GWS SPECIALISTS IN EMPIRICAL ECONOMIC RESEARCH

DEVELOPING AND MODELING POLICIES TO REDUCE REBOUND EFFECTS

1st IAEE Online Conference, June 7th 2021

Christian Lutz, Lara Ahmann, Maximilian Banning

ReCap Makro-Rebounds begrenzen

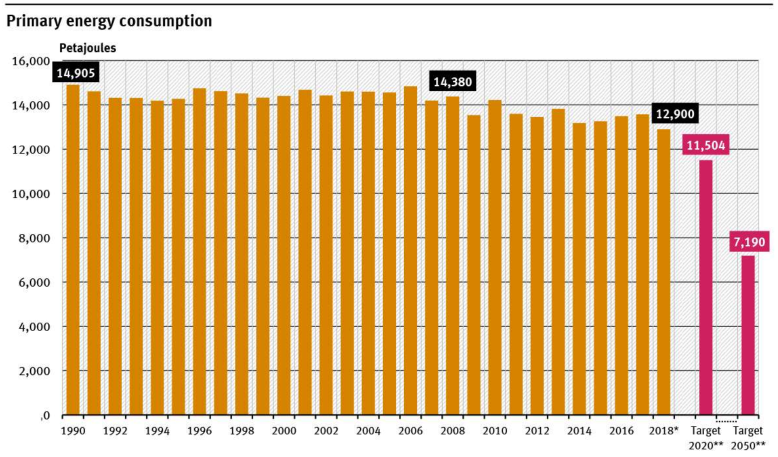
Bundesministerium für Bildung und Forschung

FONA Sozial-ökologische Forschung BMBF

Contents

1. Research question

- ReCap project (https://www.macro-rebounds.org/english/)
  - ⇨ **Re**considering the Role of Energy and Resource Productivity for Economic Growth, and Developing Policy Options for **Cap**ping Macro-Level Rebound Effects
  - ⇨ Three year project funded by BMBF as part of FONA
  - ⇨ Partners: IÖW Berlin (lead), University of Göttingen
- Despite various policy measures (such as National Energy Efficiency Action Plans) energy consumption is declining less than expected
  - ⇨ Have rebound effects been neglected?
  - ⇨ What are magnitude and drivers of rebounds?
  - ⇨ How to model and address them?

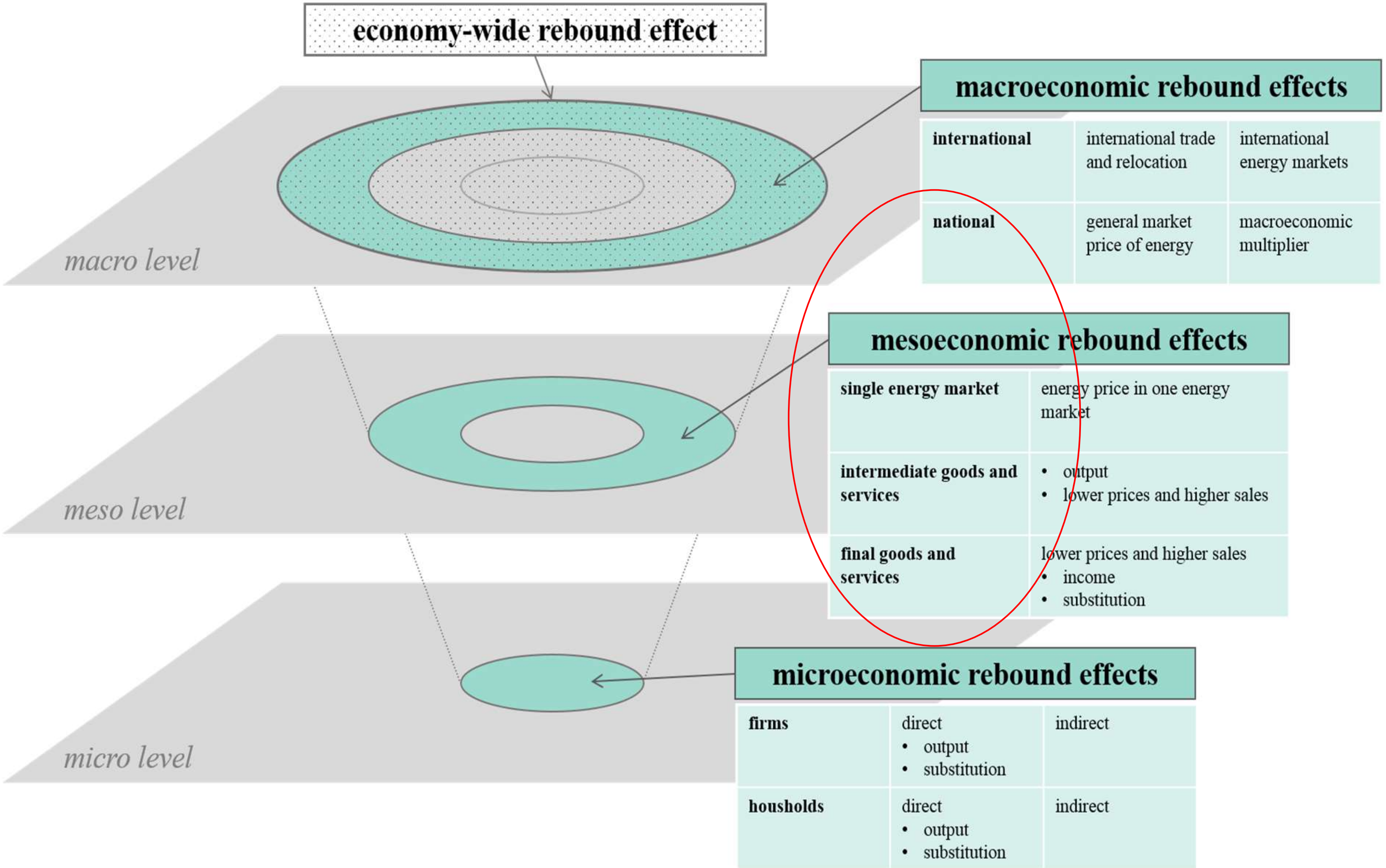


* preliminary figures
** Targets of the Energy Concept and the German Sustainable Development Strategy: Reduction of the primary energy consumption by 20 % until 2020 and by 50 % until 2050 (base year 2008)

Source: German Federal Environment Agency on basis of the Working Group on Energy Balances (AGEB), Evaluation Tables on the Energy Balance for Germany 1990 to 2017, as of 07/2018; for 2016/2017 - AGEB: Primary energy consumption, as of 12/2018

Rebound definition in ReCap

- Only part of rebound effects considered in PANTA RHEI

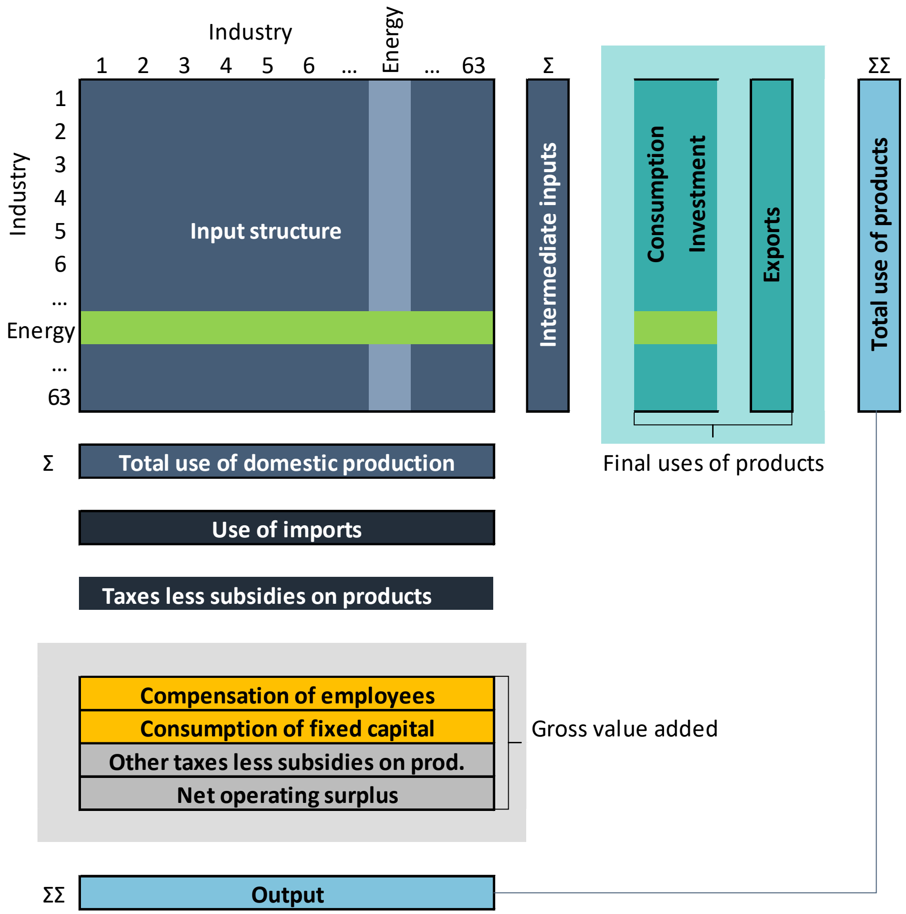


Context of analysis

- Ambitious target to reduce energy use by 30% against 2008 until 2030
- Period under consideration: 2020-2030
- Analysis of rebound effects in German industry
- Growing number of research papers on “rebound”
- Various studies exist for other countries that use macroeconomic models to calculate rebounds
- Use of the PANTA RHEI model, which is also applied for socioeconomic impact assessment in the German NECP process

2. Model structure

- Mapping of effects in the macroeconometric model PANTA RHEI
- Dynamic input-output model, myopic expectations
- does not follow any optimization algorithm
- Focus is on meso and macro level
- More information in Lutz et al. 2021, accepted in Economic Systems Research



Model adjustment

- Final energy consumption (E_i) of every industry is modeled as dependent of respective production (Y_i), relative prices ($\frac{PE_i}{PY_i}$) and trends

$$E_i = \hat{\beta}_{0,i} + \hat{\beta}_{1,i} * (1 - \delta_i) * Y_i + \hat{\beta}_{2,i} * \frac{PE_i}{PY_i}$$

with δ_i: Efficiency improvement in industry i

- Estimates based on the AFiD panel by the project partner Uni Göttingen (Panel of Cost Structure Survey for years 2003-2014, all German manuf. Companies with more than 20 employees)

Industry	Production elasticity	Price elasticity
Quarrying, other mining	0.57	-0.04
Food and tobacco	0.25	-0.06
Paper	0.51	-0.07
Basic chemicals	0.59	-
Other chemical industry	0.23	-
Rubber and plastic products	0.31	-0.07
Glass and ceramics	0.37	-0.25
Mineral processing	0.87	-0.36
Manufacture of basic metals	0.33	-0.35
Non-ferrous metals, foundries	0.50	-0.38
Metal processing	0.14	-0.09
Manufacture of machinery	0.44	-0.21
Manufacture of transp. equipment	0.31	-0.36
Other segments	0.65	-0.14

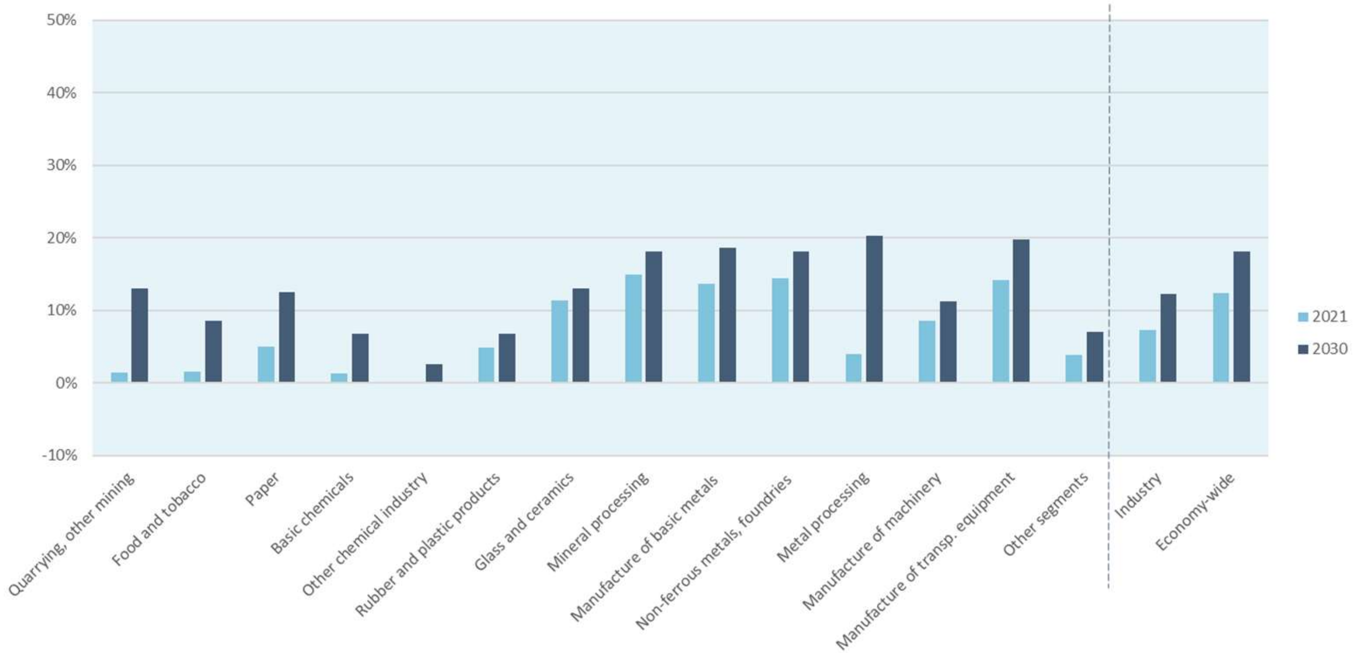
Rebound effects due to efficiency increase

- Efficiency increase takes place in the form of relative savings in final energy consumption in industry
- Determination of rebounds: potential versus actually realized reduction in energy consumption as a percentage.

$$\theta_i = 1 - \left(\frac{\frac{E_i^{actual}}{E_i^{reference}} - 1}{\frac{E_i^{targeted}}{E_i^{reference}} - 1} \right)$$

- Targeted (potential) energy consumption must be known for quantification: possible for efficiency improvement, difficult regarding policy measures

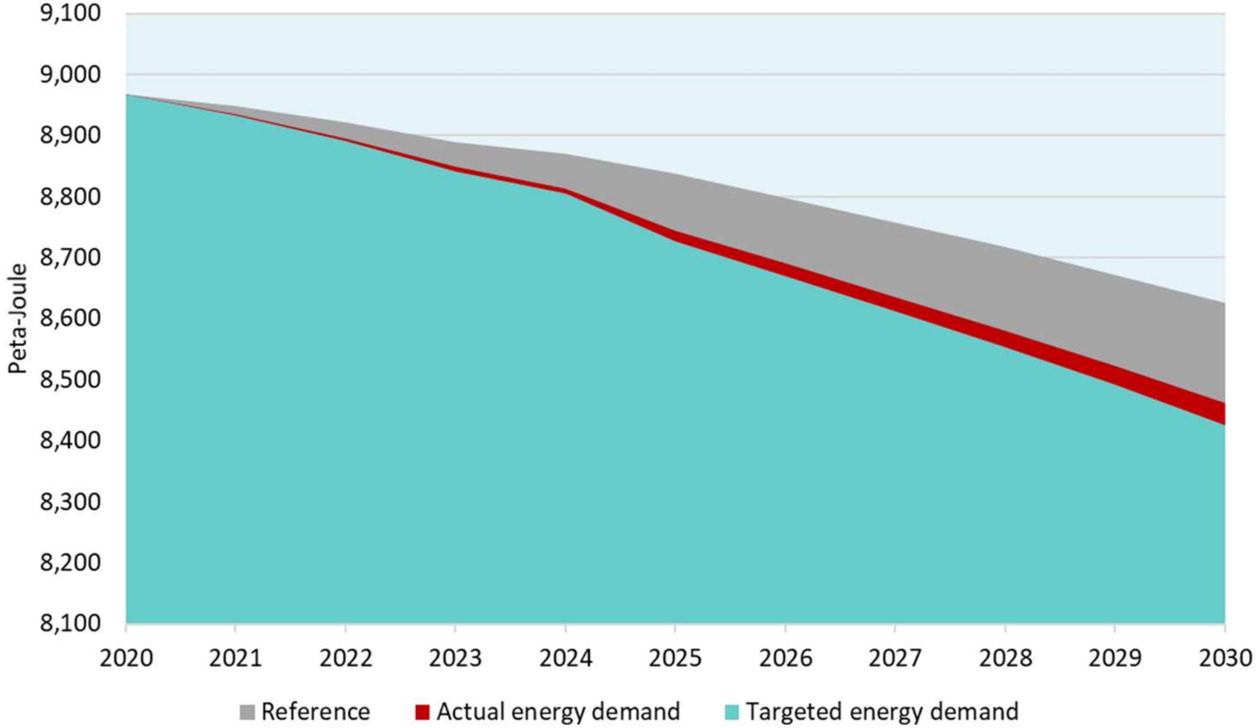
3. Rebound effects in industry in 2021/2030



- High rebounds in minerals, metals, transport equipment
- Economy-wide rebound larger than in industry
- Level of rebound effects depends, among other things, on price elasticities of energy demand

Macroeconomic rebound

Final energy consumption until 2030



Targeted reduction in industry: 7.4%; realized: 6.5%

4. Scenarios: Accompanying policy measures

1) **Reinvestment requirement**

- 50% of the savings are used by companies for further efficiency measures

2) **CO_2 pricing**

- Pricing of up to 180€/t CO_2eq in 2030.

3) **Reimbursements**

- Reduction of the EEG levy

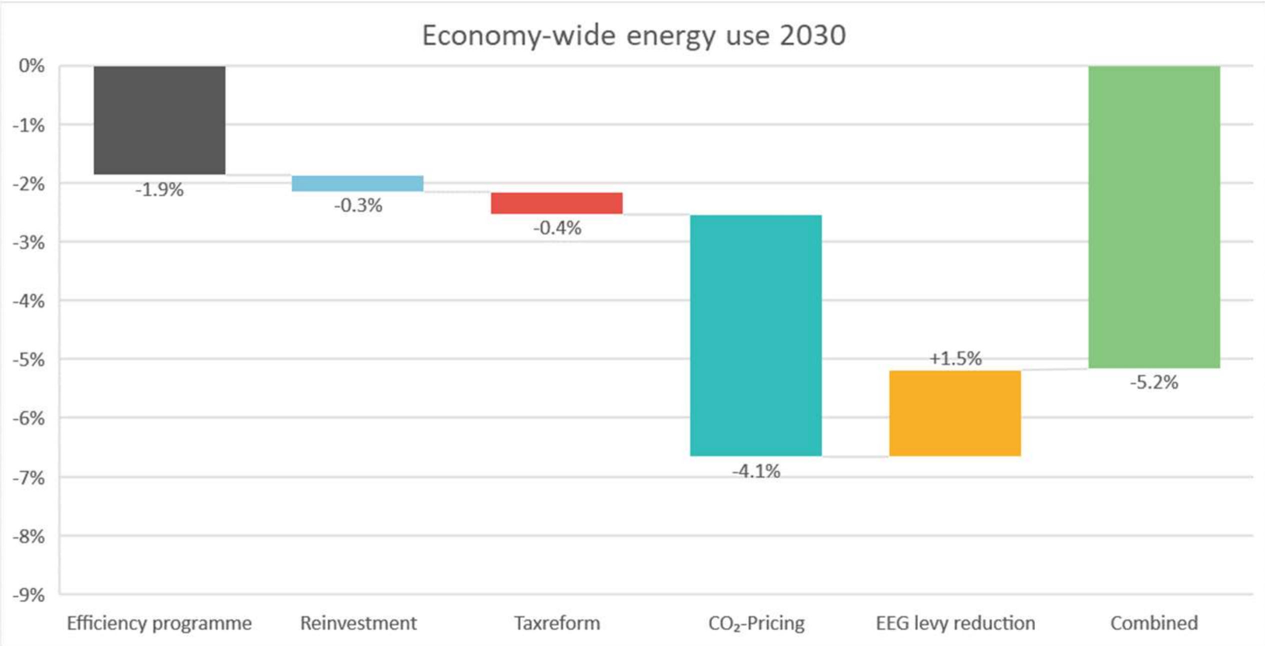
4) **Tax reform**

- Higher taxation of the energy factor (50% higher tax rates), lower taxation of the labor factor

5) **Reduction of working hours**

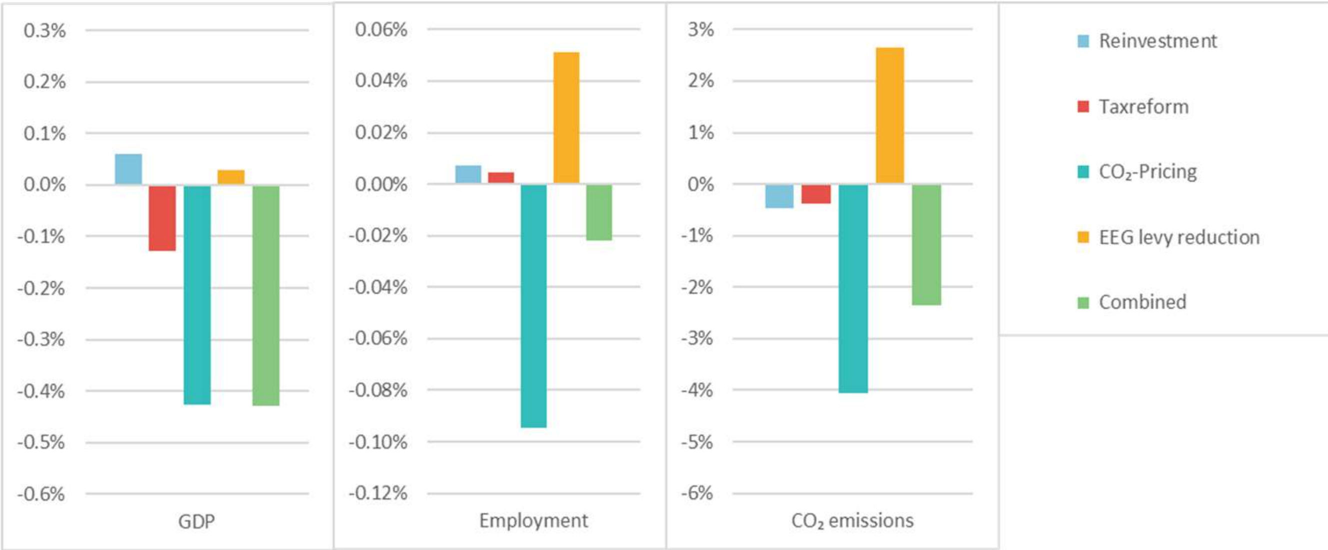
- Reduction by 10% with half wage compensation

Combined effects on energy use in 2030



- Efficiency programme in industry and carbon pricing (in non-ETS) contribute most to energy savings
- Reduction of EEG levy will increase use of electricity

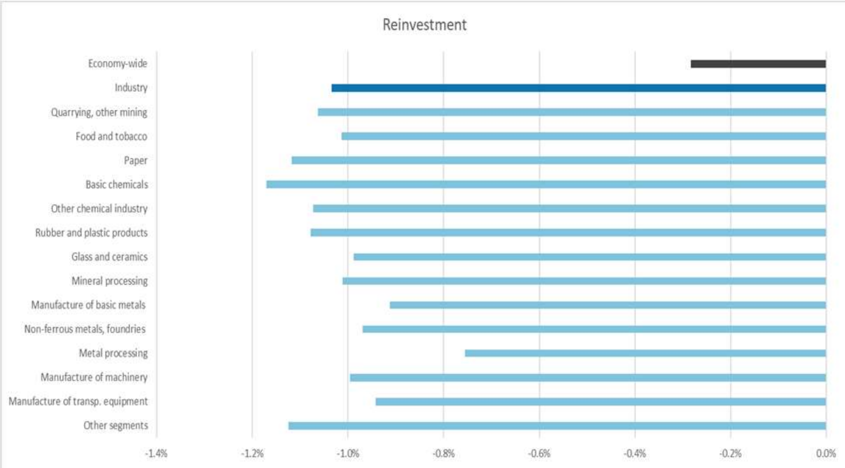
Effects on other SD indicators in 2030



- Reinvestment goes in the wanted direction for all indicators
- Carbon pricing (without recycling) has negative economic effects and reduces CO_2 emissions
- Reduction of EEG levy: Trade-off between emission increase and positive economic effects

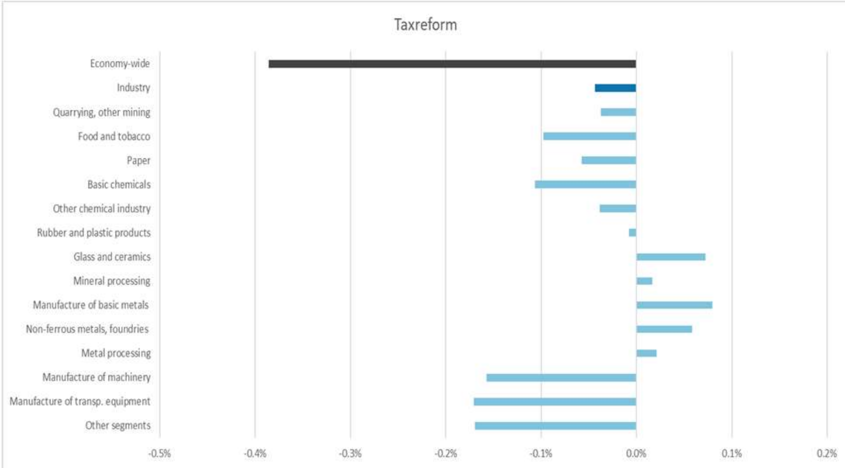
Effects on energy consumption

Reinvestment



- Reduction of energy use in industry
- No (big) macroeconomic effects

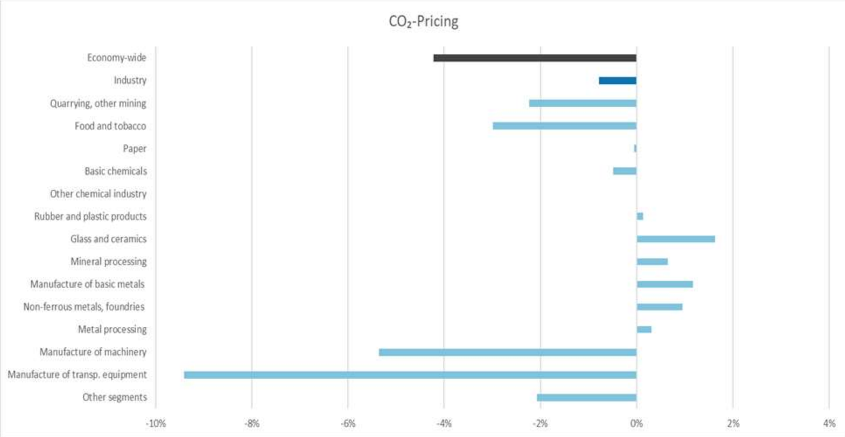
Tax reform



- Small mixed effects on energy use in industry
- Larger reduction in economy-wide energy use
- Small negative effect on GDP

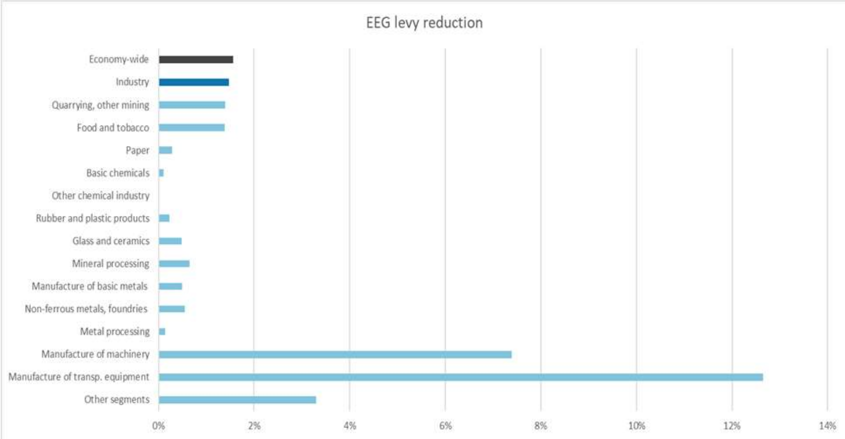
Effects on energy consumption

Carbon pricing



- Only effective in non-ETS sector/industries
- Larger reduction in total energy use
- Negative GDP effect (without revenue recycling)

Reduction of EEG levy



- Lower electricity prices In industries without exemptions
- Increase in energy (electricity use)
- Positive GDP effect

5. Conclusions and outlook

- No one-fits-all measure: **Policy-mix** needed
  - ⇨ Price instruments are important
- Modelling should also account for rebounds
  - ⇨ Include potential rebounds in modelling of policy instruments
  - ⇨ Consider global level
- Other impacts/SDGs also matter: employment, prices, GDP
  - ⇨ How are they related to energy consumption/energy prices?
- Policy
  - ⇨ Acceptance is important
  - ⇨ Higher efficiency targets to consider rebounds
  - ⇨ Systemic view: Transformation necessary because of technological limits of efficiency gains
  - ⇨ Renewables **and** efficiency needed for GHG neutrality

CONTACT PERSON

Thank you for your attention.

Christian Lutz

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

Head of division Energy & Climate

References:

- Lutz, C.; Banning, M.; Ahmann, L.; Flaute, M. Energy efficiency and rebound effects in German industry – evidence from macroeconometric modeling. Econ. Syst. Res. 2021, accepted for publication https://doi.org/10.1080/09535314.2021.1937953.
- Lange, S., Kern, F., Peuckert, J., Santarius, T. (2021): The Jevons paradox unravelled: A multi-level typology of rebound effects and mechanisms, Energy Research & Social Science, 74, 2021, https://doi.org/10.1016/j.erss.2021.101982.
- Colmenares, G., Löschel, A., Madlener, R. (2020): The rebound effect representation in climate and energy models, Environmental Research Letters 15 123010 10.1088/1748-9326/abc214.
- Brockway, P. E., Sorrell, S., Semieniuk, G., Heun, M. K., Court, V. (2021): Energy efficiency and economy-wide rebound effects: A review of the evidence and its implications, in Renewable and Sustainable Energy Reviews 141 110781 10.1016/j.rser.2021.110781.

How to model rebounds in PANTA RHEI?