GWS SPECIALISTS IN EMPIRICAL ECONOMIC RESEARCH

# SOCIO-ECONOMIC IMPACTS OF ANNOUNCED GHG REDUCTION PLEDGES

## IOWS, Osnabrück, February 2024

Dr. Christian Lutz, Maximilian Banning, Lisa Becker, Katharina Hembach-Stunden

# Background

- The EU has passed the Green Deal and set itself the target of becoming climate neutral by 2050
- Germany is already aiming for this goal by 2045
- Complemented by other policy measures, carbon prices are a central policy instrument
  - ⇨ EU emission trading system (ETS)
  - ⇨ Planned EU ETS II
- Competitive disadvantages for carbon-intensive industries and consequential shifts of production to other regions (“carbon leakage”) are a risk for ambitious climate policy as well as for the EU economy
- EU foresees a carbon border adjustment mechanism (CBAM) as part of the fitfor55 package

Two models with different model philosophies have been applied in the project “Climate Protection Scenarios until 2050 Considering $CO_2$ price Differences and Carbon Leakage” for the German Federal Environment Agency to quantify the socio-economic effects of unilateral EU climate action.

- GEM-E3 based on GTAP and GINFORS-E based on OECD/IEA data
- This paper includes scenario design and results from the GINFORS-E model

# Design of main scenarios

- Reference scenario continues the current regulations of the 4th phase of the EU ETS, all countries only achieve their NDCs announced in 2020 by 2030. Low climate mitigation ambition outside the EU.
- Three main policy scenarios to quantify the impacts of more ambitious EU climate policies

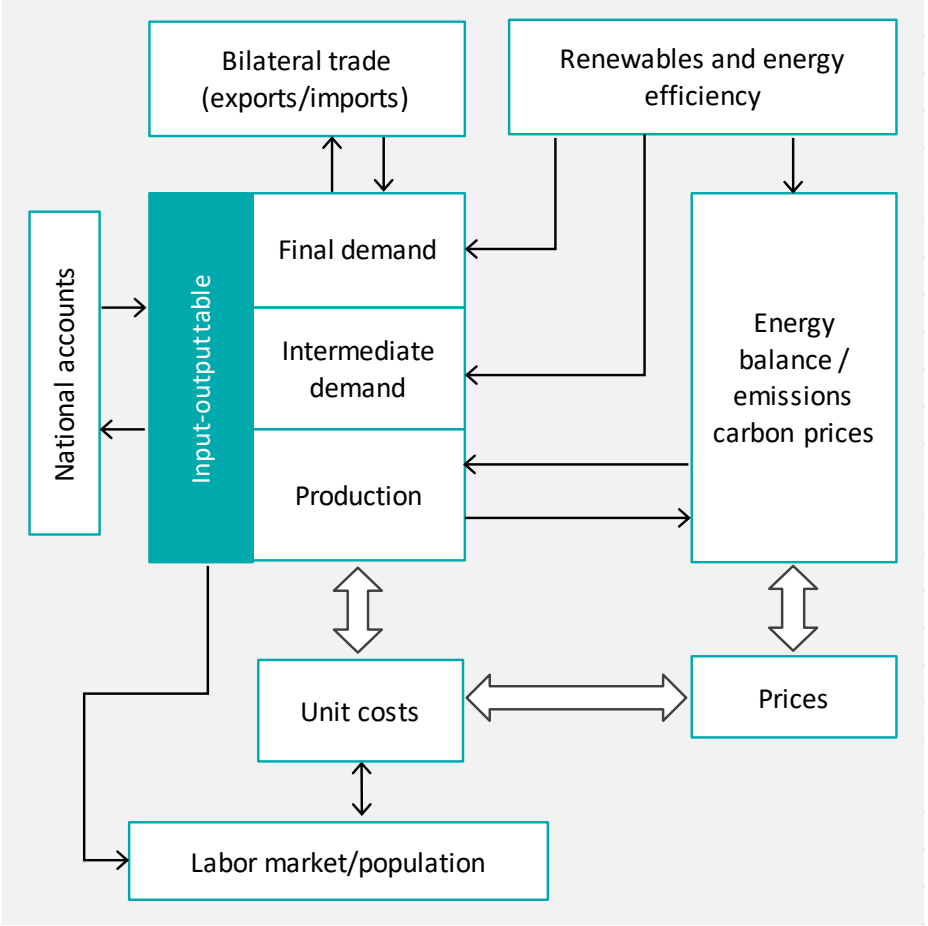
| Scenario | EU GHG emission reductions 2030/2050 | EU climate policy | EU ETS: free allocation in industry | EU usage of CBAM | Compensation of indirect emissions | Rest of World action |
|---|---|---|---|---|---|---|
| 6. NDCs_Ref | 40% / 80% | Carbon prices as proxy for all policies, sector split between ETS and non-ETS until 2030 | 80% until 2030, phased out until 2050 | No | As today until 2030, decreasing to 0 until 2040 | NDCs from 2020 for 2025/30 are met, after 2030 carbon prices increase with GDP |
| 7. EU_FA | 55% / 95% | Additional emission reduction by carbon price | As. sc. 6 | No | As sc. 6 | As sc. 6 |
| 8. EU_AU | 55% / 95% | As sc. 7 | Full auctioning | No | No | As sc. 6 |
| 9. EU_ff55 | 55% / 95% | As sc. 7 | Phase out of free allocation between 2026 and 2034 | Phase in between 2026 to 2034 according to recent regulation | As sc. 6 | As sc. 6 |

# The model GINFORS-E

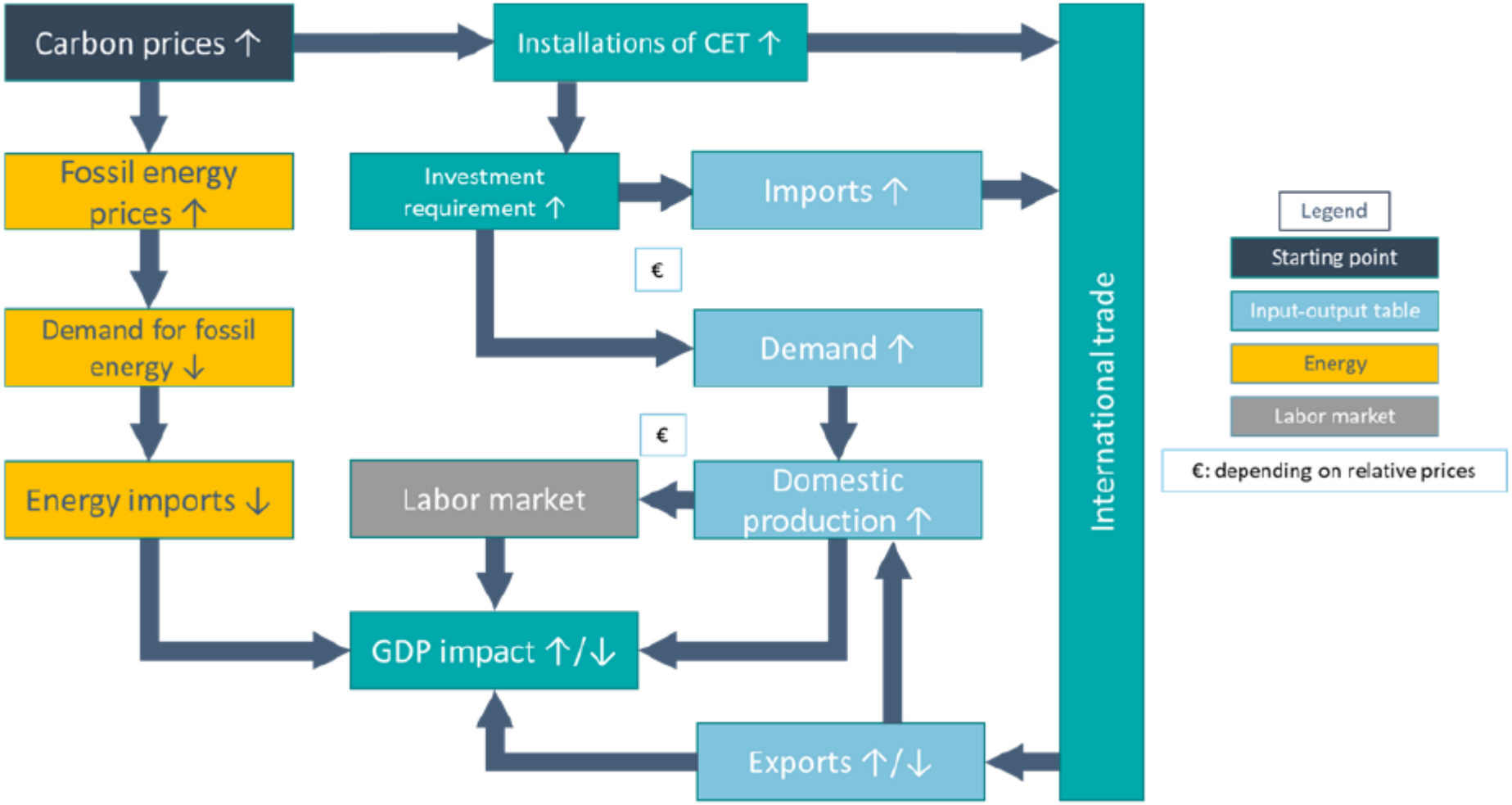
- Macroeconometric model of the world economy, combining consistently production, international trade, energy use and emissions
- Economic structures: Harmonized OECD input-output tables for 64 countries, 36 (homogenous) industries and one region Rest of the World from 2005 to 2015
- Myopic agents, non-equilibrium, annual solution

- Macro models and bilateral trade from TINFORGE (Mönnig/Wolter 2020):
  - ⇨ Bilateral trade shares for 33 goods und 154 countries econometrically estimated
  - ⇨ Explaining variables: Relative prices, trends
  - ⇨ Adjusted Armington elasticities for the project

- Changes in the cost situation at the level of 36 industries are transmitted to world trade, change sectoral production, value added, and prices as well as GDP
- Explicit modeling of carbon prices (ETS, non-ETS)

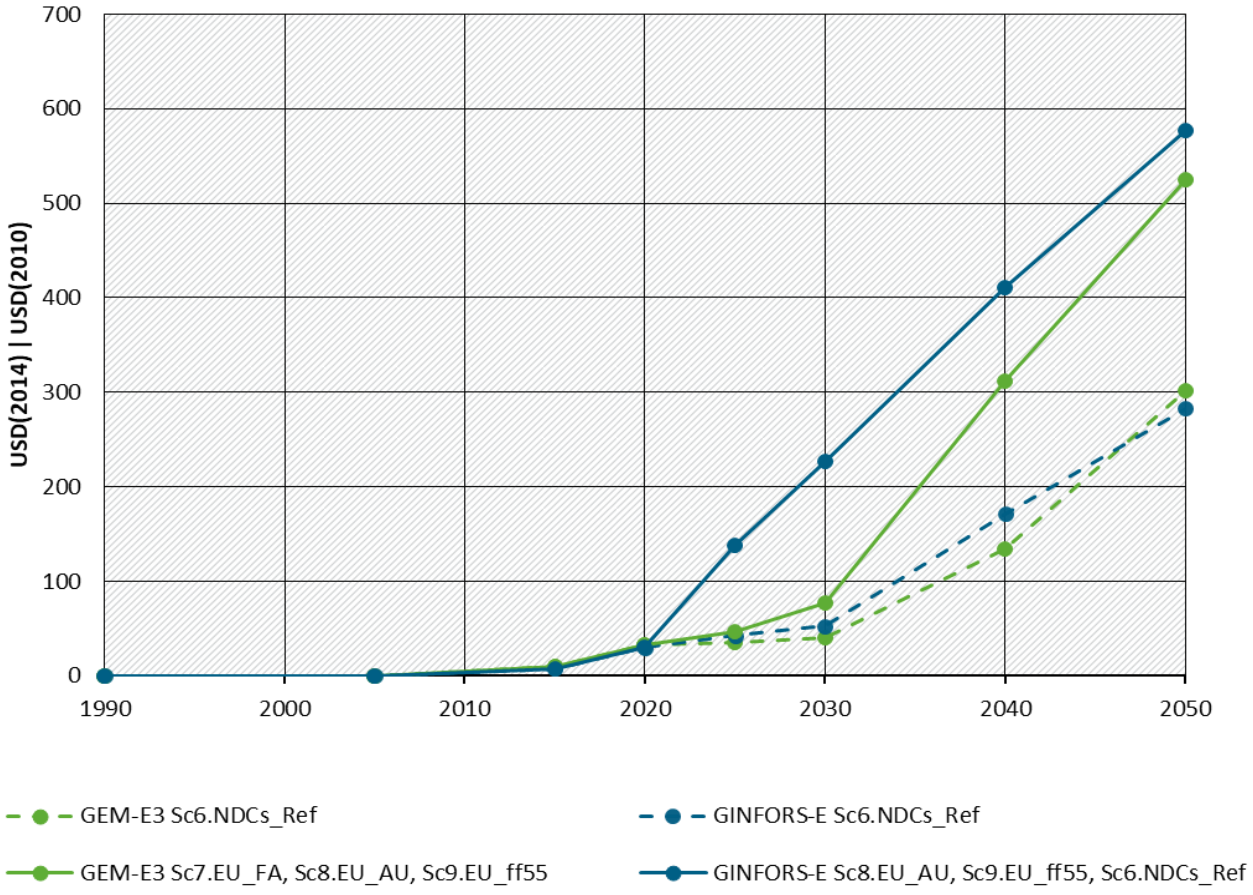


# Chain of effects in the model



# Carbon prices

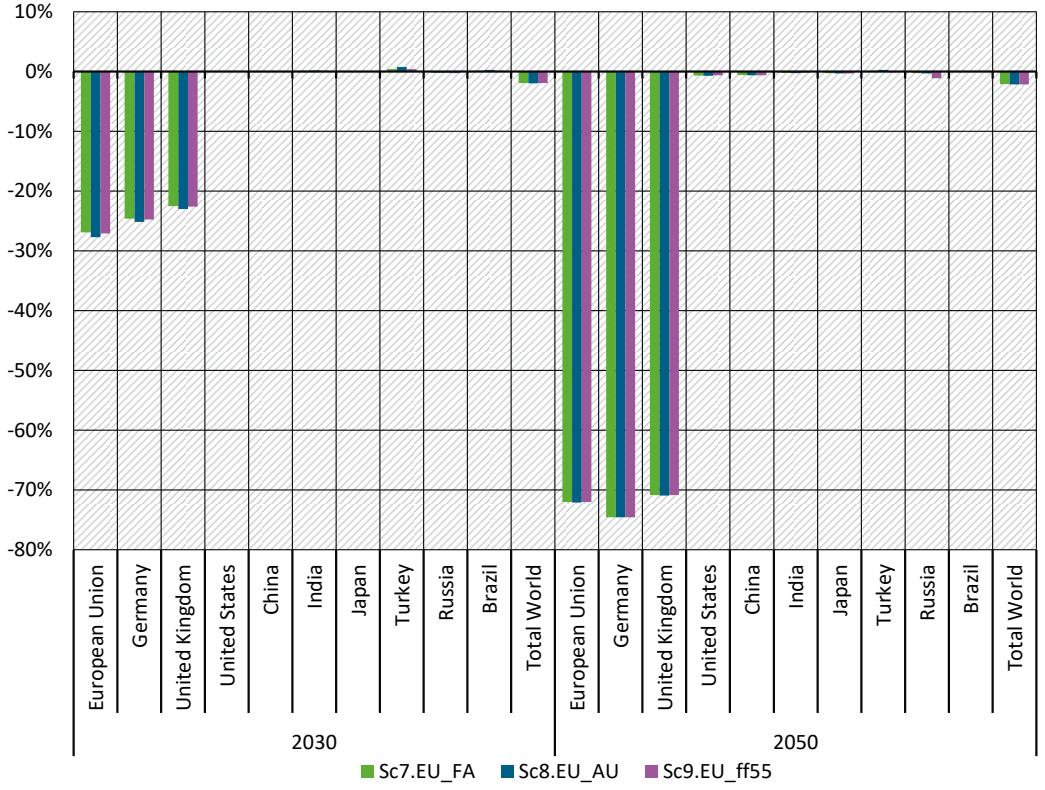
- EU Carbon prices



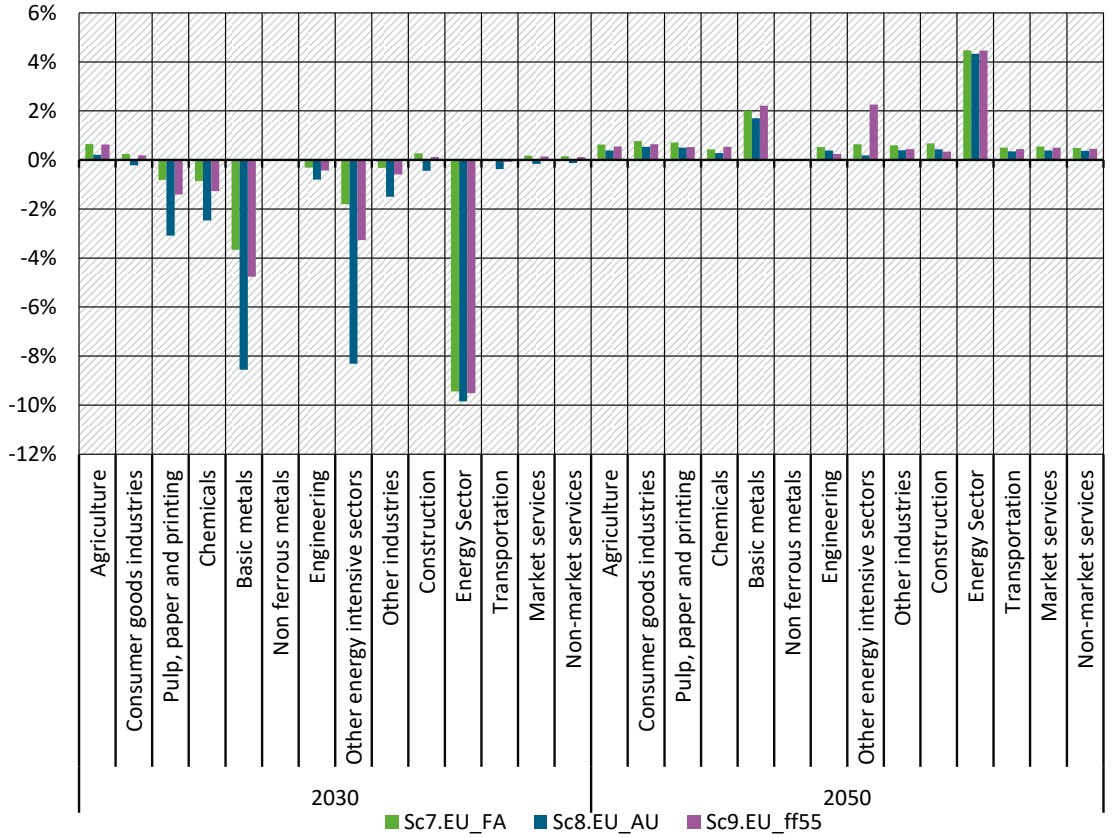

- Sectors consider carbon prices in their energy mix
  - ⇨ Highest increases in carbon-intensive sectors as basic metals
- Cost passthrough
  - ⇨ for the auctioned allowances
  - ⇨ of higher prices in other sectors (if there is no compensation)
- Only impacts of the carbon price differences to the reference considered

# Results for unilateral EU climate action (55%/95% instead of 40%/80%)

- Deviations in $CO_2$ emissions per capita against scenario 6.NDCs_Ref

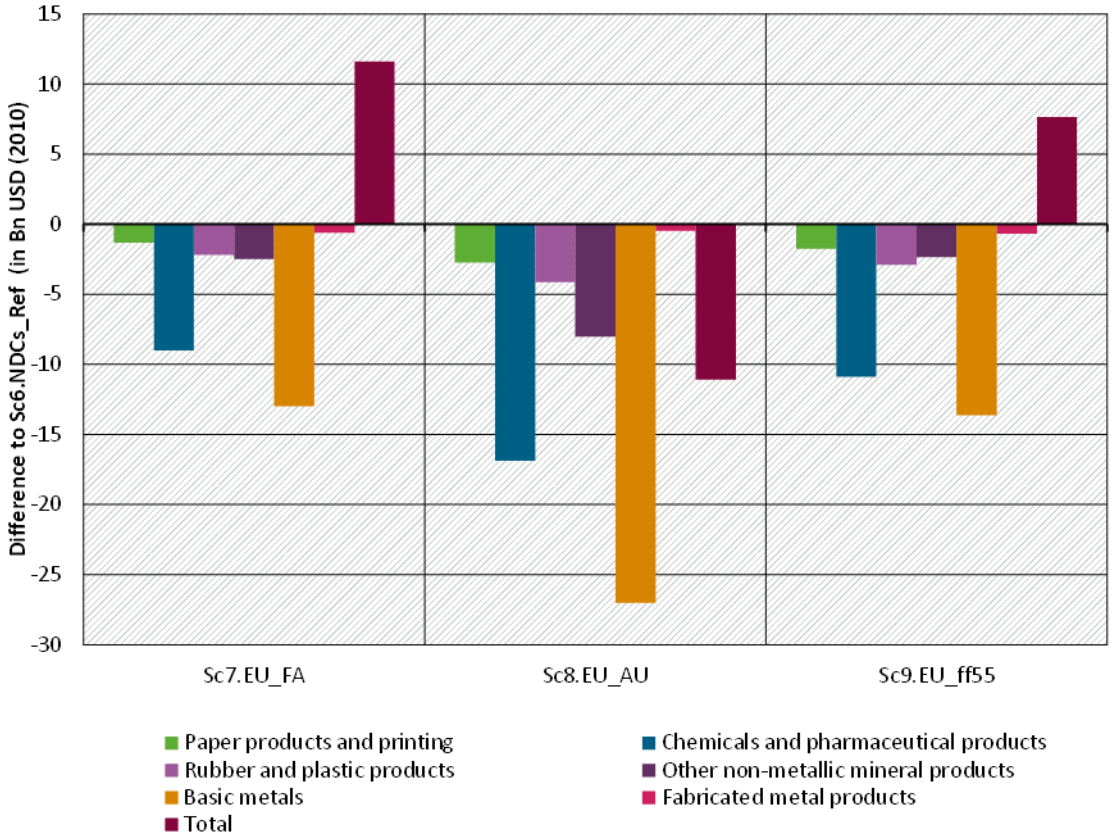



- EU sectoral production – deviations from Sc6.NDCs_Ref



# Impacts on international trade

- EU sectoral net-exports 2030 - deviations from Sc6.NDCs_Ref




- Free allocation in industry (Sc.7) best option
  - ⇨ but still negative for carbon-intensive industries (basic metals, chemicals),
  - ⇨ positive total net-exports
- Full auctioning in industry (Sc.8) worst option
  - ⇨ Very negative for carbon-intensive industries (basic metals, chemicals),
  - ⇨ negative total net-exports
- CBAM scenario (Sc.9) close to current regulation
  - ⇨ For CBAM industries similar to free allocation
  - ⇨ Negative for downstream industries due to higher prices in the CBAM industries
  - ⇨ Still positive total net-exports compared to reference

# Carbon leakage

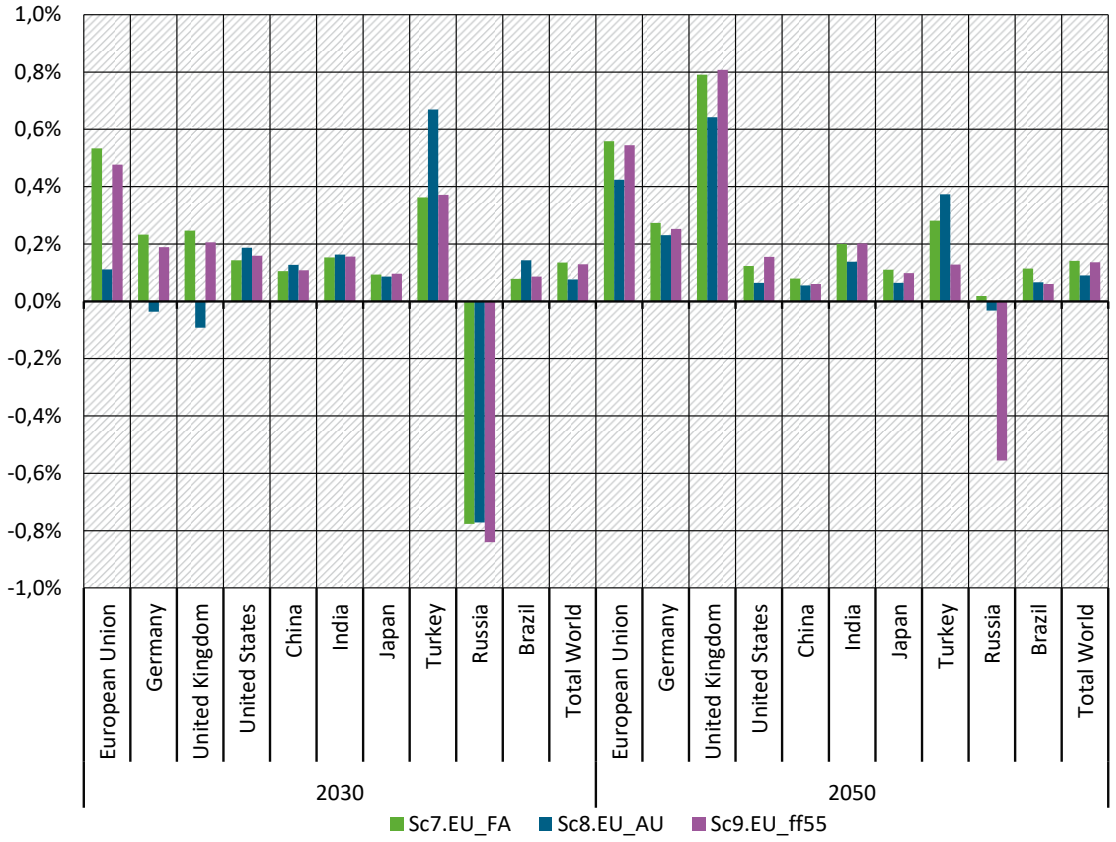
- Carbon leakage rates by sector (2020-2050)

| | Sc7.EU_FA compared to Sc6.NDCs_Ref | Sc8.EU_AU compared to Sc6.NDCs_Ref | Sc9.ff55 compared to Sc6.NDCs_Ref |
|---|---|---|---|
| Paper products and printing | - 1.59% | - 1.91% | -1.72% |
| Chemicals and pharmaceutical products | - 5.60% | - 7.84% | -1.29% |
| Rubber and plastic products | - 5.65% | - 6.57% | -6.19% |
| Other non-metallic mineral products | - 11.12% | - 16.45% | -4.47% |
| Basic metals | - 17.10% | - 22.44% | -11.91% |
| **All ETS sectors** | **- 9.85%** | **- 13.65%** | **-5.44%** |
| | | | |
| Fabricated metal products | - 0.66% | - 0.38% | -0.37% |

- Part of sectoral $CO_2$ reduction in the EU is offset by increased global emissions
- Carbon leakage is highest with full auctioning, as cost and price increases for carbon-intensive industries are highest (significant for basic metals and non-metallic minerals)
- CBAM can reduce carbon leakage, but export effects remain
  - ⇨ Higher prices in CBAM sectors and in downstream sectors

# Macroeconomic effects

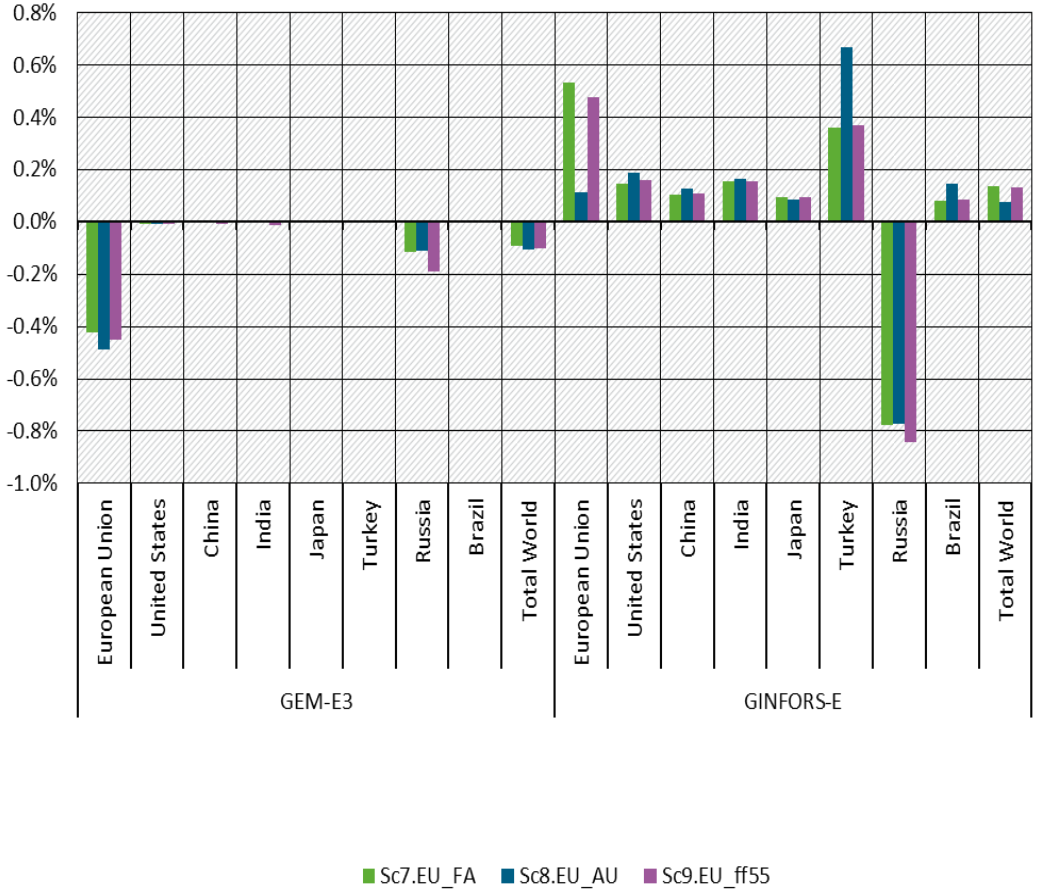
- GDP by country – deviations from Sc6.NDCs_Ref




- Positive GDP impacts in EU and most other countries
  - ⇨ EU profits from free allocation, full auctioning is the worst option
  - ⇨ Other countries profit from lower prices for low/zero carbon technologies, if EU goes ahead
  - ⇨ Competing countries as USA or Turkey profit from higher output prices in EU carbon-intensive sectors
  - ⇨ Russia and other fossil fuel exporters suffer from lower exports

# Comparison to GEM-E3 results

- GDP by country – deviations from Sc6.NDCs_Ref




- GDP effects are predominantly slightly negative in GEM-E3, and positive in GINFORS-E, except for Russia where the negative effects are much more pronounced in GINFORS-E than in GEM-E3
- In GEM-E3 additional investments in clean energy have to be financed by cancelling investments of equal value elsewhere in the economy whereas in GINFORS-E the additional investments are financed from idle financial deposits
  - ⇨ GEM-E3: 100% utilization rate
  - ⇨ GINFORS-E: utilization rates below 1
- Higher carbon leakage in GEM-E3
- CBAM (ff55) prevents CL in GEM-E3, still export effects in GINFORS-E
- Similar impacts in carbon intensive sectors
- Same order of macroeconomic effects: FA > ff55 > AU

# Further scenarios and sensitivities

1. Different CBAM design (inclusion of indirect emissions)
2. No compensation for indirect emissions
3. Higher trade elasticities in CBAM sectors (as in GEM-E3)
4. Higher climate mitigation ambition in non-EU ambition (50% of EU carbon price in other OECD countries, China to reach climate neutrality in 2060, main efforts after 2030)

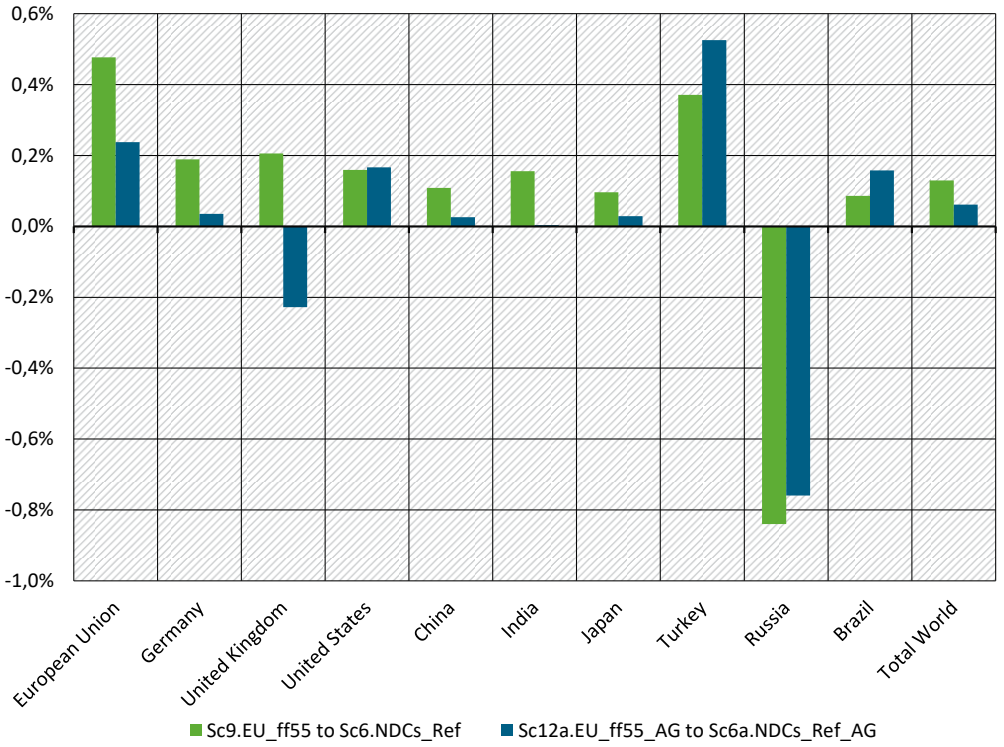
# Further scenarios and sensitivities

1. Different CBAM design (inclusion of indirect emissions)
2. No compensation for indirect emissions

- Inclusion of indirect emissions in the CBAM is slightly better for EU carbon-intensive industries, but total impact small
- No compensation for indirect emissions for electricity-intensive industries is worse for basic metals, but total effect also limited
- Effects in both sensitivities much smaller than between main scenarios (CBAM introduction or not)

# 3. Higher trade elasticities

- GDP deviations – Sc9.EU_ff55 compared to Sc6.NDCs_Ref and Sc12a.EU_ff55_AG compared to Sc6a.NDCs_Ref_AG in 2030

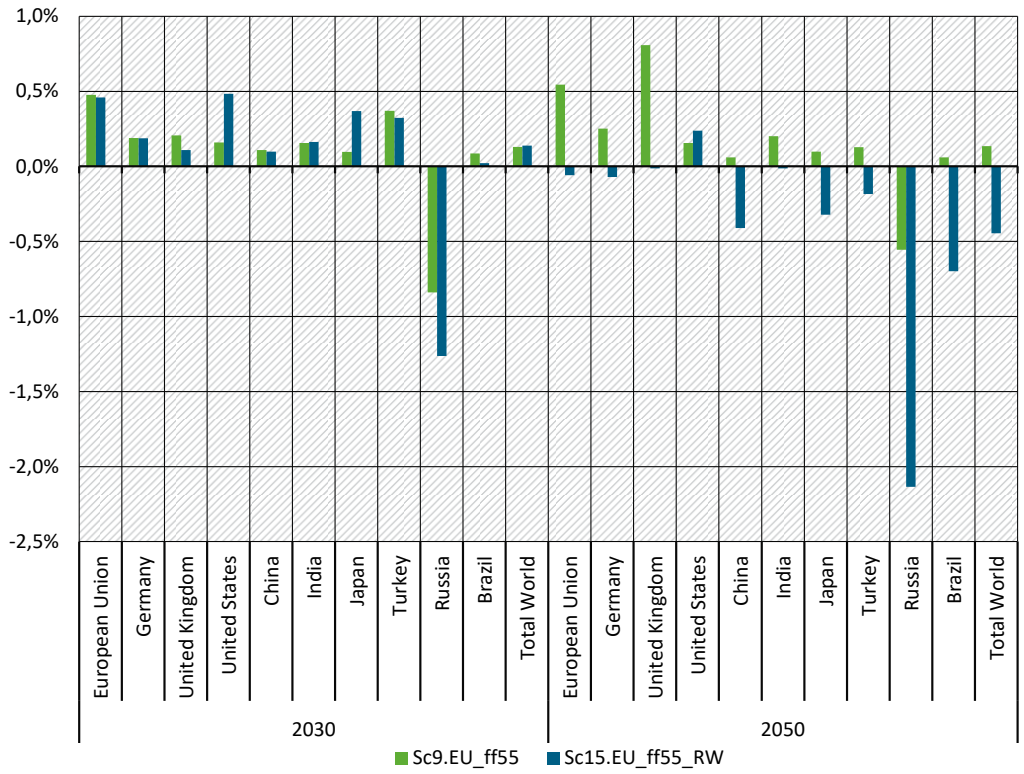



- Assumption of higher trade elasticities in the CBAM sectors will significantly reduce positive GDP impacts in EU
- More positive GDP impacts in USA, Turkey, Russia and Brazil
- Lower GDP impacts in total world and Asia
- GINFORS-E results in EU and most other countries are sensitive for assumptions on trade elasticities

| Scenarios | Industry | sigma m value | sigma x value |
|---|---|---|---|
| 6-9, 9a, 9b, 13-15 | All CBAM sectors | 4 | 1 |
| | | | |
| 6G, 10a, 11a, 12 a | Basic metals, paper and paper products | 5.94 | 2.91 |
| | Chemical Products, rubber and plastic products | 6.64 | 3.31 |
| | Non-metallic minerals | 3.84 | 1.91 |

# 4. Higher non-EU ambition in GHG emission reduction

- Deviations in GDP – Sc15.EU_ff55_RW and Sc9.EU_ff55 compared to Sc6.NDCs_Ref in 2030 and 2050




2030

- Slightly positive for most OECD countries
- Very small impact on China
- Negative for fossil fuel exporters
- Slightly negative impact in EU and UK (in relation to unilateral action)
- Impacts on carbon-intensive EU industries are small:
  - ⇨ Still lower than in the reference due to higher carbon

2050

- Negative for all countries except the USA (compared to EU unilateral action)
- Negative for fossil fuel exporters
- Impacts on carbon-intensive EU industries are small:
  - ⇨ Production still higher than in the reference, but a bit lower than in scenario with unilateral action

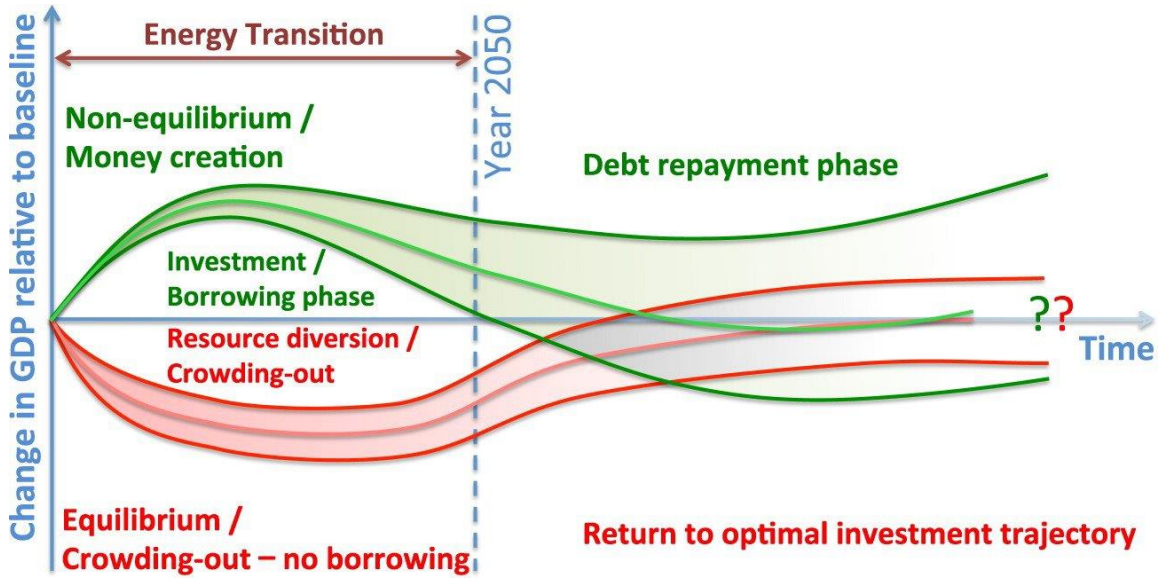
# Conclusions and outlook

- Risk of carbon leakage, if EU acts unilaterally (steps up ambition to 55%/95%)
- Effects are limited and can be further reduced by design of the EU ETS/CBAM
- Current CBAM design cannot completely prevent carbon leakage
  - ⇨ Examine further design options of CBAM, EU-ETS and EU climate policies as a whole
  - ⇨ Various policies on EU and national level, that go beyond carbon pricing (e.g. innovation and modernization funds, renewable energy policies, energy efficiency policies, regulation) need to be considered

- Unilateral climate action of the EU will have small positive macroeconomic impacts
- Economic impacts of FA > f55 > AU (partly due to no compensation of indirect emissions)
- EU can reach the Green deal targets (55% until 2030 / 95% until 2050), independent from other countries

# Discussion

- Climate mitigation/carbon pricing:
  - ⇨ No consensus on direction of socio-economic impacts (IMF 2023)
  - ⇨ Supply-side models calculate negative GDP impacts
  - ⇨ Demand-side models with positive effects
  - ⇨ Empirical study by Metcalf, Stock (2023): Positive impact of carbon price of 40 USD for the EU
  - ⇨ All studies show, that the macro effects are small
  - ⇨ Transformation is a challenge for carbon-intensive industries, but well understood
- Economic impacts of climate change
  - ⇨ Negative
  - ⇨ In the long run
  - ⇨ Probably much higher
  - ⇨ High uncertainty
  - ⇨ Danger of extremes (tipping points)

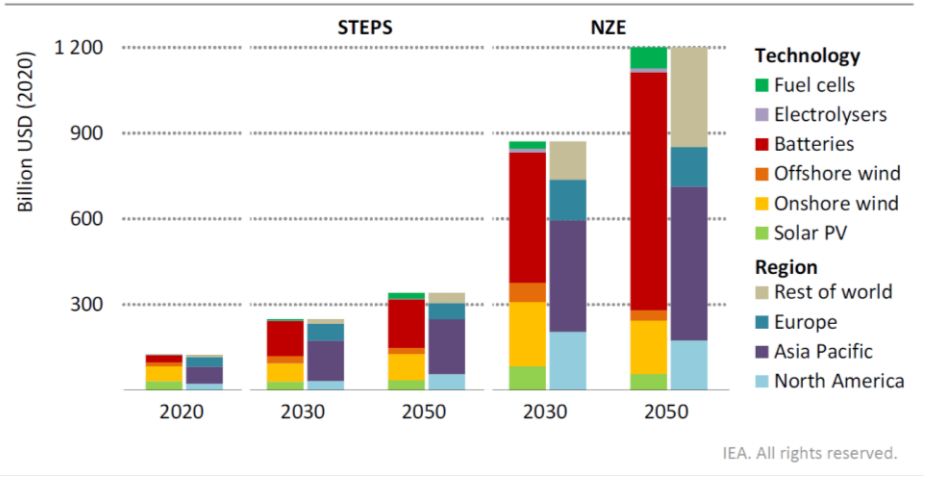



Source: Mercure et al. 2019

# Outlook on „low carbon leakage“ project

- The new emerging energy economy: IEA sees an annual 1200 billion USD market in the NZE scenario in 2050
- BMWK funded project “Low carbon Leakage”
  - ⇨ How can the relocation of clean energy technologies (CET) be prevented?
  - ⇨ Pros and cons of first mover strategy
  - ⇨ Improved understanding and modelling of global low carbon value chains: where will the new goods be produced?
  - ⇨ Socio-economic impacts (GDP, value added, jobs)
  - ⇨ How can these technologies be quantified (often not in statistical classifications)

**Figure 1.3** ▷ Estimated market size for selected clean energy technologies by technology and region, 2020-2050




Source: IEA (2021)

| | Technology | | Technology |
|---|---|---|---|
| 1 | Wind Energy | 8 | Hydropower |
| 2 | Solar energy / PV | 9 | Heat storage |
| 3 | Batteries | 10 | Fuel cell vehicles |
| 4 | CCUS and $CO_2$ infrastructure | 11 | Heat pumps |
| 5 | Biomass | 12 | Efficiency in industry |
| 6 | E-mobility | 13 | Transmission and grid |
| 7 | Hydrogen | 14 | Building technologies |

# Outlook on “low carbon leakage”

- Results of GINFORS-E are sensitive to assumptions on Armington elasticities / trade elasticities
  - ⇨ Gravity model: allocates global imports of CETs to global exports
  - ⇨ In the enlarged GINFORS-E model:
    - Link activity changes in the energy balances (PV, Wind, H2) or EV shares to changes in intermediate and final demand in the IO model
    - Use more recent IOT (OECD 2021)
    - calculate global production of CETs from global demand
  - ⇨ CETs (or components) are partly available in trade data
    - Components are assigned to different IO industries
- Scenario analysis
  - ⇨ Anounced Pledges Scenario  (APS) from the IEA WEO 2023 (1.7°)
  - ⇨ Alternative scenario based on Multi-Level-Perspective (MLP) analysis
- Which determinants lead to relocation of CET production

- Results should be available in April

# THANK YOU FOR YOUR ATTENTION!

**Christian Lutz**

T +49 (0) 541 40933 - 120
E lutz @ gws-os.com

Head of division Energy & Climate

References:


- GINFORS-E:https://web.jrc.ec.europa.eu/policy-model-inventory/explore/models/model-ginfors-e
- Mönnig, A. & Wolter, M. I. (2020): TINFORGE – Trade in INFORGE. Methoden-Update 2020. GWS Discussion Paper 2020/4, Osnabrück.
- Banning, M., Becker, L., Hembach-Stunden, K., Horst, J., Klann, U., Lutz, C. & Matschoss, P. (2023): Zentrale Technologien und Länder der globalen grünen Transformation. Methoden und Analysen vor dem Hintergrund des „Low Carbon Leakage“-Risikos. GWS Research Report 2023/07, Osnabrück.