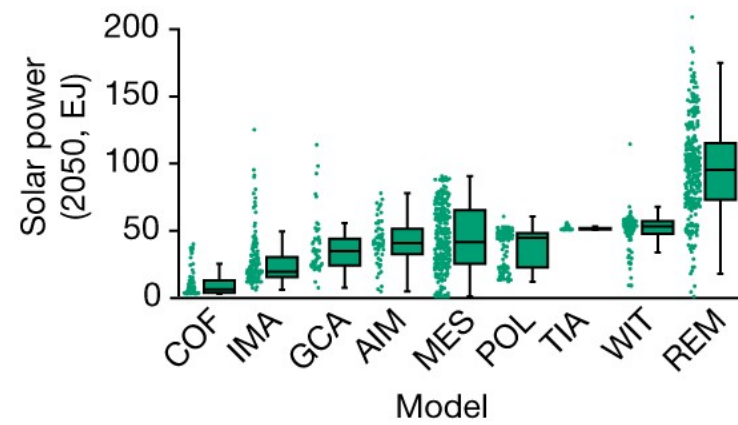
Climate change

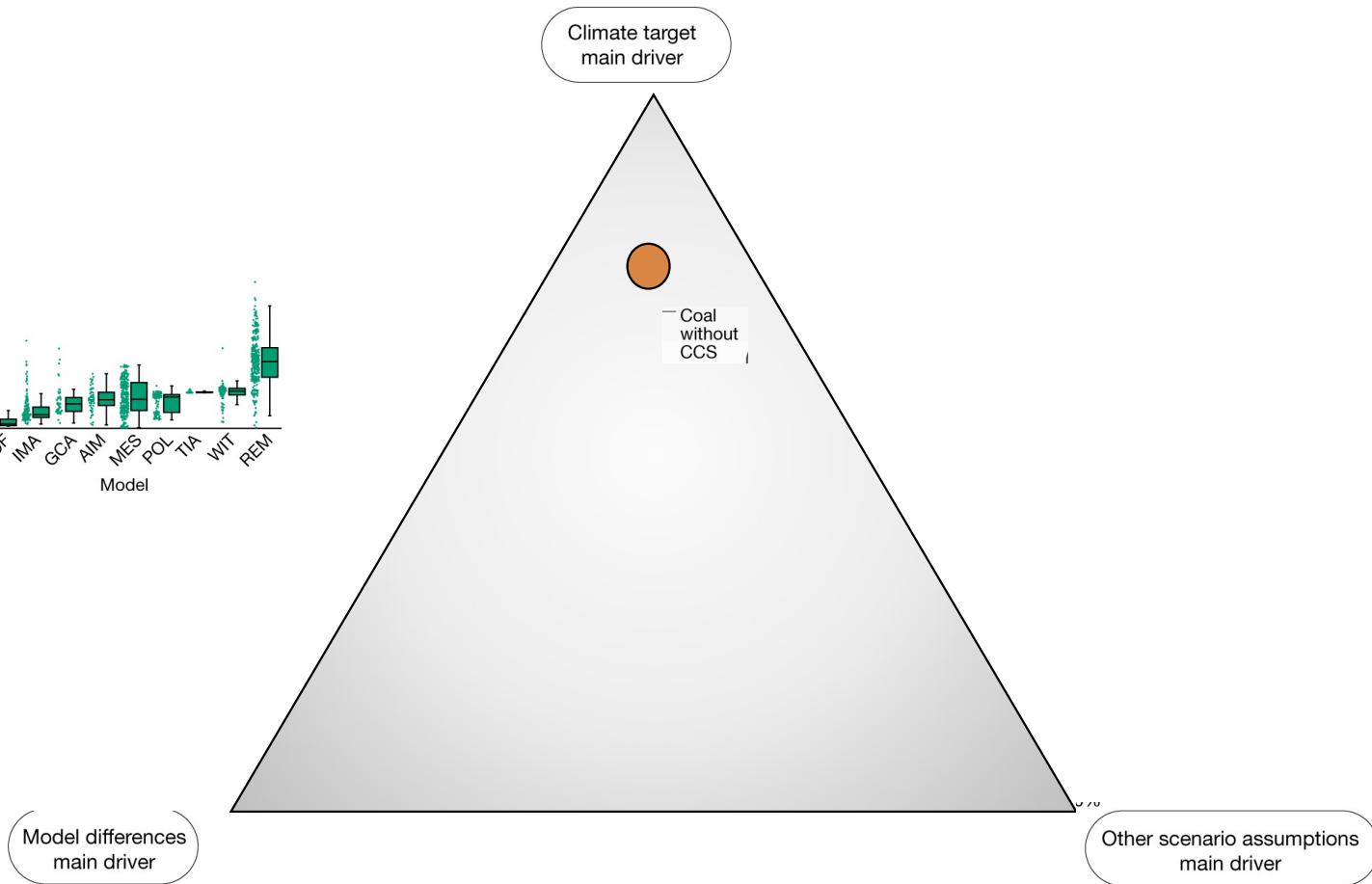
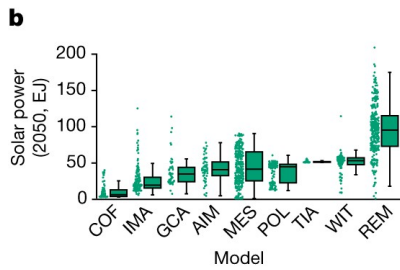
Impacts





b





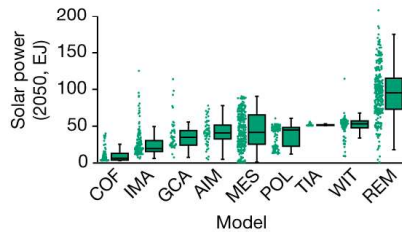


a

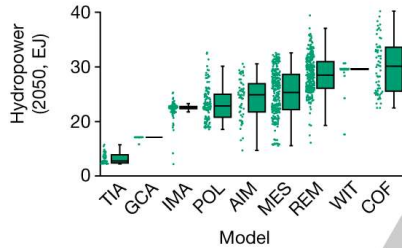
Renewables

Total renewables: early century determined by climate target, later more model dependent.
Individual sources: highly model dependent, except early-century wind.

b

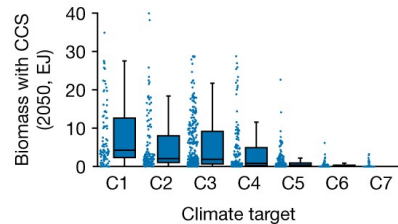


c

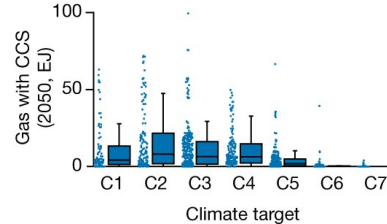


Model differences
main driver

d



e

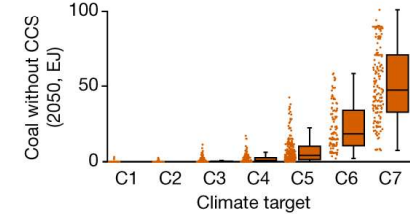


Climate target
main driver

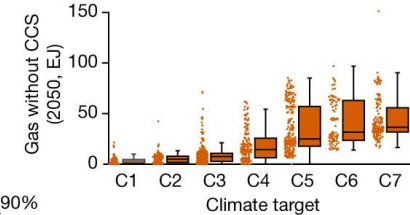
Fossil use (without CCS)

Total fossil use: highly determined by climate target.
Individual sources: coal highly climate target determined, gas only after 2050.

g



f

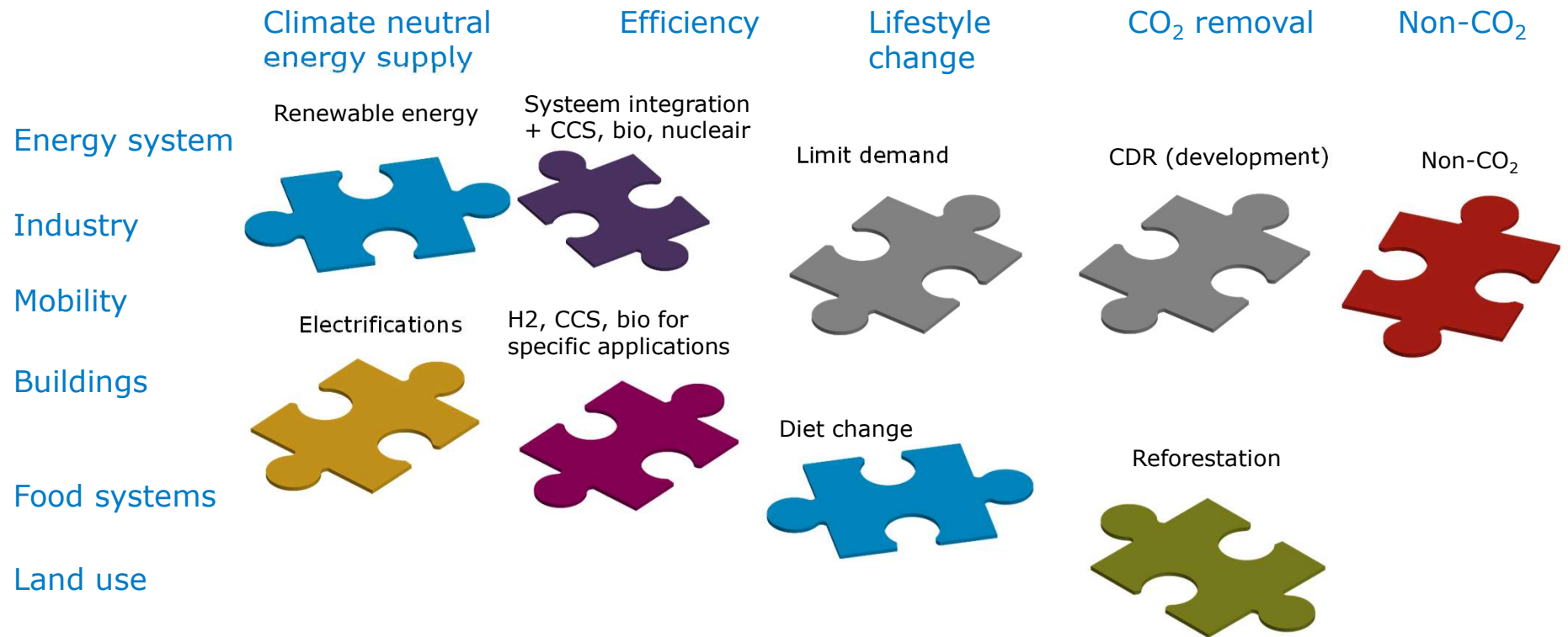


Other scenario assumptions
main driver

Carbon capture and storage (in electricity generation)

Total CCS: early mostly determined by climate target and scenario.
Individual sources: mostly model dependent.

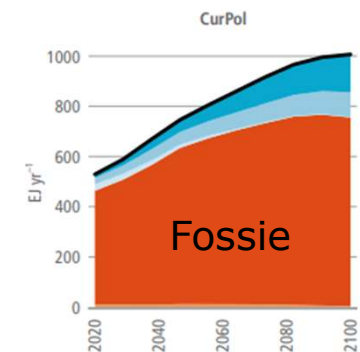
Dekker et al, 2023



Implications for fossil fuels

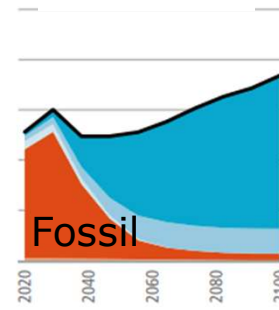
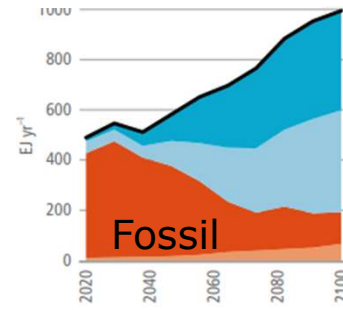
Current policy

1.5 graden



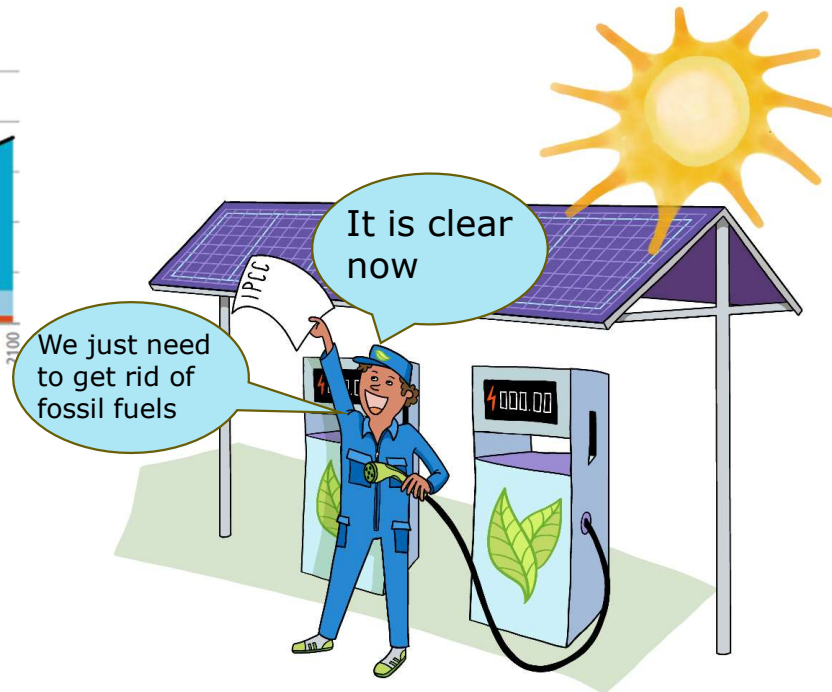
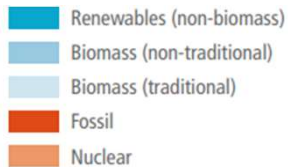
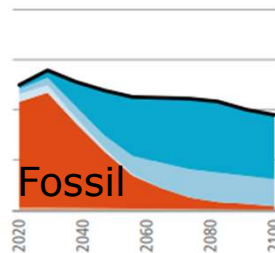
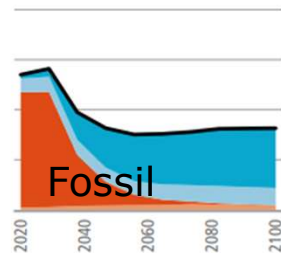
Negative emissions

Renewables

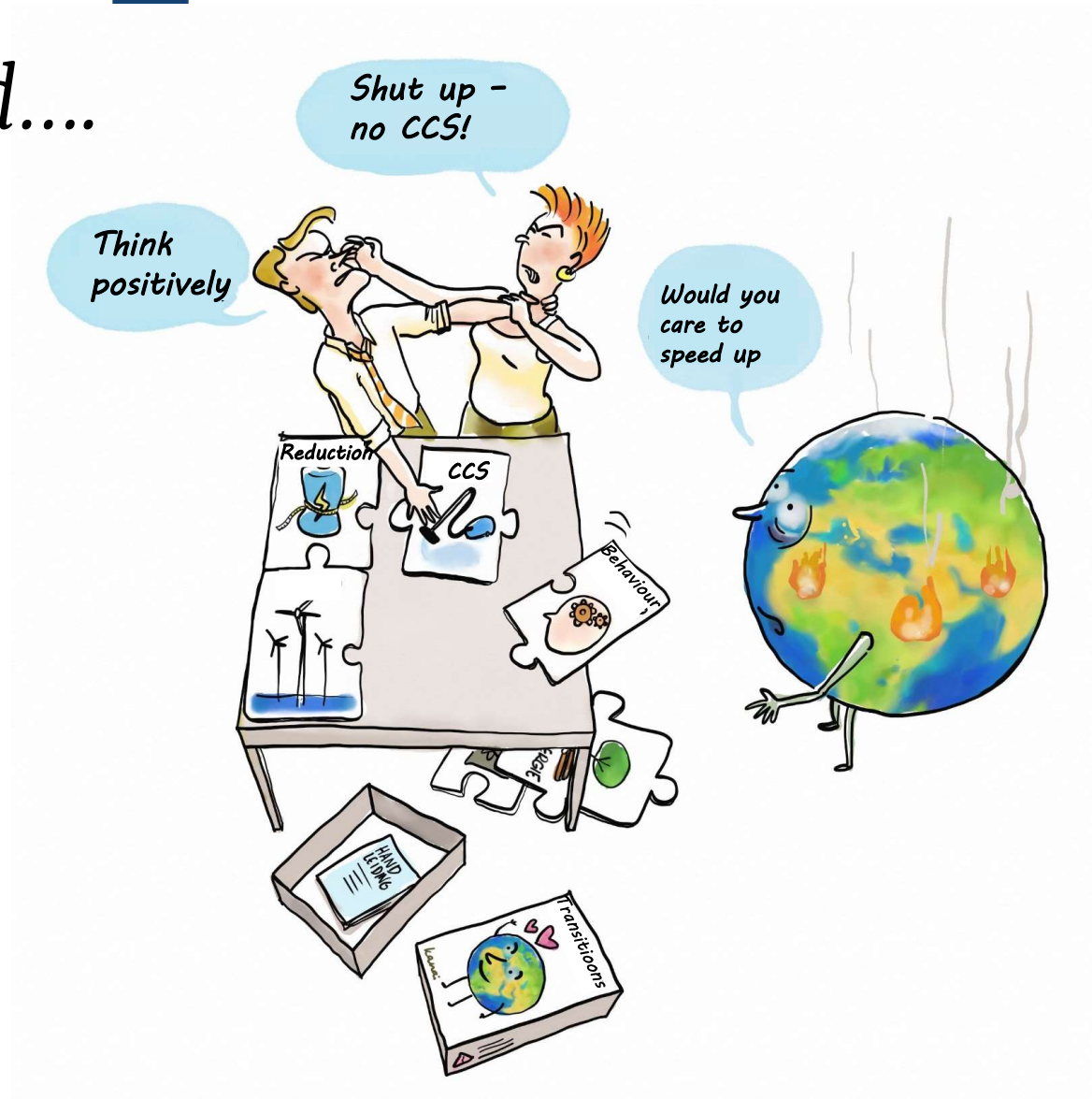
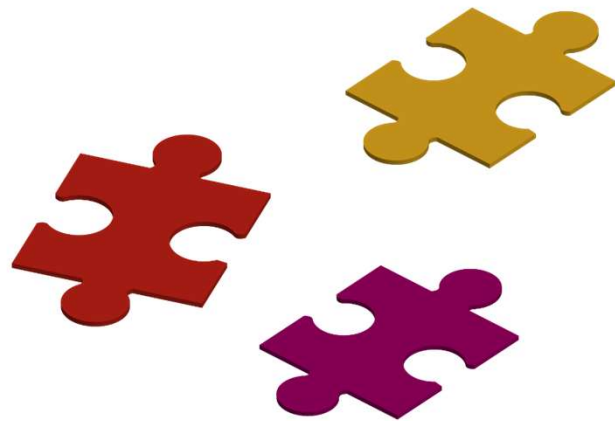


Low demand

Sustainable dev.

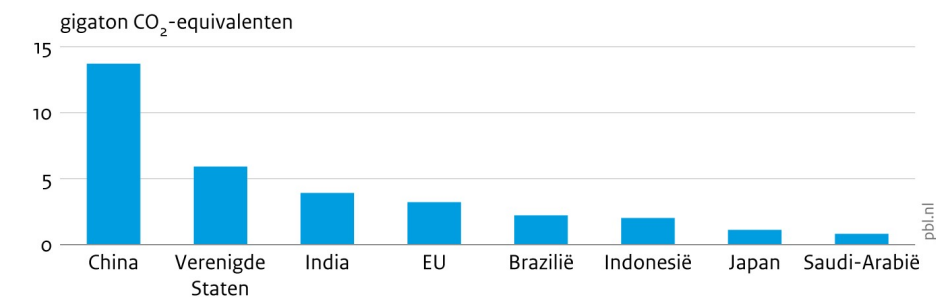


Clear vision needed....

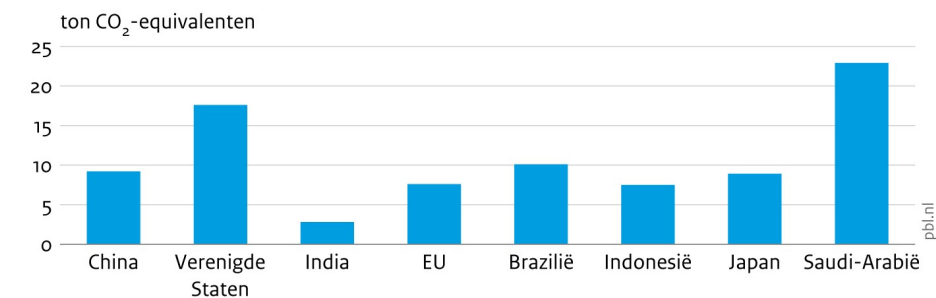


Emissie broeikasgassen

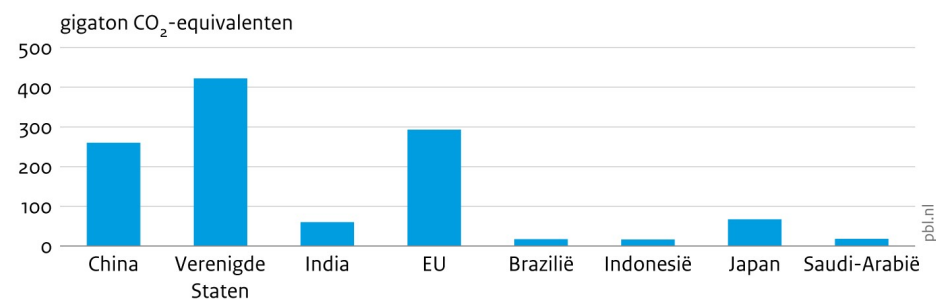
Totale emissie, 2021



Emissie per hoofd, 2021



Cumulatieve emissie, 1850 – 2021



Bron: Global Carbon Budget



Planbureau voor de Leefomgeving



Historic CO₂ OECD = 66.8%
2019 CO₂ OECD = 35.1%



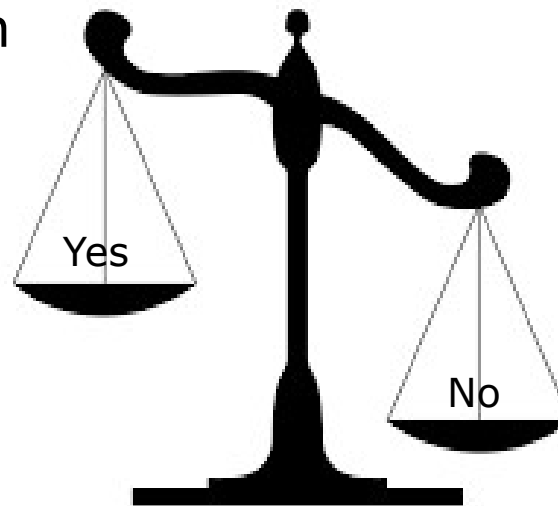


Planbureau voor de Leefomgeving

Unique moment in time

Budget almost depleted

Ambition and
implementation gap



Technological breakthrough



Net zero targets (2050-2060)



IEA: End of fossil



Financial sector changing



Planbureau voor de Leefomgeving

Thank you for your attention



<http://www.pbl.nl/en/aboutpbl/employees/detlef-van-vuuren>

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