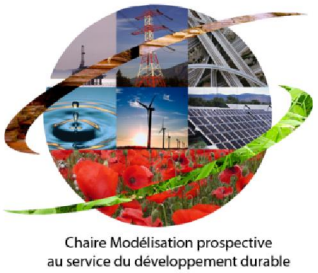

How CO2 Capture and Storage Can Mitigate Carbon Leakage

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Presentation outline

1. About CCS and CO2 leakage
2. A few words on the model
3. The impact of CCS on international energy and CO2
4. Energy prices are the main chanel of carbon leakage

About CCS and CO2 leakage

Carbon leakage comes not from leaky reservoirs

- When implementing non-global mitigation policies:
  - Firms may outsource CO2 intensive production and import finished products (competitiveness channel).
  - Most mitigation policies reduce demand for fossil fuel, hence international prices, which in turn increases demand hence emissions in the rest of the world (energy price channel).
  - Energy price channel is believed to be stronger.

- As CCS does not reduce fossil fuel demand, it should generate less leakage

At our knowledge, CCS reducing leakage has not been quantified before

- Most studies that quantify leakage do not take into account CCS

- Most studies that asses CCS economic impact do not take into account leakage

Our main findings…

- Most of the leakage comes from the energy prices channel
- CCS cancels about half the leakage

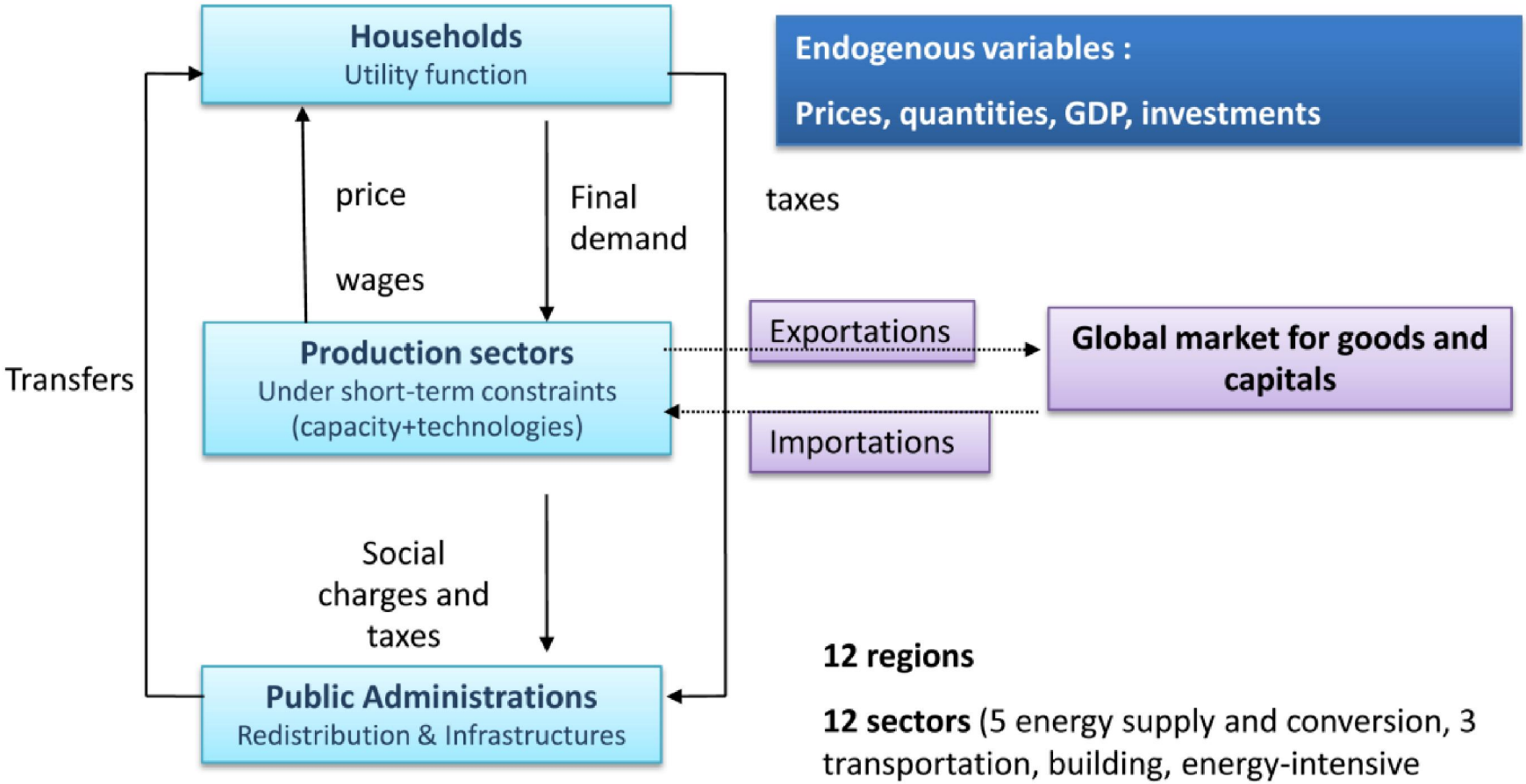
A few words on Imaclim-R

Imaclim-R was built for analyzing consistent energy-economy scenarios

- The model endogenously calculates:
  - Consistent energy prices (including coal and electricity)
  - Technologies market shares (incl. CCS)
  - CO2 prices
  - GDP
  - …

- Takes as upfront input:
  - Energy reserves and extraction costs (e.g oil fields)
  - Technologies costs and investor's trade-off
  - CO2 emissions targets
  - Population and labor productivity trends
  - …

A general equilibrium is solved at each time step



12 regions

12 sectors (5 energy supply and conversion, 3 transportation, building, energy-intensive industry, agriculture, composite)

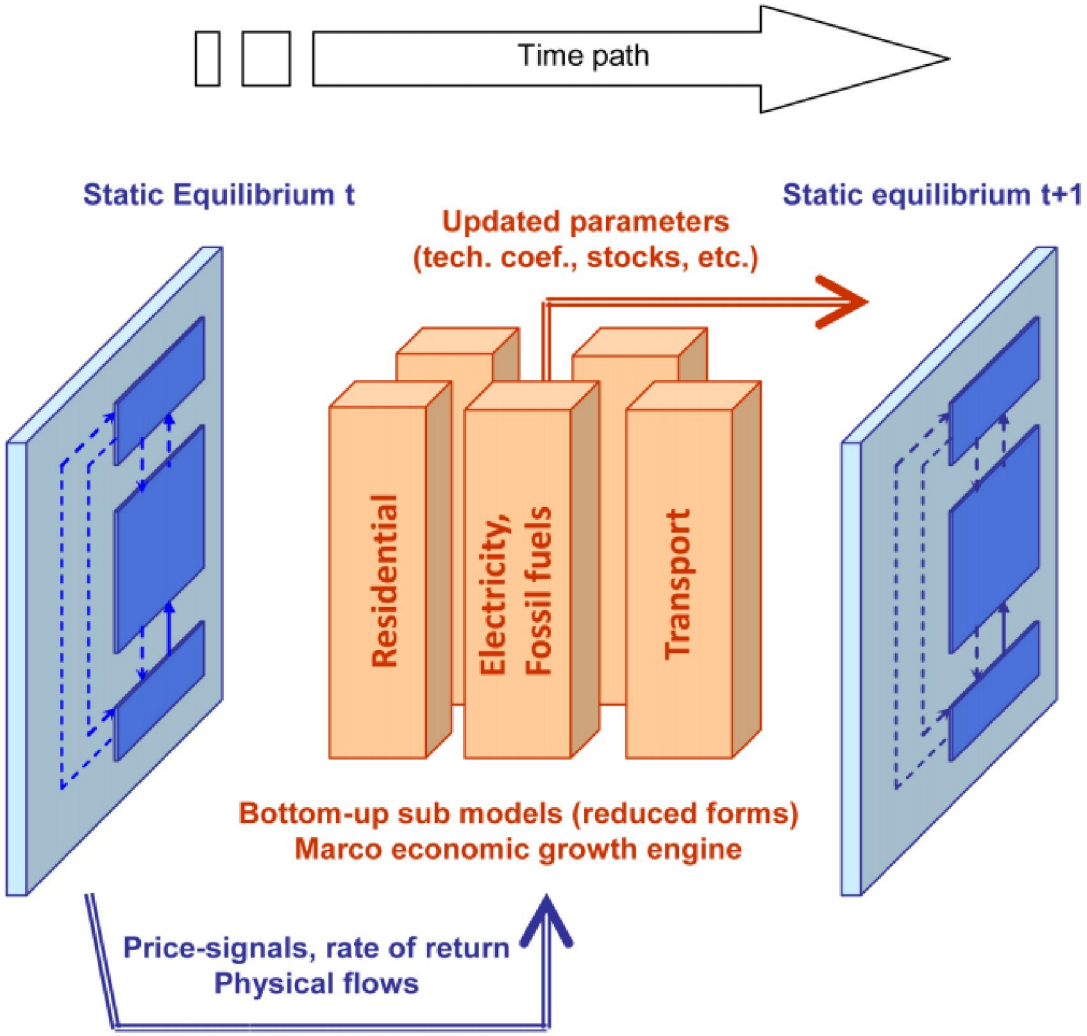
The short term equilibriums are very rigid

- Production function is a *static* Leontieff
  - Based on GTAP input/output matrices…
  - …and IEA energy balances.
  - We called them technical coefficients
  - The productive capital structure is given

e.g. 1MWh elec = 0.8 MWh oil + 0.7MWh coal + 0.4MWh nuke
+ 0.1 MWh wind + 0.3 units transportation

- Mitigation options are very limited in the short term:
  - Redirecting households' consumption (eg. from industry to services)
  - Importing more and using less local production (competitiveness channel)
  - Producing less (unemployment and capital under-utilization)

Technical coefficients are updated recursively



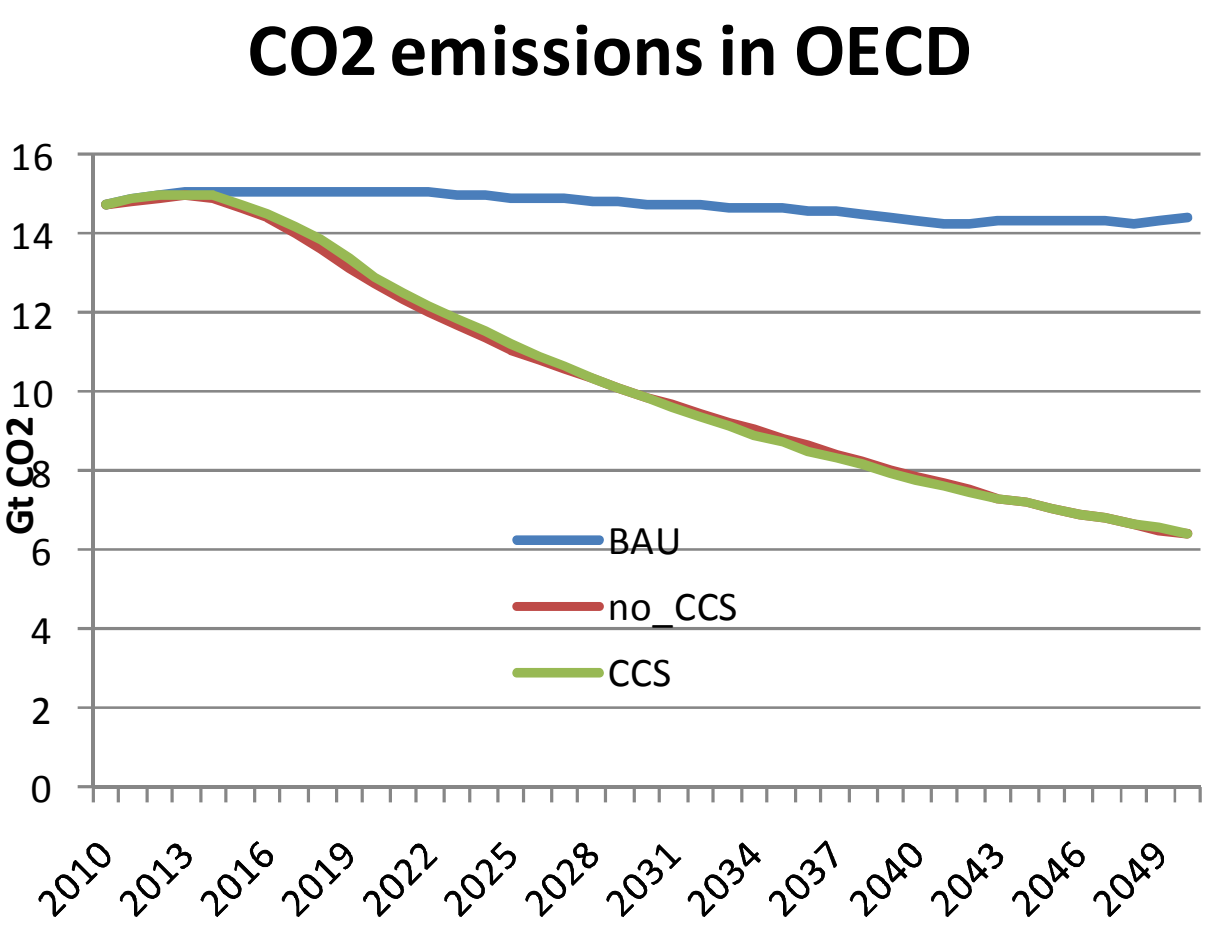
Technical coefficients are updated recursively

- In each economic sector, investments are computed from bottom up models representing:
  - Capital accumulation
  - Technology choices
  - Energy efficiency

- For instance, new power plants are built based on:
  - Forecasted power demand
  - Existing and deprecated capacities
  - Investor's trade off (CAPEX and OPEX based on current fuel prices)
  - CSS implemented if profitable (carbon price)

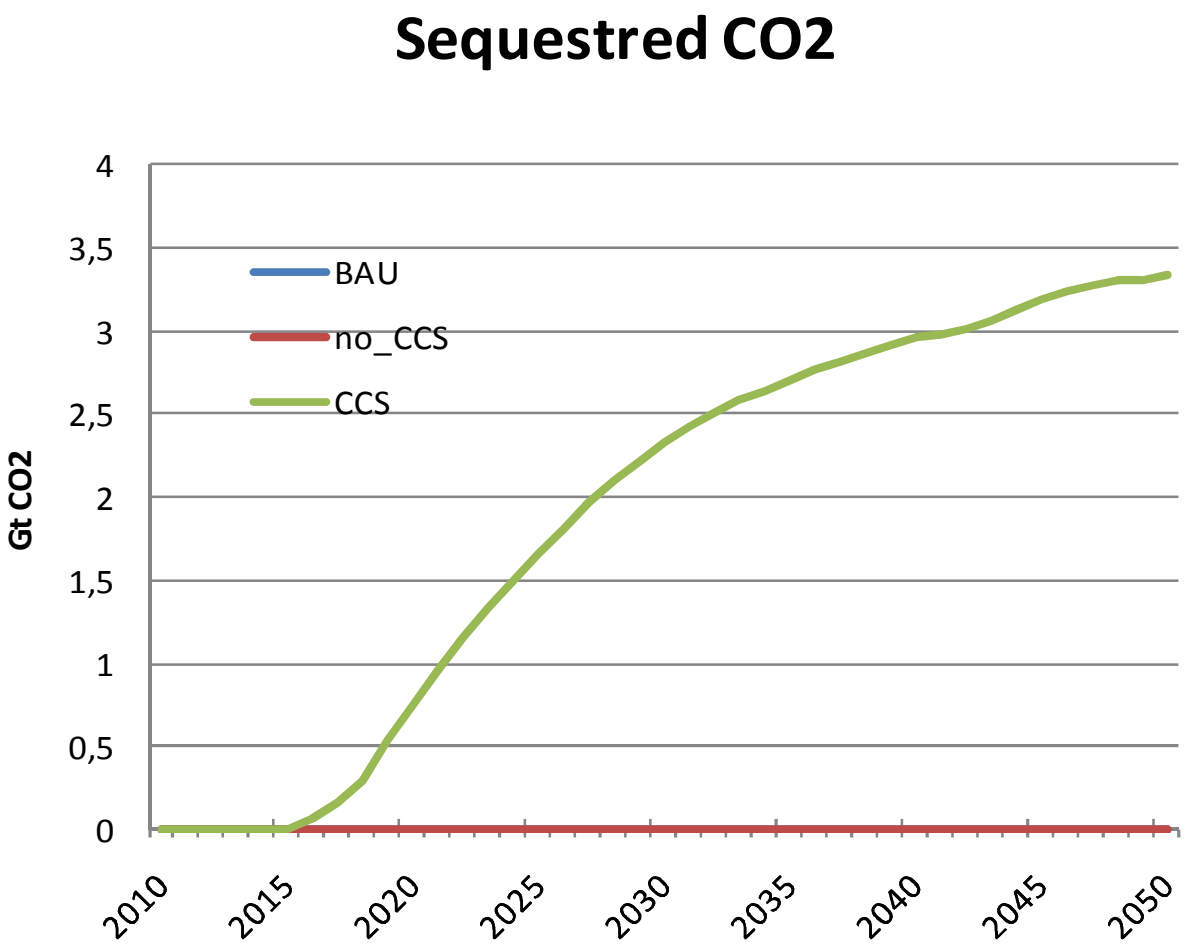
Assessing the effect of CCS on international energy markets and on CO2 emissions

We simulate three scenarios



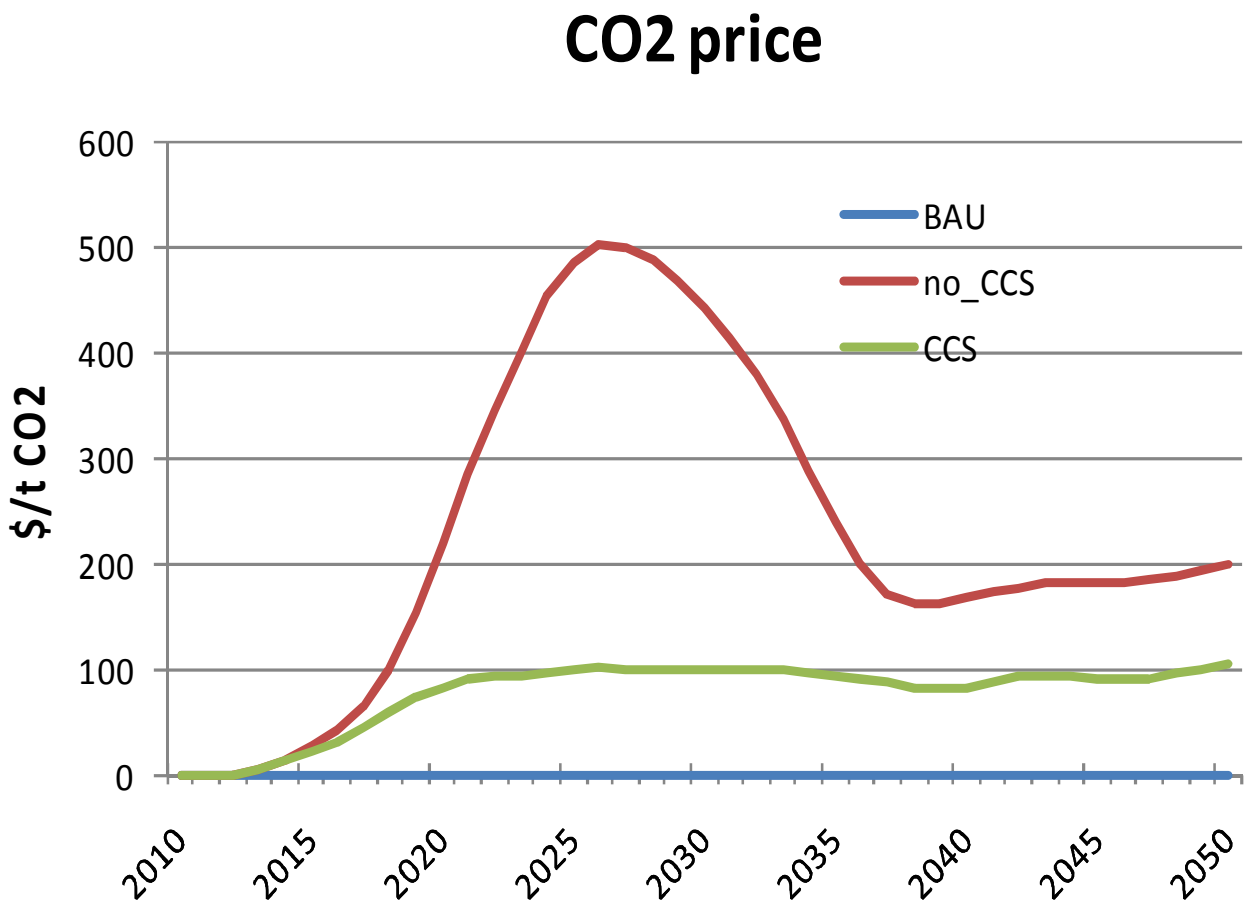
- In the baseline there is no mitigation policies
- In the CCS and no_CCS the model finds a carbon price in order to halve CO2 emissions in OECD

CCS is available in one scenario only



- In the noCCS scenario, the CCS is not available
- In the CCS scenario, CCS is available and endogenously penetrates in the power generation sector mainly

CSS decreases carbon prices …

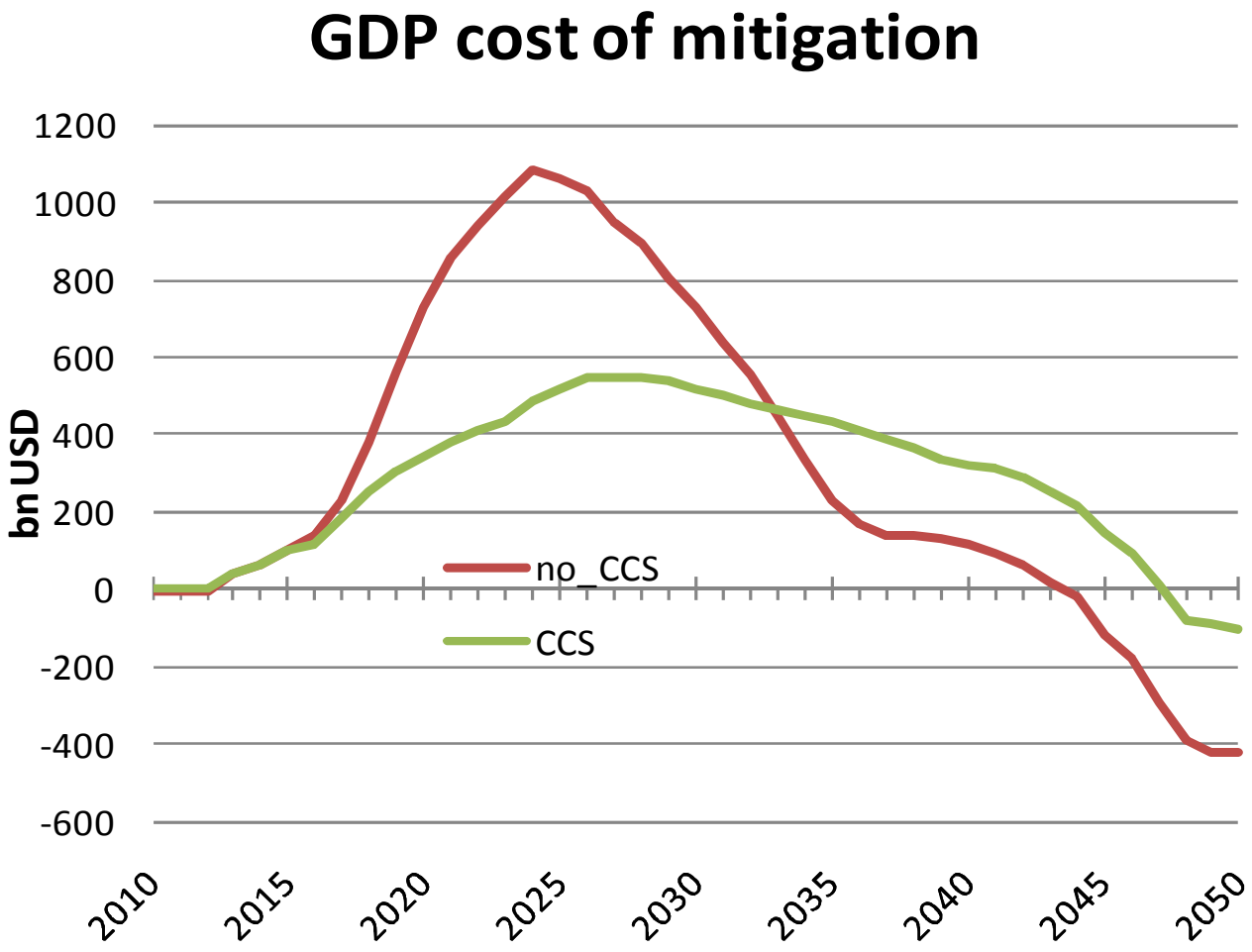


-In the noCCS scenario, carbon price is high while CO2 intensive capital is replaced

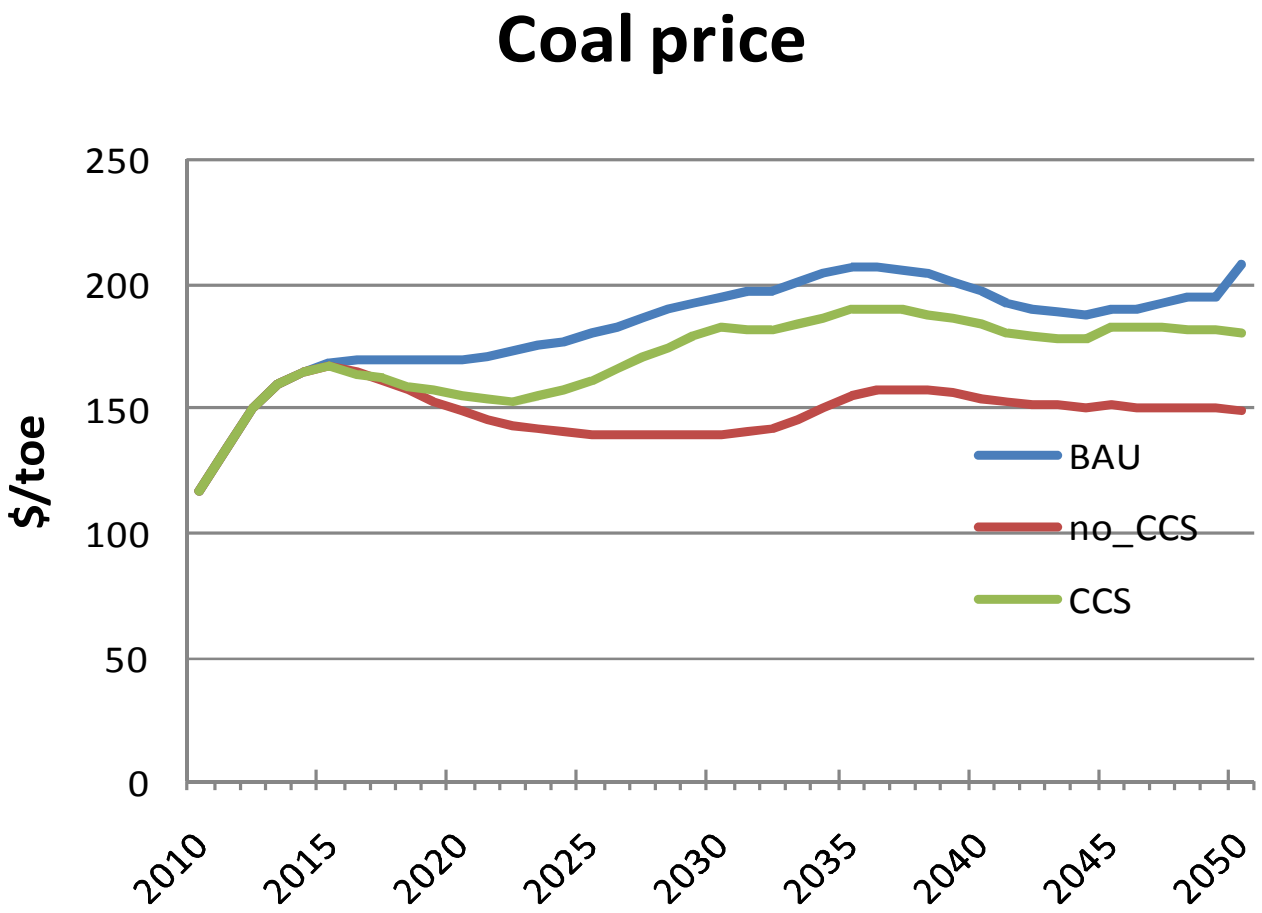
-The CCS penetration allows carbon prices to remain lower

- CO2 price is zero outside OECD

CSS decreases mitigation cost

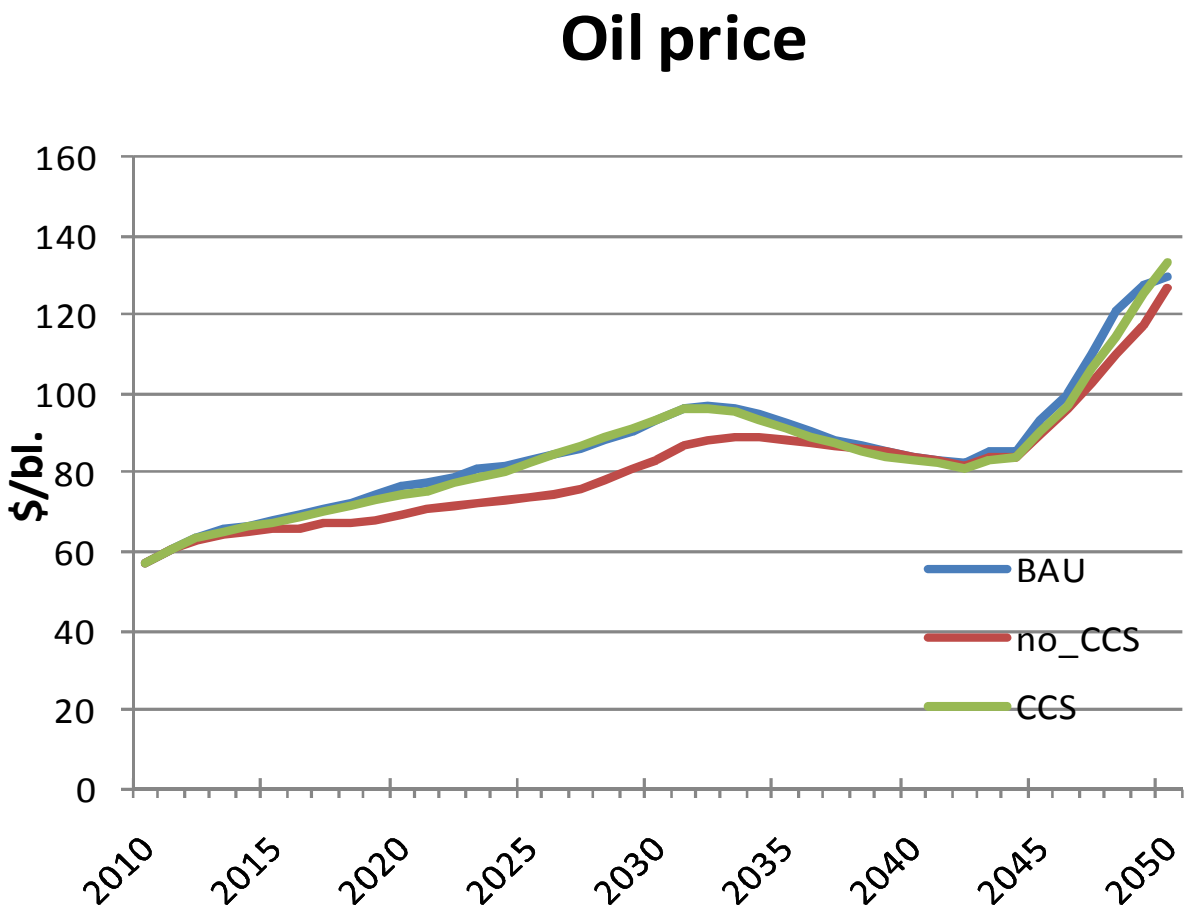


CSS rises coal demand and prices

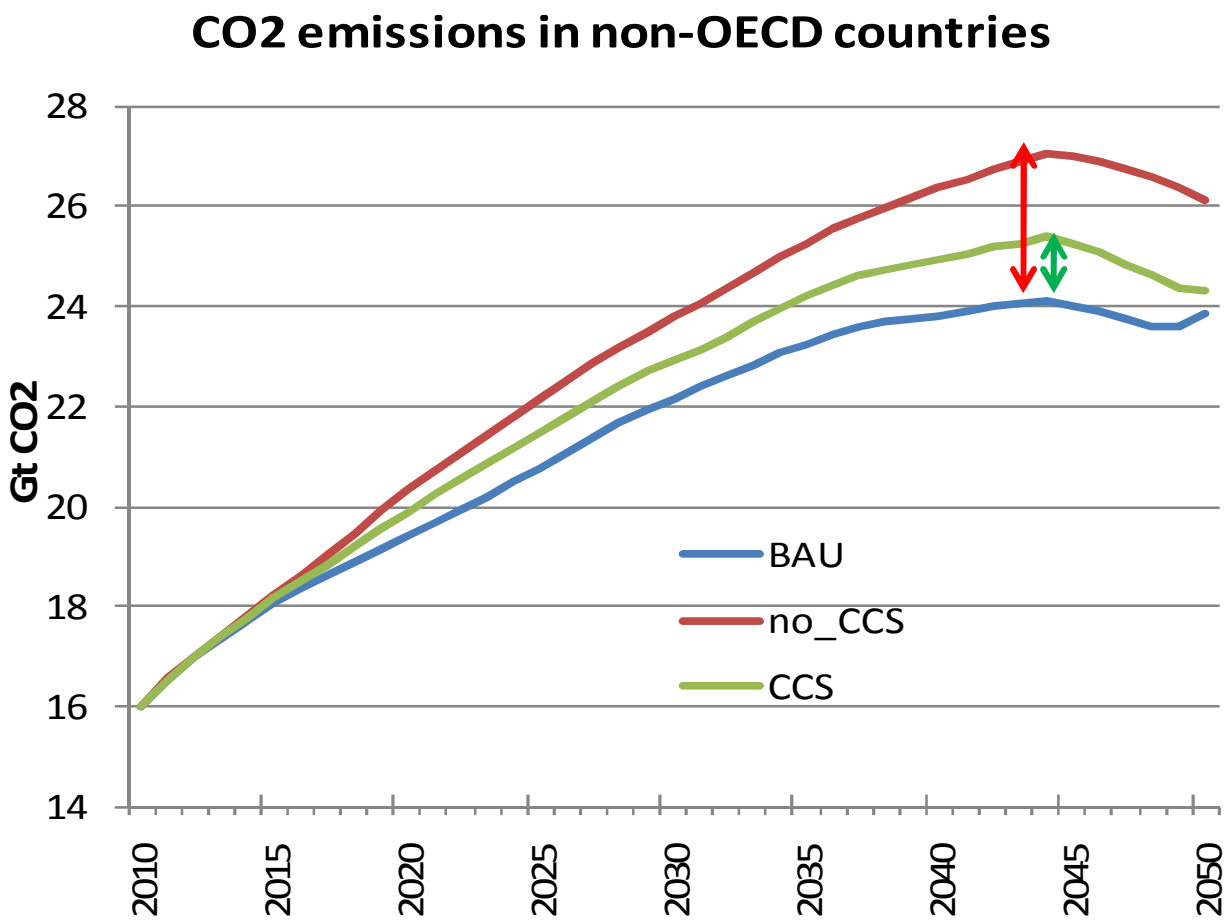


- Mitigation policies decrease coal demand and price
- CSS availability mitigates this effect

Coal and oil are substitutes, their price are correlated

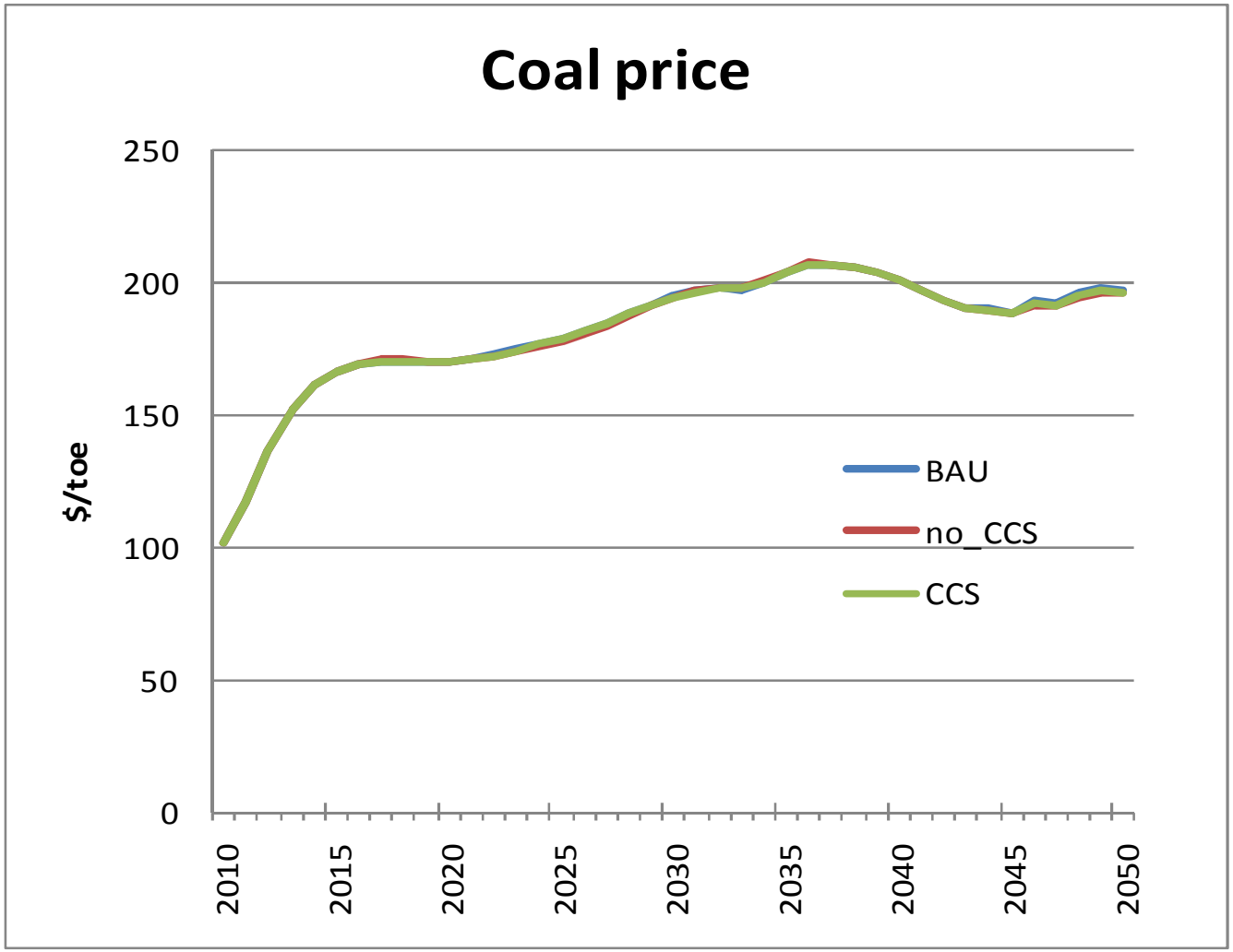


CSS reduces about half the leakage

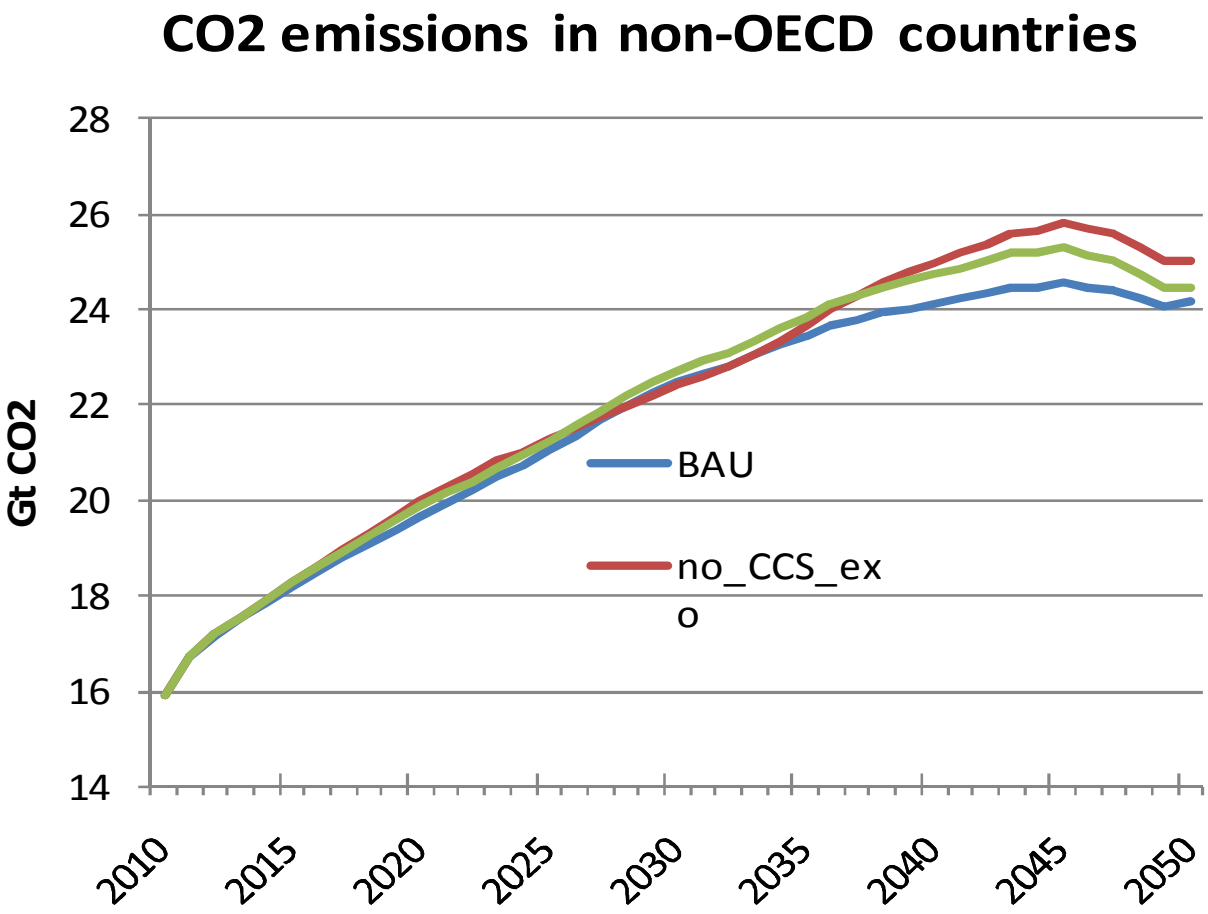


Confirming that energy prices are the main leakage channel

A new set of scenarios with exogenous fuel prices



The leakage is reduced by ≈70%



To summarize our main findings

Leakage-to-reduction ratio (2013-2050)

	CCS	no_CCS
endogenous energy prices	16%	37%
Exogenous energy prices	7%	10%

- Most of the leakage comes from the energy prices channel
- CCS cancels about half the leakage

Thank you for your attention