

Bridging the Gap: Evaluating Climate Policy Progress through Integrated Input-Output Monitoring Frameworks

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Motivation and Background

- Growing number of net zero emissions (NZE) commitments and corresponding “climate action plans” by German federal states
- Action plans often resemble a 'basket shop' of measures
 - Shiny lists of imprecise measures that were based on participatory stakeholder input to which political filtering was applied
- Arepo has been asked to evaluate their sufficiency and support with further development:
 - Berlin
 - Hesse
 - Saxony
 - Rhineland-Palatinate

Insight: Policymakers have limited knowledge regarding the actual impact of proposed measures in climate action plans and their sufficiency to meet NZE goals



Central Question

How can climate action plans be designed and monitored to effectively contribute to NZE targets?



Three Key Challenges

1. Fragmented GHG inventory system → lack of responsibility and accountability
2. Lacking knowledge of link between climate policies and (expected) GHG outcomes
3. Lacking transparency regarding GHG impact of other (fiscal) policy measures



Fragmented GHG Inventories in Germany

Challenge 1

In Germany, multiple standards coexist

- A CRF-based framework with deviations at the national level (source-based) → time-lagged and complex, e.g.:
 - Emissions from energy used in buildings is reported under energy supply, not the building sector
 - THG emissions from construction is reported in the industry sector
- Lacking coherence at the subnational level → each subnational state uses their own (source-based) version
- Municipalities use mostly BSKO system
 - Consumption and responsibility-based inventory
 - Omits non-energy-related sectors (e.g. agriculture, LULUCF)
- Cities, organisations, and companies often use scope-based GHG Protocol approach or the ISO standard 14064-1

→ **Lack of comparability, responsibility, and accountability**

→ **Undermines policy coherence and leads to blind spots**

Use scenario modeling to project emissions trajectories and identify implementation gaps

1. Establish an analytical reference point through scenario modeling
2. Use scenario comparison to identify implementation gaps

Establish an analytical reference point (scenario modeling)

Example: Saxony

Three scenarios

- **Trend scenario**
- **KSG scenario:** Top-down transfer of federal goals to the state level
- **Paris scenario:** Based on Paris-aligned CO₂ budget for the state of Saxony distributed across sectors

Key insights

- Climate action in all sectors required
- Lacking Paris-conformity of federal climate law

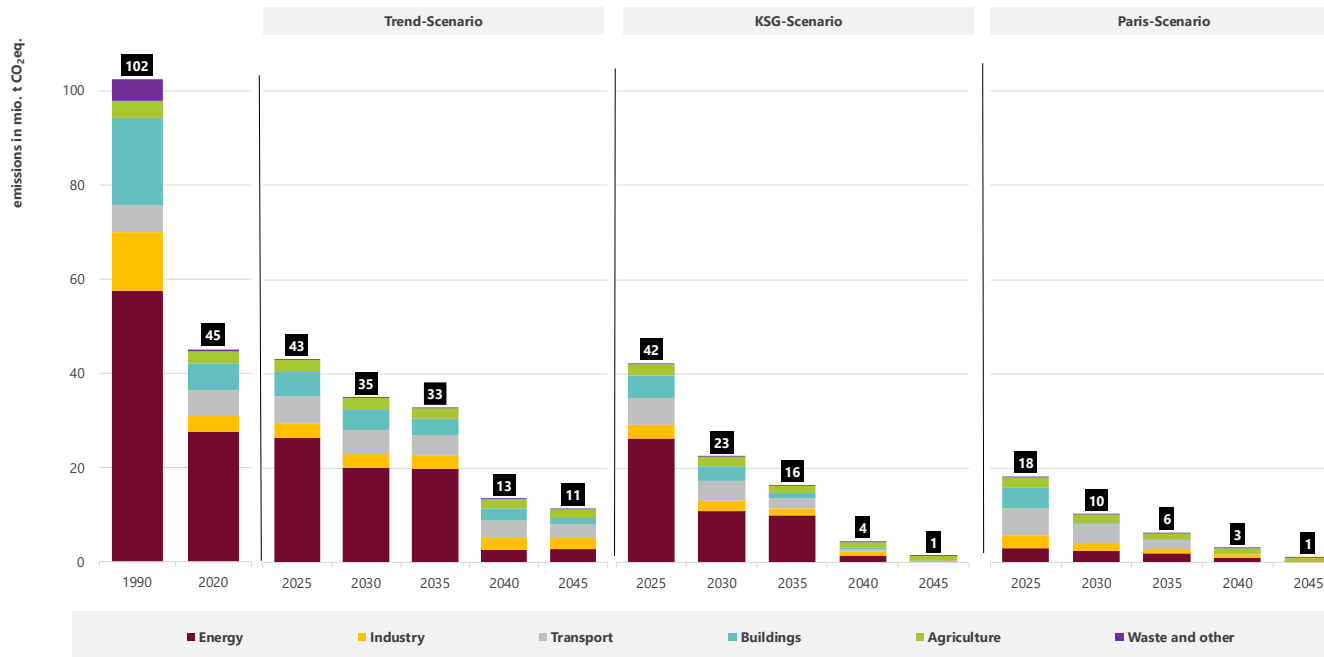


Fig.: GHG emissions by sector in 1990 and 2020 as well as by scenario until 2045 in Saxony
(Source: StLA Sachsen (2022a), LfULG (2022a), AK UGRdL (2022), Rösemann et al. (2023), own calculation)

Use scenario comparison to identify implementation gaps

Example: Saxony

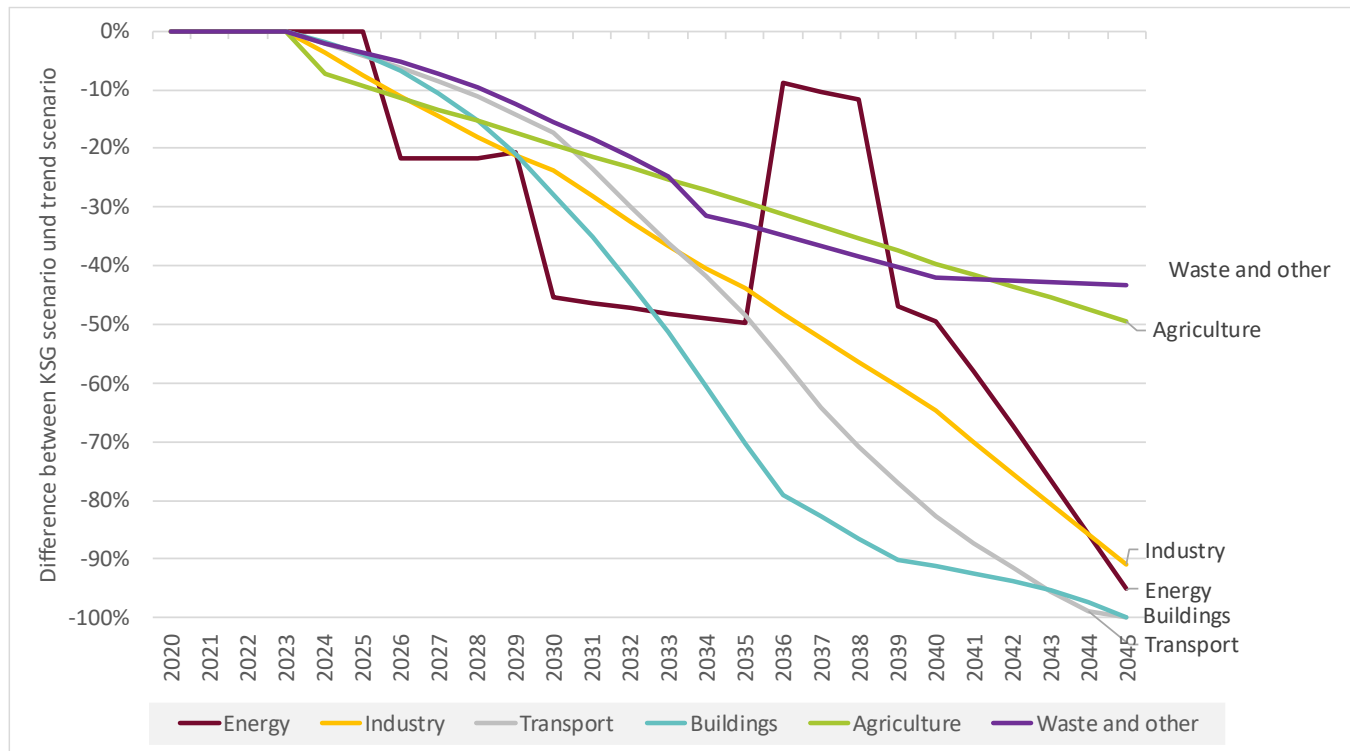


Fig.: Relative difference in GHG emissions between KSG scenario and trend scenario by sector in Saxony (2020-2045)

(Source: StLA Sachsen (2022a), LfULG (2022a), AK UGRdL (2022), Rösemann et al. (2023), own calculations)

Comparison in GHG emission trajectory between trend scenario and KSG scenario

Highlights implementation gap to reach NZE goal

- Substantial implementation gap in energy sector due to late coal phase out
- Buildings sector has the largest implementation gap over studied period

Lacking Link between Policies and Outcomes

Challenge 2

- Action plans list many measures without quantifying their impact
- Need to translate qualitative actions into quantitative output indicators
- Various existing barriers (regulatory, financial, behavioral) require policy bundles rather than standalone measures
- Arepo's "Theory of No Change" (TONC) is useful for barrier & stakeholder analysis

→ Translate action gaps into concrete policy bundles with quantitative targets for output-based indicators (e.g. insulation rates, heating system phase-out, transport shifts)

Define subsectoral strategies and put targets on them

Example: building sector in Rhineland-Palatinate

Subsector strategy 1: Substitution of fossil-fueled heat generators in the heating structure

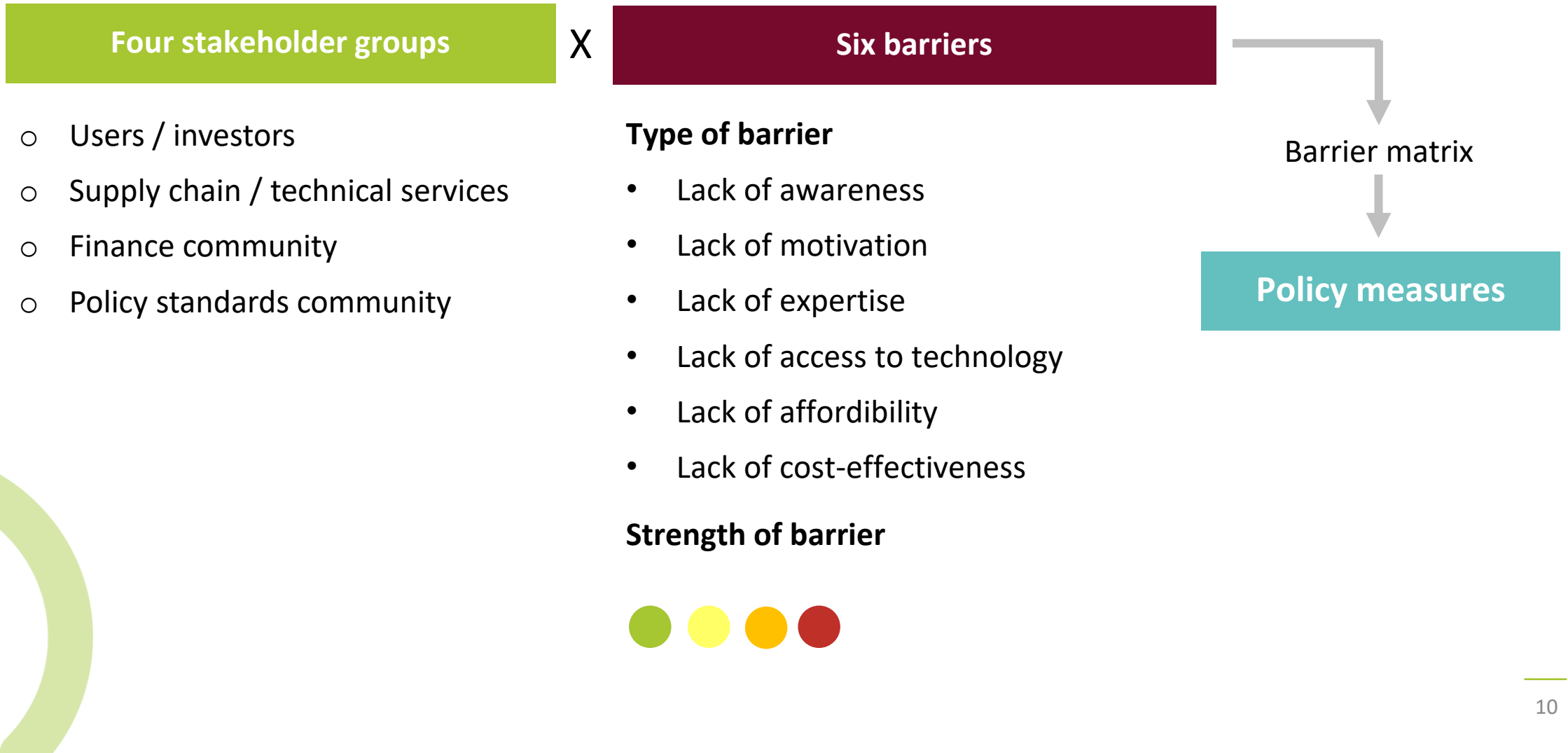
- Share of coal heating: -89 % between 2020 and 2040
- Share of oil-fired heating: -80 % between 2020 and 2040
- Share of natural gas heating: -58 % between 2020 and 2040

Subsector strategy 2: Building insulation

- Increasing the building insulation rate...
 - Single-family houses: ... by 80 % to an annual rate of approx. 2,0 % by 2030
 - Multi-family houses: ... by 48 % to an annual rate of approx. 1,8 % by 2030
- ...

Understand barrier structure of subsectoral strategy

Theory of No Change (TONC): Stakeholder and barrier logic



Understand barrier structure of subsectoral strategy

Example: building sector

Details	Barrier	Stakeholder	Possible policy measures
Debt aversion, lacking liquidity	Affordability	User (building owner)	Funding program
Home owners are uncertain about costs, perceive technology and funding programme as complex and are insufficiently aware of information and counselling services	Awareness	User (building owner)	Public advertisement and information campaign
Preference for gas-fueled systems (path dependency)	Motivation	User (building owner)	Installation ban for fossil systems; legal requirements for building insulation and new build
Contractors are insufficiently familiar with the new heating technologies	Expertise	Supply chain (contractor)	Upskilling programm
....	...	...	

Design policy bundles

Example: building sector

Bundle I: Heat generator substitution

- **door-to-door energy consulting**
 - neighborhood outreach campaigns for energy consulting
- **energy consulting provided by chimney sweeps**
- **Funding for investment subsidies**
 - Focus on low-income households
- **Upskilling of contractors**

Bundle II: Building insulation

- **Law:** Obligatory roadmaps for building insulation in worst-performing buildings
- **Funding for...**
 - Building insulation roadmaps
 - Building insulation measures by low-income households
 - Serial renovation
- **Publicity campaign** on funding options
- ...

Bundle III:

...

Important: Put output targets and GHG emission targets on these policy bundles

Lack of Fiscal Policy Transparency

Challenge 3

Challenge

- Many relevant measures outside climate strategies indirectly affect NZE targets
 - Risk of trade-offs (e.g. subsidies for fossil fuel sectors)
- Need for alignment of financial flows with climate goals

Solution: Green budgeting tools:



1. Budget tagging → categorizes expenditures according to their expected impact



2. Climate impact assessments → estimate the GHG impact of budget measures

→ Align fiscal policy with NZE targets

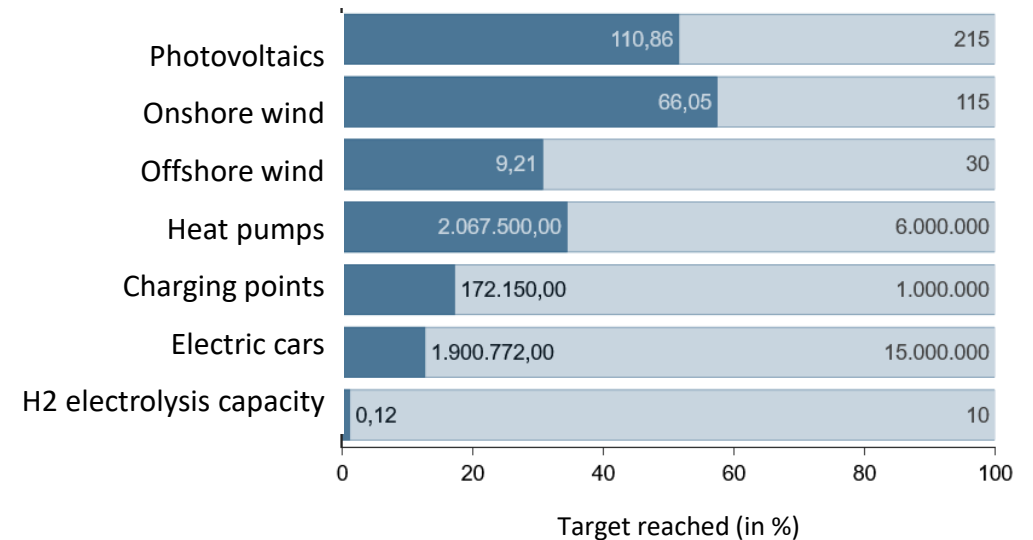
Input-Output Monitoring Approach as Governance Approach

Shift from static reporting to dynamic climate governance

For ensuring effective policy implementation we propose to combine budgetary and output-based monitoring approaches

- Input monitoring (green budgeting approach) for financial alignment with NZE
- Output monitoring: linking emissions targets to output indicators of policy (bundles)

Example for transparent output monitoring: Open Energy Tracker of DIW



Source: [Open Energy Tracker](#) by Roth and Schill (2025)

Conclusion

- Achieving NZE requires:
 - Methodological coherence across governance levels
 - Quantification of policy bundle effects
 - Alignment of financial resources with climate goals
- Integrated input-output monitoring enables impactful and accountable climate policy



Thank you for your attention!

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