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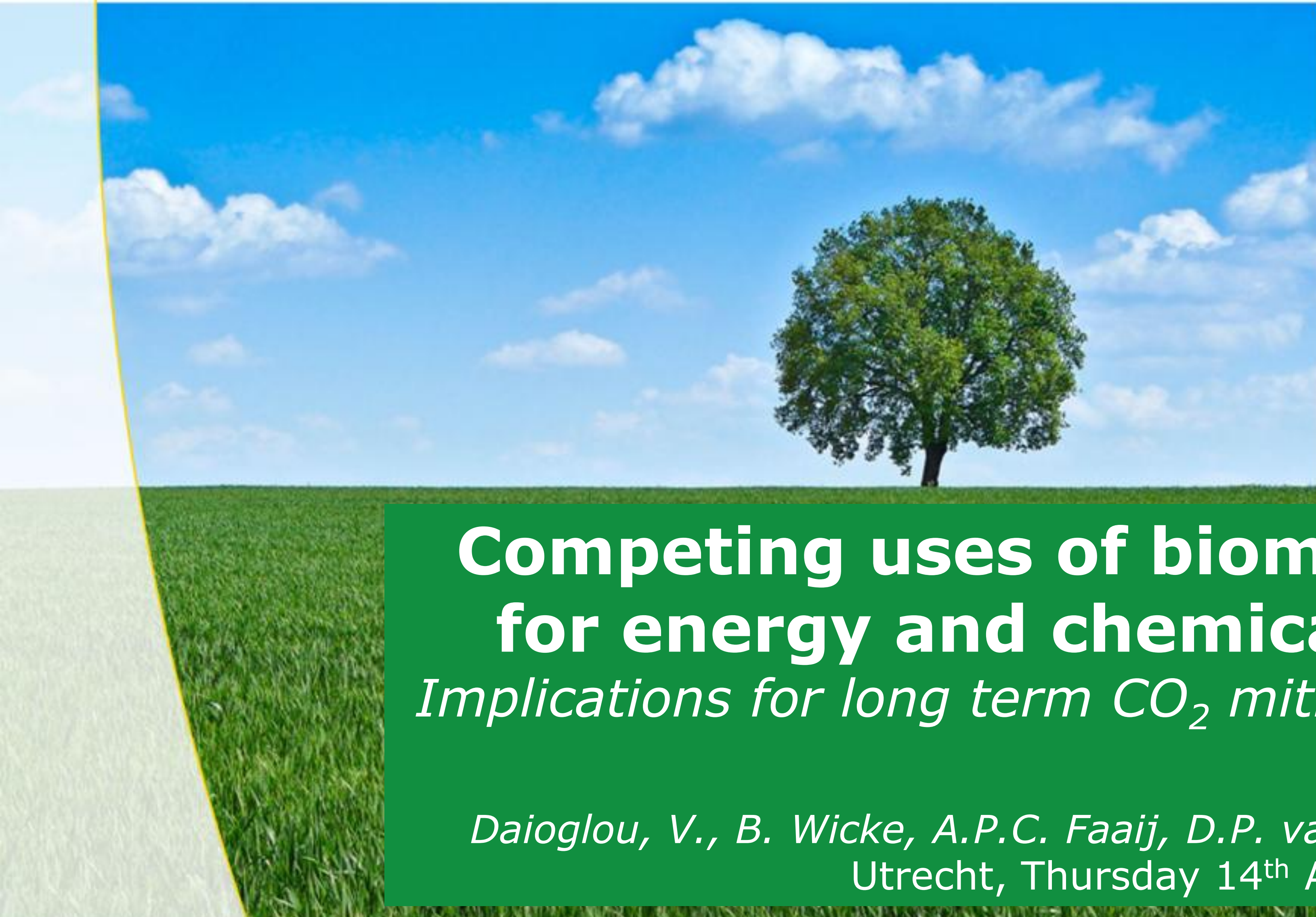


Competing uses of biomass for energy and chemicals

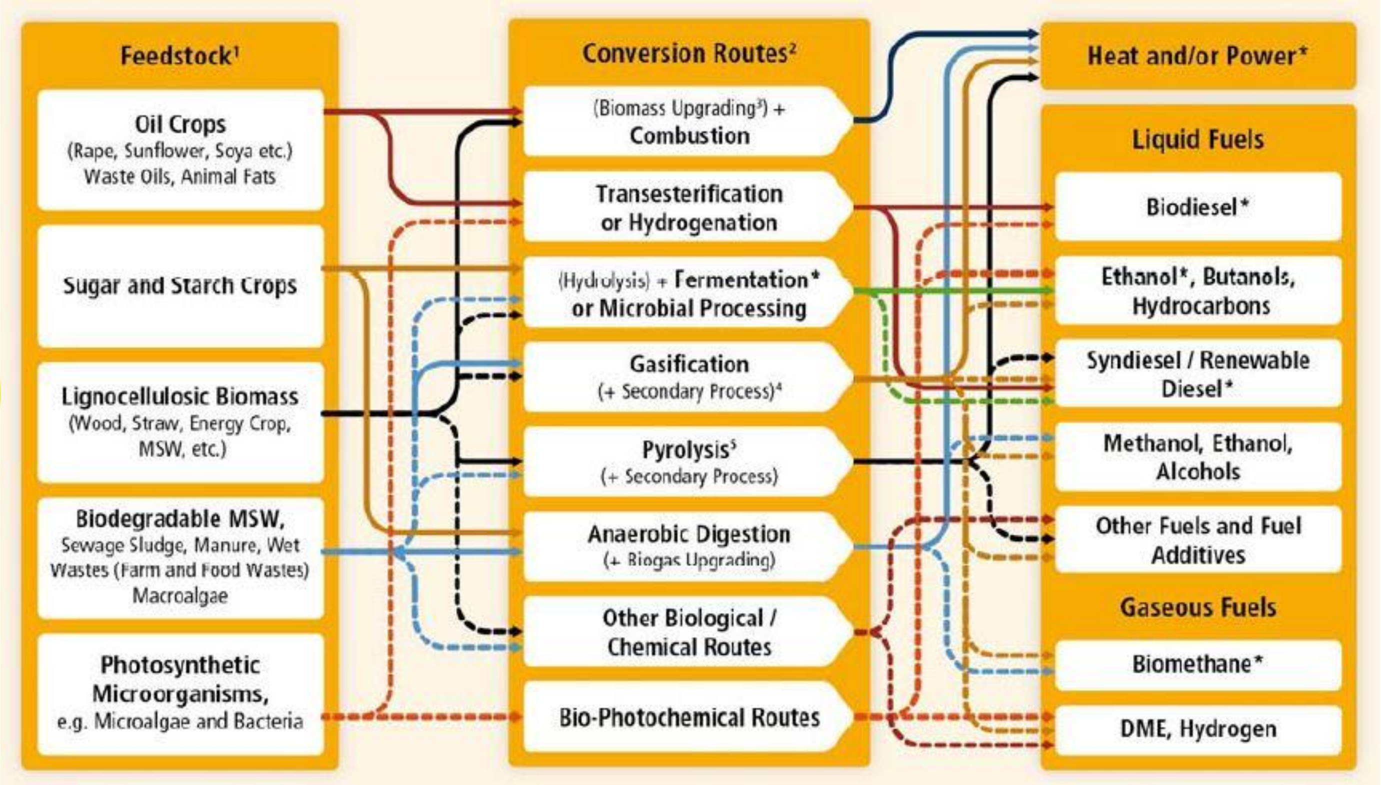
Implications for long term CO_2 mitigation

Daioglou, V., B. Wicke, A.P.C. Faaij, D.P. van Vuuren

Utrecht, Thursday 14th April 2016

Introduction

Biomass and energy system emissions



(Chum et al., 2011)

- Emission mitigation depends on
  - → Potential and competitivness of biomass per sector
  - → Which fossil fuel is displaced and potential leakage
  - → Possibility of advanced technologies (CCS)

What do we want to know?

What is the mitigation potential of different biomass uses, and how may competition between these uses limit its effective deployment?

How do the competing uses and the mitigation potential change with increasing carbon prices?

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Method

Scenario Analysis

- We project and compare the energy system under different bioenergy use scenarios:

Default– *Bioenergy available to all sectors*

1. **Bio-Industry**
2. **Bio-Transport**
3. **Bio-Buildings**
4. **Bio-Chemicals**
5. **Bio-Electricity**

(1–5: *Bioenergy limited to specific sector*)

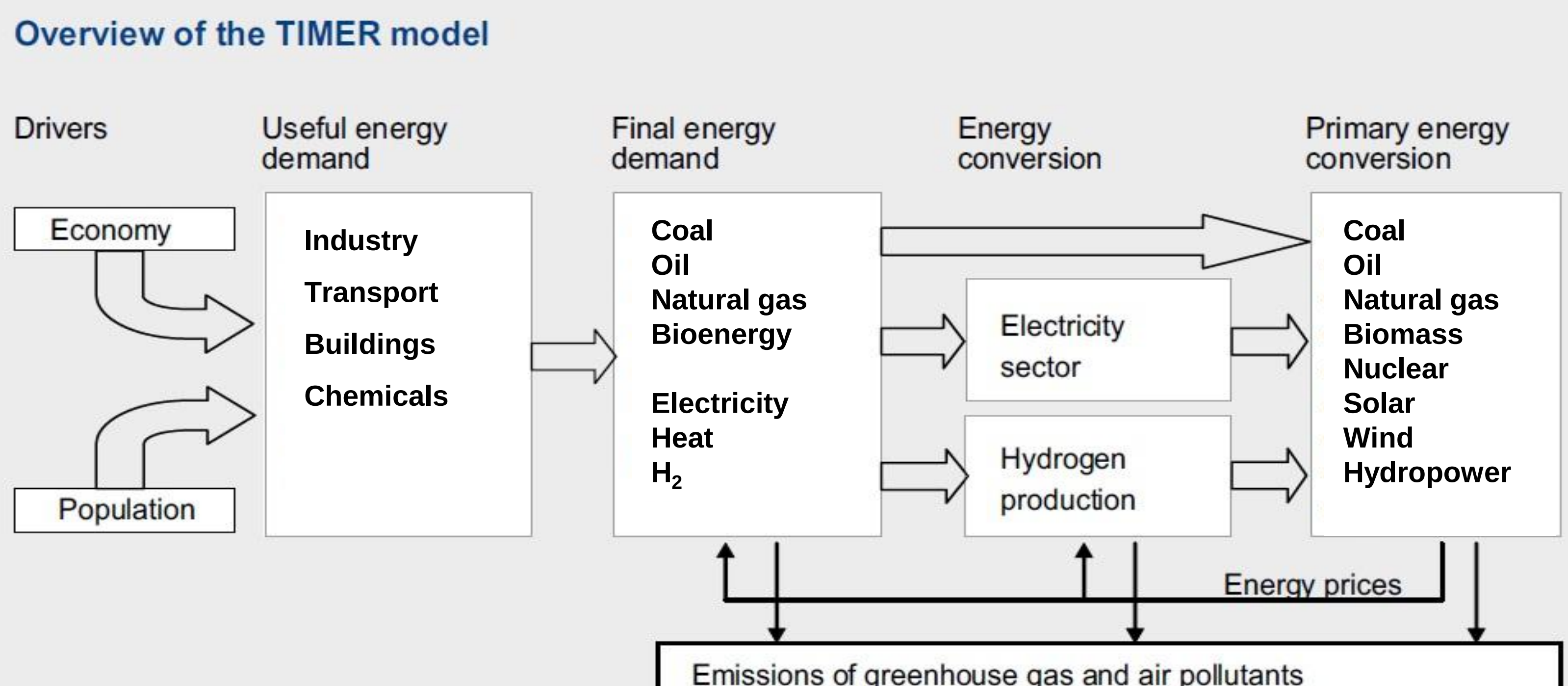
Counterfactual – *No bioenergy available*

- Compare **cumulative CO_2 emissions** for all scenarios to the **counterfactual** in order to investigate effect of biomass
- Repeat with increasing carbon taxes: *0 – 700$/tC*

TIMER Energy System Model

Outline

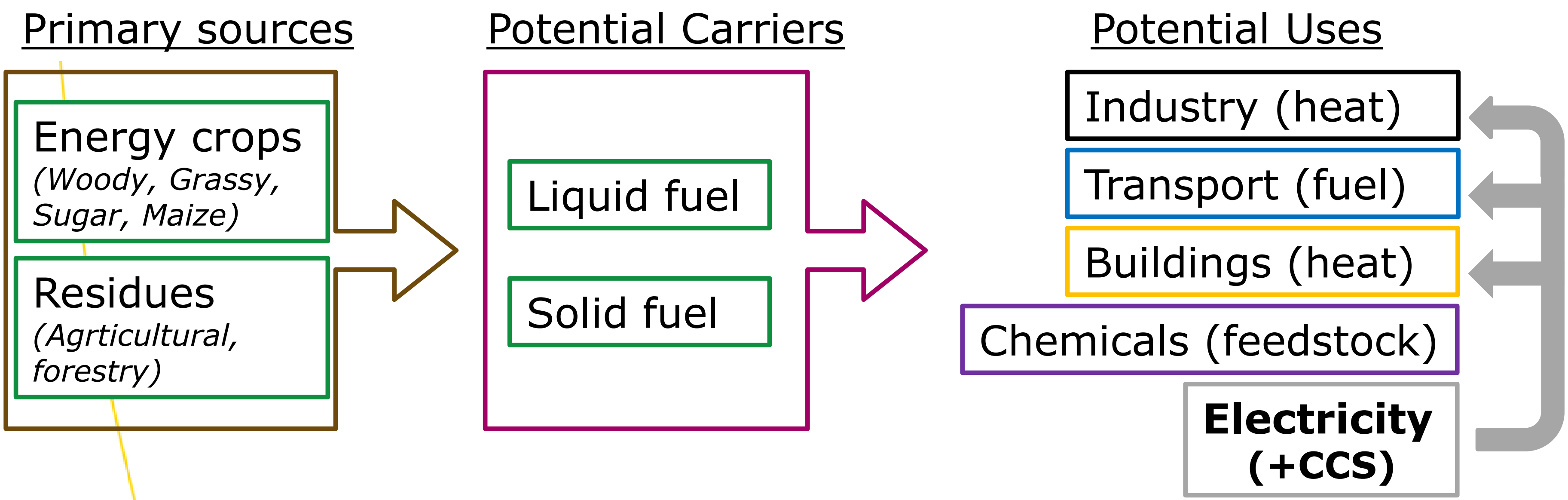
- Long term, global simulation model
- Projects energy demand, fuel choices and associated emissions
- Demand sectors have specific energy functions and technologies



Adapted from Bowman *et al. 2006*

TIMER Energy System Model

Biomass and Bioenergy



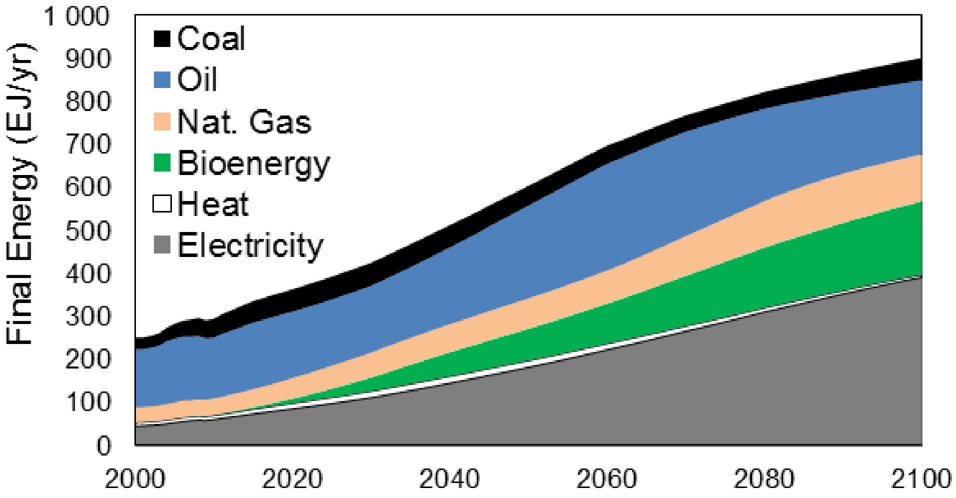
Projection: Default

In 2100:

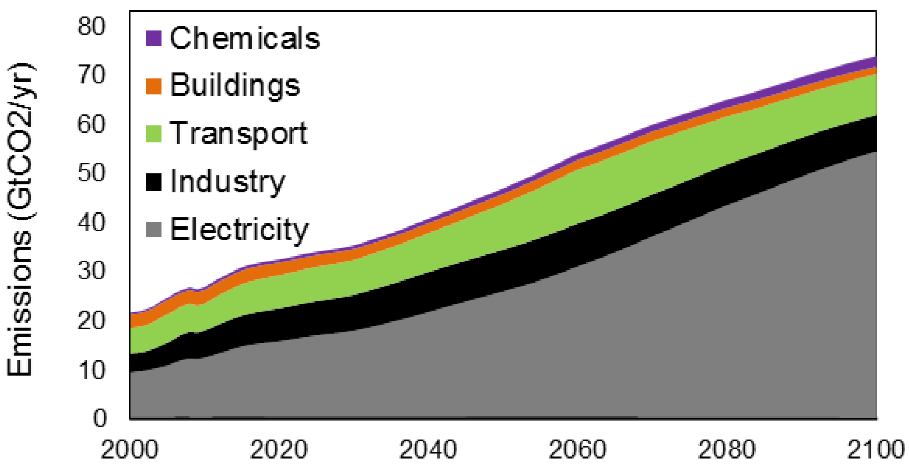
- Bioenergy = 18% *(170 EJ/yr)* of total final energy demand
- Used primarily in **transport** *(118 EJ/yr)* and **buildings** *(33 EJ/yr)*

  → *Substitutes liquid fuels*
- Increased electrification of energy services leads to indirect emissions

Final Energy



Emissions



*Note: In **Default** case no biomass is used to generate electricity.*

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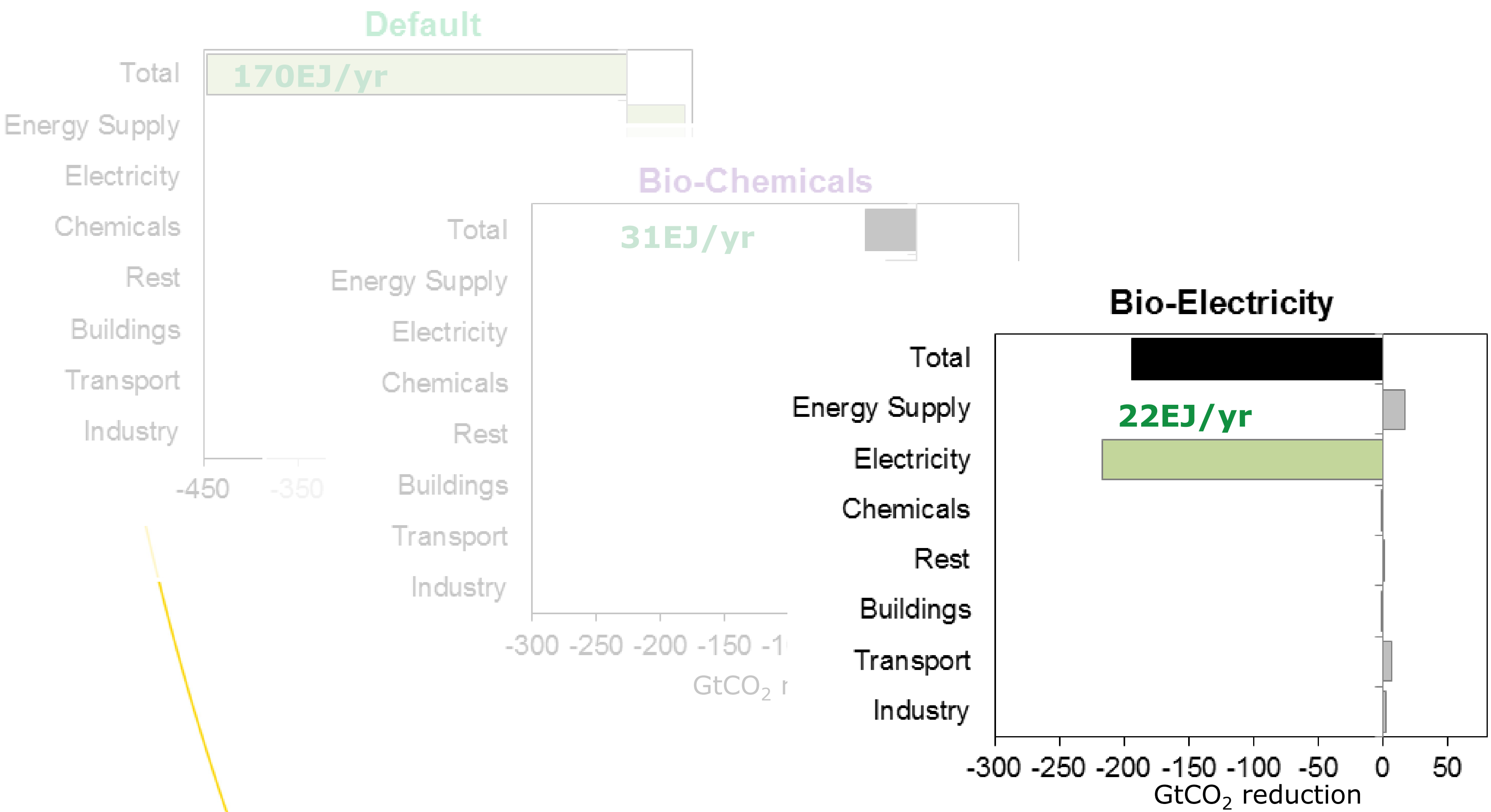
Results: Bio-Sector Scenarios

Counterfactual cumulative emissions in 2100: **5099 $GtCO_2$**



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Results: Bio-Sector Scenarios

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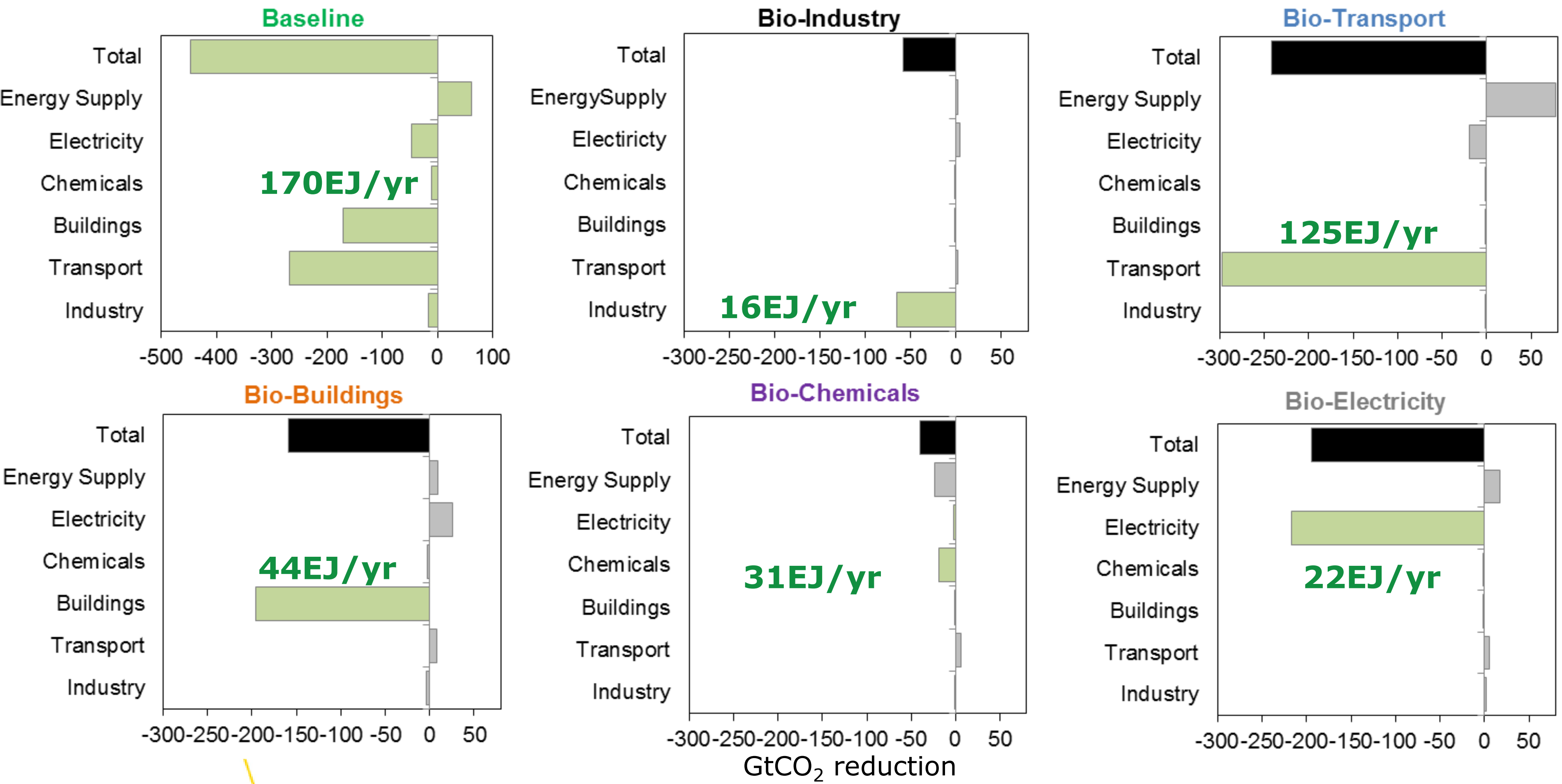
2100 Change in Cumulative Emissions (GtCO2)



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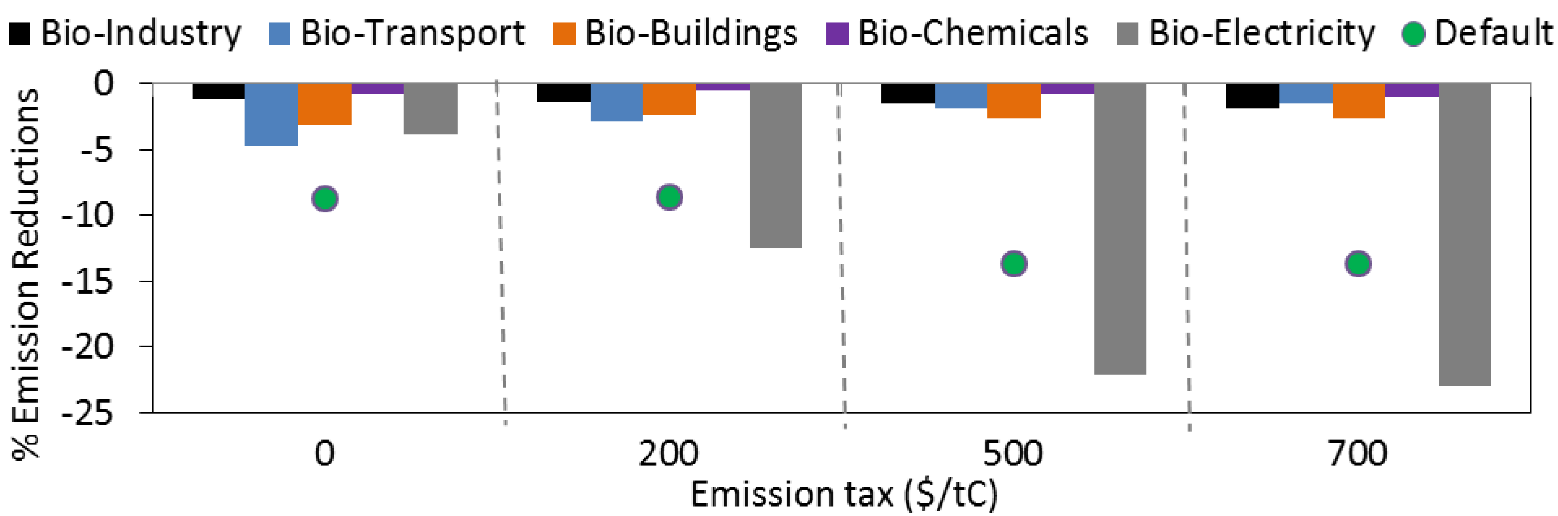
Results: Increasing C-taxes

Total emission reduction for each scenarios:

- At taxes > 200$/tC, limiting bioenergy to power production is more effective than having it compete freely

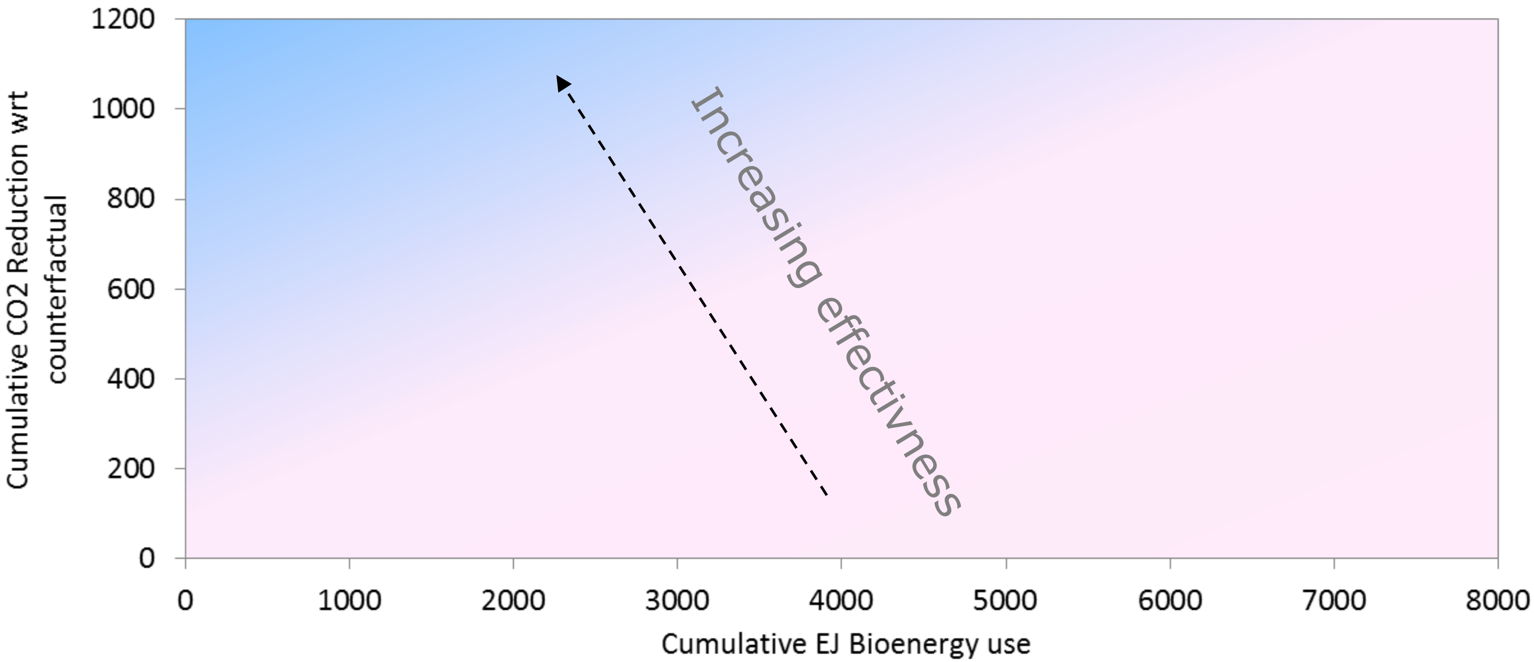
→ Recall: In baseline electricity demand grows significantly and is increasingly produced from fossil fuels



Results: Effectiveness

Emission reduction per unit bioenergy

- Top-left corner indicates most “effective” use
- Taxes usually increase effectiveness



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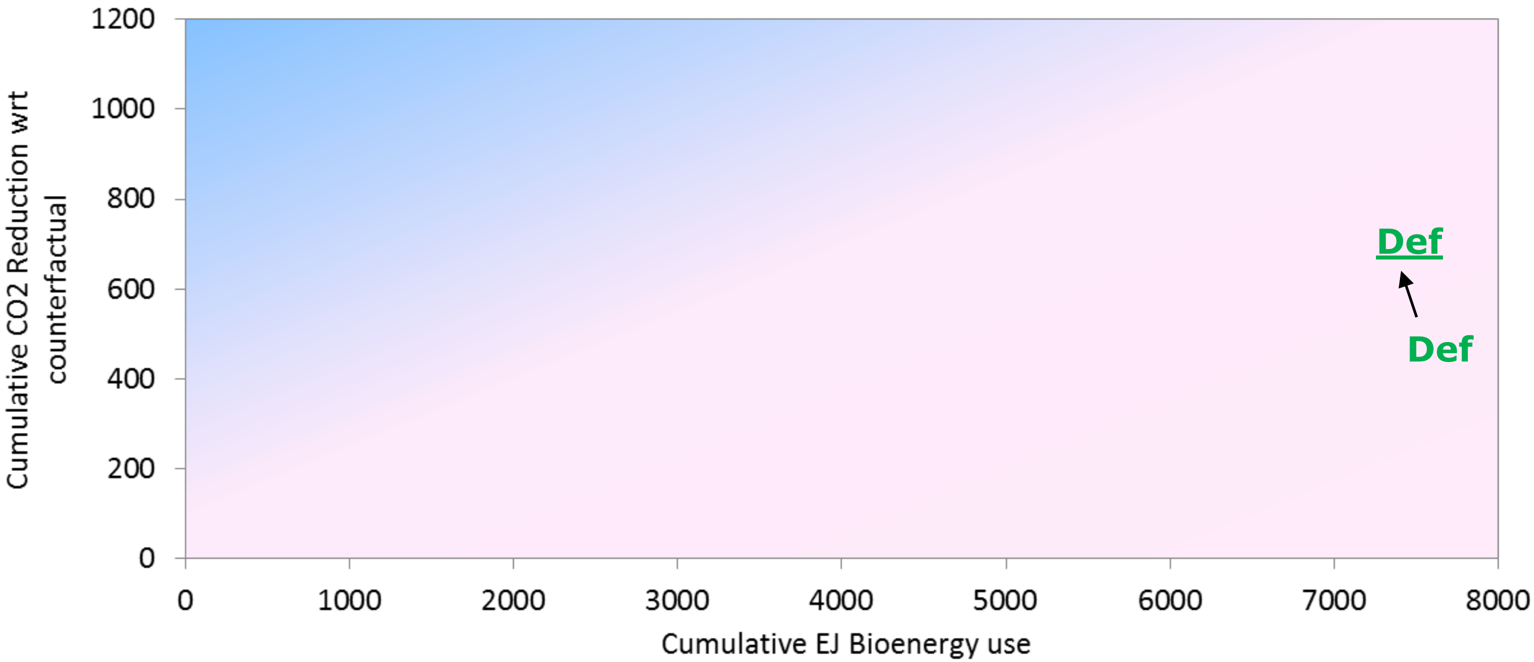

Def: Default

700$/tC case underlined

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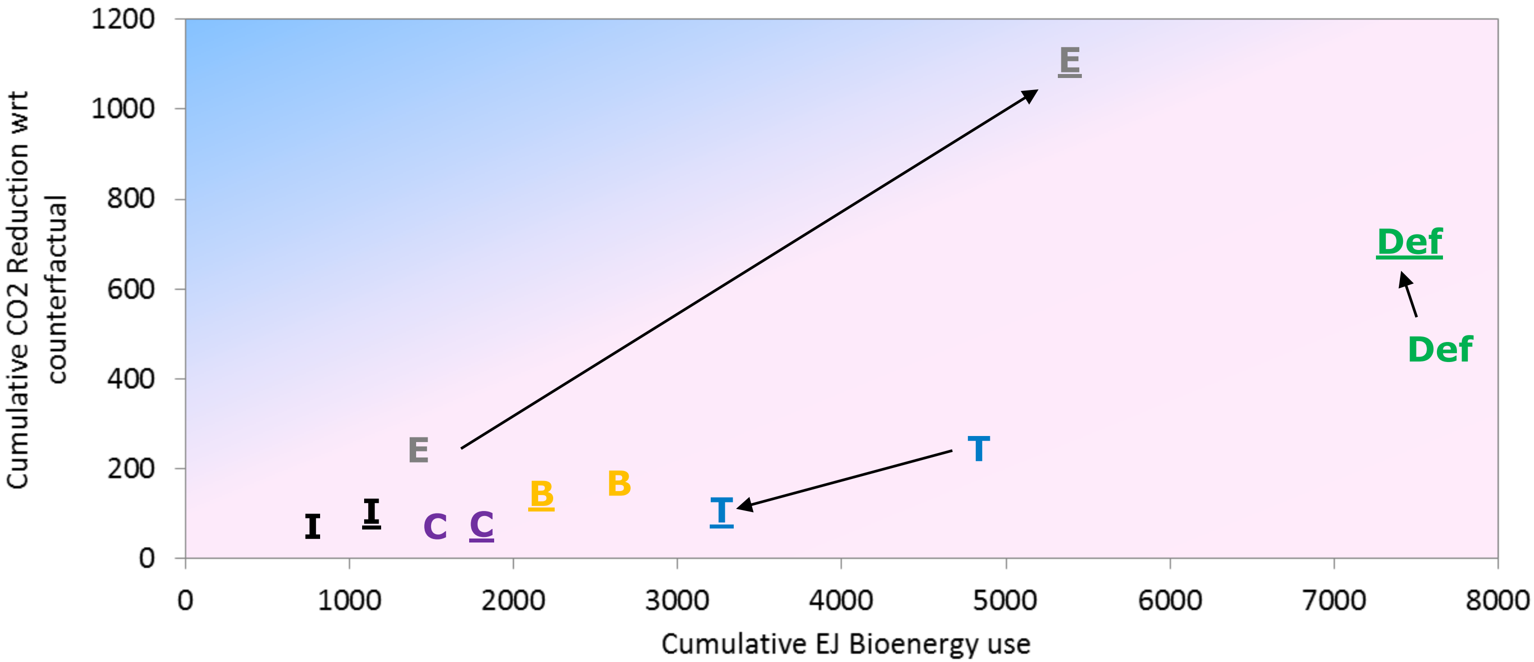
Results: Effectiveness

Emission reduction per unit bioenergy

- Top-left corner indicates most “effective” use
- Taxes usually increase effectiveness
- Transport and Chemicals get <u>less</u> effective due to biomass displacing increasingly cleaner (fossil) options.



I: Industry
T: Transport
B: Buildings
C: Chemicals
E: Electricity
Def: Default

700$/tC case <u>underlined</u>

Vassilis Daioglou

Conclusions

Bioenergy contribution to emission reductions

- *Transport and Electricity generation*
  - *→ Large sectors*
  - *→ CCS a critical technology for deep emission reductions*

Competing uses of biomass limit its emission reduction potential

- *Electricity generation offers deeper and more effective emission reductions*
  - *→ Displacement of coal*
- *Especially at high taxes and with CCS*
- *Competitive use in transport limits this*

Conclusions

Biomass: Chemicals vs. Energy uses

- *Biomass very competitive for chemical uses*
  - → *Projections show its adoption in* ***Default*** *scenario*

- *From a mitigation perspective, chemicals do not contribute much*
  - → *Sector has low overall energy use and emissions*
  - → *Biomass demand does not surpass ≈50 EJ/yr (globally, 2100)*
  - → *Inefficiencies in recycling and cascading limit emission mitigation of these operations*

Importance of different contexts

- *Global long term studies (such as this one) cannot capture particularities of specific regions, technologies, complexities, etc.*
  - → *Also need detailed mid-term regional assessments*

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Thank you for your attention

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