

Modelling zero-carbon transitions: The E3ME-FTT model in Brazil's context

March – 25

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Modelling zero carbon transitions: The E3ME-FTT model

1- Introduction to E3ME-FTT

The model and the research community
developing it

2- Insights on zero-carbon transitions from E3ME- FTT

The macroeconomic impacts of sustainability transitions
(growth, balance of trade, competitiveness, efficiency)

3- Modelling Brazil's Ecological Transformation plan

The ongoing study and early results

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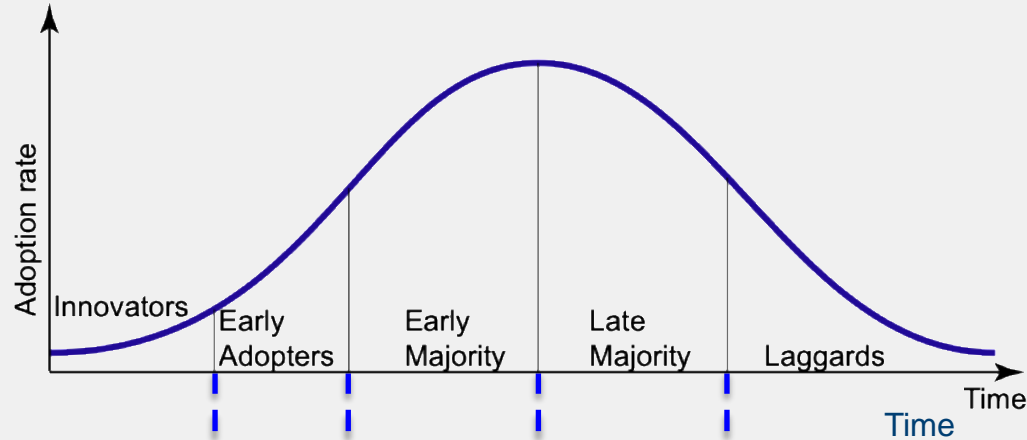
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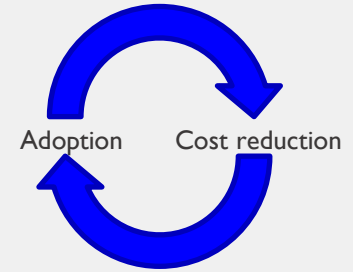
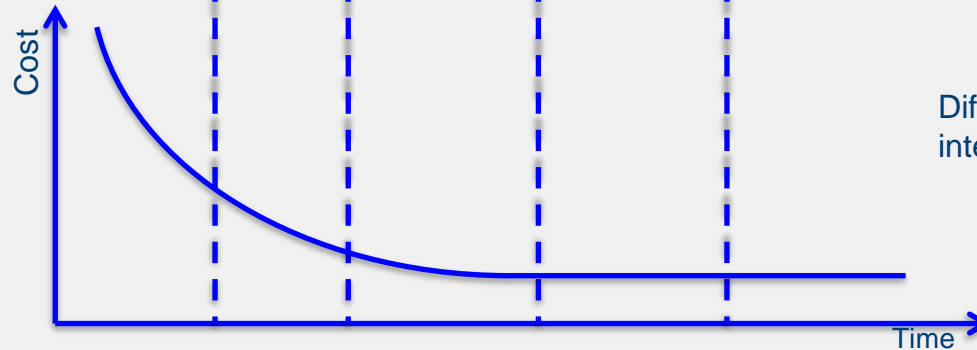
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Principles of technological change

Diffusion justifies
expansion of
productive
capacity
→ Costs go down



Declining costs
enable access to
a growing
population of
users
→ Sales go up



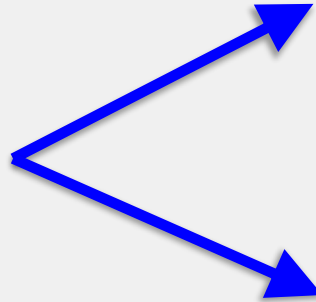
Diffusion and learning
interact

Future Technology Transformations (FTT)

FTT is a family of micro-models of technology choice and substitution, given economic/policy context



t



$t + \Delta t$

Evolutionary discrete choice modelling + process innovation

Current FTTs

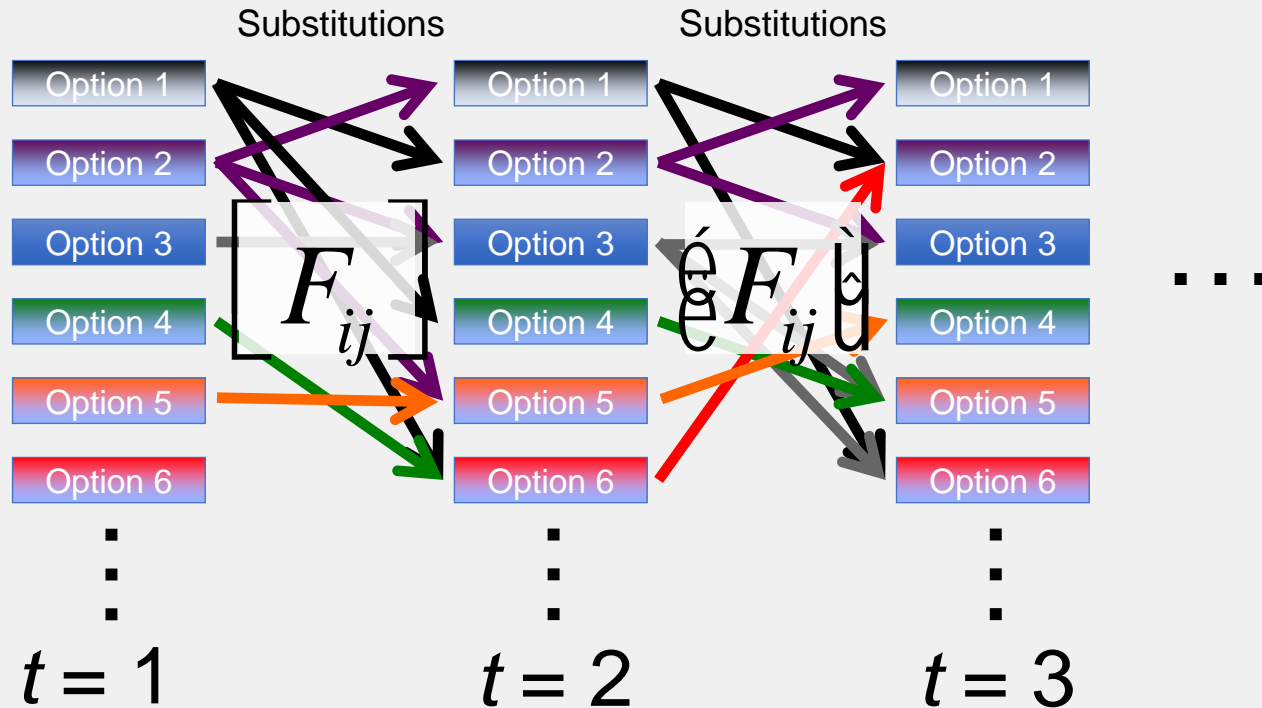
- Power generation
- Road transport
- Domestic heat
- Industrial heat
- Steelmaking

Upcoming FTTs

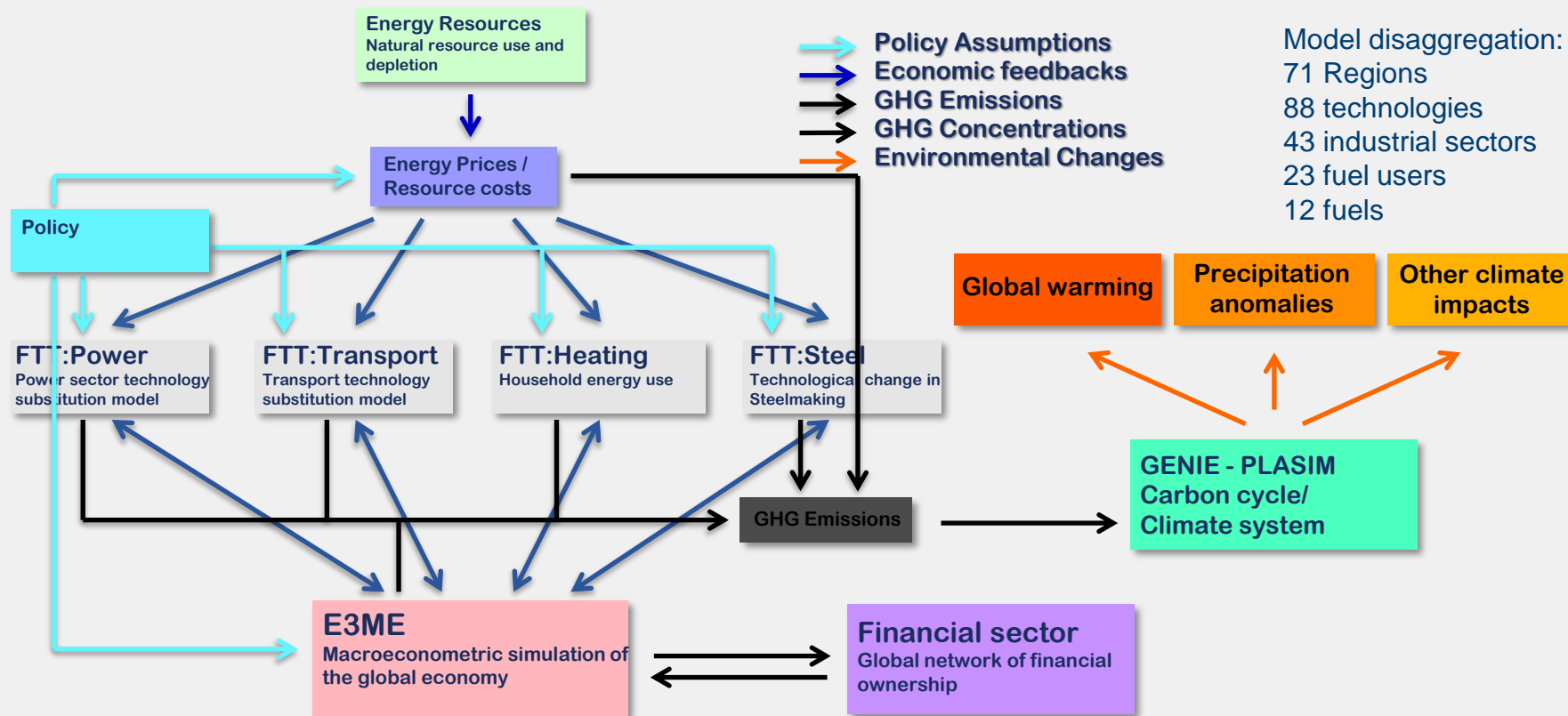
- Land-use
- Hydrogen
- Aviation
- Shipping
- ...

71 regions/countries

Future Technology Transformations (FTT)



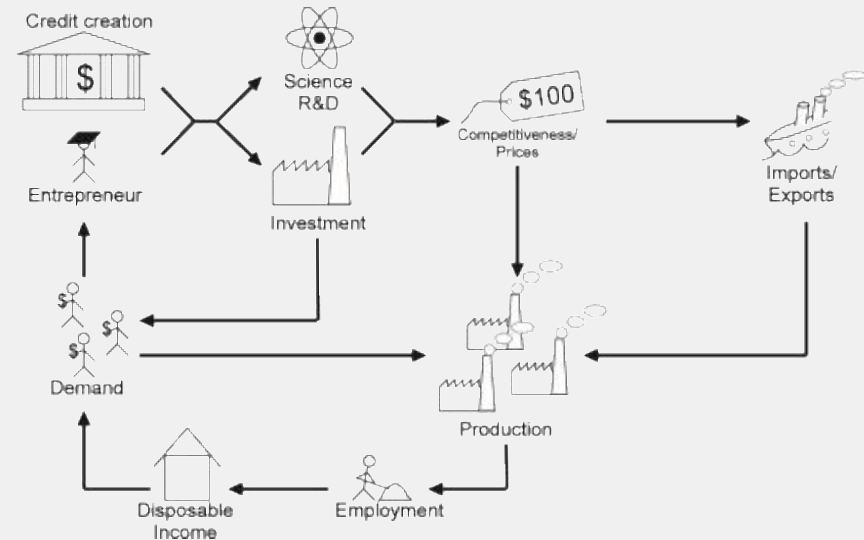
The E3ME-FTT integrated model:



The economic cycle in E3ME

The demand-driven nature of growth in E3ME-FTT:

- 1- Entrepreneurs have skills to **innovate**,
- 2- Financial institutions/partners **provide investment**
- 3- Investment and Innovation **reduces costs** and increases productivity
- 5- Cost reductions cause **prices declines** and/or **profits**
- 6- Consumers have **leftover income**
- 7- Income and profits **boost aggregate demand**
- 8- Aggregate demand motivates further **innovation** and **investment**

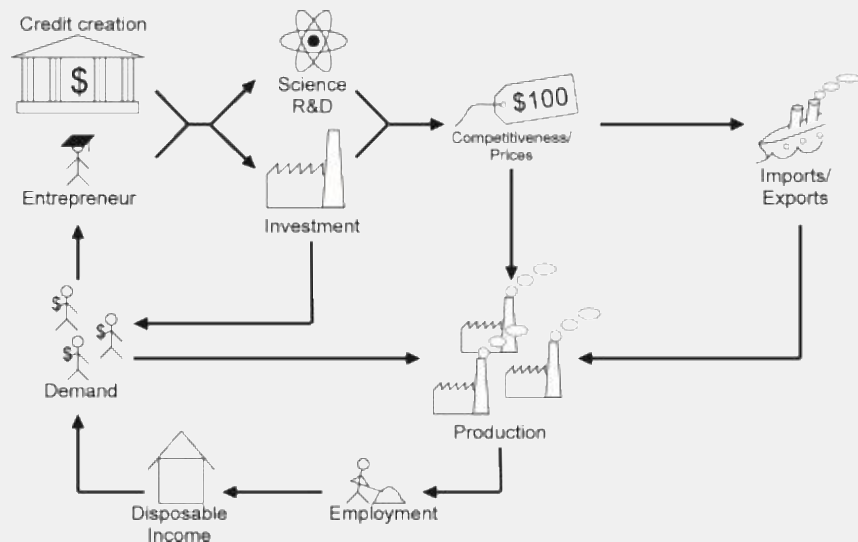


The economic cycle in E3ME

Demand-driven endogenous behavioural equations

- 1- Consumption in 43 sectors of final products,
- 2- Investment in 43 industrial sectors
- 3- Prices (incl. technological progress/productivity growth, imports, exports)
- 4- Import and export volumes
- 4- Employment (incl. labour participation, hours worked, wages)
- 7- Capacity utilisation (incl. inflation)
- 8- Energy demand and supply in physical units

**43 industrial sectors, 43 consumption sectors, 22 fuel users,
71 regions covering the globe, 12 fuels, bilateral trade,
monetary and physical units**



The E3ME-FTT modelling community

The core modelling community:



Primary FTT developer

Lead academic partner,
develops and uses E3ME-FTT
Writes scientific modelling
papers



E3ME owner and host

Primary E3ME developer
Hosts and maintains
E3ME-FTT
Offers model licenses
CE is a consultancy
Largely non-profit



E3ME user and developer

Primary E3ME developer for
financial services
Provides financial risk analysis
TREX is a startup company



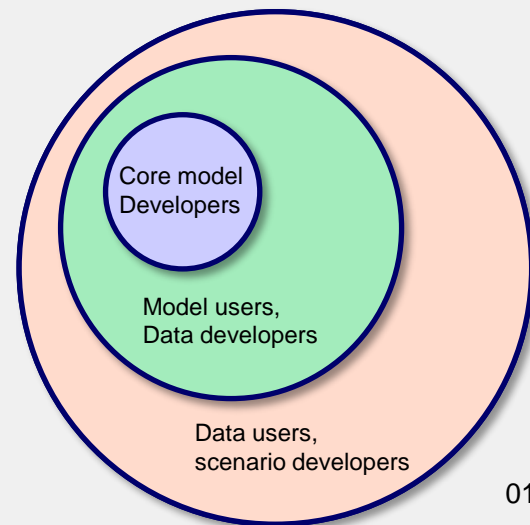
FTT user and developer

Primary FSMAT developer
Connects FSMAT with FTT
C3A is a World Bank program

Other community members:



Fiscal unit



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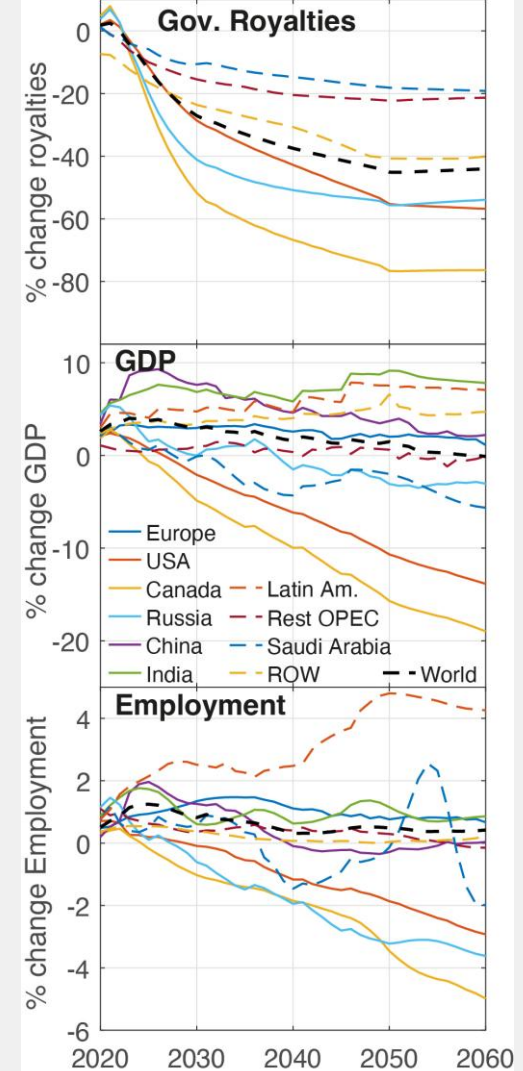
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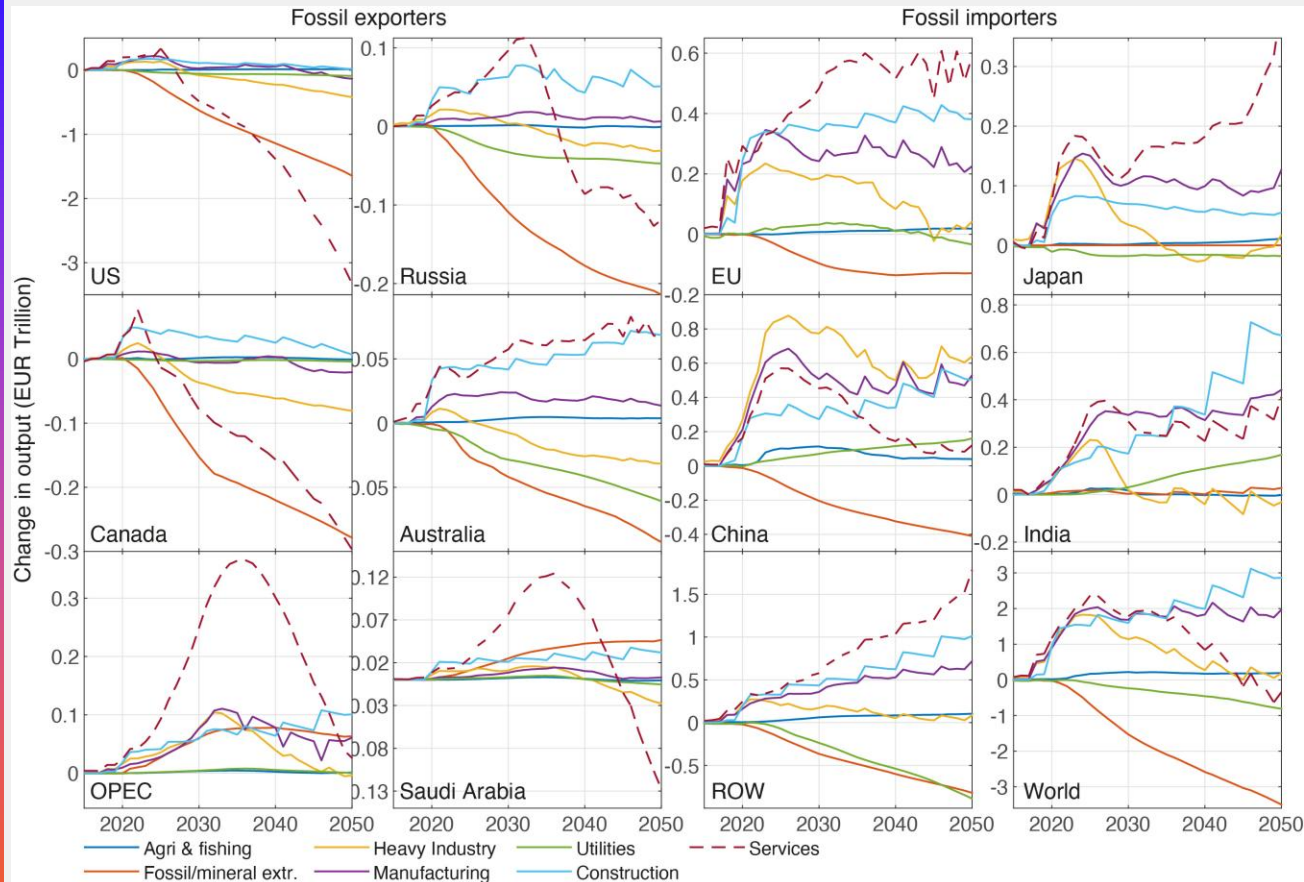
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Impacts of low-carbon transitions on Economic growth in E3ME-FTT

1. Low-carbon investment boosts economic activity
 - Building activity ↗, GDP ↗, jobs ↗
 - Implies large investment and possible debt burdens
2. Decline in demand for fossil fuels
 - Excess supply, FF prices ↘, production ↘, GDP ↘, jobs ↘
 - Declines in investment across supply chains
3. Trade balance:
 - Importers:
Reduces energy imports and redresses trade balance,
income ↗, competitiveness ↗, GDP ↗
(e.g. Europe, China, Japan, India)
 - Exporters
Decline of the fossil fuel industry, jobs ↘,
GDP ↘
(e.g. USA, OPEC, Canada, Russia)



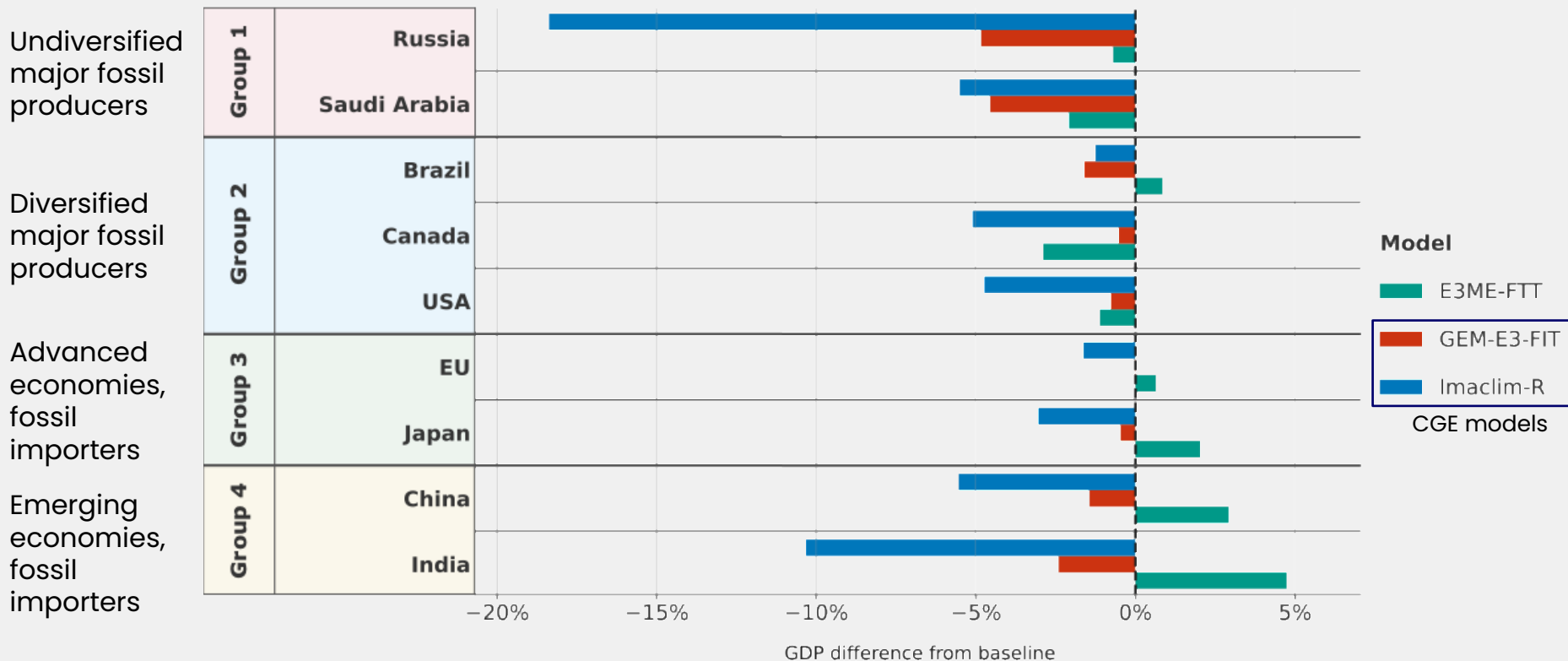
Low-carbon and structural transformation in E3ME-FTT



1. Structural change more important than GDP effects
 - Global GDP +1%
 - Country GDP: -10 to +10%
 - Huge changes in sectoral output
 - Investment losses/gains
2. Fossil exporters:
 - Large indirect impacts in construction, manuf, services due to huge loss of brown investment
 - Offset by green investment
3. Fossil importers
 - Huge gains green investment
 - Small losses brown activity
 - Large positive indirect impacts (excl fossil fuels)

Low-carbon and structural transformation in E3ME-FTT: Global

5 country archetypes according to economic structure

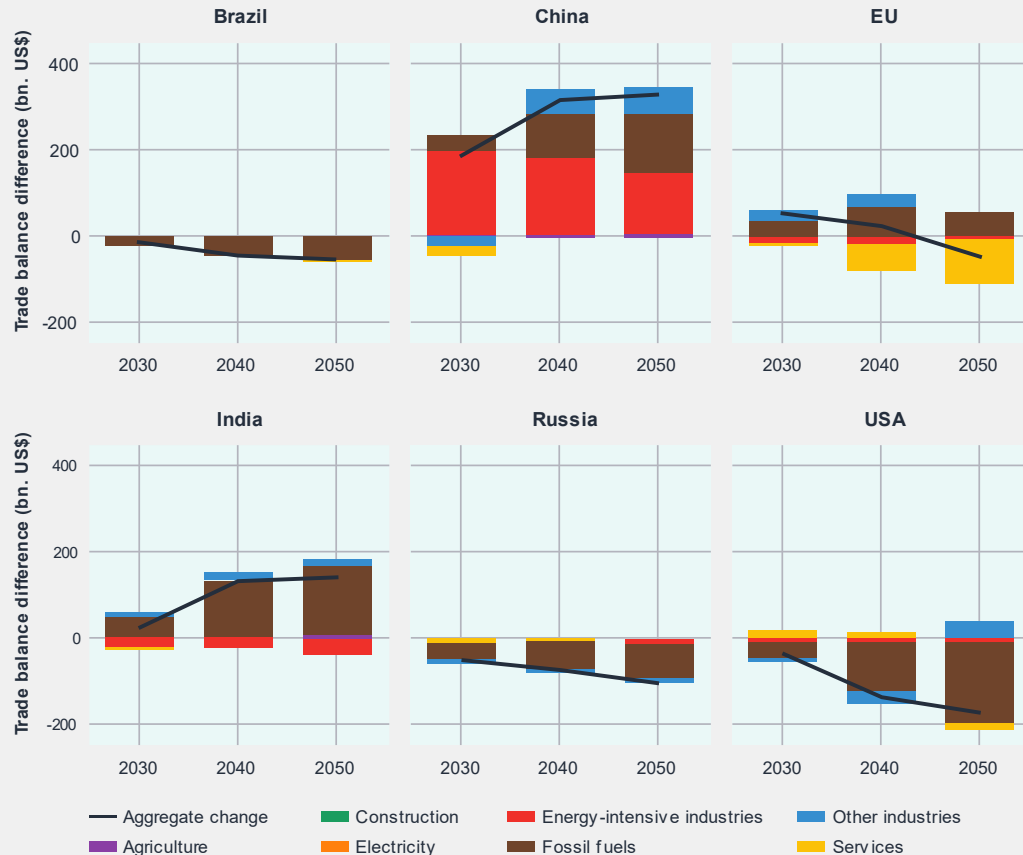


Low-carbon and structural transformation in E3ME-FTT: Brazil



- Sectoral losses of jobs (and output) more severe than economy-wide metrics suggest.
- Brazil – some losses in fossil fuels
- But offset by more substantial gains in services and construction
- Gains driven by increased domestic investment

Low-carbon and structural transformation in E3ME-FTT: Brazil

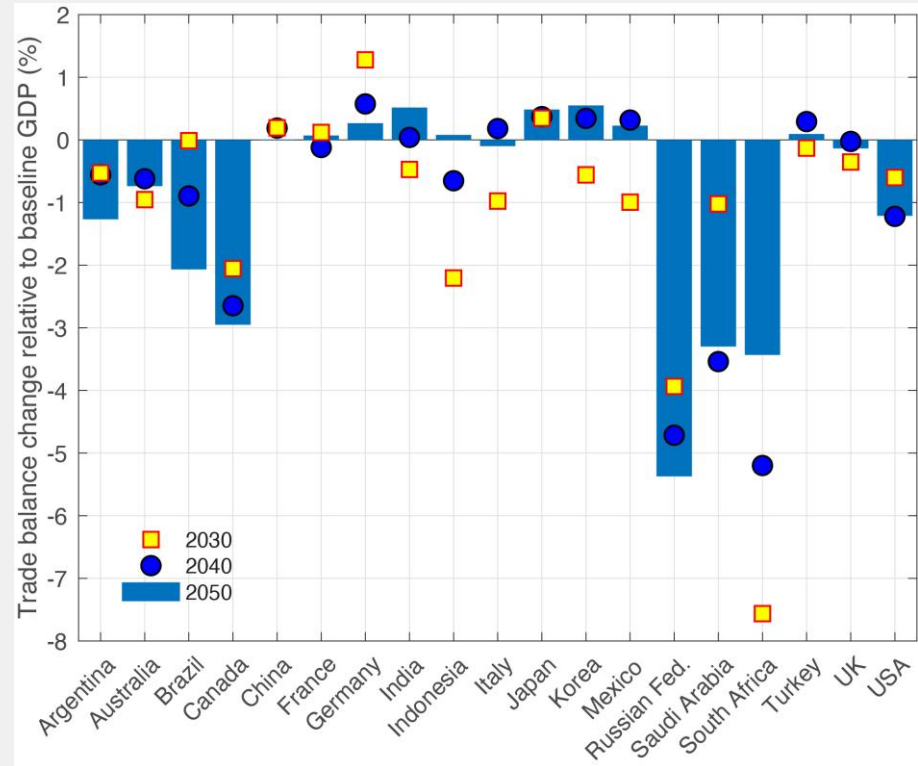


- Trade balance worsens for fossil fuel net exporters, improves for importers
- Decreases are either decreases in exports or gains of imports
- Worsening trade balance somewhat offsets boost from investment

Low-carbon and balance of trade in E3ME-FTT

Outcomes of the transition on the trade balance

- Large fossil fuel exporters experience substantial export losses (Canada, Russia)
- Large fossil fuel importers benefit from lower imports and increased international purchasing power (e.g., India, China)
- Some decarbonizing countries have higher manufacturing exports
- **Risk of currency devaluation!!**



Espagne, Mercure, Oman et al, Cross-Border risks of a global economy in mid-transition, *IMF working paper*, (2023)

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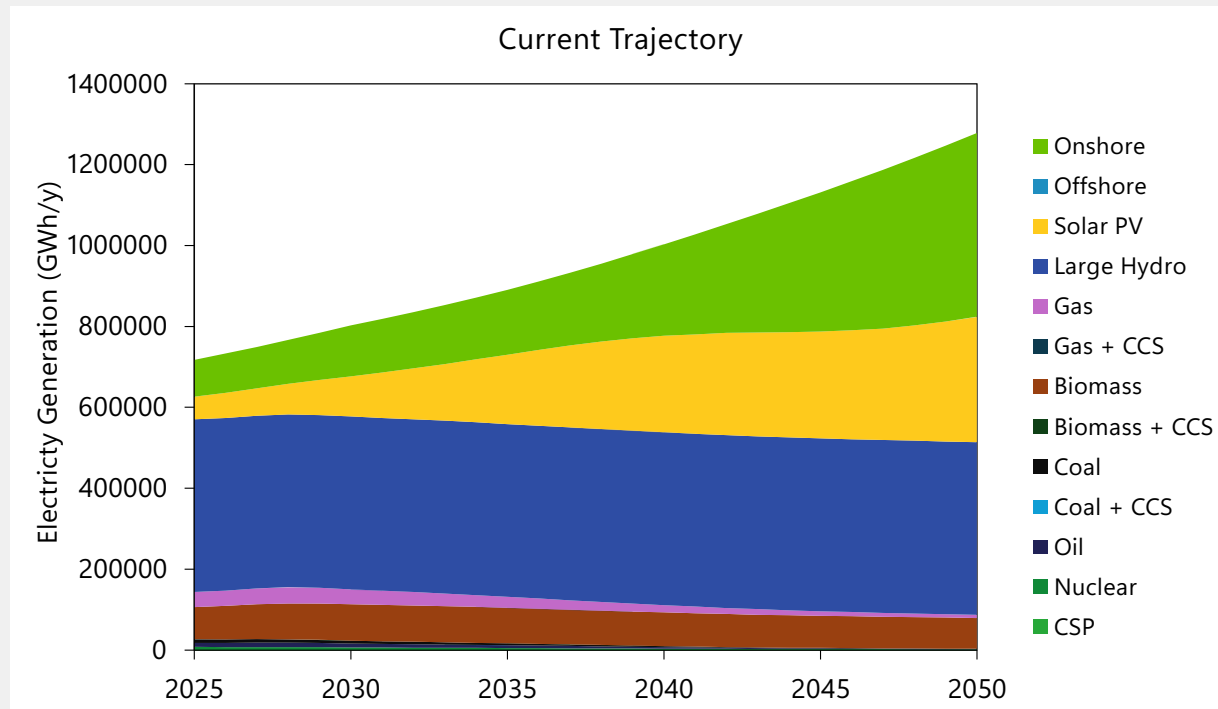
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Modelling the Ecological Transformation Plan

- Using E3ME-FTT, we aim to simulate how the Ecological Transformation Plan could impact Brazil's economy
- We are focusing on:
 - Sectoral output (structural change)
 - Employment
 - Exports and imports
 - Prices of goods and services
- Comparing scenarios of varying degrees of global action on climate change

Modelling the Ecological Transformation Plan – Power transition



- Rapid growth of onshore wind and solar PV
- Driven by globally declining technology costs
- Large hydro market share decreases
- No additional policy here

Modelling the Ecological Transformation Plan

- Representing ambitious investments into the power sector, railways, urban mobility and more
- Combined with decarbonization policies in high emitting sectors including power and road transport
- Aim to capture outcomes that change the long-term productivity of sectors with changes to imports and exports

Thank You!