Potsdam Institute for Climate Impact Research

PIK

A global abundance of natural gas increases the difficulty to achieve the 2°C target

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Leibniz Association

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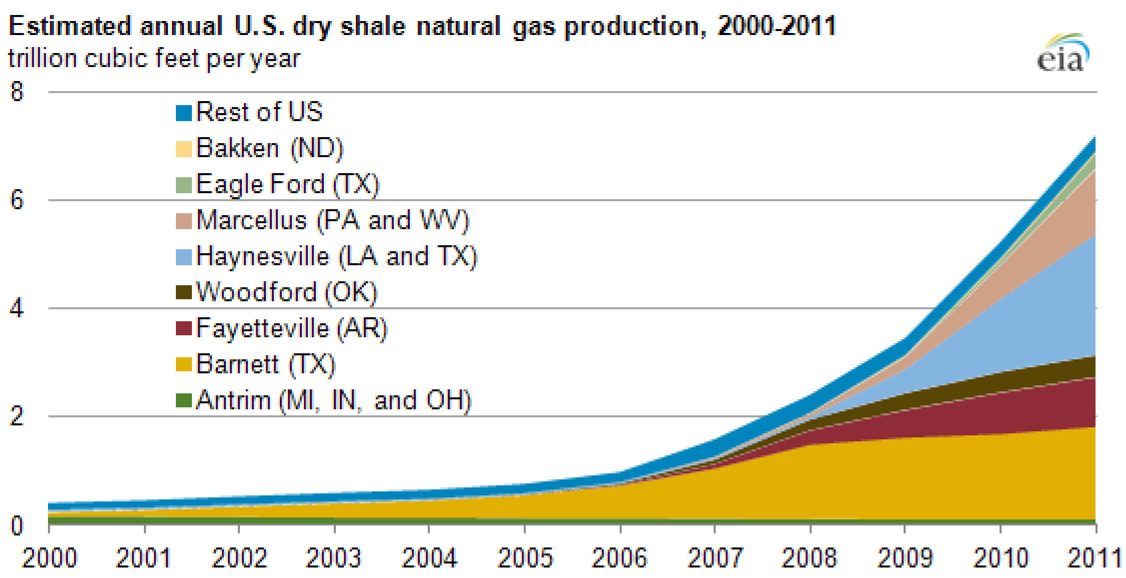
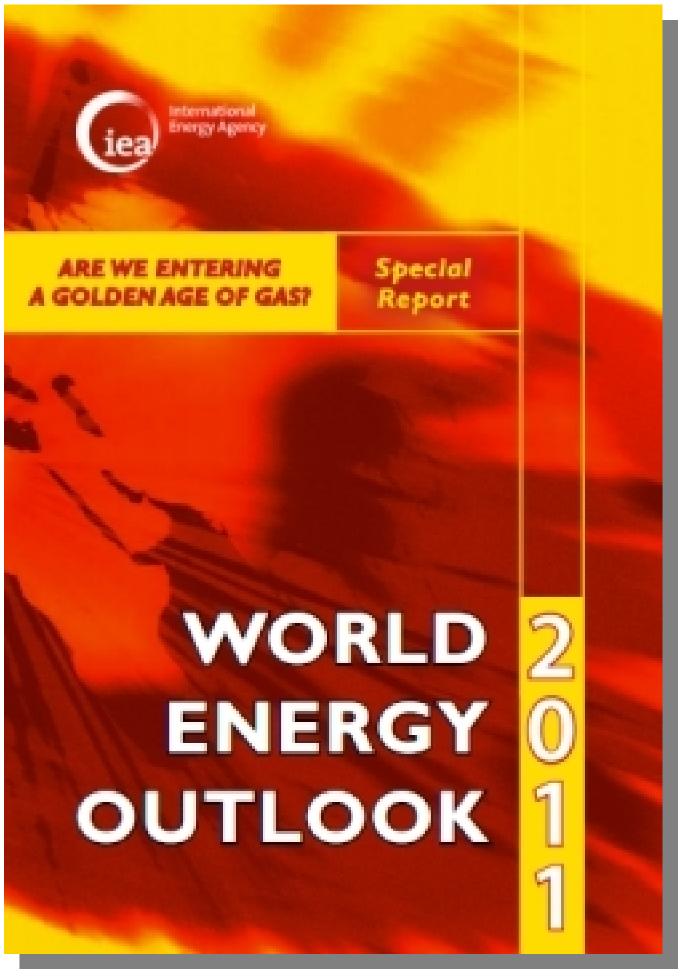
- Shale gas boom





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- Fossil fuel resource surveys
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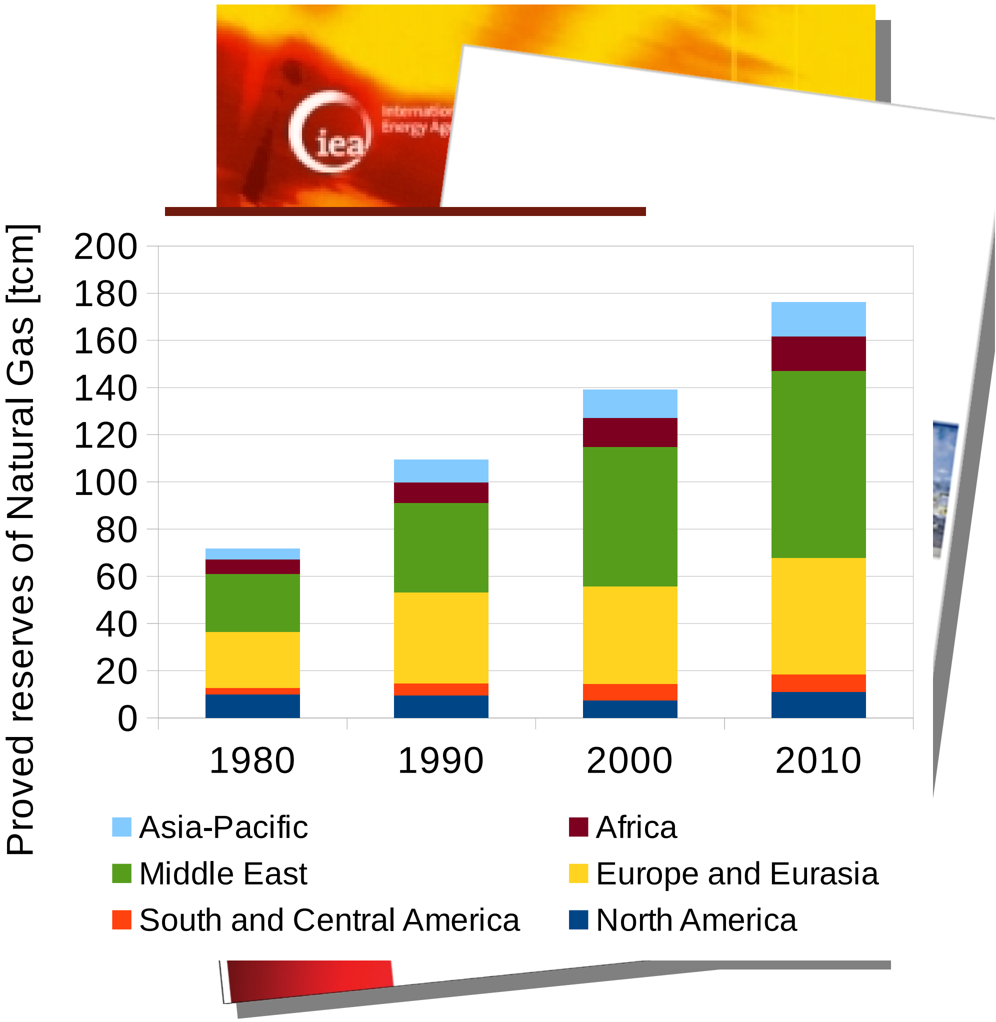

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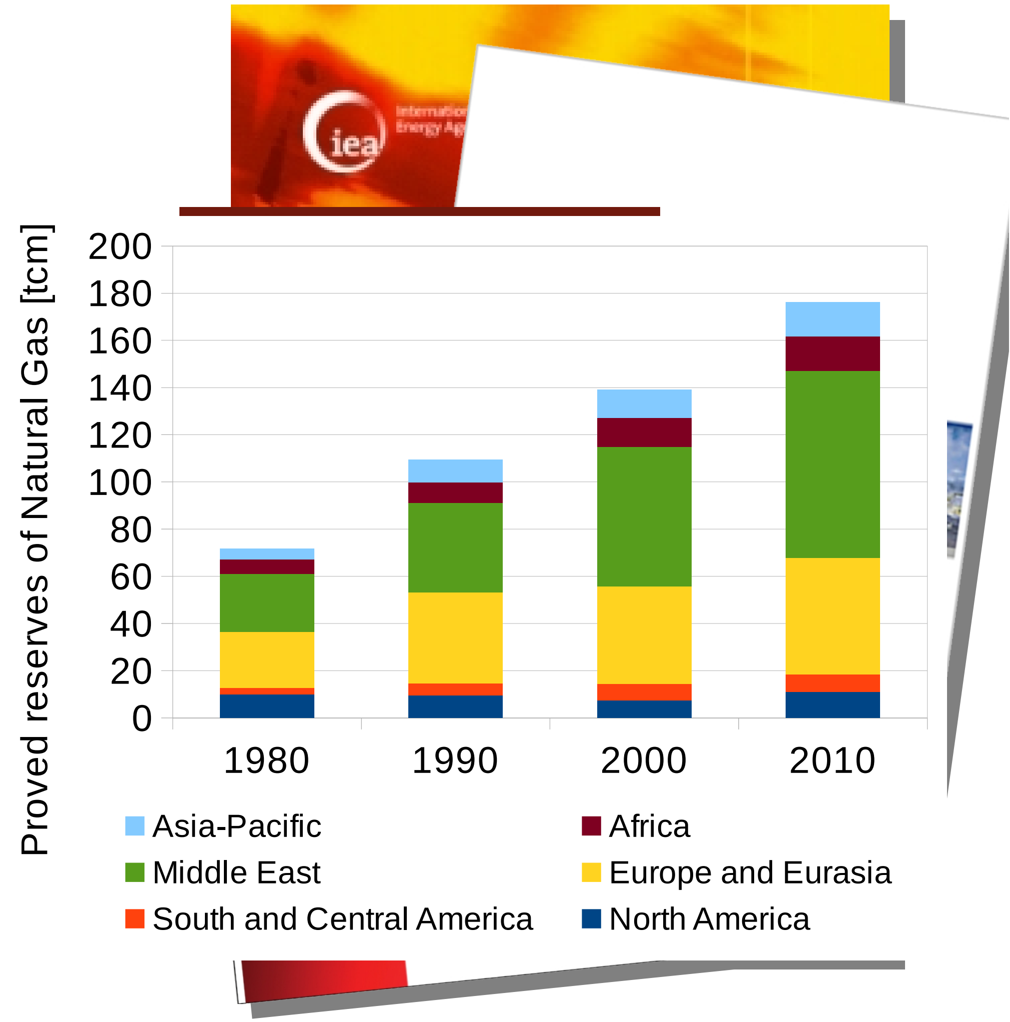
  - extraction costs
  - above ground factors



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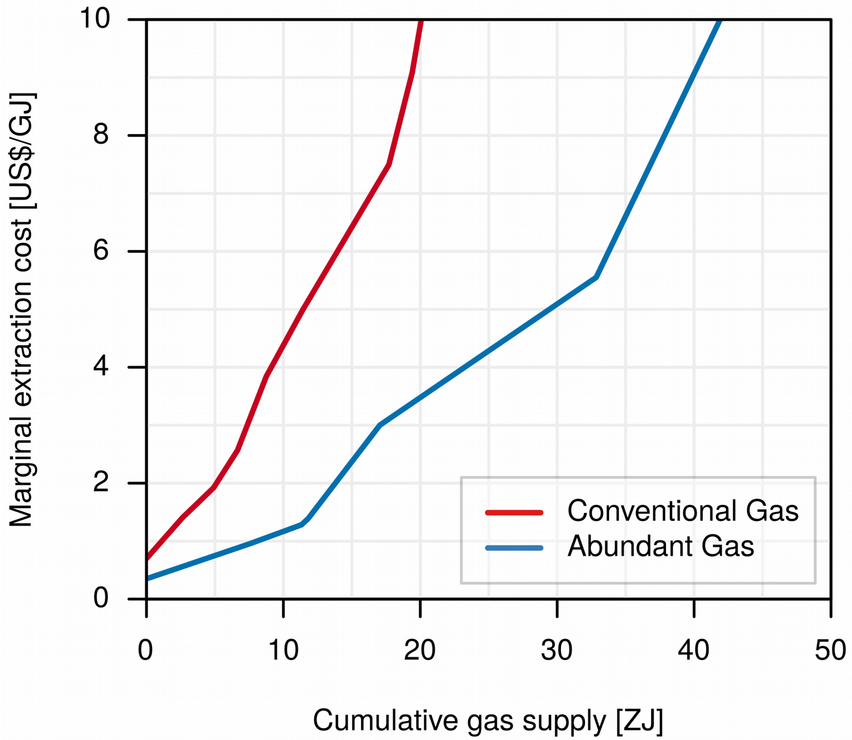
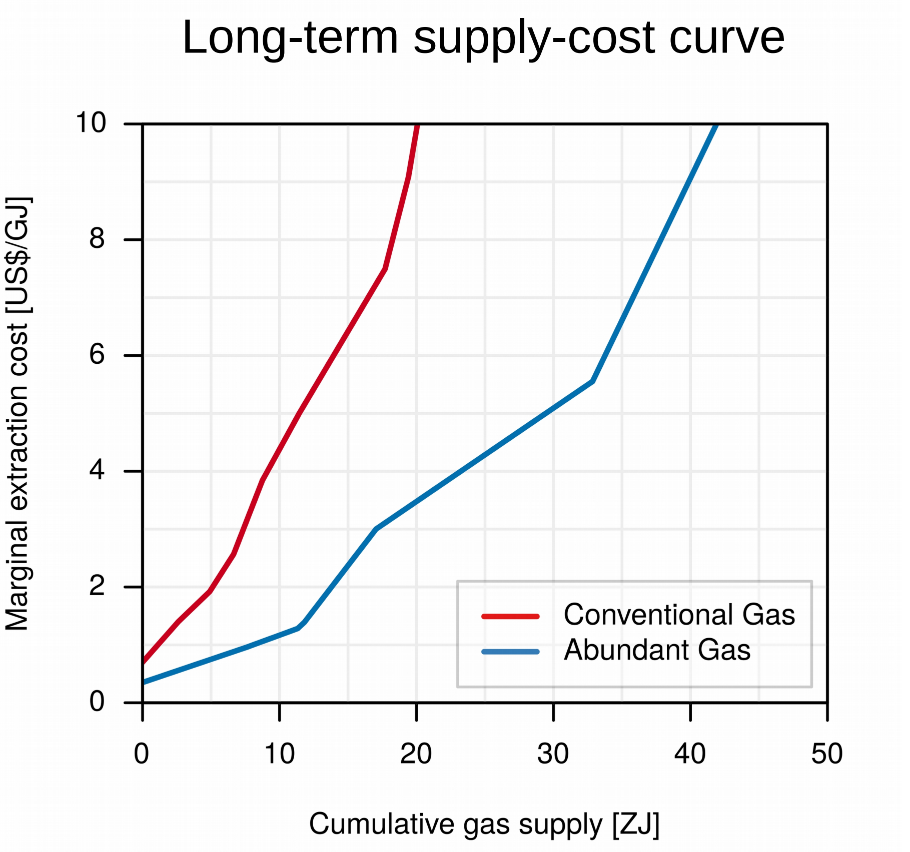
Long-term supply-cost curve



Natural gas: a bridge to a low-carbon future?

- LCAs show lower GHG emissions impact of gas compared to coal *(Burnahm et al 2012, Heath et al 2014)*
- Economic benefits *(IEA 2011, 2012)*
- Energy consumption increase and substitute low-carbon technologies (nuclear, renewables) *(EMF 2013, Shearer et al 2014, McJeon et al 2014)*
- No global study analysing effects of increasing gas supply while implementing climate policies



Climate policy: What is the current state of climate policies in the World?

- 2°C target to avoid dangerous climate change
- Carbon pricing
- Climate policy fragmentation and delay

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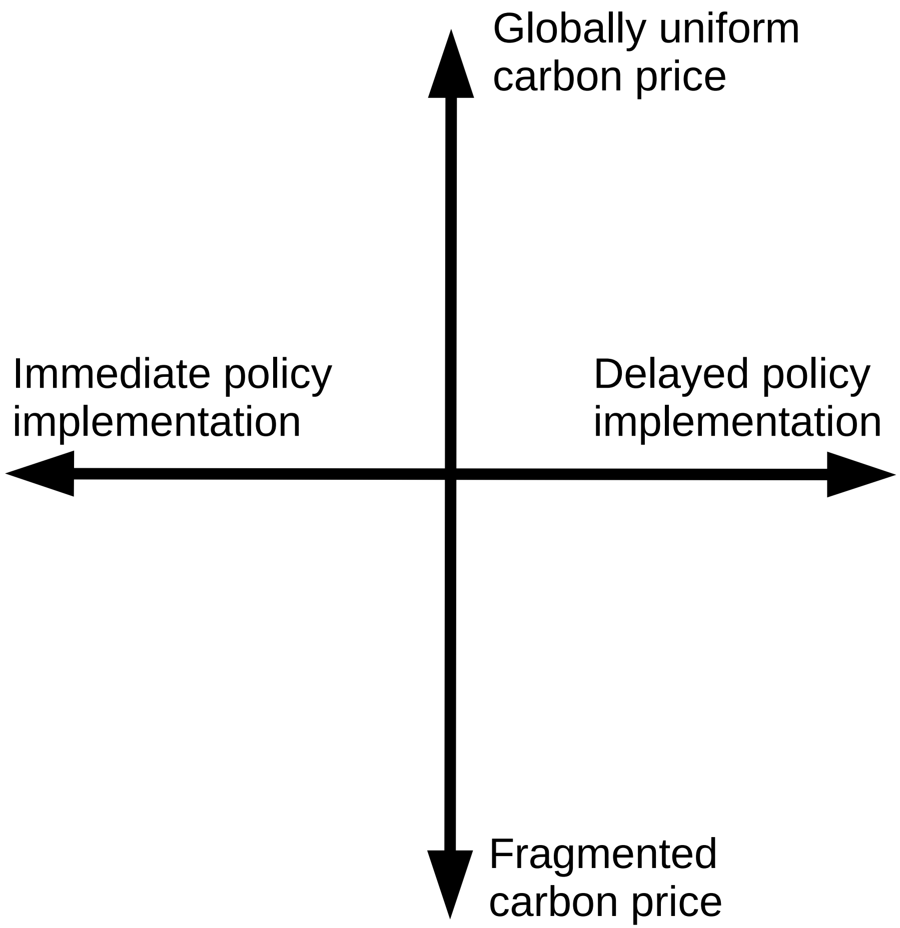

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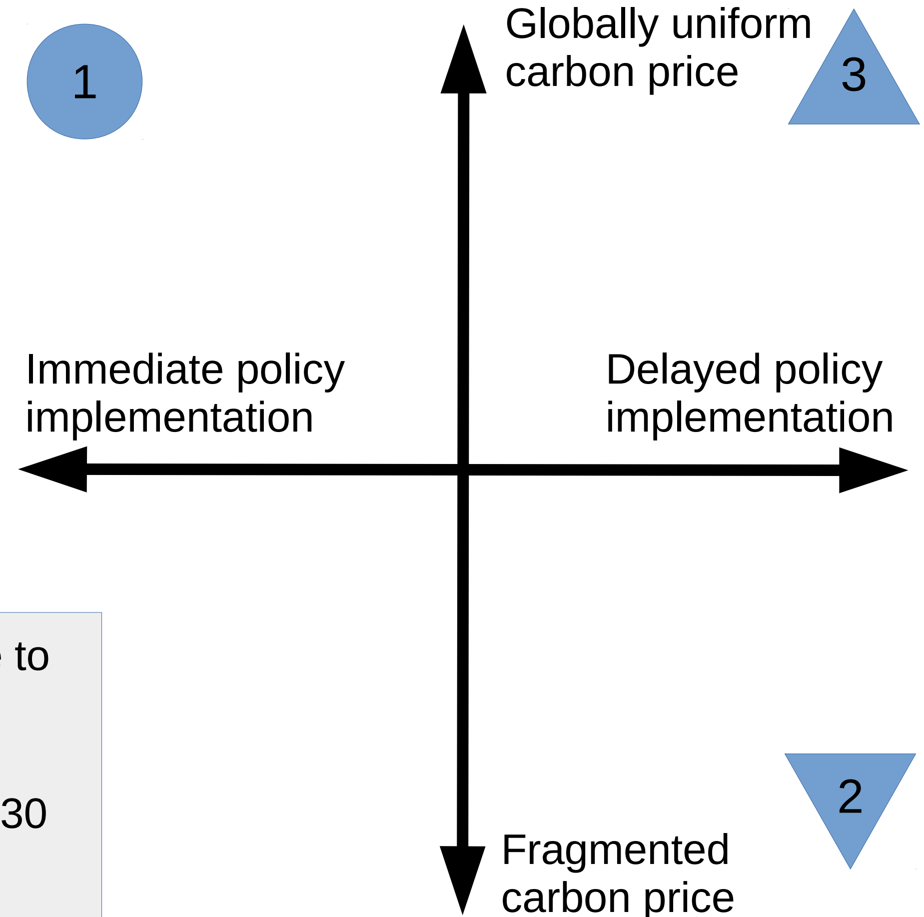


1 Immediate implementation of global carbon price to achieve the 2°C target

2 Delayed and fragmented implementation until 2030 to achieve the 2°C target

3 Delayed implementation until 2030 to achieve the 2°C target

Natural gas as a bridge to a low-carbon future?

- A scenario analysis

Natural gas supply

Climate policy

	Conventional gas (CG)	Abundant gas (AG)	
Baseline	CG-base	AG-base	0
Delayed climate policy until 2030 (shock)	CG-dCPk	AG-dCPk	3
Delayed climate policy until 2030 (smooth)	CG-dCPh	AG-dCPh	2
Immediate climate policy	CG-iCP	AG-iCP	1

Natural gas as a bridge to a low-carbon future?

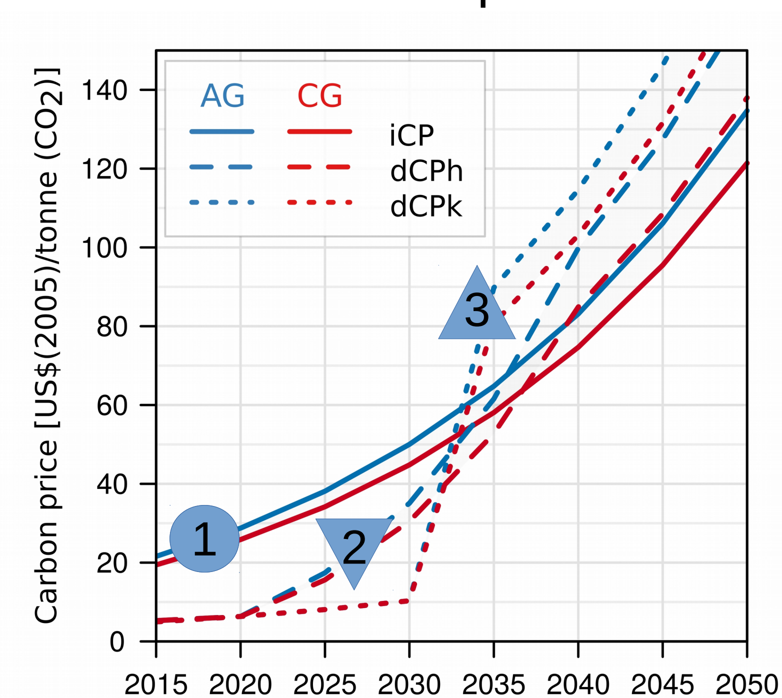
- A scenario analysis

Natural gas supply (columns) / *Climate policy* (rows)

	Conventional gas (CG)	Abundant gas (AG)
Baseline	CG-base	AG-base
Delayed climate policy until 2030 (shock)	CG-dCPk	AG-dCPk
Delayed climate policy until 2030 (smooth)	CG-dCPh	AG-dCPh
Immediate climate policy	CG-iCP	AG-iCP

0

Carbon prices



Modeling framework: the REMIND model

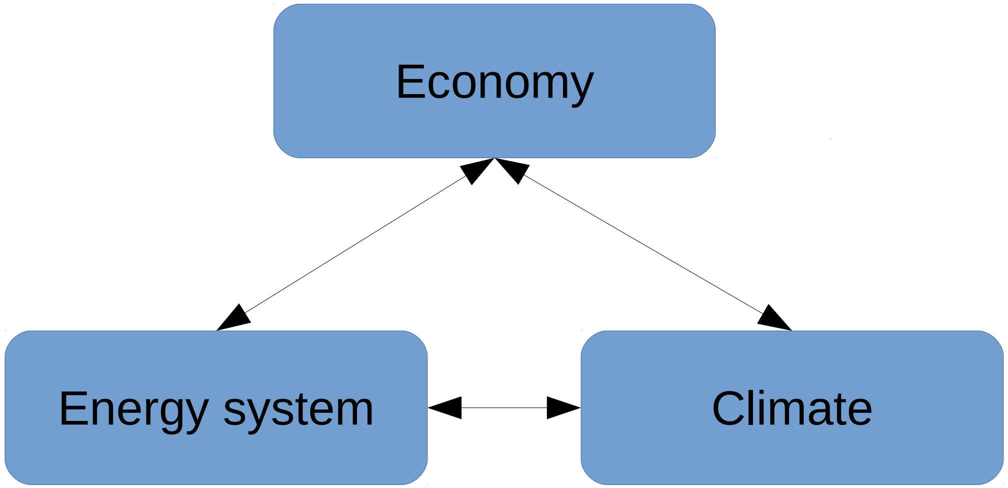
- Energy-economy-climate integrated model

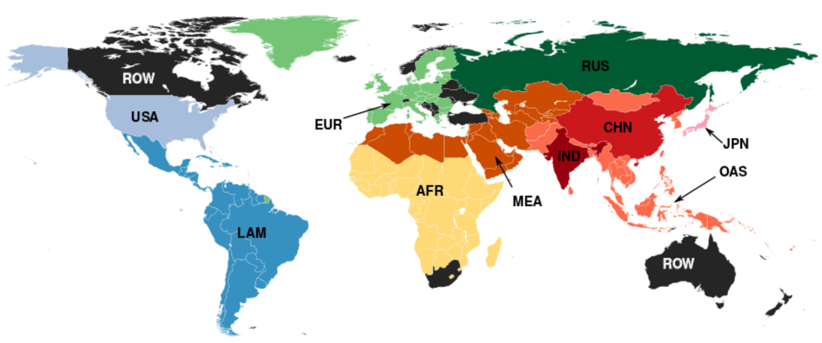
- Welfare optimising
- Perfect foresight

- Bottom-up energy system

- Climate: MAGICC

- 11 regions
- Time frame: 2010-2100

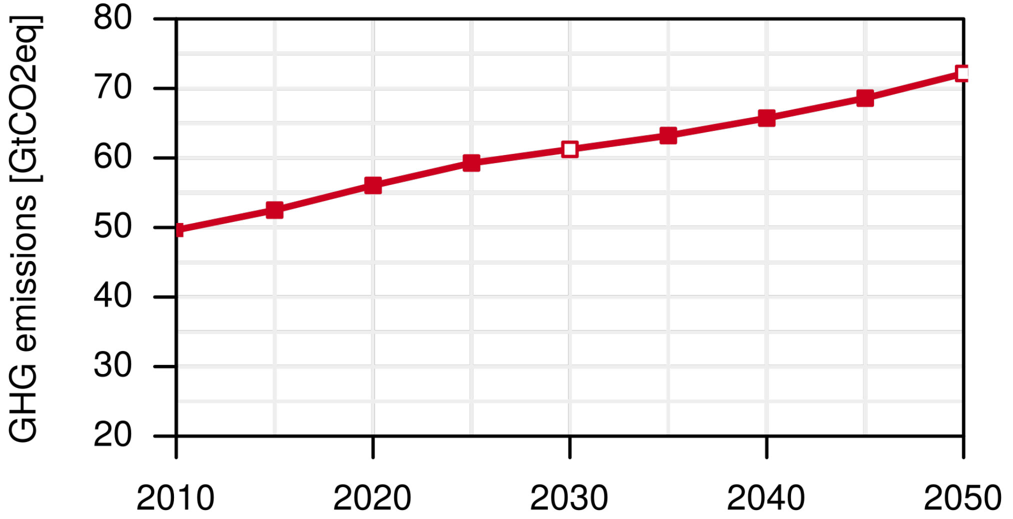




Results

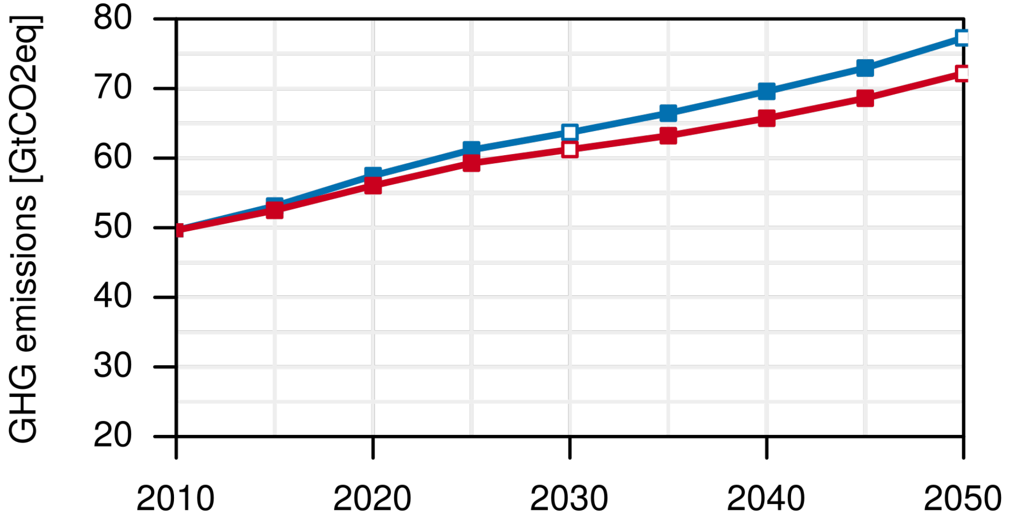
Global GHG emissions – over time

- Absence of climate policy
  - GHG emissions increase in CG world



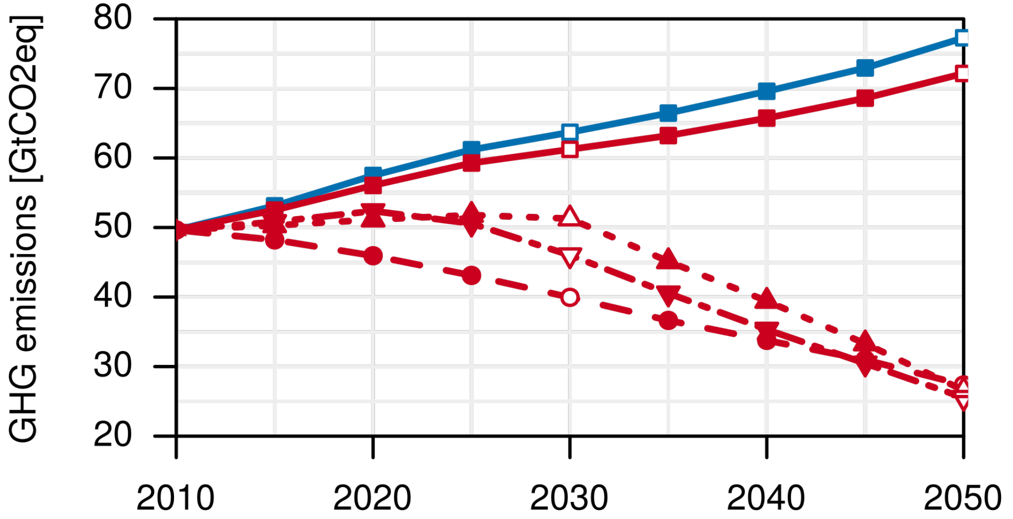
Global GHG emissions – over time

- Absence of climate policy
  - GHG emissions increase in CG world
  - Even larger in AG world



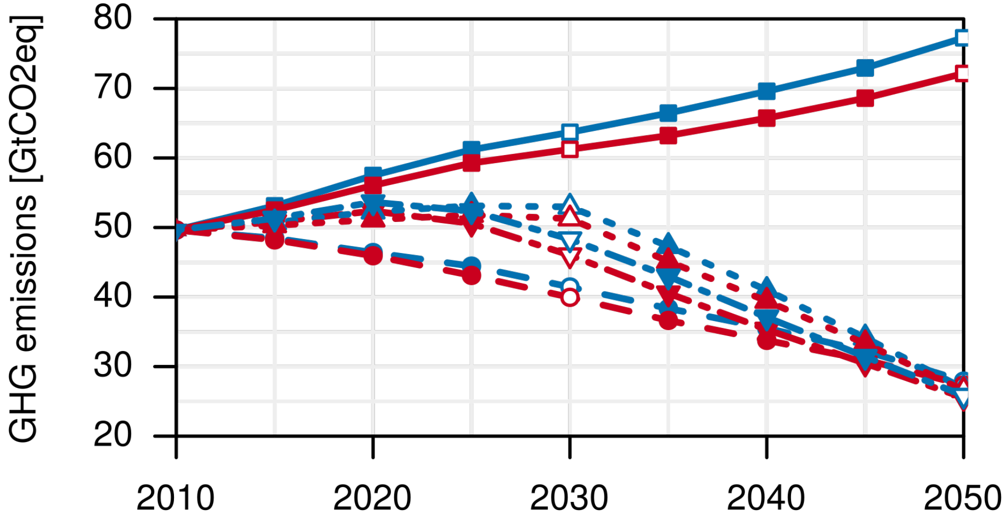
Global GHG emissions – over time

- Absence of climate policy
  - GHG emissions increase in CG world
  - Even larger in AG world
- Climate policies implemented
  - Significant GHG emissions reduction in CG ...



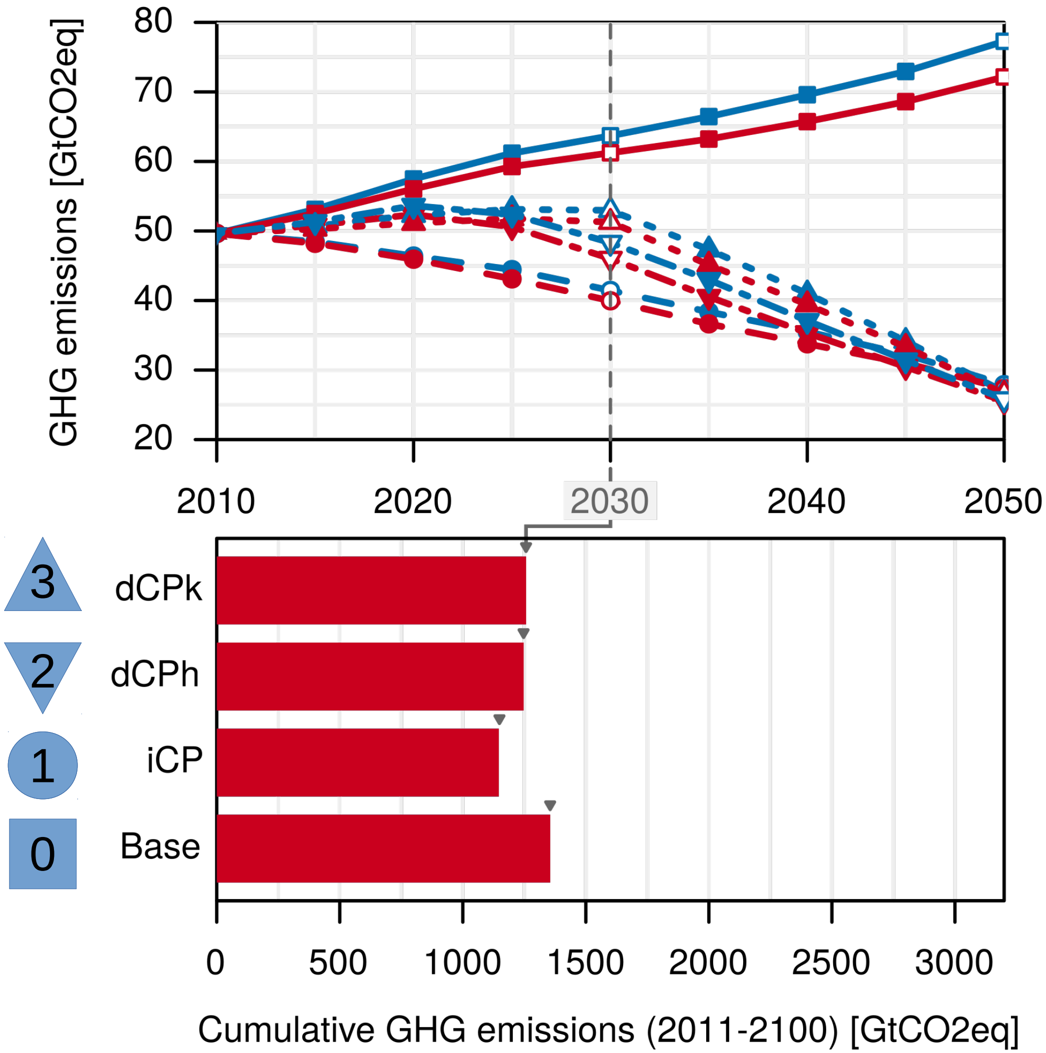
Global GHG emissions – over time

- Absence of climate policy
  - GHG emissions increase in CG world
  - Even larger in AG world
- Climate policies implemented
  - Significant GHG emissions reduction in CG and AG worlds
  - Though GHG emissions remain larger in AG world



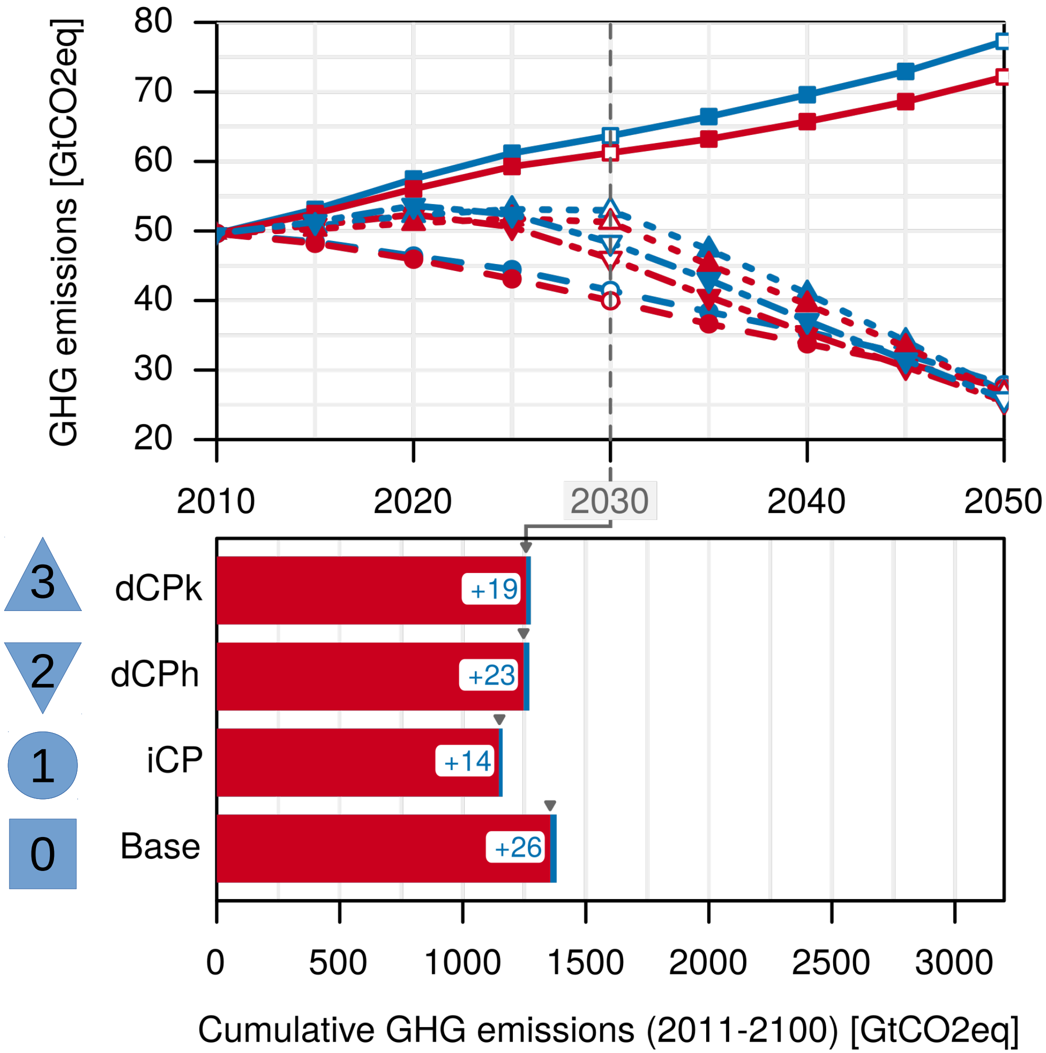
Global GHG emissions - cumulative

- Immediate climate policy more effective



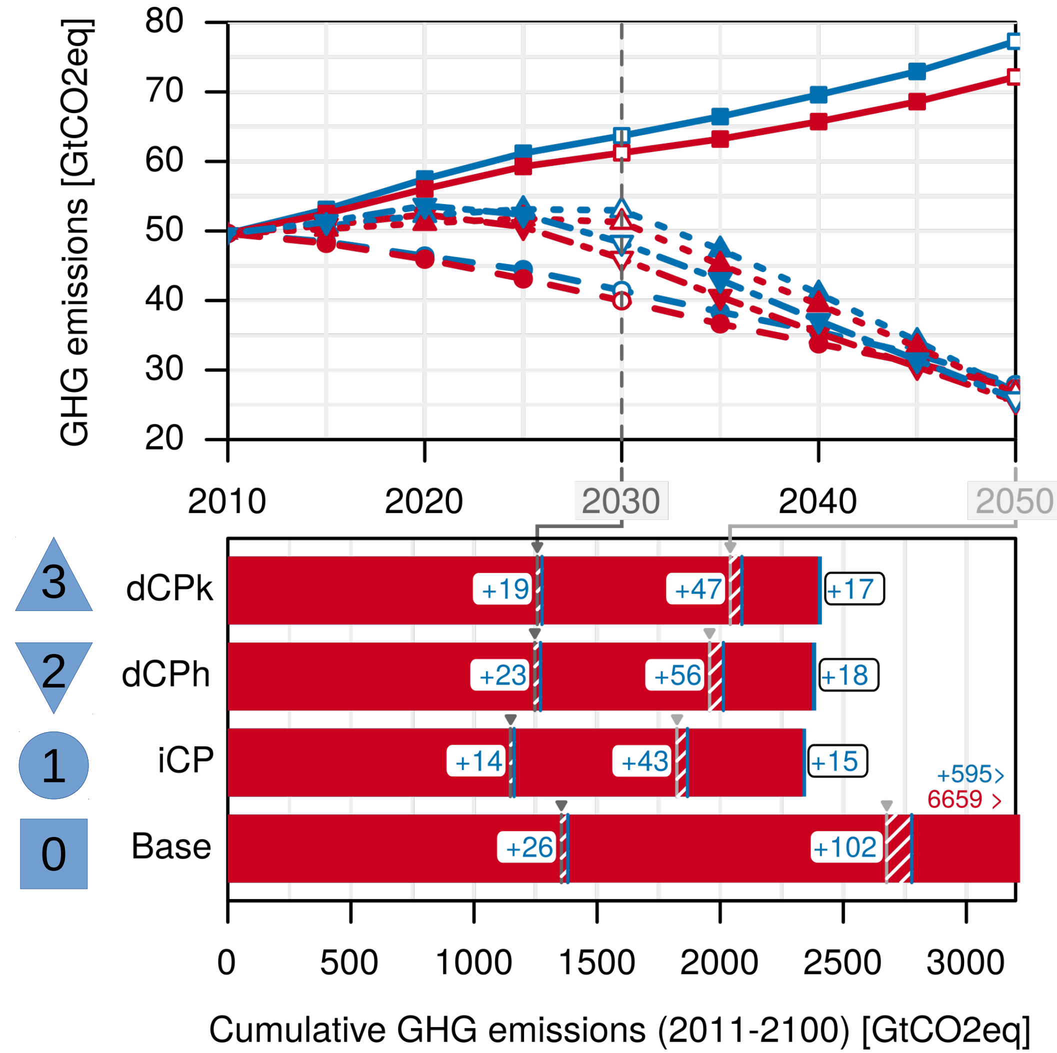
Global GHG emissions - cumulative

- Immediate climate policy more effective
- Also to reduce GHG emissions increase from AG



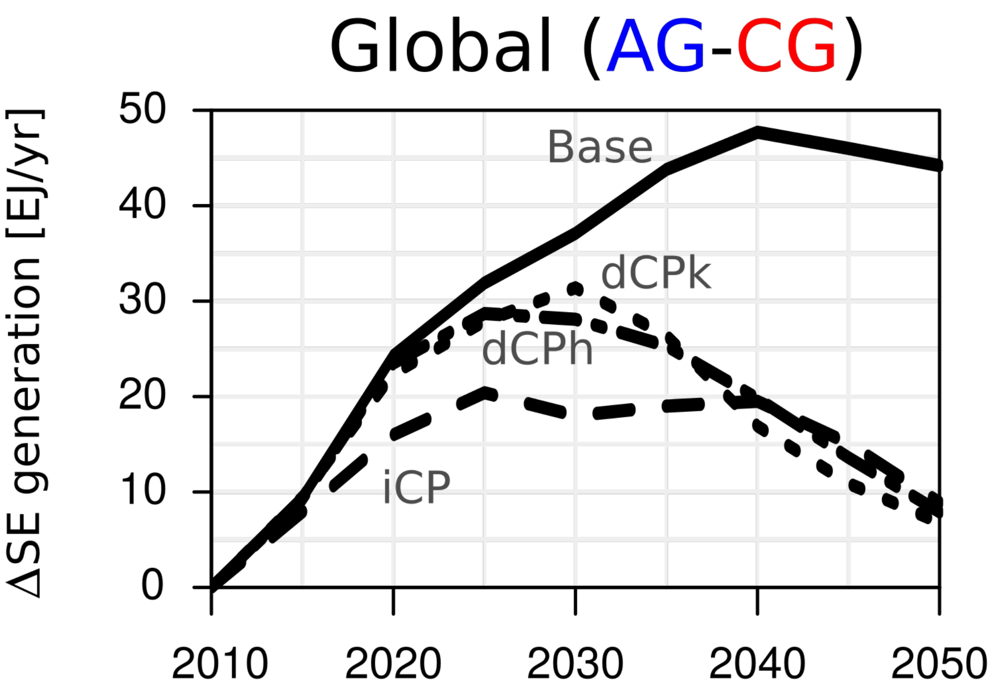
Global GHG emissions - cumulative

- Immediate climate policy more effective
- Also to reduce GHG emissions increase from AG
- Additional GHG emitted in delayed cases will have significant impact on the energy system



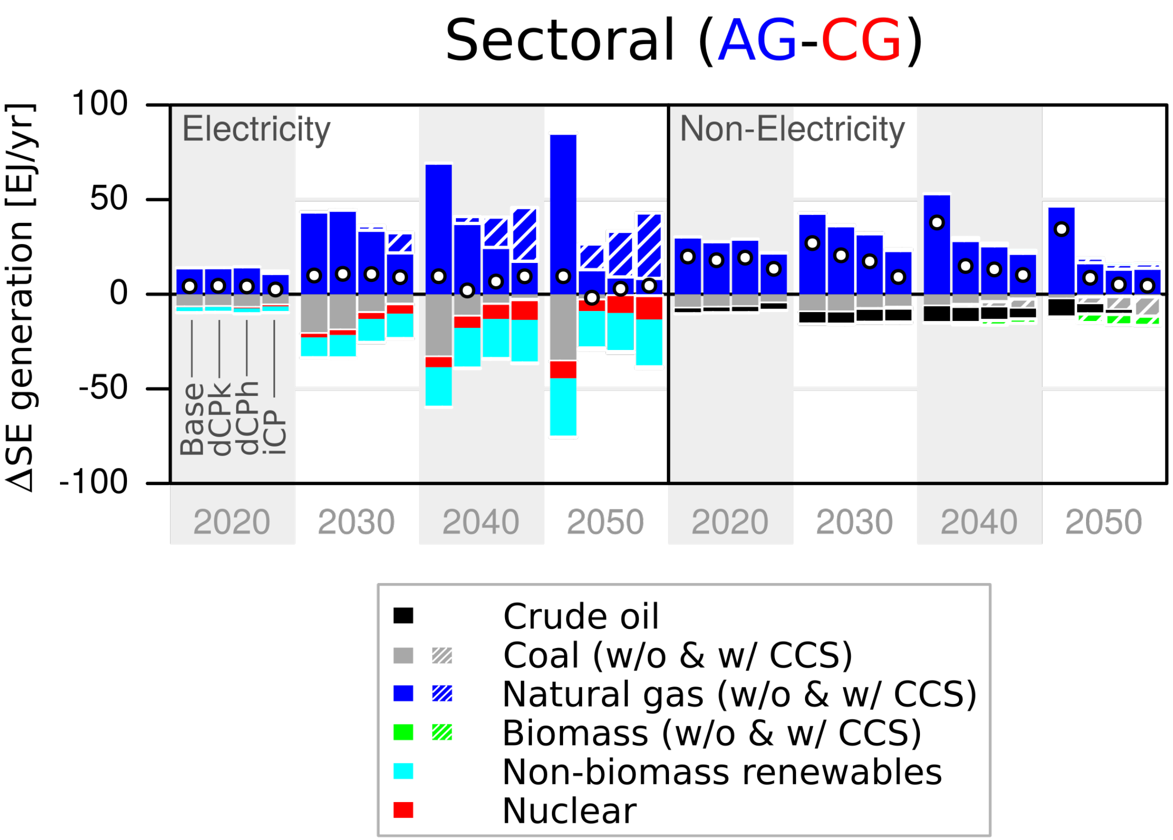
Energy system transformation

- Increase in energy generation
- Partially explains increase in GHG emissions



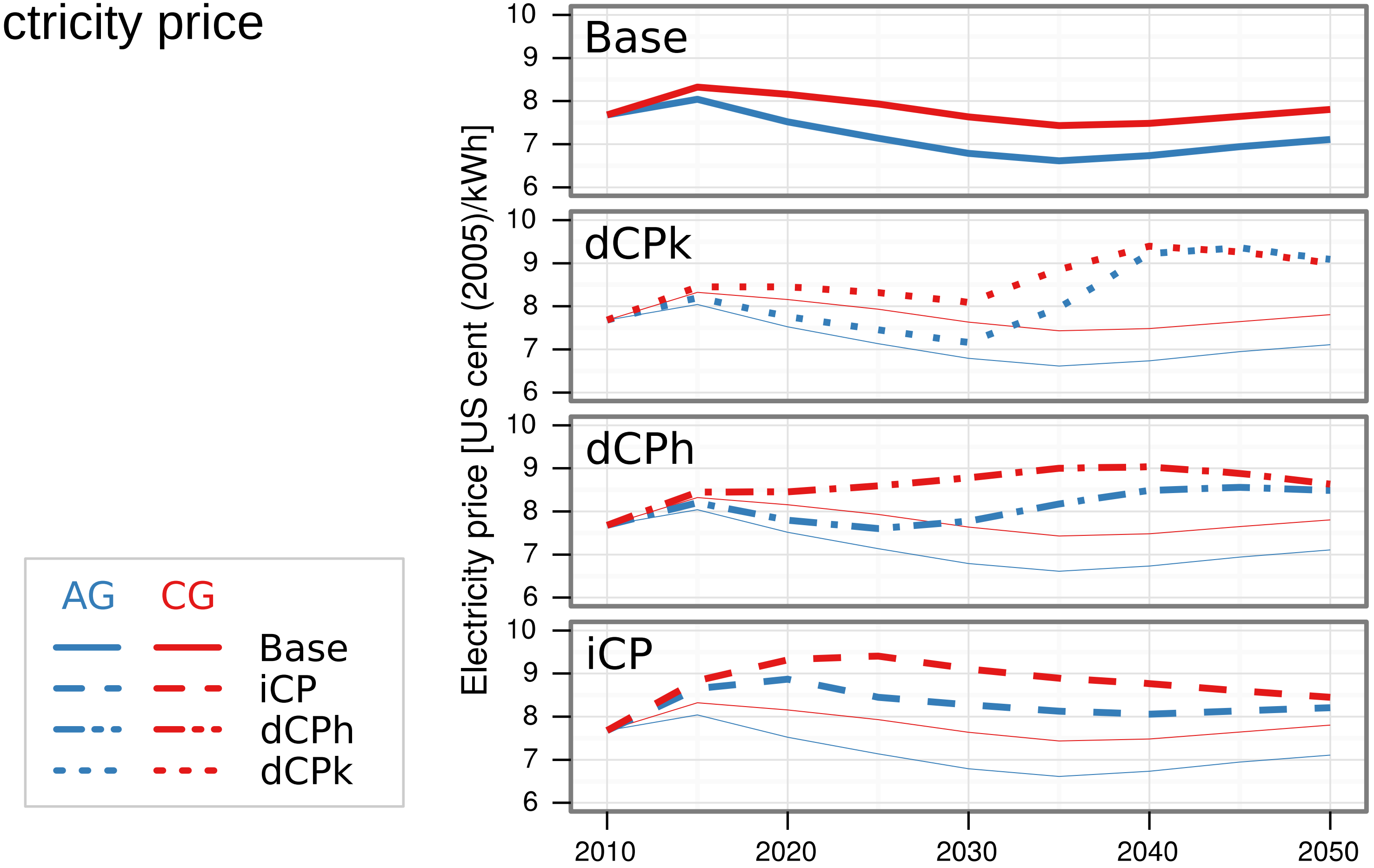
Energy system transformation

- Electric sector
  - Increase of gas+CCS
  - Decrease of coal, nuclear and renewables
- Non-electric sector
  - Increase of gas
  - Decrease of coal, oil and biomass



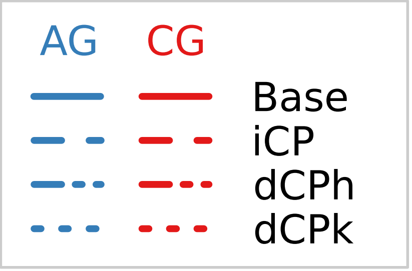
Macro-economic implications

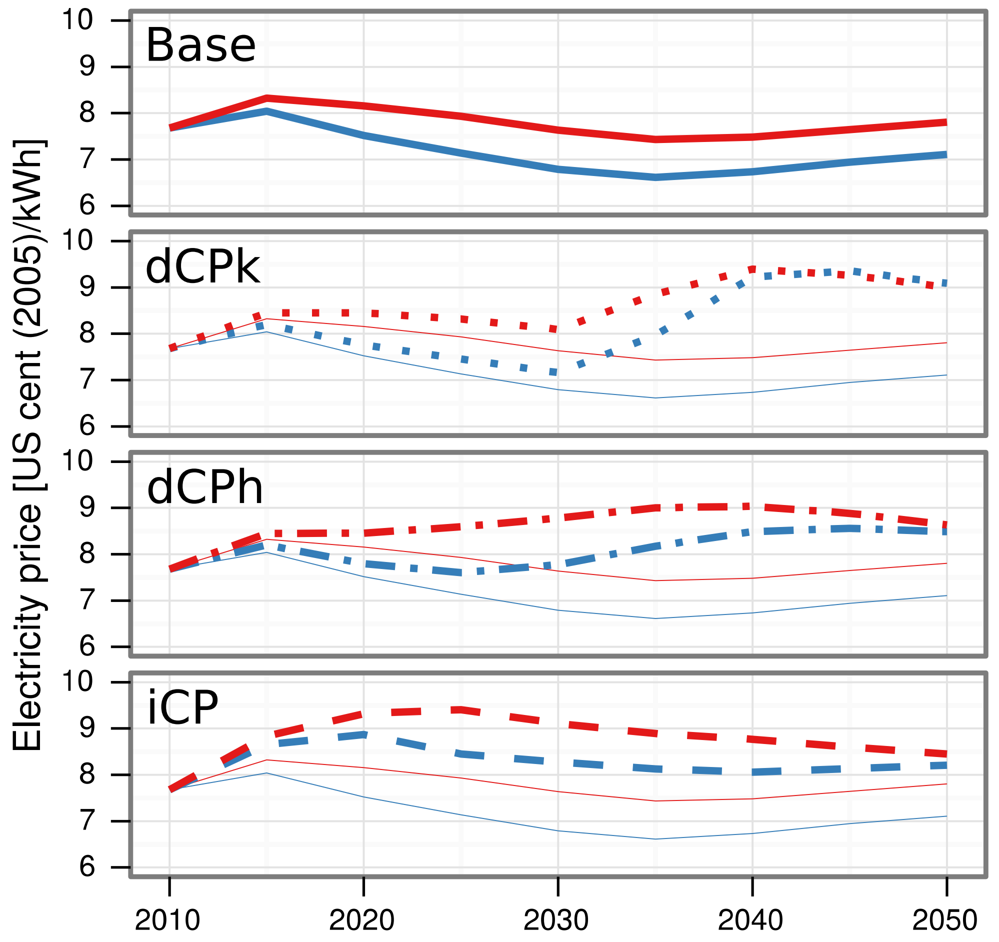
- AG leads to electricity price decrease



Macro-economic implications

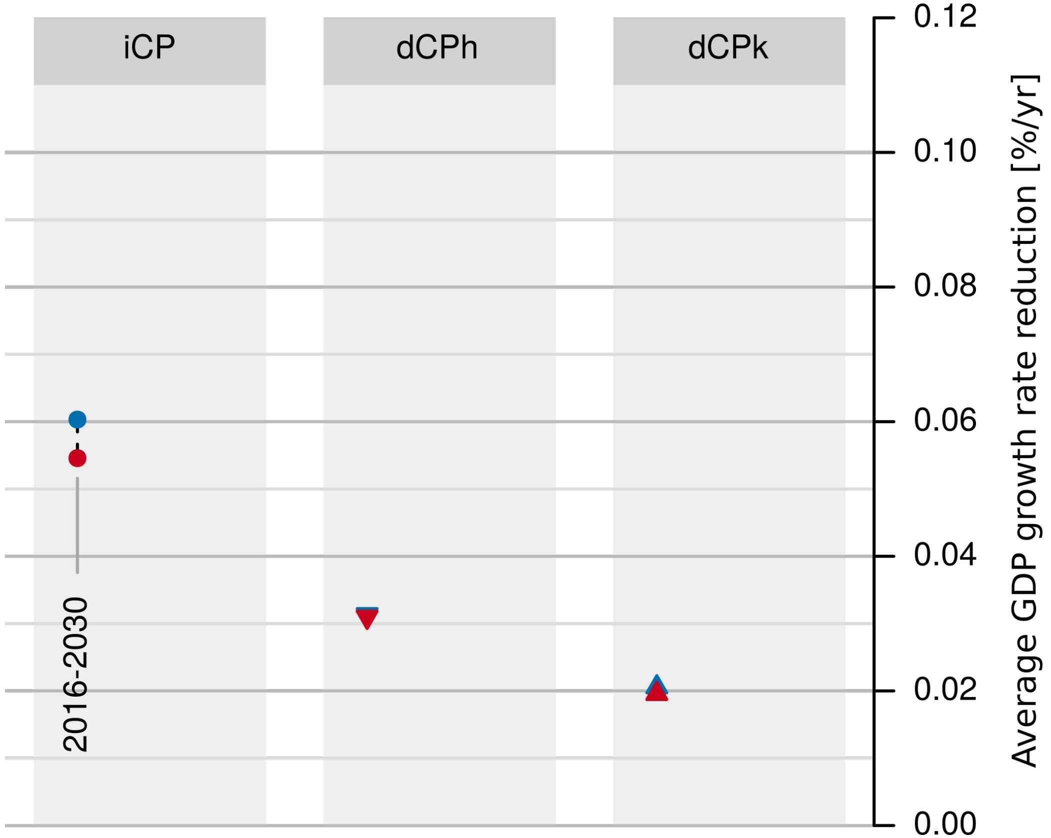
- AG leads to electricity price decrease
- Climate policy results in price increases





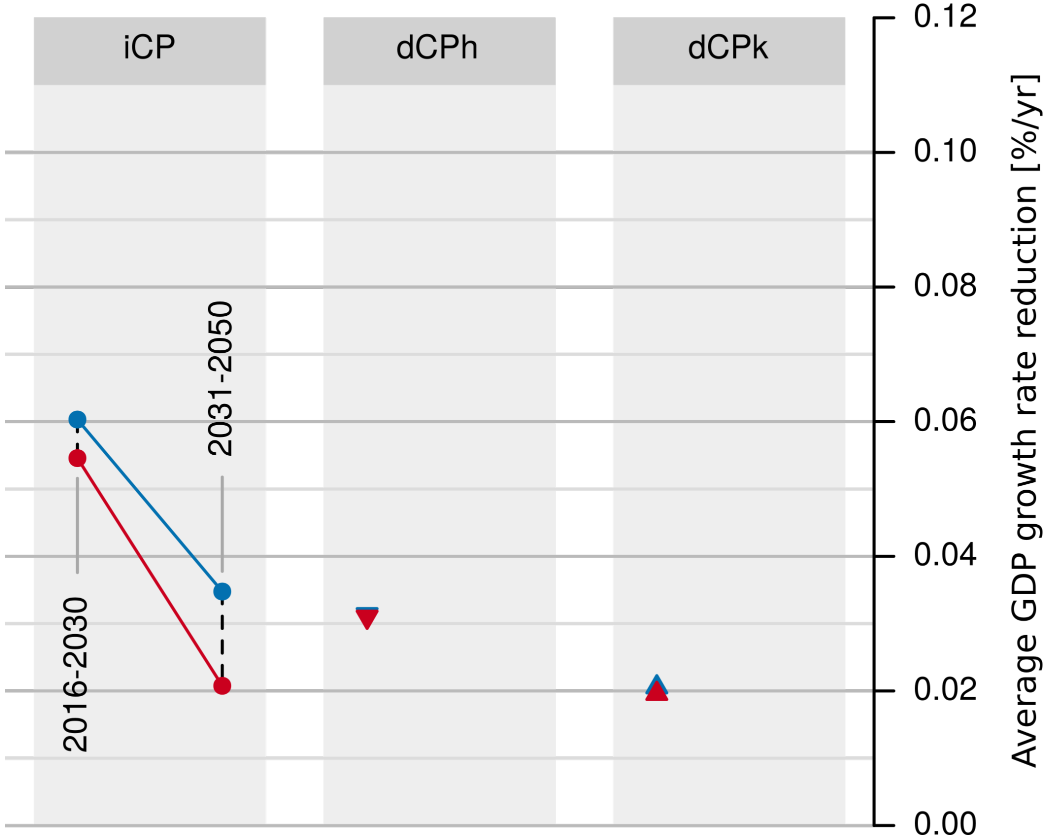
Macro-economic implications – near-term effects

- Trade-off: immediate VS. delayed climate policies



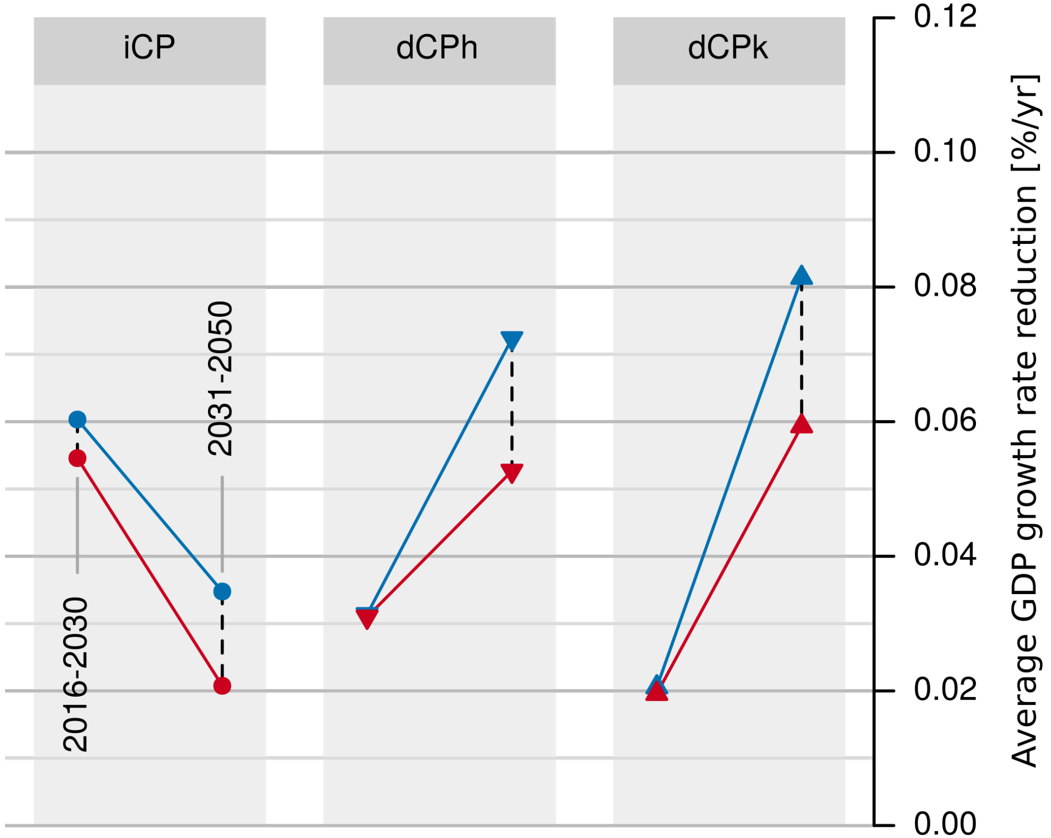
Macro-economic implications – near-term effects

- Trade-off: immediate VS. delayed climate policy
- Immediate CP have higher costs in the near-term (2016-2030) but lower ones afterwards

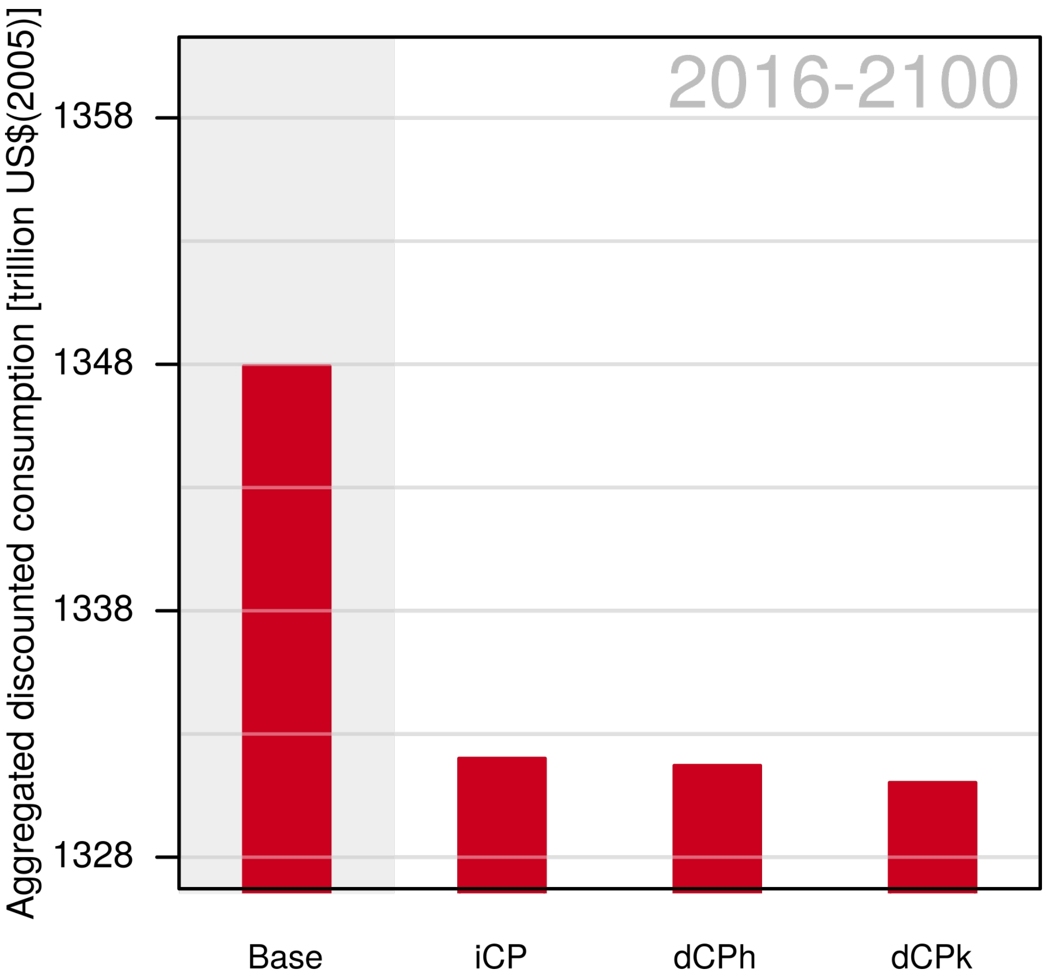


Macro-economic implications – near-term effects

- Trade-off: immediate VS. delayed climate policy
- Immediate CP have higher costs in the near-term (2016-2030) but lower ones afterwards
- Delayed CP have lower costs in the near-term but higher ones afterwards

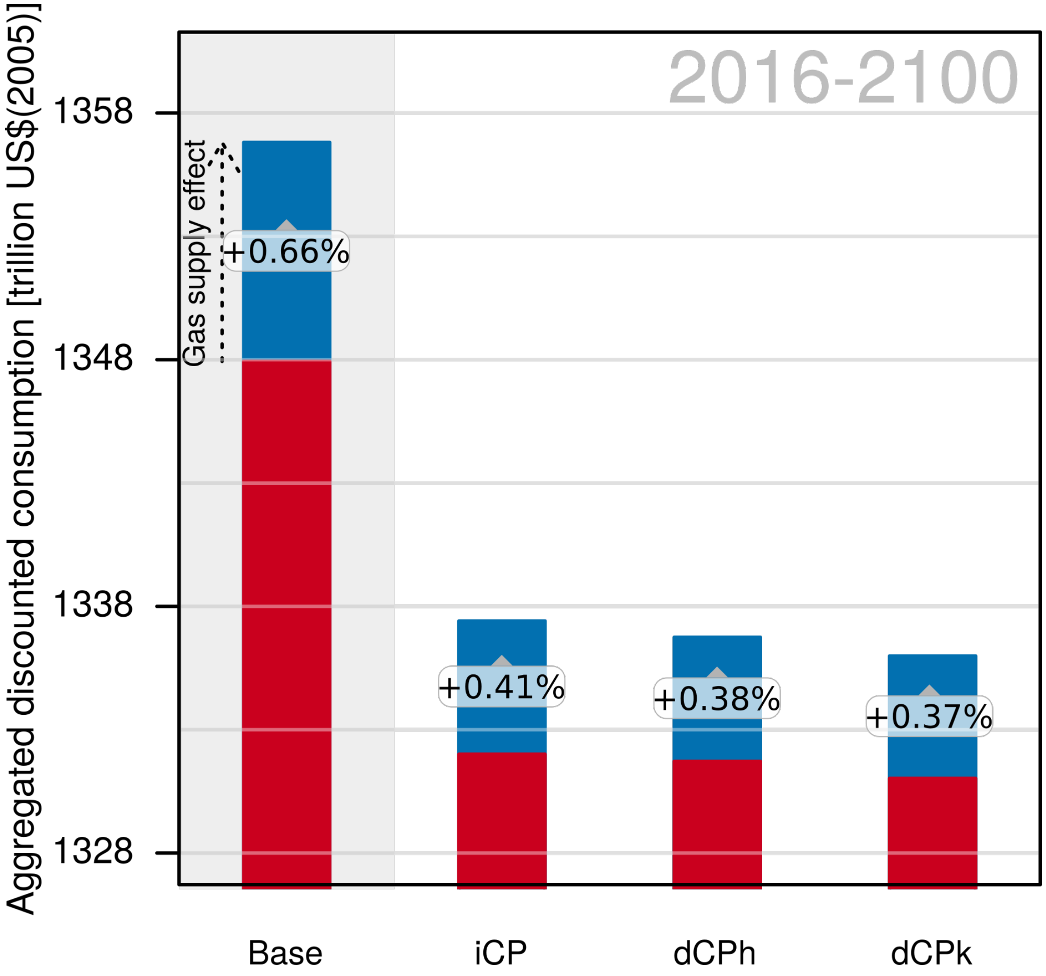


Macro-economic implications – long-term effects



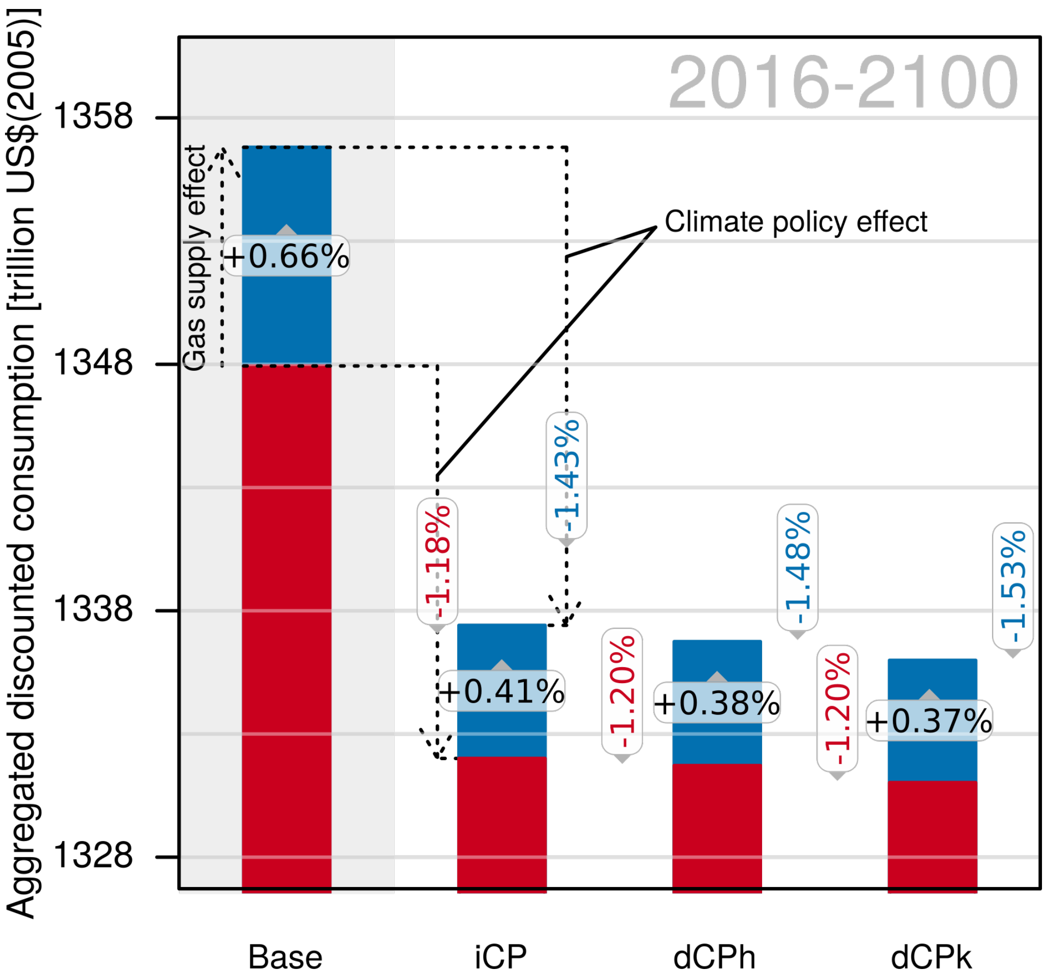
Macro-economic implications – long-term effects

- Gas supply effect increases consumption



Macro-economic implications – long-term effects

- Gas supply effect increases consumption
- Climate policy effect decreases consumption
- Largest effect for AG and delayed climate policy



Conclusions

- Increasing natural gas supply would bring some benefits:
  - Higher GDP and consumption
  - Lower electricity prices

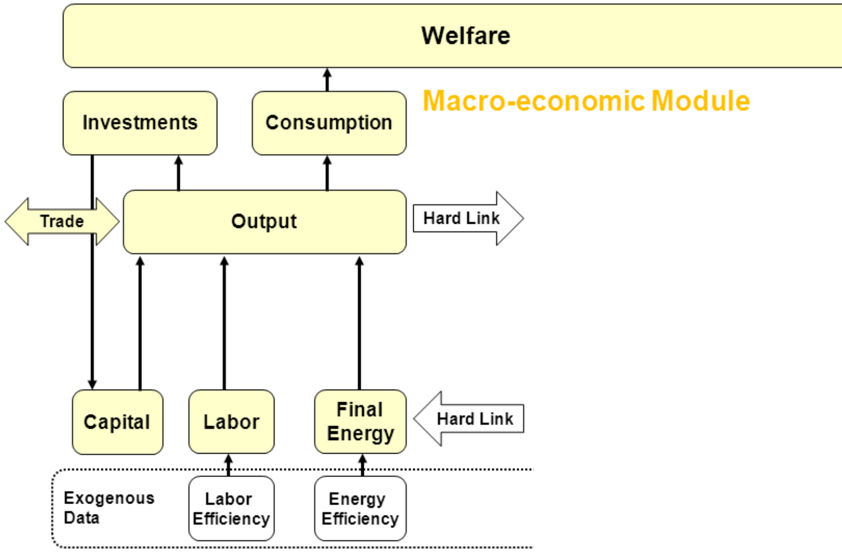
Conclusions

- Increasing natural gas supply would bring some benefits:
  - Higher GDP and consumption
  - Lower electricity prices
- But its role as a bridge to a low-carbon future is called into question because
  - Delaying climate policy lead to higher opportunity costs
  - It would be even more difficult if the target would be 1.5°C

Thank you for your attention!

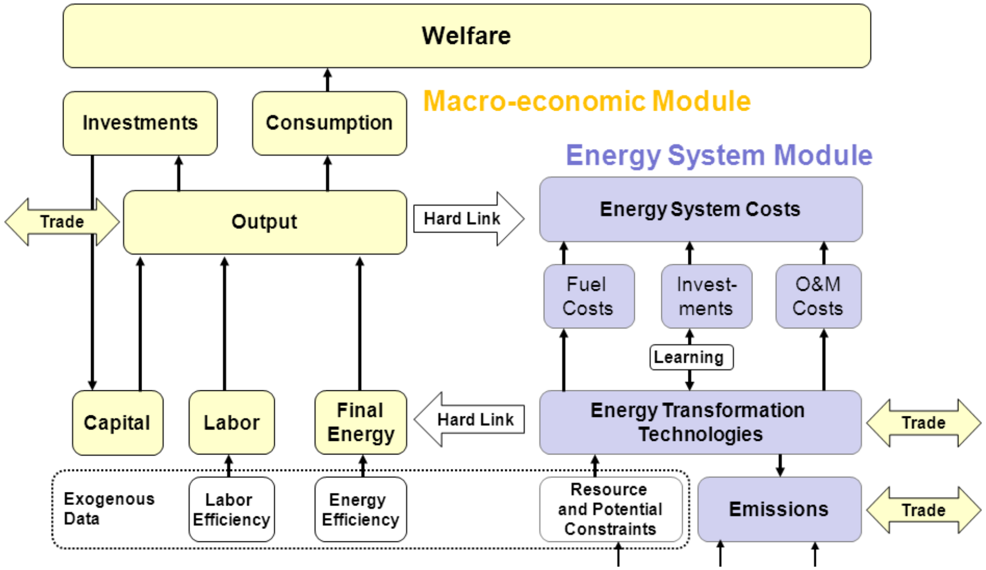
Modeling framework: the REMIND model

- Hybrid model
- Intertemporal optimisation



Modeling framework: the REMIND model

- Hybrid model
- Intertemporal optimisation
- Bottom-up representation of energy system: fossil fuel supply (incl. Trade), renewable energy potentials and various energy technologies



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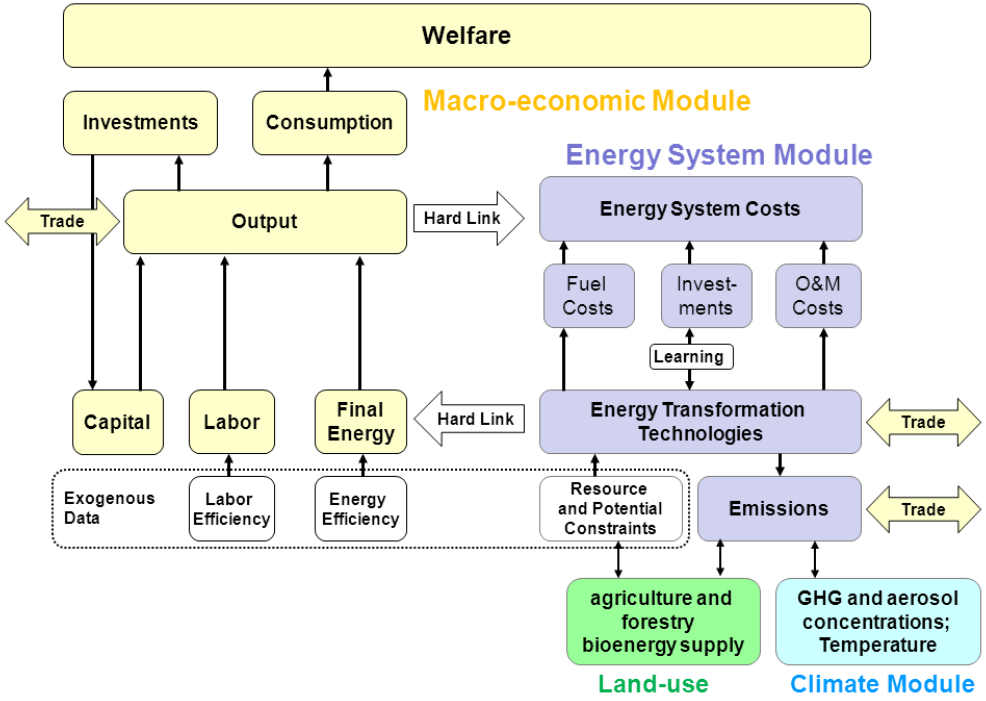

Modeling framework: the REMIND model

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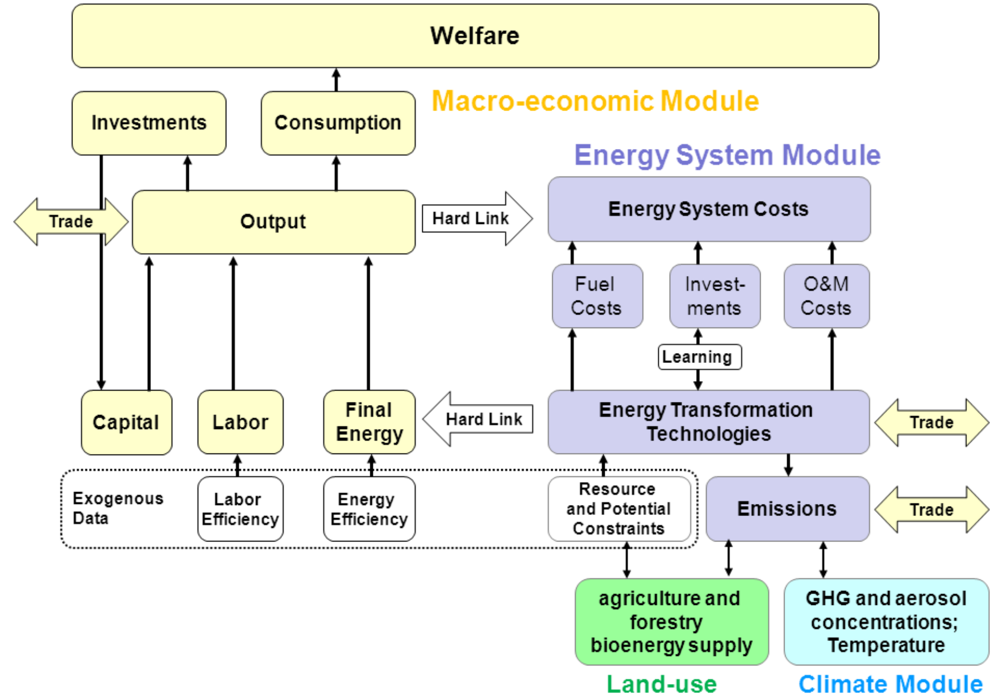
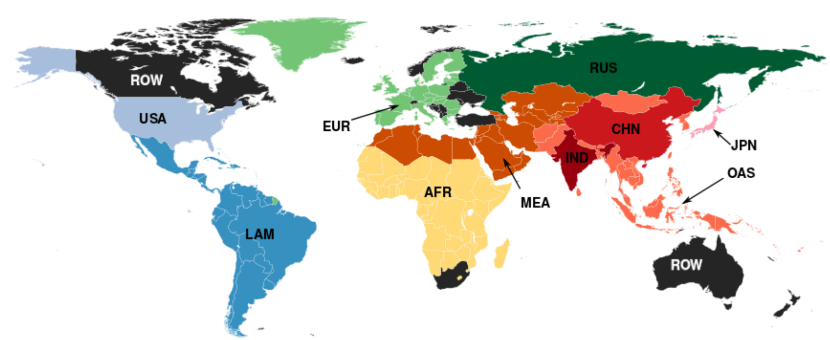
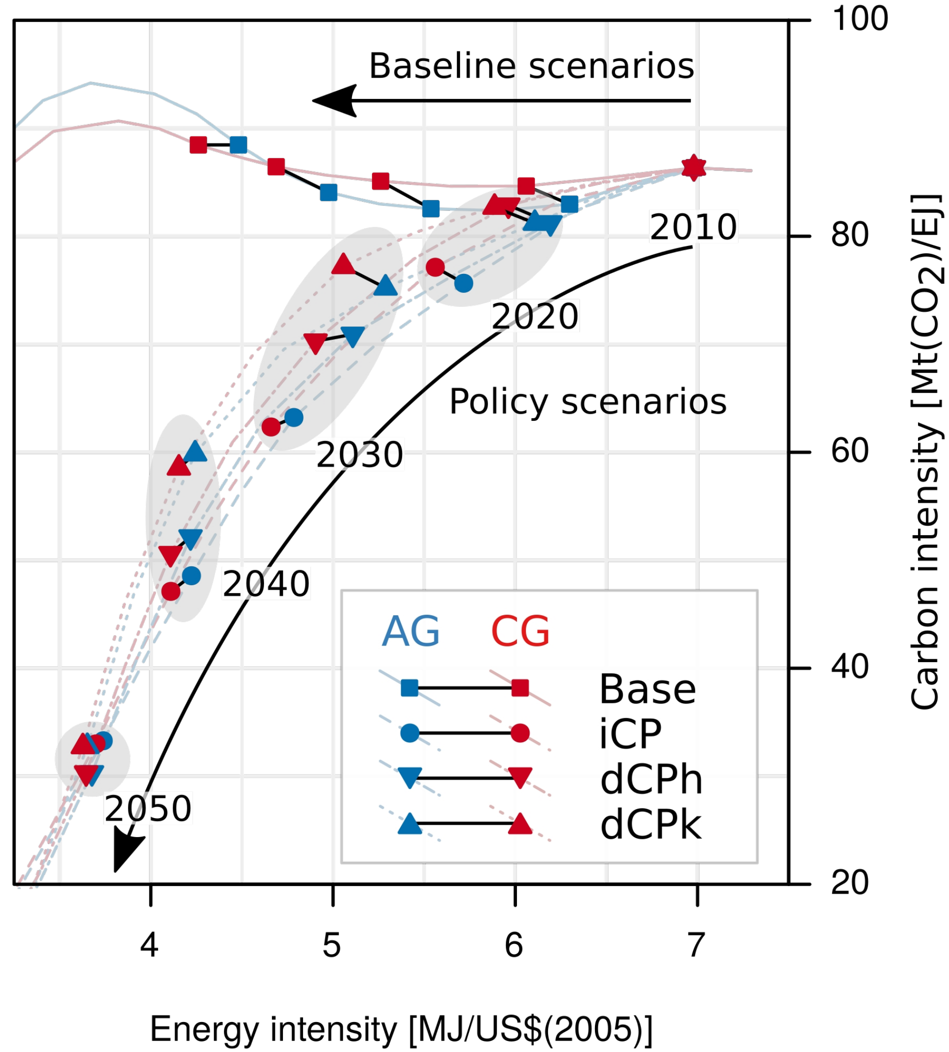
- 11 world regions
- Time frame: 2010 – 2100





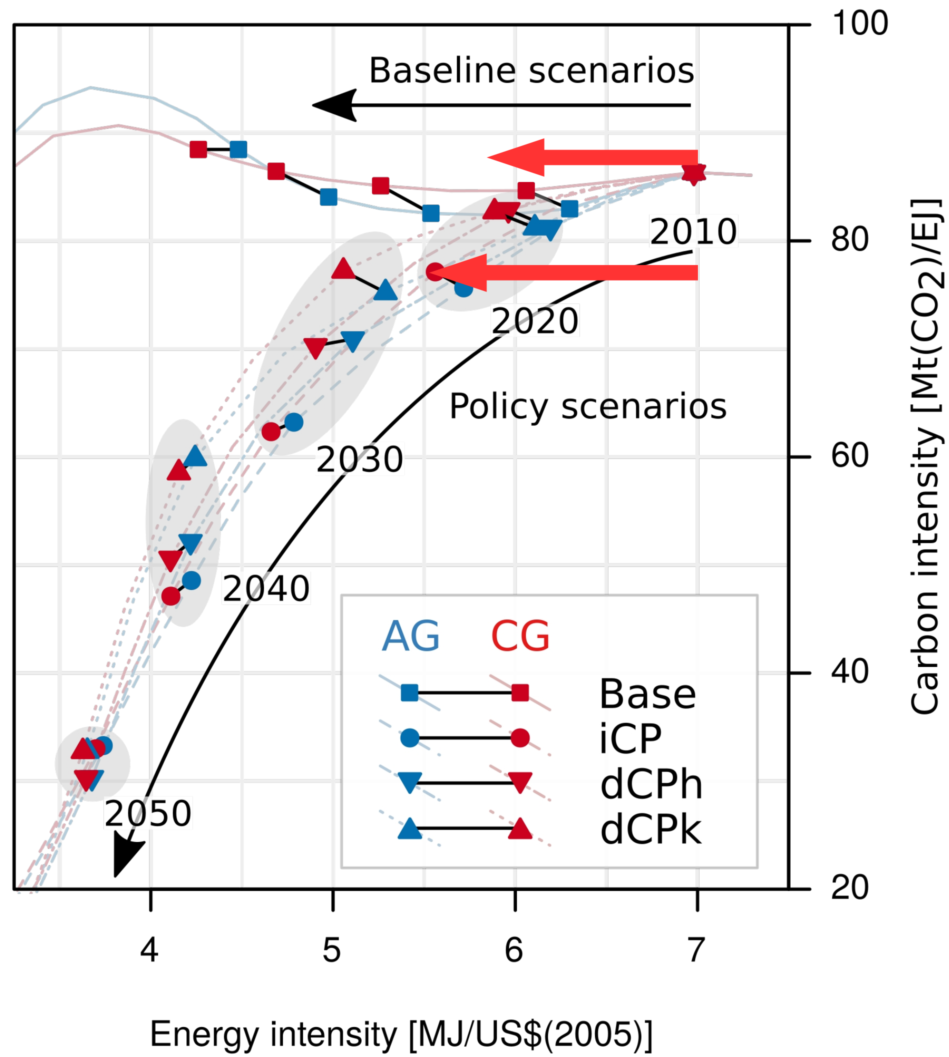
Global GHG emissions – energy transition

- Transitions between the immediate and delayed climate policy cases are different



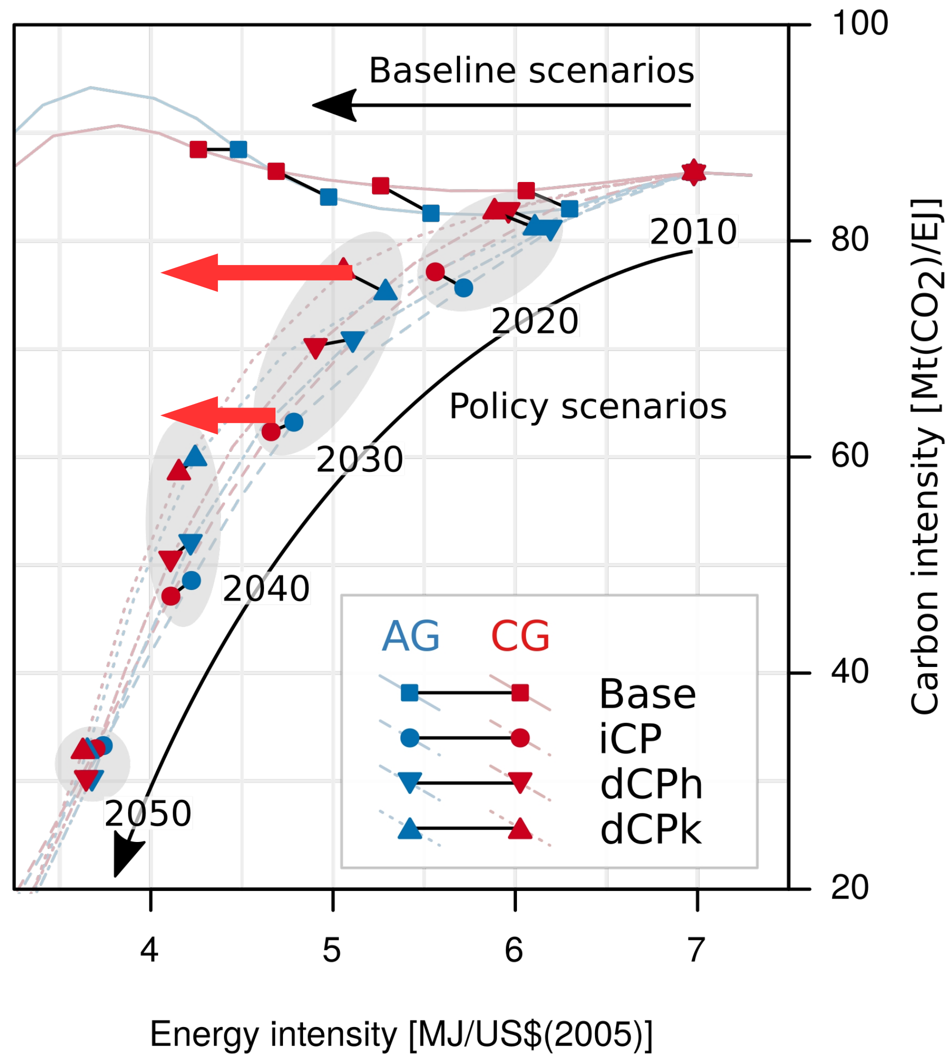
Global GHG emissions – energy transition

- Transitions between the immediate and delayed climate policy cases are different
- Delaying CP requires less changes initially



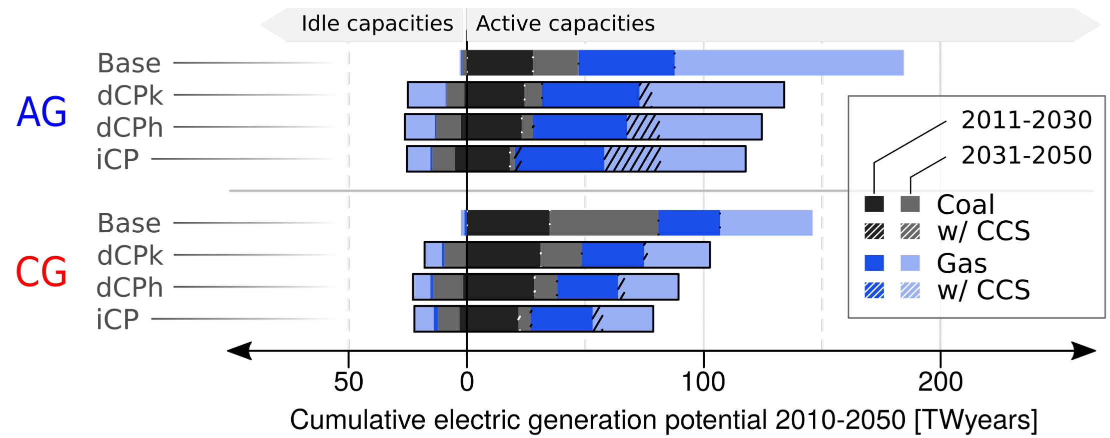
Global GHG emissions – energy transition

- Transitions between the immediate and delayed climate policy cases are different
- Delaying CP requires less changes initially
- But much more after 2030 (accelerated transition)



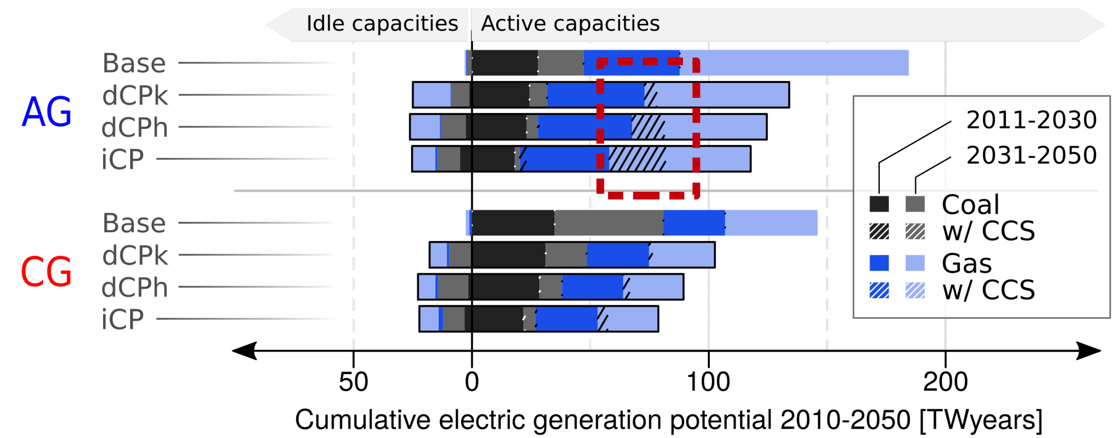
Energy system transformation

- More active gas capcities in AG than in CG (→ less coal capacities)



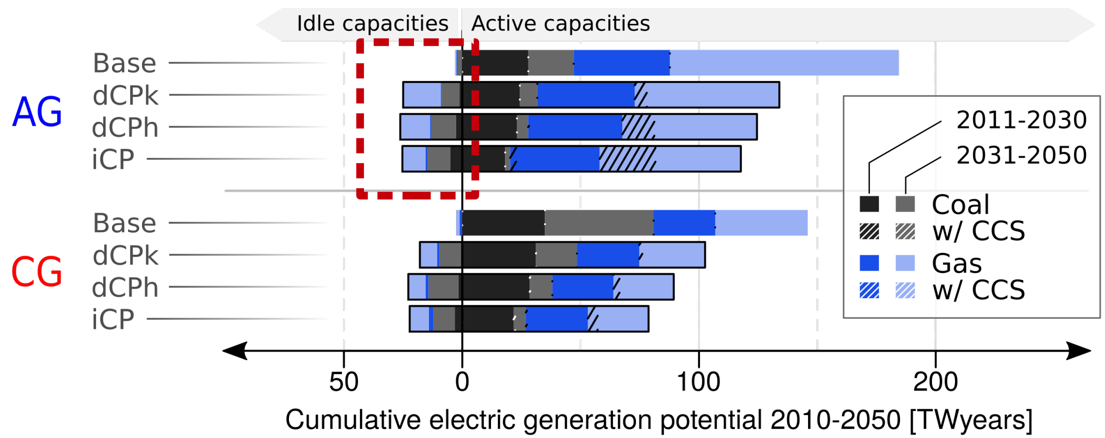
Energy system transformation

- More active gas capcities in AG than in CG (→ less coal capacities)
- More CCS in immediate than in delayed CP cases



Energy system transformation

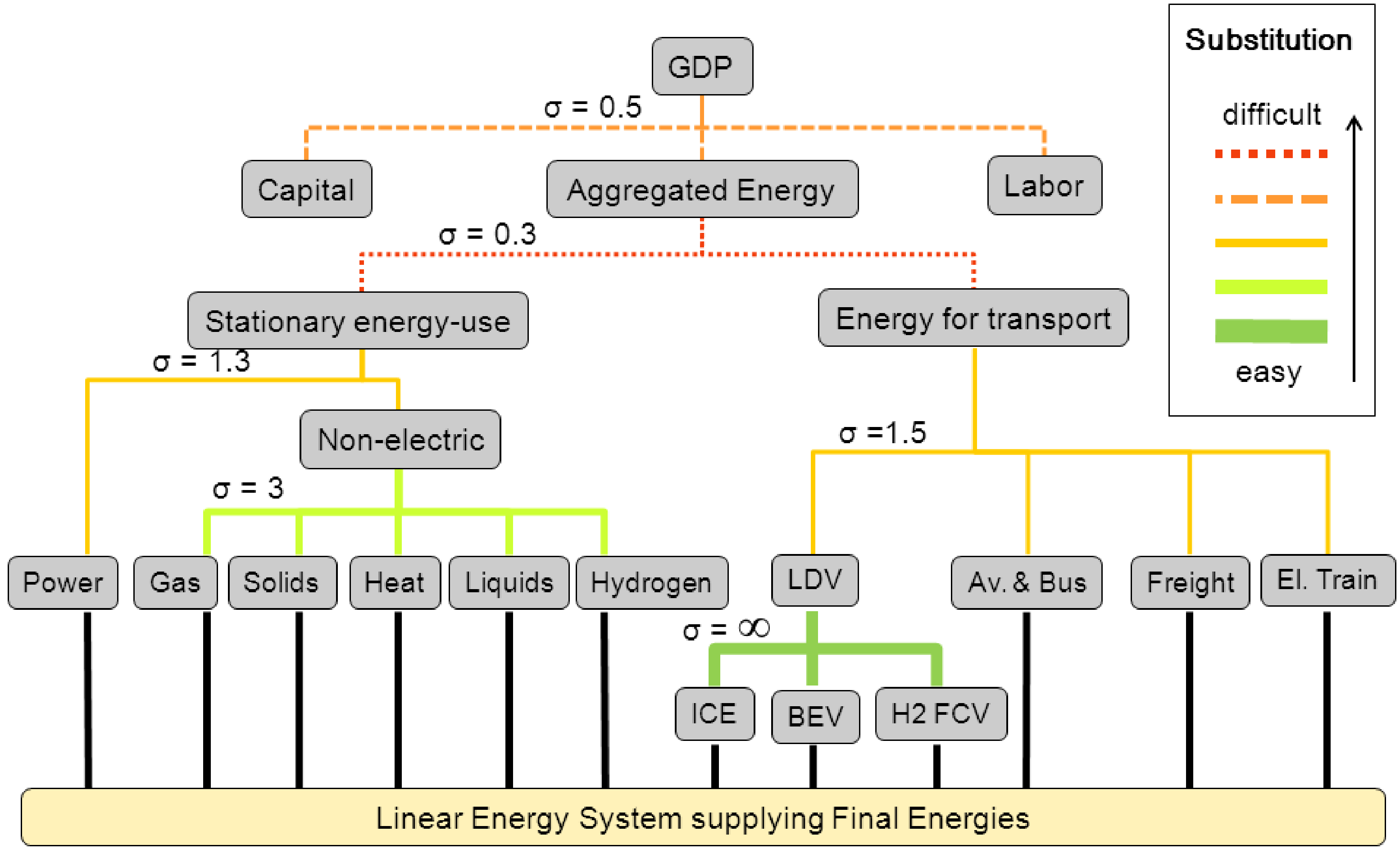
- More active gas capcities in AG than in CG (→ less coal capacities)
- More CCS in immediate than in delayed CP cases
- More idle capacities in AG
- In particular idle gas capacities



REMIND: Techno-economic assumptions

		Life-time	Overnight investment costs		O&M costs		Conversion efficiency		Capture Rate
		Years	$US/kW		$US/GJ		%		%
			No CCS	With CCS	No CCS	With CCS	No CCS	With CCS	With CCS
Coal	PC	40	1400	2400	2.8	5.1	45-51[#]	36	**90**
	Oxyfuel	40		2150		4.7		37	**99**
	IGCC	40	1650	2050	3.4	4.6	43-52[#]	38-48[#]	**90**
	C2H2*	35	1260	1430	1.9	2.1	59	57	**90**
	C2L*	35	1450	1520	4.2	5.0	40	40	**70**
	C2G	35	1200		1.4		60		
Gas	NGT	30	350		1.5		38-43[#]		
	NGCC	35	650	1100	1.0	1.7	56-64[#]	48/59	**90**
	SMR	35	500	550	0.6	0.7	73	70	**90**
Biomass	BIGCC*	40	1860	2560	4.2	6.0	42	31	**90**
	BioCHP	40	1375		5.0		43		
	B2H2*	35	1400	1700	5.7	6.8	61	55	**90**
	B2L*	35	2500	3000	3.8	4.9	40	41	**50**
	B2G	40	1000		1.9		55		
Nuclear	TNR	40	3000		5.2		33[§]		

REMIND: Production function



Abbr.: *Heat - District heat & heat pumps, LDV - Light Duty Vehicle, ICE - Internal Combustion Engine, BEV - Battery Electric Vehicle, H2 FCV - Hydrogen Fuel Cell Vehicle, Av.& Bus - Aggregate of Aviation and Bus, El. Trains* – Electric Tr.