# ECONOMIC RESILIENCE IN THE LOW-CARBON TRANSITION: A CGE ANALYSIS OF CLIMATE POLICIES BEYOND CARBON PRICING

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BETTER POLICIES FOR BETTER LIVES

# Overview of the presentation

1. Introduction

2. Model and scenario setup

3. Implications of the low-carbon transition on public finance

# INTRODUCTION

# Motivation

- More and more countries are committing to achieving net-zero emissions (NZE) by 2050 or 2060
  - 127 countries (Hale et al., 2021).
  - Different perimeters, trajectories and strategies
- A transition to "net zero" by mid-century requires sustained investments and structural reforms, in a time of constrained public budgets
  - Recovery stimulus: 300 billion USD according to the OECD Green Recovery database
- An open question remains on the fiscal sustainability of such ambitious policy targets
- Linking ambitious global mitigation with fiscal sustainability will improve our understanding of the opportunities and challenges of achieving net-zero emissions by mid-century

# Climate chante mitigation policies and public finances

| Policy levers | Link to public finances |
|---|---|
| • Carbon pricing<br>• Fossil fuel subsidy removal | Government revenues |
| • Investments in cleaner technologies<br>• Technology subsidies | Government expenditures |
| • Regulations | Unclear effect on government budget |

- Other factors affecting public finances
  - Macroeconomic determinants (demographics, factor productivity, etc.)
  - Indirect effect of decarbonization policies on economic activity (e.g. reduced activity due to carbon pricing mechanisms)

# Existing litterature

- Large litterature on the economic consequences of climate policy and requirements for the Paris Agreement, mostly using IAM.
  - Geiges et al., 2020, van Soest, den Elzen and van Vuuren, 2021
  - NZE attained between 2070 and 2080
- CGE models, focusing on net-zero emissions by 2050
  - Fujimori et al., 2021; Drummond et al., 2021; Liu, McKibbin and Jaumotte, 2021
  - Regional or global scope, mostly through carbon pricing mechanisms
- Subtopics
  - Fossil fuel subsidies: Burniaux and Chateau (2011) with CGE but no producer support, Jewell et al. (2018) with IAM.

# Contribution of the paper

- Global scope
- Industrial process $CO_2$ emissions
- Accounts for recent climate action commitments
- Fiscal instruments beyond carbon pricing: fossil fuel support removal, behavioral subsidies
- Policy instruments beyond fiscal instruments: regulations
- Link to public budget

# MODEL AND SCENARIO SETUP

# ENV-Linkages model

- Reference: Château, Dellink and Lanzi (2014)
- Computable General Equilibrium (CGE) model
  - Multi-regional, multi-sectoral
  - Full description of economies
  - All economic activity is part of a closed, linked system
  - Dynamics
    - Solved iteratively over time (recursive-dynamic) until 2050
  - Link from economy to environment
    - Environmental indicators (greenhouse gas emissions, air pollutants, plastics, materials..) linked to economic activity
    - Scenario analysis to study
      - The socio-economic consequences of environmental policies
      - Economic feedbacks from environmental damages

# 3 pillars for climate scenarios

1. Structural transformation:
   - Power, Transport, Buildings
   - Calibrated after WEO energy projections

2. Direct and indirect carbon pricing:
   - Fossil fuel support removal
   - Carbon taxes and Cap & Trade systems

3. Cost of transition:
   - Target desired investment and expenditure behaviors through regulations or subsidies
   - Calibrated after WEO « investment » projections

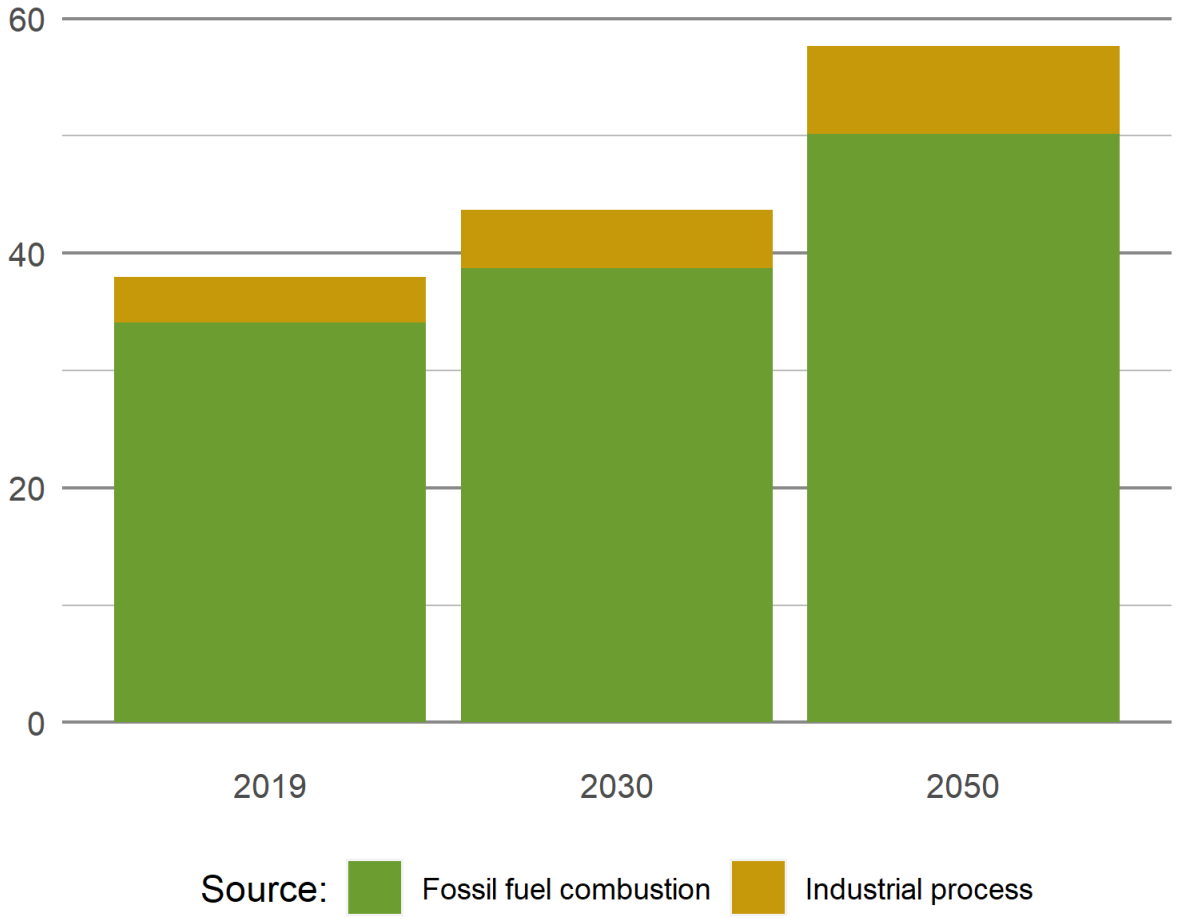
# Scenario summary

| Climate scenario → ↓ Pillars | Moderate | NZE |
|---|---|---|
| 1. Structural transformation | WEO SDS | WEO NZE (downscaled) |
| 2.1 Indirect carbon pricing | 100% removal of fossil fuel support | 100% removal of fossil fuel support |
| 2.2 Direct carbon pricing | WEO SDS carbon price trajectory | Cap & trade system for NDCs and NZE commitments |
| 3. Cost of transition | WEO SDS « Investment » | WEO NZE « Investment » (downscaled) |

# IMPLICATIONS OF THE LOW-CARBON TRANSITION ON PUBLIC FINANCE

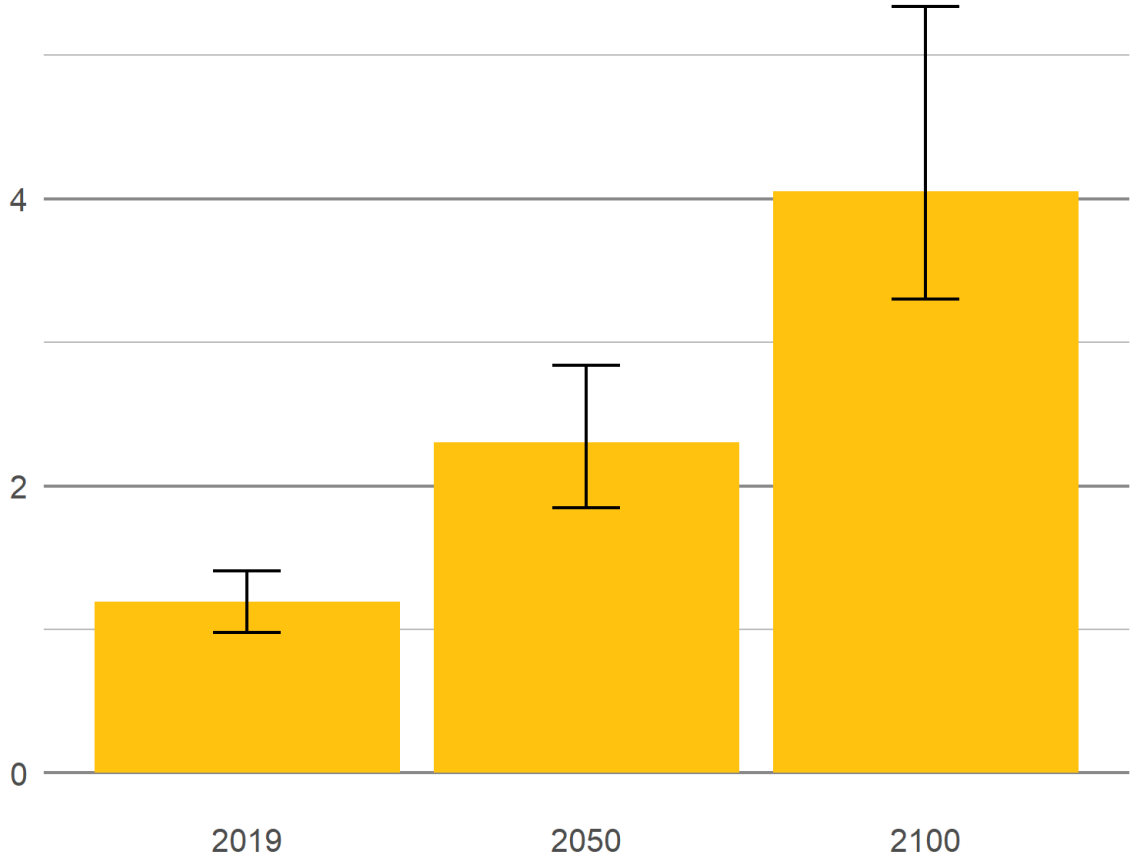
# Baseline – Climate change

## CO2 emissions (Gt $CO_2$)



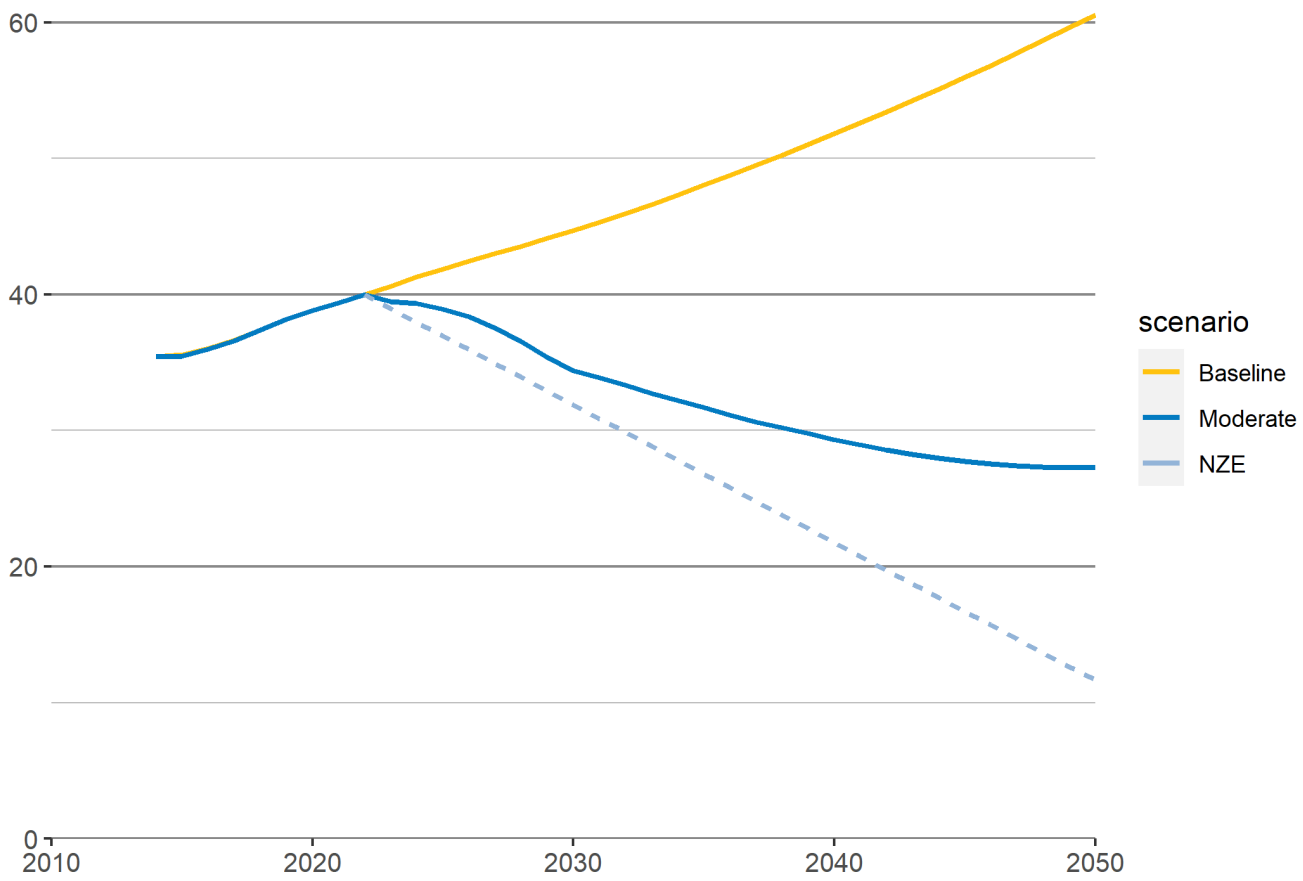

Source: OECD ENV-Linkages model

## Global average temperature increase (°C)




Source: MAGICC 7, based en ENV-L projections

# Global $CO_2$ emissions ($GtCO_2$)

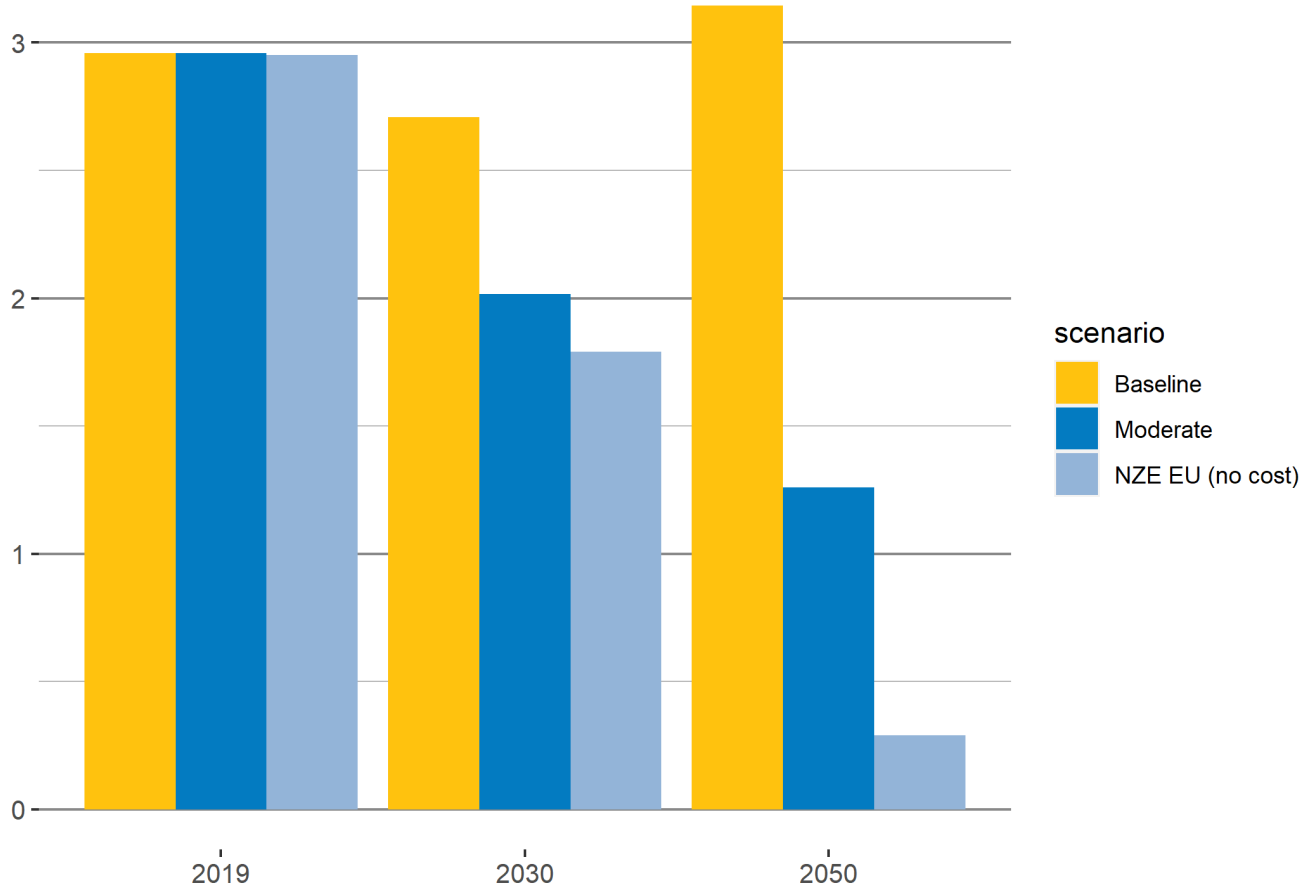



Source: OECD ENV-Linkages model

# An illustration with the European Union

- To illustrate the mechanisms and key results, results are presented for the EU
  - Structural transformation: All regions in the world
  - Carbon pricing:
    - Fossil fuel support removal : All regions
    - NZE cap&trade: EU only
  - Costs:
    - With and without costs for the EU
    - No cost for other regions

# EU $CO_2$ emissions ($GtCO_2$)

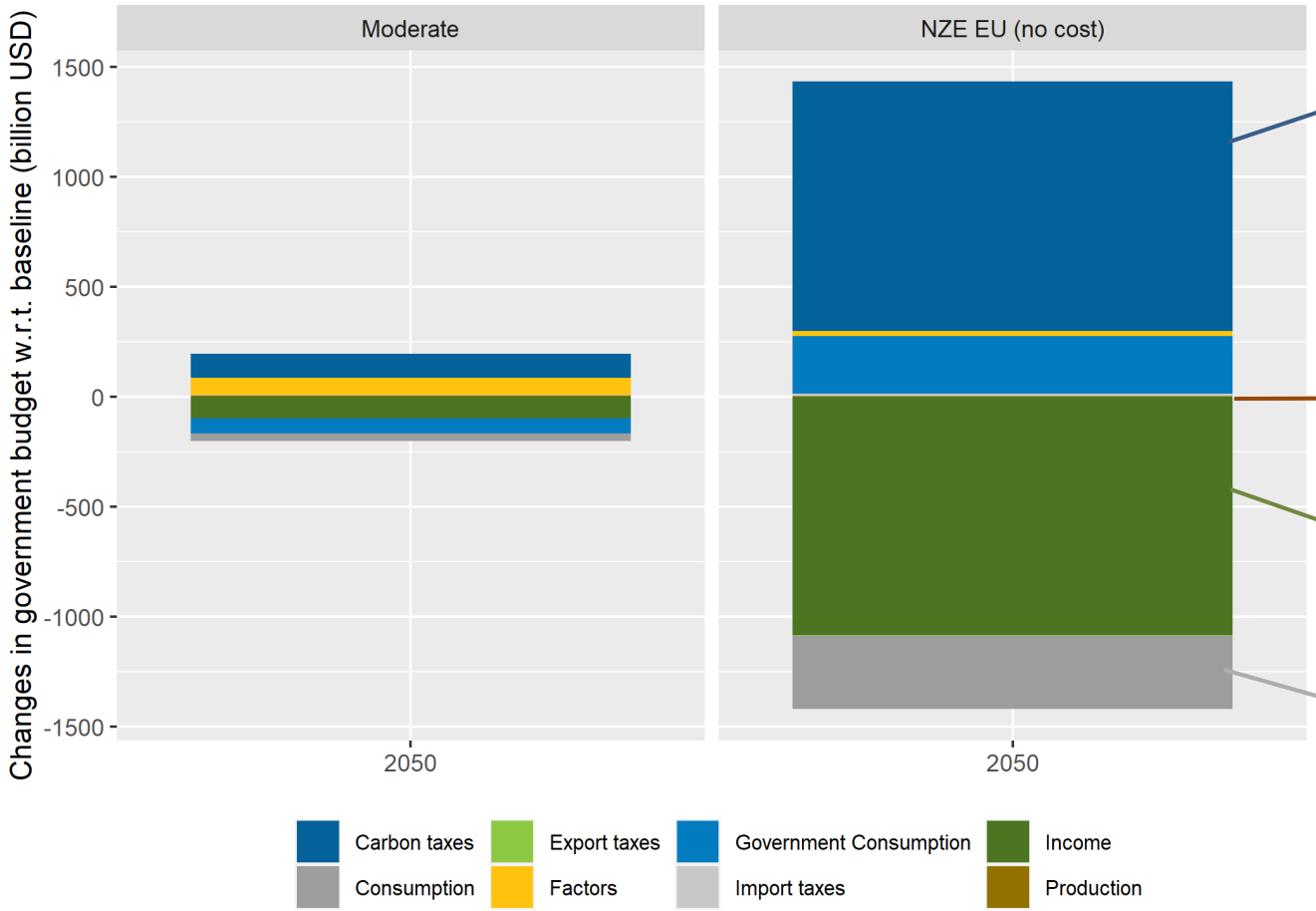



Source: OECD ENV-Linkages model

# EU public budget implications for NZE (with no cost) w.r.t. BAU

More surplus

More deficit




Explicit carbon pricing

Fossil fuel support (prod.)

Closure rule: lump-sum transfer

Fossil fuel support (cons.)

⚠ incl. GE effects

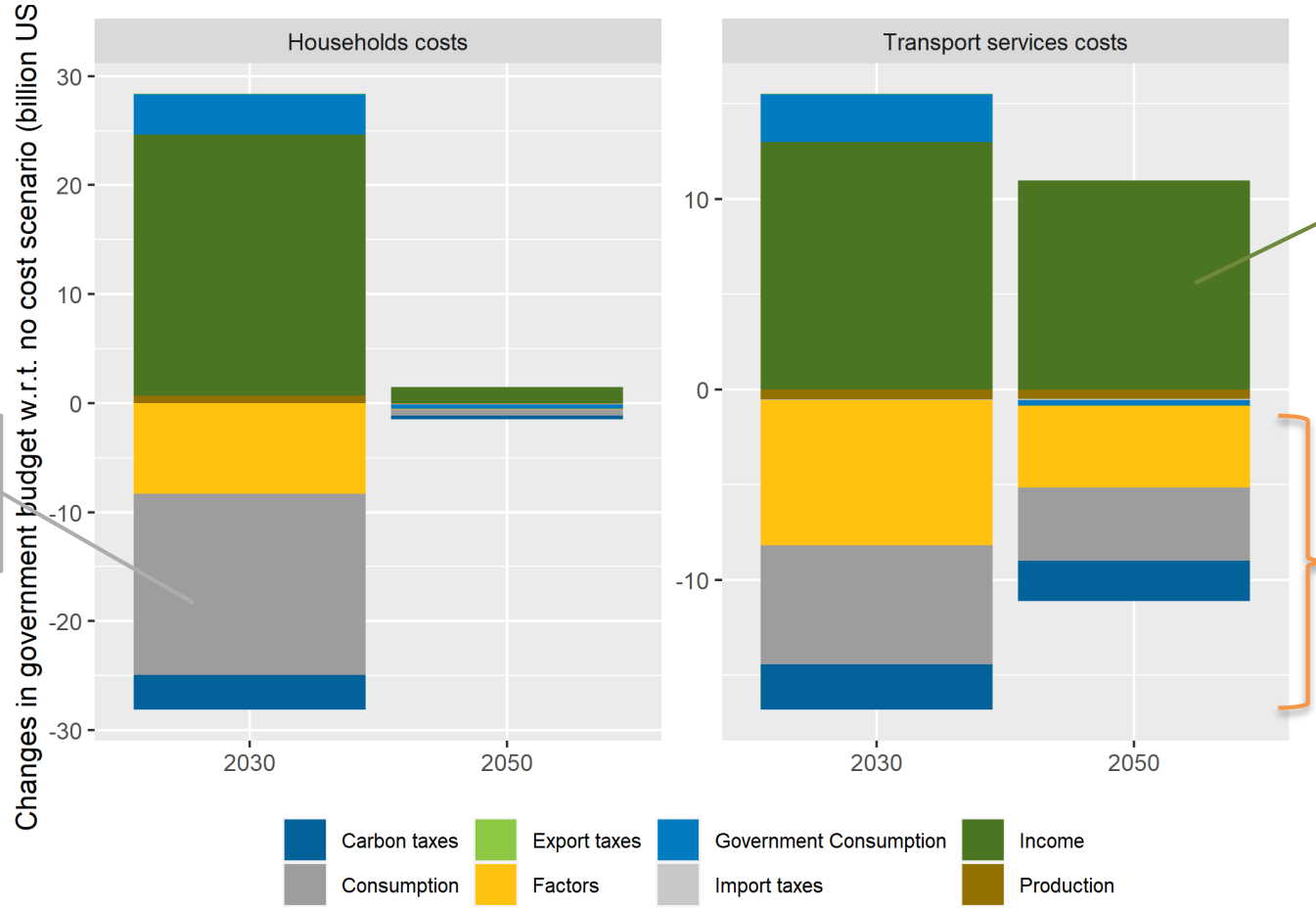
Source: OECD ENV-Linkages model

# EU public budget implication for NZE (with costs) w.r.t. no cost

More surplus

More deficit

More cons. subsidies




Closure rule: less transfers

Effect through factor and (interm.) demand allocation

Level of cost (2030): 43 bn USD

Level of cost (2030): 17 bn USD

Source: OECD ENV-Linkages model

# CONCLUDING REMARKS

# Preliminary conclusions

- At first glance, the cost of « triggering » the transition by subsidies or regulation is lower than the revenues from carbon pricing for the EU
- Impact of regulation depends on general equilibrium effects, which will vary accross regions
- Importance of government closure and recycling

# Next steps

- Next steps
  - Go from regional NZE to global NZE
  - Sensitivity analysis on costs modelling
    - Carbon pricing vs. Subsidies vs. Regulations
  - Sensitivity analysis on revenue recycling

- Further research
  - Some shortcomings will need to be addressed: Hydrogen and Biomass energy
  - Role and quantification of CCS technologies (CCUS, BECCS)

# THANK YOU FOR YOUR ATTENTION

# SUPPLEMENTARY SLIDES

# 26 regions

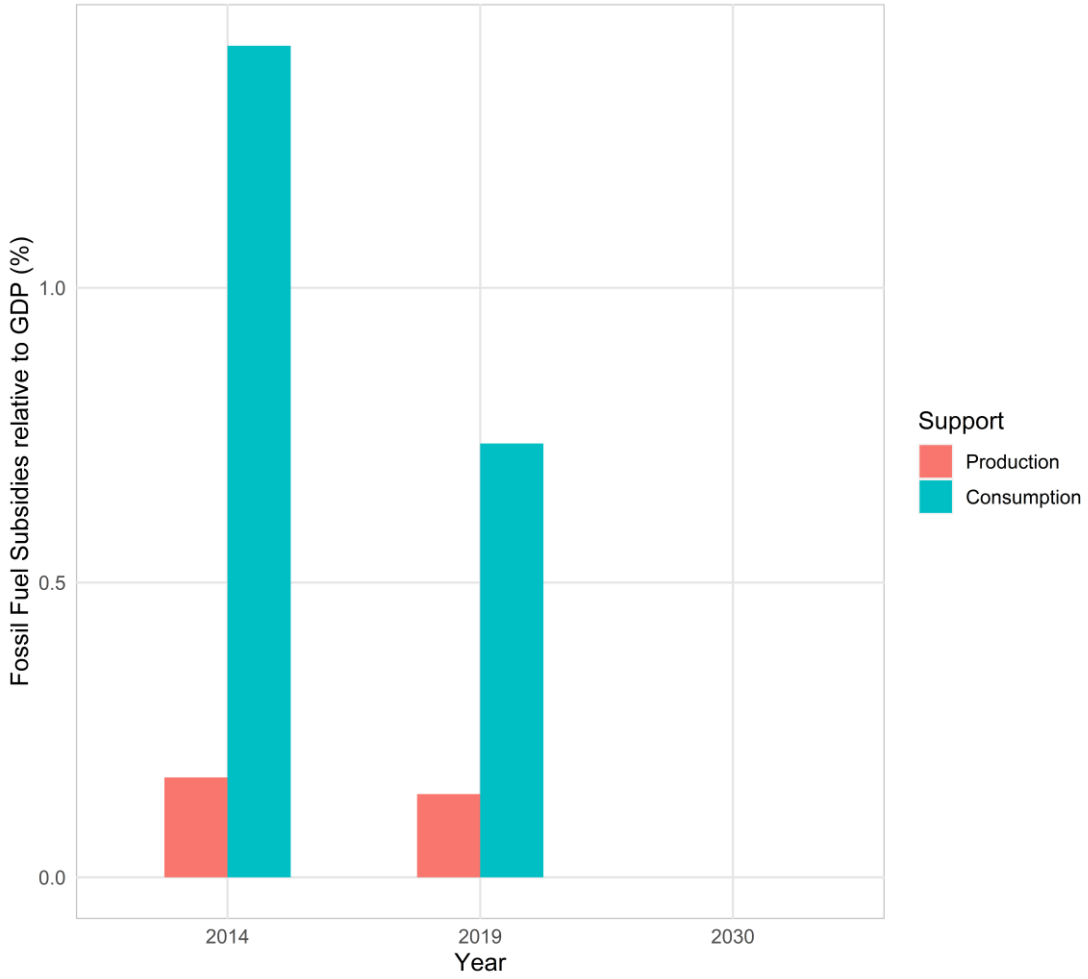
| | |
|---|---|
| Australia and New Zealand (AUNZ) | Korea (KOR) |
| Brazil (BRA) | Mexico (MEX) |
| Canada (CAN) | Middle East (ME) |
| Caspian (CASP) | North Africa (NAFR) |
| Central and South America A (CSAMa) | Other Africa (OAFR) |
| Central and South America B (CSAMb) | Other Asia (OASIA) |
| China (CHN) | Other Europe A (OEURa) |
| European Union A (EUa) | Other Europe B (OEURb) |
| European Union B (EUb) | Other Europe C (OEURc) |
| European Union C (EUc) | Other Southest Asia (OASEAN) |
| India (IND) | Russia (RUS) |
| Indonesia (INDO) | South Africa (SAFR) |
| Japan (JPN) | United States (USA) |

# 37 activities

| Primary |
| --- |
| Animal agriculture (AnimAgr) |
| Mining (Mining) |
| Other agriculture (OthAgr) |
| Vegetal agriculture (VegAgr) |
| **Energy** |
| Coal (coa) |
| Coal power (clp) |
| Gas (gas) |
| Gas manufacture and distribution (gdt) |
| Gas power (gsp) |
| Hydro power (hyd) |
| Nuclear power (nuc) |
| Oil (oil) |
| Oil power (olp) |
| Other power (xel) |
| Petroleum and coal products (p_c) |
| Power transport and distribution (etd) |
| Solar power (sol) |
| Wind power (wnd) |

| Manufacturing |
| --- |
| Chemicals (Chemicals) |
| Electric equipment (ElecEqui) |
| Food (Food) |
| Iron and steel (IronSteel) |
| Minerales (Minerals) |
| Other EITE (OthEITE) |
| Other manufacturing (OthManuf) |
| Other metals (OthMetals) |
| Textile (Textile) |
| Transport equipment (TransEqui) |
| **Services** |
| Air transportation (atp) |
| Construction (cns) |
| Dwellings (Dwellings) |
| Finance Insurance Business services (FinInsBus) |
| Ground transportation (otp) |
| Other services (OthServ) |
| Public services (PubServ) |
| Water and waste (wts) |
| Water transportation (wtp) |

# Fossil fuel support data




- Support on consumption are higher than those on production
- More than 50% of the total support are in the Middle-East and North Africa regions
- The value of support in 2019 is smaller than the value in 2014

# Emission targets

| Region | 2014 Emissions | 2030 target (NDC) | 2050 target (NZE) |
|---|---|---|---|
| Australia and New Zealand (AUNZ) | 0.45 | 0.31 | 0.15 |
| Brazil (BRA) | 0.55 | 0.22 | 0.46 |
| Canada (CAN) | 0.64 | 0.41 | 0.02 |
| China (CHN) | 10.7 | 13.41 | 4.81 |
| Central and South America A (CSAMa) | 0.17 | 0.26 | 0.03 |
| Central and South America B (CSAMb) | 0.57 | - | 0.48 |
| European Union | 3.03 | 1.72 | 0.18 |
| Indonesia (INDO) | 0.53 | - | 0.54 |
| Japan (JPN) | 1.41 | 0.98 | 0.06 |
| Korea (KOR) | 0.62 | 0.51 | 0.02 |
| Mexico (MEX) | 0.51 | - | 0.10 |
| Other Africa (OAFR) | 0.36 | - | 0.74 |
| South Africa (SAFR) | 0.48 | 0.61 | 0.03 |

| Region | 2014 Emissions | 2030 target (NDC) | 2050 target (NZE) |
|---|---|---|---|
| United States (USA) | 5.47 | 2.97 | 0.20 |
| Middle East (ME) | 2.15 | - | 3.79 |
| India (IND) | 2.21 | 4.59 | |
| North Africa (NAFR) | 0.54 | - | |
| Russia (RUS) | 1.67 | 1.80 | |
| Caspian (CASP) | 0.51 | - | |
| Other Southeast Asia (OASEAN) | 0.92 | - | |
| Other Asia (OASIA) | 0.59 | - | |
| Other Europe A (OEURa) | 0.51 | - | |
| Other Europe B (OEURb) | 0.43 | - | |
| Other Europe C (OEURc) | 0.44 | - | |
| **World** | **35.41** | | **11.64** |

# Removal of fossil fuel support

- Support mechanisms to the demand and supply of fossil fuels (direct transfers, tax expenditures, price support)
- Data for year 2014: OECD Inventory of Fossil Fuel Support (OECD, 2022), complemented by IEA Fossil Fuel Subsidies Database (IEA, 2022)
- Modelling: Support measures are modeled as consumption and production *ad valorem* subsidies
- Scenario: Full removal by 2030

# Emission objectives for the NZE scenario

- Definition: equilibrium between gross annual $CO_2$ emissions and annual carbon sequestration (AFOLU only) in 2050
- Data sources:
  - List of countries with NZE commitment: Net Zero Tracker (Hale et al., 2021)
  - Level of carbon sequestration: PBL IMAGE dataset (Van Vuuren et al., 2021)
- Scenario: Cap & trade system that targets level of gross emissions corresponding to carbon sequestions.
  - Regions with no NZE commitment: shared cap & trade objective for the remainder

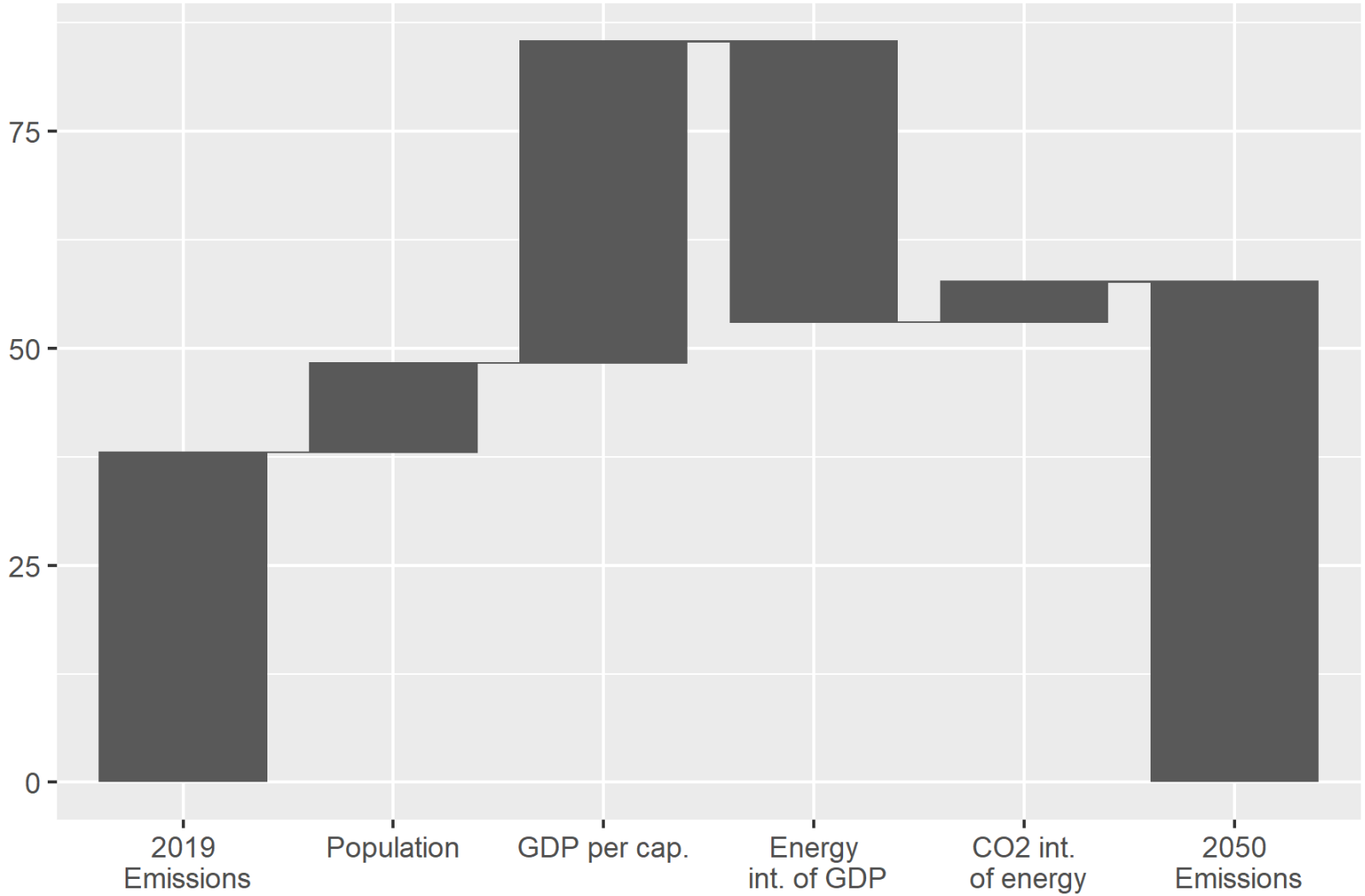
# Cost of transition

- Definition: Level of expenditure and/or investment required to deploy low-carbon alternatives
- Data source: World Energy Outlook 2021 (IEA, 2021) « investment »
- Four different kinds of costs depending on the activity:
  - Power: Investment in power generation sectors. Modelled as regulation.
  - Transportation services: Investment in transport equipment. Modelled as regulation.
  - Other services (tertiary buildings): Investment in construction and electric equipments. Modelled as regulation.
  - Households
    - Expenditure on construction and electric equiments. Modelled as regulation.
    - Expenditure on transport equipment. Modelled as subsidy.

# Modelling of transition costs

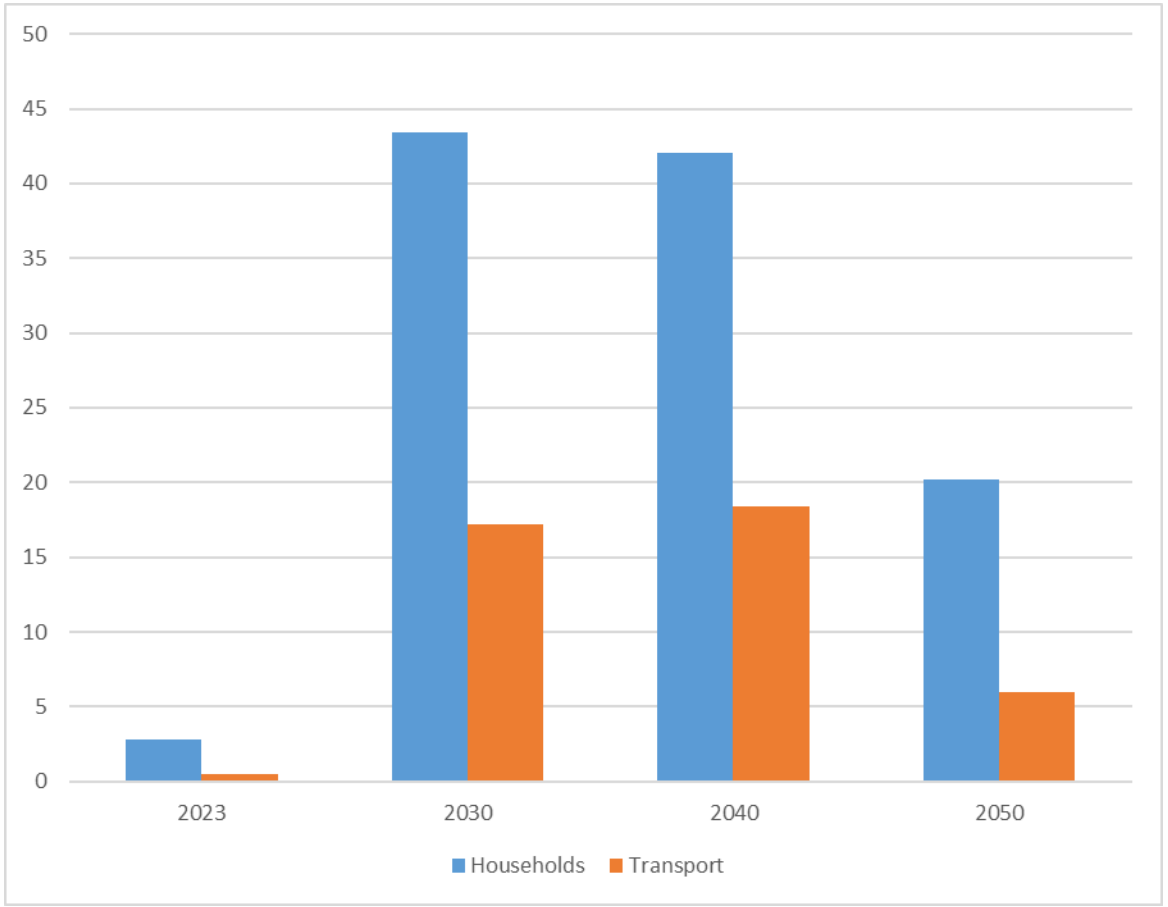
- Investment
  - Year t : build up of capital stock
    - Targetted level of additional (w.r.t. no cost scenario) demand for corresponding good by investing agent
    - Regulation: endogenous preference (efficiency) parameter
    - Subsidy: endogenous subsidy rate
  - Year t+1: sector allocation of capital stock
    - Targetted level of additional (w.r.t. no cost scenario) sectoral investment in correspondinc activity
    - Regulation: endogenous capital efficiency parameter
    - Subsidy: endogenous capital subsidy rate
- Expenditure
  - Targetted level of additional expenditure (w.r.t. no cost scenario)
  - Regulation: endogenous preference (efficiency) parameter.
  - Subsidy: endogenous subsidy rate.

# Baseline – Kaya decomposition




Source: OECD ENV-Linkages model

# Cost scenario for EU (Bn. 2014 USD)




Source: OECD ENV-Linkages model, using IEA (2021)

# EU GDP implications of costs (% of GDP w.r.t. no cost)