GWS SPECIALISTS IN EMPIRICAL ECONOMIC RESEARCH

REBOUND EFFECTS AND COUNTERACTING POLICIES FOR GERMAN INDUSTRY

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ReCap Makro-Rebounds begrenzen

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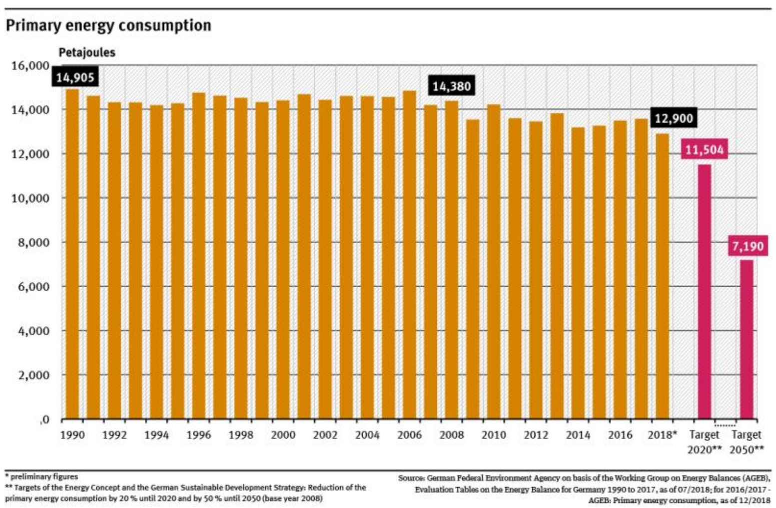
FONA Sozial-ökologische Forschung BMBF

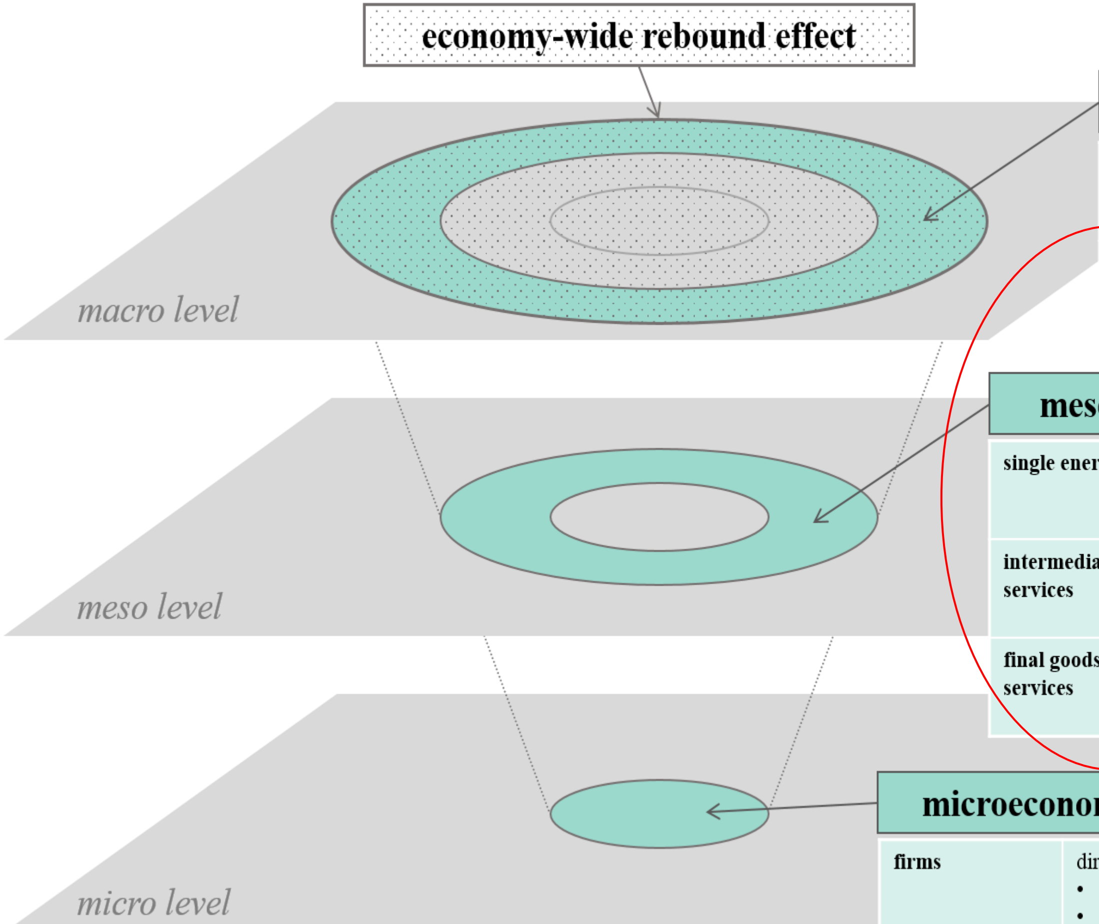
Background and research question

- 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?



Rebound definition in ReCap

- Only part of rebound effects considered in PANTA RHEI



macroeconomic rebound effects

international	international trade and relocation	international energy markets
national	general market price of energy	macroeconomic multiplier

mesoeconomic rebound effects

single energy market	energy price in one energy market
intermediate goods and services	• output • lower prices and higher sales
final goods and services	lower prices and higher sales • income • substitution

microeconomic rebound effects

firms	direct • output • substitution	indirect
housholds	direct • output • substitution	indirect

Context of analysis

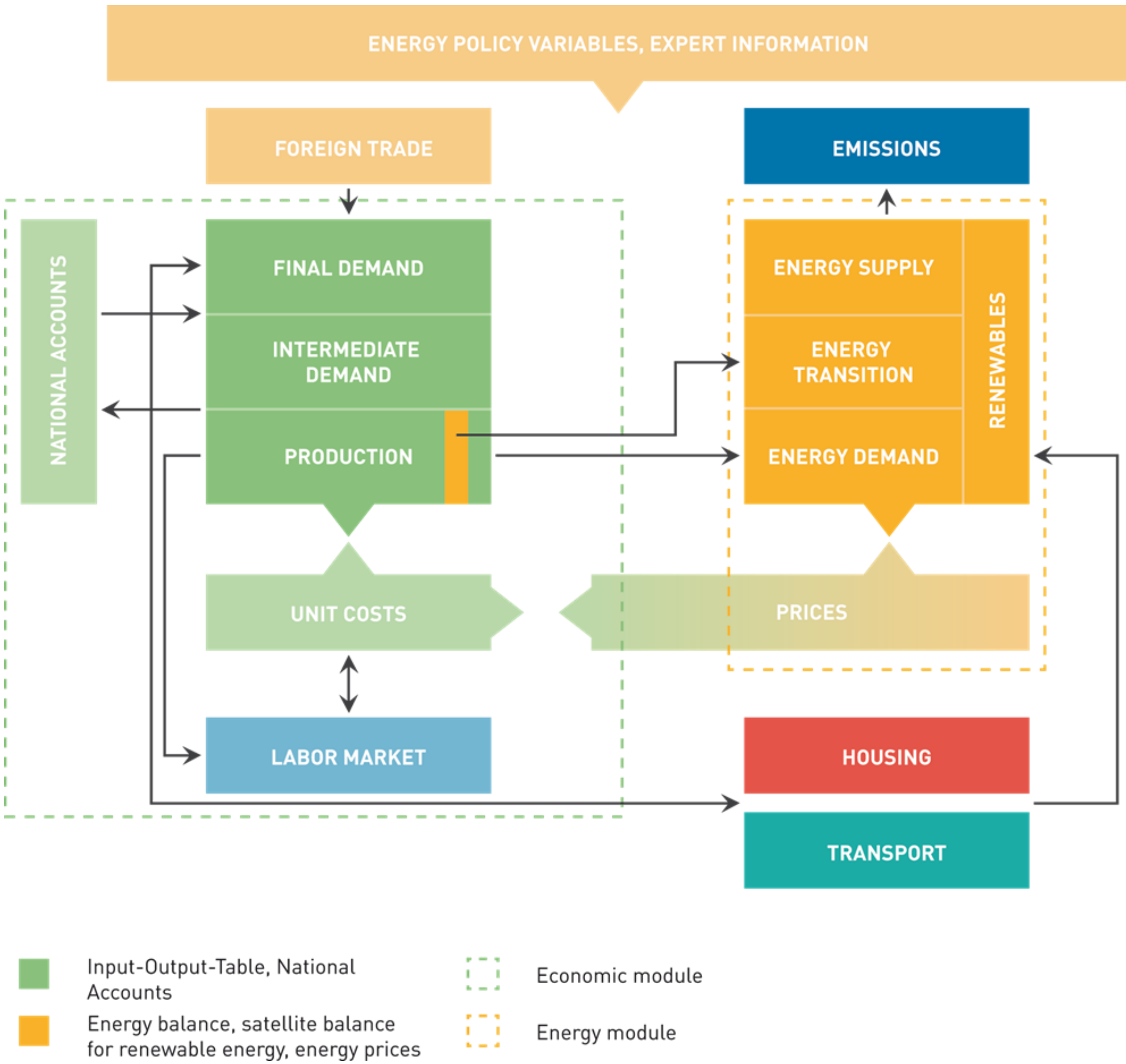
- Ambitious target to reduce energy use by 30% against 2008 until 2030
- Analysis of rebound effects in German industry
- Period under consideration: 2020-2030

- Growing number of research papers on “rebound”
- Various studies exist for other countries than Germany 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

Model structure

- Mapping of effects in the macroeconometric model PANTA RHEI



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

- 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)

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

with δ_i: Efficiency improvement in industry i

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

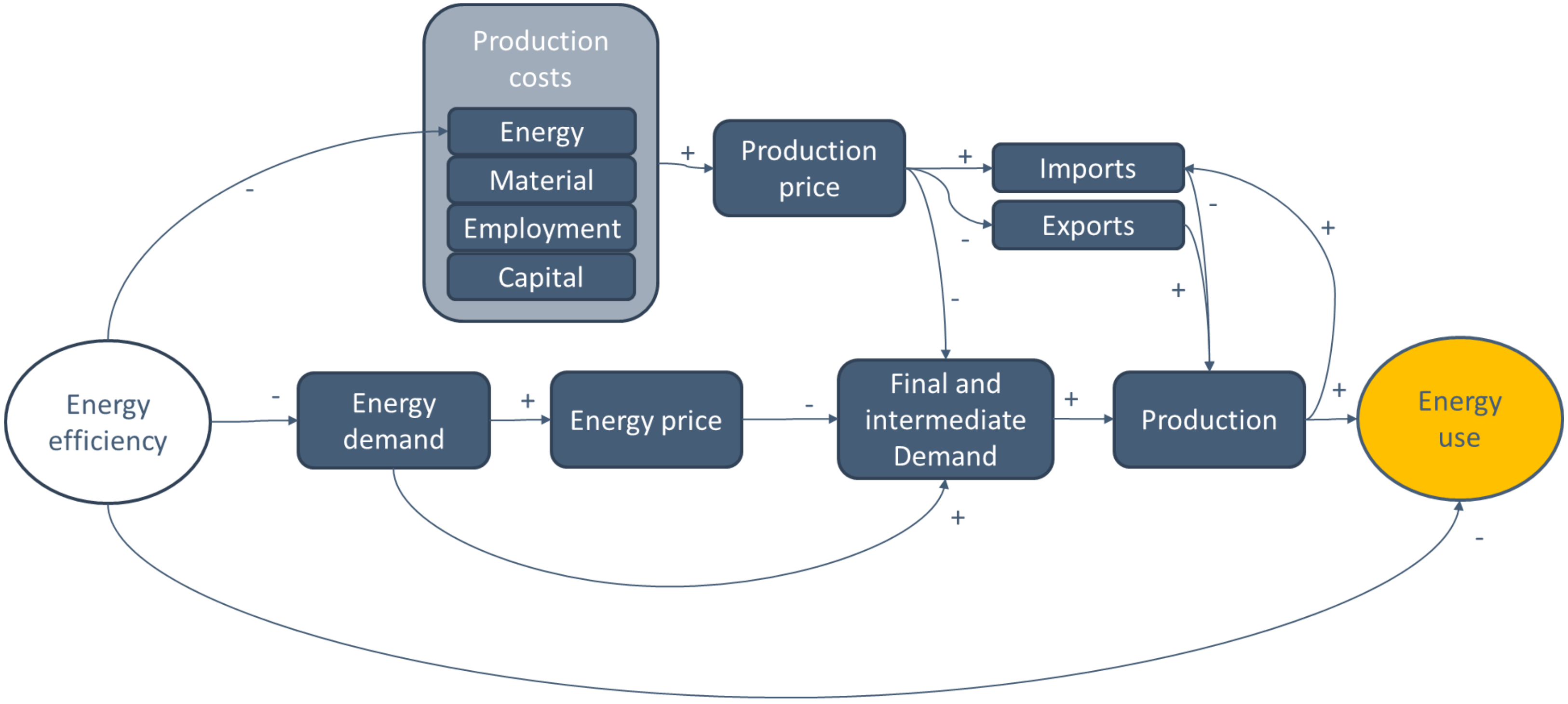
Rebound effects due to efficiency increase

- 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.

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

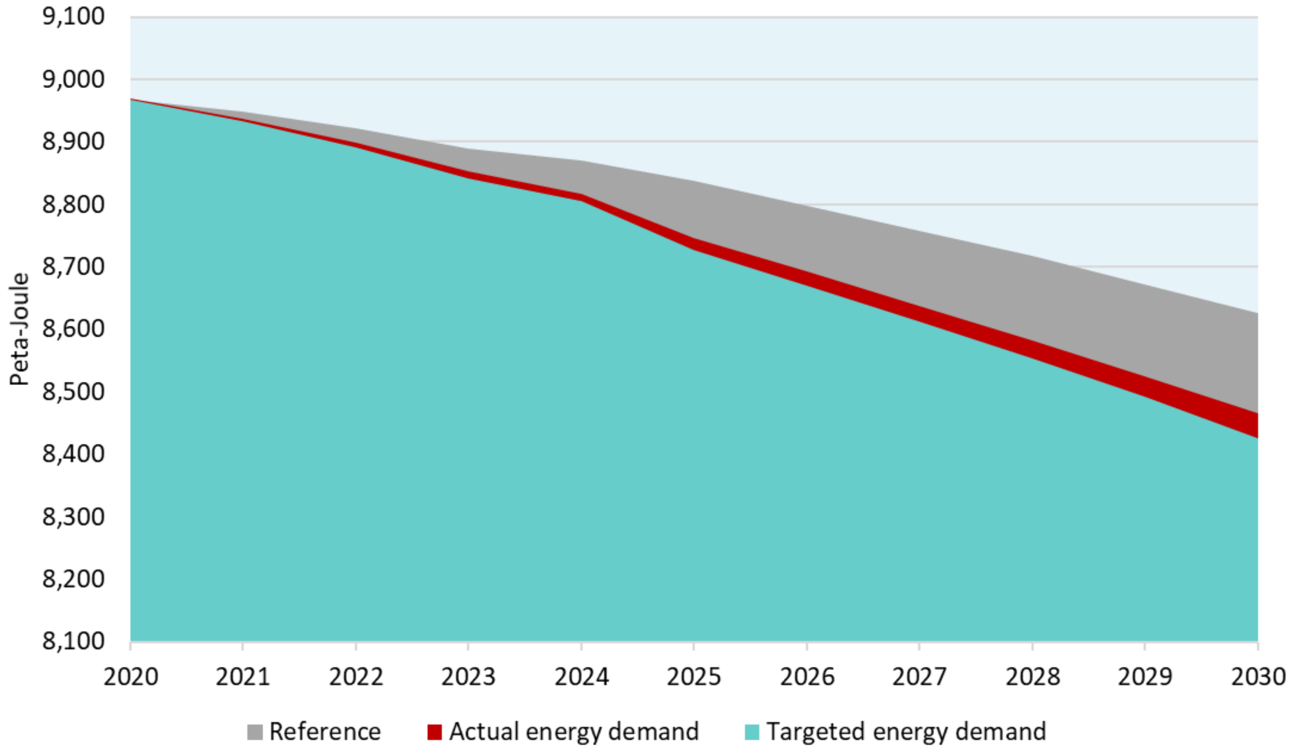
- Targeted (potential) energy consumption must be known for quantification: possible for efficiency improvement, difficult regarding policy measures

Channel of Rebound effects



Macroeconomic rebound

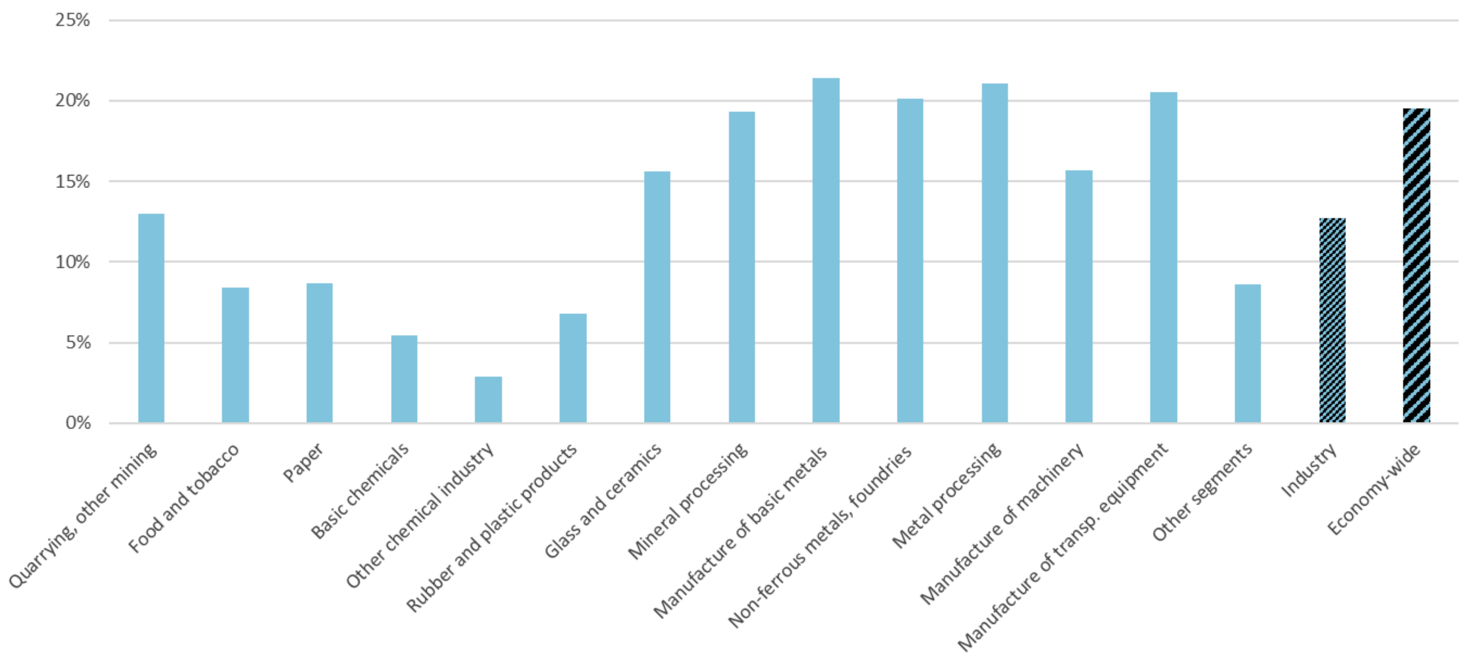
Final energy consumption until 2030



Targeted reduction in industry: 7.4%; realized: 6.4%

→ Rebound effect of 13% in industry, 19% economy wide

Rebound effects in industry in 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

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

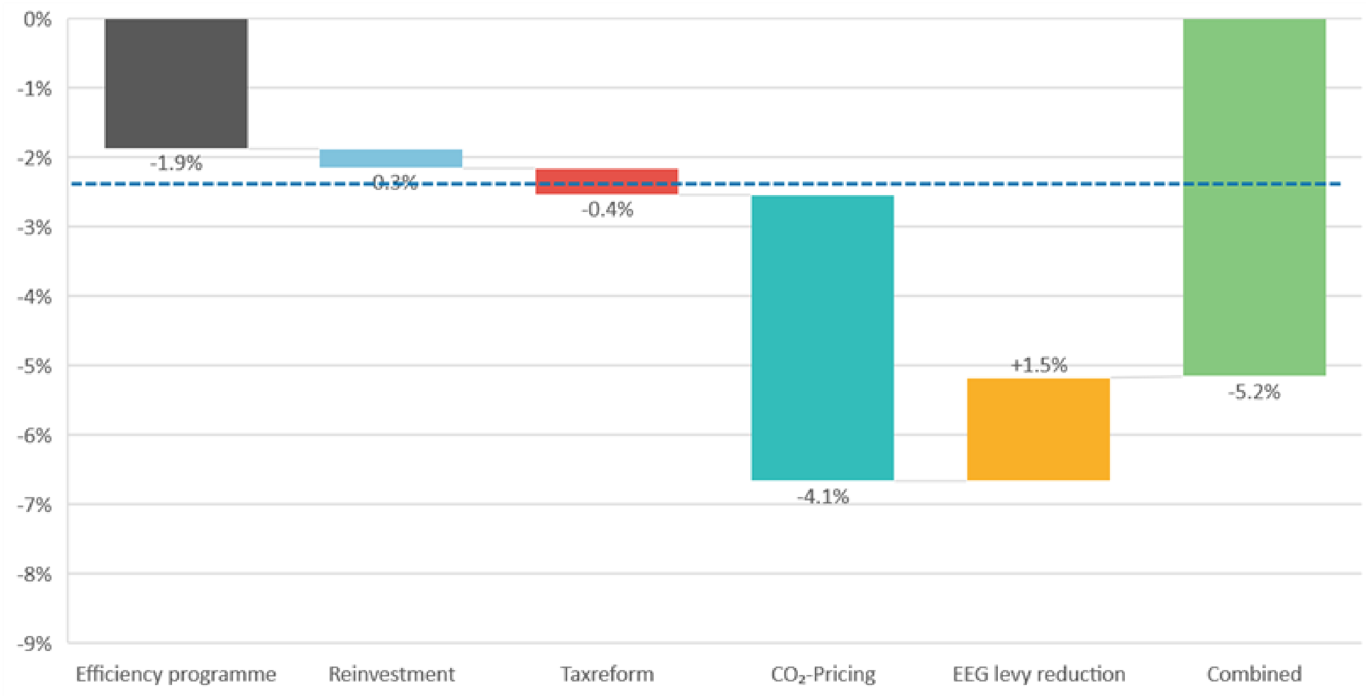
Impact of policy measures

- All policy measures can counteract rebound effects to various degrees, with macro economic effects on other variables varriing

Policy measure	Final energy demand	GDP	Employ-ment
Reinvestment requirement	-	0	0
CO_2 pricing and reimbursement	---	-	0
Tax reform	--	-	0
Reduction of working hours	-	---	+++

0: absolute change in 2030 < 0,1% \| +/-: < 0,5% \| ++/--: < 1% \| +++/---: > 1%

Effects of a combined set on energy use in 2030



- The combined set comprises all listed policy measures except working hour reduction
- Efficiency programme in industry and carbon pricing (in non-ETS) contribute most to energy savings
- Reduction of EEG levy will increase use of electricity

Conclusions and outlook

- Effects lie at the lower bound of comparable studies (20-50%)
  - ⇨ CGE models tend to assume higher elasticities of substitution, driving rebound effect
- The rebound effect in general is dependent on sector specific price and production elasticities
  - ⇨ Policy measures are not targeting and effecting all sectors homogenously
- Acceptance was one criterion influencing the policy selection, no recommended combined set
  - ⇨ Selection of suitable measures is at the center of the debate in Germany
- Specific rebound calculation proves difficult for scenarios with no clear reduction target

Thank you for your attention.

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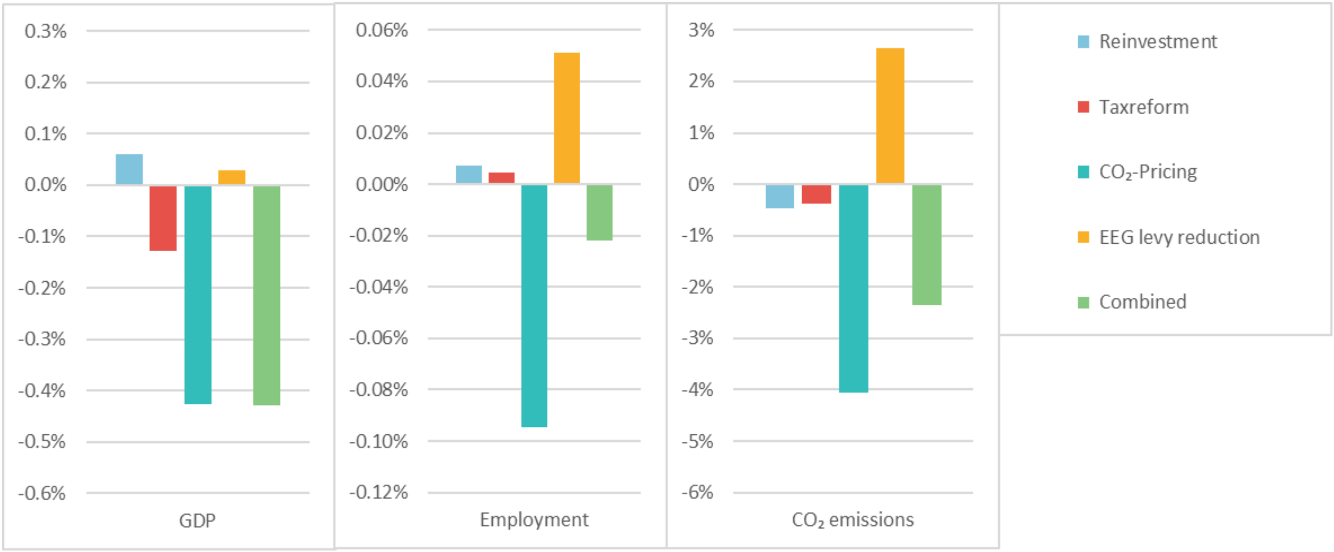
- Lange, S., Kern, F., Peuckert, J., Santarius, T. (2021): The Jevons paradox unravelled: A multi-level typology of rebound effects and mechanisms, Energy Research & Social Science, 74, 2021, https://doi.org/10.1016/j.erss.2021.101982.
- Ahmann, L., Bannning, M., Lutz, C. (forthcoming): Modeling rebound effects and counteracting policies for German industry, submitted to Ecological Economics.

Effects on other SD indicators in 2030



- Reinvestment takes all indicators into the desired direction
- 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