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Bioenergy strategies in a Well below 2°C world

Integrated Assessment Models' perspective

Vassilis Daioglou

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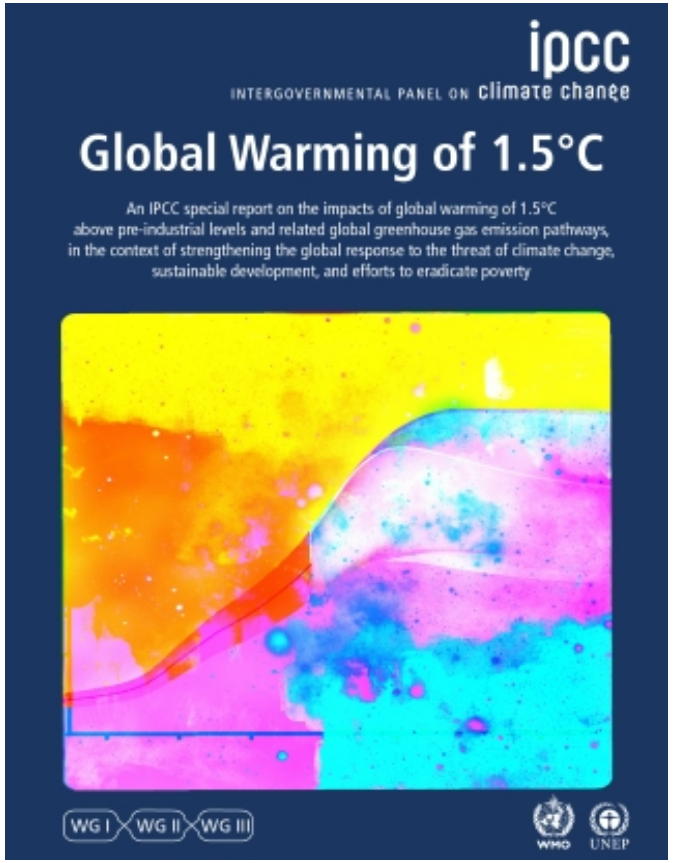


Billion tonnes of CO_2/yr

In pathways limiting global warming to 1.5°C with **no or limited overshoot** *as well as in pathways with a* **higher overshoot**, *CO2 emissions are reduced to net zero globally around 2050.*

Four illustrative model pathways

P1
P2
P3
P4

50
40
30
20
10
0
-10
-20

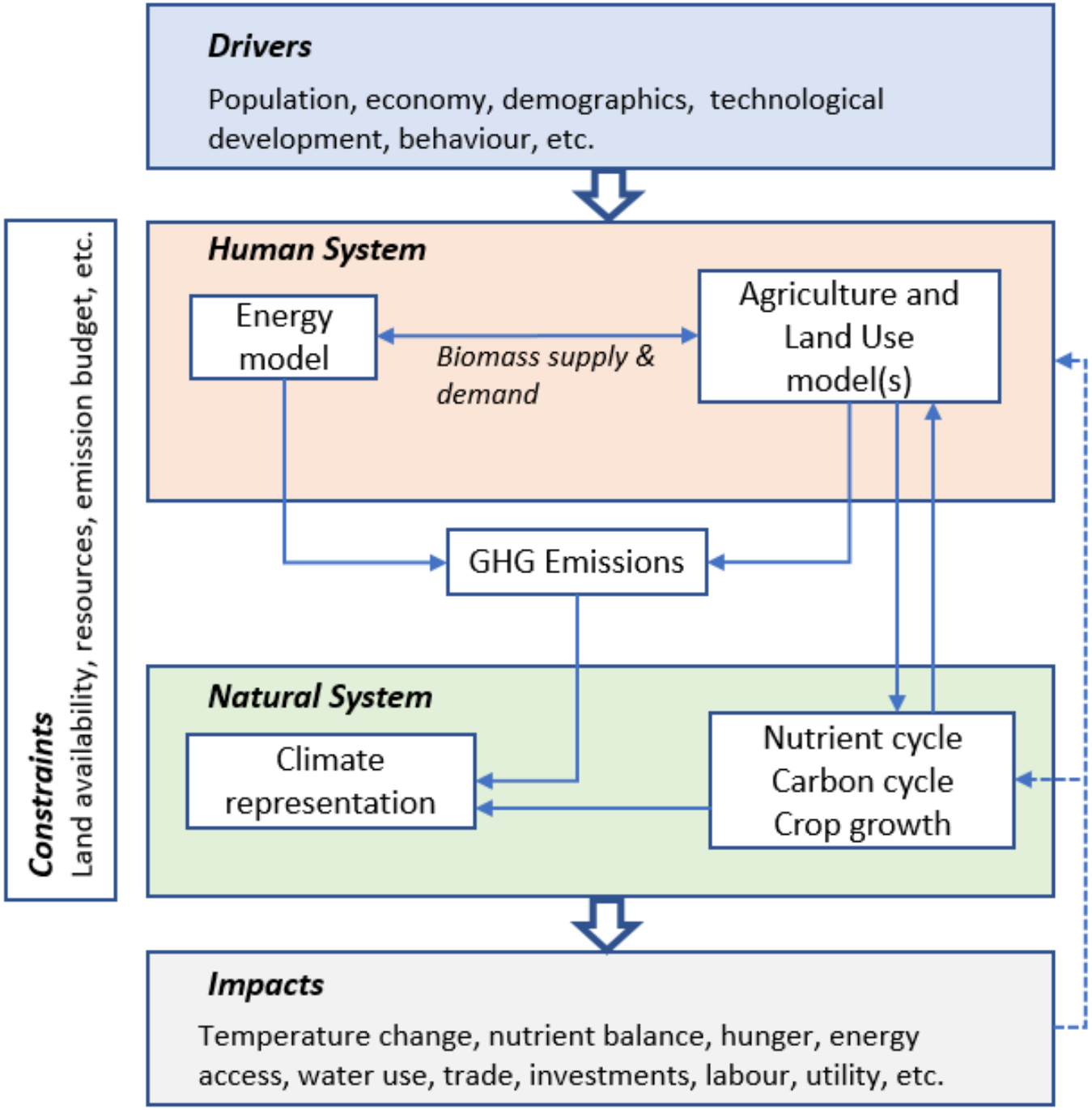
2010
2020
2030
2040
2050
2060
2070
2080
2090
2100

IPCC, SR1.5, SPM (2018)

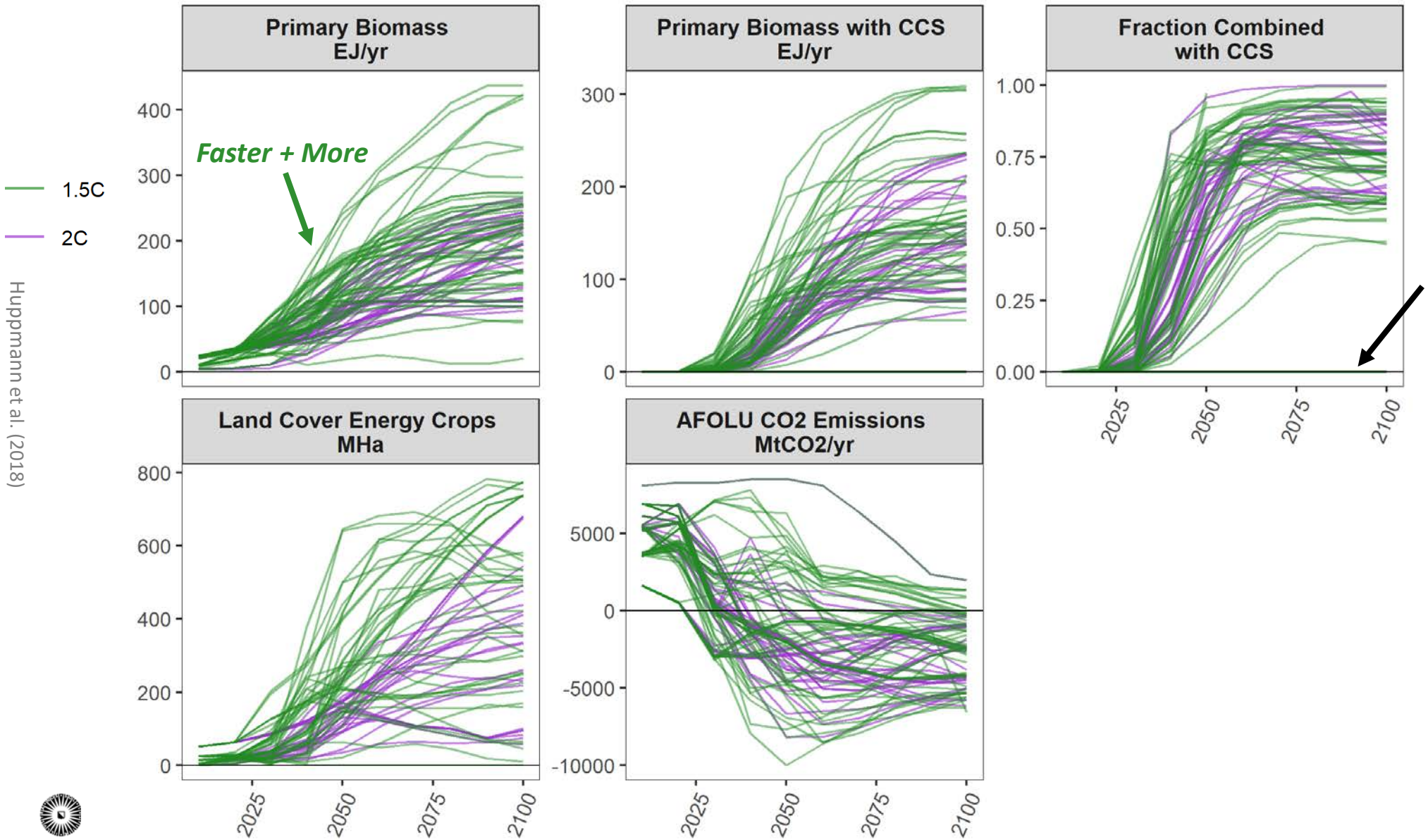
IAM Overview

- Assess interactions between human and natural systems
- Contain stylized representations of
  - The energy system
  - Agricultural economy
  - Climate
  - Land system
- Bridge the Science/Policy interface
  - What if?
  - What are the drivers or constraints of change?
  - Uncertainties? Sensitivities?

→ *Scenario Analysis*



Bioenergy Projections in "Paris Agreement" Scenarios



Huppmann et al. (2018)

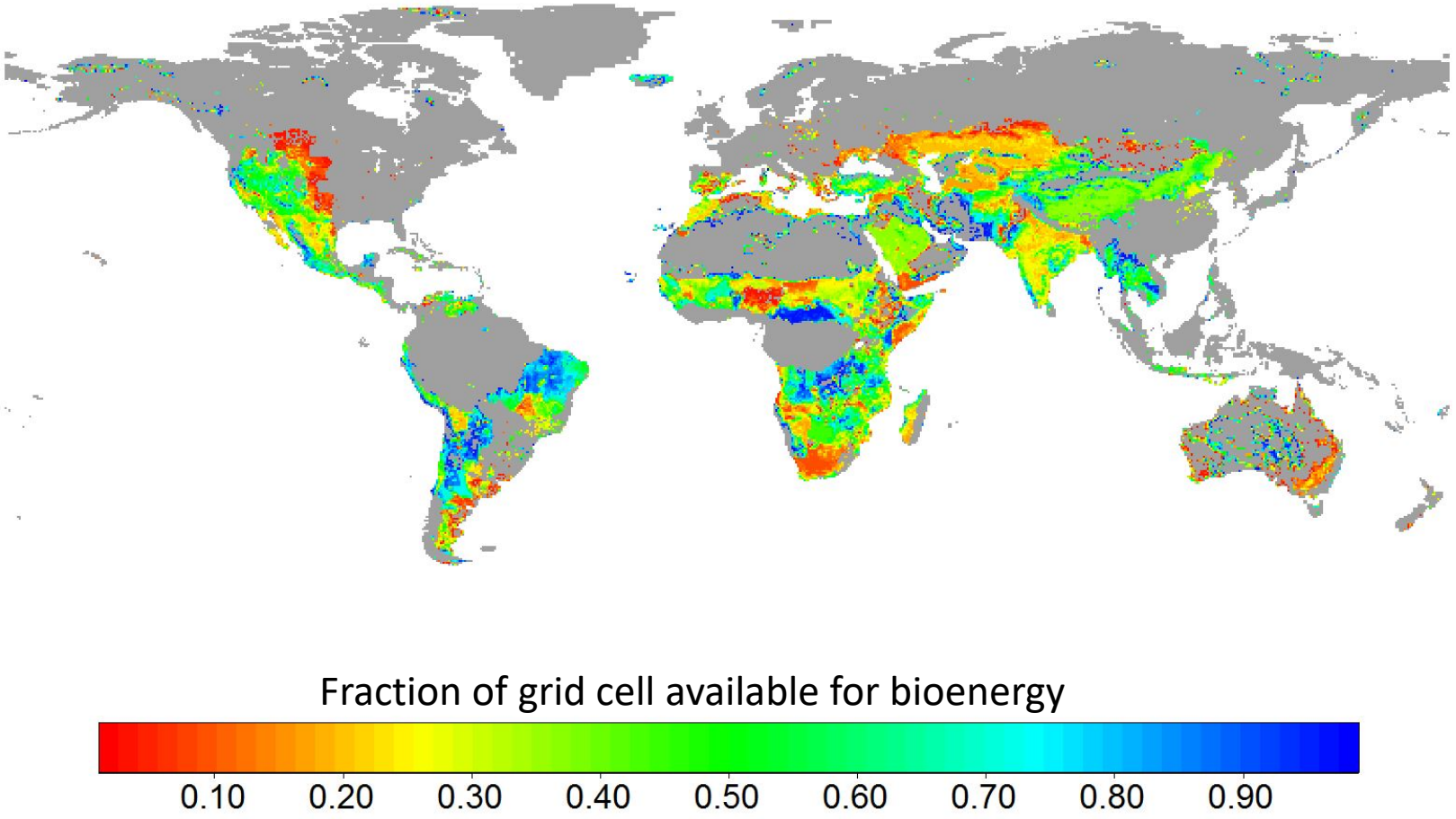
Scenarios specifically aiming to avoid BECCS

- Behavioural change
- Technological change
- Other CDR (Afforestation)

Important: Constraint on Land Availability

Example: The IMAGE model

- Avoid sensitive areas
  - Forests
  - Agricultural lands



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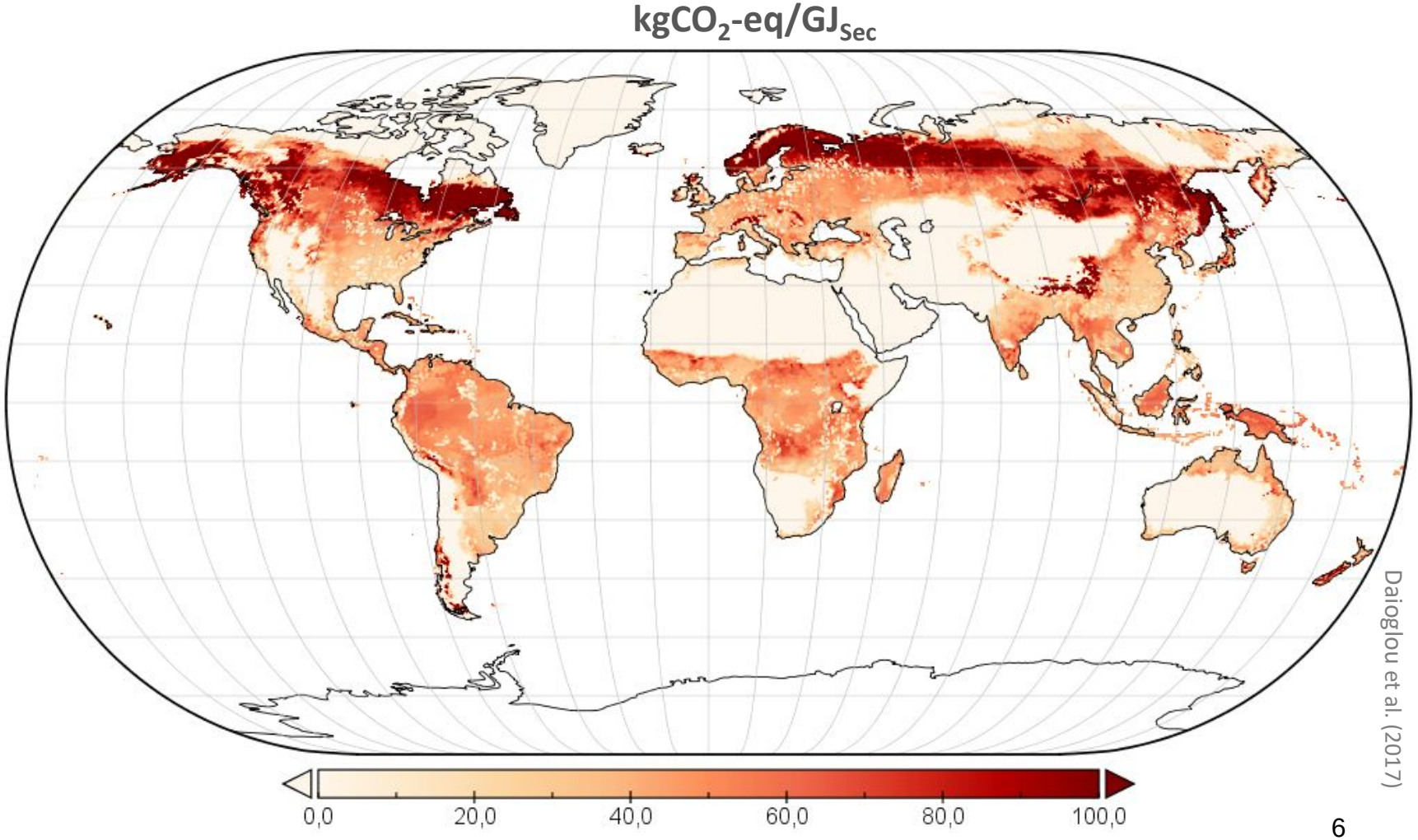
Example: The IMAGE model

- Avoid sensitive areas
  - Forests
  - Agricultural lands
- Produce biomass on areas offering GHG benefits



Daioglou et al. (2017)

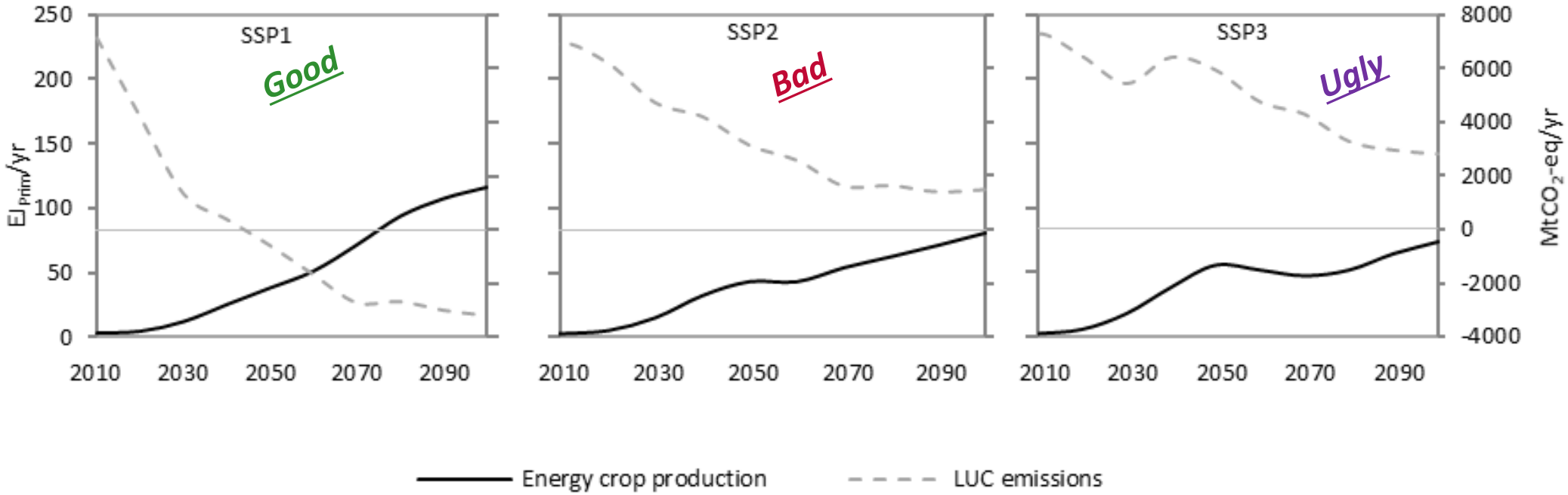
Uncertainty & Sensitivity: Land Use Scenarios

How will agriculture production and productivity develop?

What if protection of Natural lands is weakly enforced?

→ ***Scenario Analysis***

Baseline



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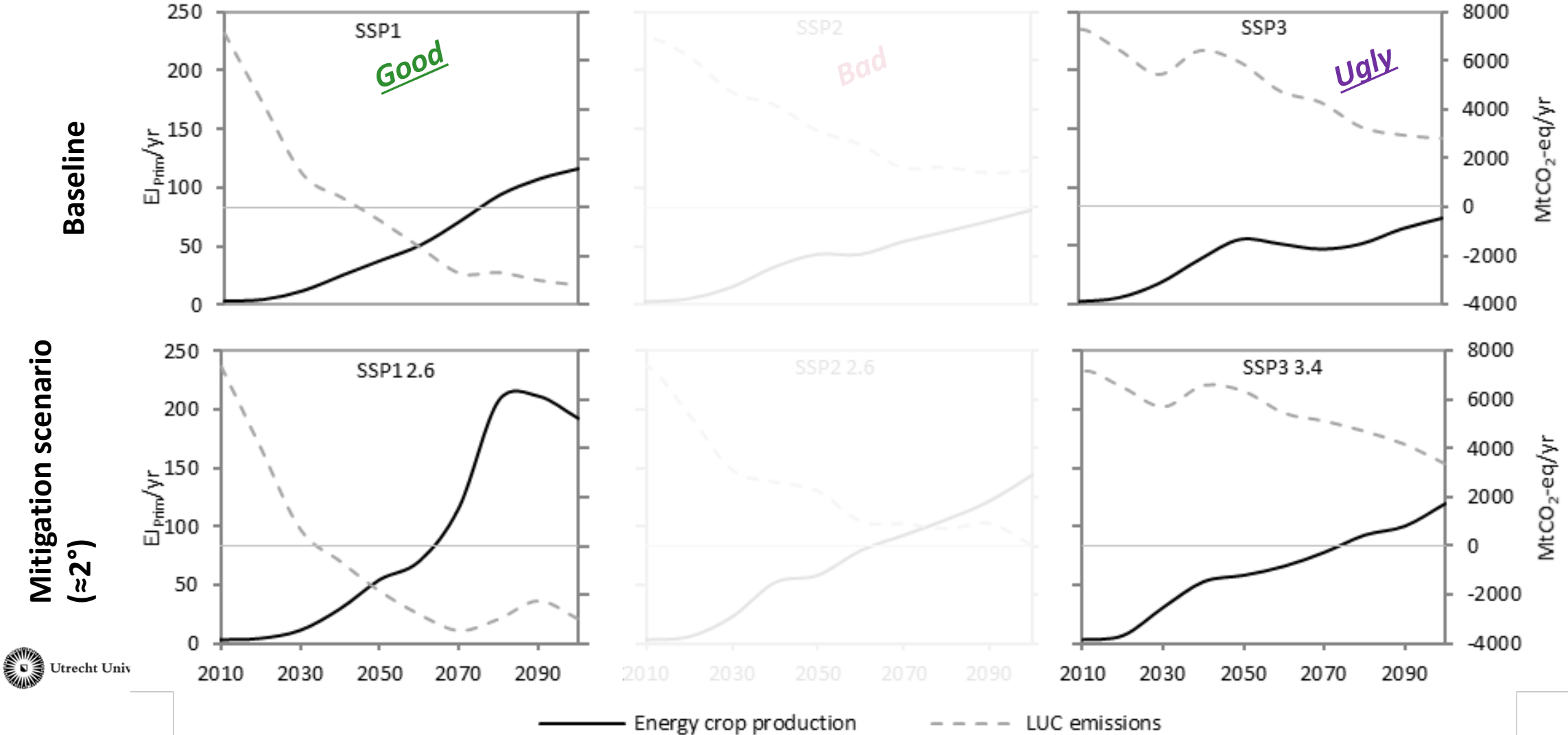

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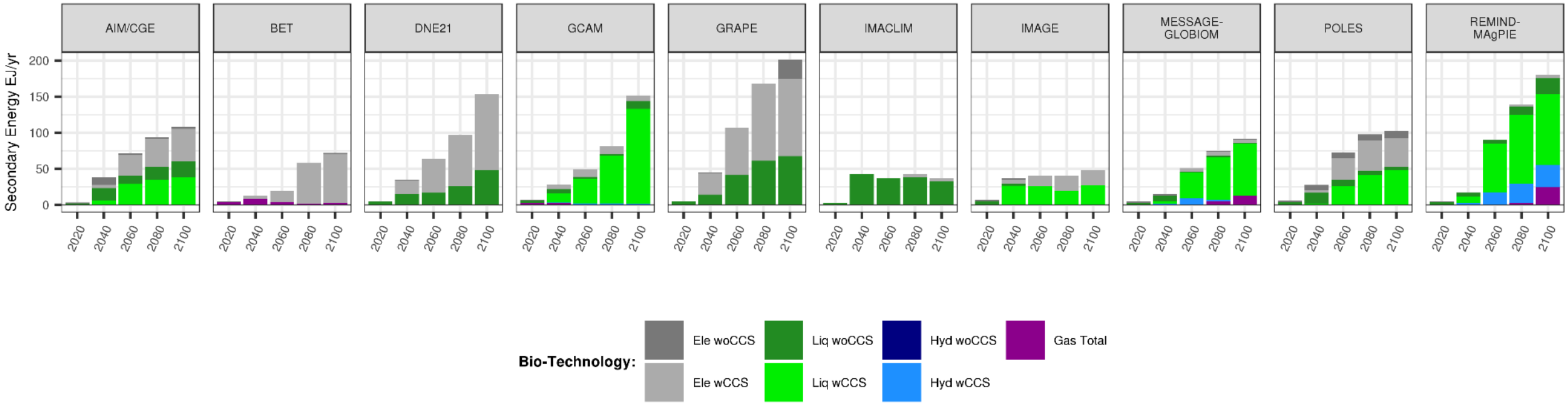
Uncertainty & Sensitivity: Do IAMs agree on bioenergy strategies?

No…not really…

Bioenergy use in 2˚C scenarios

Bauer et al. (2018)



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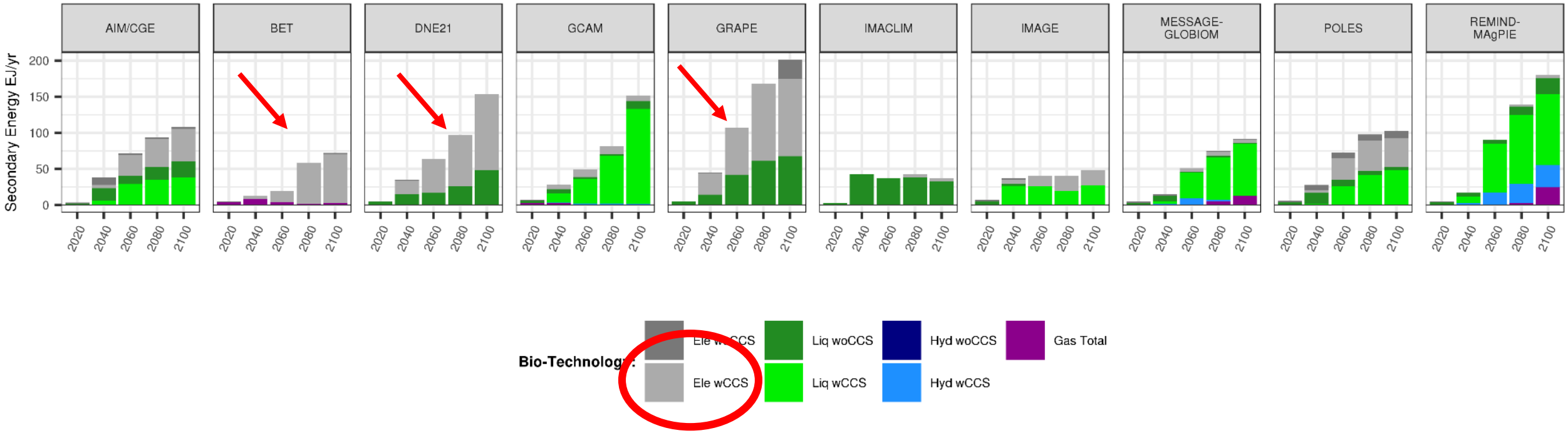

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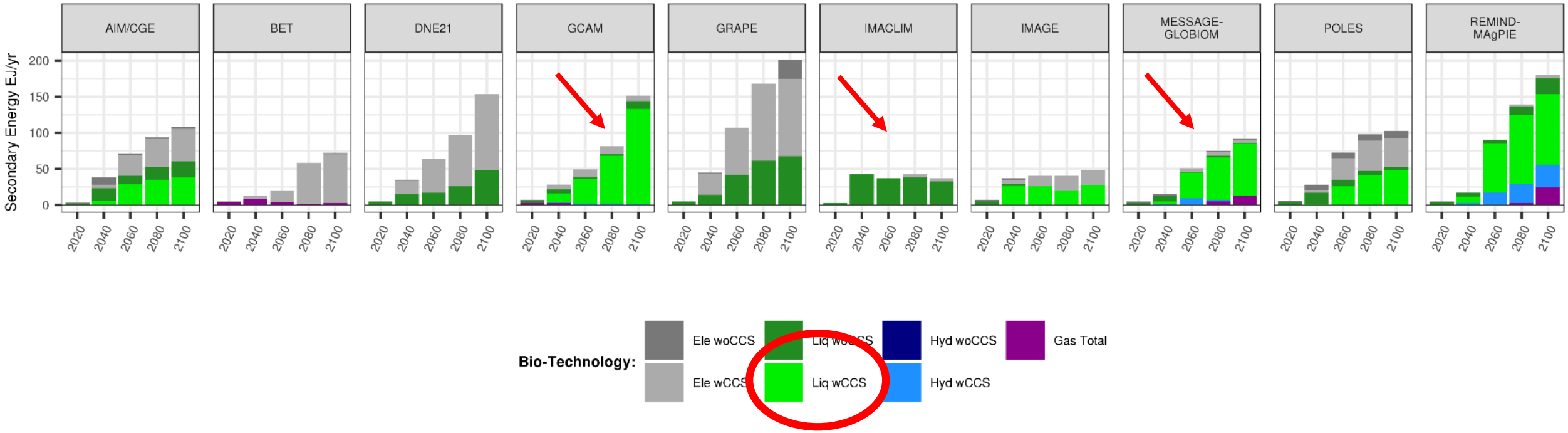

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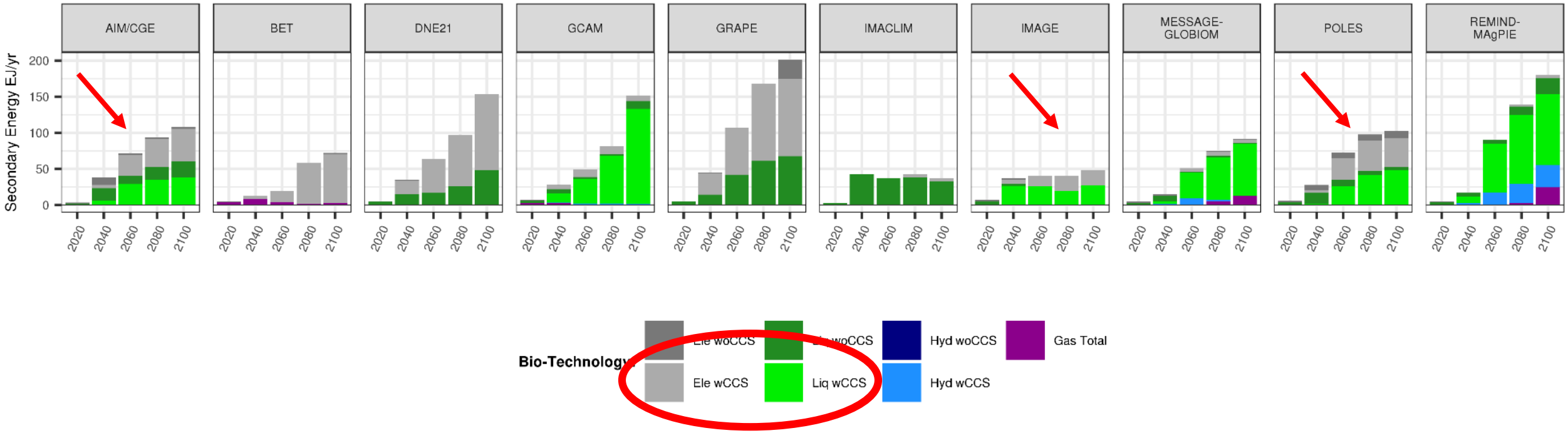

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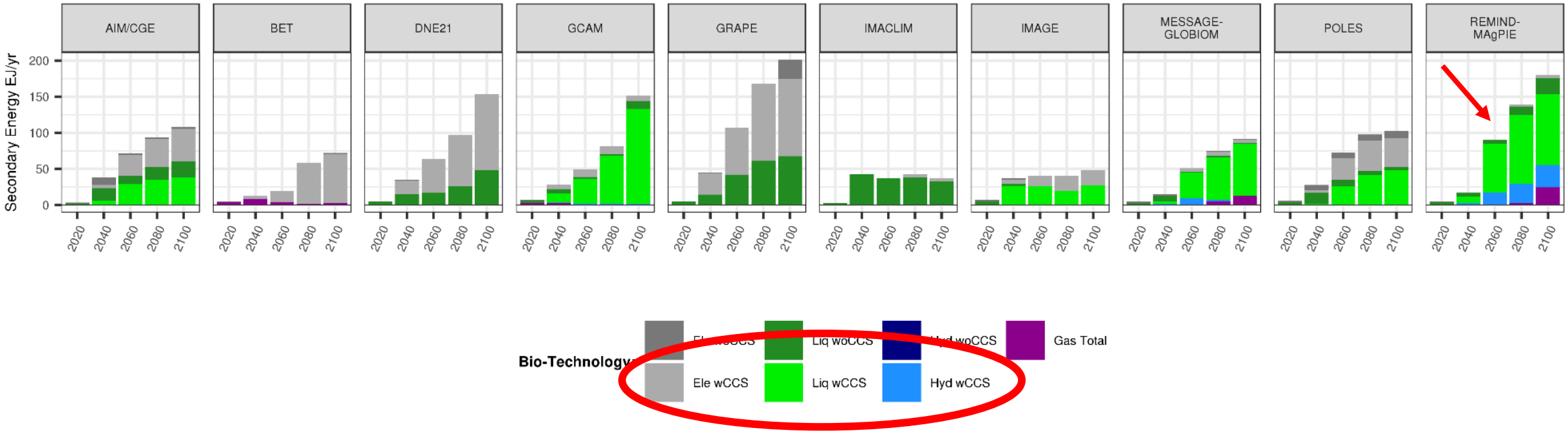

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How Important are advanced technologies?

- Lack of technologies make targets less viable, ***but not impossible!***
- Bioenergy ***still important*** even in limited technology or potential scenarios

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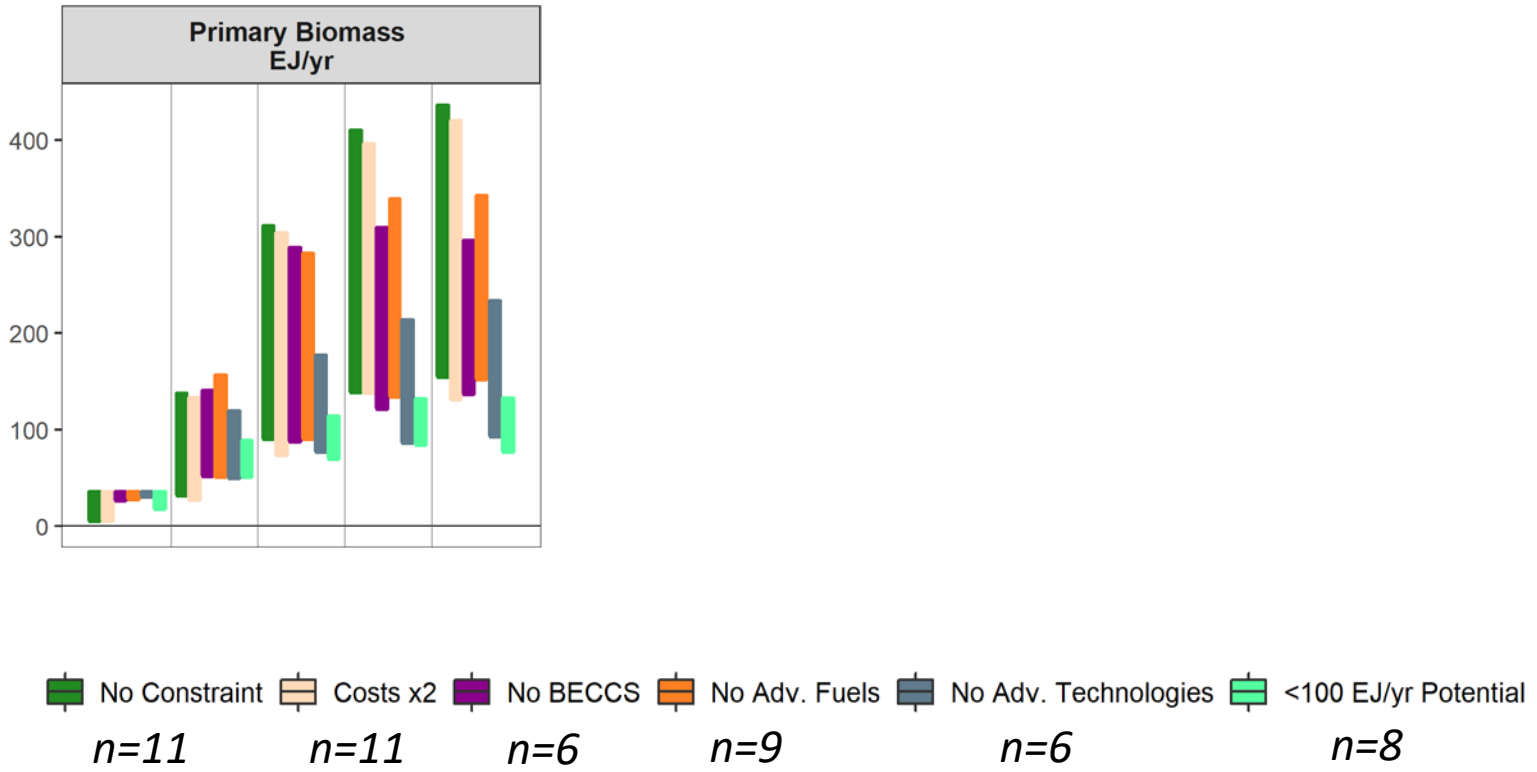

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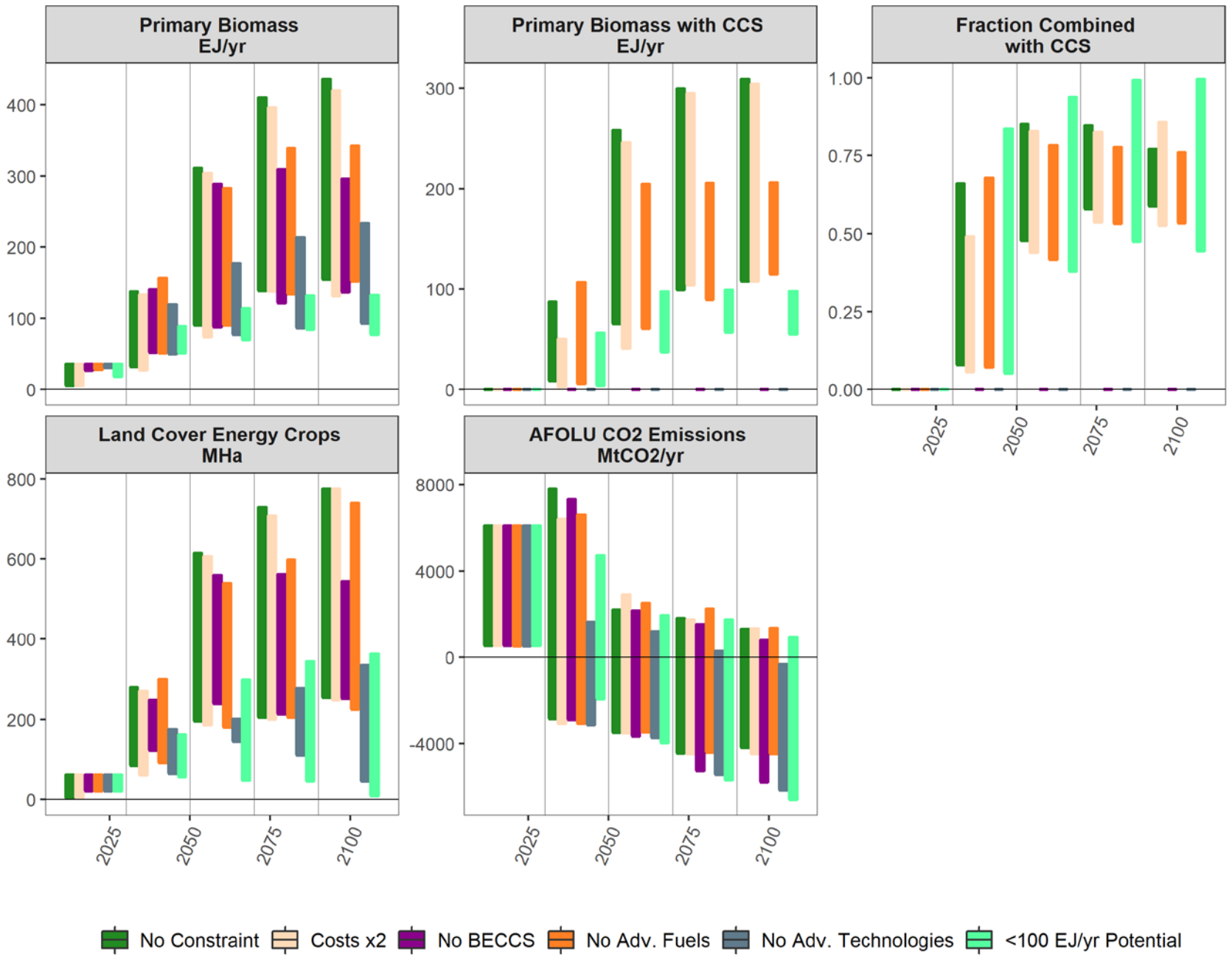
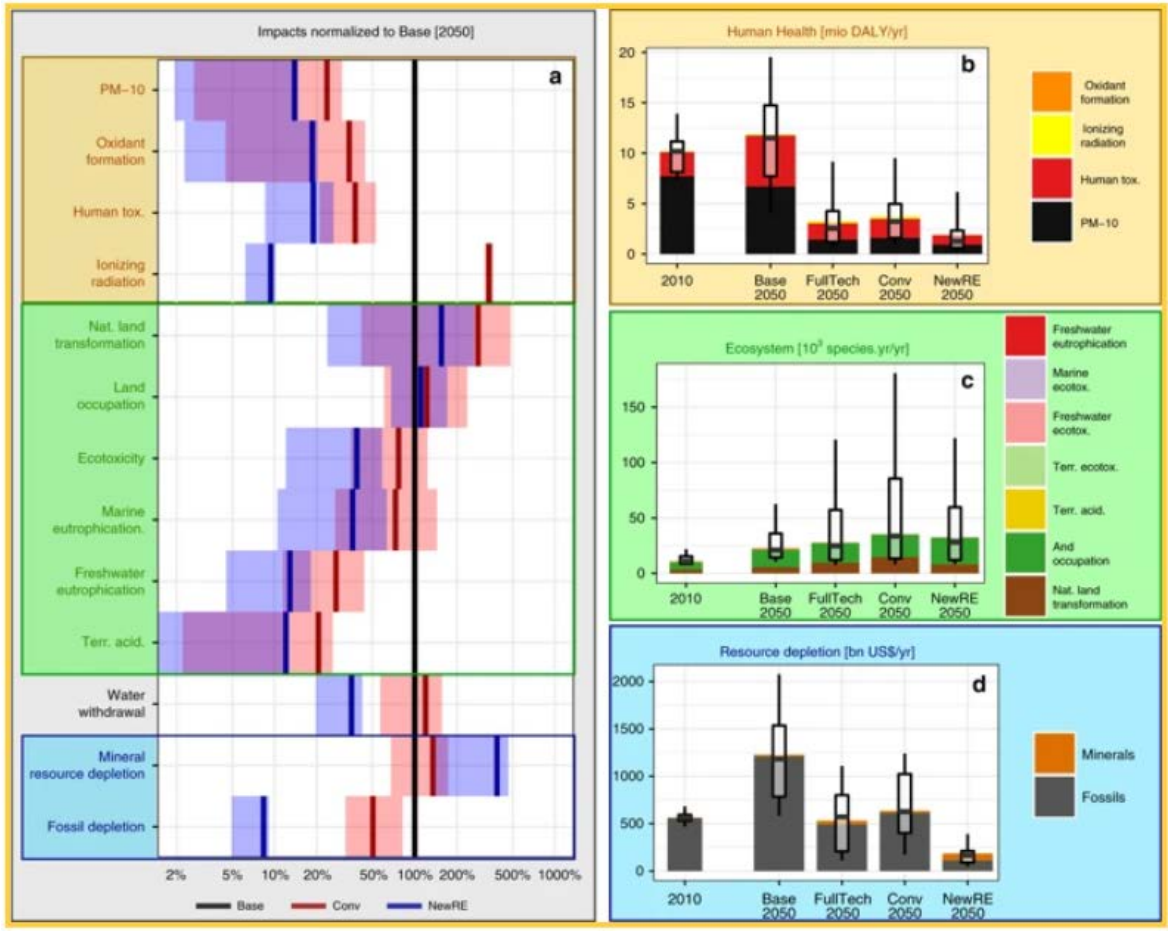


Future Avenues and Emerging questions

- Improve Links with LCA and MRIO
  - Assess multiple effects
  - Water / Biodiversity / Eco-toxicity
  - Evaluation of synergies and trade-offs
  - Land-Climate-Water-Energy Nexus



Luderer et al. (2019)

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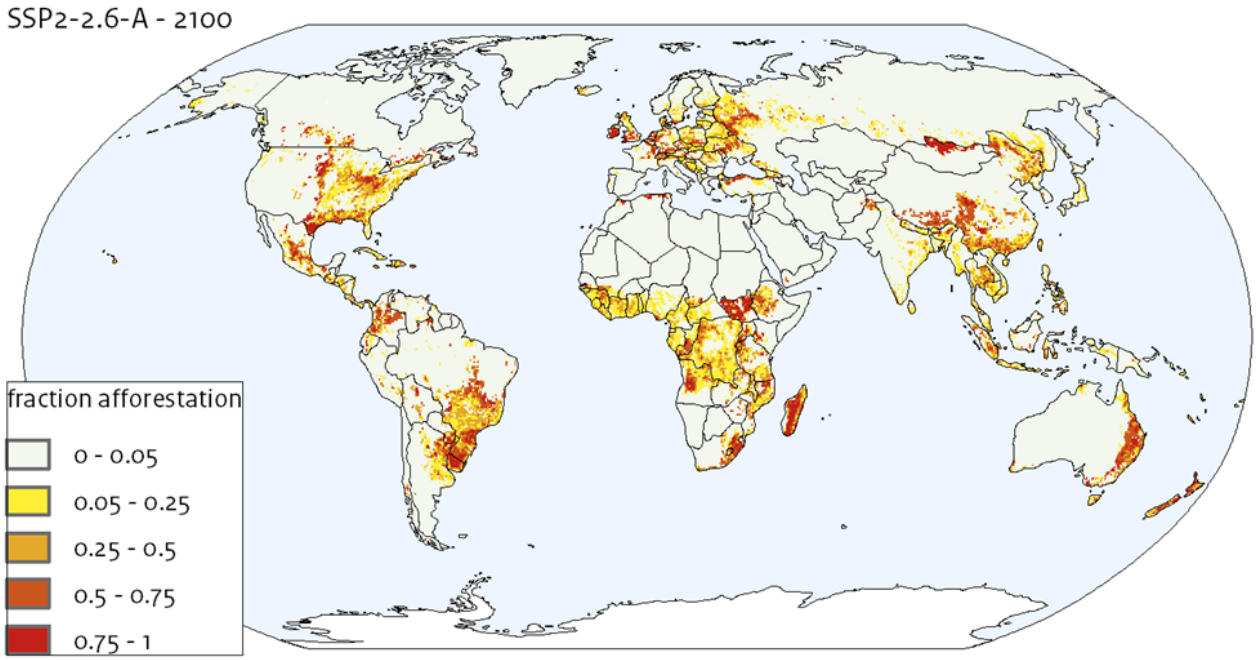
  - Afforestation / Reforestation
  - Biochar, Soil Carbon Sequestration, Enhanced weathering, etc.



Doelman et al. (2019)

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  - Bio-Chemicals & Bio-materials
  - Demand, recycling & cascading

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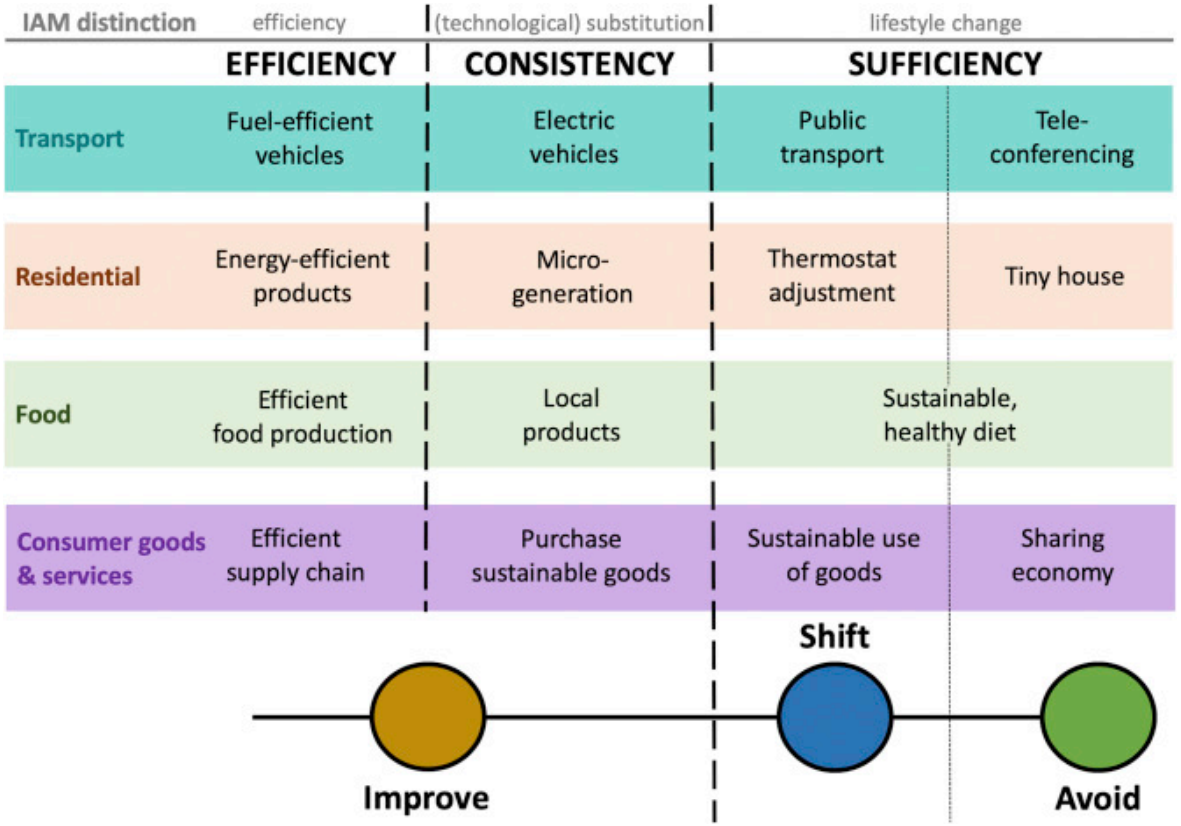
- Demand-Side Measures
  - Behavioural Change and lifestyle
  - Reduced waste and efficiency



van den Berg et al. (2019)

Conclusions

- Biomass plays an important and active role in mitigation scenarios
  - Up to 400 EJ/yr by 2100 (most scenarios at 100-250 EJ/yr)
  - 1.5˚C use ***more*** and ***sooner***
  - Predominantly supplied by lignocellulosic crops and residues
- Advanced technologies are preferred
  - Scenarios not sensitive to techno-economic parameterization
  - No-BECCS scenarios depend on other CO_2 removal or extreme changes in lifestyle & efficiency
- Mitigation strategies have profound implications for land management
  - IAM strategies imply strong land governance
  - Land-based mitigation measures are critical in mitigation scenarios
- (Some) uncertainties, sensitivities, and areas of concern
  - IAMs adopt a plethora of methods…each with its own energy and land-use strategies
  - Deployment logistics (seasonality, infrastructure, international trade, etc.)
  - Broader ‘sustainability’ implications

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Thank you

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Further Reading:

Bauer, N. et al (2018), Global energy sector emission reduction and bioenergy use: overview of the bioenergy demand phase of the EMF-33 model comparison, *Climatic Change*, pp. 16

Daioglou, V. et al (2019), Integrated assessment of biomass supply and demand in climate change mitigation scenarios, *Global Environmental Change (52),* 88-101

Daioglou, V. et al (2017), Greenhouse gas emission curves for advanced biofuel supply chains, *Nature Climate Change (12),* 920-926

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