POTSDAM INSTITUTE FOR CLIMATE IMPACT RESEARCH

The calm before the storm

What happens to CO_2 emissions before their price starts to increase?

Nico Bauer, Jérôme Hilaire, Christoph Bertram

7th Annual Meeting of the Integrated Assessment Modeling Consortium
College Park, Maryland
October 17 – 19, 2014

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- Methodology
  - General REMIND model
- Results
  - Policy runs
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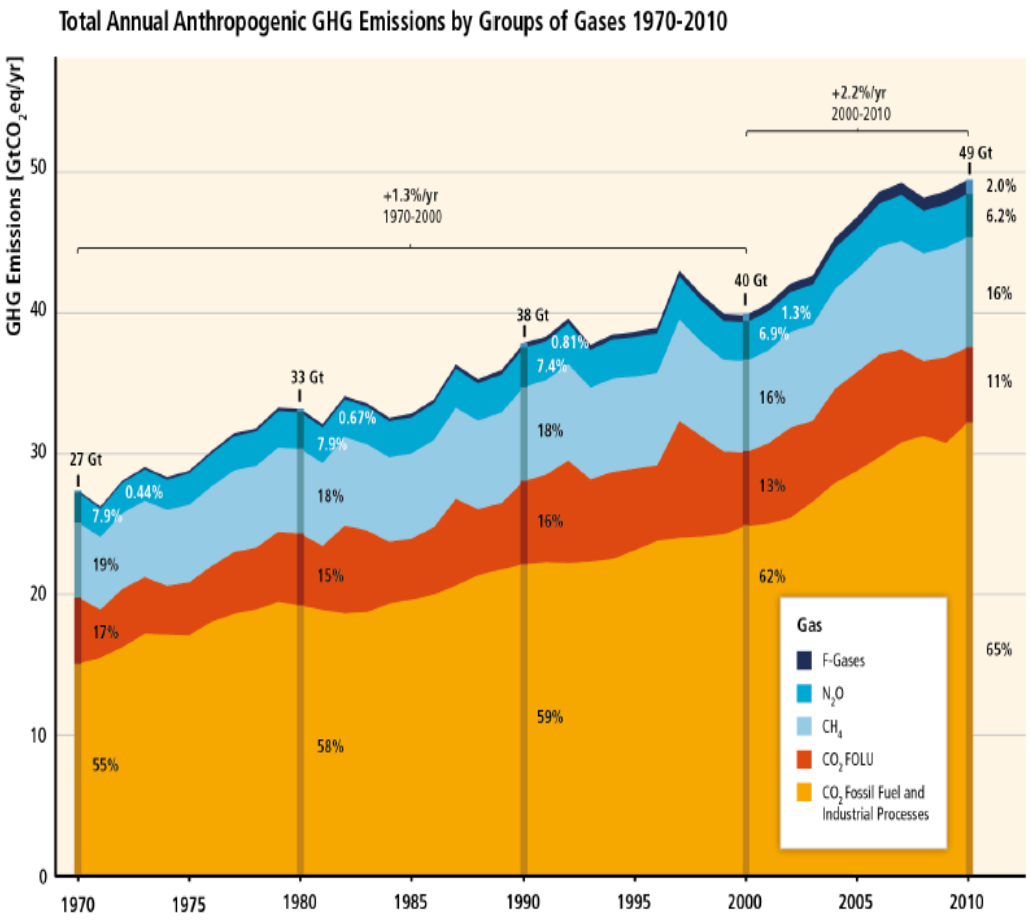
Global GHG Emissions – History of the last 45 years



IPCC AR5 WG3 SPM

Cumulative sum from 1750

⇒ 1300GtCO$_2$-eq FFI

⇒ 490GtCO$_2$-eq FOLU

CO$_2$ Budgets and 2°C

⇒ <1600GtCO$_2$ for 50:50

⇒ <1100GtCO$_2$ for 66:33

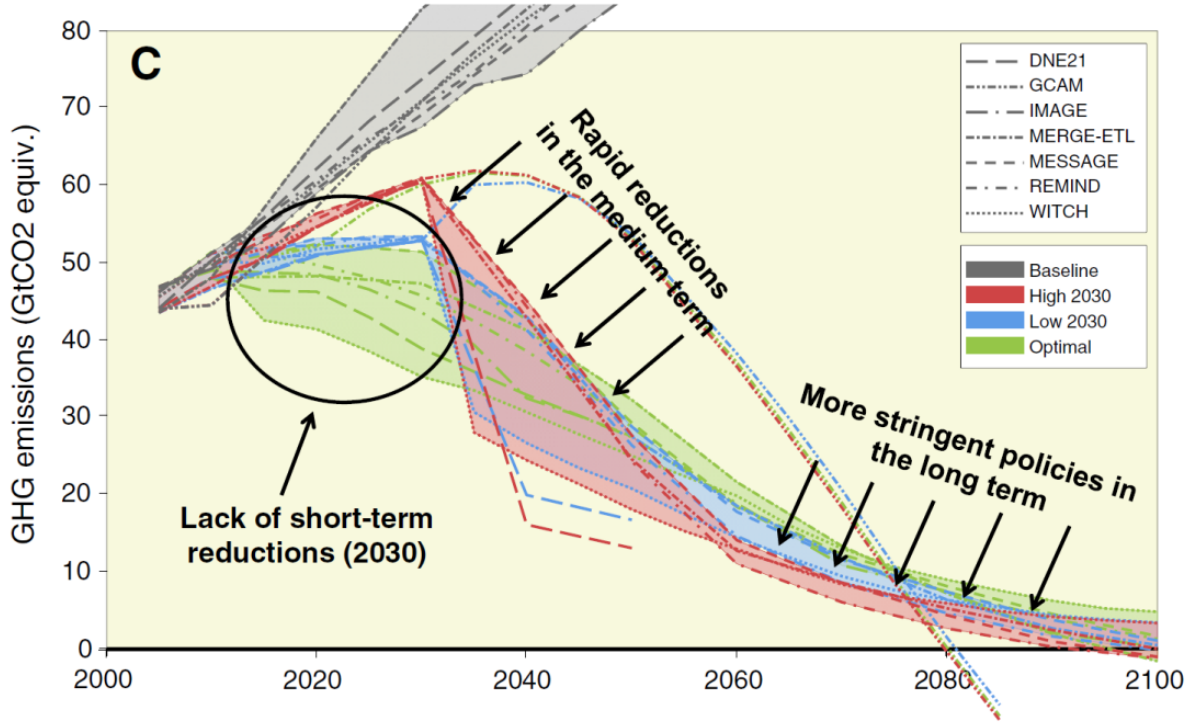
Drama of Climate Policy

⇒ Long-term target

⇒ Short-term ambition

Quantitative Studies on Delayed Climate Policies

- Delayed climate polices imply intertemporal mis-allocation of emission budget; mostly coal (Bauer et al. 2014)
- State of the art to assess delayed climate policies



Riahi et al. (2014)

Quantitative Studies on Delayed Climate Policies

- Delayed climate polices imply intertemporal mis-allocation of emission budget; mostly coal (Bauer et al. 2014)
- State of the art to assess delayed climate policies:
- Effects after policy kick-start
  - Very high GHG prices
  - Fossil fuel *supply side*: extreme drop in fossil fuel prices
  - Fossil fuel *demand side*: Stranded assets
  - Higher stabilization costs; temporary reduction of growth rate
  - (Bauer et al. 2014, Bertram et al. 2014, Luderer et al. 2014, Johnson et al. 2014, Rogelj et al. 2014)
- Delayed policies crucial for economics of climate change mitigation (IPCC AR5 WG3 SPM)

Announcing Delayed Climate Policies

- Supply Side – Fossil Fuel Owners (Green Paradox)
  - Sinn (2008) seminal paper on tax evasion by fossil fuel owners
  - Heal model with extraction costs => cumulative emissions decrease

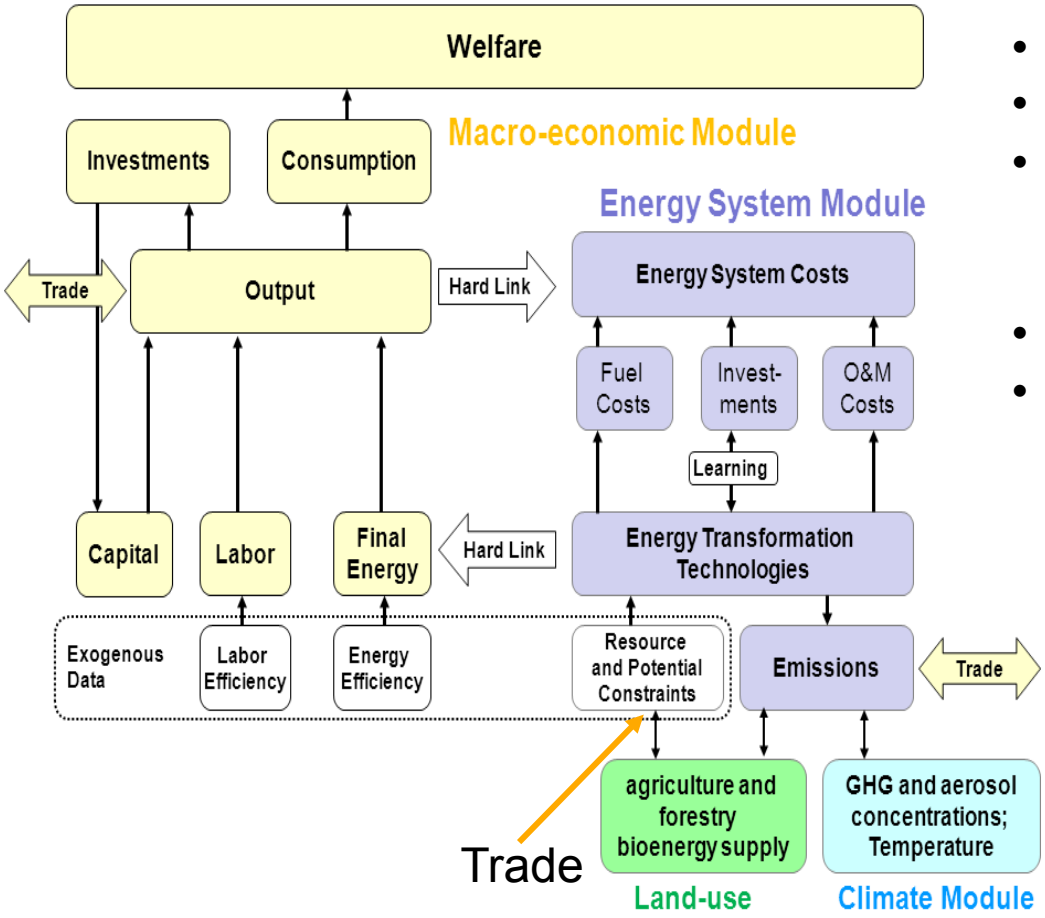
    ➔ Forces emissions upwards, but demand side is fully flexible
- Demand Side – Capacities and Investments
  - Bosetti et al. (2009) emissions reduced 10y earlier
  - Blanford et al. (2009) initial CO_2 price: 27 => 17US$/t$CO_2$

    ➔ Forces emissions downwards, but rent dynamics not sufficient

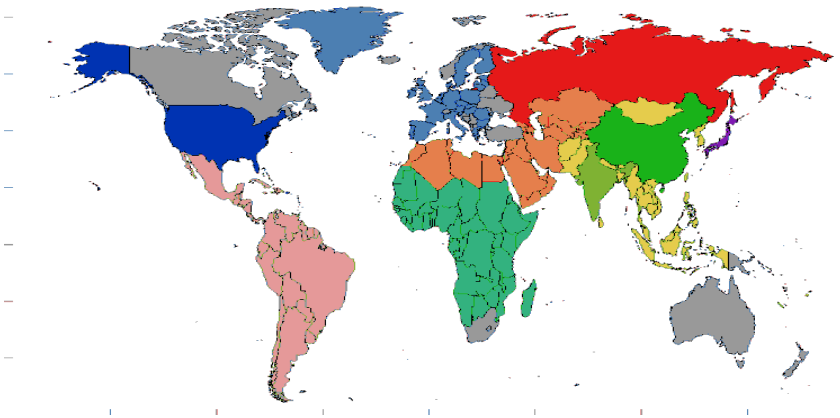
➔ Comprehensive assessment of policy announcement needs integration of Supply and Demand side reaction

Methodology
The REMIND Model

Methodology – The REMIND Model



- Ramsey-type growth model, GE
- Intertemporal with perfect foresight
- Hard-link of a
  - Top-down macro-economic model
  - Bottom-up energy sector model
- Time horizon until 2100
- Global multi-regional with trade



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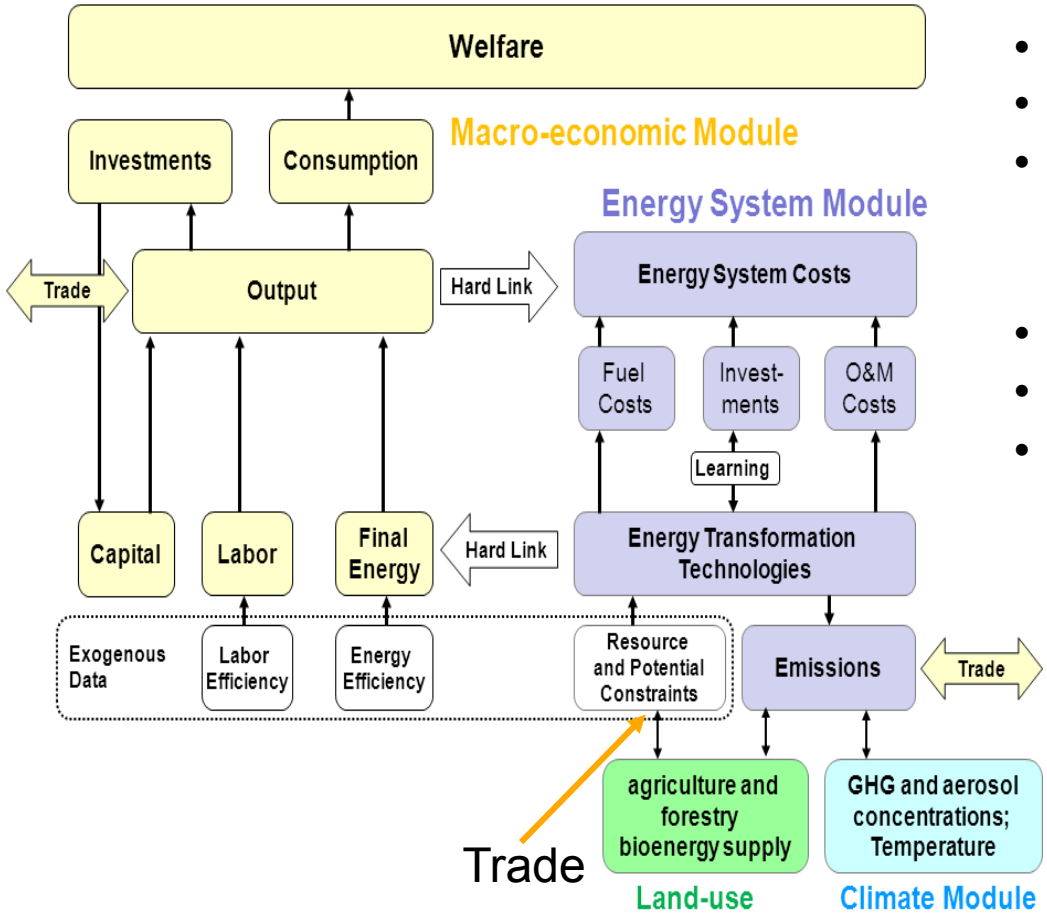

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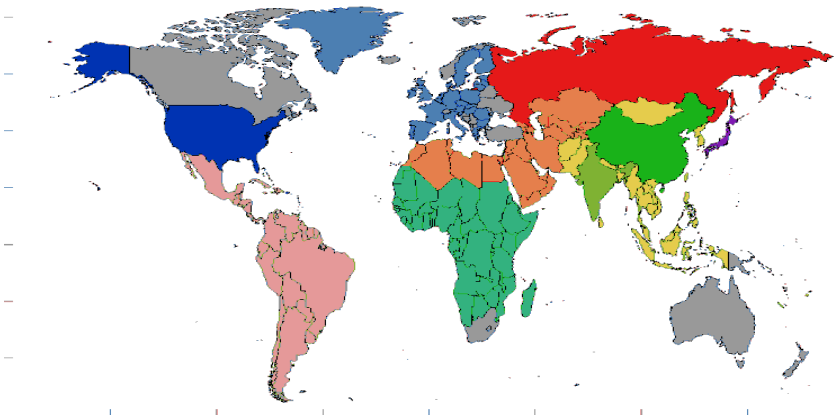
  - Top-down macro-economic model
  - Bottom-up energy sector model
- Time horizon until 2100
- Global multi-regional with trade
- Solution concept
  - Social optimal in each region
  - Global non-cooperative Nash



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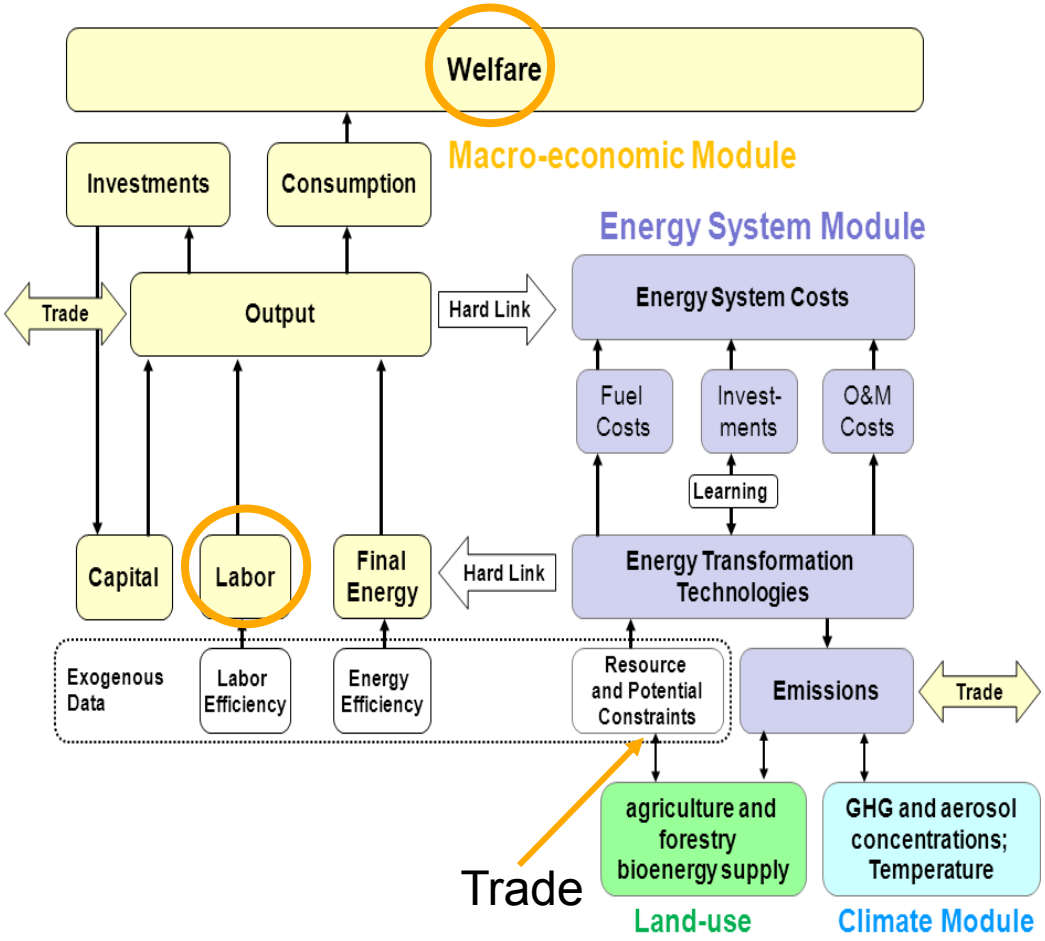
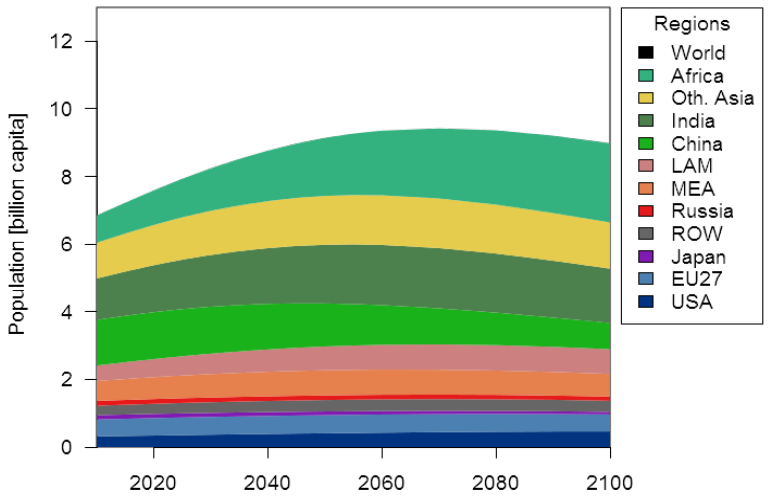
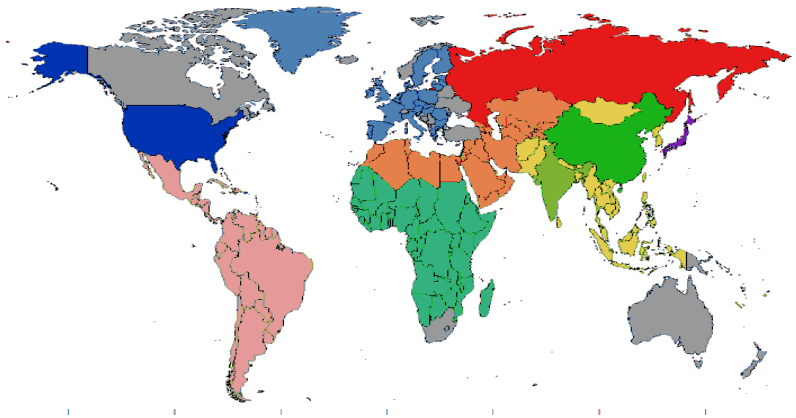


Population





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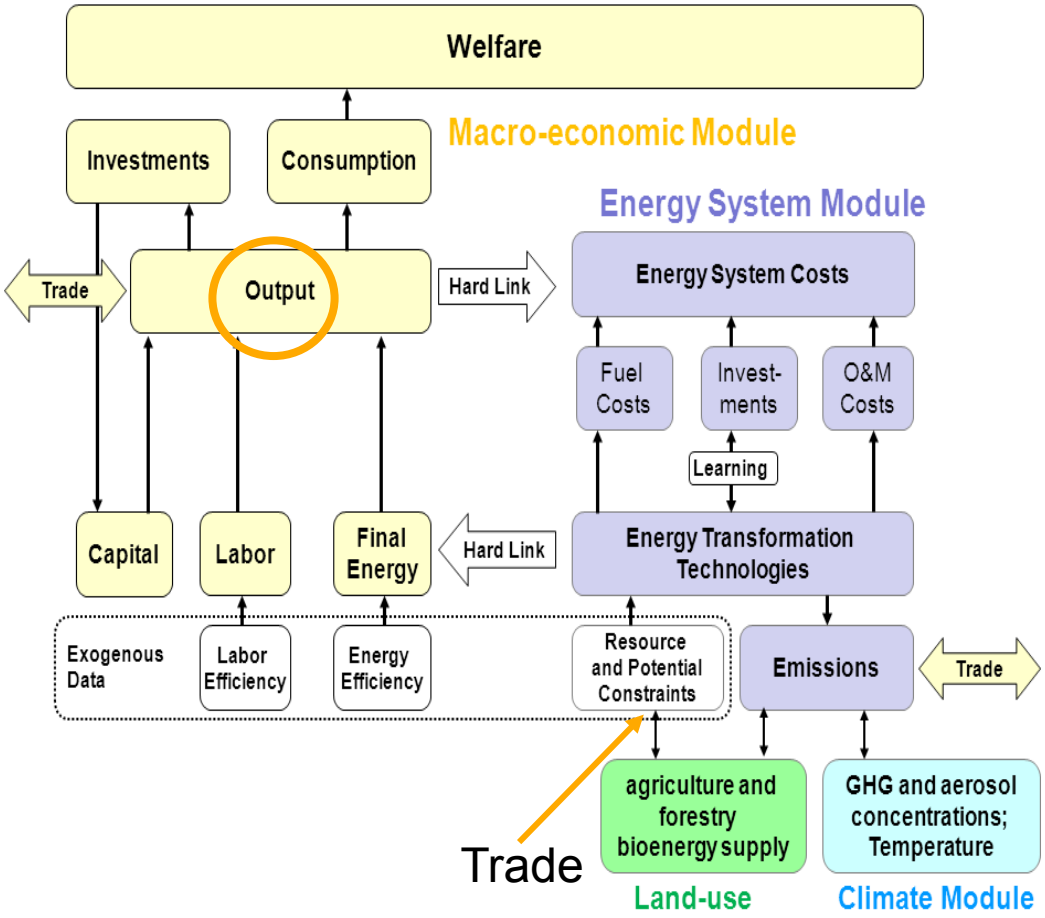
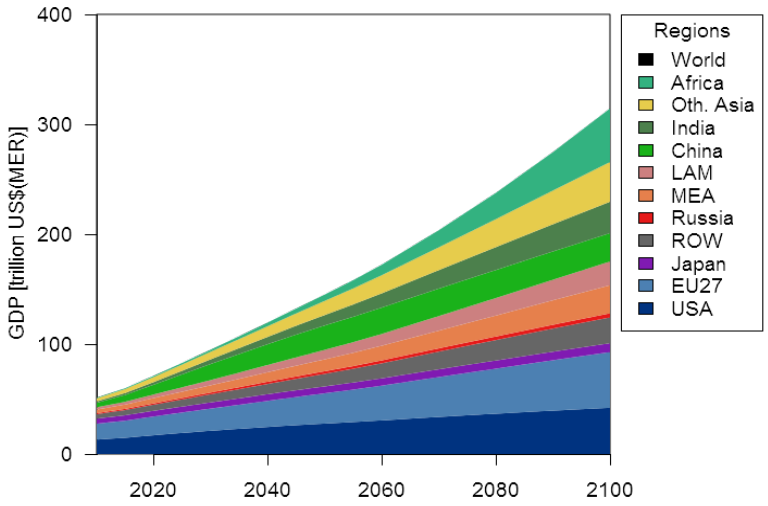
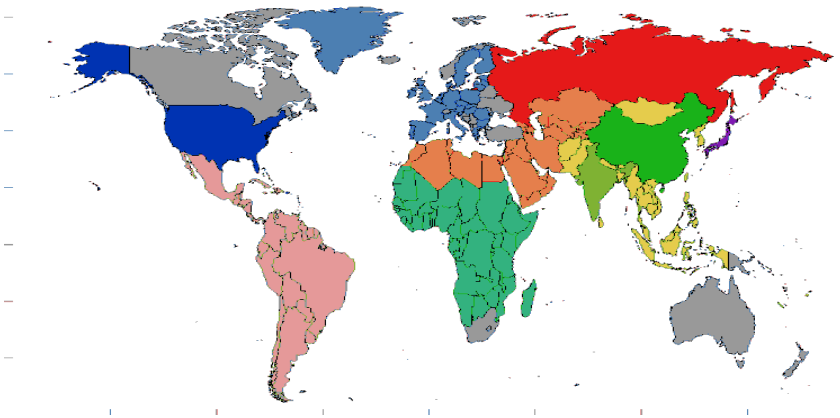


GDP – MER





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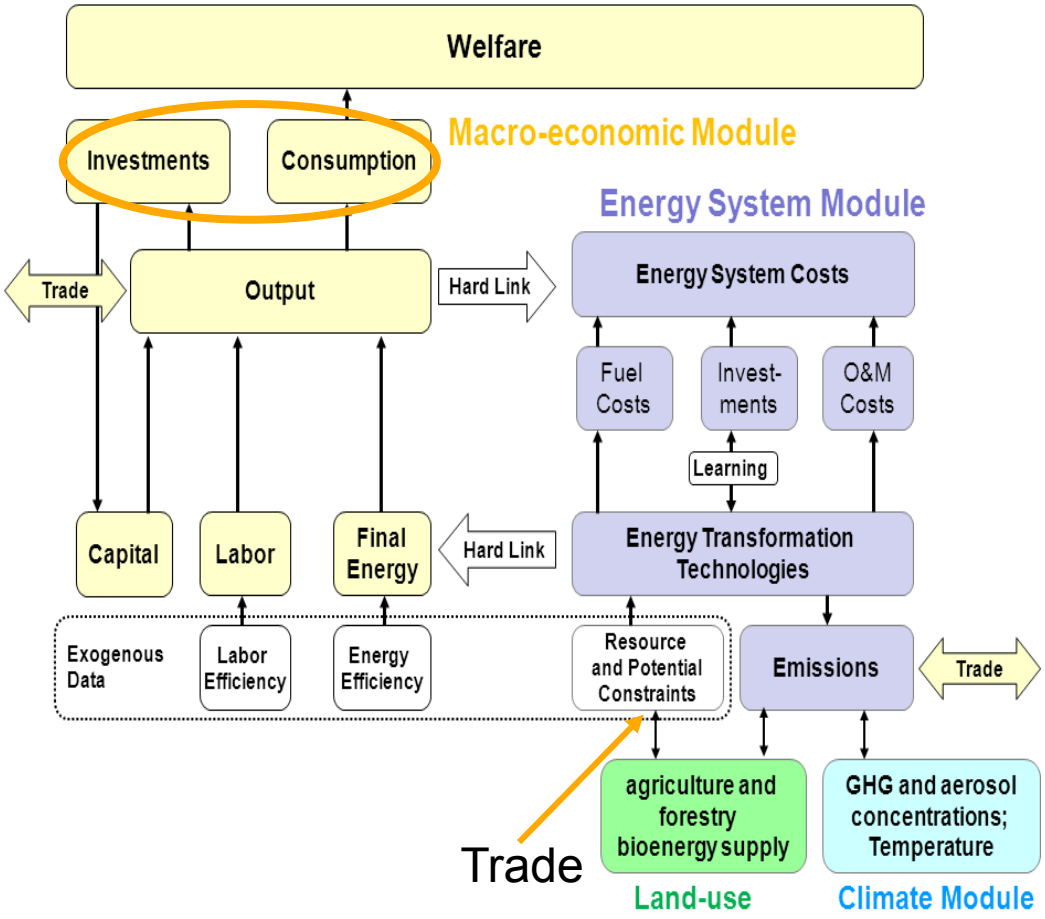
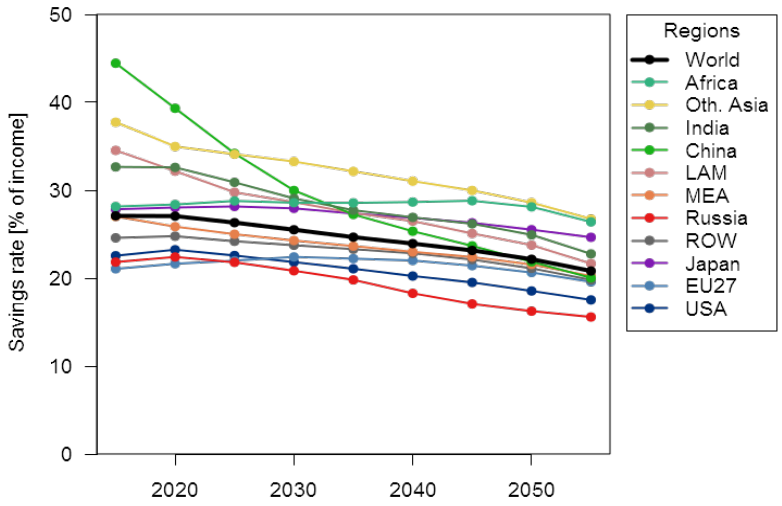
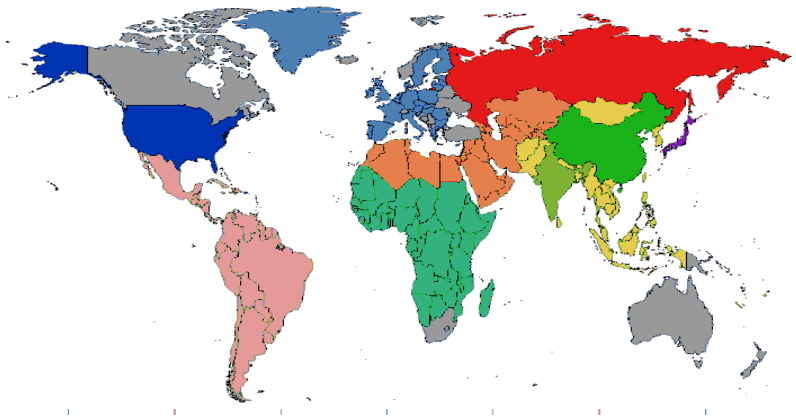


Investment Rate





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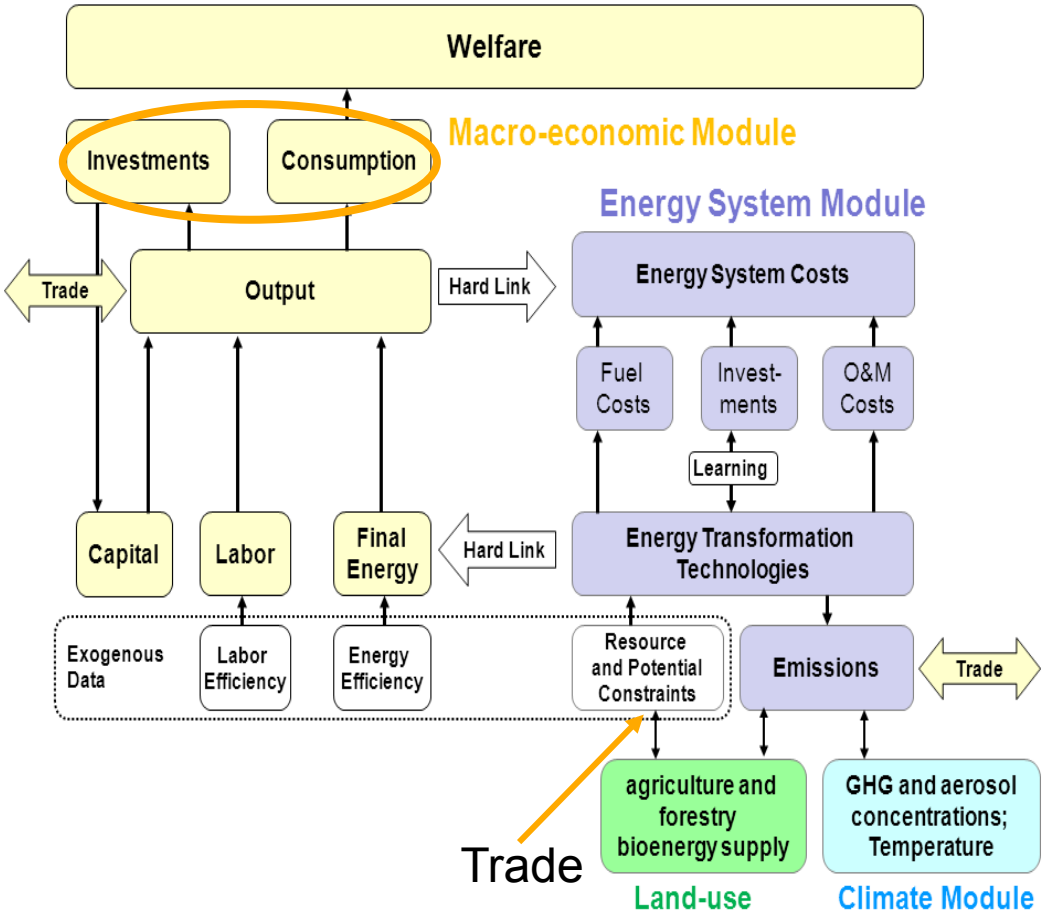
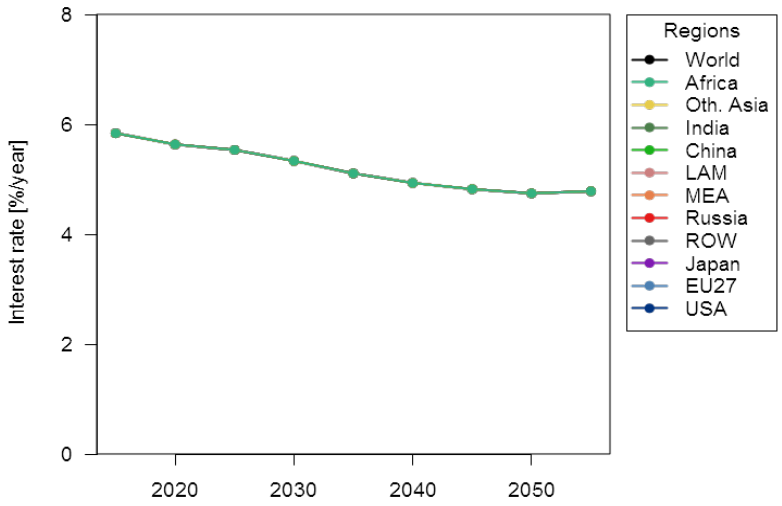
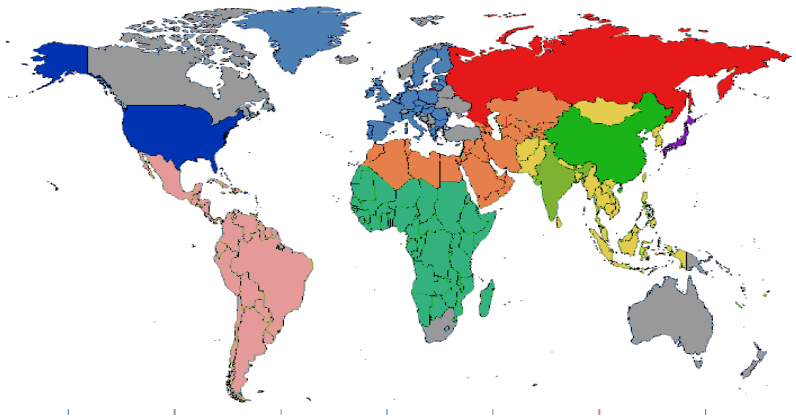


Interest Rate





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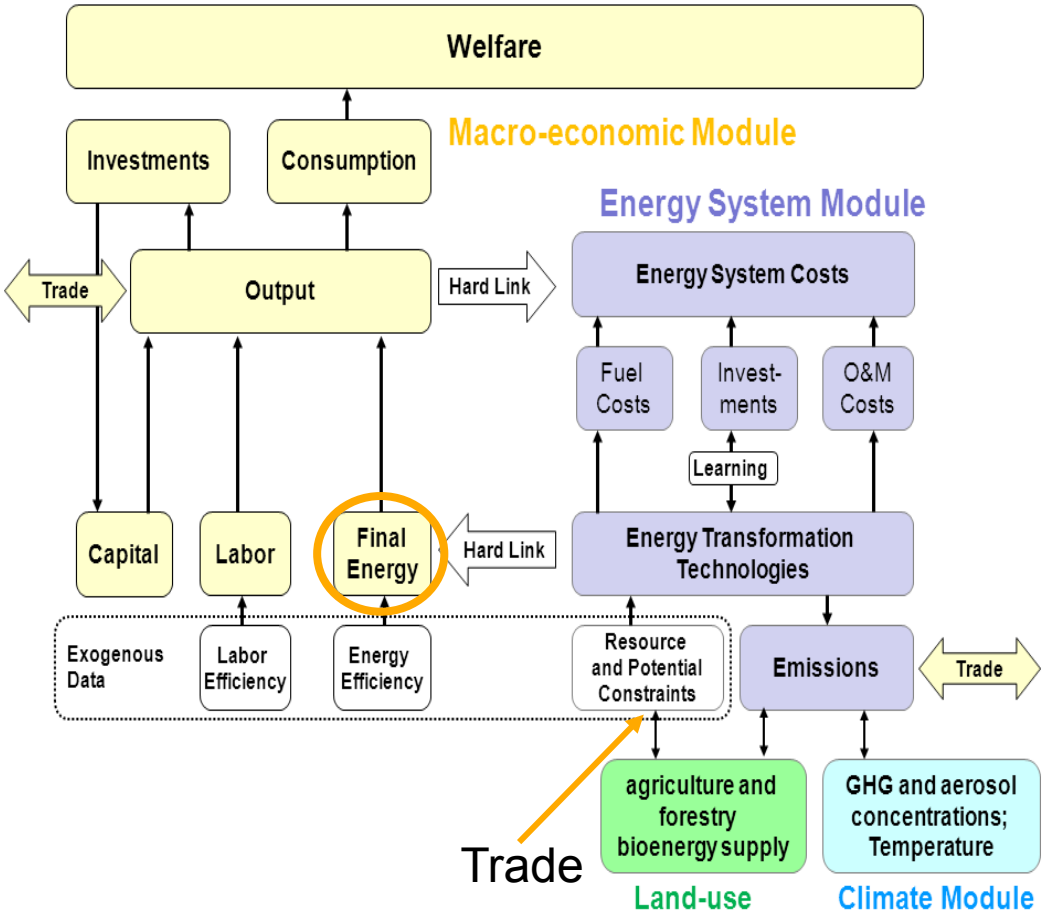
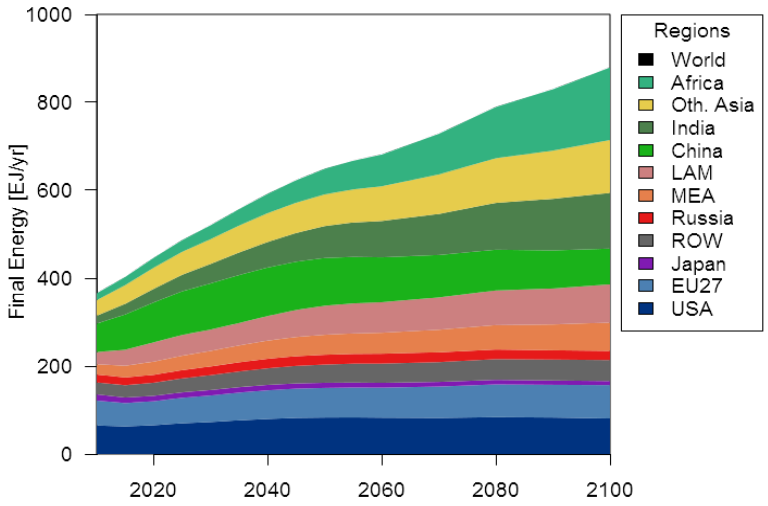
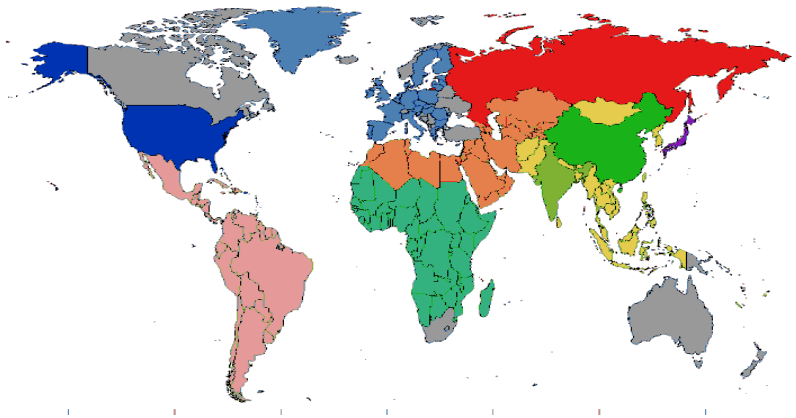


Final Energy





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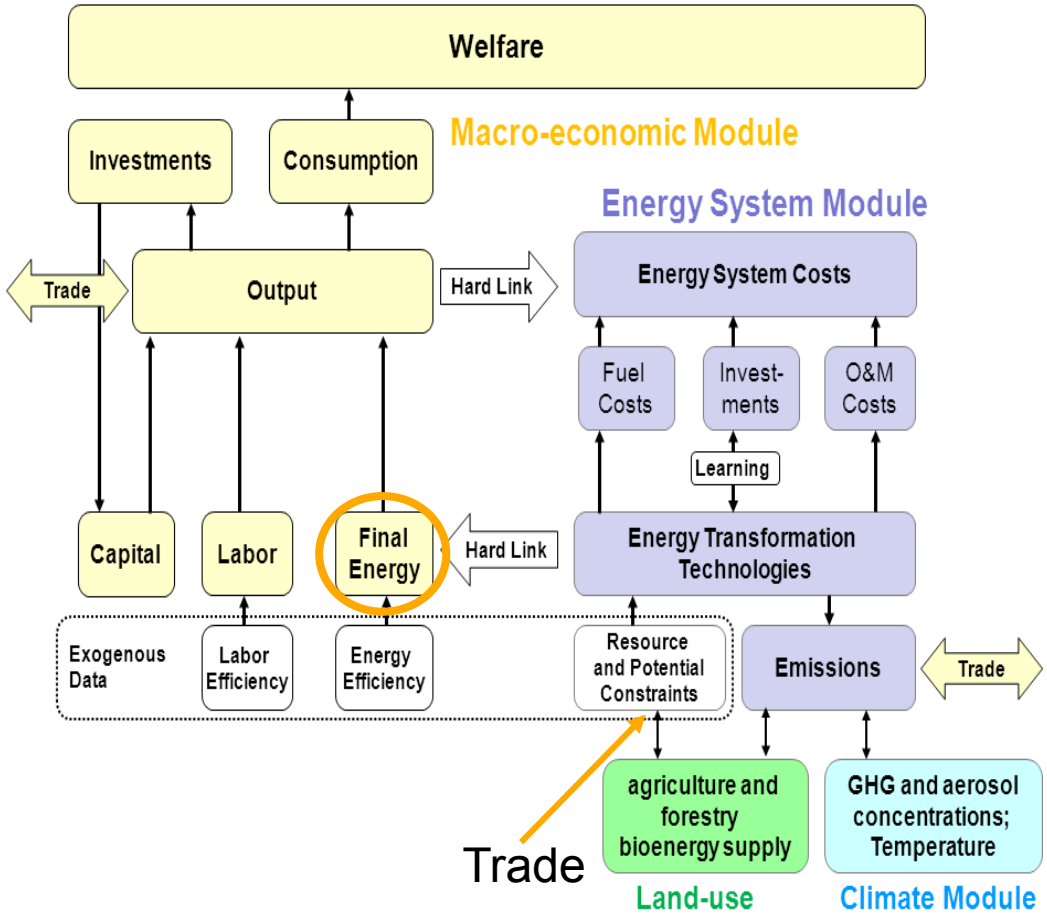

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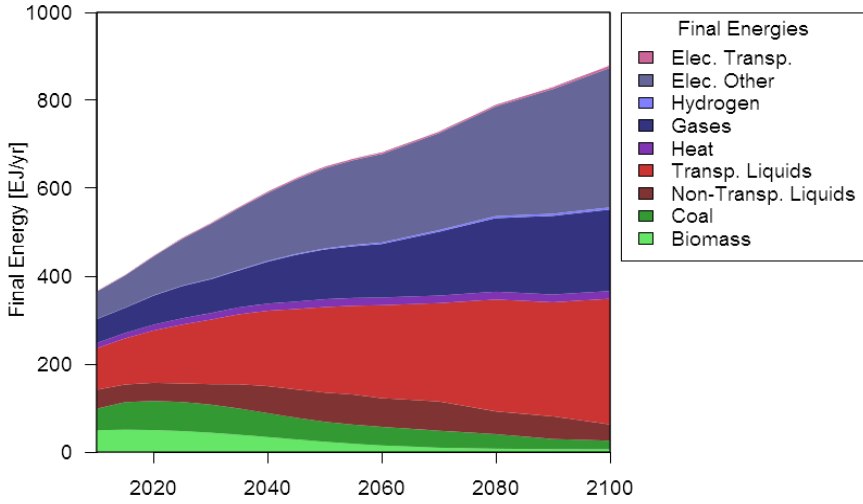

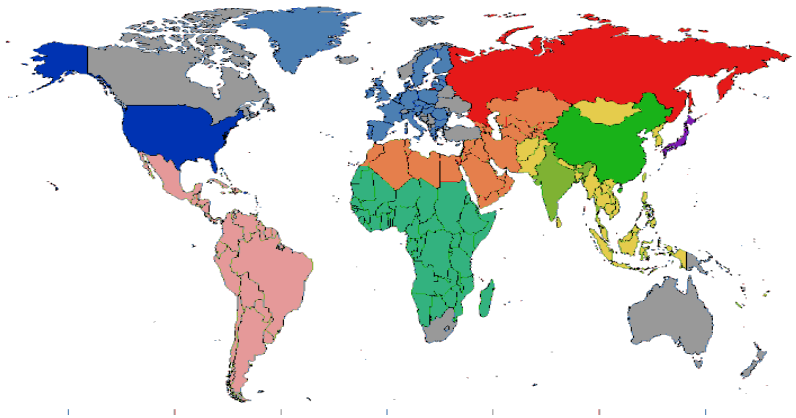

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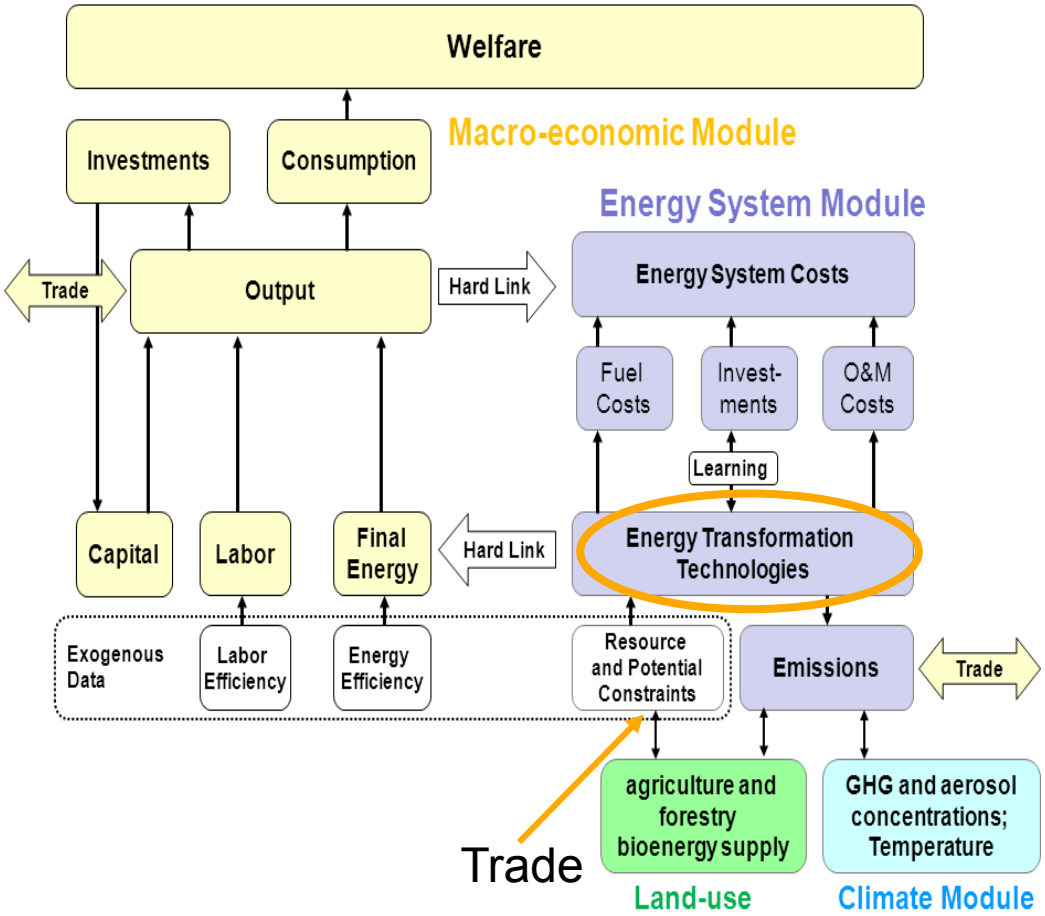
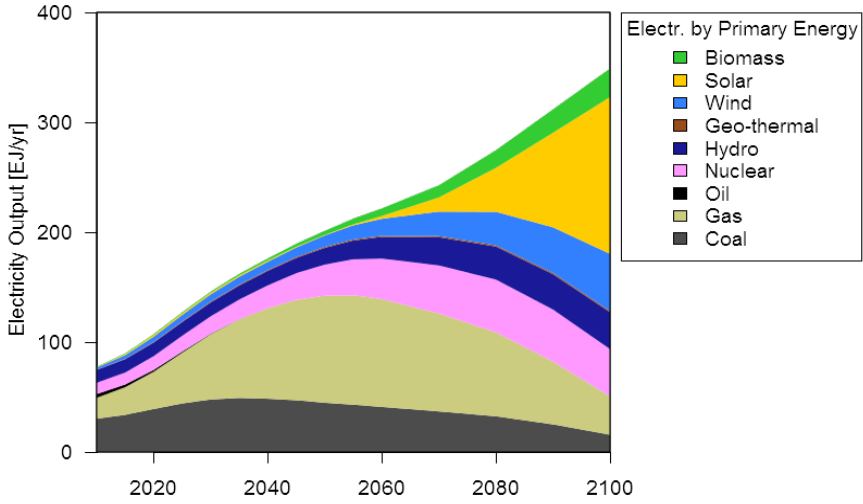
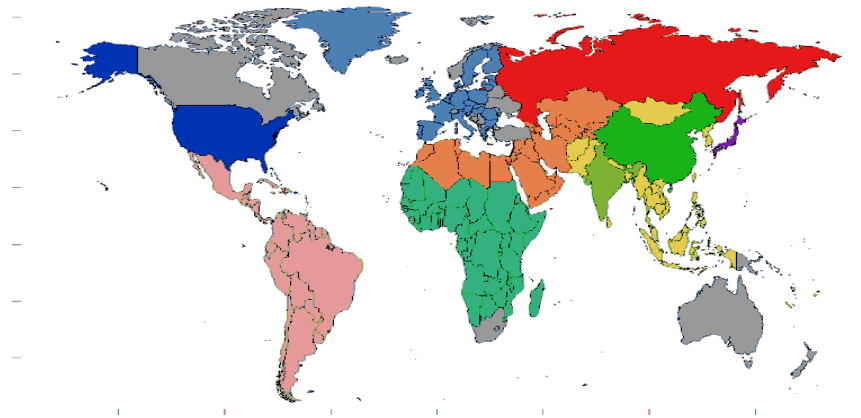


Electricity Mix





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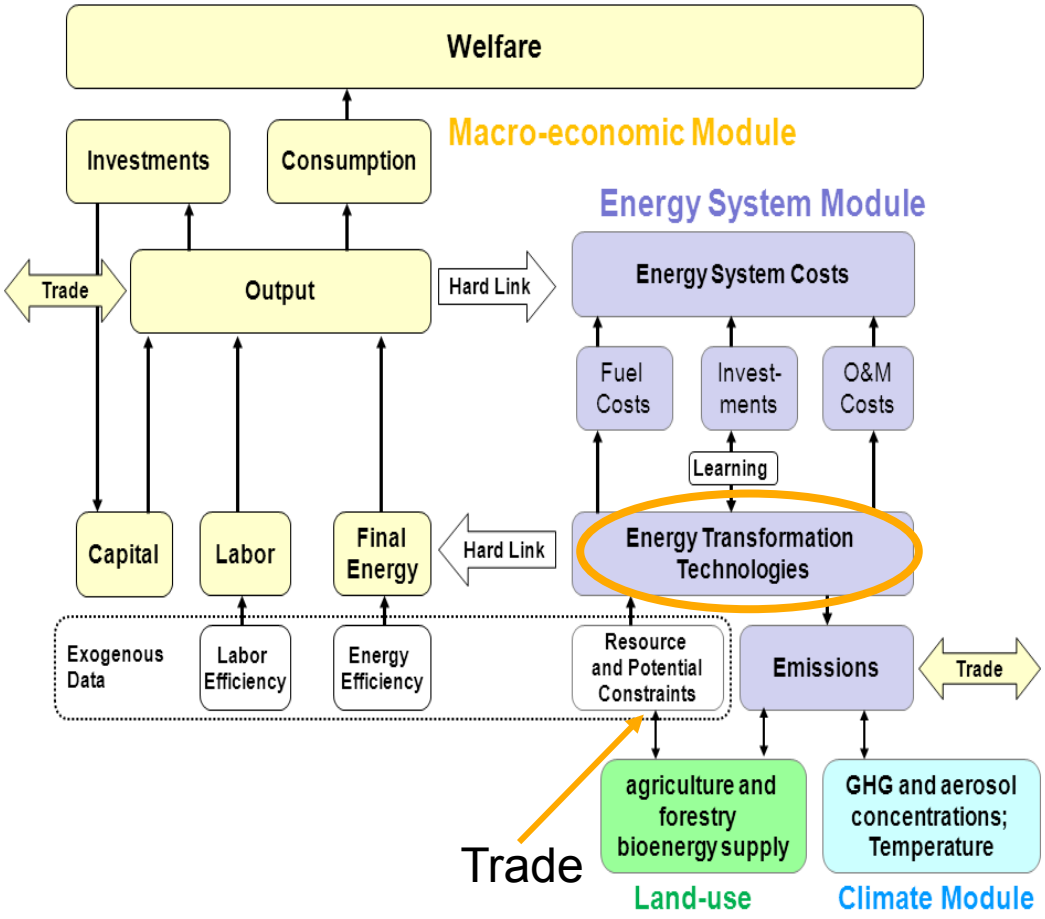
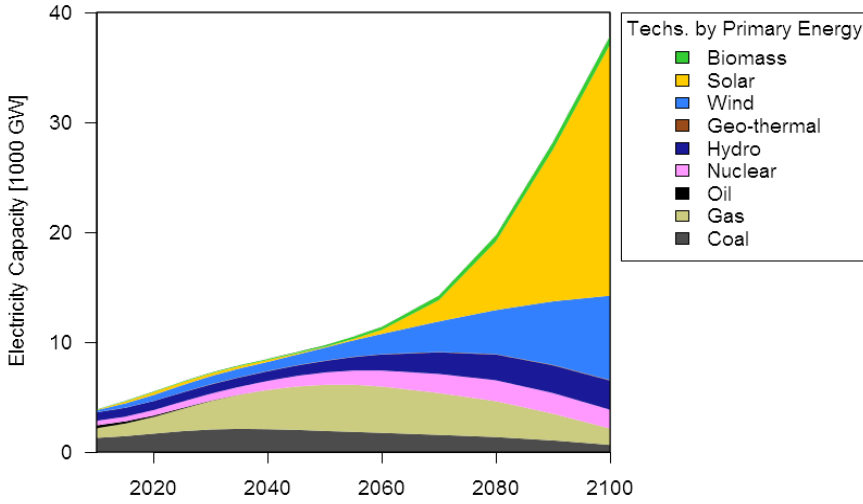
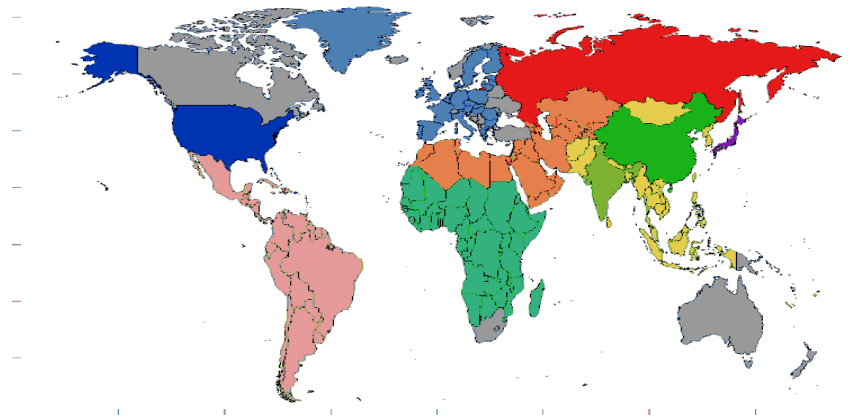


Electricity Capacity





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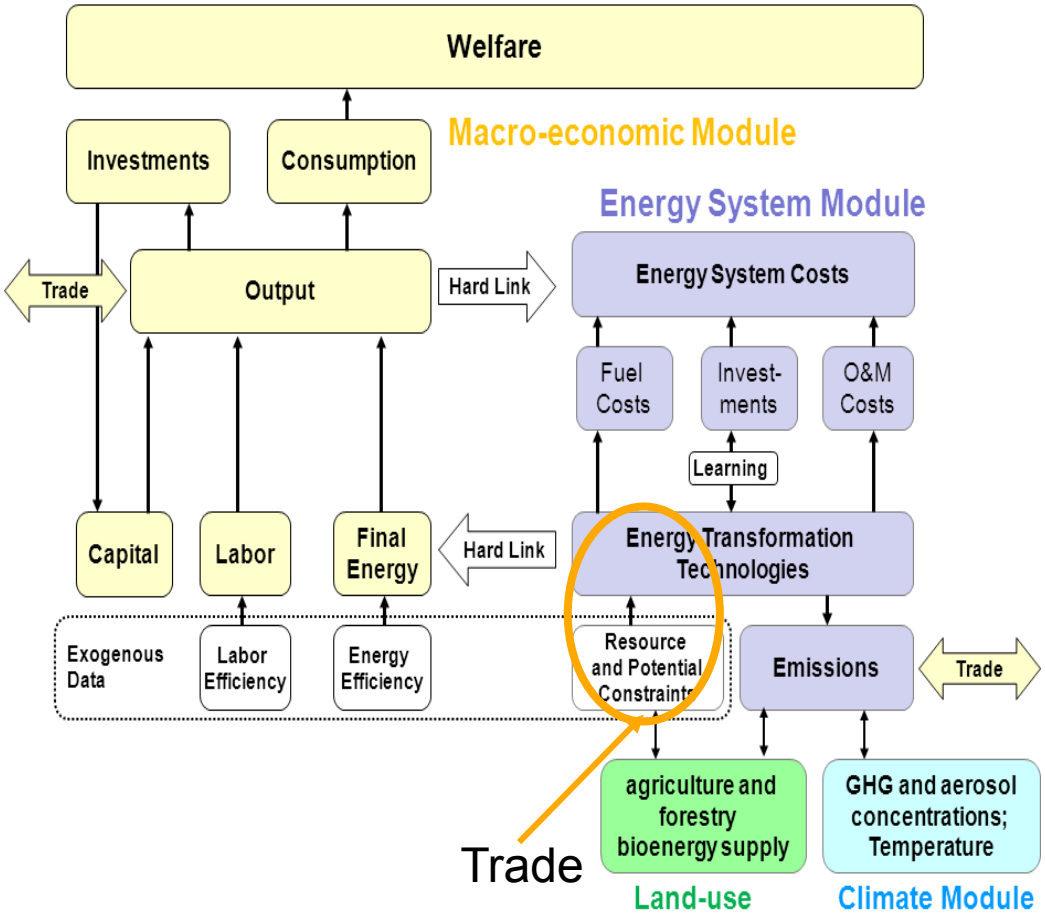
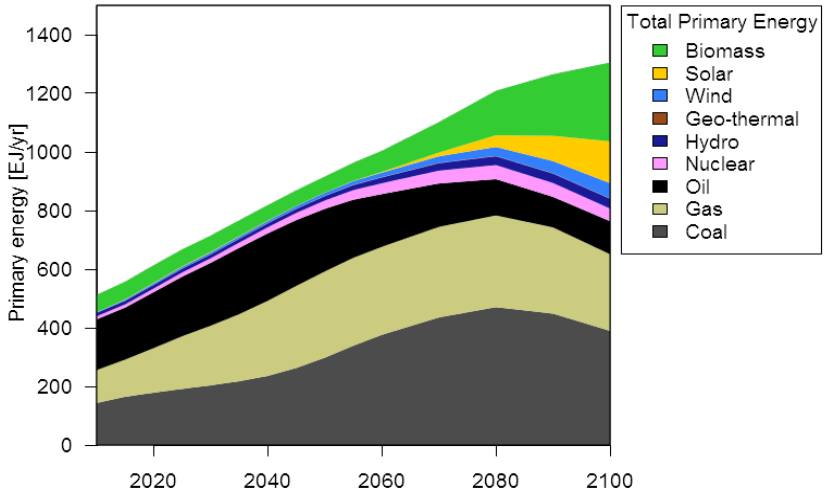
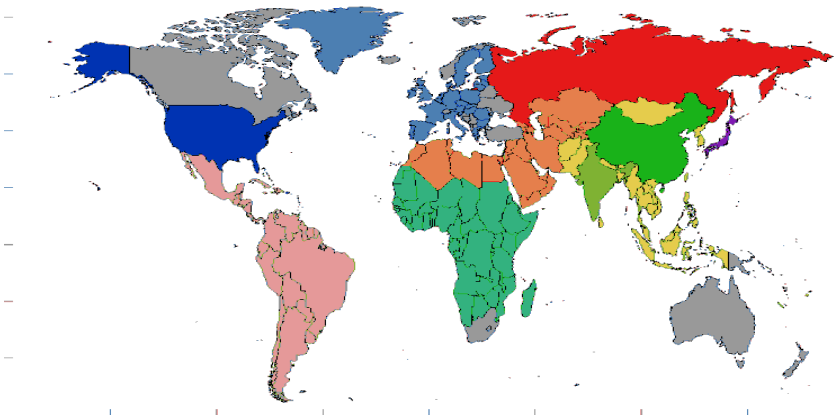


Primary Energy





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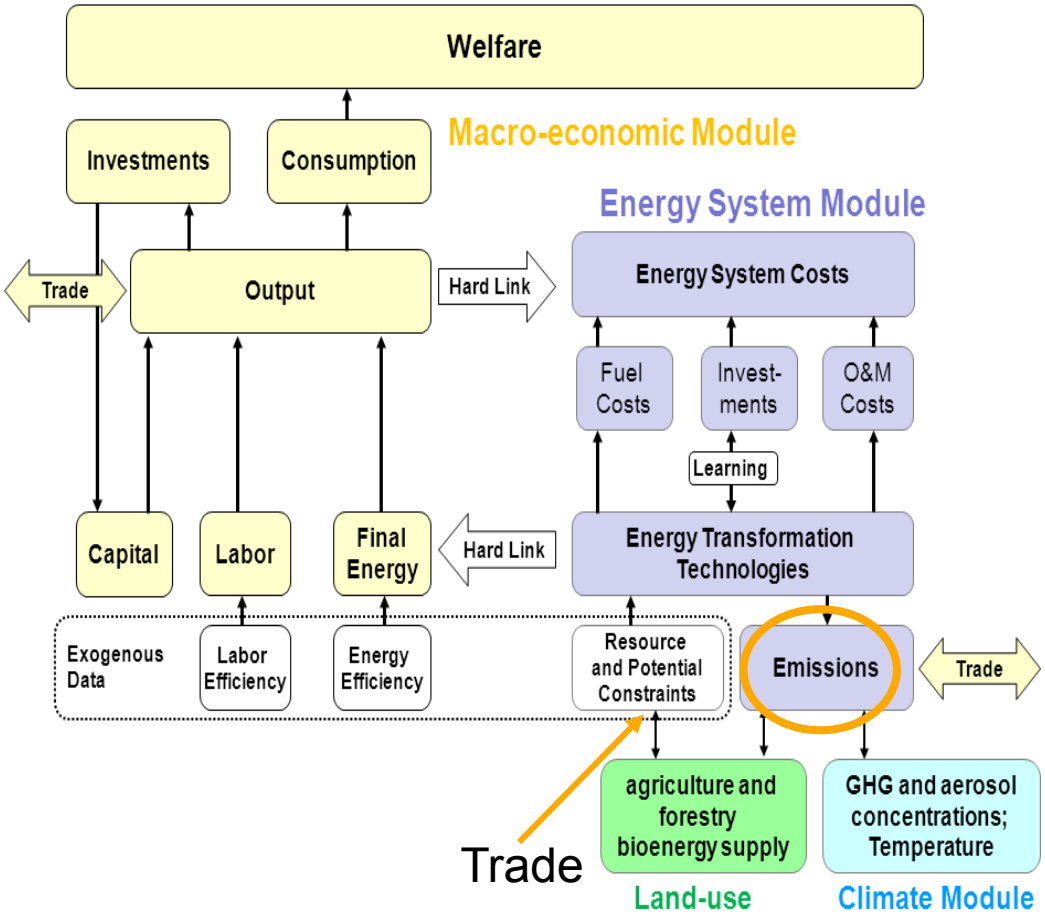
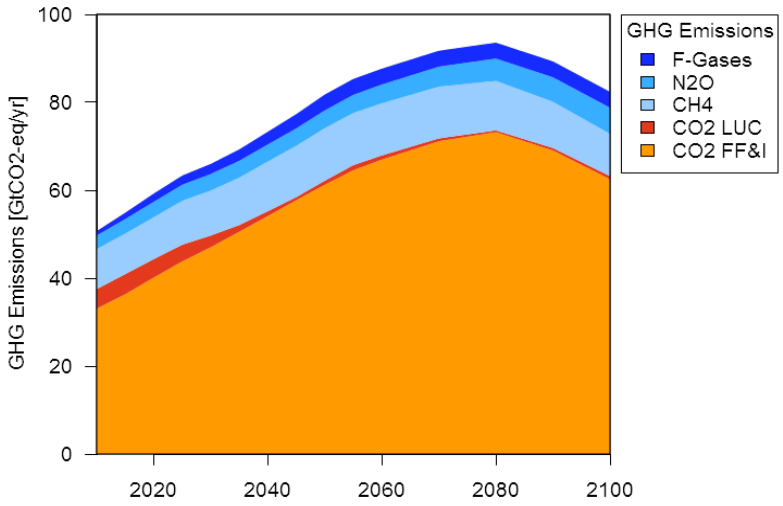
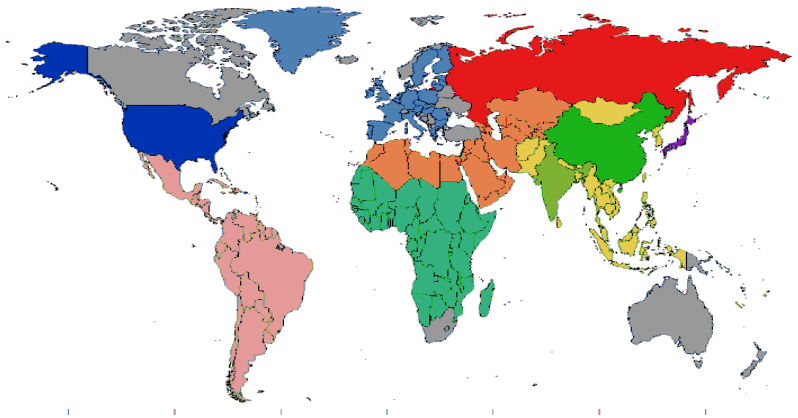


GHG Emissions





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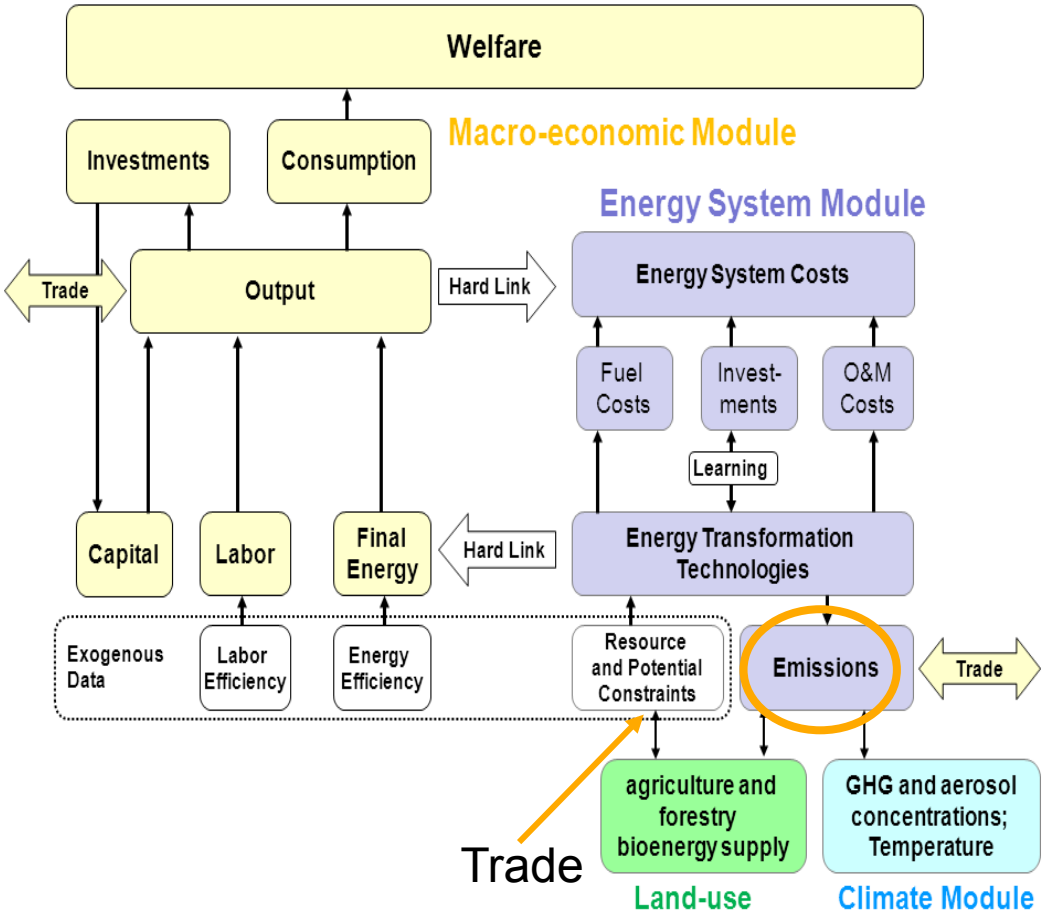
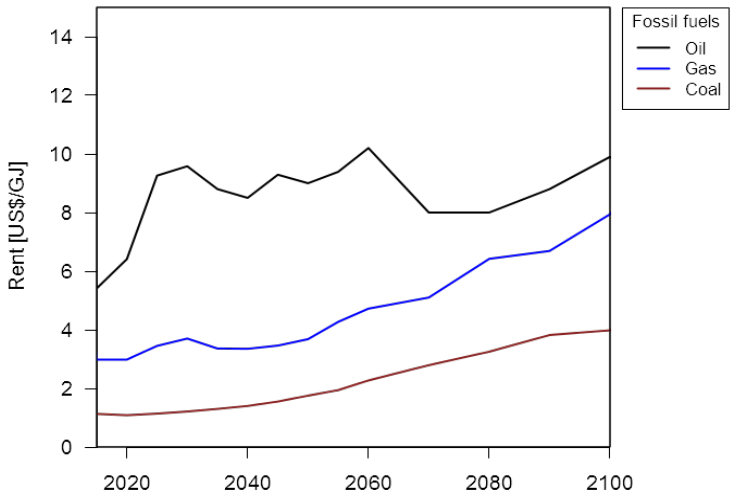
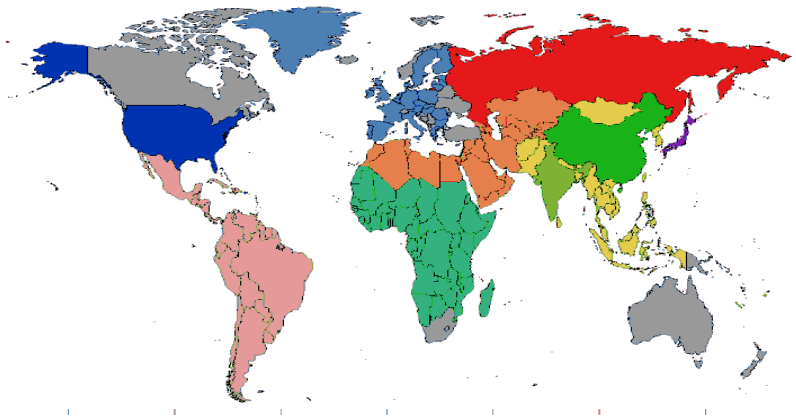


Fossil Fuel Rents





Global Uniform Tax Scenarios

(Regional lump-sum revenue recycling)

Nico Bauer, et al.
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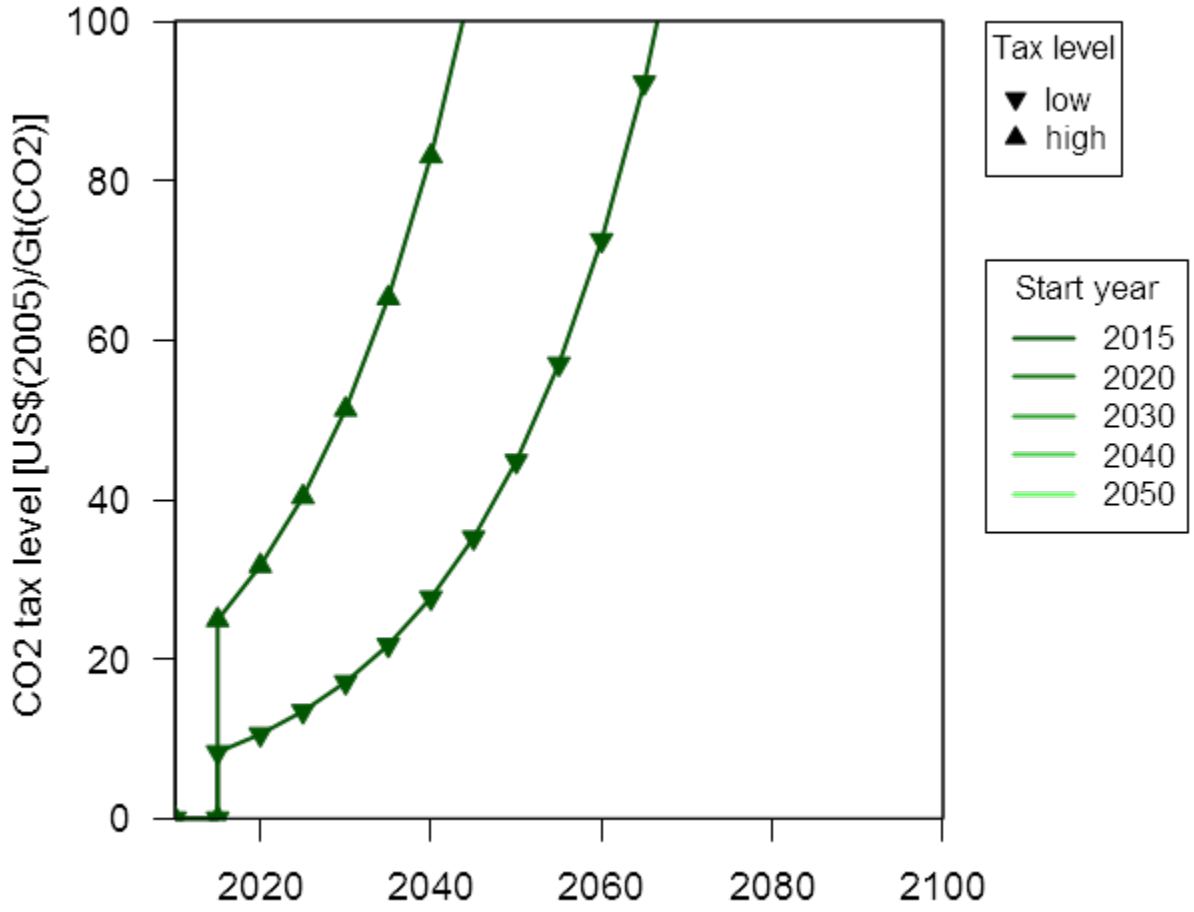
Global Uniform Tax Scenarios



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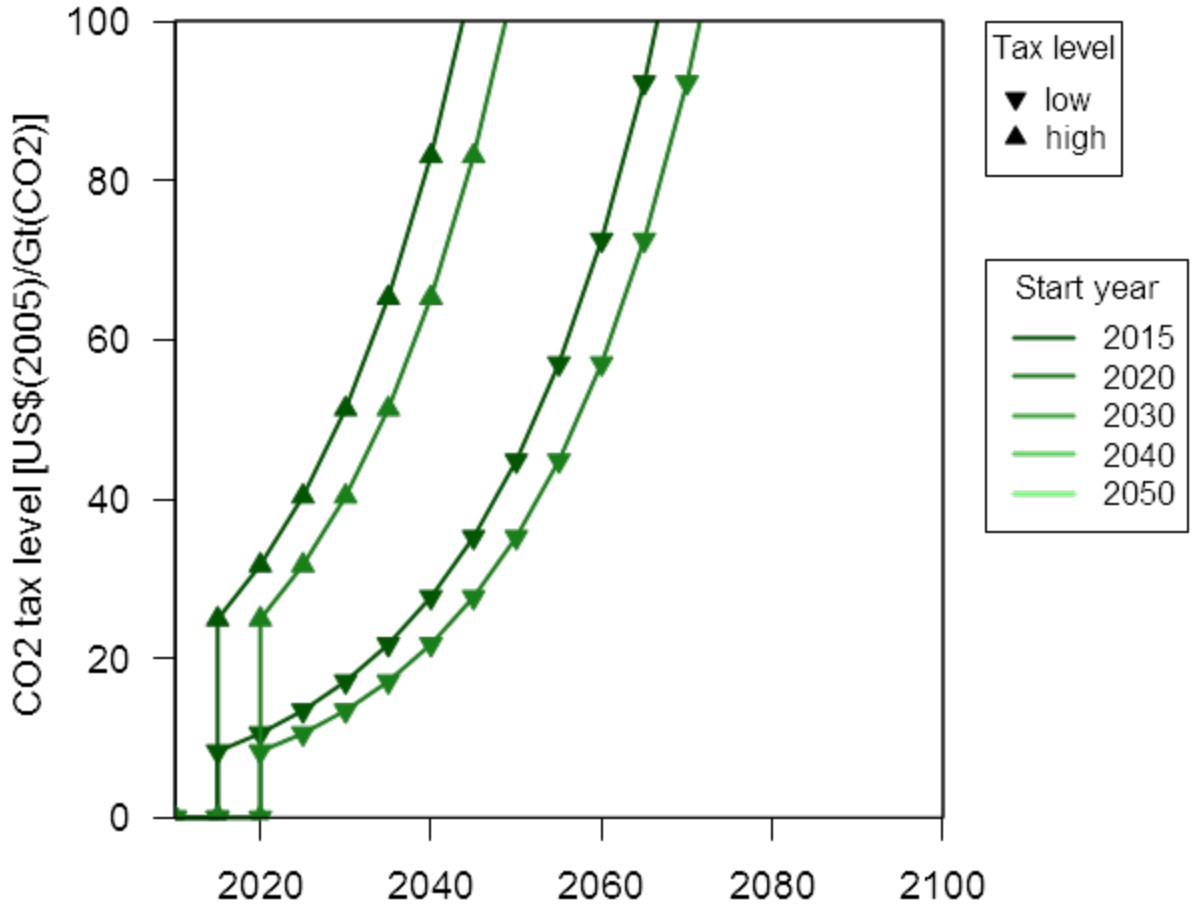

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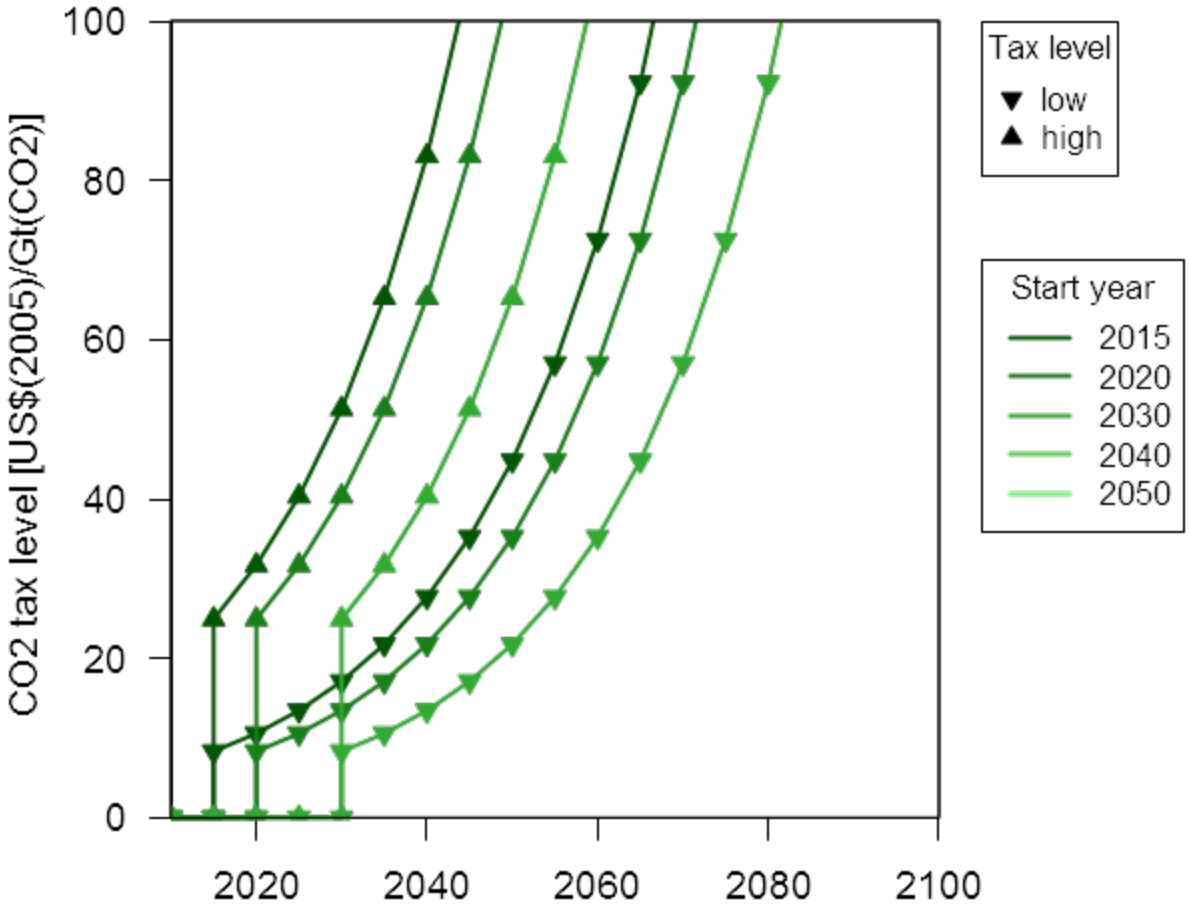

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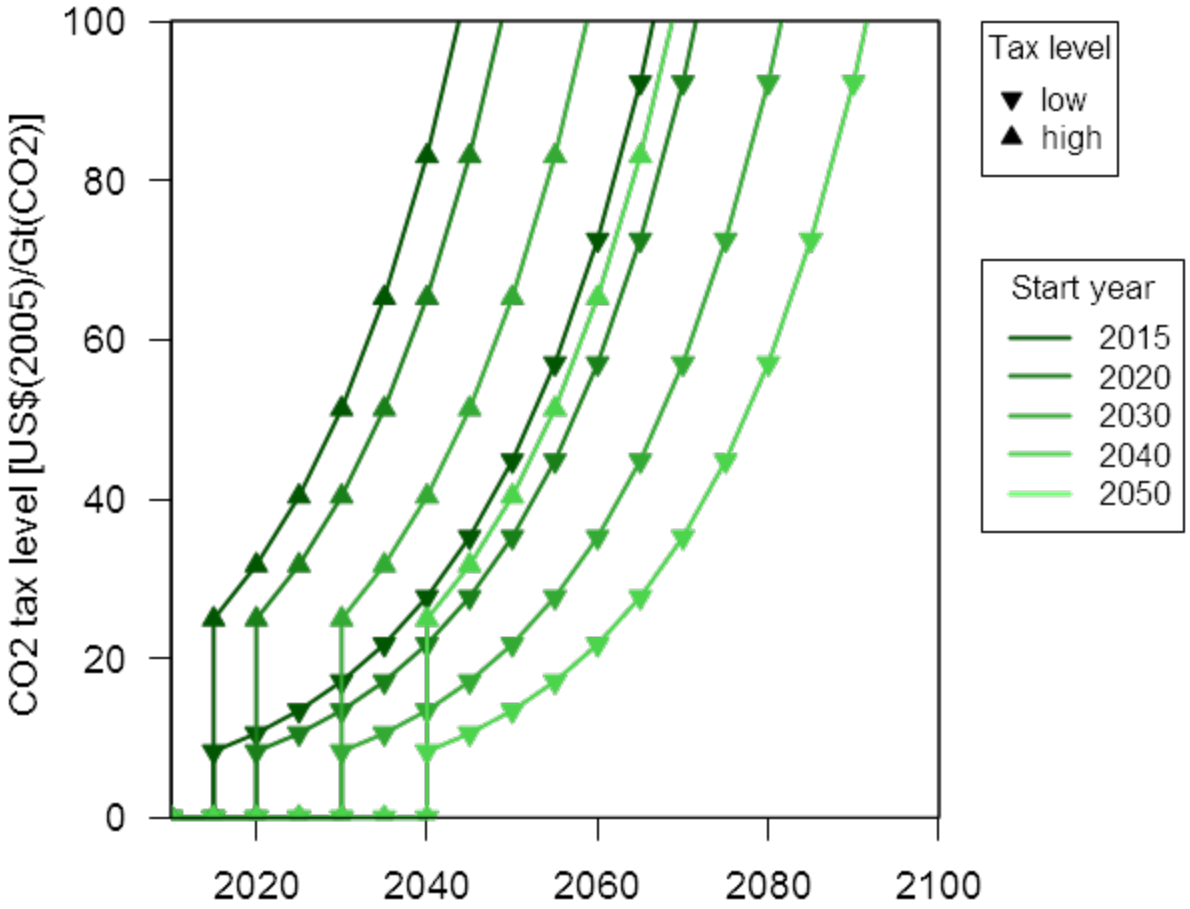

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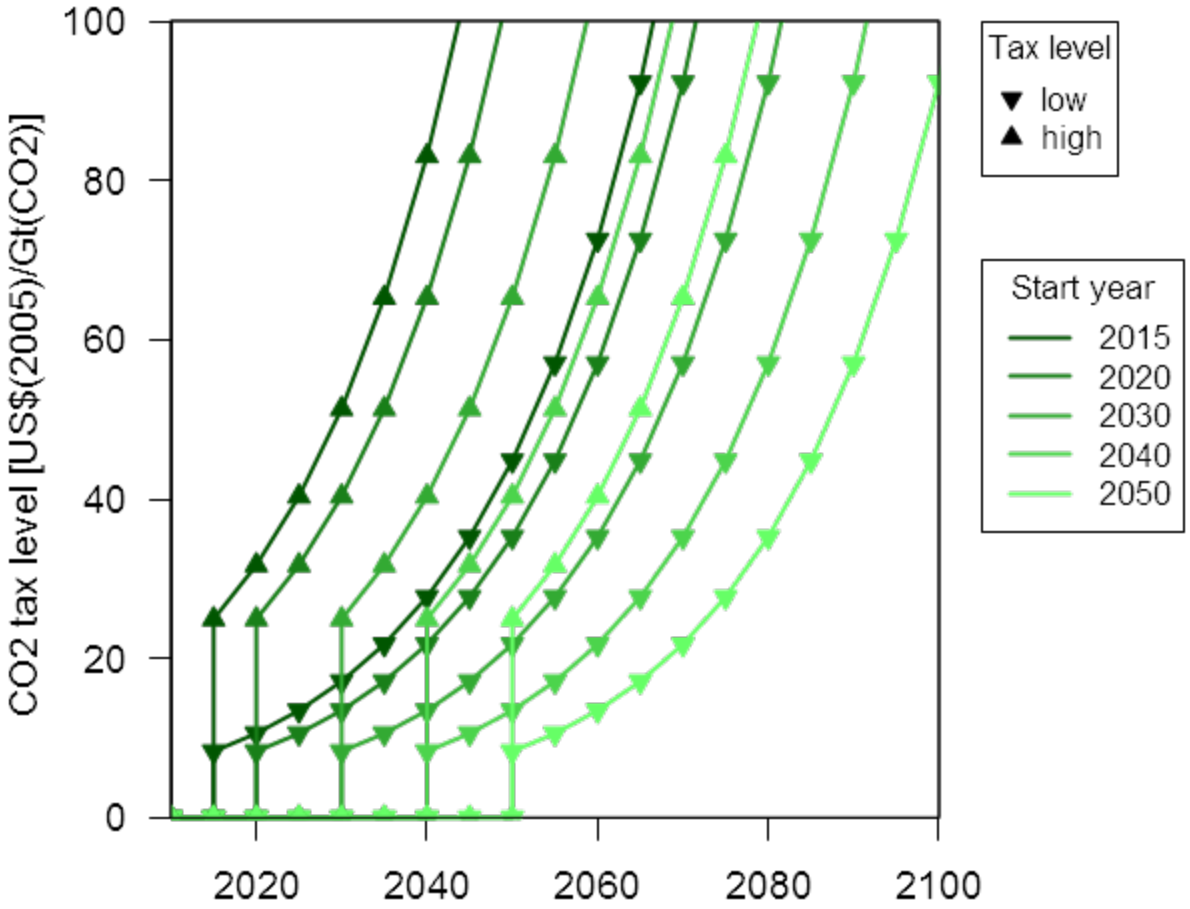
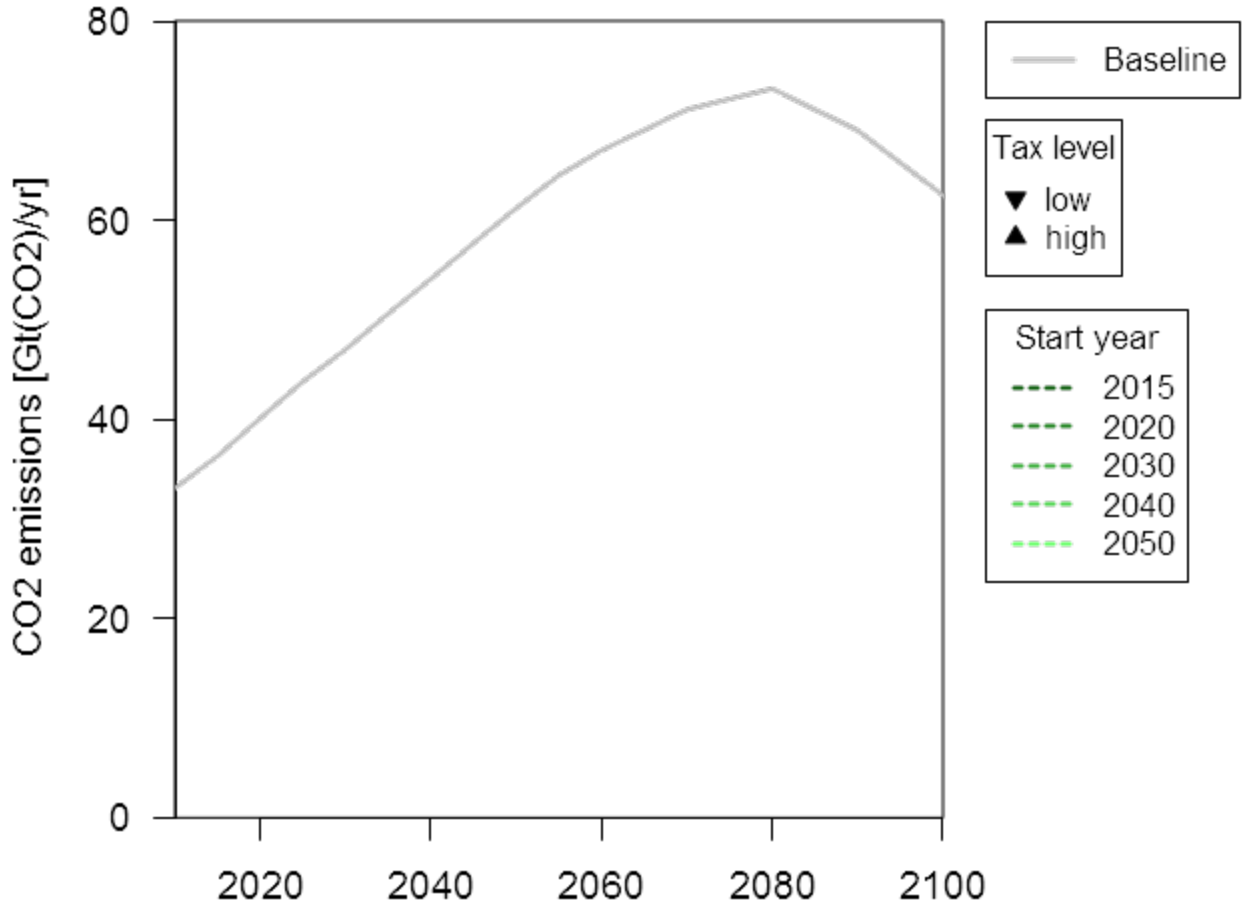


Results – Reference Case

Medium Resources

Early Retirement

Results – Base Case



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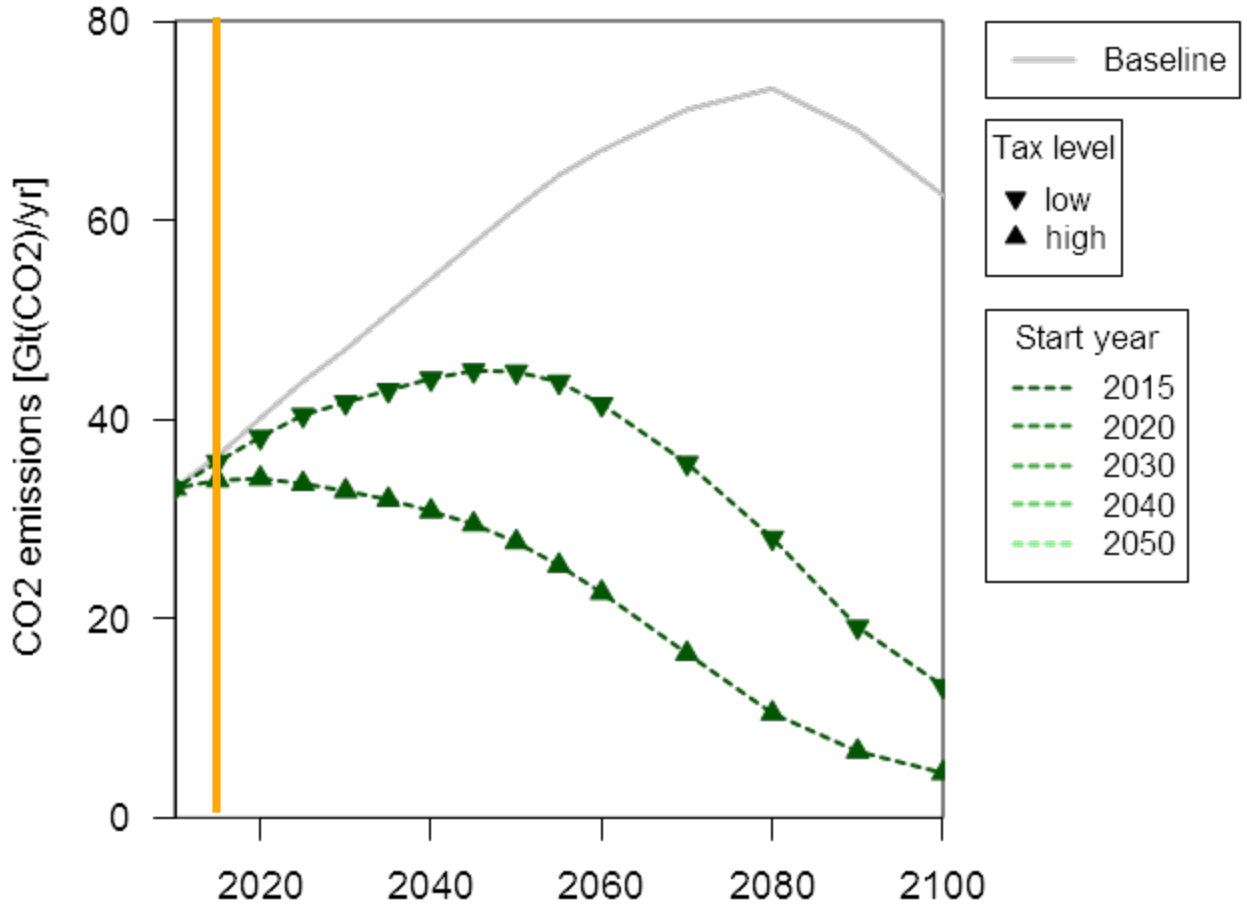

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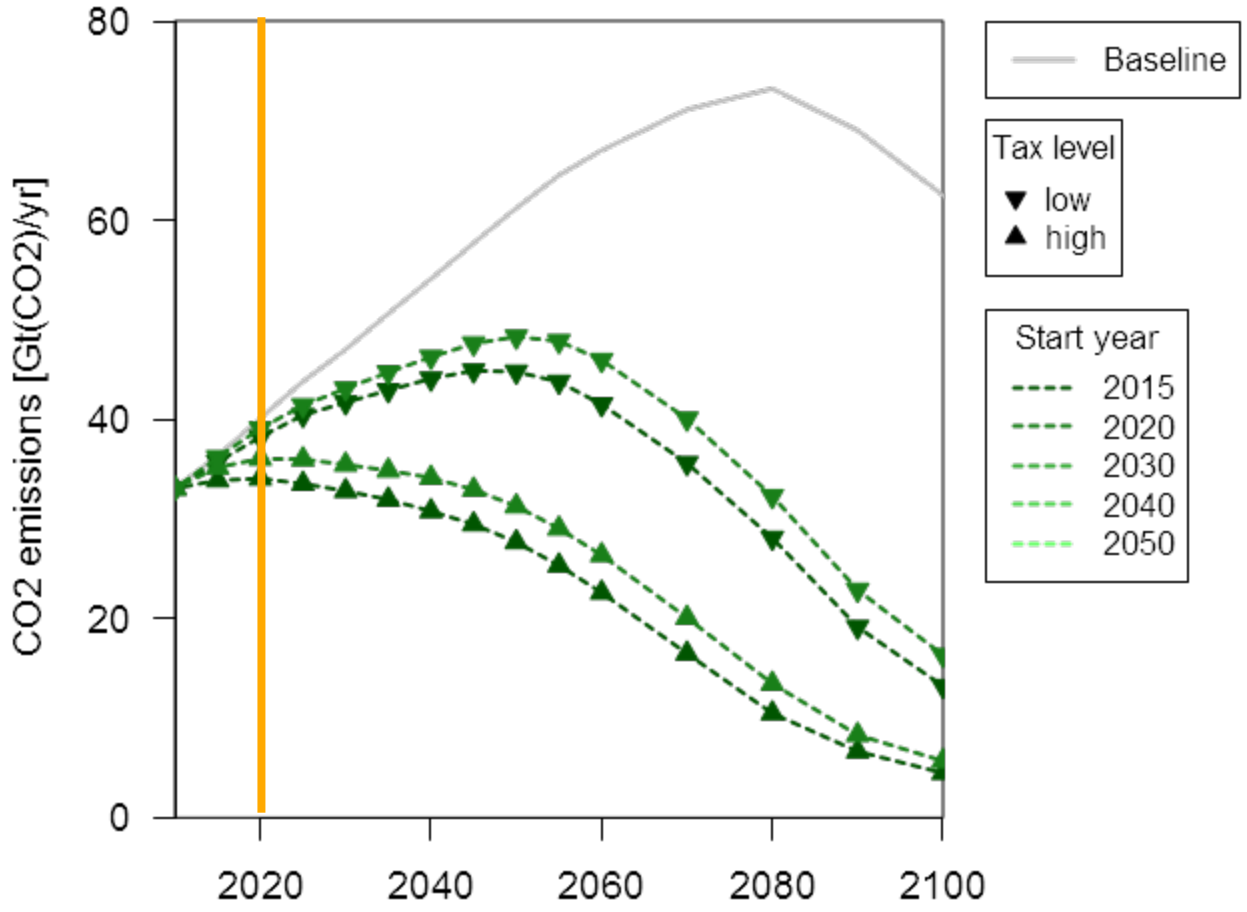

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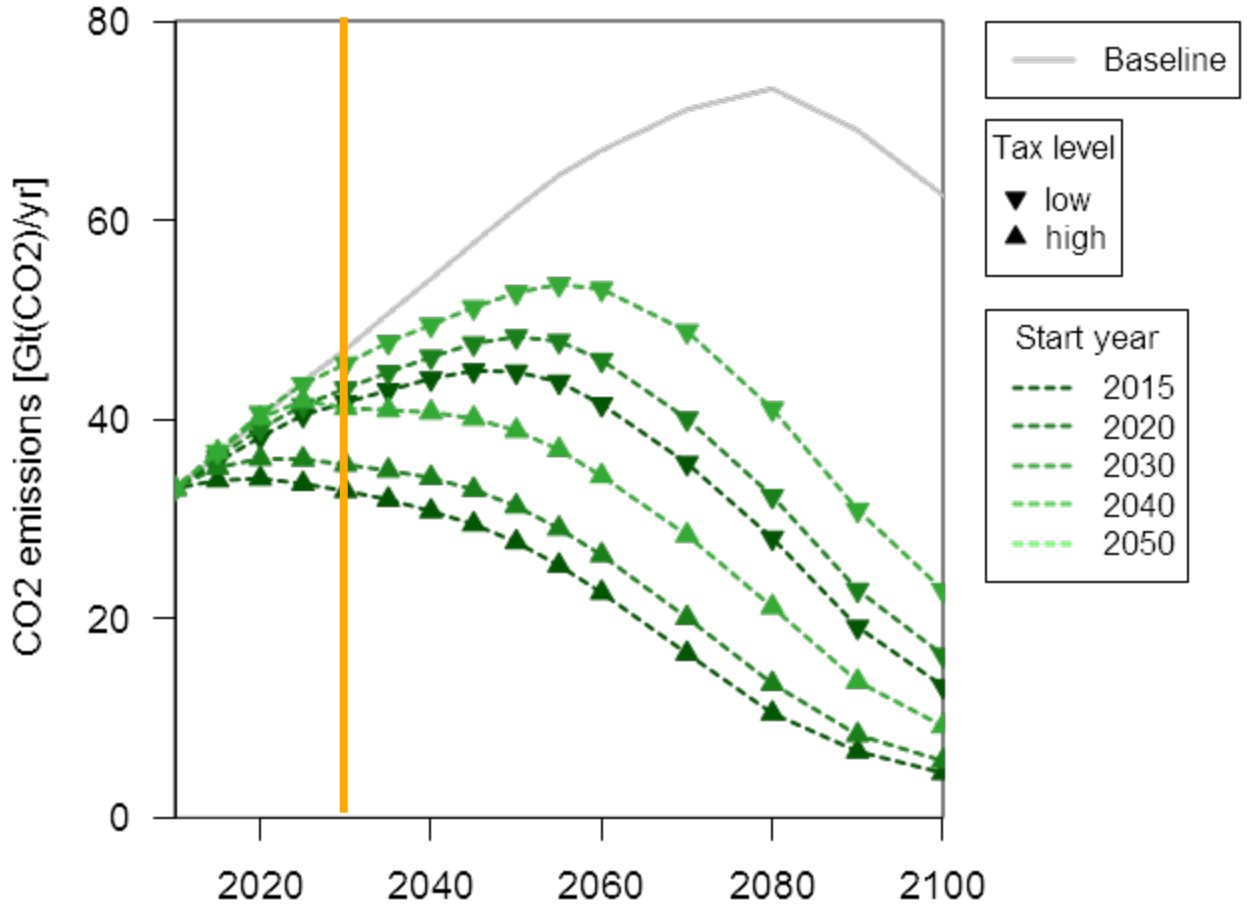

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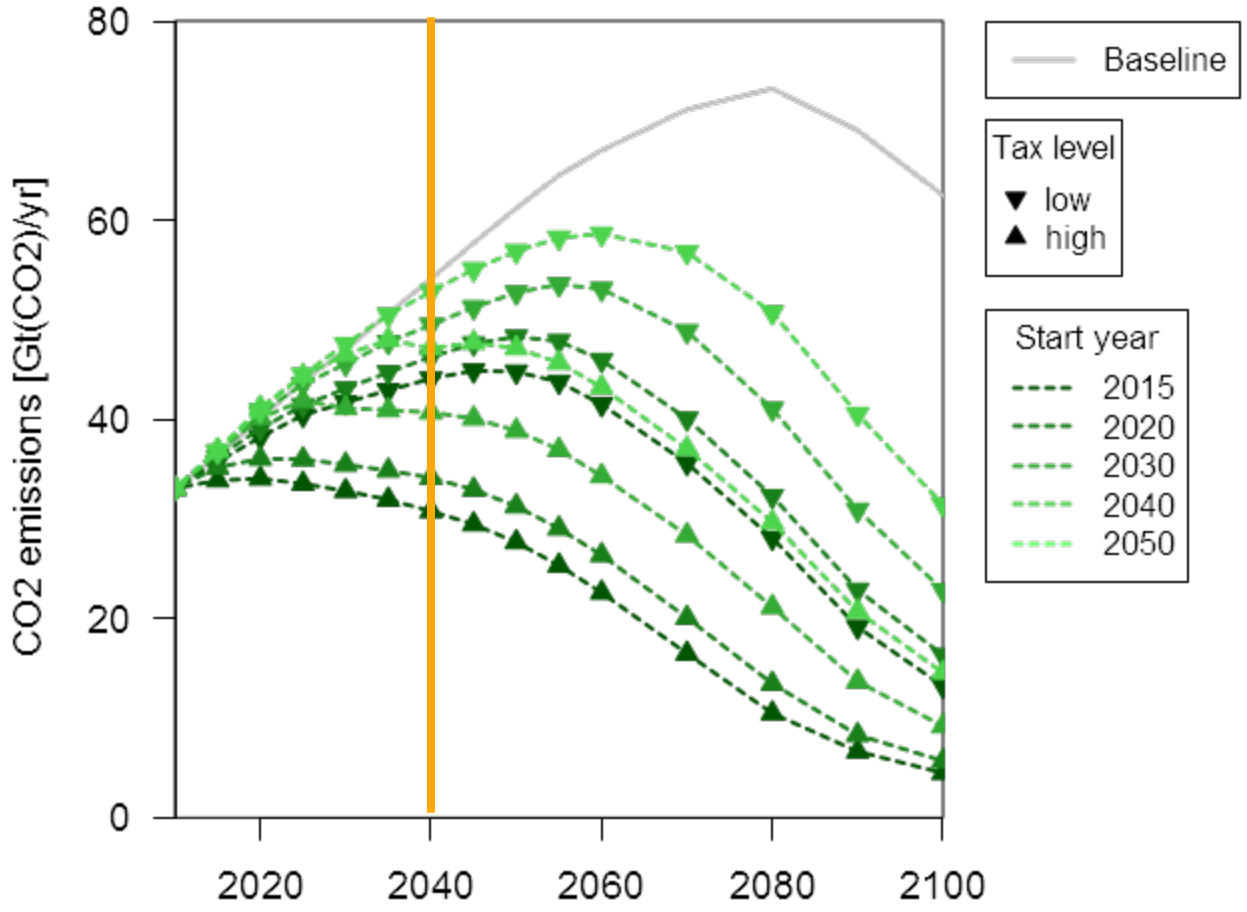

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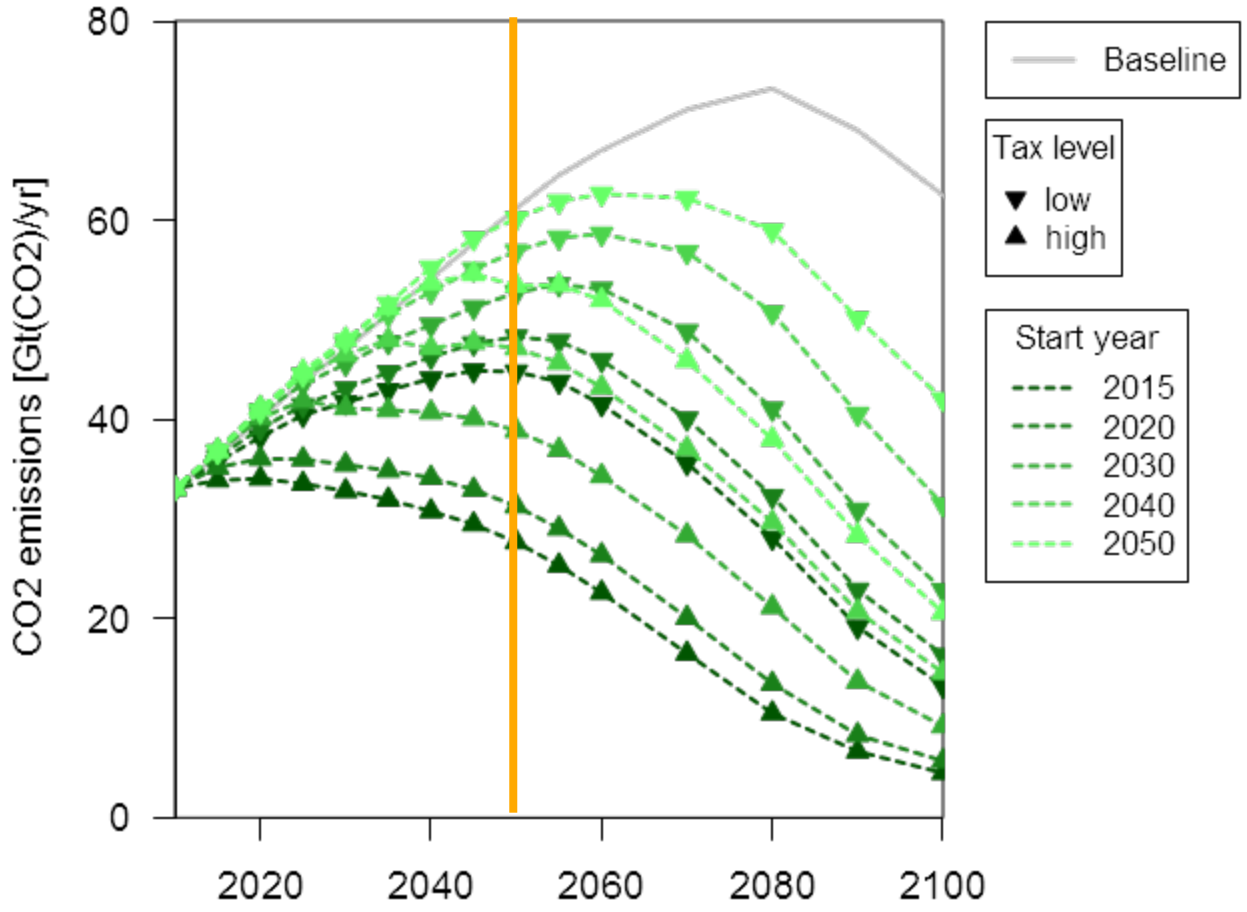

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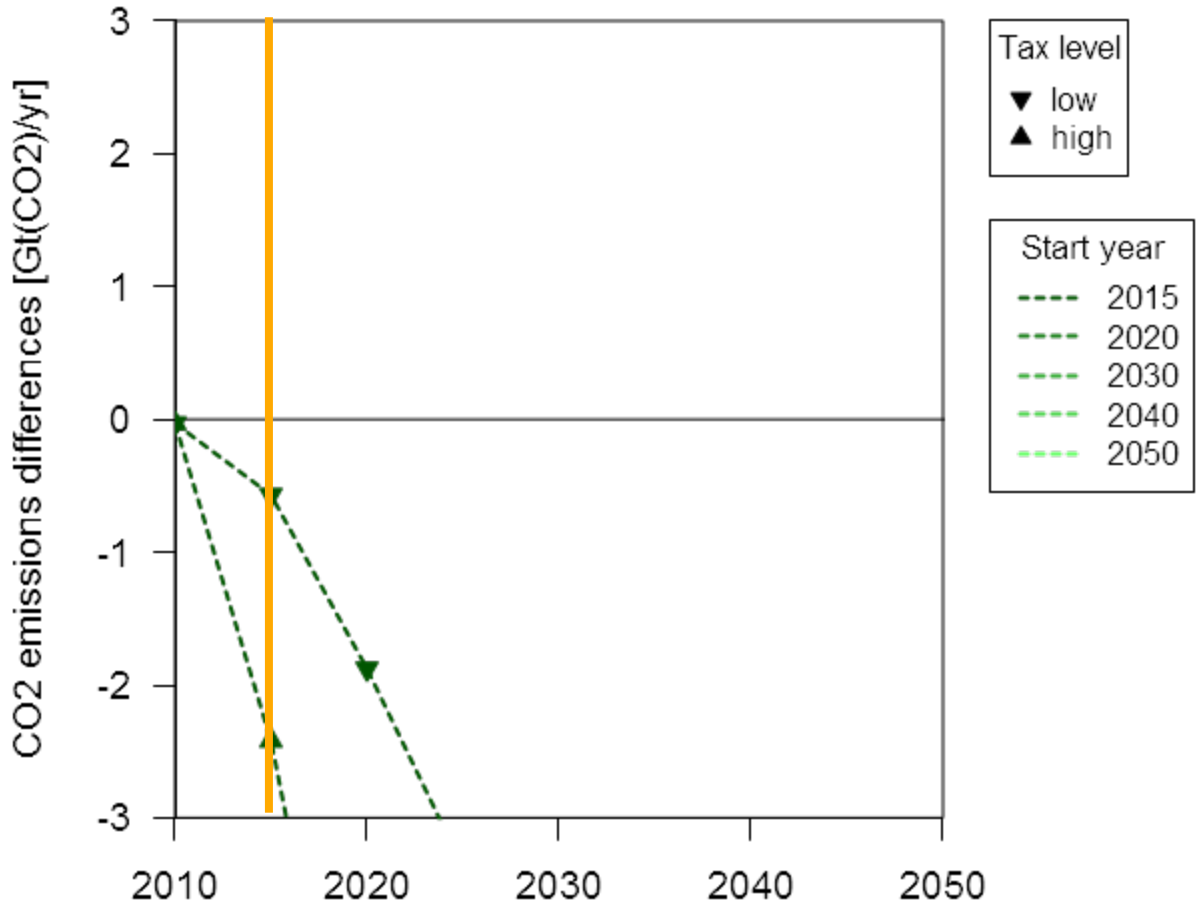

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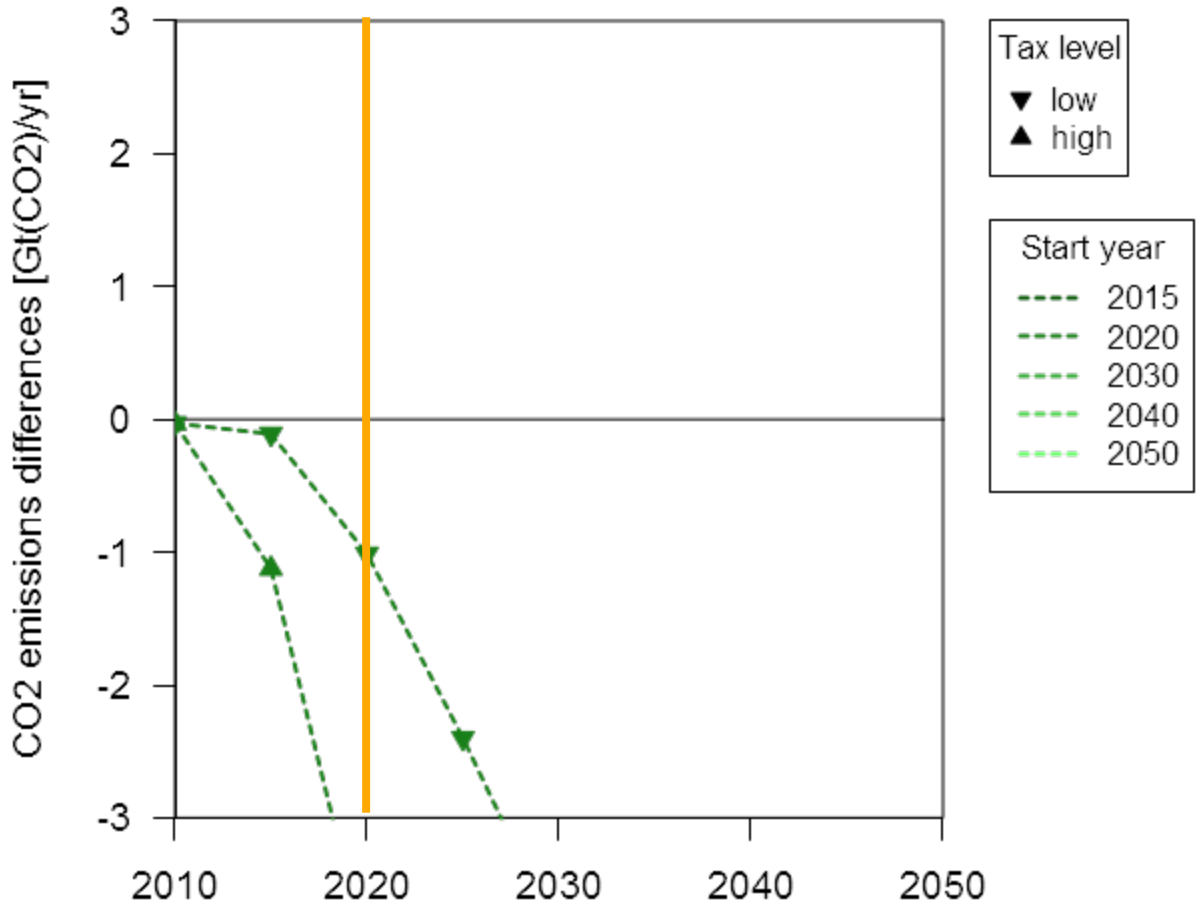

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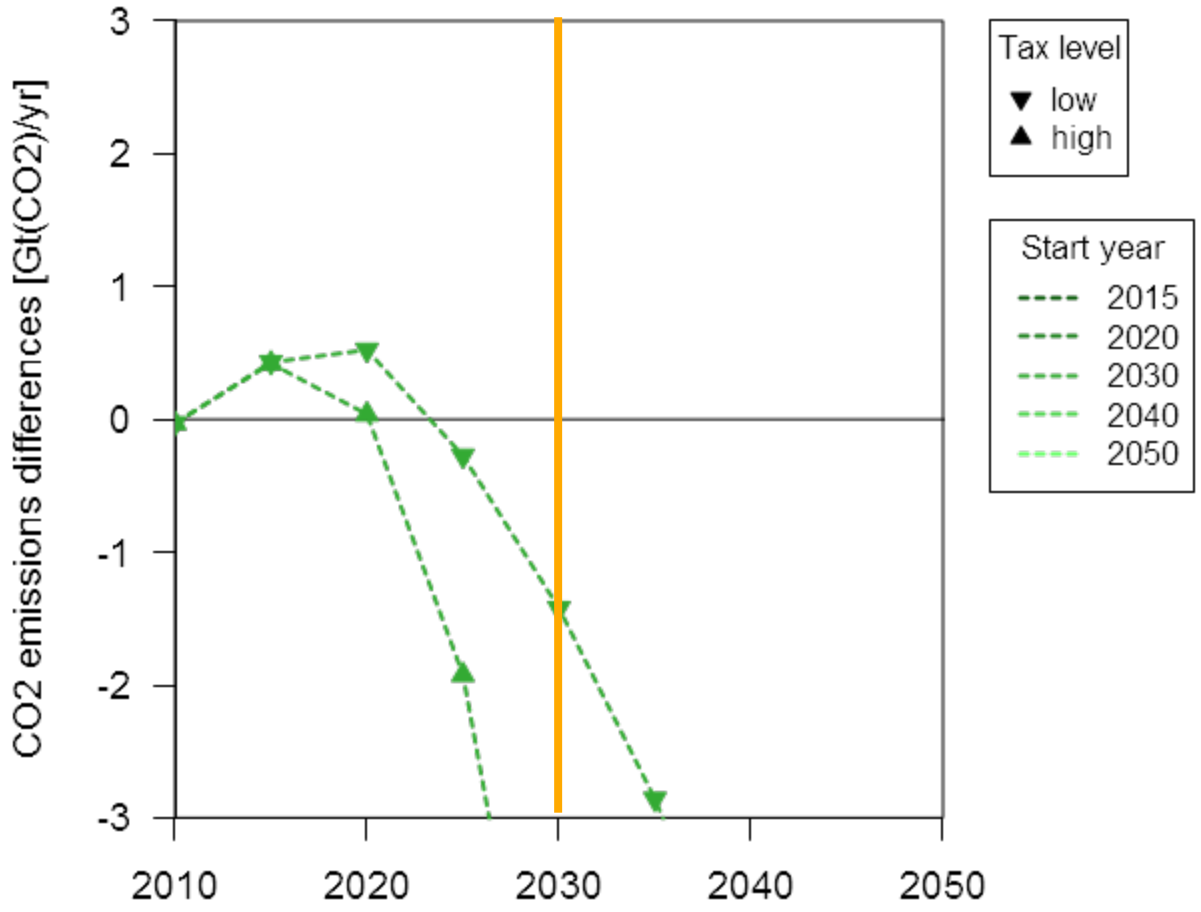
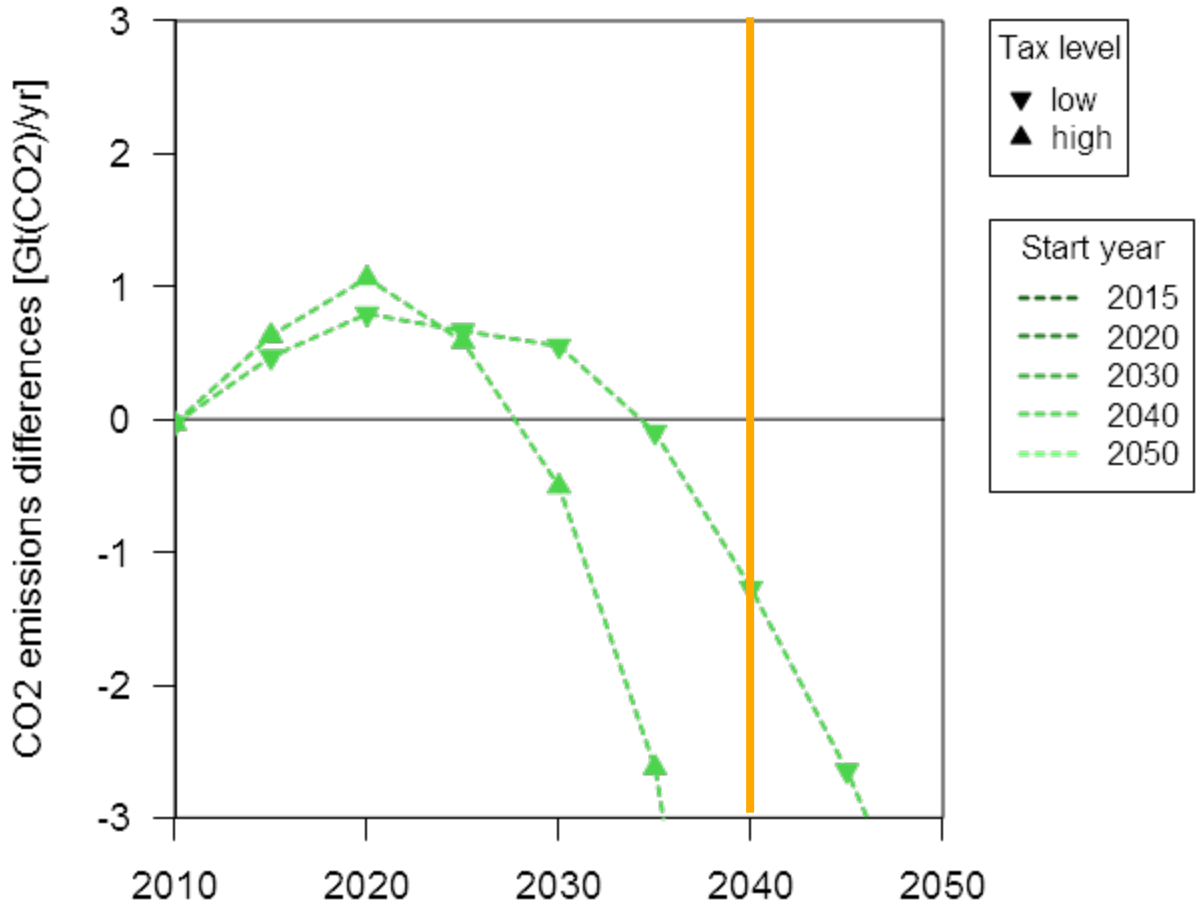
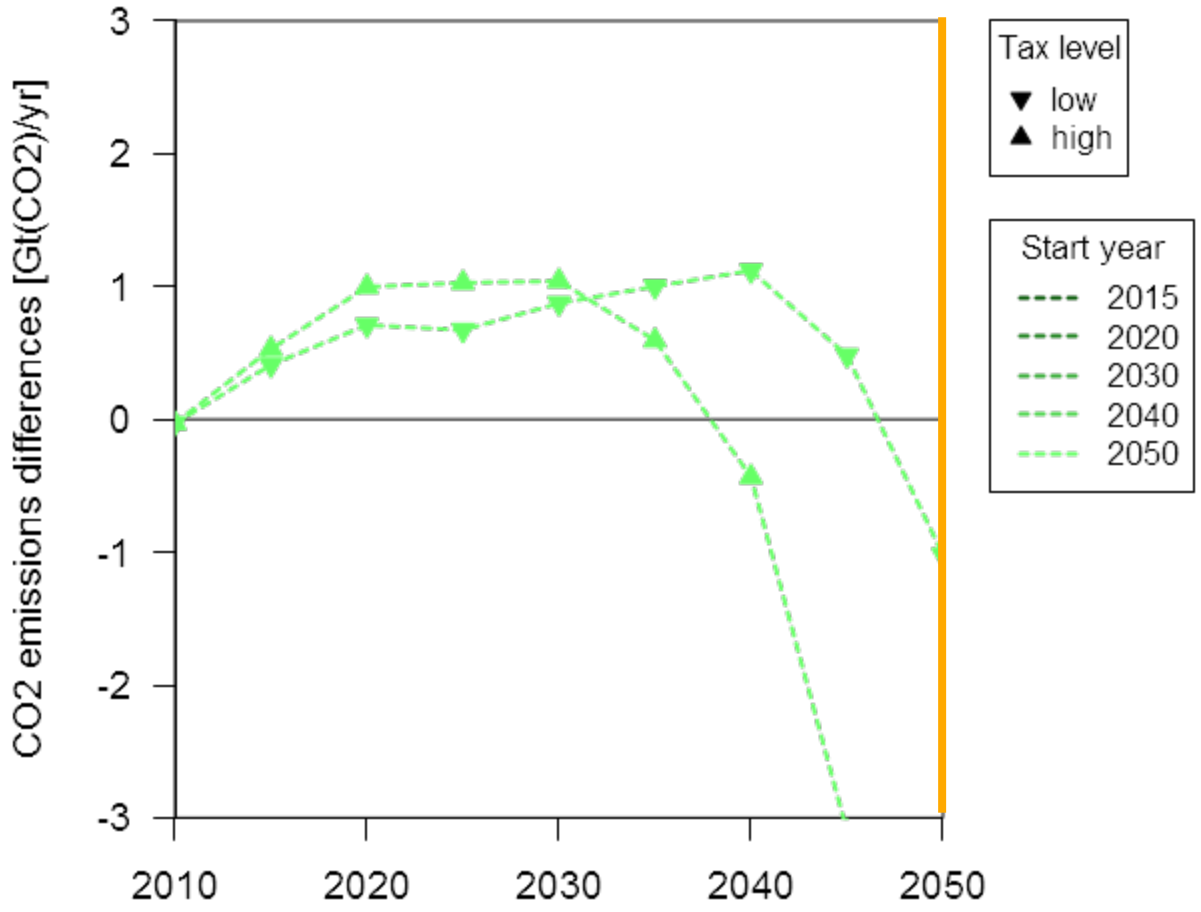


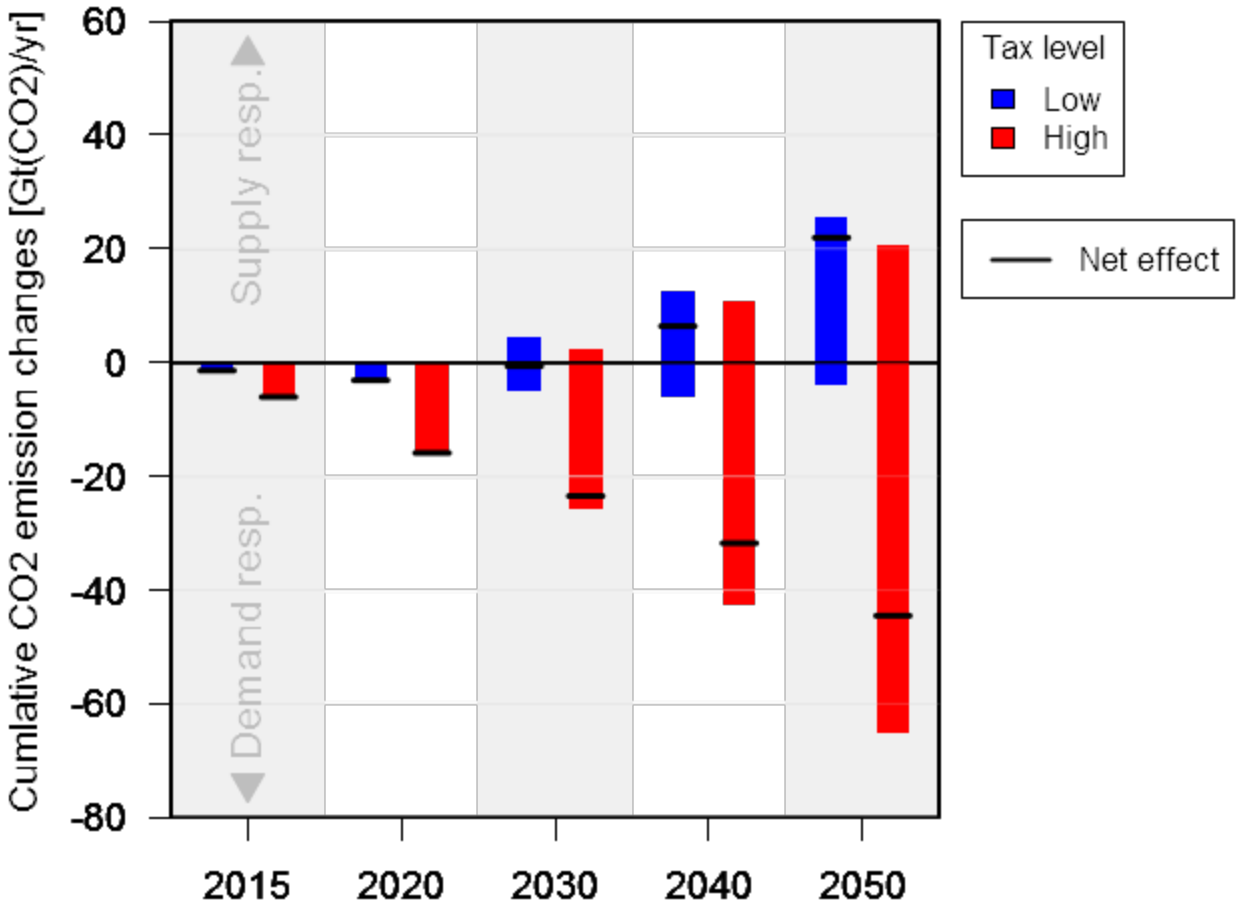
Results – Base Case



Results – Base Case



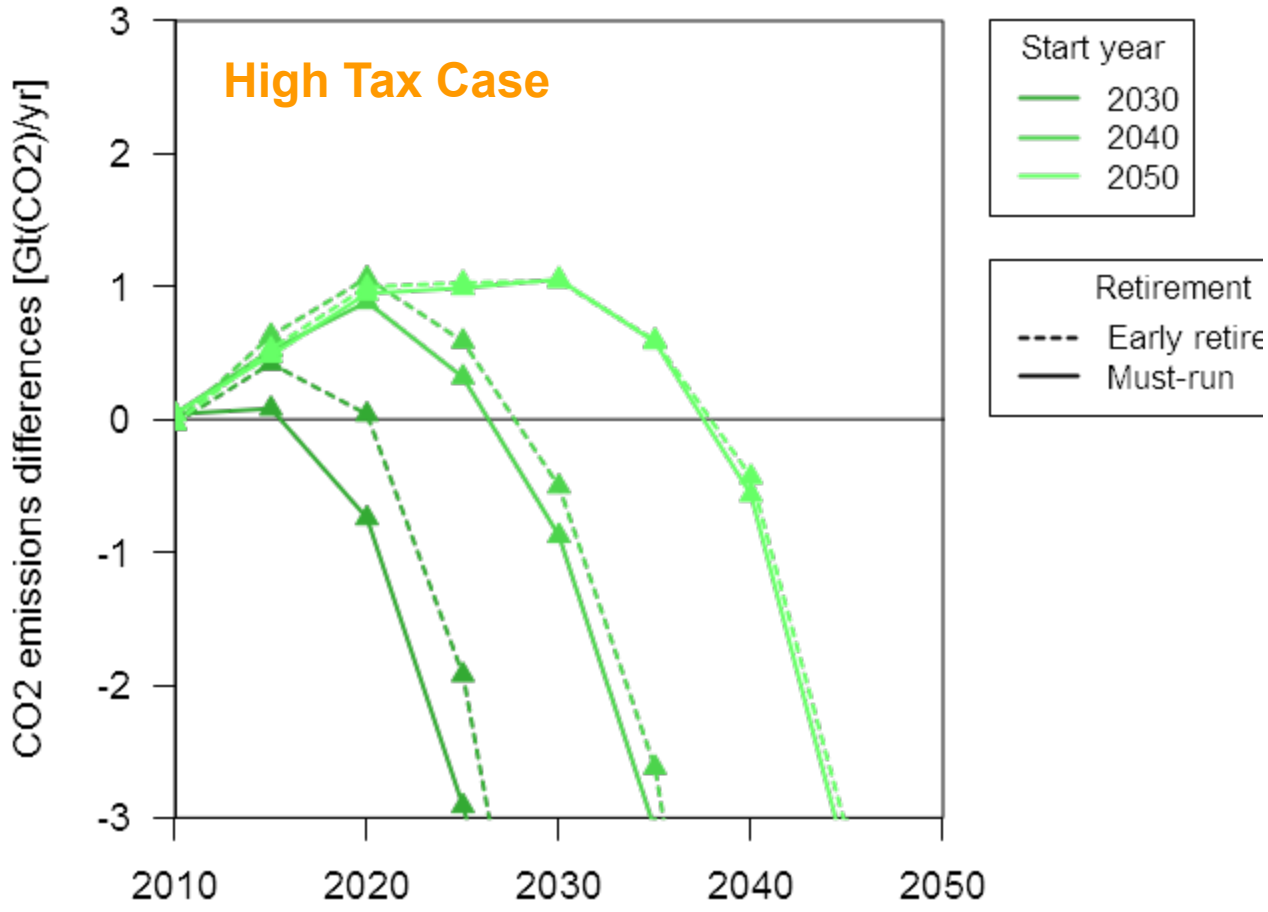
Results – Base Case



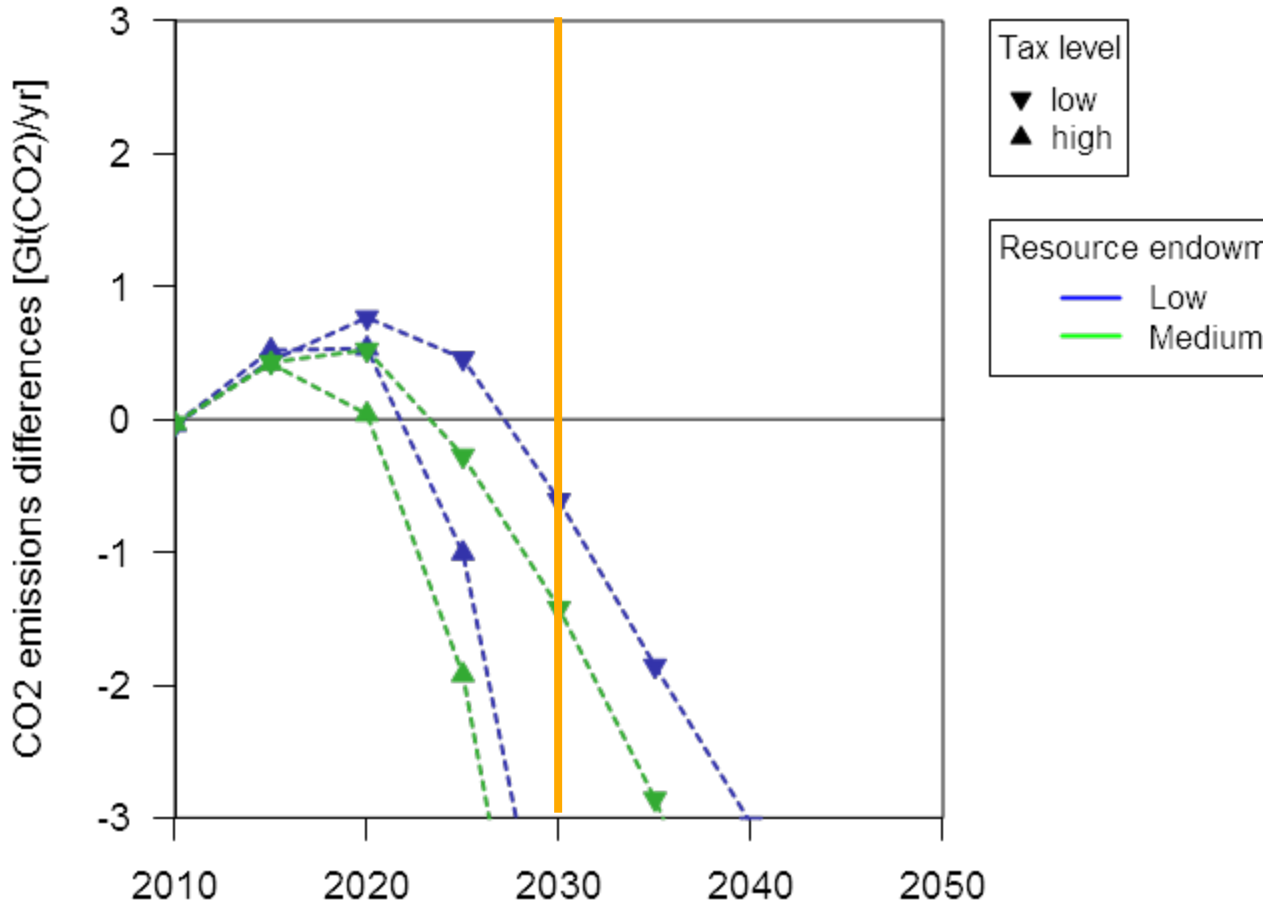
Sensitivity Analysis

Demand Side – Early Retirement off
Supply Side – Fossil Fuel

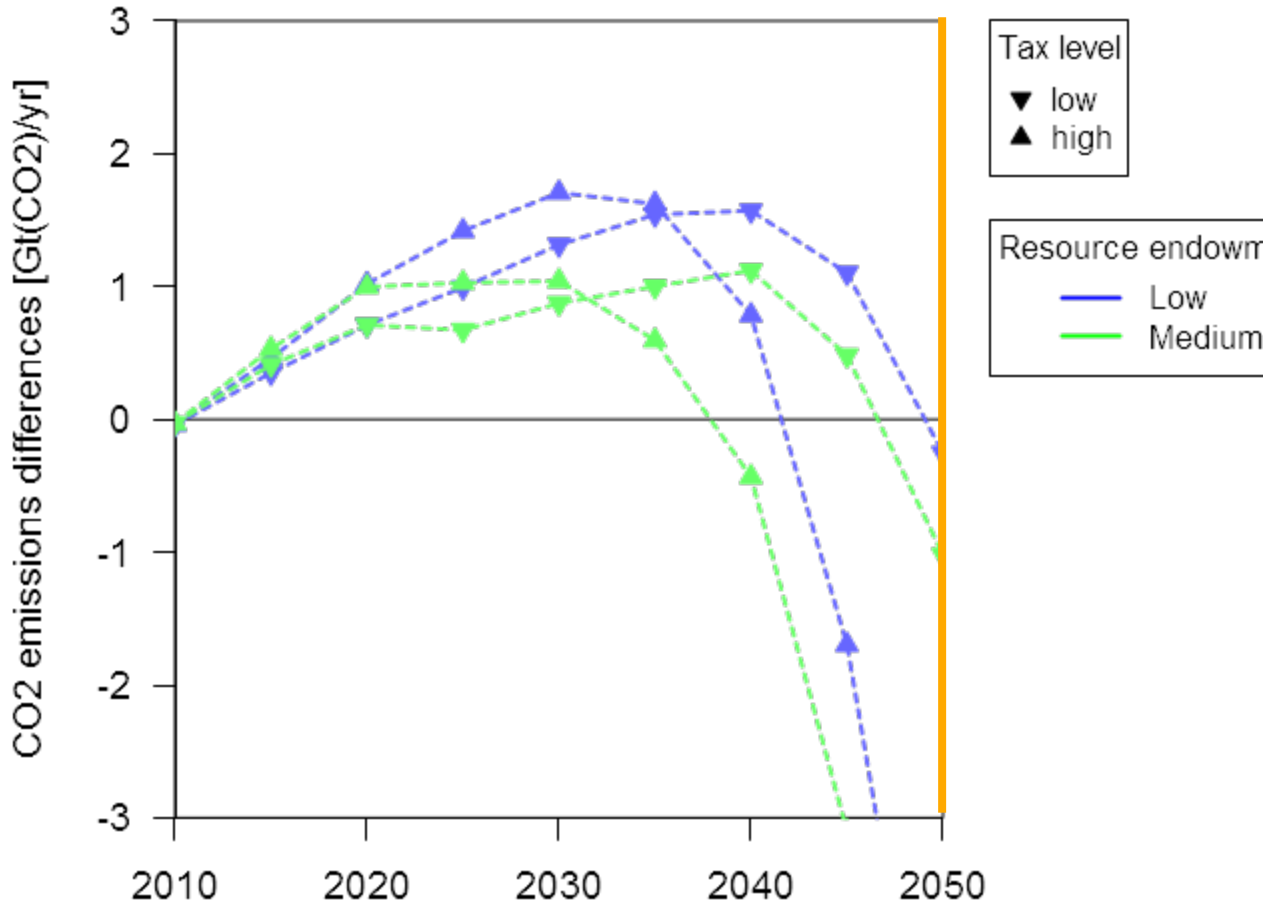
Sensitivity Analysis – Demand Side



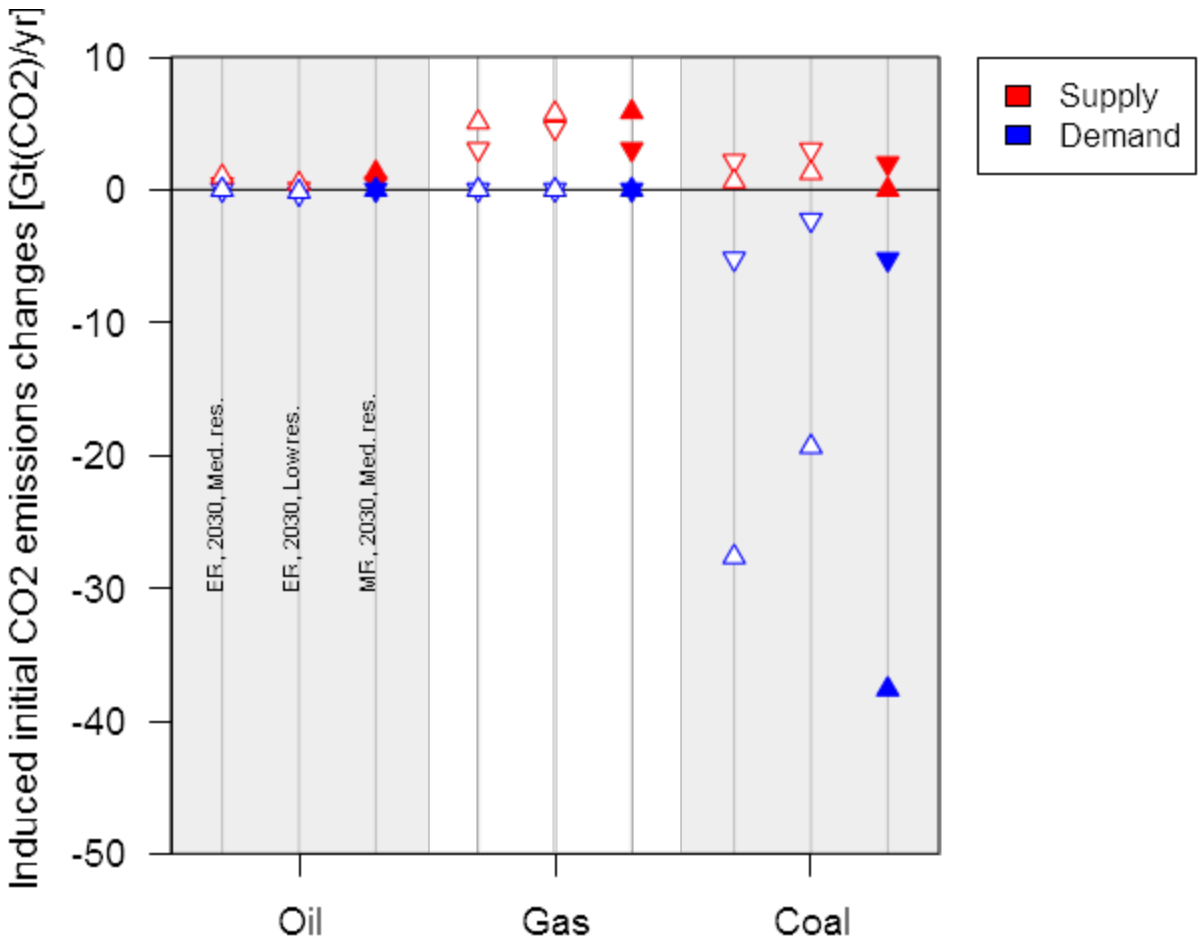
Sensitivity Analysis – Supply Side



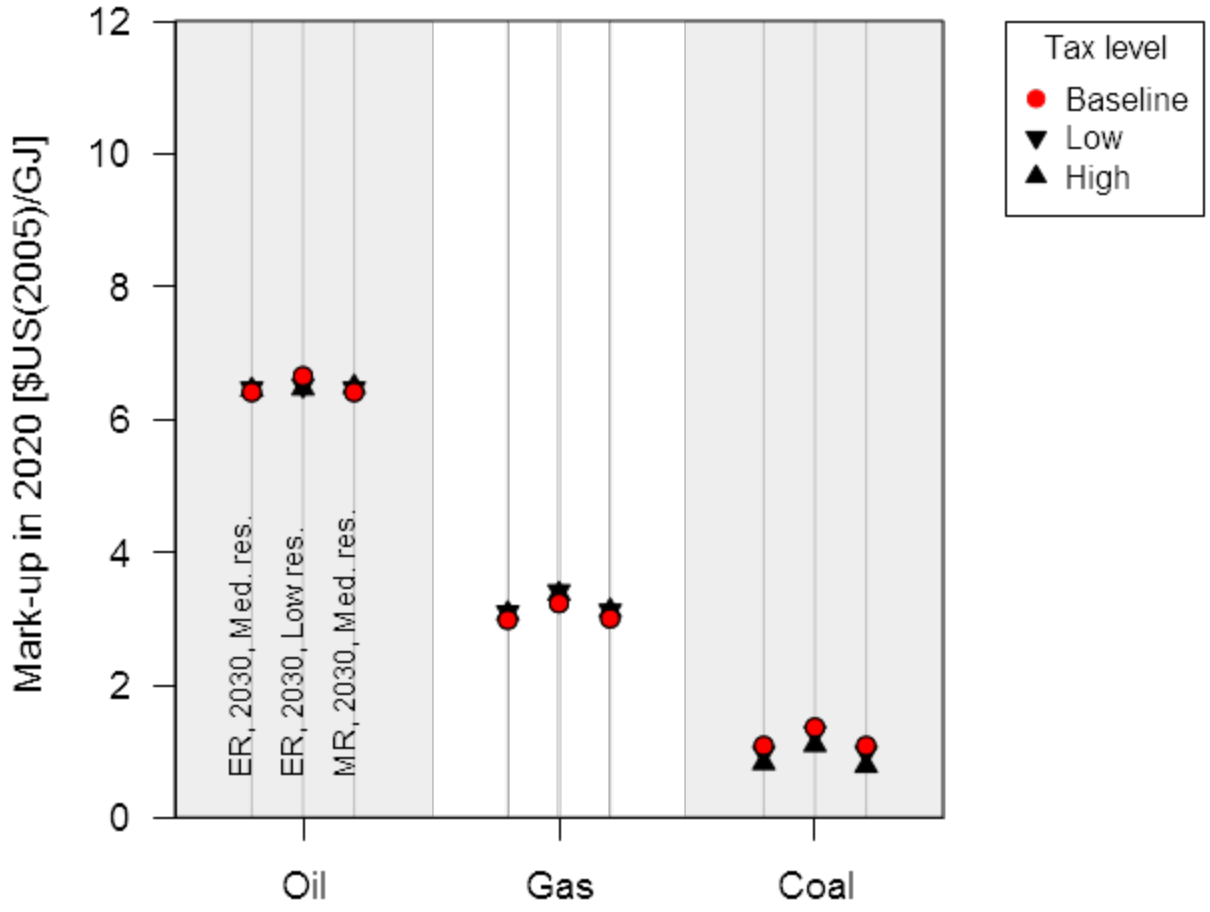
Sensitivity Analysis – Supply Side



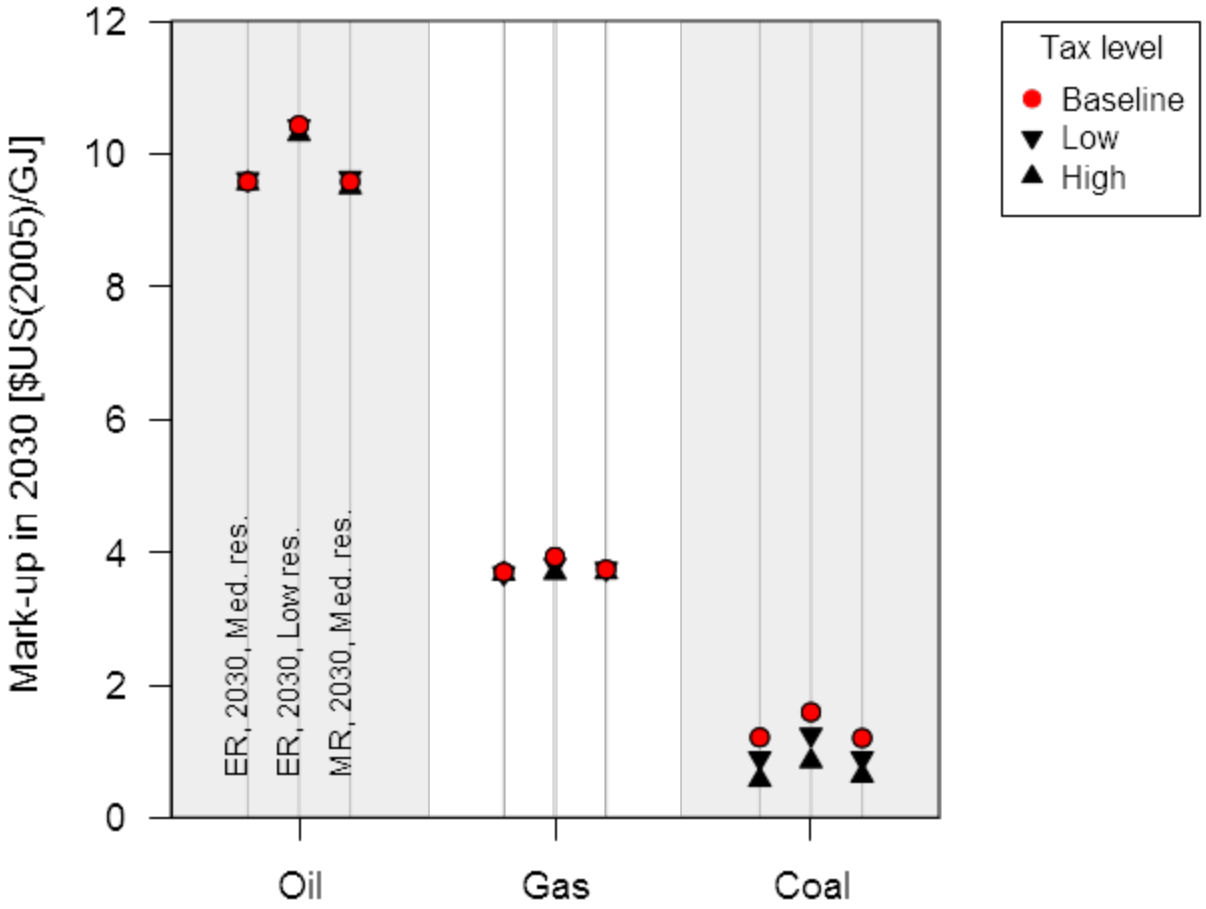
The Effect on Fossil Fuel Use – Tax starts in 2030



The Effect on Fossil Fuel Rents – Tax starts in 2030



The Effect on Fossil Fuel Rents – Tax starts in 2030

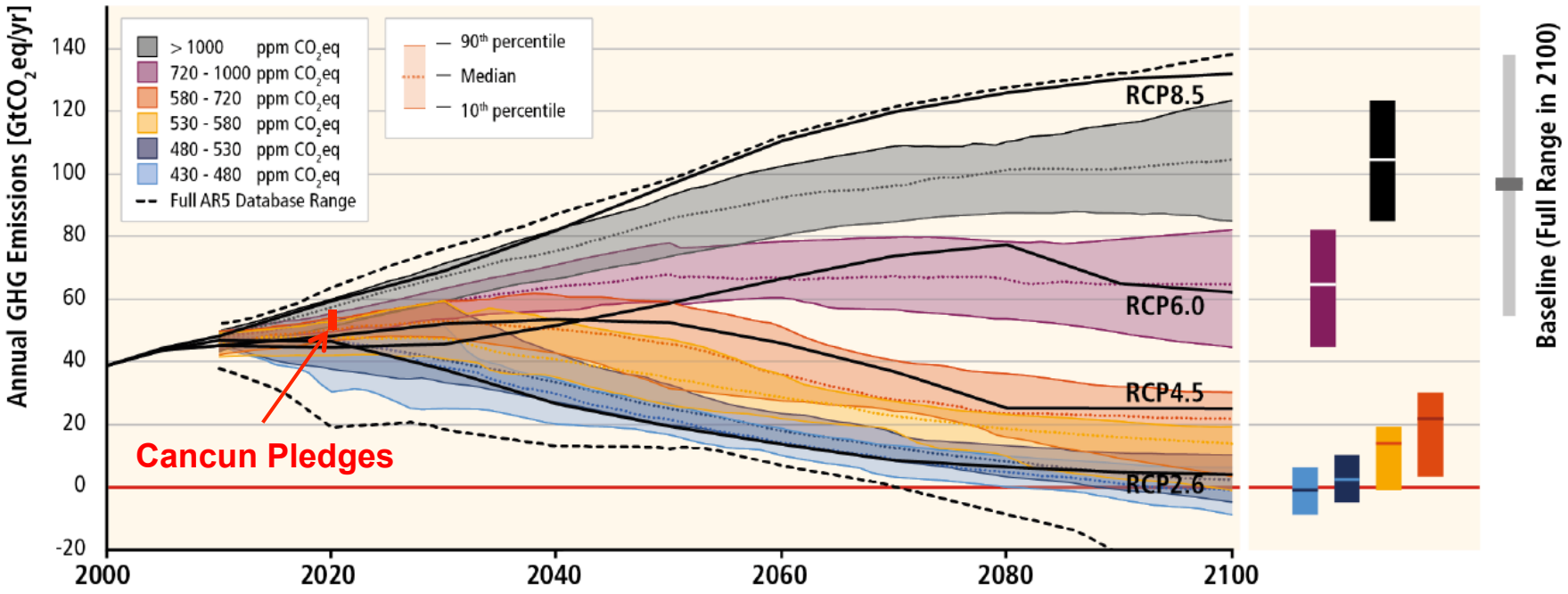


Conclusion

- Announcing a C-tax implies reactions on supply and demand side
- Total cum. effect is relatively small (<50 $GtCO_2$)
- Demand side important shortly before tax starts
- Supply side important only with sufficiently long lead time of about 5 – 15 years
- With higher initial tax demand side clearly dominates
- Coal penalty highest; thus strongest demand side reaction
- The scarcer fossil fuels, the stronger the supply side effect

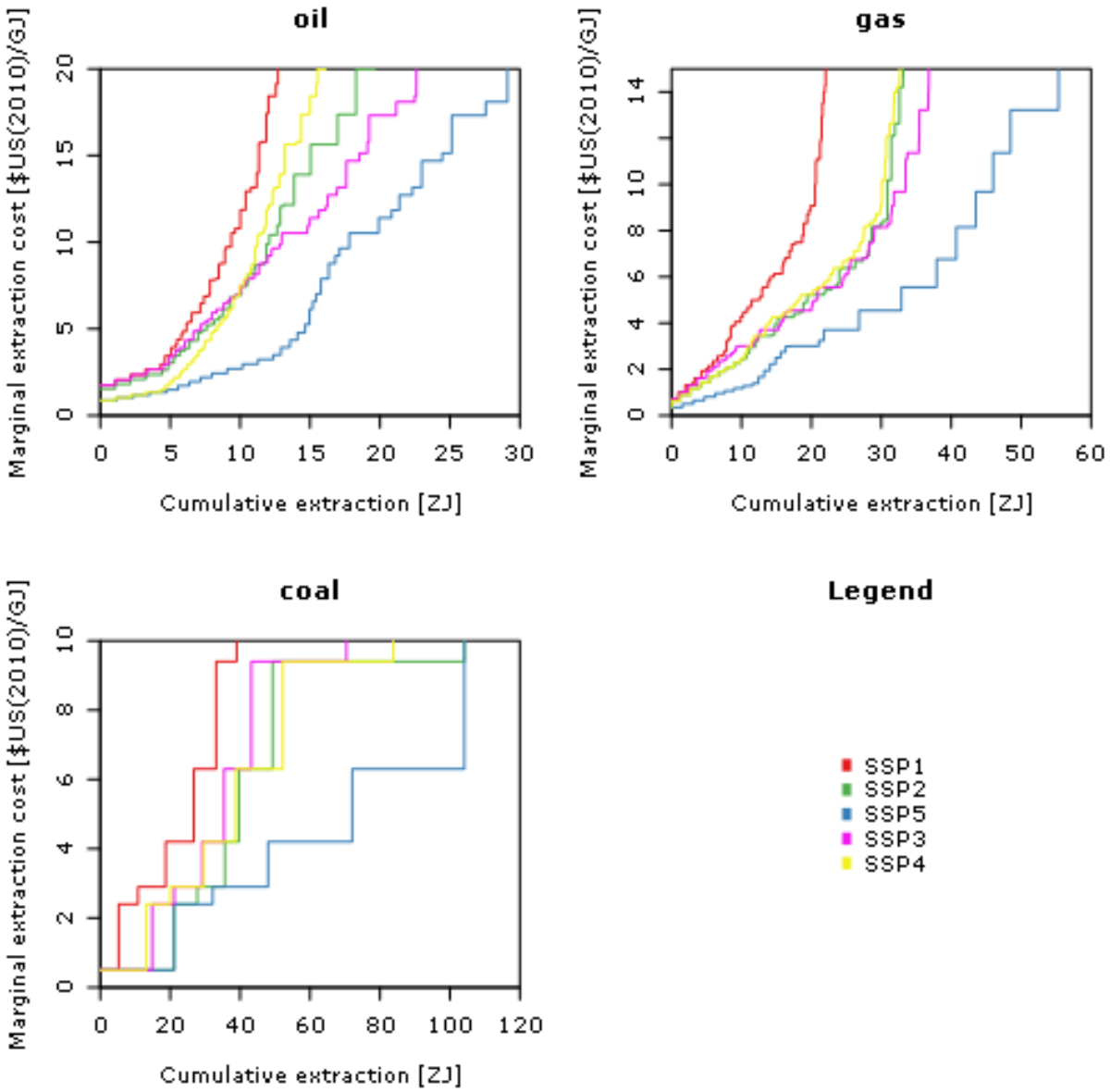
Supporting Material

Global GHG Emissions – Alternative Futures



Drama of global and long term climate policies

⇒ Stringent stabilization (2°C target) require short-term emission limitations
⇒ And long-term reductions of GHG emissions
⇒ Cancun pledges are relatively high (50–56 $GtCO_2$-eq in 2020)


oil
Marginal extraction cost [$US(2010)/GJ]
0
5
10
15
20
0
5
10
15
20
25
30
Cumulative extraction [ZJ]
gas
Marginal extraction cost [$US(2010)/GJ]
0
2
4
6
8
10
14
0
10
20
30
40
50
60
Cumulative extraction [ZJ]
coal
Marginal extraction cost [$US(2010)/GJ]
0
2
4
6
8
10
0
20
40
60
80
100
120
Cumulative extraction [ZJ]
Legend
SSP1
SSP2
SSP5
SSP3
SSP4