

# Spatial & Multisectoral Impacts of Paris Agreement Article 6 under Different Equity-driven Emissions Mitigation Pathways

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## Abstract

Article 6 of the Paris Agreement on greenhouse gases enables countries to cooperate in implementing their nationally determined contributions (NDCs) towards emission reduction. Current national policies may fail to deliver on the “well below 2” climate goal & international cooperation through carbon markets under Article 6 is expected to enhance flexibility in mitigation options, make it cost-effective and enhance mitigation ambition overall. As countries prepare for the Glasgow Conference of Parties (COP26), the rules for such mechanisms are expected to be finalized. We analyze three questions: What is the aggregate & spatial distribution of economic efficiency gains & financial flows between Global North & South with Article 6? What is the impact of limits on inclusion of nature-based solutions? What are the multisectoral dynamic effects on technology deployment & capital investment in the Global South? We use the GCAM (Global Change Analysis Model) integrated assessment model & an 8-scenario matrix with two emission trajectories achieving carbon neutrality based on equity principles. In each case, we measure the geographic distribution of economic gains till 2050 between a pathway where countries move independently or participate cooperatively in a global carbon market. We analyze the spatial and multisectoral impacts on electricity asset stranding & investments in different mitigation options, including CCS (carbon capture & sequestration), electric vehicles, energy efficiency & renewable energy technologies. Employing limits on land area engaged for mitigation from fossil fuel sources, we showcase the sensitivity of these results to nature-based solutions. We find that in contrast to the popular notion that the Global South will inevitably gain through such global carbon market transfers, the story is more intricate. There is also a noticeable impact of limiting nature-based solutions for countries in Latin America & Sub-Saharan Africa. Further we show differences in deployment of low-emissions technologies in the near term. This has implications for technological growth & incentives for mitigation. This study provides insights for design of future global markets or regional carbon clubs & shows equity tradeoffs in achieving economic efficiency in climate change mitigation.

# Spatial & Multisectoral Impacts of Paris Agreement Article 6

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Center for Global Sustainability, Univ. of Maryland

Pacific Northwest National Lab

**AGU** FALL  
MEETING



**SCIENCE**  
*is* **SOCIETY**



# MEL GEORGE

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Grad. Assistant, CGS, U of Md  
Visiting Research Fellow, PNNL





## PARIS AGREEMENT, ARTICLE 6

- Key, understated outcome of COP-26 at Glasgow
- Co-operative implementation of NDCs
- Reducing the variability of marginal abatement costs between regions (Aldy et al. 2016)
- Gains from increased efficiency leading to enhanced ambition (Edmonds et al. 2021)
- International transfers of mitigation obligations and outcomes
- Carbon markets can take different forms





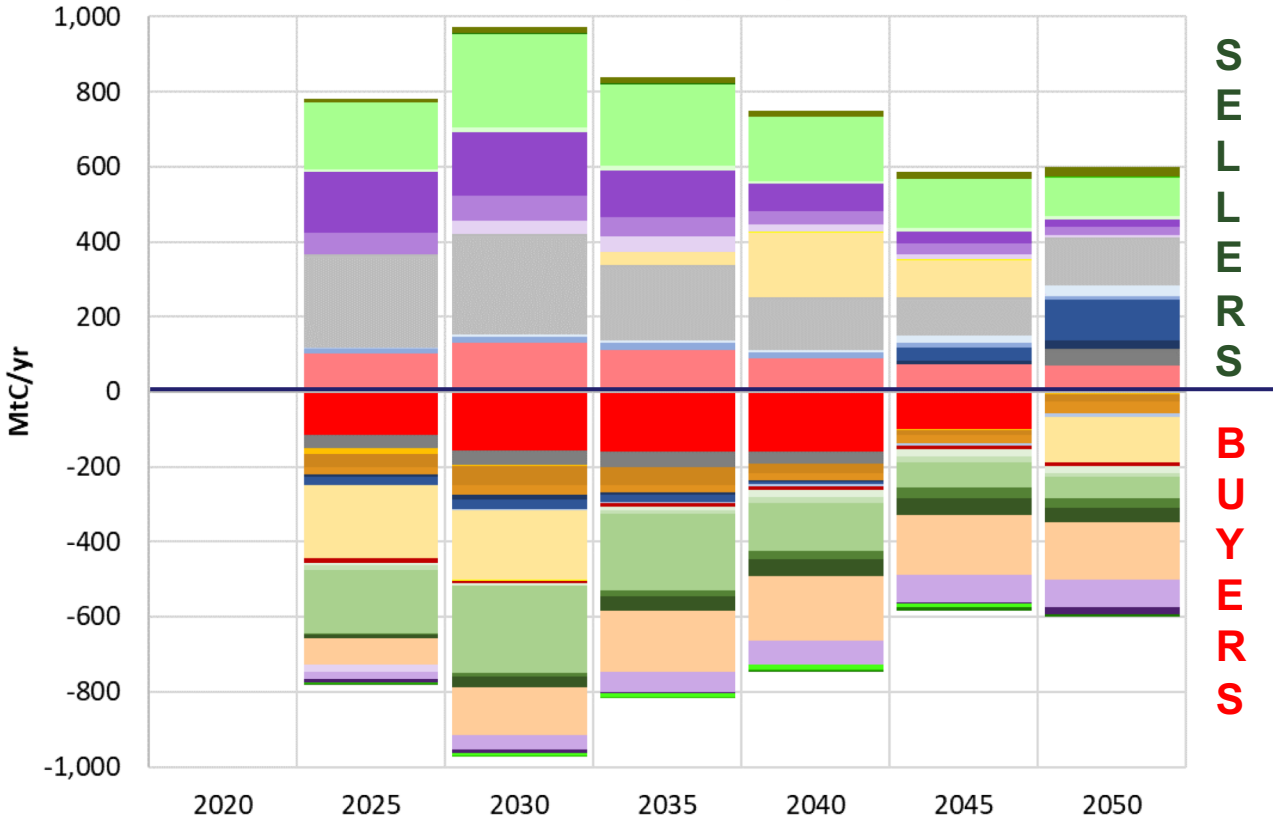
## STUDY DESIGN

- 2 core scenarios: (A) Global Net Zero attainment in 2050, (B) Regional net zero targets by GDP/capita
- Effect of Article 6 Global Market
- Effect of including/excluding nature-based mitigation options (LUC=1, 0.25, 0)
- Impacts on:
  - Volume of trade and market efficiency
  - Mitigation costs
  - Electricity sector investments, CCS, RE

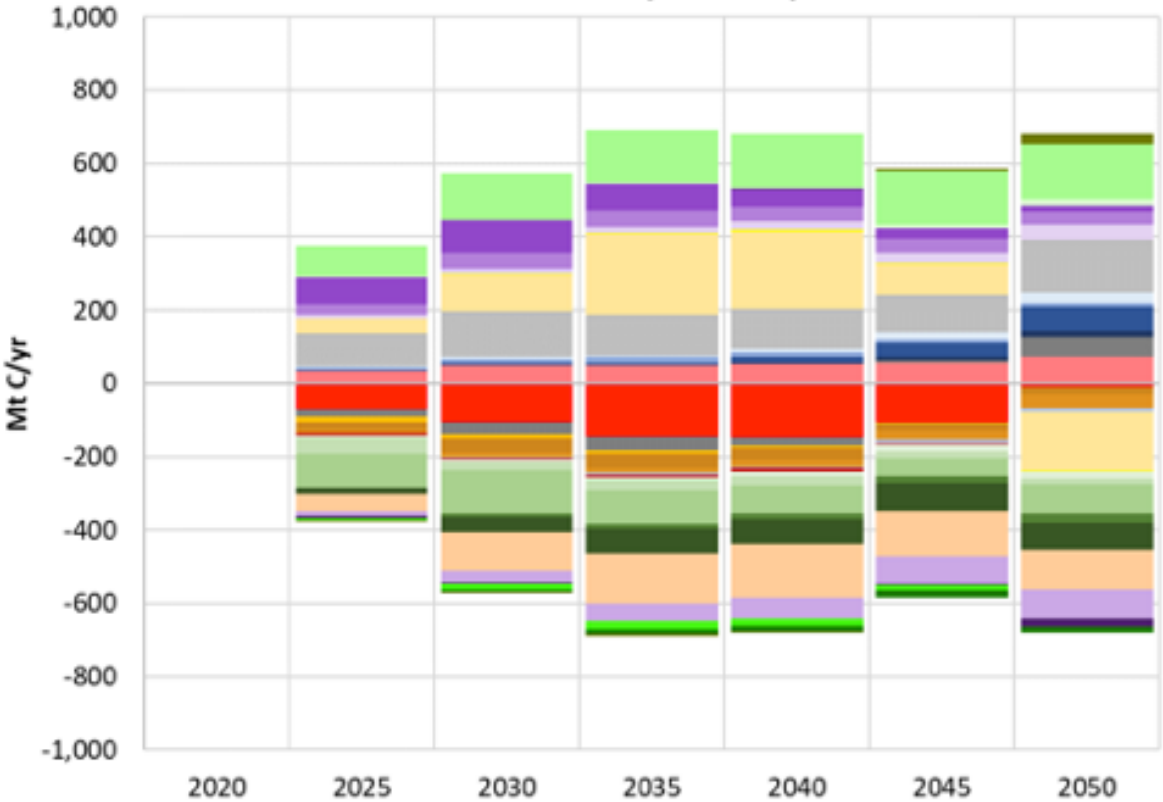


# CARBON TRADE VOLUMES WITH ARTICLE 6 (SCENARIO A)

Net CO2 emissions (LUC=1)



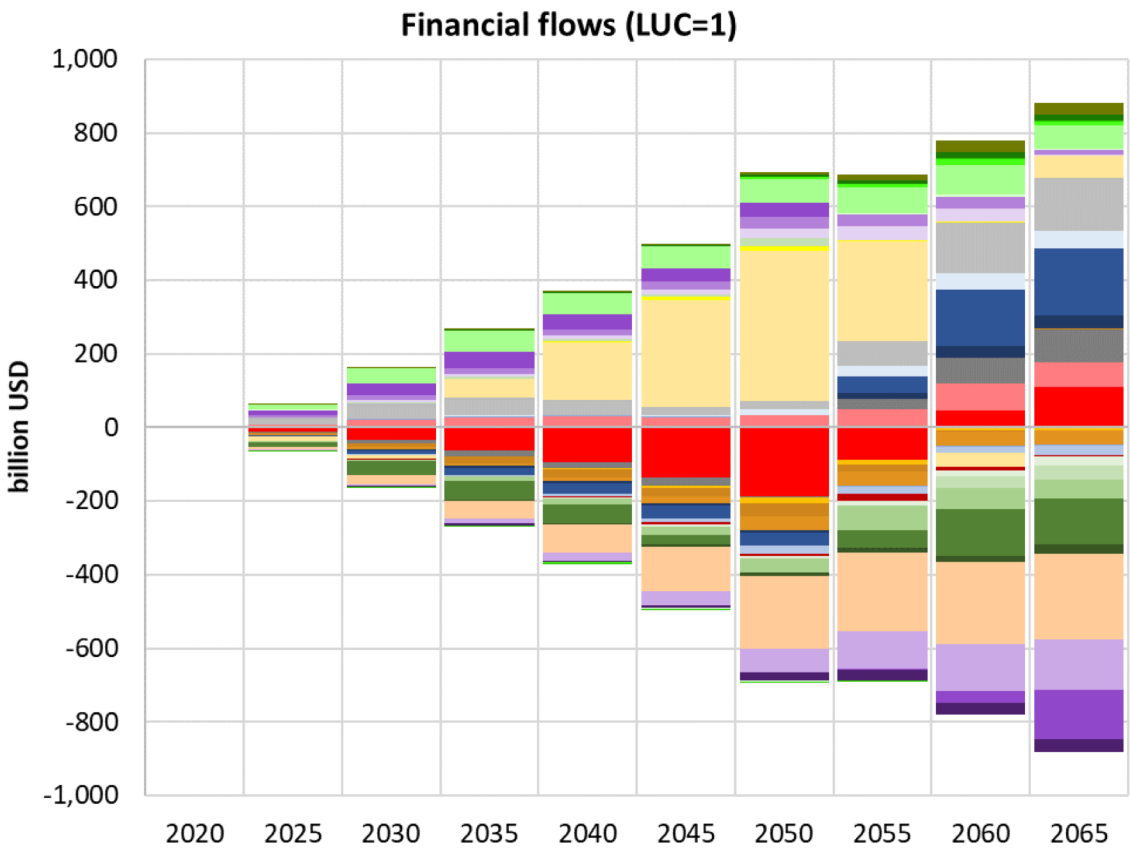
Net CO2 emissions (LUC=0.25)



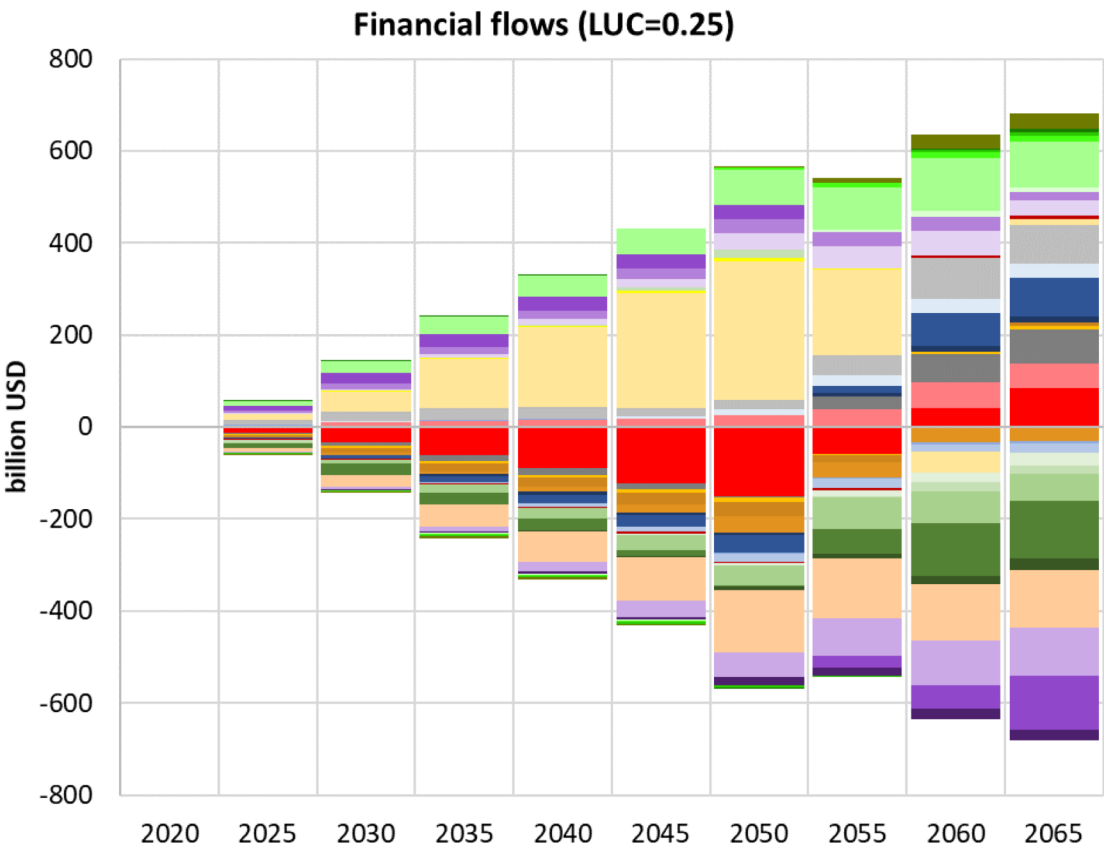
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| India                  | Pakistan               | Middle East    | Africa_Eastern | Africa_Northern                 | Africa_Southern |
| South America_Northern | South America_Southern | Argentina      | Brazil         | Central America and Caribbean   | Colombia        |



# RESULTANT FINANCIAL FLOWS (SCENARIO A)



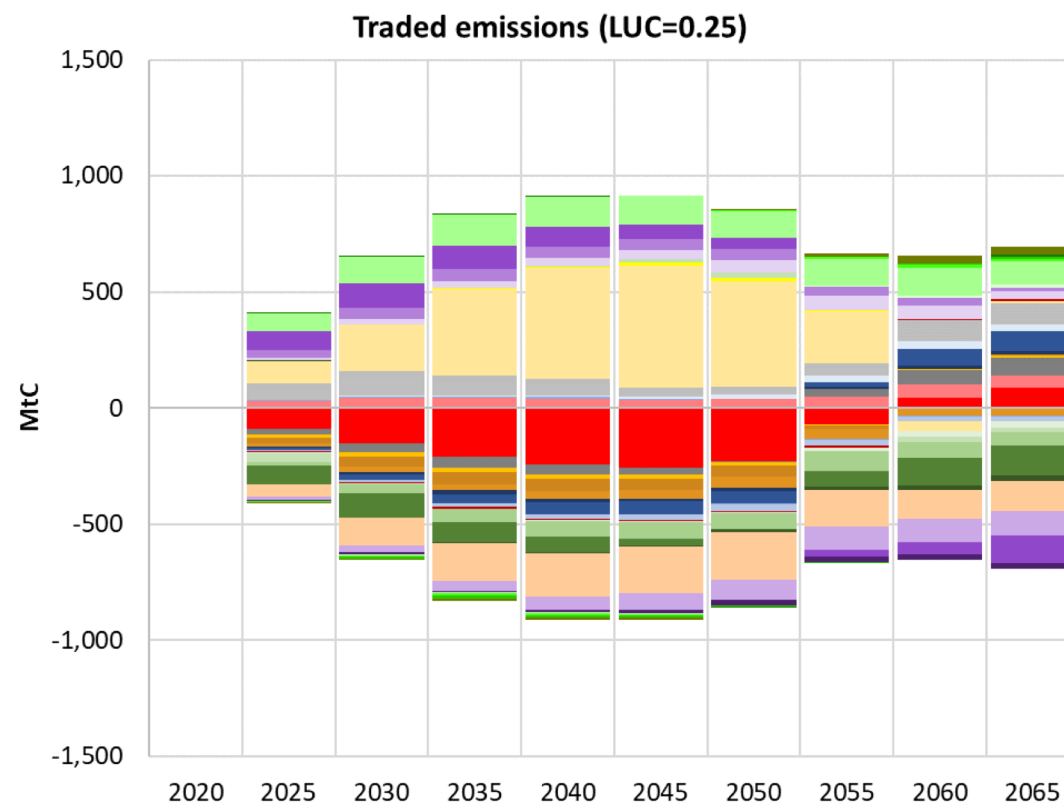
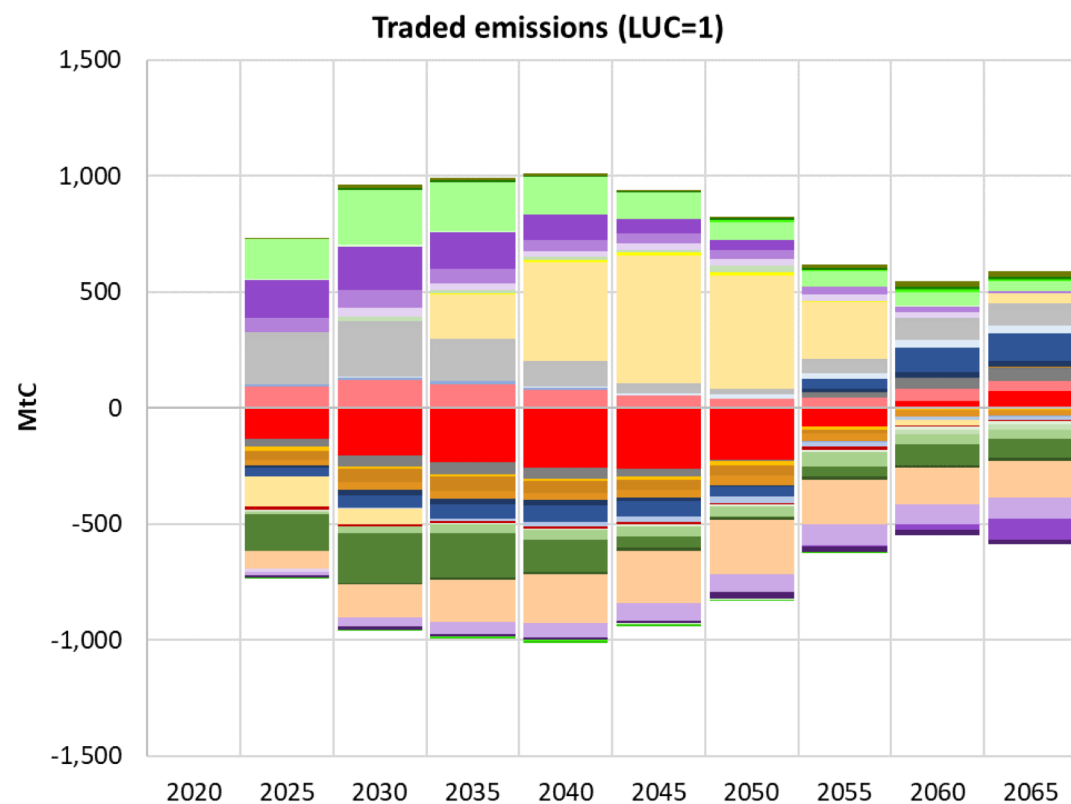
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- Mexico
- Europe\_Eastern
- Central Asia
- Middle East
- Argentina



- Australia\_NZ
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- Africa\_Eastern
- Brazil
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- Russia
- Indonesia
- Africa\_Southern
- Colombia



## TRADE VOLUMES (SCENARIO B)



- USA
- EU-12
- China
- India
- Africa\_Western
- South America\_Northern

- Canada
- EU-15
- Taiwan
- Pakistan
- South Africa
- South America\_Southern

- Mexico
- Europe\_Eastern
- Central Asia
- Middle East
- Argentina

- Australia\_NZ
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- South Asia
- Africa\_Eastern
- Brazil

- Japan
- European Free Trade Association
- Southeast Asia
- Africa\_Northern
- Central America and Caribbean

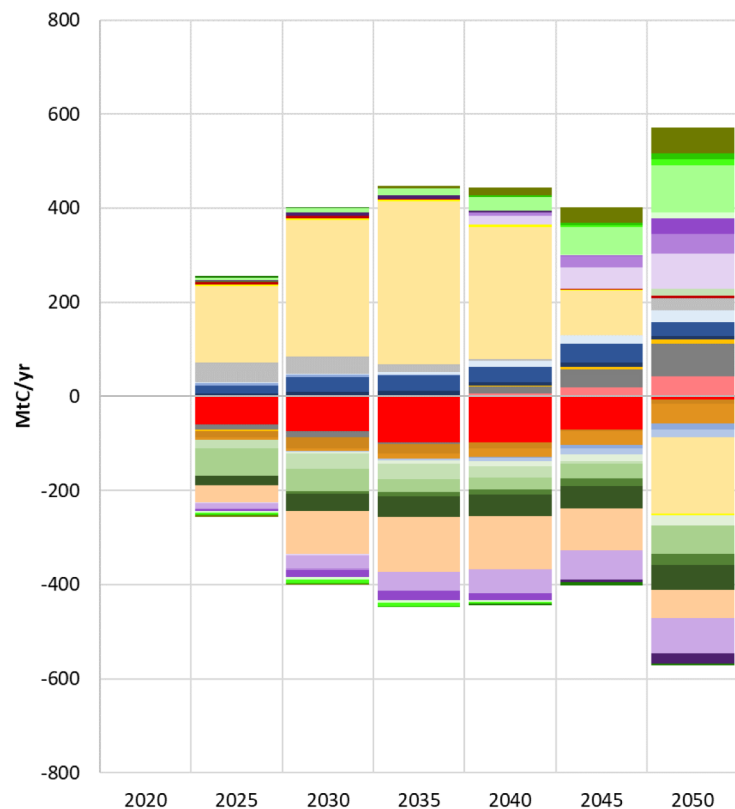
- South Korea
- Russia
- Indonesia
- Africa\_Southern
- Colombia



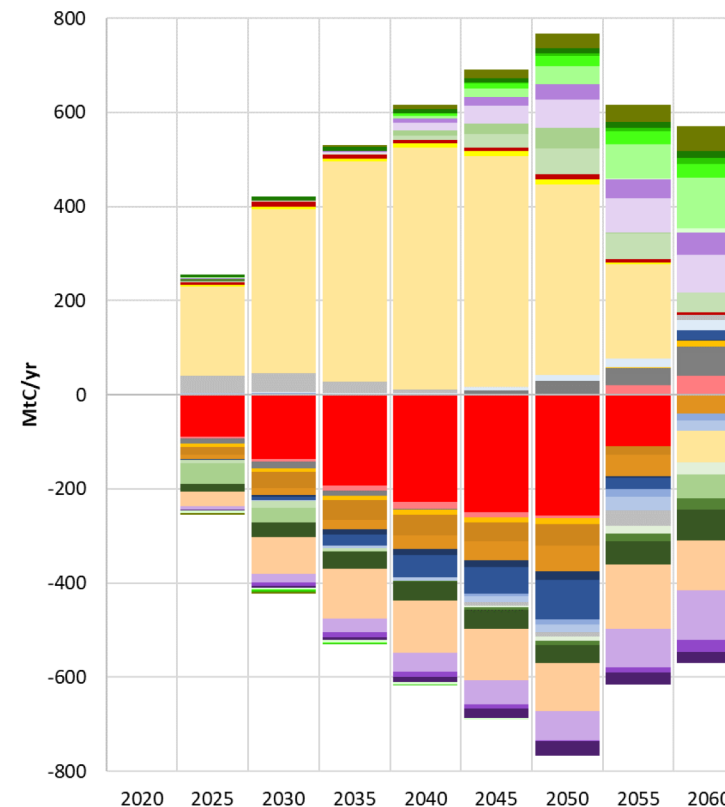


## WITH NO NATURE BASED MITIGATION SOLUTIONS

Global NZ in 2050



Timed regional NZ



■ USA  
 ■ EU-12  
 ■ China  
 ■ India  
 ■ Africa\_Western  
 ■ South America\_Northern

■ Canada  
 ■ EU-15  
 ■ Taiwan  
 ■ Pakistan  
 ■ South Africa  
 ■ South America\_Southern

■ Mexico  
 ■ Europe\_Eastern  
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 ■ Argentina

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 ■ South Asia  
 ■ Africa\_Eastern  
 ■ Brazil

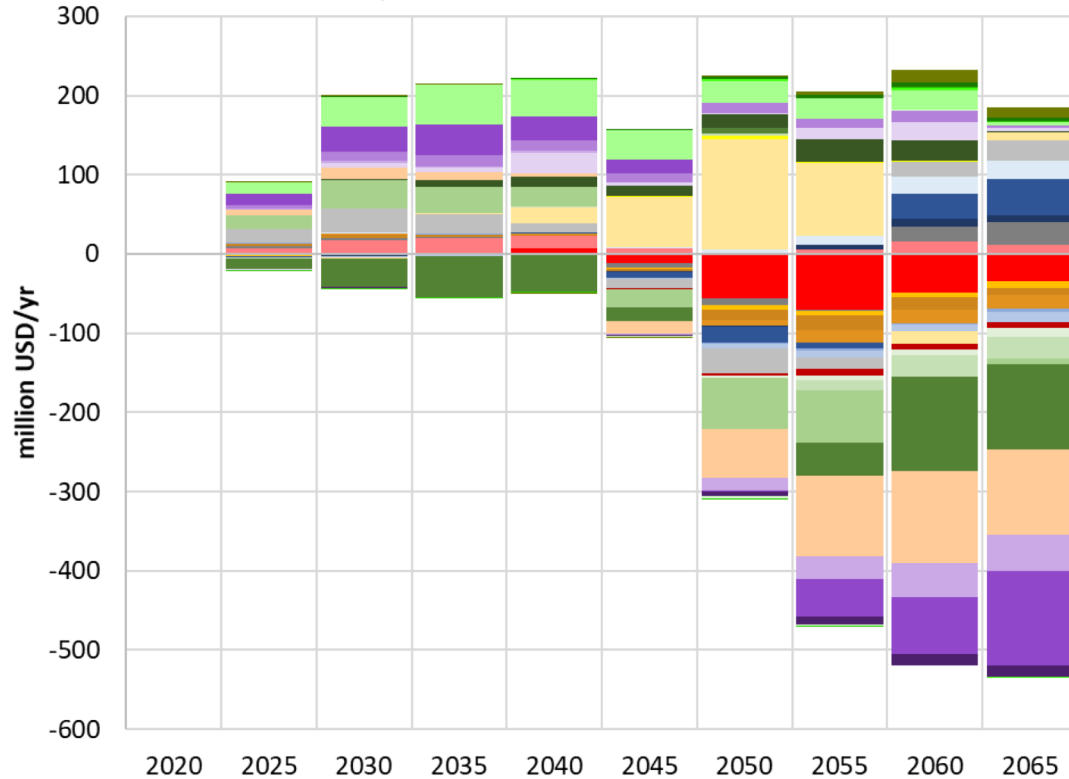
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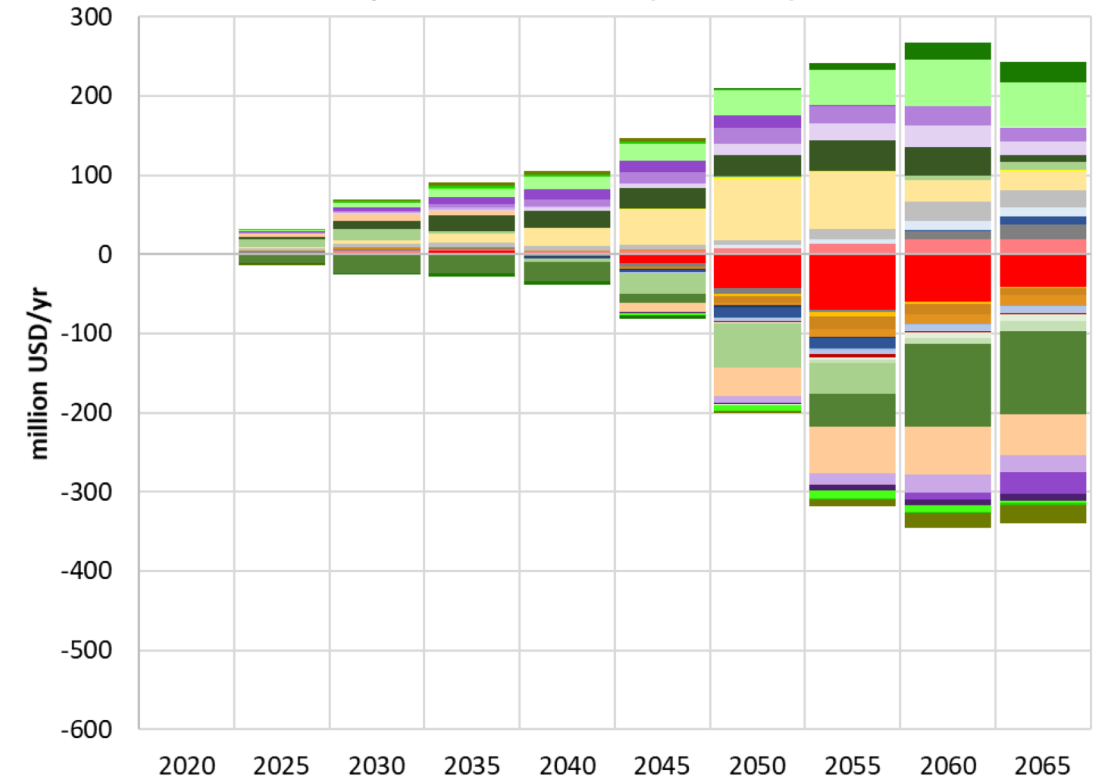


# MARKET EFFICIENCY GAINS: FOR WHOM?

Policy cost incl transfers (LUC=1)



Policy cost incl transfers (LUC=0.25)



USA  
EU-12  
China  
India  
Africa\_Western  
South America\_Northern

Canada  
EU-15  
Taiwan  
Pakistan  
South Africa  
South America\_Southern

Mexico  
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Central Asia  
Middle East  
Argentina

Australia\_NZ  
Europe\_Non\_EU  
South Asia  
Africa\_Eastern  
Brazil

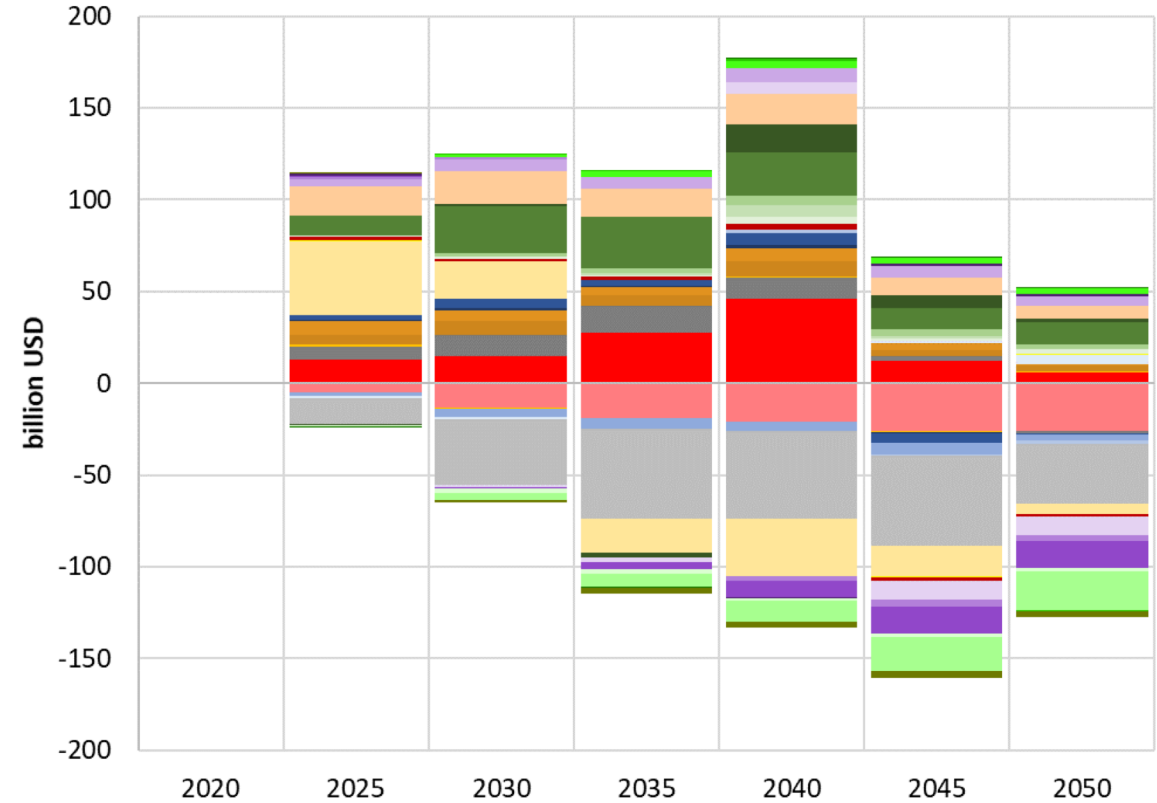
Japan  
European Free Trade Association  
Southeast Asia  
Africa\_Northern  
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South Korea  
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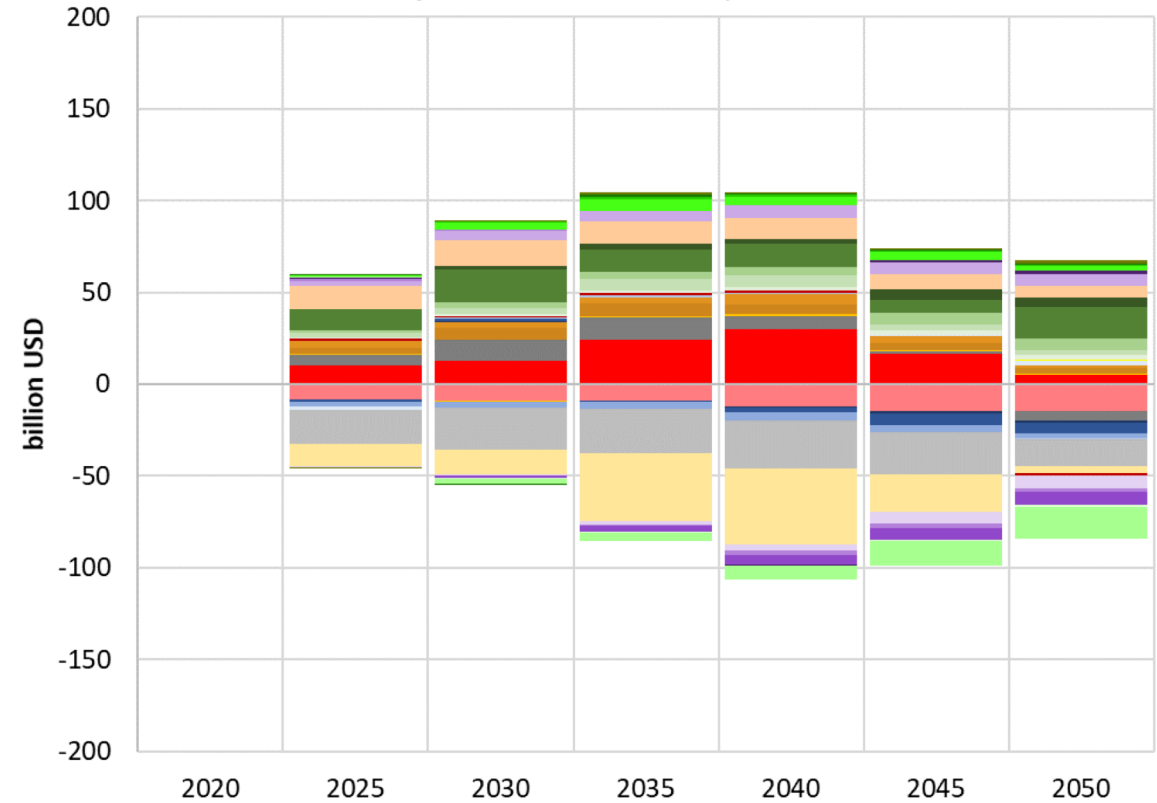
# EFFECT ON ELECTRICITY SECTOR INVESTMENTS

Electricity sector investments (LUC=1)



- USA
- EU-12
- China
- India
- Africa\_Western
- South America\_Northern
- Canada
- EU-15
- Taiwan
- Pakistan
- South Africa
- South America\_Southern
- Mexico
- Europe\_Eastern
- Central Asia
- Middle East
- Argentina

Electricity sector investments (LUC=0.25)

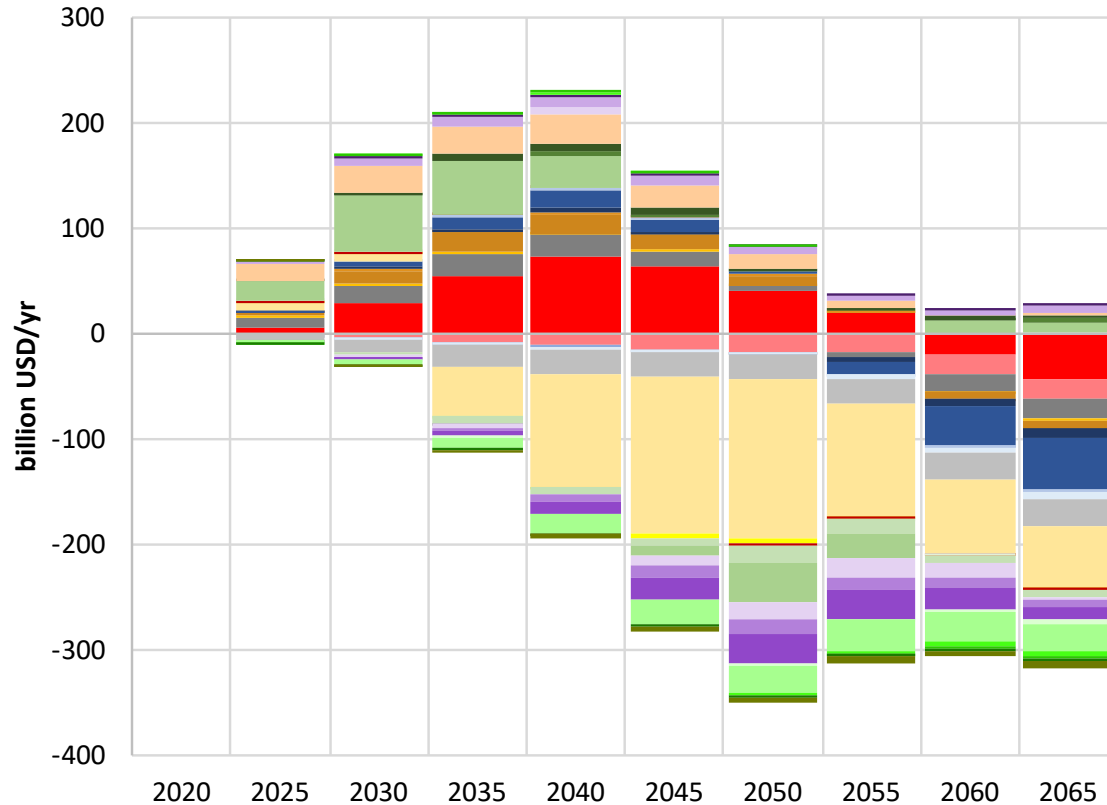


- Australia\_NZ
- Europe\_Non\_EU
- South Asia
- Africa\_Eastern
- Brazil
- Japan
- European Free Trade Association
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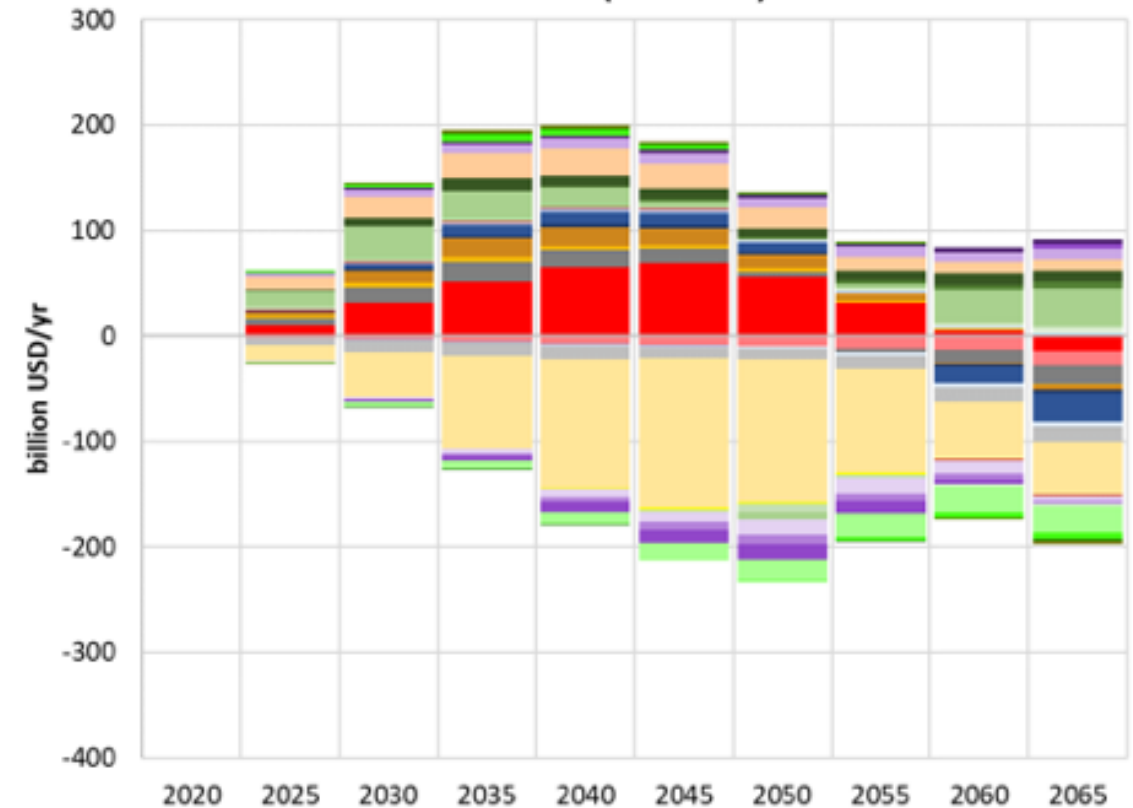


# DISTRIBUTIONAL QUESTION – INVESTING IN CCS

CCS investment (LUC=1)



CCS investment (LUC= 0.25)



- USA
- EU-12
- China
- India
- Africa\_Western
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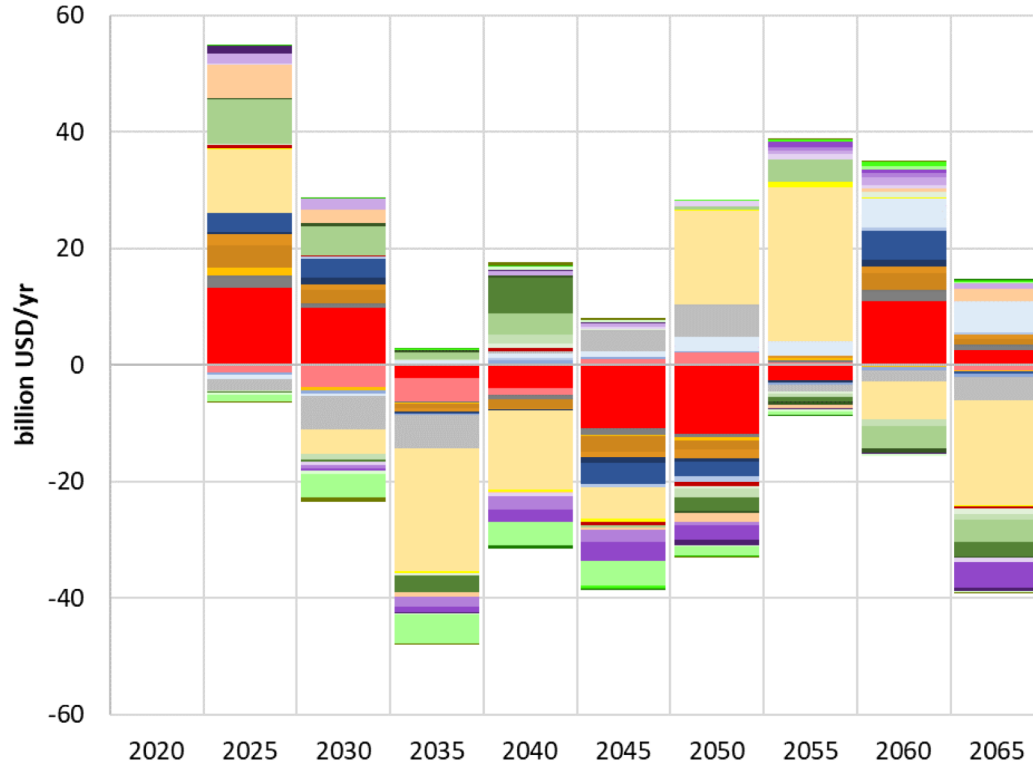
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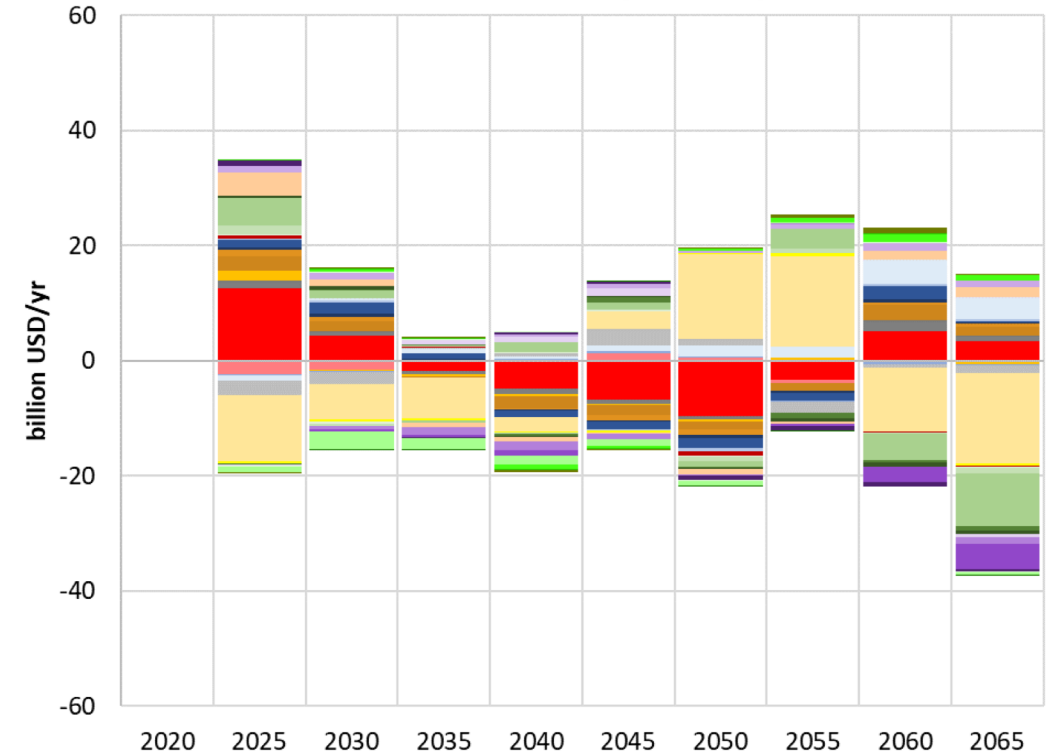


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Wind & solar investment (LUC=1)



Wind & solar investment (LUC=0.25)



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## KEY RESULTS & IMPLICATIONS

- Market efficiency gains
- .. but not for everyone
- Nuanced story beyond conventional understanding of beneficiaries of carbon trade
- Market design matters
- Choice between investing versus buying mitigation
- Investing in CCS & RE for higher near-term ambition & longer-term trade advantages
- There are no losers - Need to consider other benefits beyond mitigation costs; need to innovate according to market design

# THANK YOU

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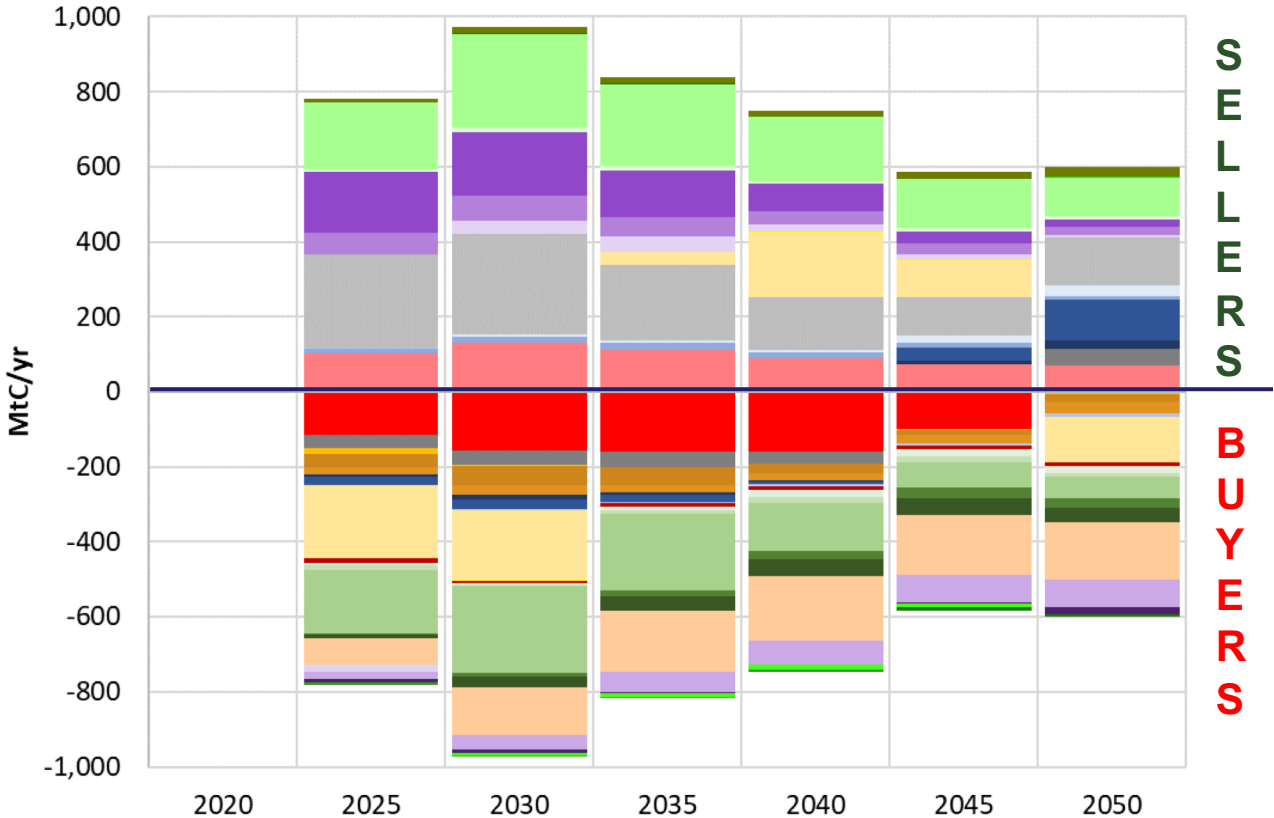
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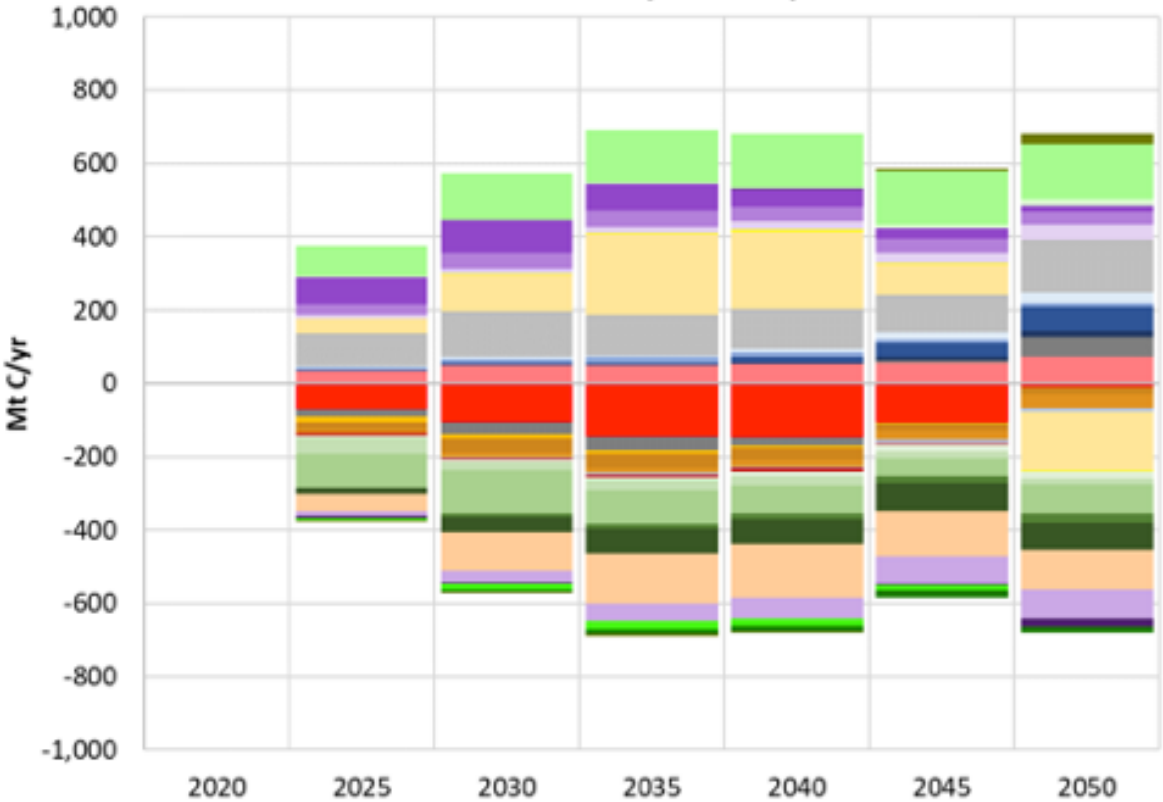


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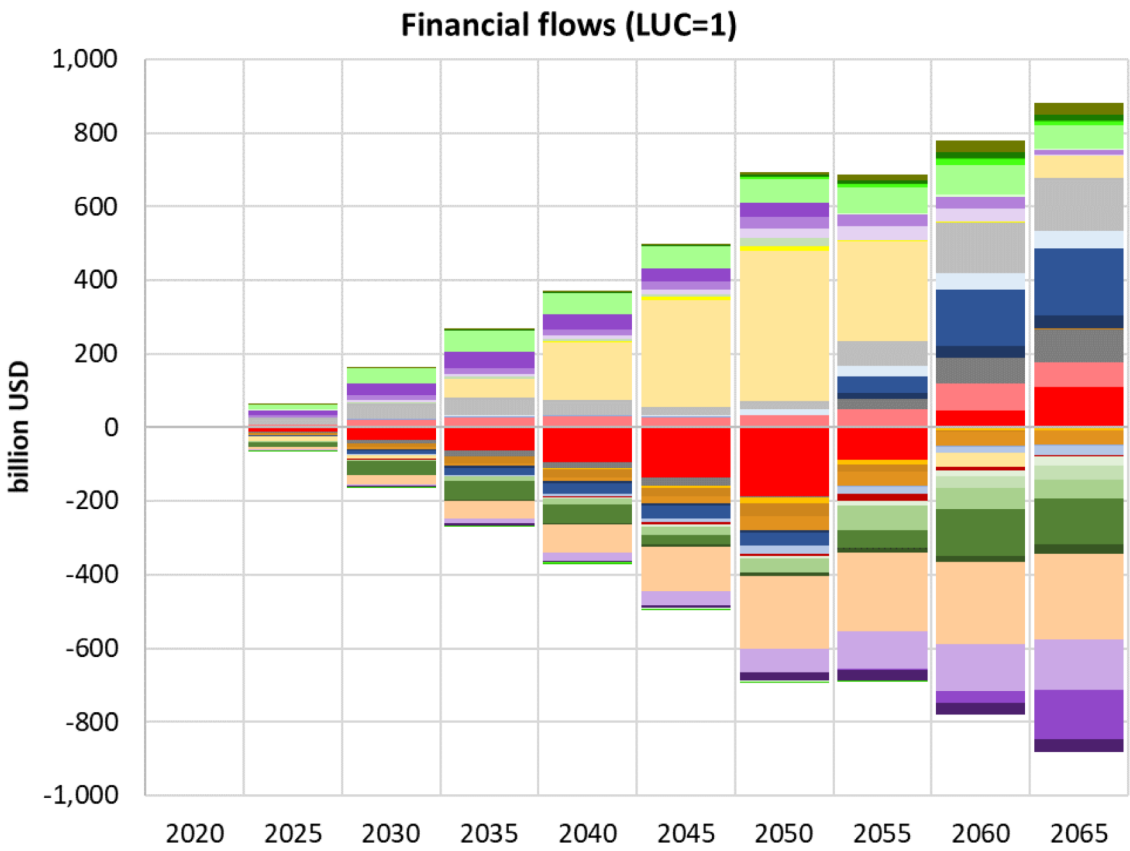


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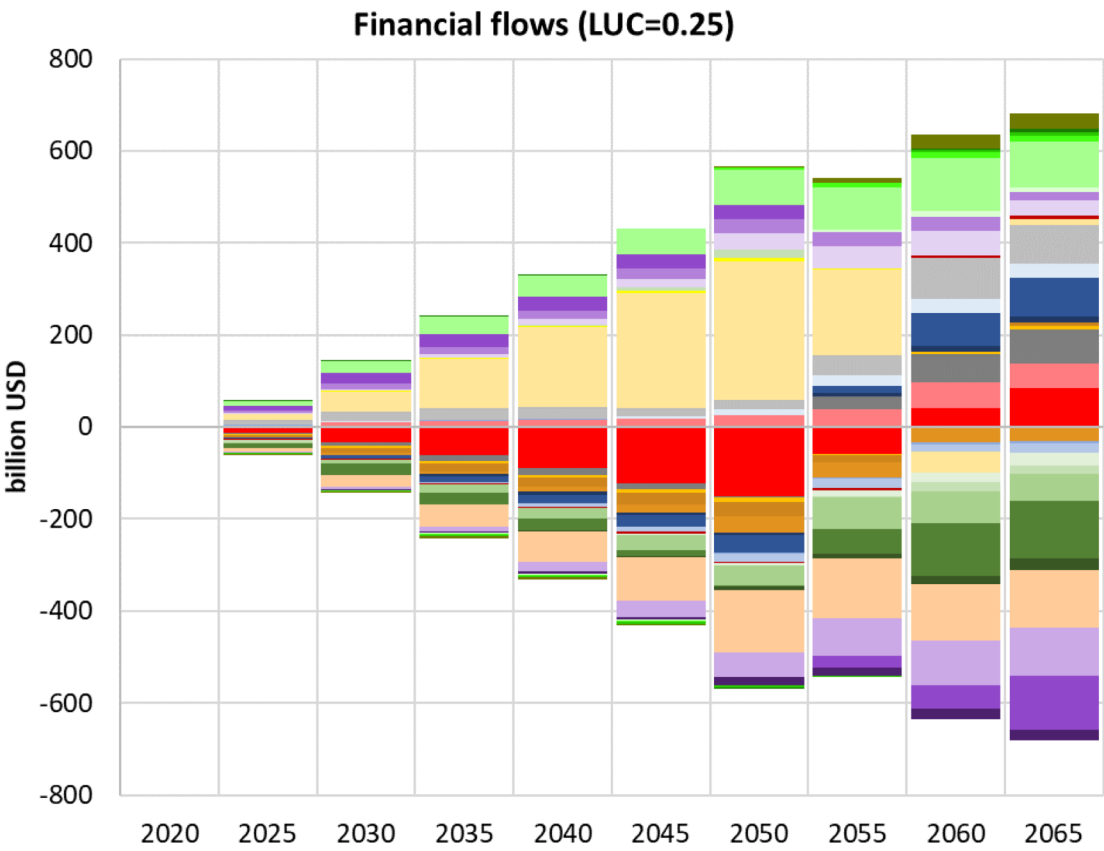




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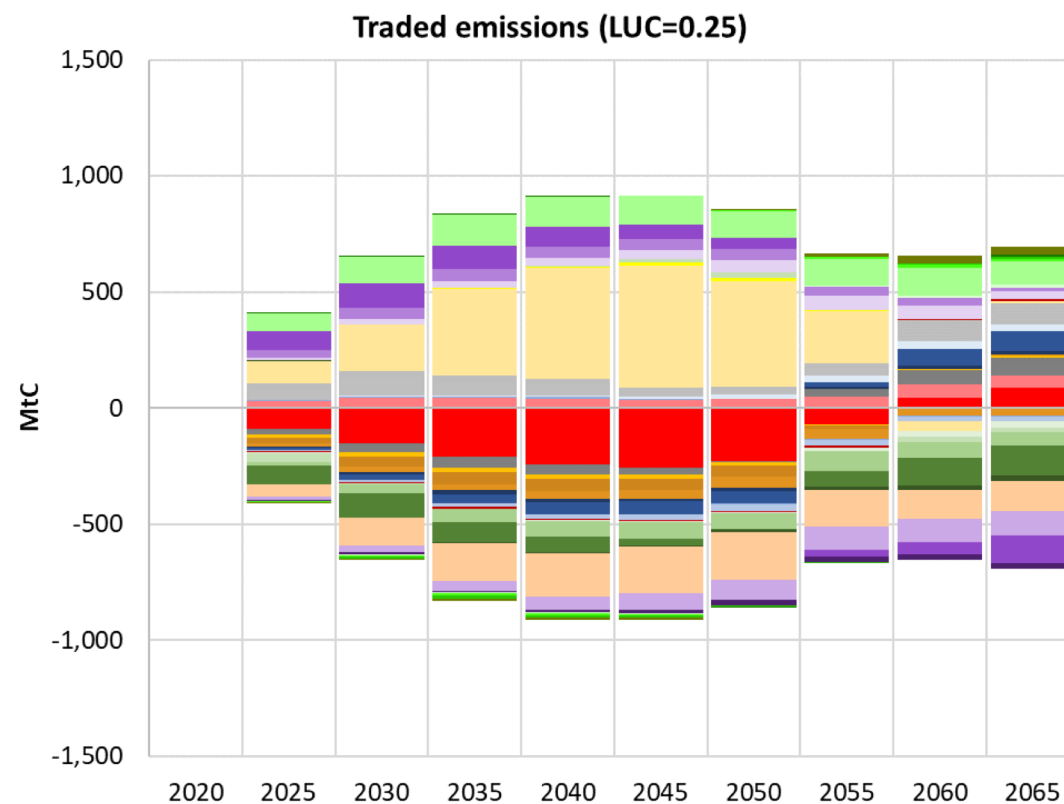
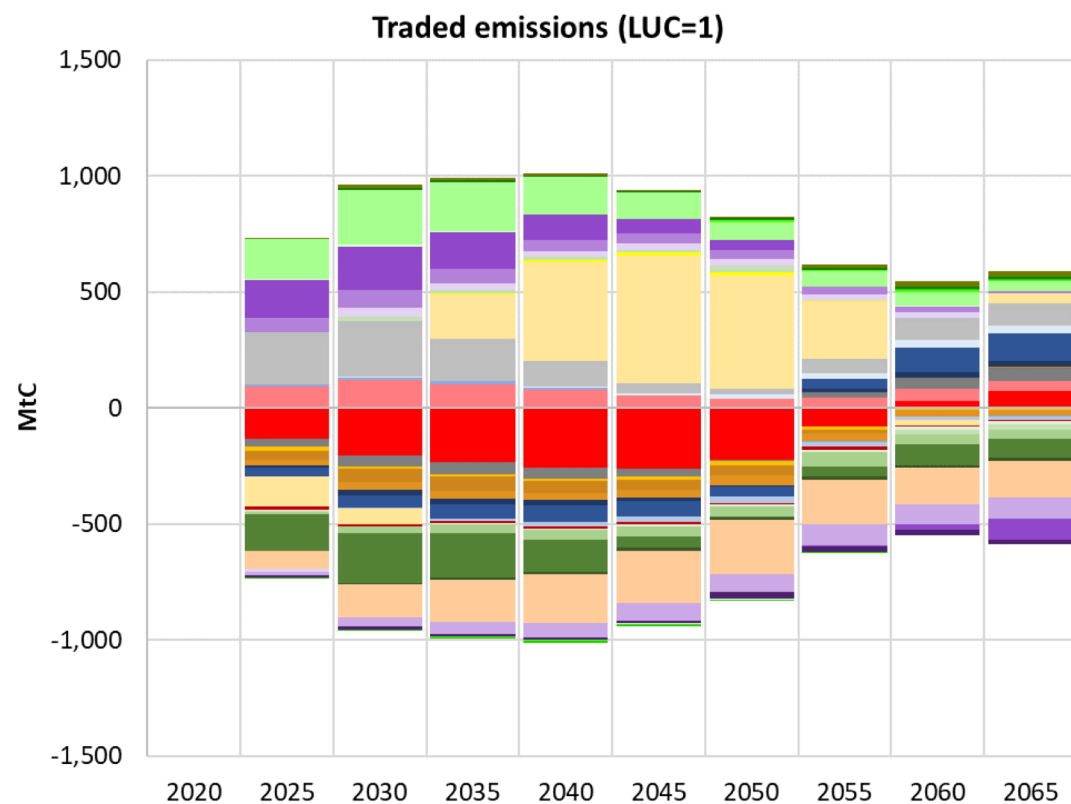
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## TRADE VOLUMES (SCENARIO B)



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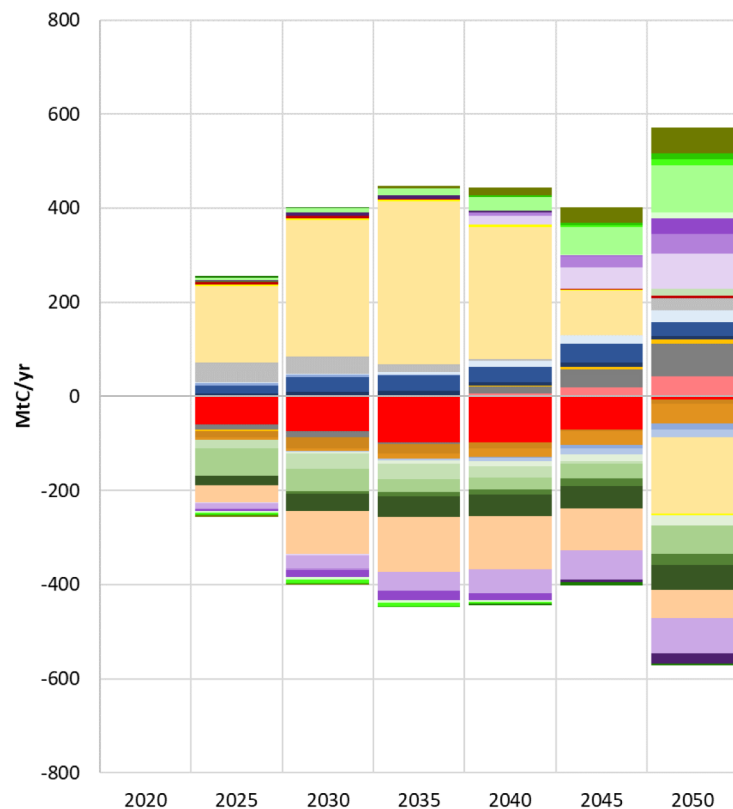
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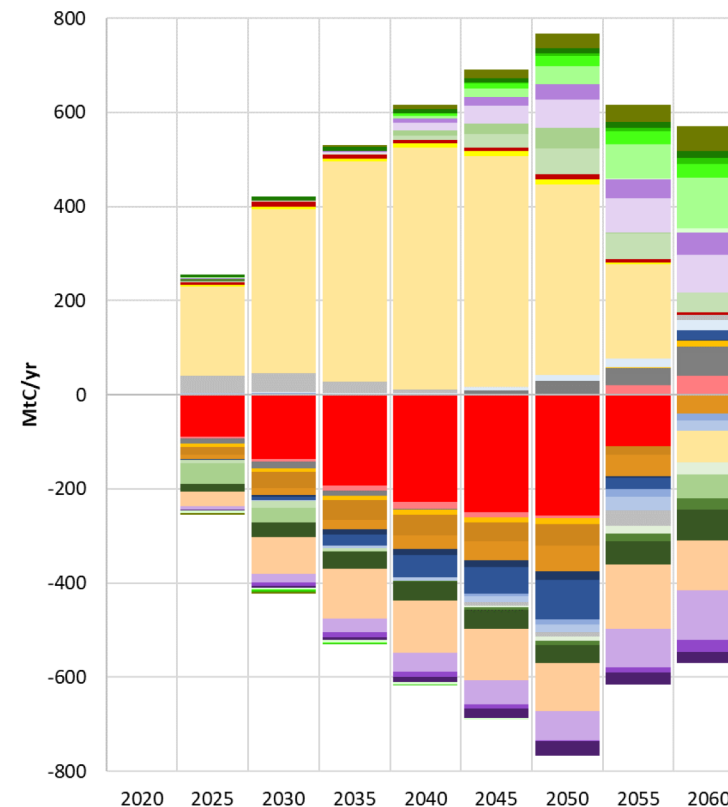


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Global NZ in 2050



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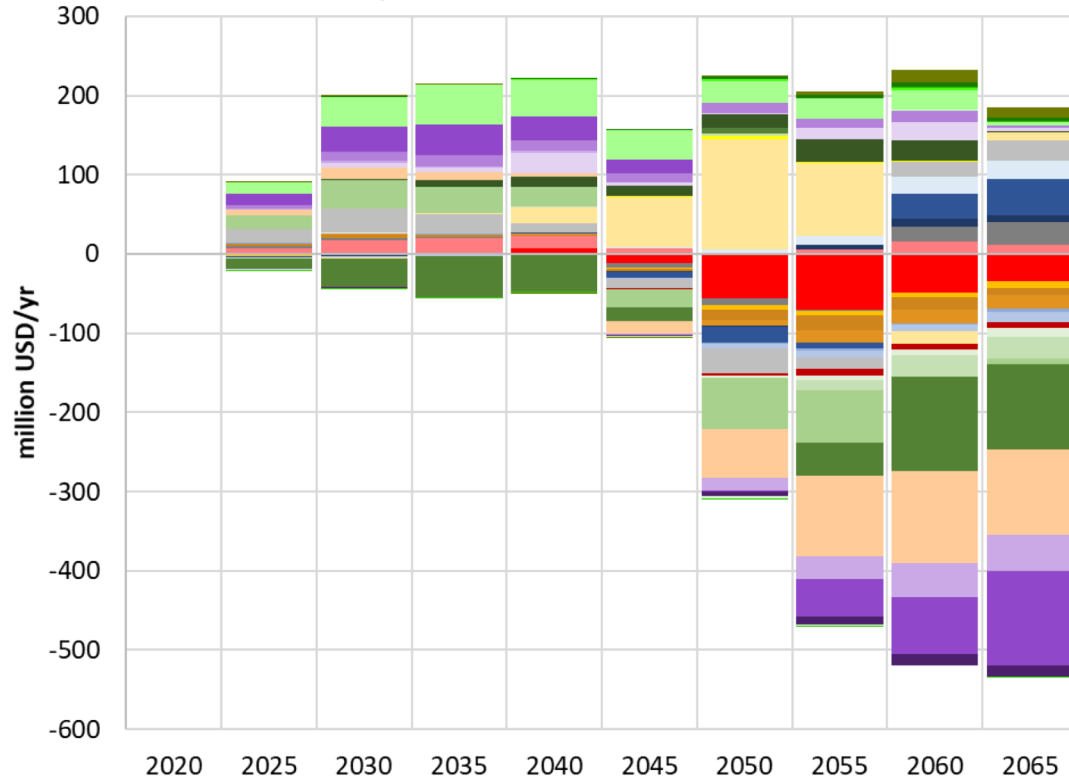
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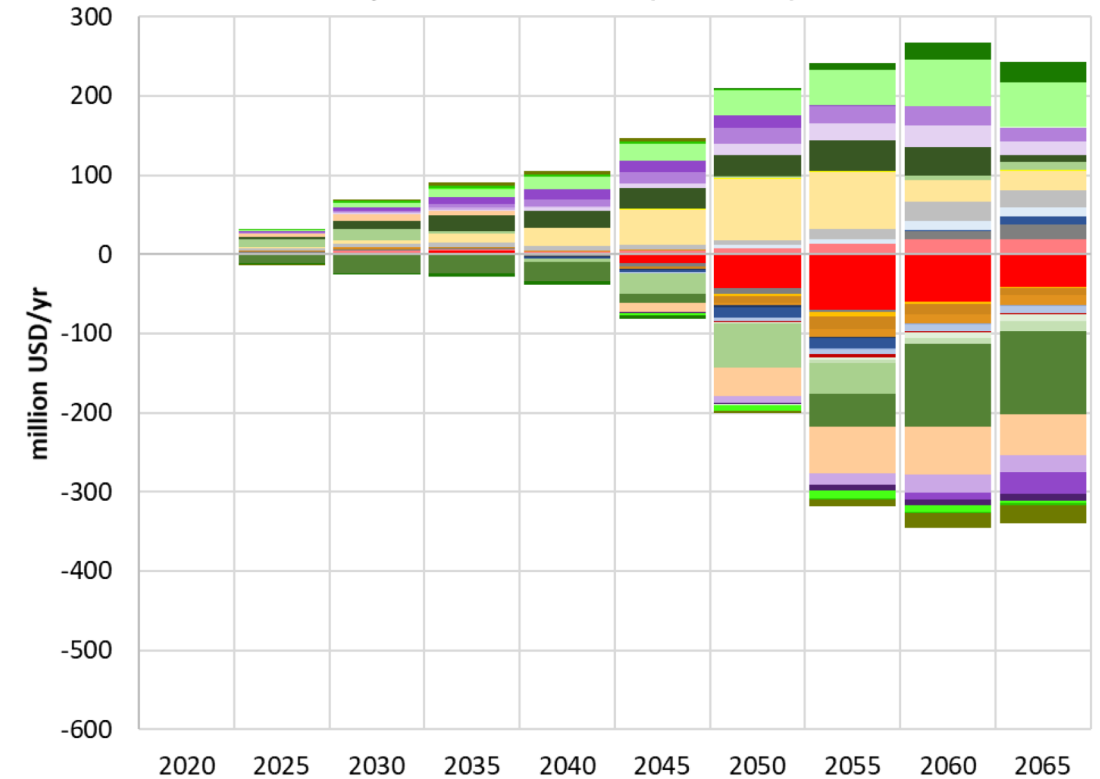


# MARKET EFFICIENCY GAINS: FOR WHOM?

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Policy cost incl transfers (LUC=0.25)



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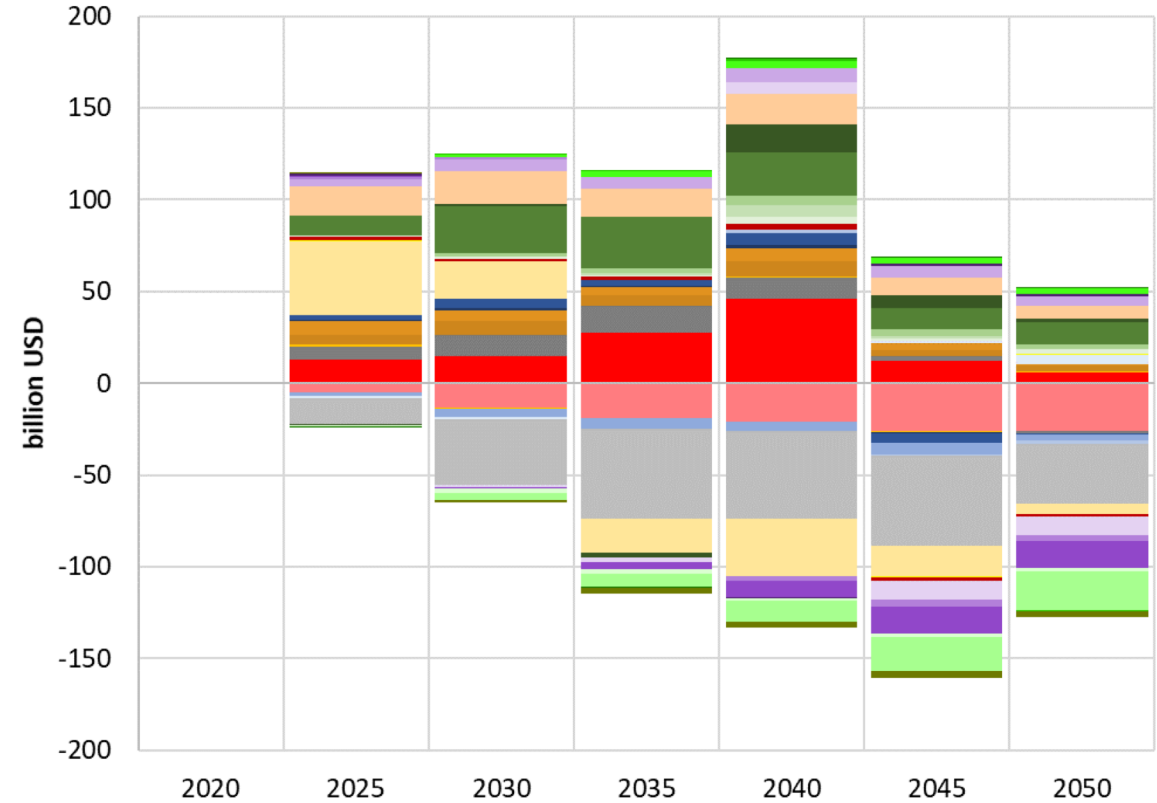
South Korea  
Russia  
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Africa\_Southern  
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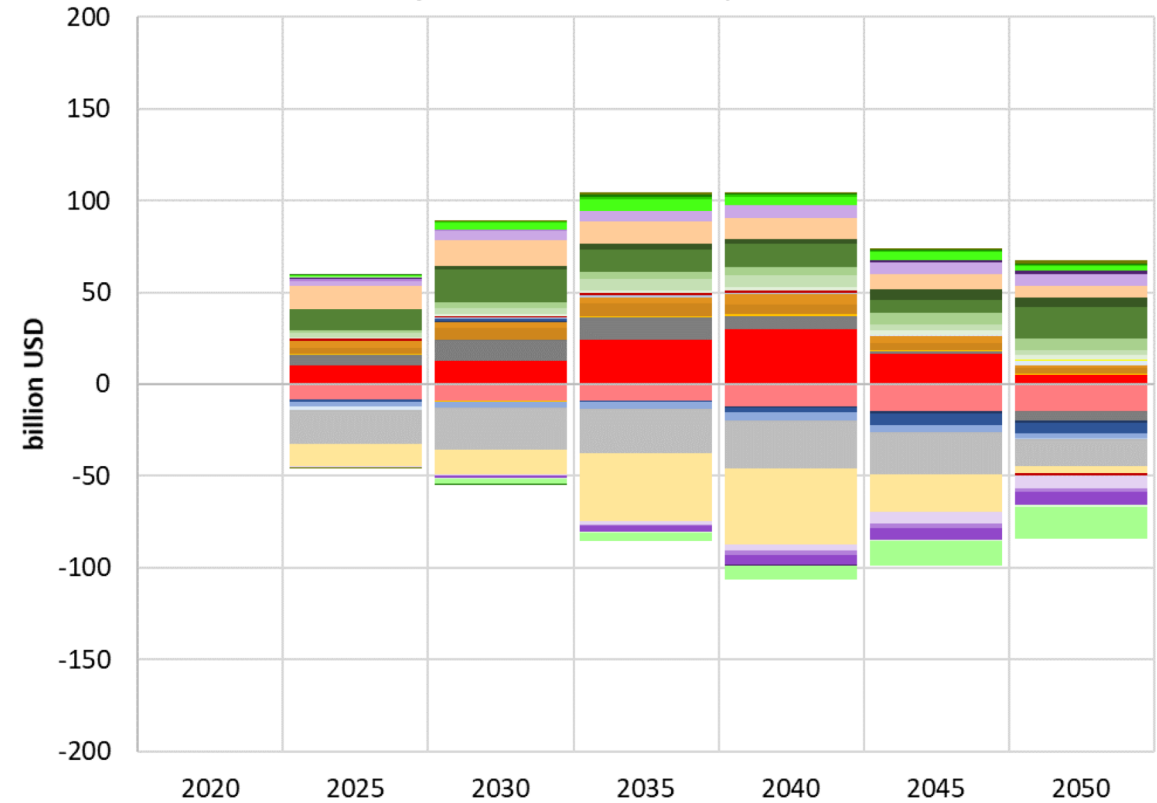


# EFFECT ON ELECTRICITY SECTOR INVESTMENTS

Electricity sector investments (LUC=1)



Electricity sector investments (LUC=0.25)



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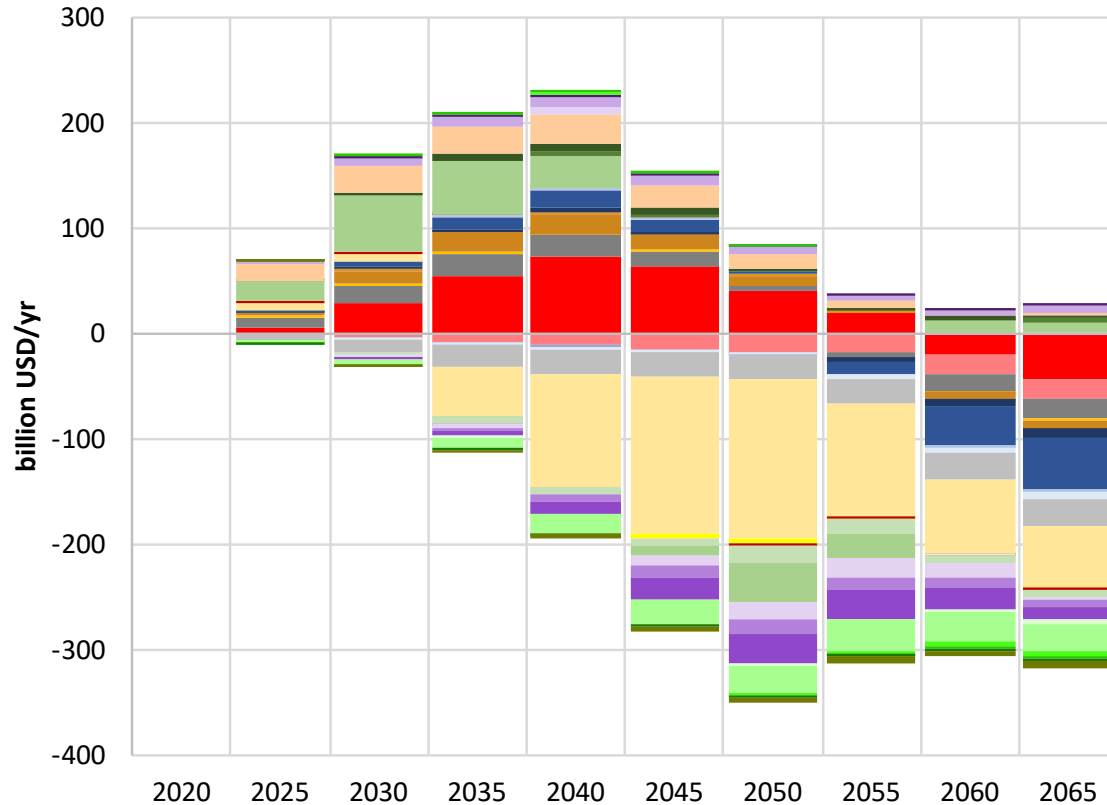
Africa\_Southern

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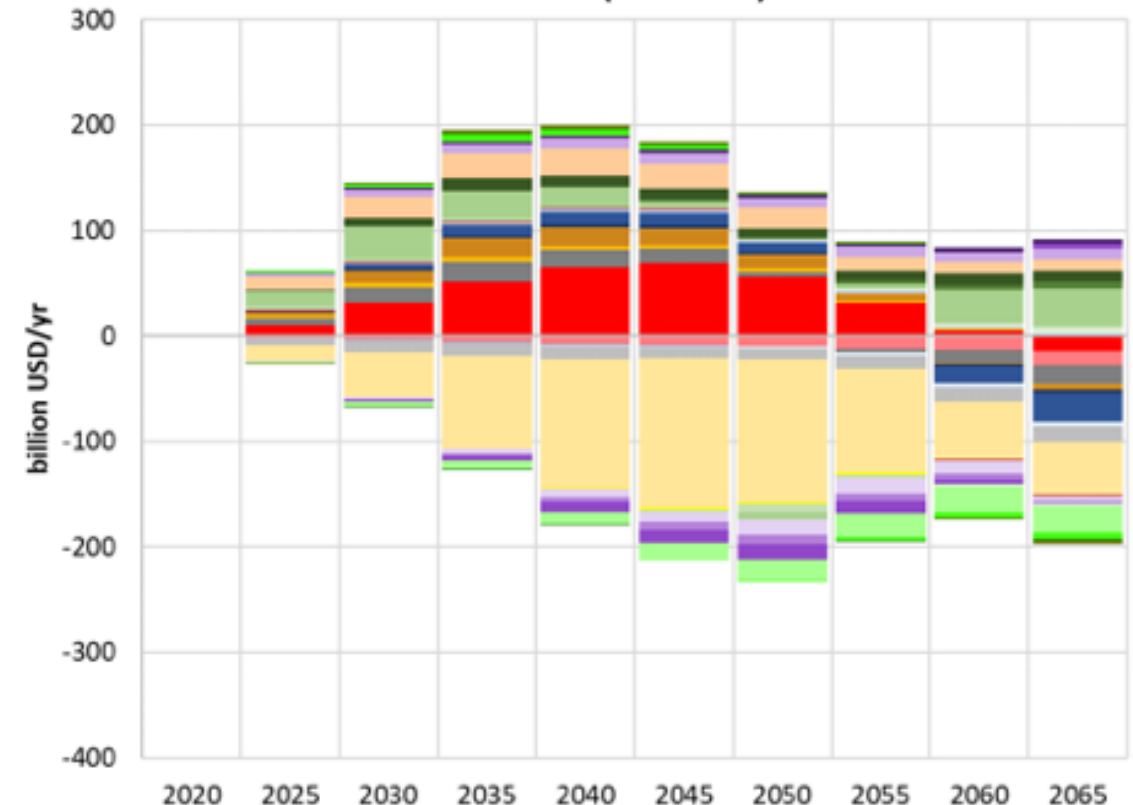


# DISTRIBUTIONAL QUESTION – INVESTING IN CCS

CCS investment (LUC=1)



CCS investment (LUC= 0.25)



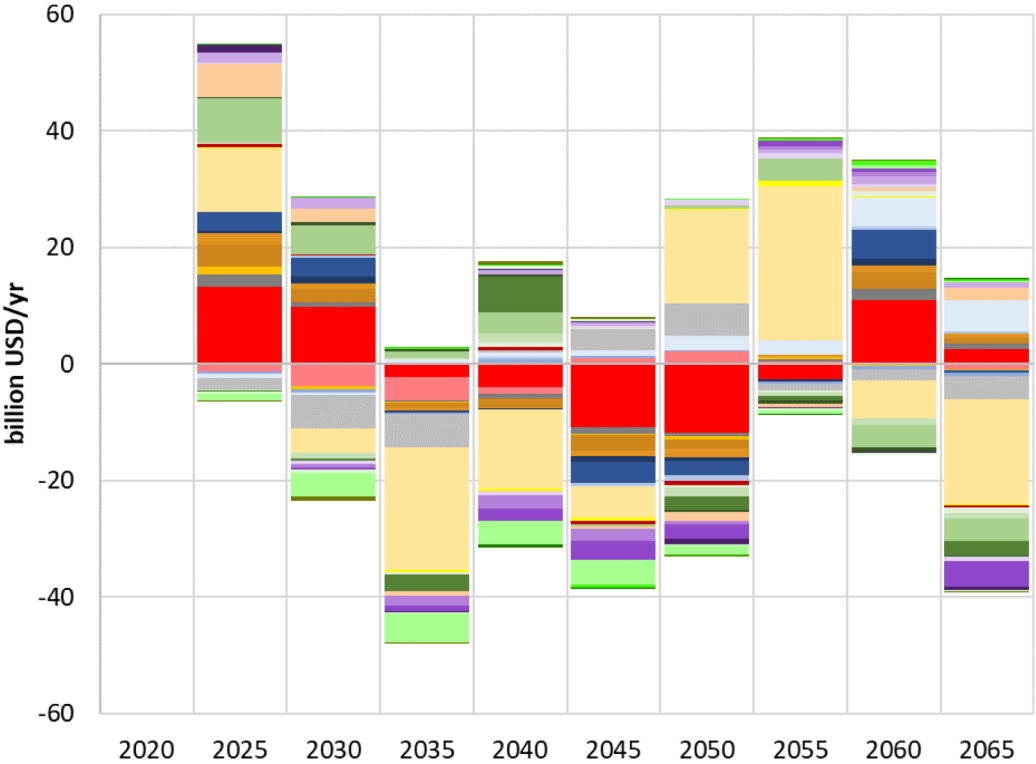
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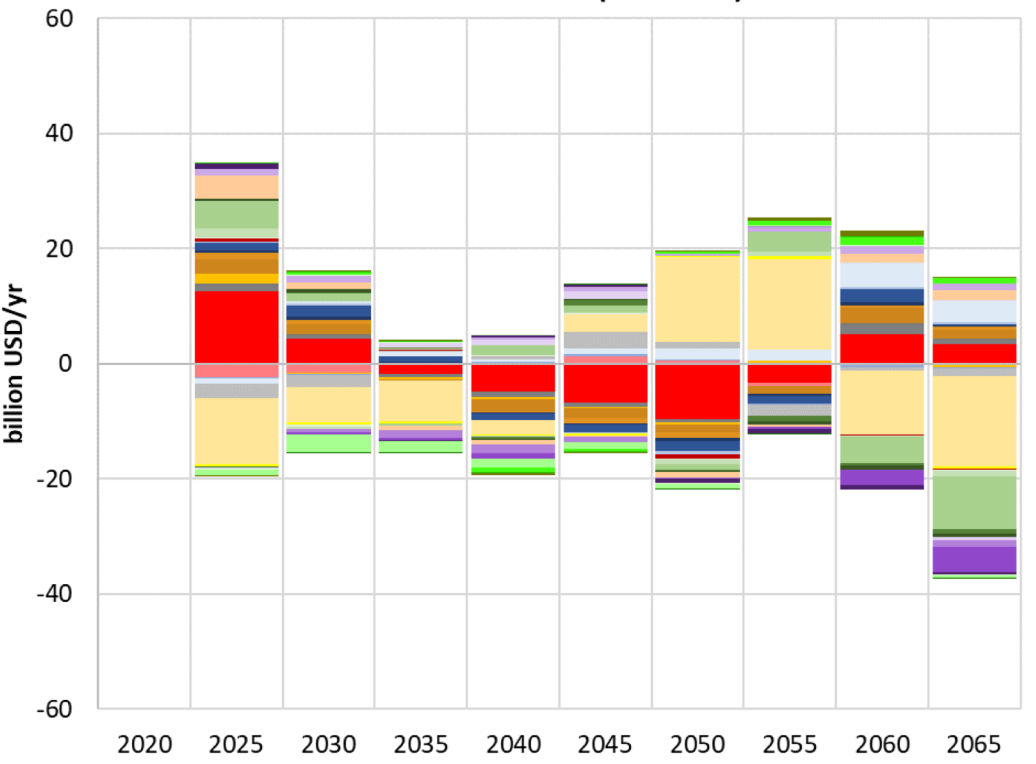


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Wind & solar investment (LUC=1)



Wind & solar investment (LUC=0.25)



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