

# Virtual Seminar on Climate Economics



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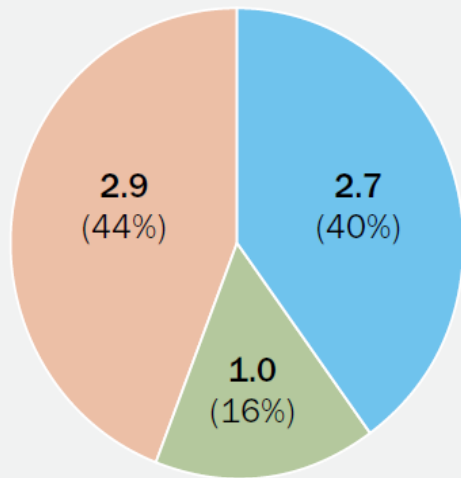
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# COUNTRY CLIMATE AND DEVELOPMENT REPORT

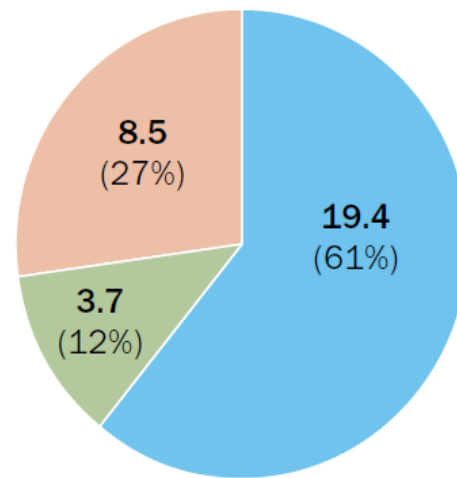
Approaches of and lessons from 45+ Country Climate and Development Reports  
Stephane Hallegatte, Senior Climate Change Adviser

# CCDRs covers 45+ economies

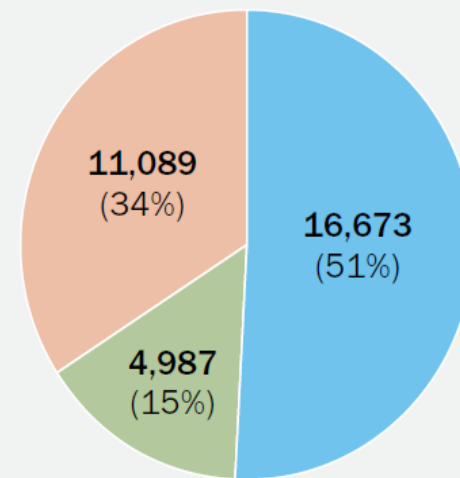
Population (billions, 2021)



GDP (\$, trillions, 2020)

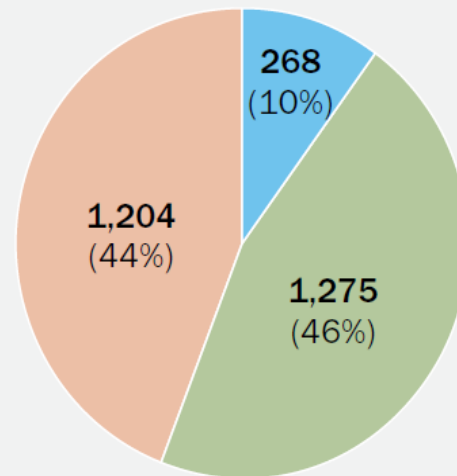


GHG emissions (MtCO2e, 2020)

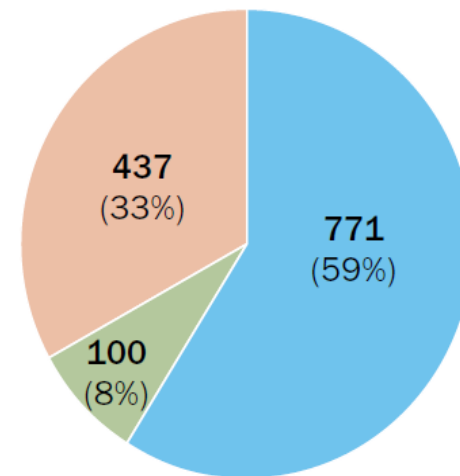


- Countries published by COP27
- Countries published since COP27 and forthcoming
- Other LICs and MICs

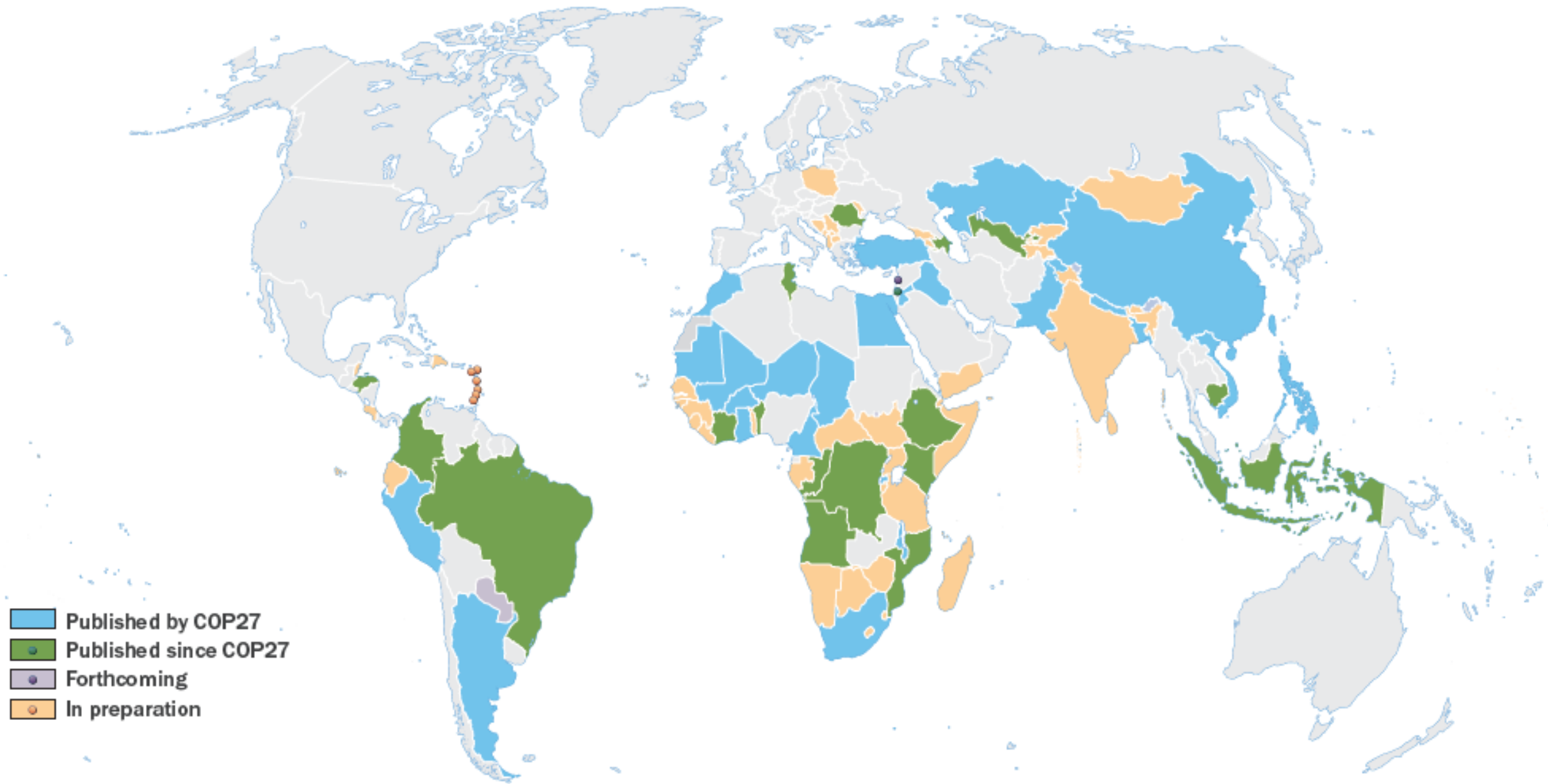
Tropical forested area (MHa, 2020)



Disaster losses (\$, billions, 2000-23)



Notes: GDP = gross domestic product; GHG = greenhouse gas; MHa = million hectares; MtCO2e = million tonnes of carbon dioxide equivalent; the population, GDP, GHG emissions, and disaster losses charts cover LICs and MICs; the tropical forested area covers all countries.



*Notes: CCDRs published by COP27 cover 24 countries: Argentina, Bangladesh, Burkina Faso, Cameroon, Chad, China, the Arab Republic of Egypt, Ghana, Iraq, Jordan, Kazakhstan, Malawi, Mali, Mauritania, Morocco, Nepal, Niger, Pakistan, Peru, the Philippines, Rwanda, South Africa, Türkiye, and Vietnam. CCDRs published since COP27 cover 18 economies: Angola, Azerbaijan, Benin, Brazil, Cambodia, Colombia, Côte d'Ivoire, the Democratic Republic of Congo, Ethiopia, Honduras, Indonesia, Kenya, Mozambique, the Republic of Congo, Romania, Tunisia, Uzbekistan, and West Bank and Gaza.*



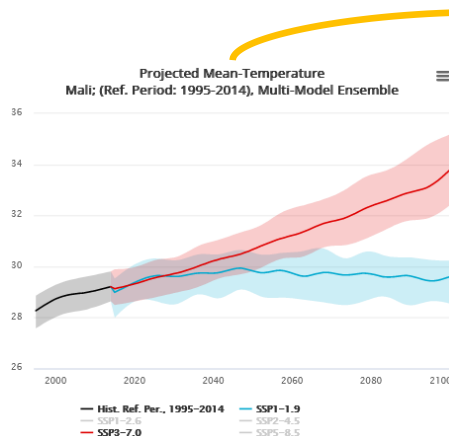
# Message 1

**Development and resilience are mutually reinforcing:** development contributes to resilience, and resilience is crucial for safeguarding development gains from increasingly frequent crises.

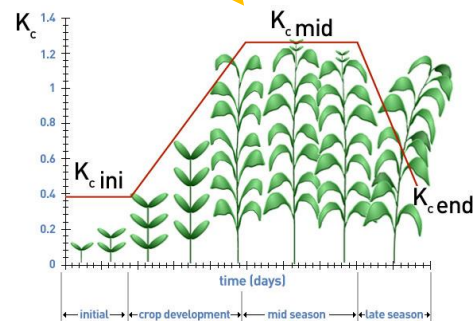
But **countries are not capturing readily available opportunities** to adapt to climate change and improve people's lives, health, and safety by building more resilient economies.

# Analytical approach to impact channels

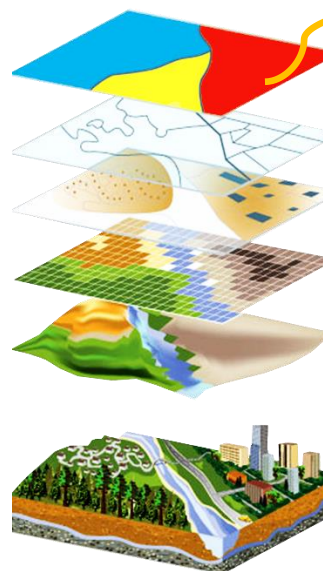
## CLIMATE VARIABLES



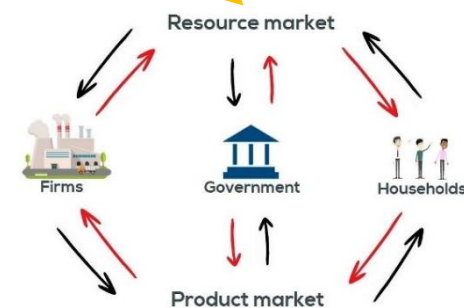
## BIOPHYSICAL MODELS



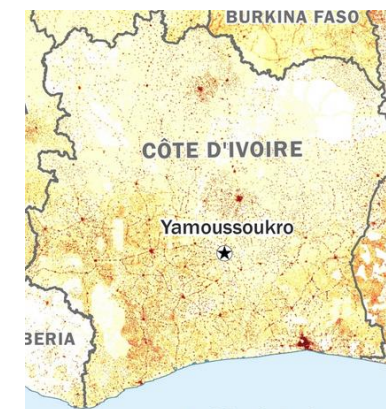
## GEOSPATIAL AGGREGATION



## MACROECONOMIC MODEL



## POVERTY OUTPUTS



- ½ degree data on precip and temp
- 2020-2050
- Multiple SSP scenarios

- Conversion of climate variables to biophysical effects
- E.g., yields, productivity, flood depths

- Aggregation to national scale using weights
- e.g., land cover or population

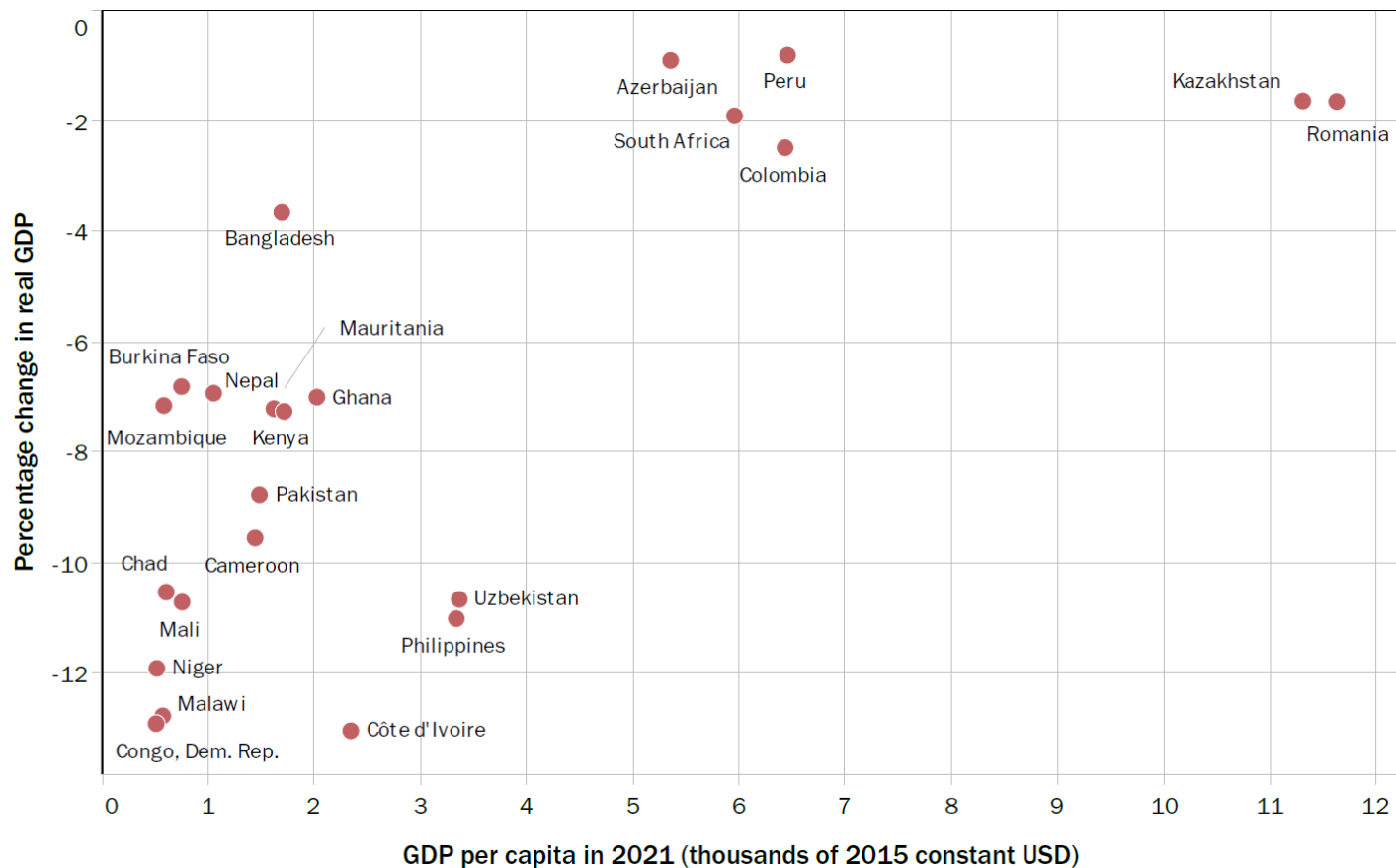
- Shocks to:
  - Sector productivity
  - Labor
  - Capital

- Spatially disaggregated
- Informed by household survey data

# Impact channels

CHANNEL	HOOK TO MACRO MODEL			
	(Sub)sector productivity	Labor Productivity	Labor Supply	Capital
<b>Human Health and Development</b>				
Labor heat stress		✓		
Human health			✓	
Fuelwood harvest and clean cooking			✓	
Water supply and sanitation			✓	
Tourism	✓			
<b>Agriculture and Land Use</b>				
Rainfed crop yields	✓			
Livestock yields	✓			
Erosion - crop yields	✓			
<b>Infrastructure and extreme events</b>				
Inland flooding	✓	✓		✓
Sea level rise and storm surge	✓			✓

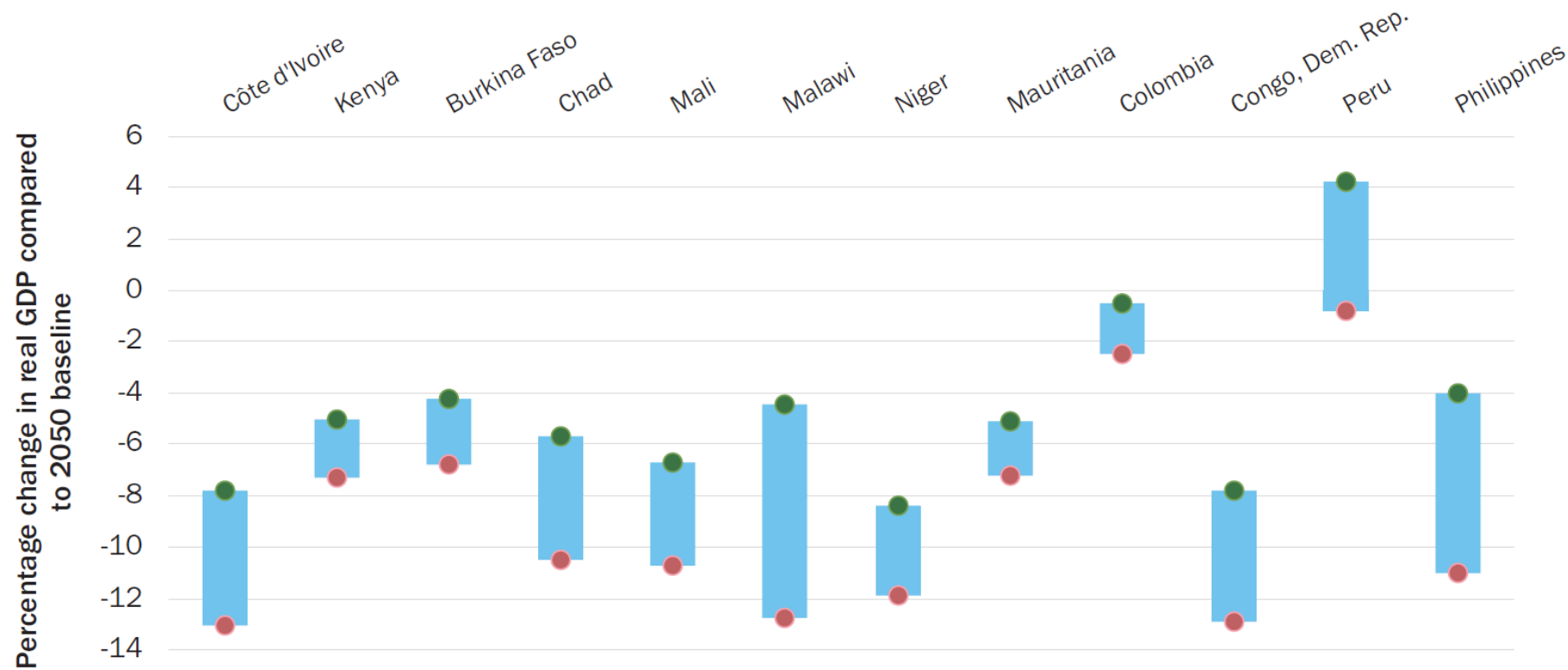
# Lower-income countries are more vulnerable, and effects on well-being include poverty, gender inequality, food insecurity, and impacts on health.



- In **DRC**, the poverty rate could increase by nearly 8 percentage points due to climate change, pushing 16 million people into poverty by 2050.
- In **Colombia**, poorer areas are more exposed to floods and droughts, and climate change is expected to increase inequality
- In **Kenya**, the mortality and morbidity due to malaria and dengue are expected to increase by 56 and 35 percent respectively by 2050.
- In **Benin**, women are particularly vulnerable due to pre-existing gender inequalities. For instance, only 4 percent of women claim agricultural land ownership compared to 26 percent of men



# Adaptation is a great investment, but it alone cannot completely prevent climate impacts



Even the most efficient adaptation cannot replace emission reductions, especially in high-income countries and other big emitters.

Notes: The red dots show the impact of climate change represented in CCDRs, with current policies and practices; the green dots show the impacts with recommended adaptation measures and their co-benefits.

# Integrating natural and climate disasters in a macroeconomic model



Economic Modelling



Volume 139, October 2024, 106787






Three innovations:

- Distinguishing infrastructure from non-infrastructure assets in the production function
- Representing the impact of the disaster on the capital stock and its productivity
- Representing realistic reconstruction timeline and constraints

## Modeling the macroeconomic consequences of natural disasters: Capital stock, recovery dynamics, and monetary policy ☆

Stéphane Hallegatte, Charl Jooste, Florent McIsaac  

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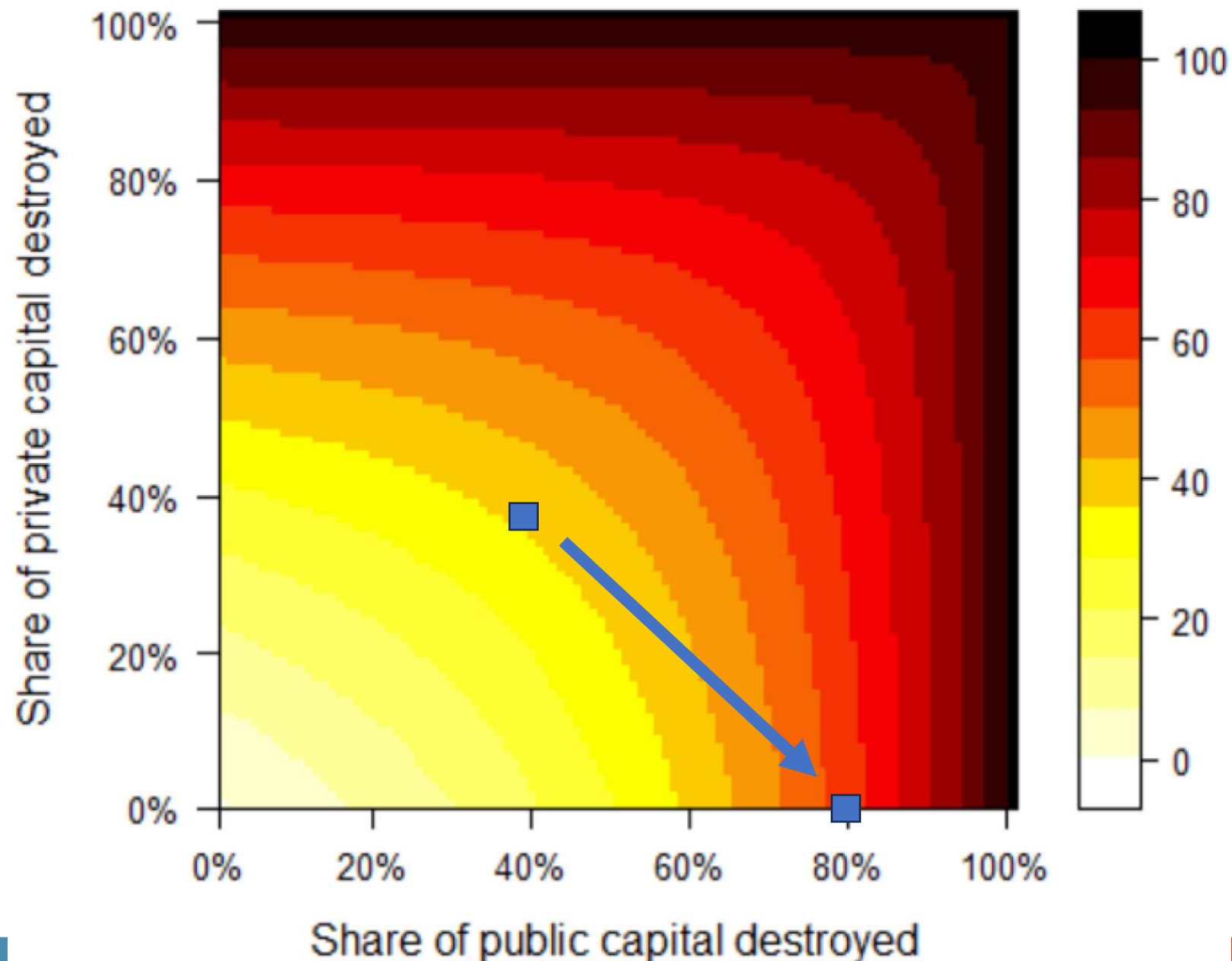
<https://doi.org/10.1016/j.econmod.2024.106787> 

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# Integrating natural and climate disasters in a macroeconomic model

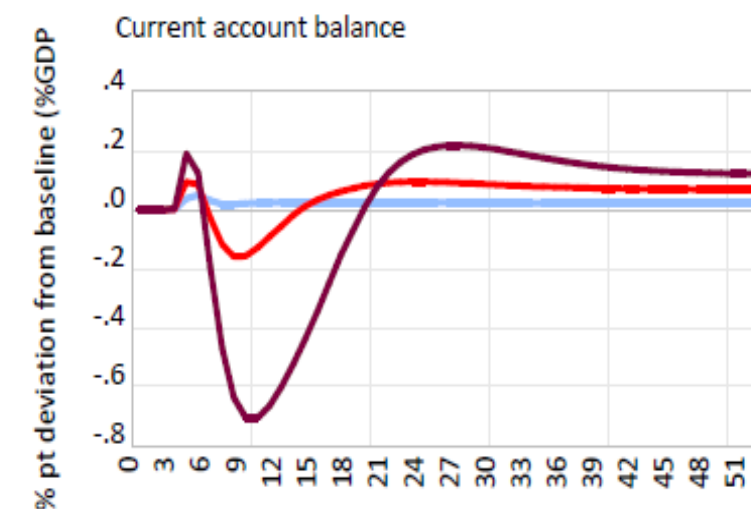
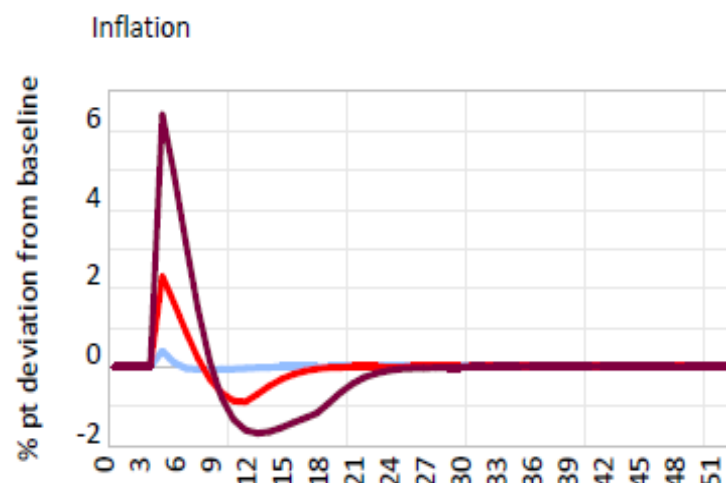
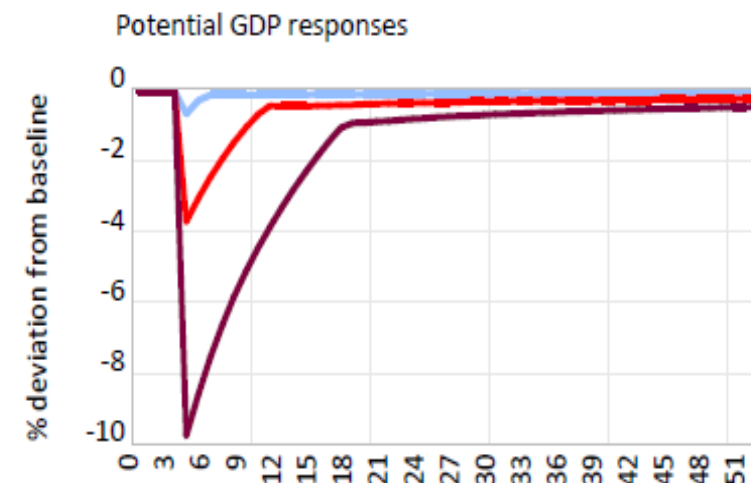
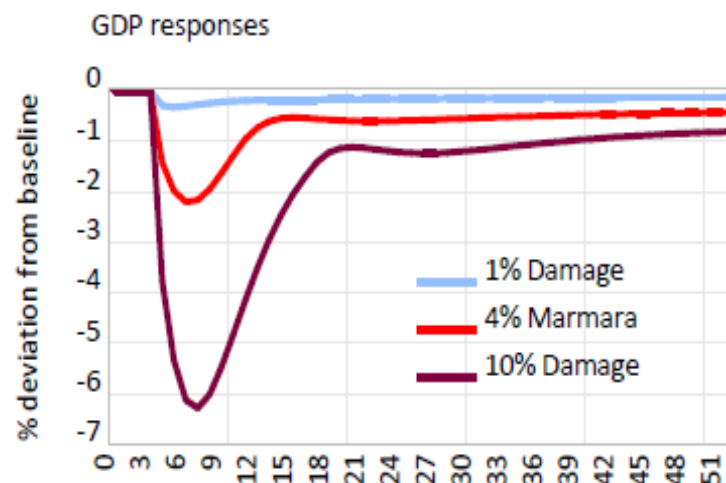
Three innovations:

- **Distinguishing infrastructure from non-infrastructure assets in the production function**
- **Representing the impact of the disaster on the capital stock and its productivity**
- Representing realistic reconstruction timeline and constraints

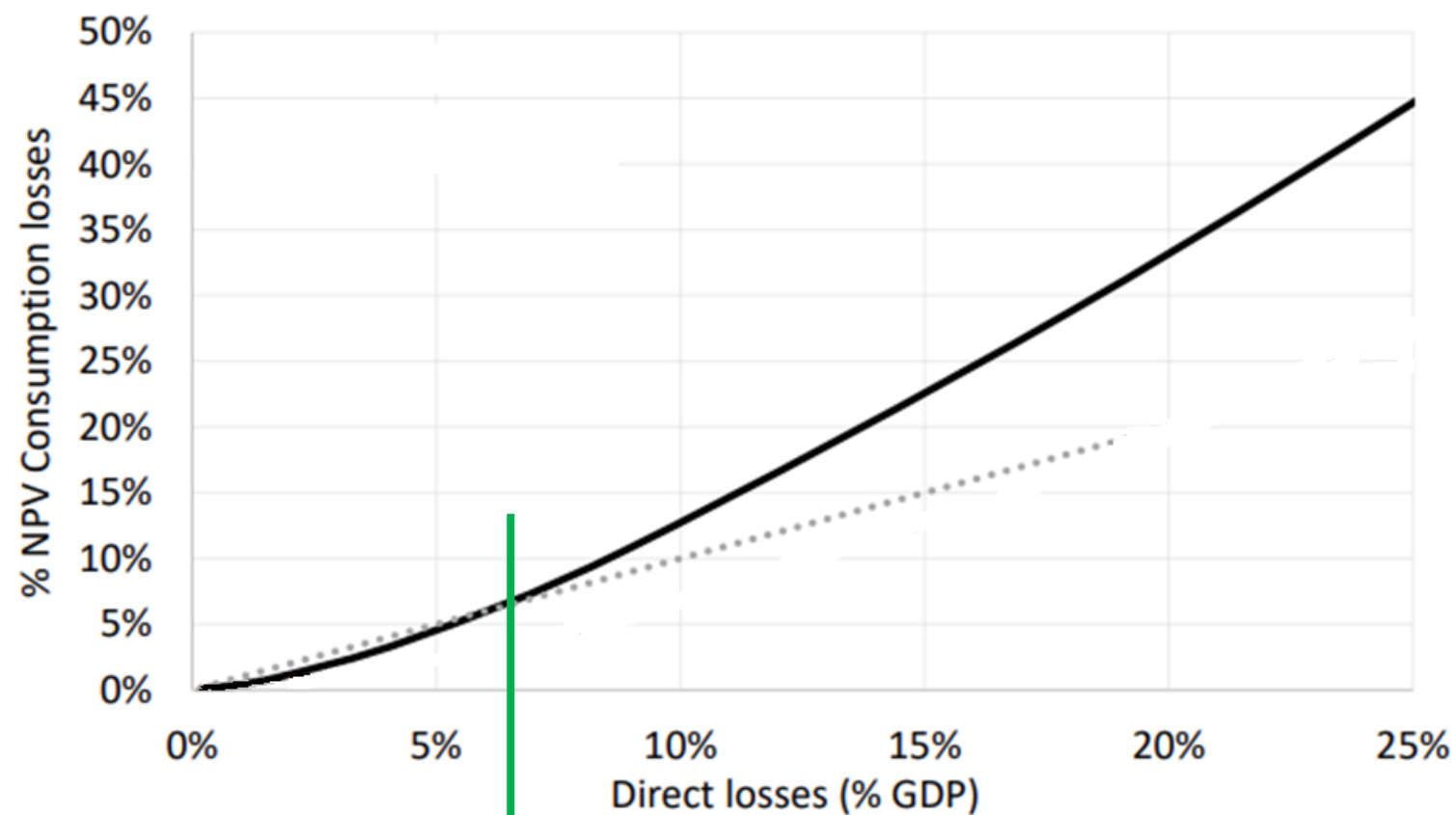


# A non-linear response to a single disaster

- Nominal response adds a lot of inertia to the system: response in terms of GDP much longer than in potential GDP.
- Monetary policy plays a key role

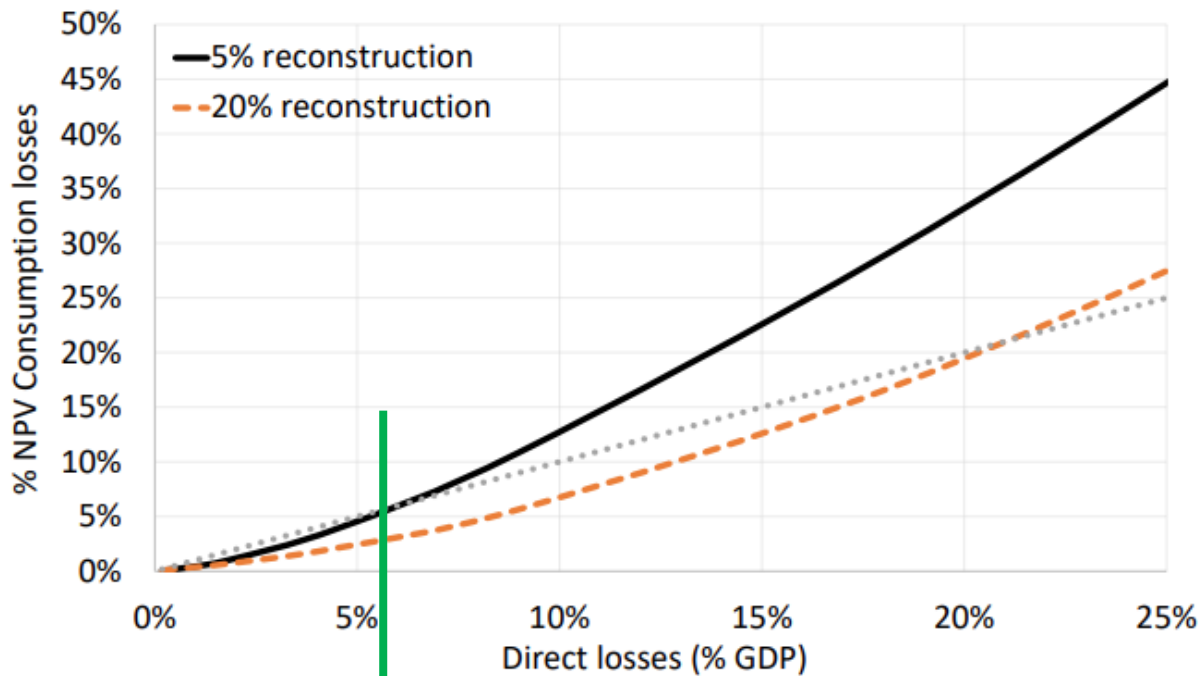


# A non-linear response to a single disaster



“Absorption capacity” in Türkiye?

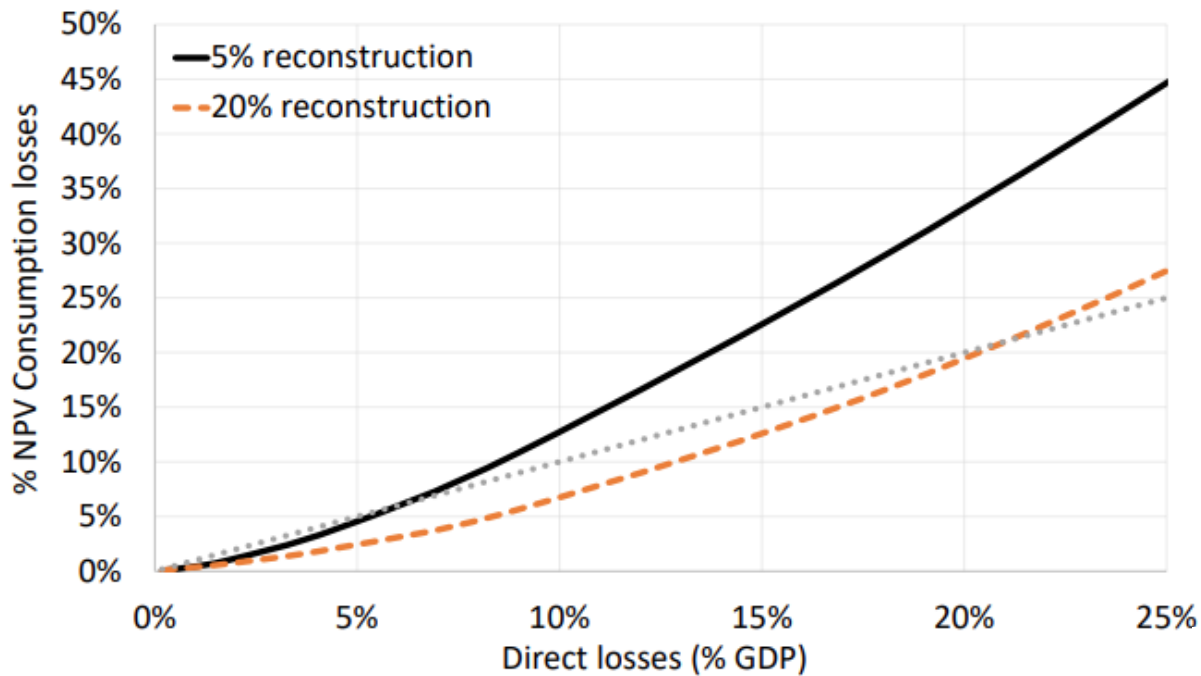




“Absorption capacity” in Türkiye?

**Total consumption loss increases nonlinearly with direct damages:** macroeconomic effects negligible for small shocks, but really matter for big disasters.

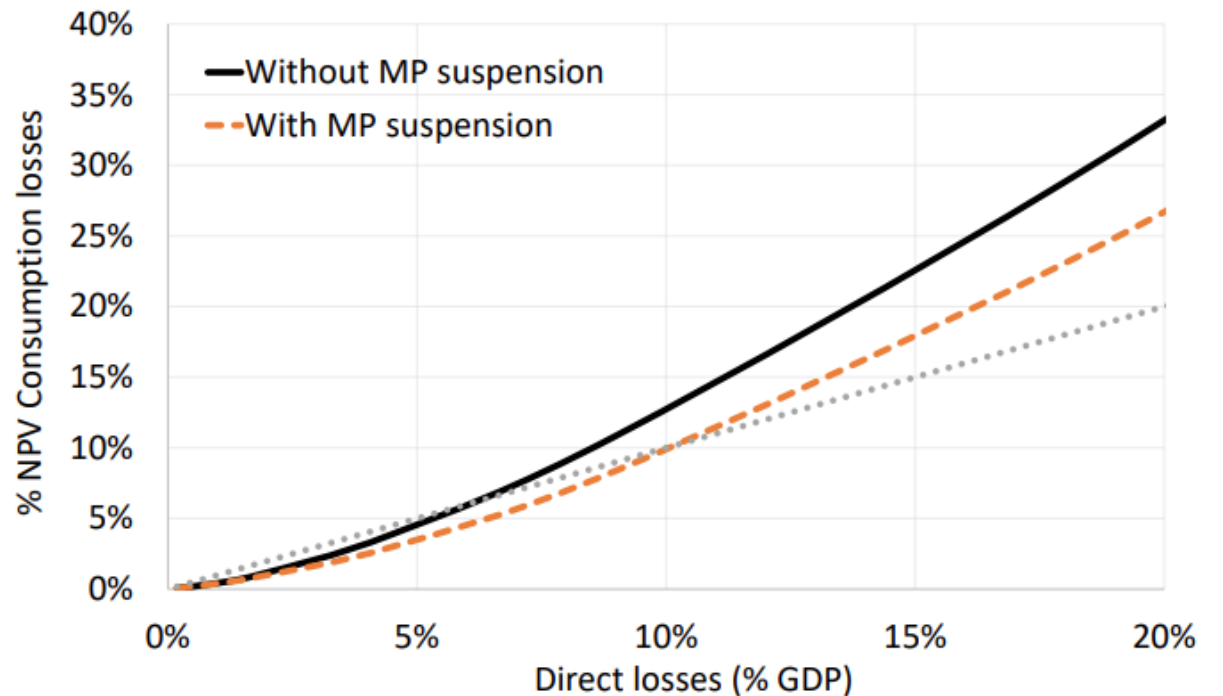
Total consumption loss can be reduced by faster reconstruction process: **preparedness is essential**



**Monetary policy matters:** a more flexible policy, responding with a delay to the disasters, makes the economic more resilient (it can absorb bigger shocks) and reduce the welfare impacts

**Total consumption loss increases nonlinearly with direct damages:** macroeconomic effects negligible for small shocks, but really matter for big disasters.

Total consumption loss can be reduced by faster reconstruction process: **preparedness is essential**



The background of the slide is a photograph of an industrial factory floor. Several large, white robotic arms are visible, positioned at various heights and angles. The lighting is somewhat dim, and the overall scene is a typical industrial environment. The text is overlaid on this image.

## Message 2

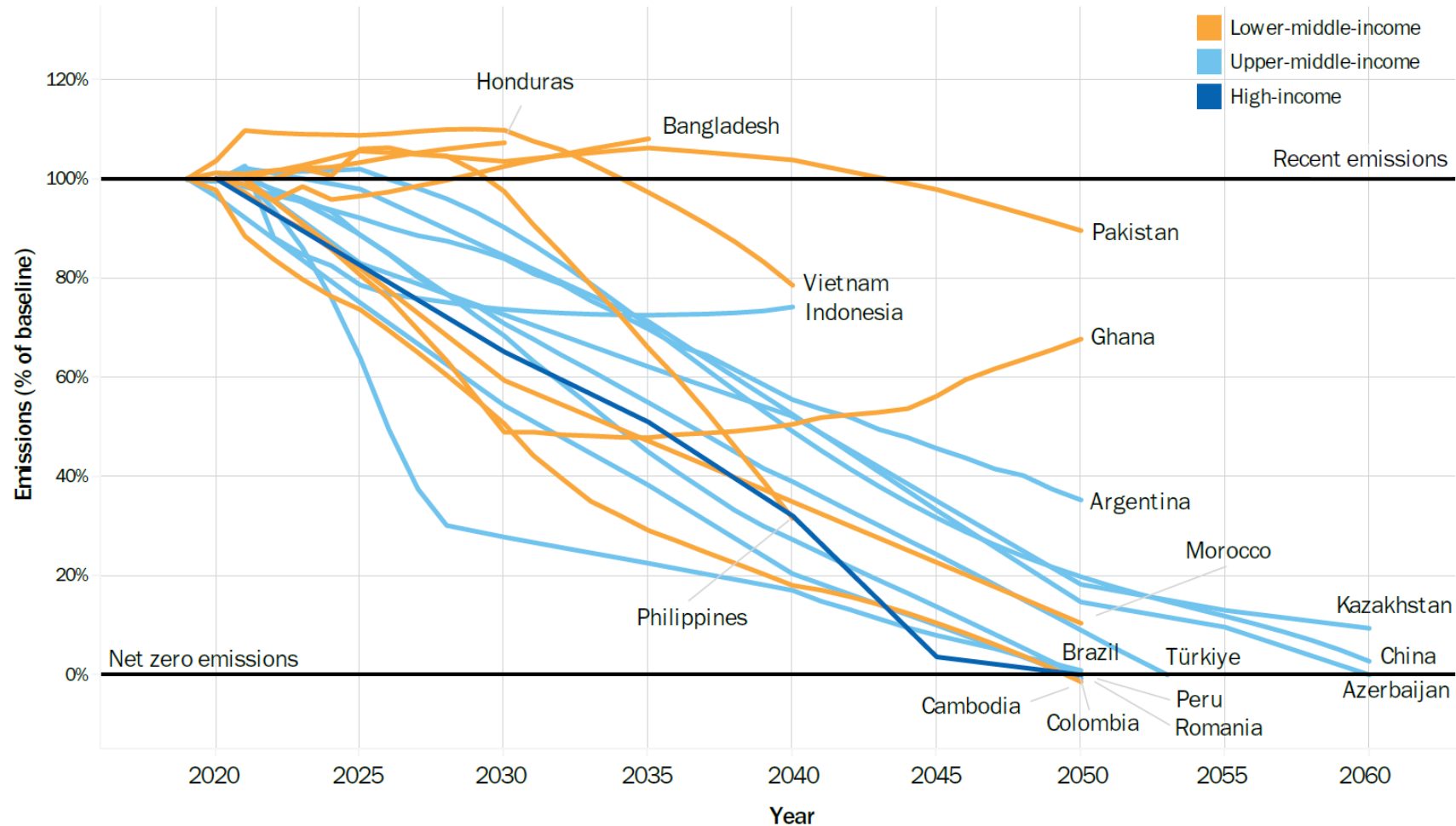
Annual incremental needs for **resilient low-emission development** in developing countries are estimated at 0.4–10 % of GDP.

The **private sector** has a key role to play in meeting investment needs, but also in delivering **innovation, faster technology adoption, and new business models**.

To incentivize private sector involvement, countries will need to develop an appropriate legal and institutional framework and provide adequate concessional resources to mitigate **credit, foreign exchange, or market risks** when it is needed.



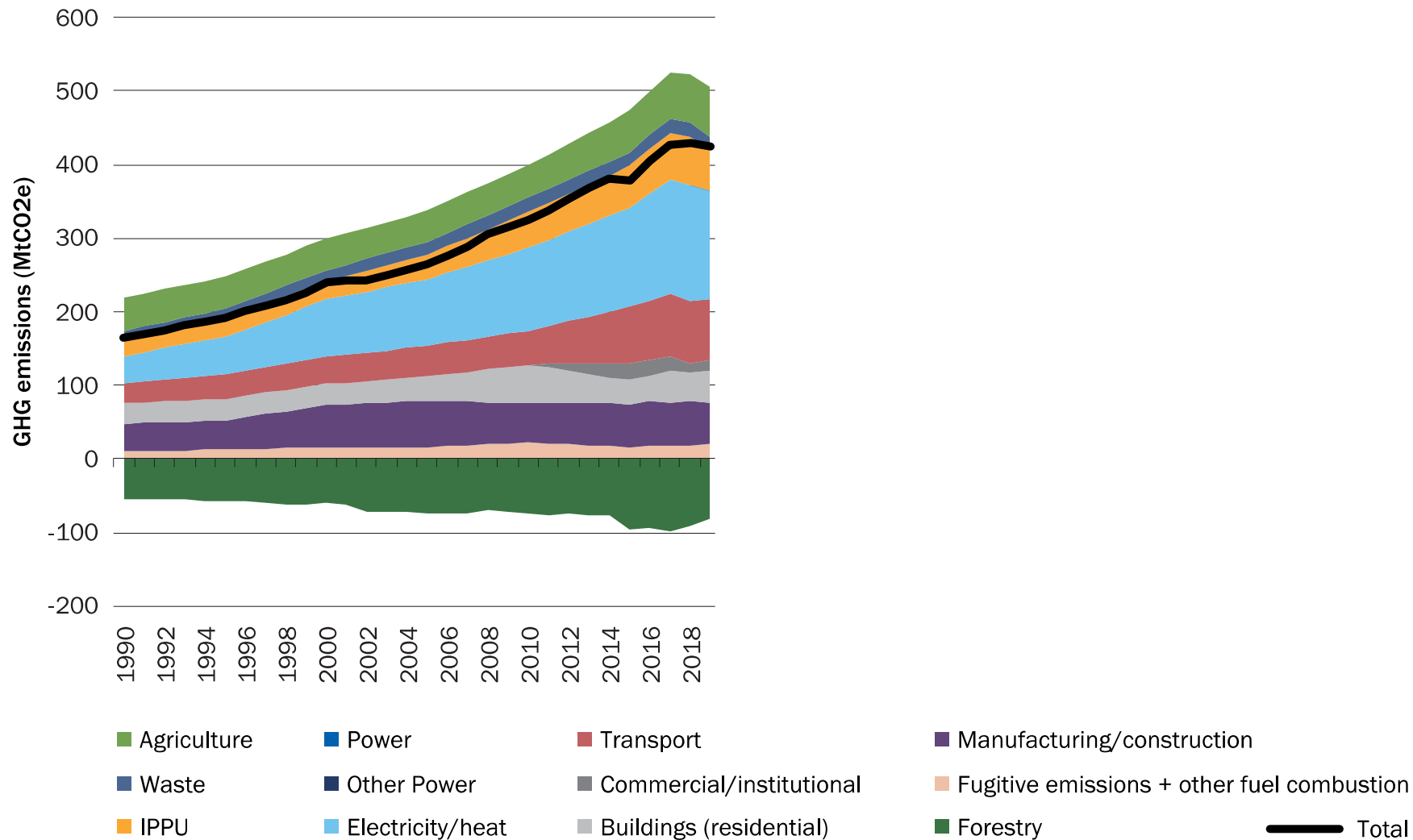
# CCDRs use low-emission development pathways to assess costs and benefits, opportunities and trade-offs



-73%

# An example: Resilient Net zero Pathway (RNZP) for Türkiye

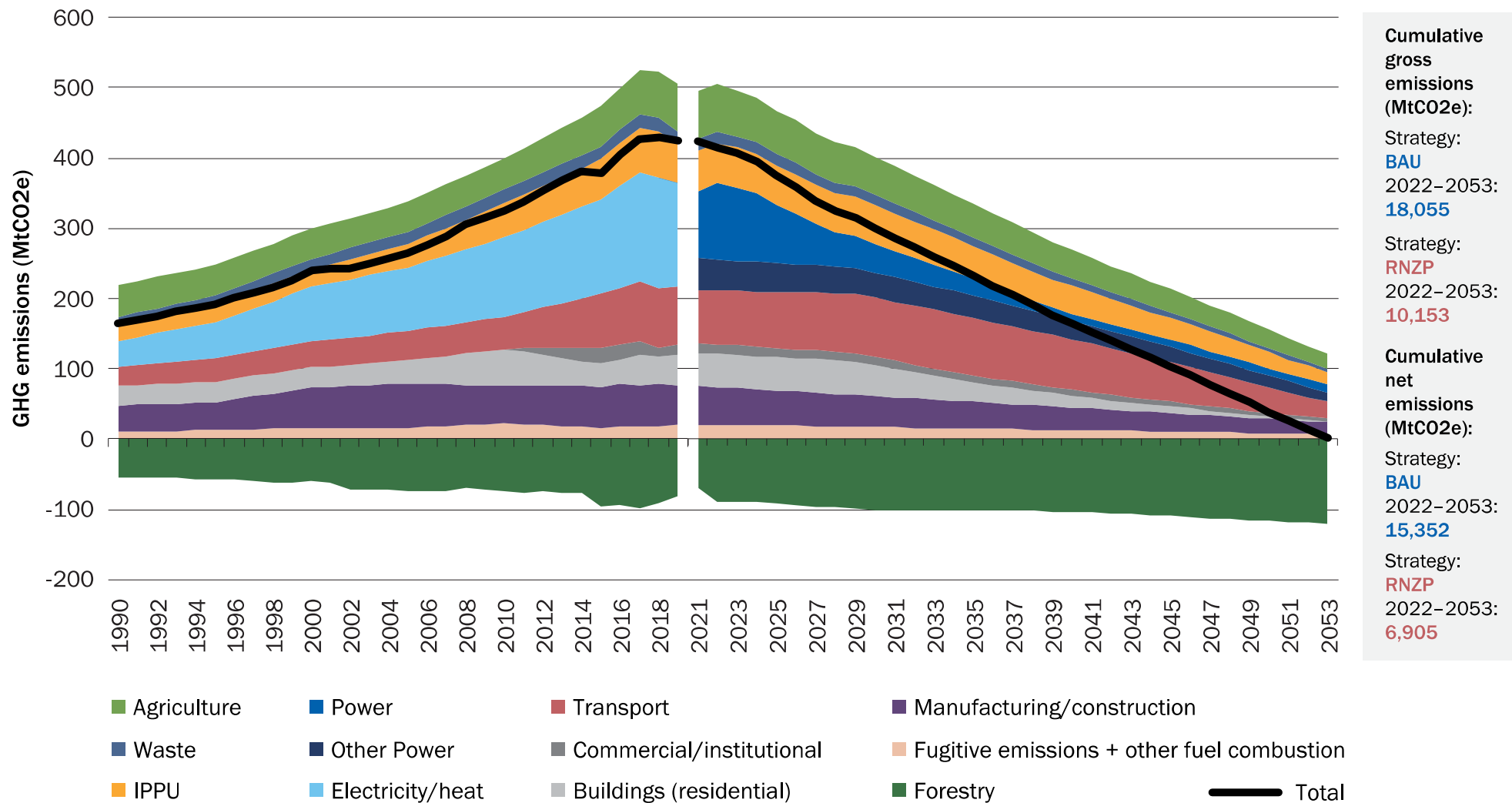
## Historical emissions and scenario for 2053





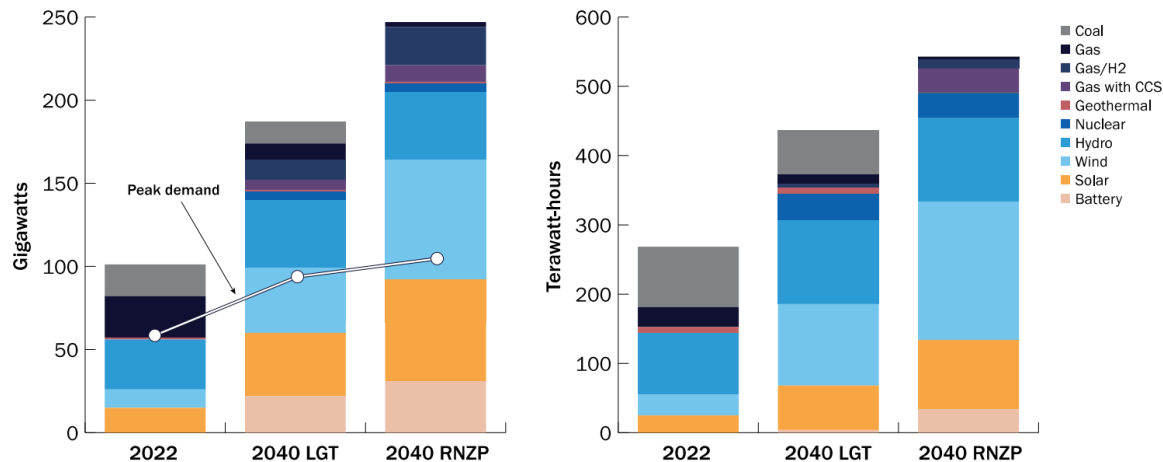
# An example: Resilient Net zero Pathway (RNZP) for Türkiye

## Historical emissions and scenario for 2053



# An example: Resilient Net zero Pathway (RNZP) for Türkiye

## A set of techno-economic models (here energy and transportation)



Source: World Bank staff estimates

Notes: Gas/H2 = hydrogen gas; CCS = carbon capture and storage. Note: LGT = least-cost with current government targets (BAU)

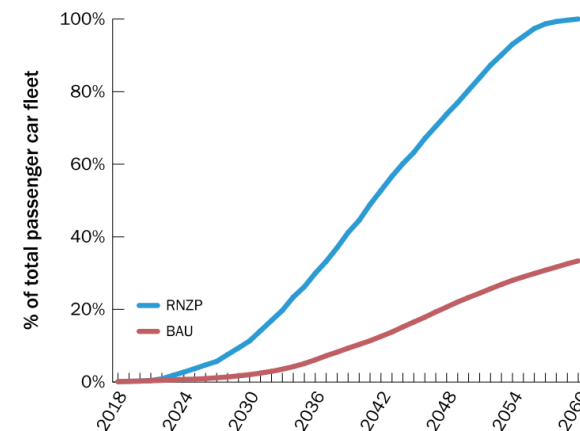
### Energy

- least-cost power sector planning model EPM (Chattopadhyay, de Sisternes, & Oguah, 2018) to meet 90% reduction by 2040
- calculates the consumption of different fuels, distinguishing between imported and domestically produced fuels, operating costs and simple estimates of air pollution costs

### Transportation

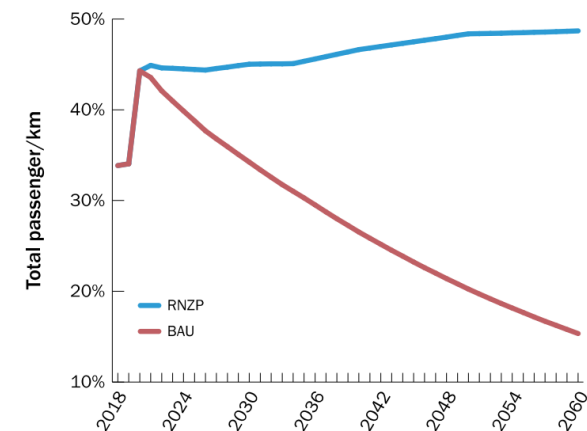
- A simple sectoral roadmap combining modal shift, energy efficiency, and electrification in transport.
- The shift affects total energy consumption, the energy mix used in transportation, as well as energy costs for households and firms as well as imports.
- calculates the consumption of various fuels, distinguishing imported and domestically produced fuels, the operational costs, and simple estimates for air pollution costs, as well as congestion and road fatalities

a) EV adoption for passenger cars



Source: World Bank staff estimates

b) Modal share, public transit (buses and rail)



# An example: Resilient Net zero Pathway (RNZP) for Türkiye

## Summary of investment needs, economic costs, and benefits

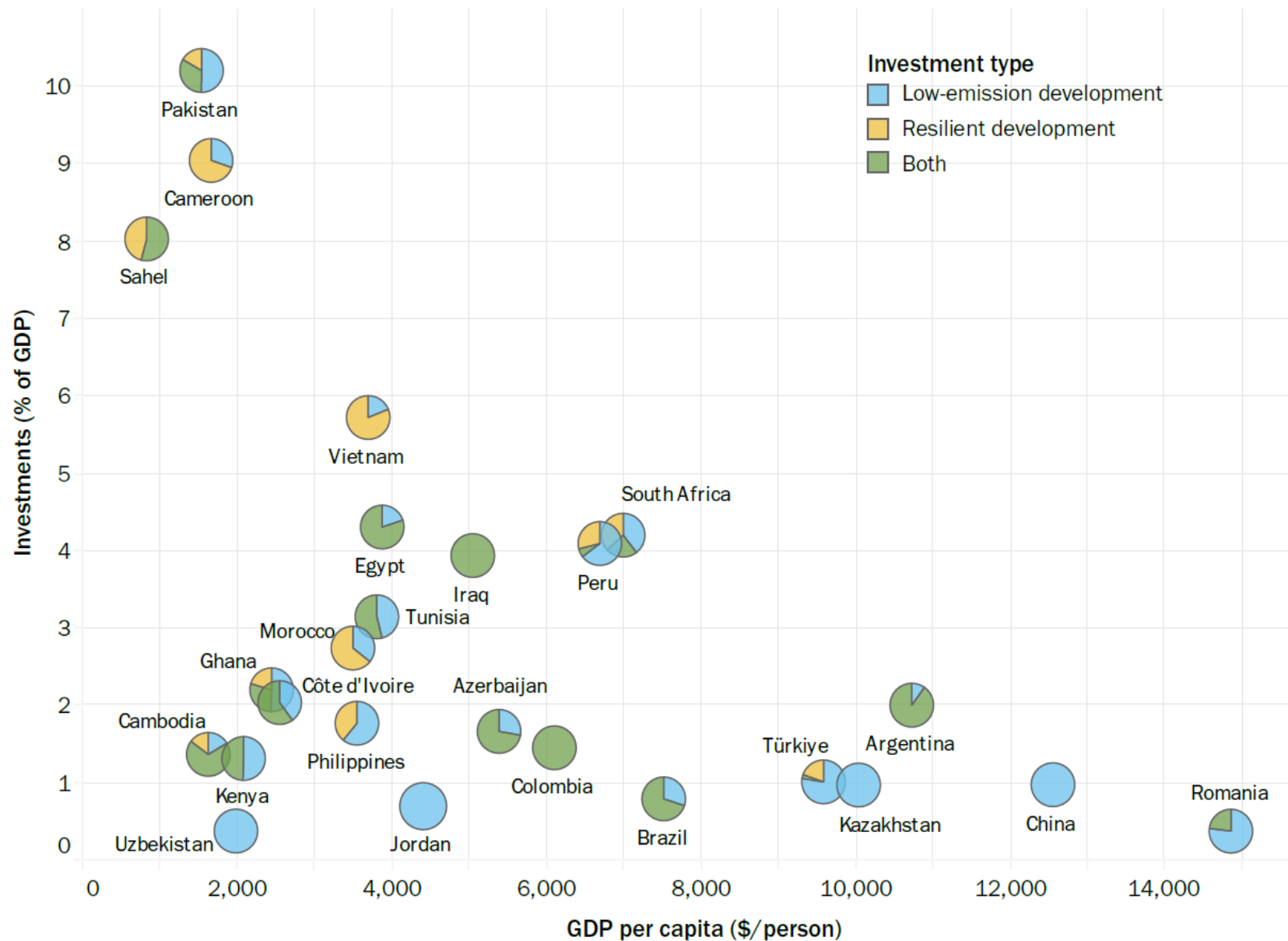
Table S.1: Investment needs and economic costs in the RNZP (additional compared with baseline)

	2022–30 (\$, billions)	2022–40 (\$, billions)
<b>POWER</b>		
Additional investment: new generation and storage capacity	+5	+33
Additional investment: transmission and distribution	+8	+14
Other economic costs: operational and fuel costs	-9	-23
Other economic costs: air pollution externality costs from coal	-9	-38
Other economic costs: decommissioning of coal plants and mines	< +1	+1.4
<b>RESIDENTIAL</b>		
Additional investment: energy efficiency, electrification, and resilience	+45	+100
Other economic costs: gas imports	-11	-46
Other economic costs: lives lost and injuries	-1	-3
<b>TRANSPORT</b>		
Additional investment: new resilient infrastructure	+8	+15
Other economic costs: fuel imports	-12	-36
Other economic costs: cost of disruptions	-3	-11
Other economic costs: air pollution, congestion, and road fatalities	-40	-171
<b>FOREST LANDSCAPES</b>		
Additional investment: restoration, reforestation, and fire management	+2	+3
Other economic costs: loss of harvest revenues	+1	+5
<b>AGRICULTURE</b>		
Other economic costs: on-farm emissions reductions	< +1	-
<b>INDUSTRY AND MANUFACTURING</b>		
Other economic costs: cement, iron, and steel	-	+11
<b>TOTAL INVESTMENTS AND ECONOMIC COSTS</b>		
Net economic costs	-15	-146
includes: additional investment	68	165

Notes: All amounts are discounted using a 6 percent discount rate. Decommissioning costs do not include the social expenditures to facilitate the transition of affected workers and communities. Numbers in red are net costs; numbers in green are net benefits.

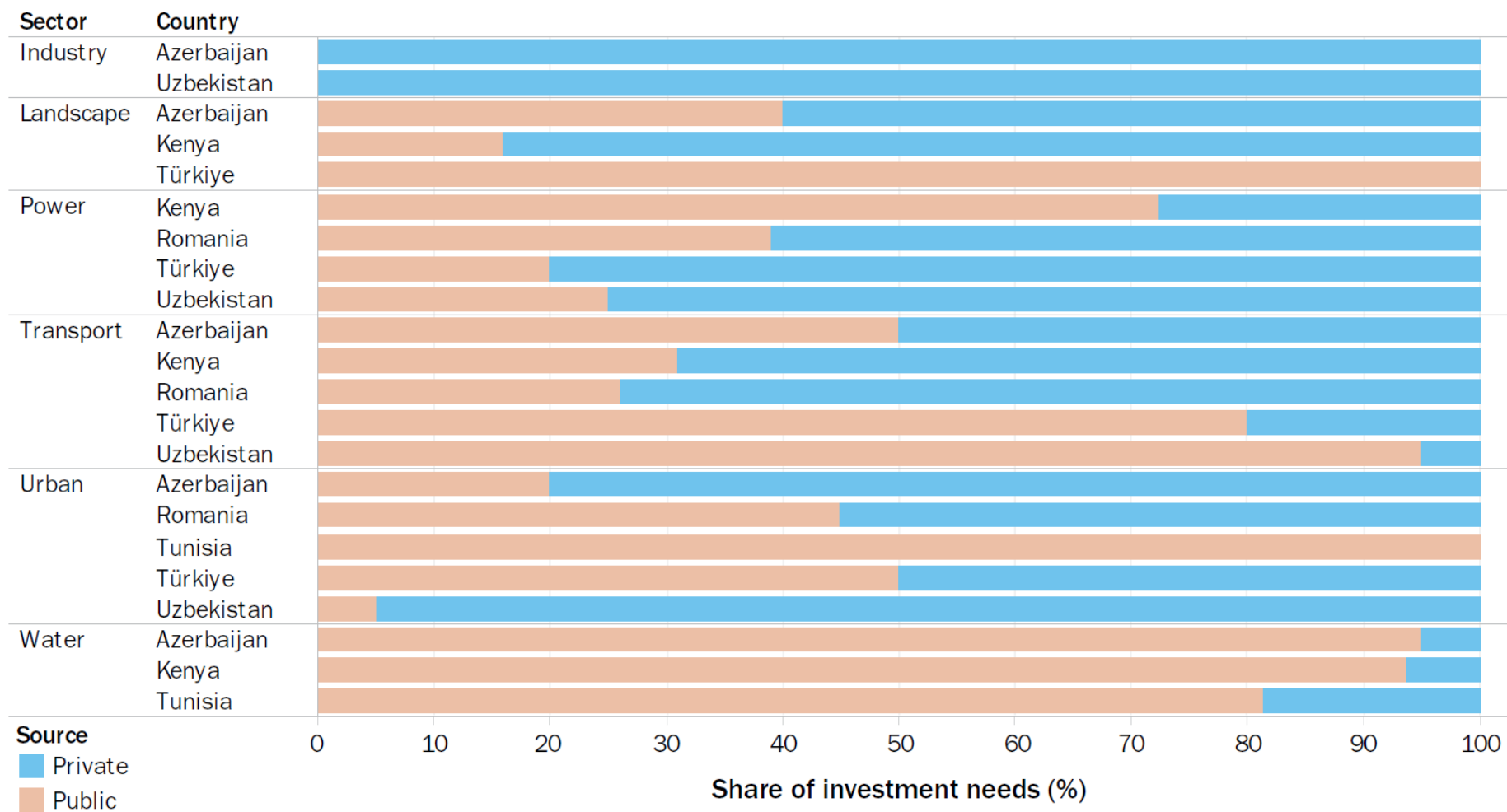
# Lower-income countries have higher financial needs

Additional annual investment needs over 2023-2030, percent of GDP



Note: Sahel is Burkina Faso, Chad, Mali, Mauritania, and Niger.

# The private sector has a key role to play in meeting investment needs for resilient low-emission development

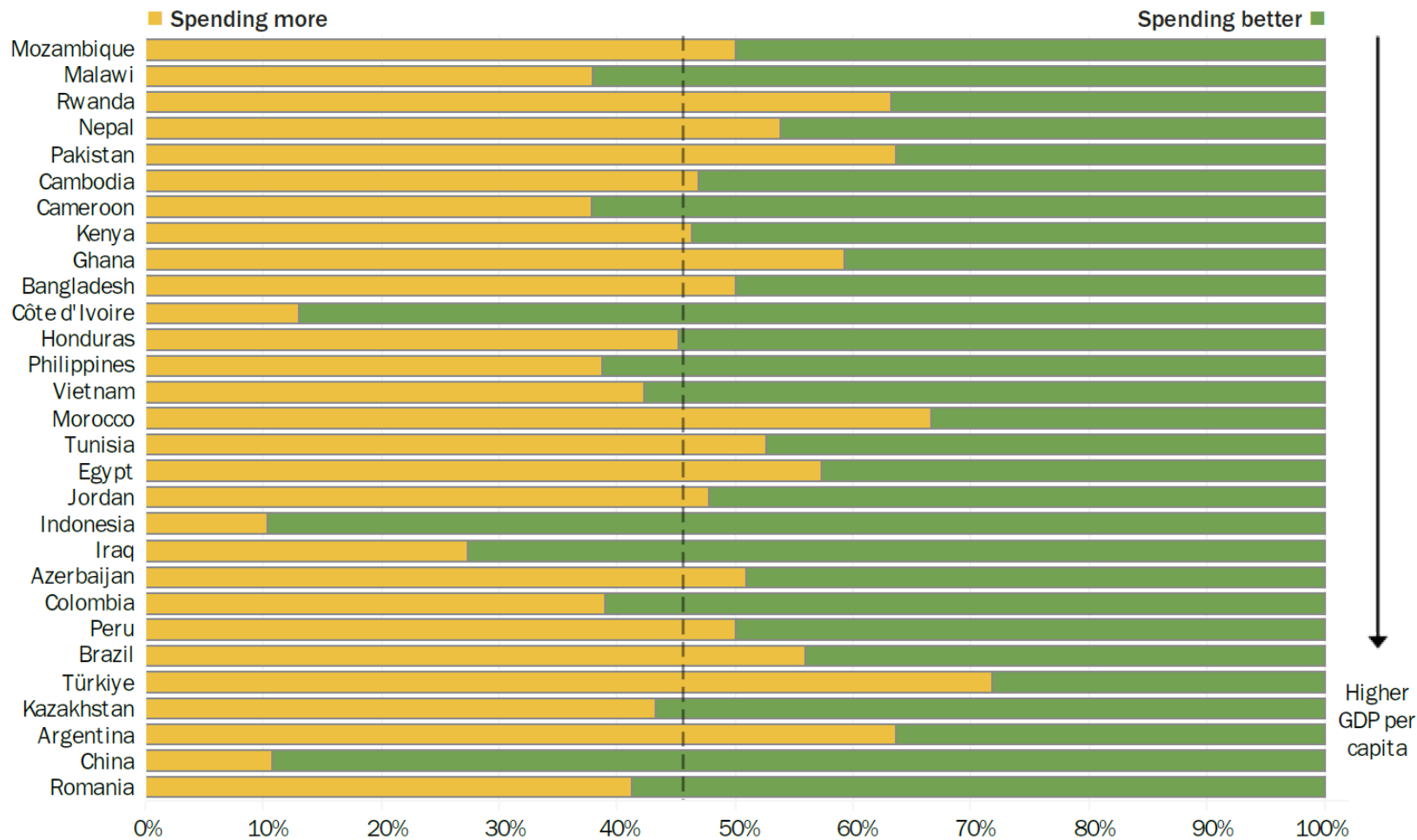


Note: Landscape includes forestry, agriculture, and land management.



# CCDRs identify many opportunities to spend existing resources better

This includes the repurposing of energy, water, and agriculture subsidies and trade policy reforms.



## Message 3

Low-emission development can foster **similar—or even faster—economic growth and poverty reduction** as current development pathways.

This requires **a supportive enabling environment and macroeconomic context**, well-designed policies, management of negative impacts in some sectors, communities, and regions, and stronger financial and technical support from high-income countries and the international community.

# An example: Resilient Net zero Pathway (RNZP) for Türkiye

## Summary of investment needs, economic costs, and benefits

Table S.1: Investment needs and economic costs in the RNZP (additional compared with baseline)

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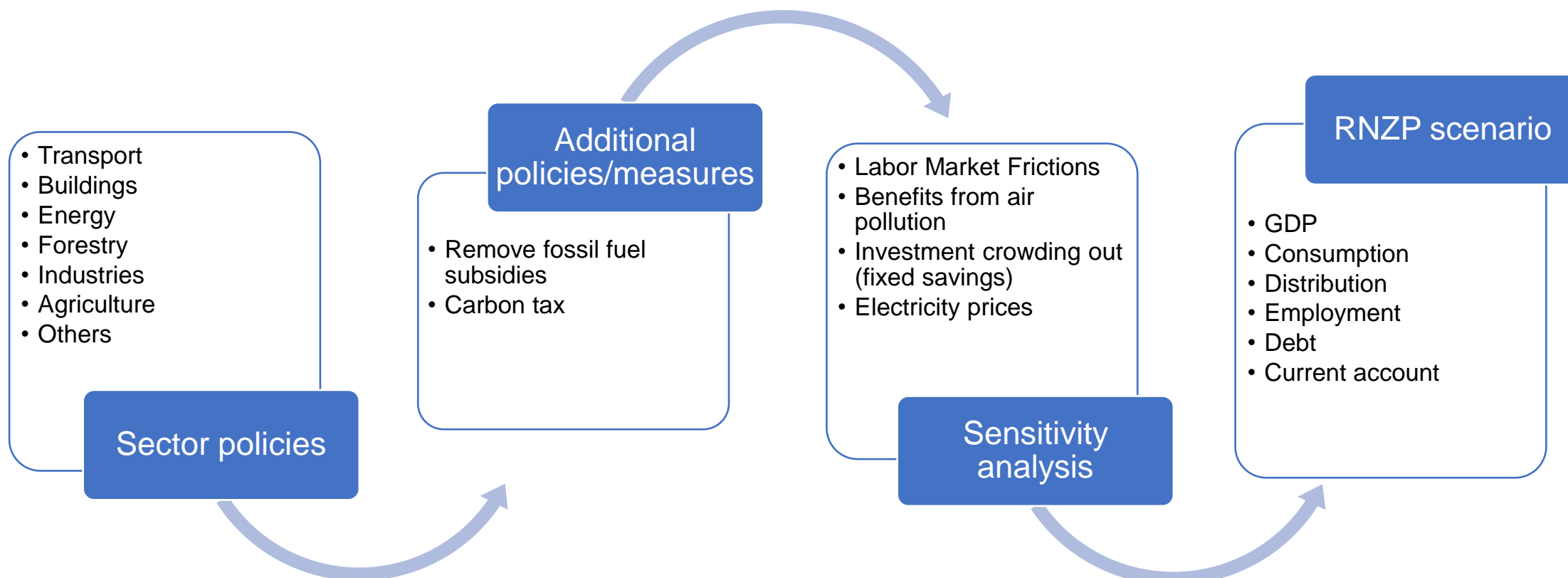
What are the implications for growth and other macro variables?

Notes: All amounts are discounted using a 6 percent discount rate. Decommissioning costs do not include the social expenditures to facilitate the transition of affected workers and communities. Numbers in red are net costs; numbers in green are net benefits.

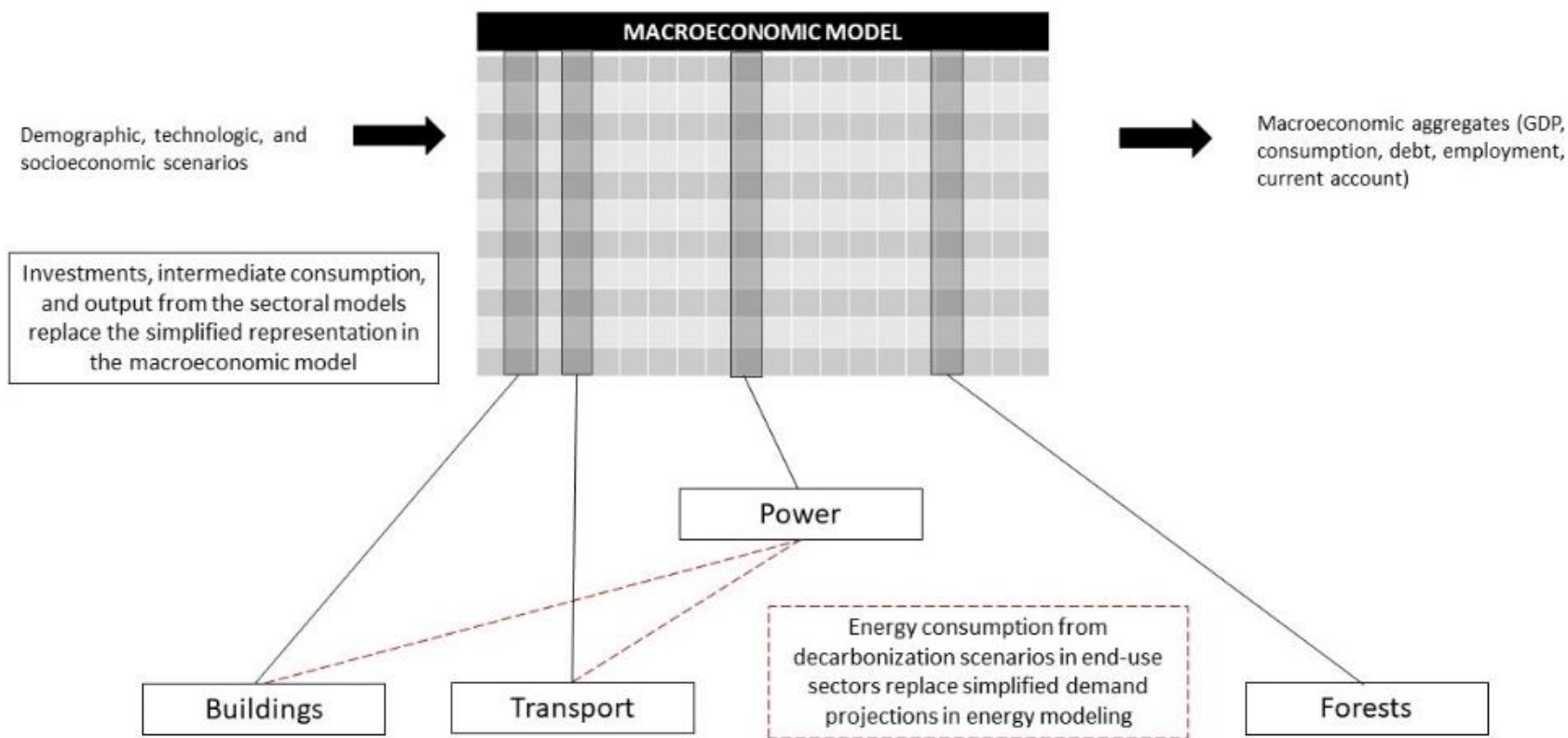


# Connecting sectoral roadmap to macroeconomic models

Necessary to check consistency, and feasibility



# A hybrid modeling approach combining sectoral roadmap with macro modeling

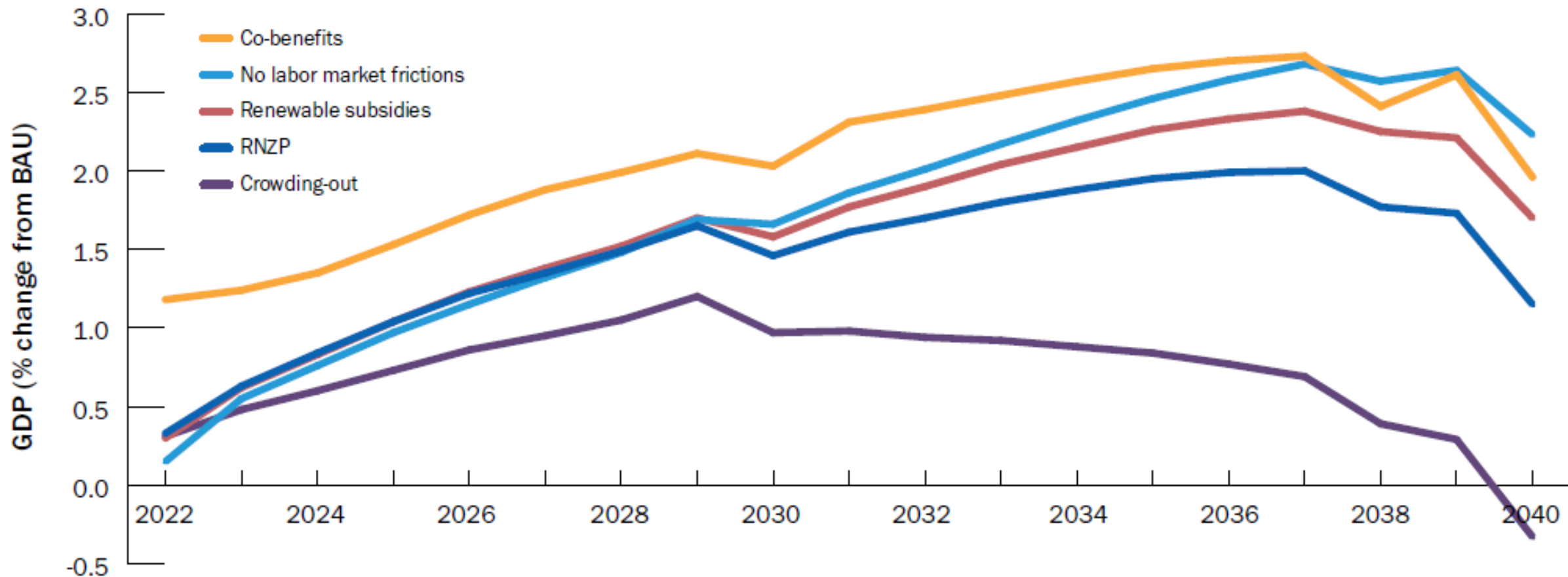


1. **A sequence of models rather than a single integrated framework** (Bataille, Jaccard, Nyboer, & Rivers, 2006 ; Bosetti, Carraro, Galeotti, Massetti, & Tavoni, 2006 ; Böhringer & Rutherford, 2008 ; Hourcade, Jaccard, Bataille, & Gherzi, 2006 ; Kim, Edmonds, Lurz, Smith, & Wise, 2006 ; Köhler, Barker, Anderson, & Pan, 2006)
2. **Plausible rather than optimal decarbonation path** (Pindyck, 2013 ; IMF, 2022)
3. **Many market failures rather than one** (Lipsey & Lancaster, 1956 ; Batten 2018 ; Pisani-Ferry 2021)

# An example: Resilient Net zero Pathway (RNZP) for Türkiye

## Implication for GDP and growth

Figure 4.1: Projected growth benefits of transitioning to RNZP

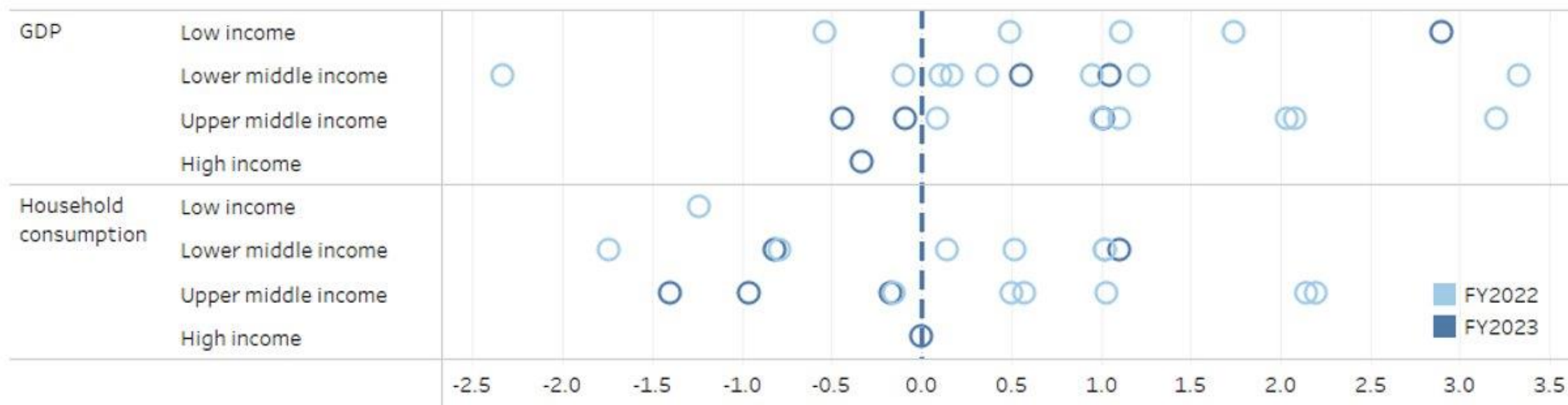


Source: World Bank staff estimates



## Economic growth in low-carbon scenarios is similar – or even faster – than that in reference scenarios, but impacts on consumption are larger.

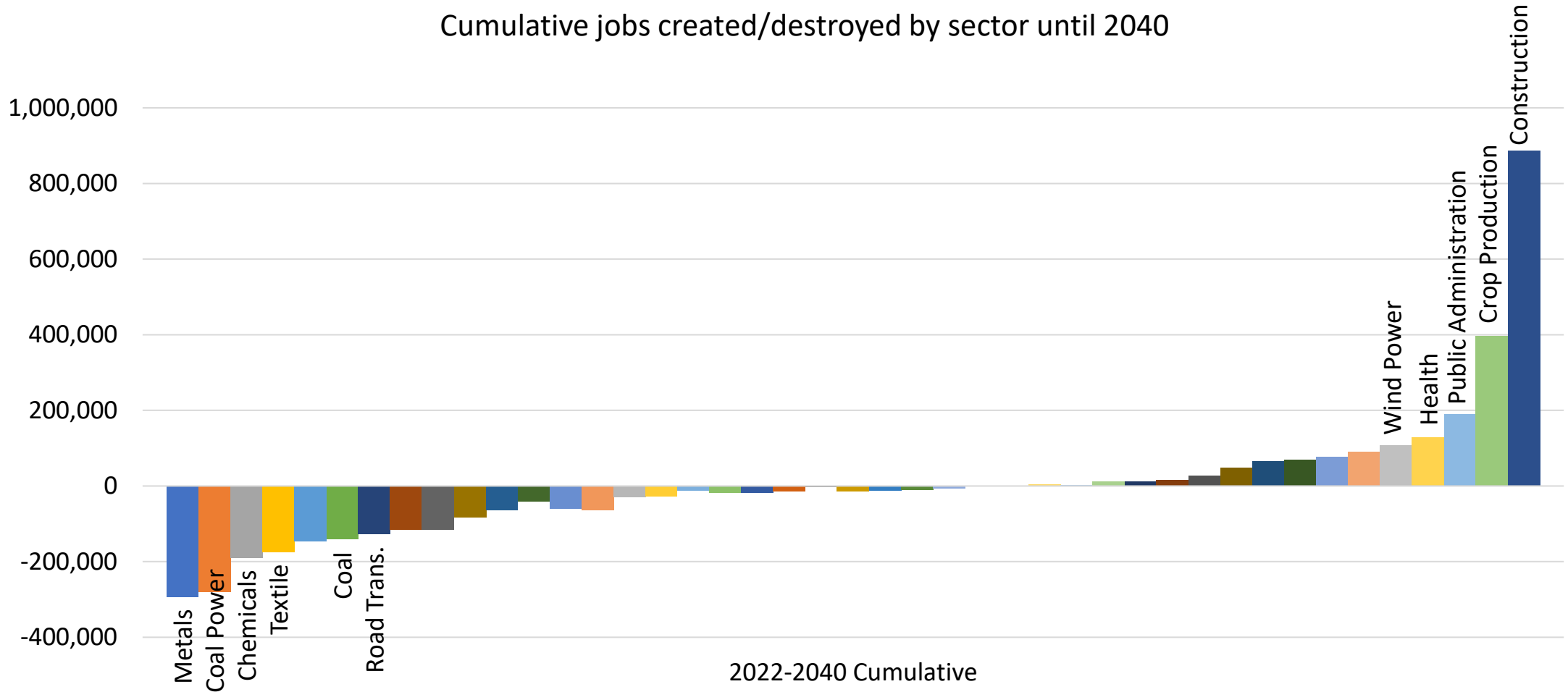
Impact on GDP and consumption by 2030 (% of baseline)



This requires a supportive enabling environment and macroeconomic context, well-designed policies, management of negative impacts in some sectors, communities, and regions, and stronger financial and technical support from high-income countries and the international community

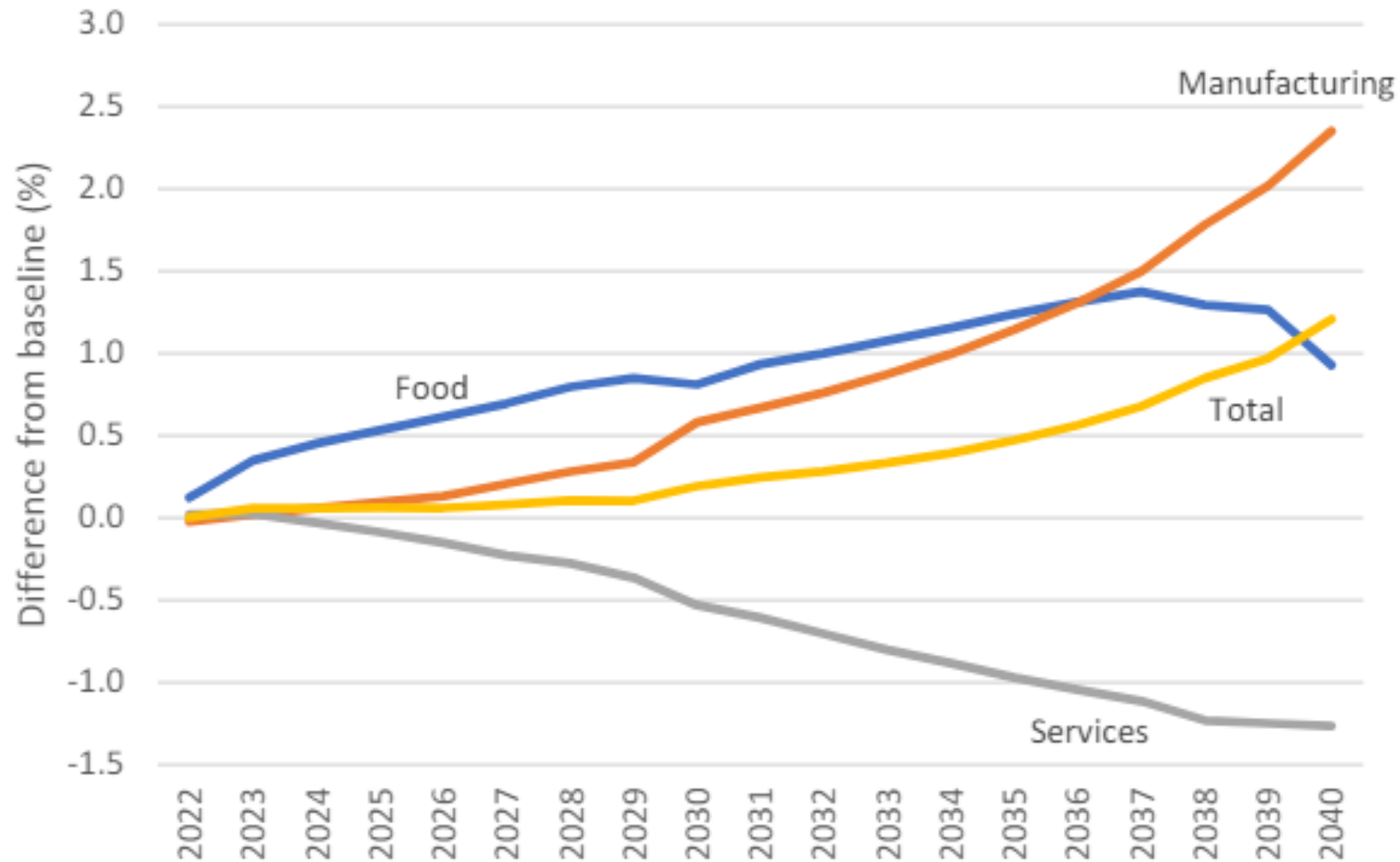
# An example: Resilient Net zero Pathway (RNZP) for Türkiye

## Implications for job creation and destruction



# An example: Resilient Net zero Pathway (RNZP) for Türkiye

## Implications for inflation pressures





# The Macroeconomic Implications of a Transition to Zero Net Emissions

## **24-6 Macroeconomic implications of a transition to net zero emissions**

**Approaches of and lessons from World Bank Group  
Country Climate and Development Reports, with an  
application to Turkey**

Stéphane Hallegatte, Florent Mclsaac, Hasan Dudu, Charl Jooste, Camilla  
Knudsen, and Hans Beck

March 2024

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### **ABSTRACT**

In 2022 the World Bank Group launched a new core diagnostic tool: the Country Climate and Development Report (CCDR). Published for 42 economies so far, CCDRs use resilient and low-emission development scenarios to identify synergies and tradeoffs between development and climate objectives. There are

**Stéphane Hallegatte** is a senior climate change advisor of the World Bank. **Florent Mclsaac** is a senior economist at the Macroeconomic

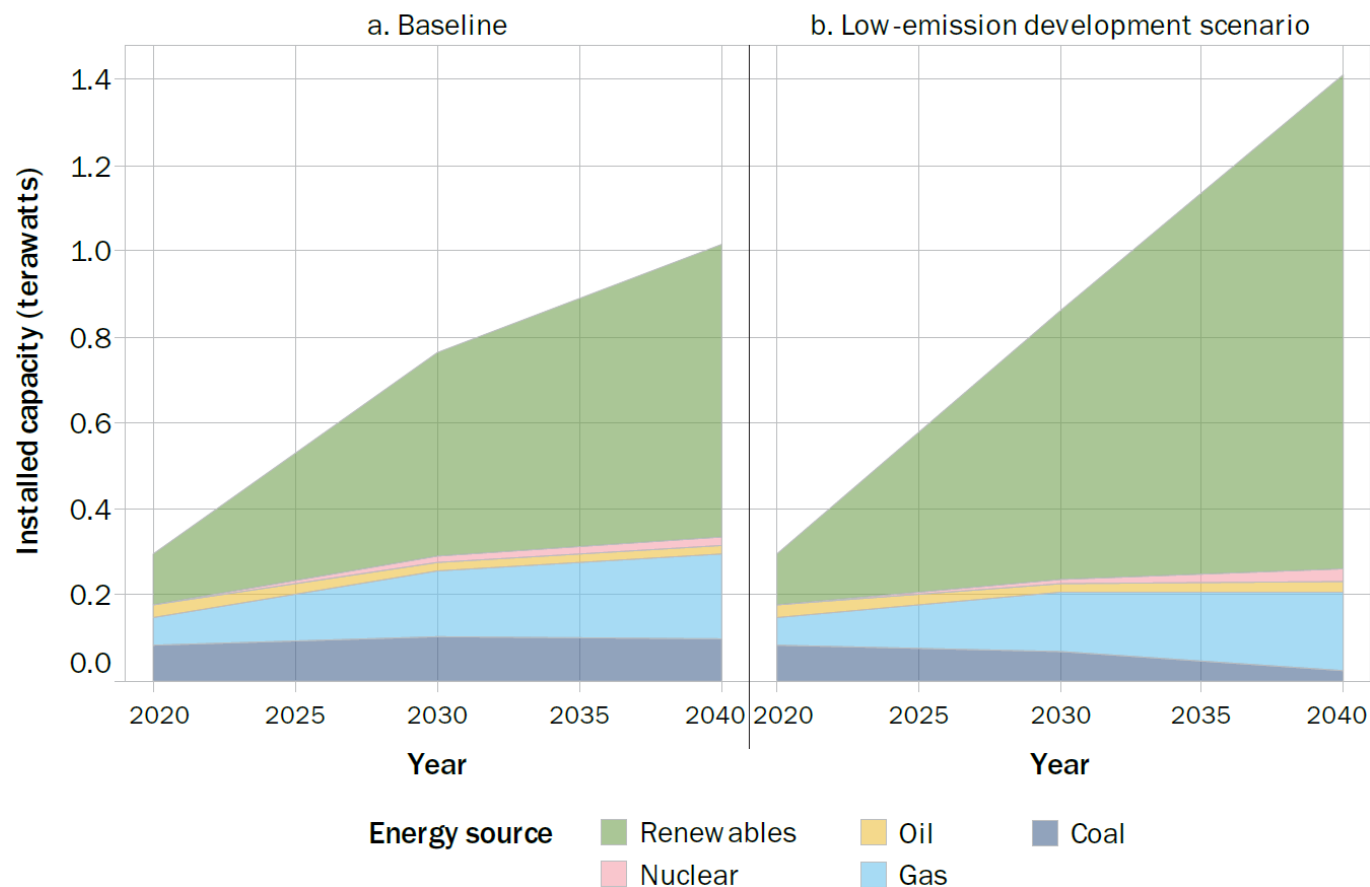
World Bank  
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COUNTRY  
CLIMATE AND  
DEVELOPMENT  
REPORT



# There are many synergies between GHG emission reductions, development, and resilience, including through renewable energy

## Power generation capacity in 25 CCDRs



Renewable energy is the main addition even in baseline scenarios, a result of their low cost.

Low-carbon scenarios have higher power sector capacity due to more rapid electrification in the transport, building, and industrial sector, and demand from green hydrogen.

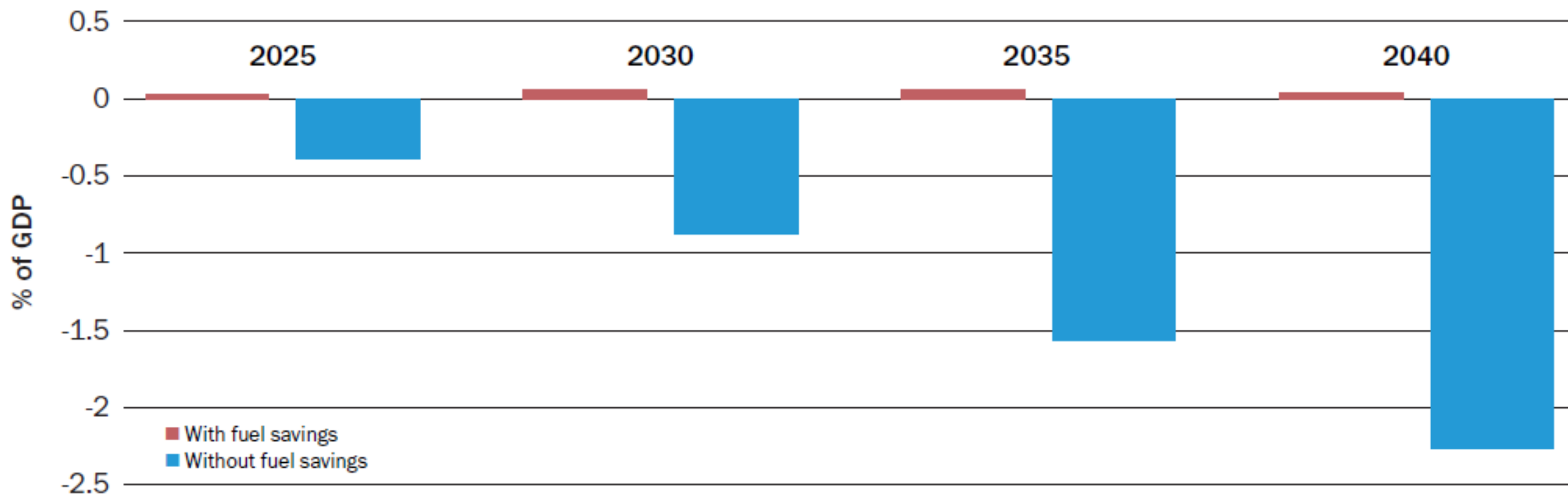
Note: China is not included in this figure, due to the size of its power system, but the figure with China shows similar trends.



# An example: Resilient Net zero Pathway (RNZP) for Türkiye

## The role of fuel and energy imports

Figure 4.2: Current account balance in the RNZP, compared with the baseline

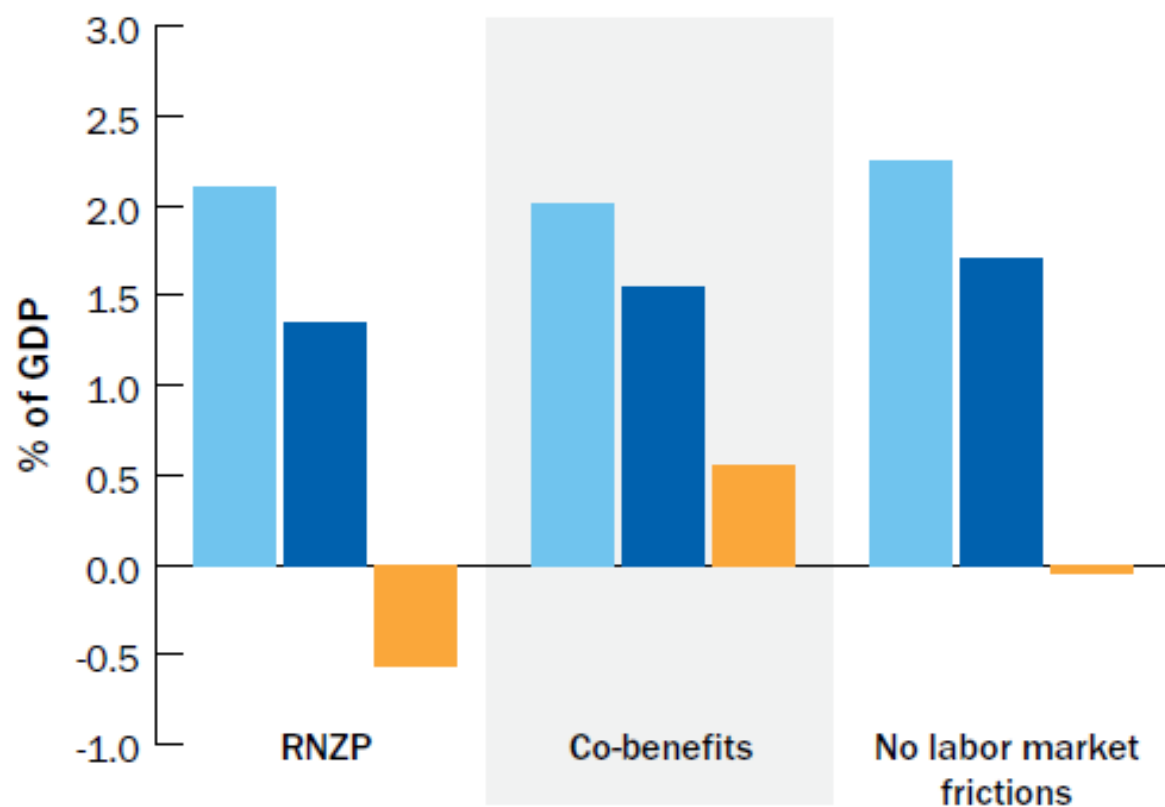


# An example: Resilient Net zero Pathway (RNZP) for Türkiye

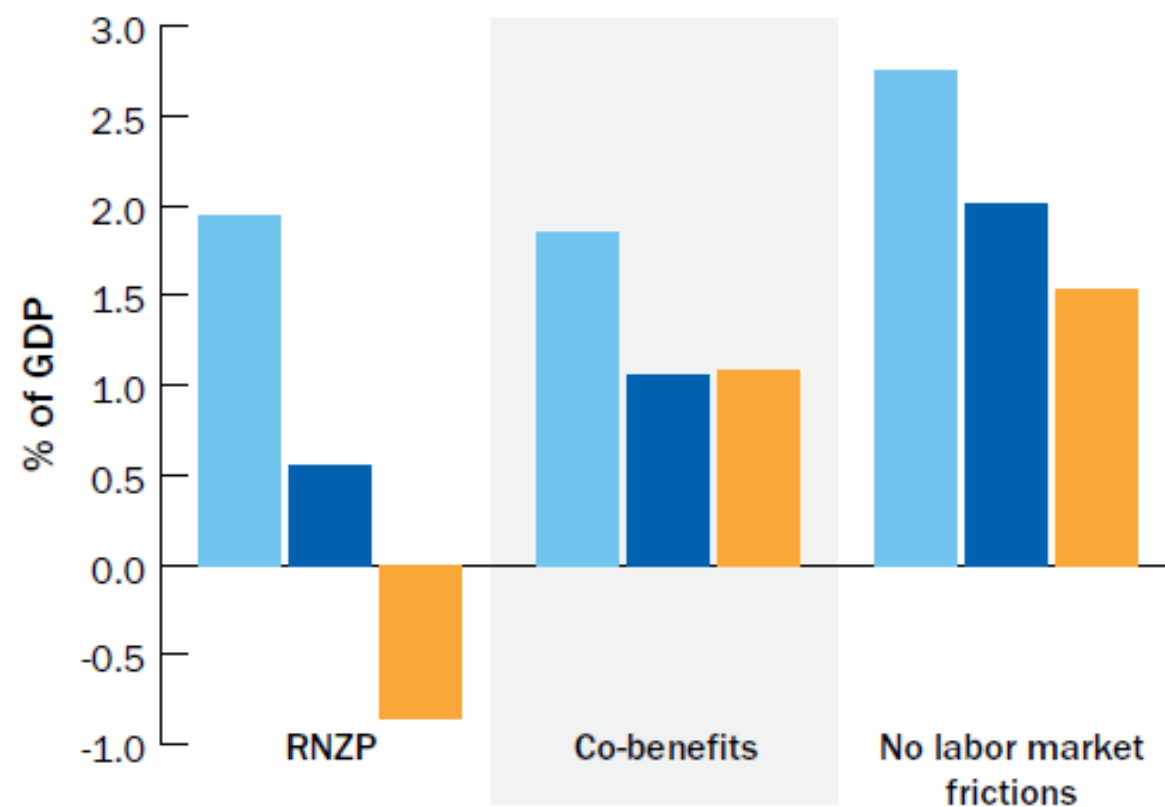
## Consumption is affected more than growth

Figure 4.3: Impact on welfare for poor, middle, and rich households, in three scenarios

a) Impact by 2030

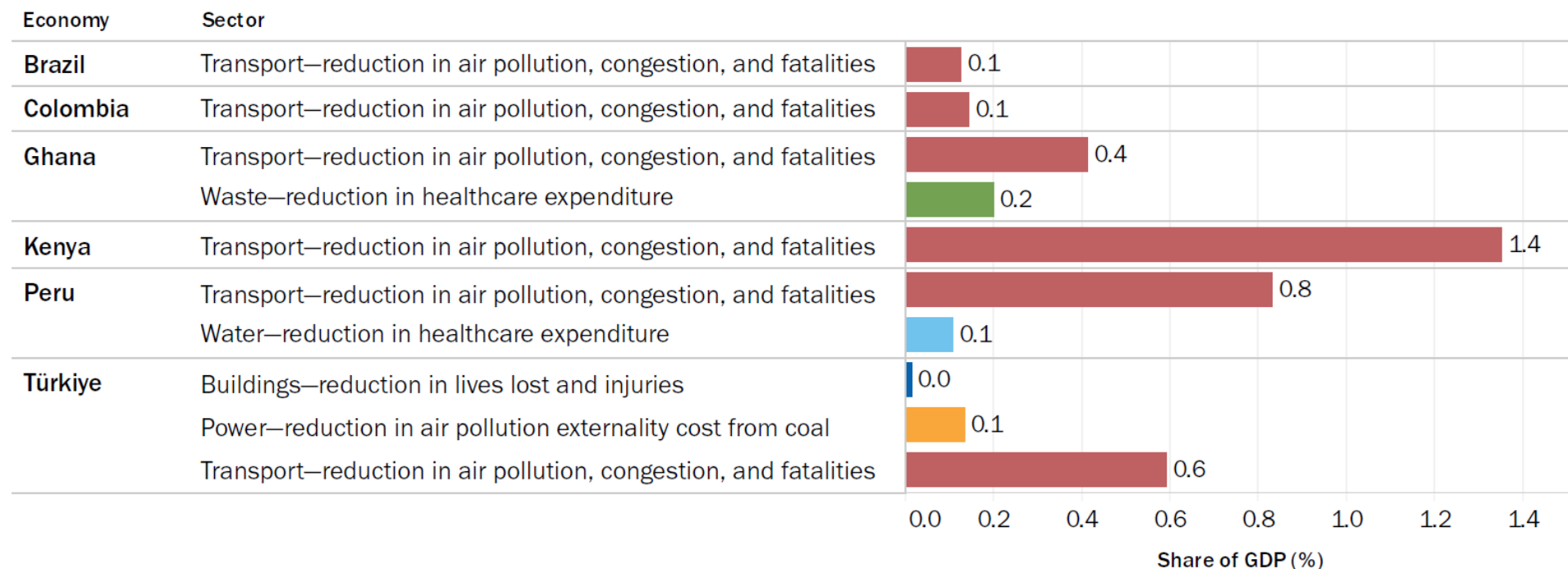


b) Impact by 2040



# There are many additional synergies between GHG emission reductions, development, and resilience, including health benefits from improved air quality

Health, congestion, and accident-related benefits in some CDR's low-carbon development pathways (current-2030)



Other important sources of economic and welfare benefits include clean cooking, reduced food waste, and improved transport infrastructure effects on logistics and competitiveness.