

Evaluating Co-Benefits of Energy Efficiency Policy Measures: A Holistic Framework with Case Studies from Germany

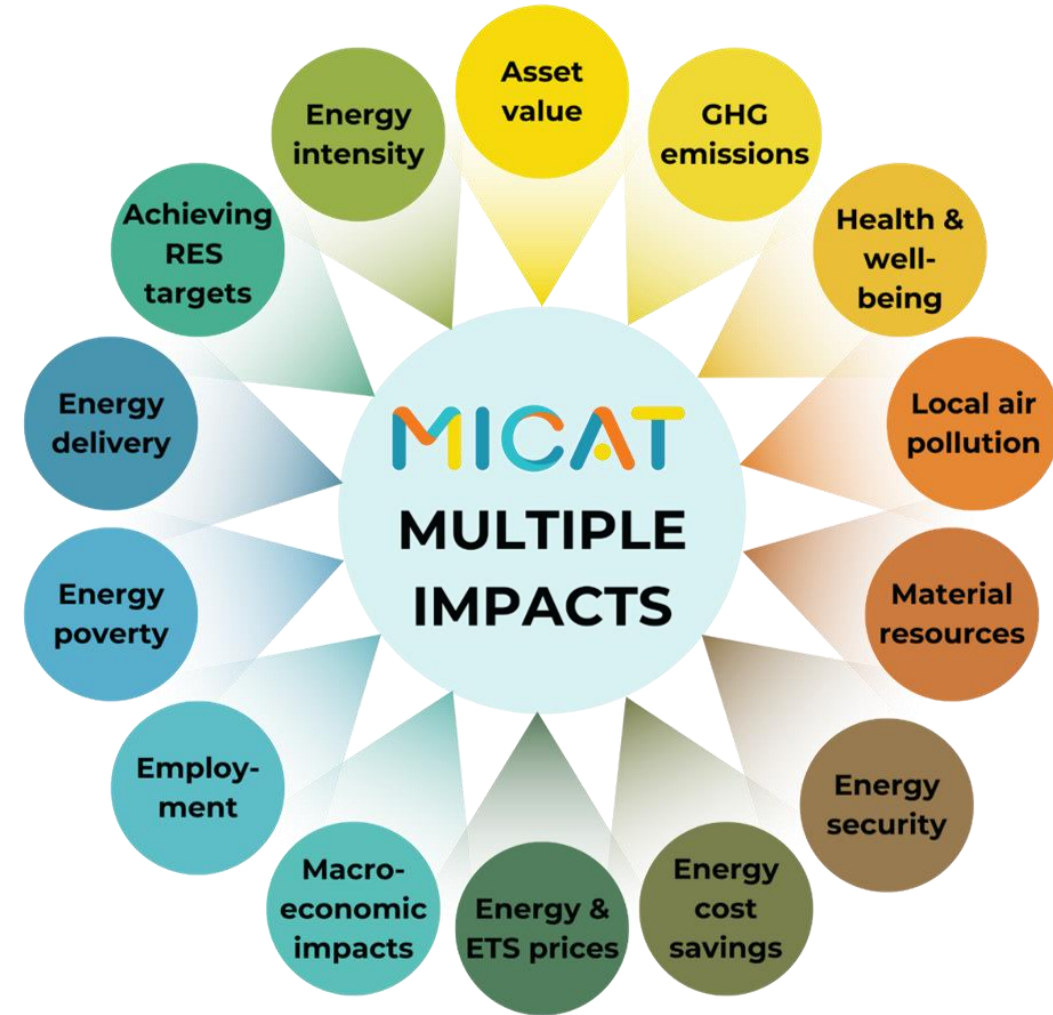
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What Co-Benefits in Energy Policy are ...

- Co-Benefits = **Additional positive outcomes** of energy efficiency policies next to reduced energy consumption and GHG emissions
 - Social co-benefits: e.g., improved indoor climate, reduced energy costs
 - Economic co-benefits: e.g., job creation, energy security
 - Environmental co-benefits: e.g., reduced local pollutants
- People are the ones experiencing positive and negative results of climate and energy policy

→ Increasing need for holistic policy design and, accordingly, **holistic evaluations including co-benefits** of energy efficiency policies such as social and economic impacts



... and why they matter

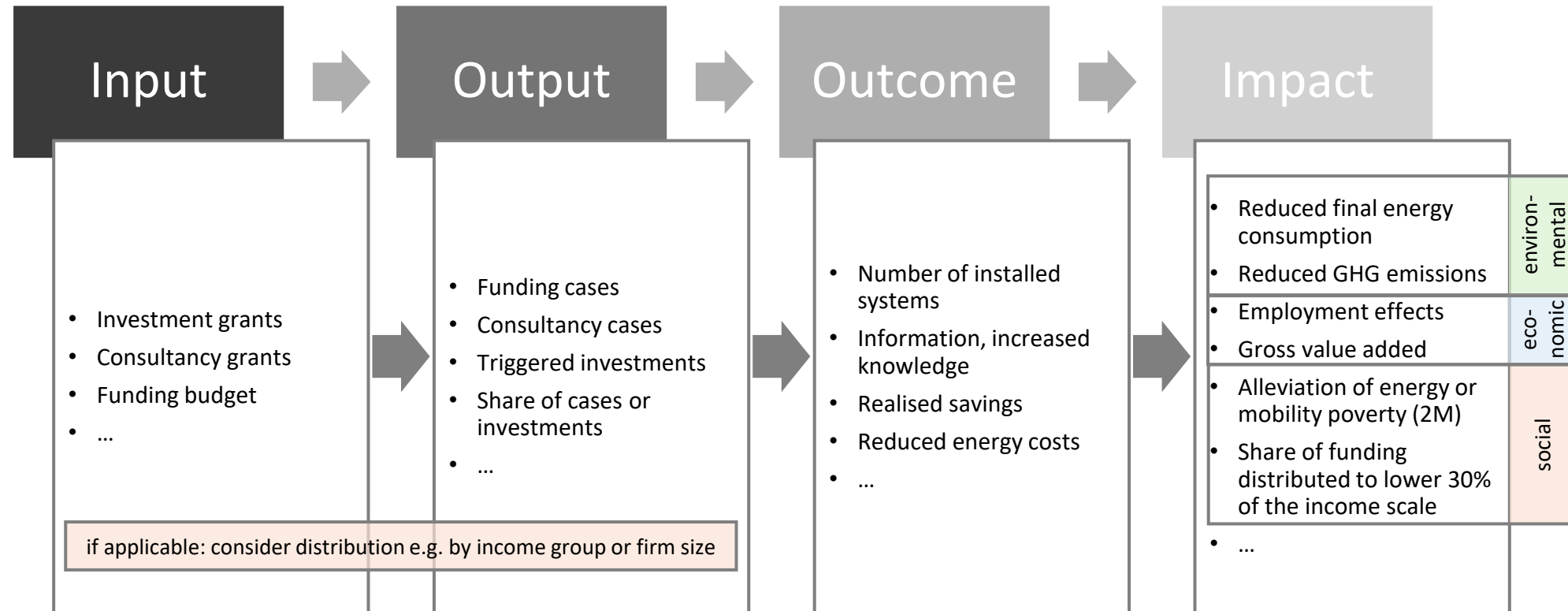
Energy Poverty and social impacts of climate and energy policy as part of the EU Green Deal

- Energy Poverty as „a household’s **lack of access** to essential energy services, where such services provide **basic levels and decent standards of living and health**”
- Non-affordability of energy, high energy prices, low incomes, low energy-efficiency of buildings, and high energy expenditure
- Increased self-reported energy poverty since the Russian invasion of Ukraine

Economic resilience, competitiveness and innovativeness in the EU

- Core targets in the **Clean Industrial Deal** and the **Omnibus Package**
- Economic impacts of energy efficiency policies can add to these aims
- Overall, energy efficiency policies can contribute to increasing employment by **creating demand for skilled labour**
→ E.g. in the buildings sector, production of (electrical) motor vehicles and similar relevant sectors

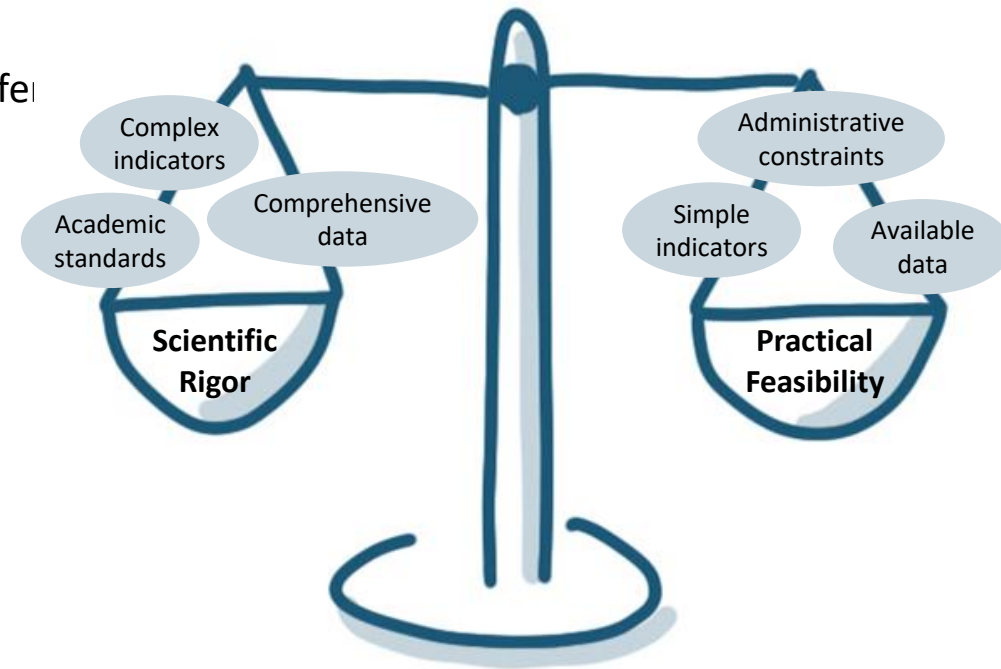
Applying a Structured Lens: The Impact Model



Impact model for the evaluation of energy efficiency policies, adjusted based on Schlomann et al. (2020).

Methodological Challenges

- Assessing two key benefits of energy efficiency policies
 - Employment effects
 - Distributional impacts and energy poverty alleviation
- Highlighting multidimensional nature of co-benefits and how they interact differently across sectors
- Empirical focus on fiscal policy instruments
 - Offers a clear lens
 - Helps highlighting evaluation complexities
- Methodological Challenges
 - Indicators must balance scientific rigor with practical feasibility
 - Data limitations and administrative constraints shape what's measurable



Key insights

- A flexible framework helps bridge the gap between policy needs and academic standards
- Systematic evaluation enables more inclusive and effective policy design

Quantifying Employment Effects and Skill Intensity

- Employment per investment coefficients with an Input-Output-Model (ISI-Macro)
- Disaggregation of investments by measure and economic sector
- Skill intensity → Analysis based on employment shares by skill level and bottleneck professions
- Identification of bottleneck professions
- Limitations:
 - Since only domestic industry is considered, additional jobs might accrue in other countries
 - A measure's funding might curtail other programmes, resulting in job losses somewhere else in the economy
 - Possible changes in income and prices are not considered

Measuring who benefits from Energy Policies

Share of funding distributed to the lower 30% in income rank

- Simple to calculate, does not require major assumptions
 - Key assumption that the average grant is **consistent across income brackets**
 - Chosen threshold (2000€ net/month) aligns with poverty line and evaluation norms
- **Comparability** across different measures and sectors
- Highlights whether policies disproportionately benefit wealthier groups

Alleviation of energy/mobility poverty (2M)

- 2M identifies households spending **over twice the national median** on energy or mobility
- Applicable **across sectors** – unlike most residential only indicators
- Focuses on **disproportionate expenditure** as a root cause of deprivation
- Used to estimate how many people are lifted out of energy/mobility poverty through a policy intervention

Case Studies from the Transport and Buildings Sectors in Germany

Environmental Bonus for Electric Vehicles

- Subsidy programme (2016–2023) supporting **electric vehicle (EV) purchases** in Germany
- Aimed to boost electric mobility, reduce GHG emissions and support the transition in the transport industry
- More than 2.17 million Evs subsidised, 10.2 billion€ in federal funding
- Evaluation revealed **unequal distribution** with benefits skewed toward wealthier and western regions



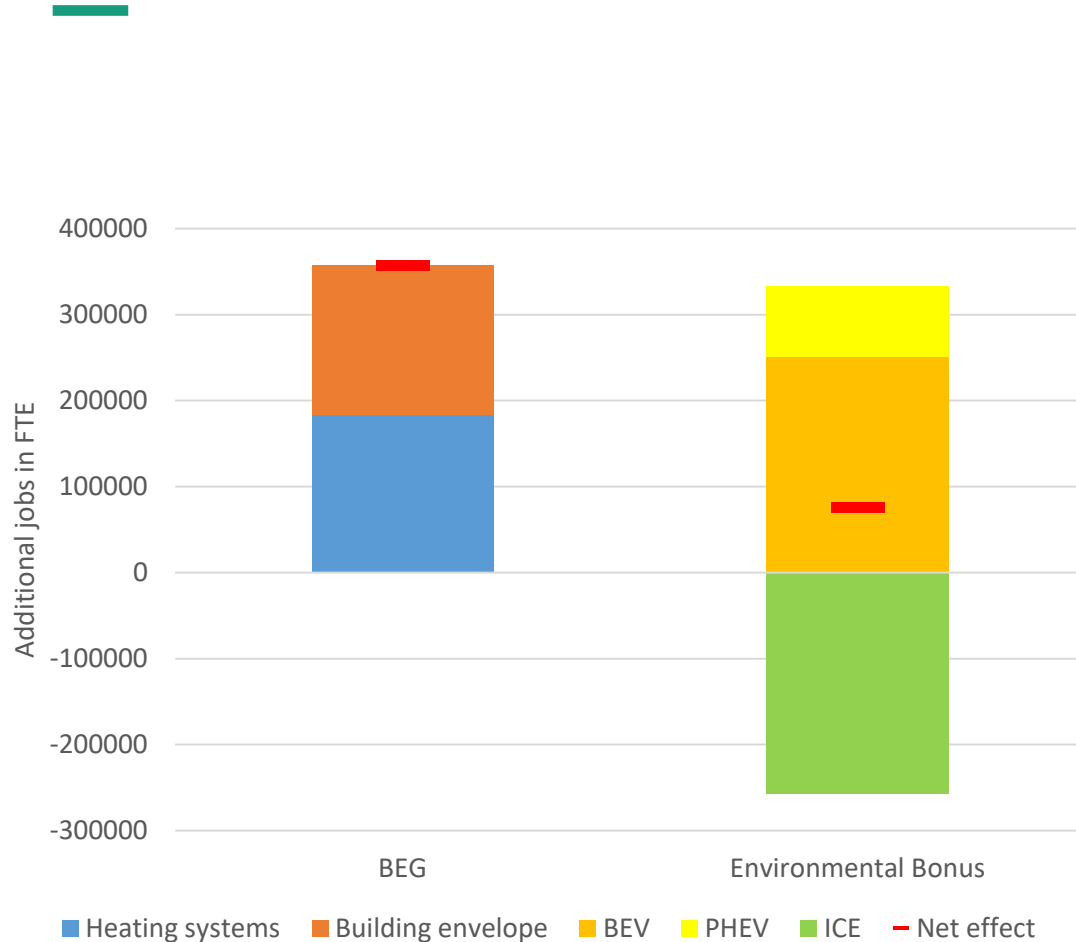
Case Studies from the Transport and Buildings Sectors in Germany

Federal Funding for Efficient Buildings (BEG)

- **Subsidy programme** launched in 2021, summarising multiple previous measures
- Includes three subprogrammes for different **building renovation** scopes: BEG WG (residential), BEG NWG (non-residential) and BEG EM (individual measures)
- Offers loans and grants based on building efficiency standards; municipalities receive additional support
- Targets private, commercial, and municipal actors
 - Private individuals made up 89% of recipients in 2023
 - municipalities and housing associations took up 43% of the investment volume and 38% of the funding budget in 2023



Comparing Impacts: Employment Effects of Environmental Bonus and BEG



- BEG generated 357 000 FTEs, Environmental Bonus 76 000 FTEs
- BEG measures created new demand, while Environmental Bonus shifted demand from ICE to EVs
- Environmental Bonus led to job losses in ICE-related industries, reducing net employment gains

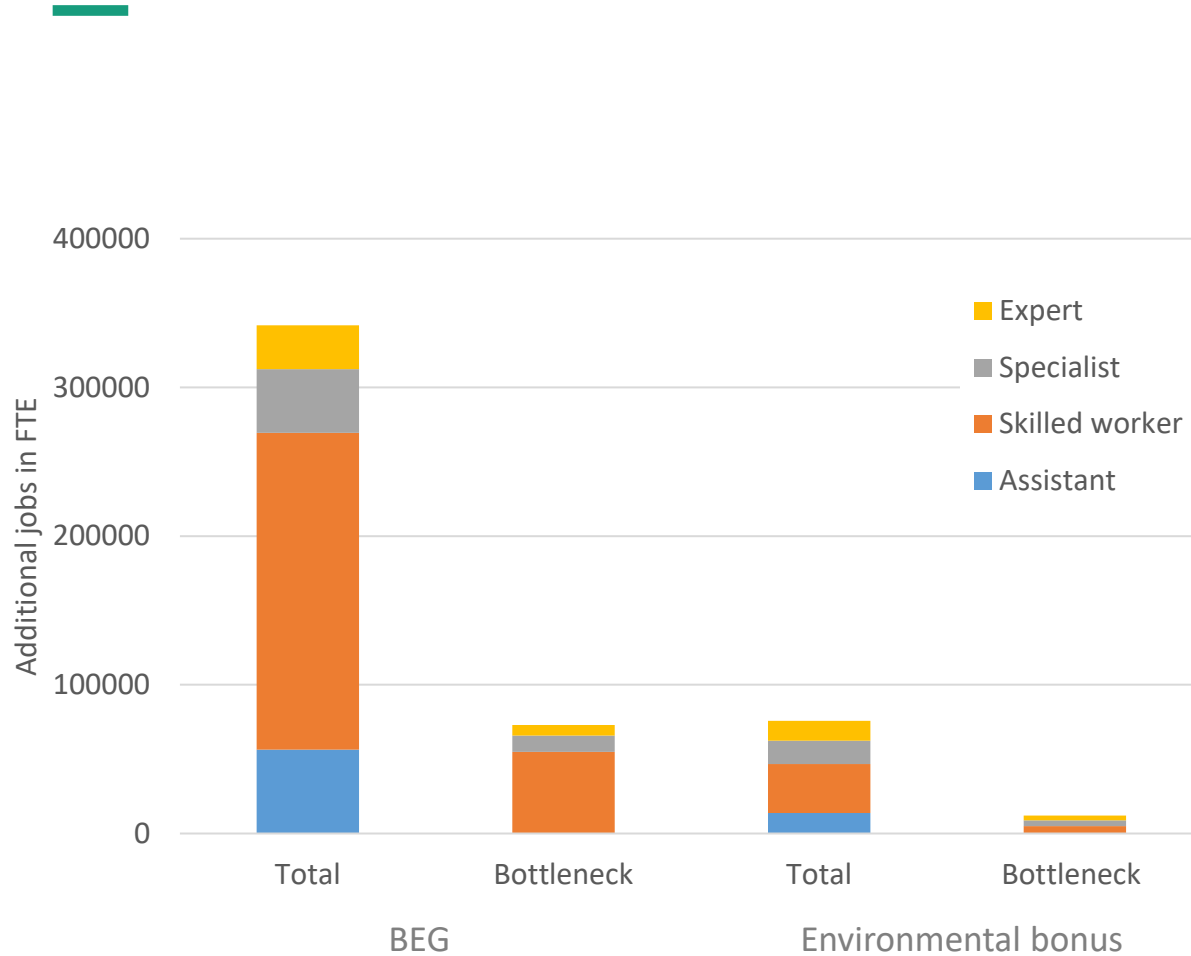
Additional jobs in full-time equivalents associated with the BGE and Environmental Bonus programmes. Source: own calculations.

FTE = Full-Time Equivalent

BEV = battery-electric vehicle, PHEV =plug-in hybrid vehicle

ICE = Internal combustion engine

Relevance of Bottleneck Professions



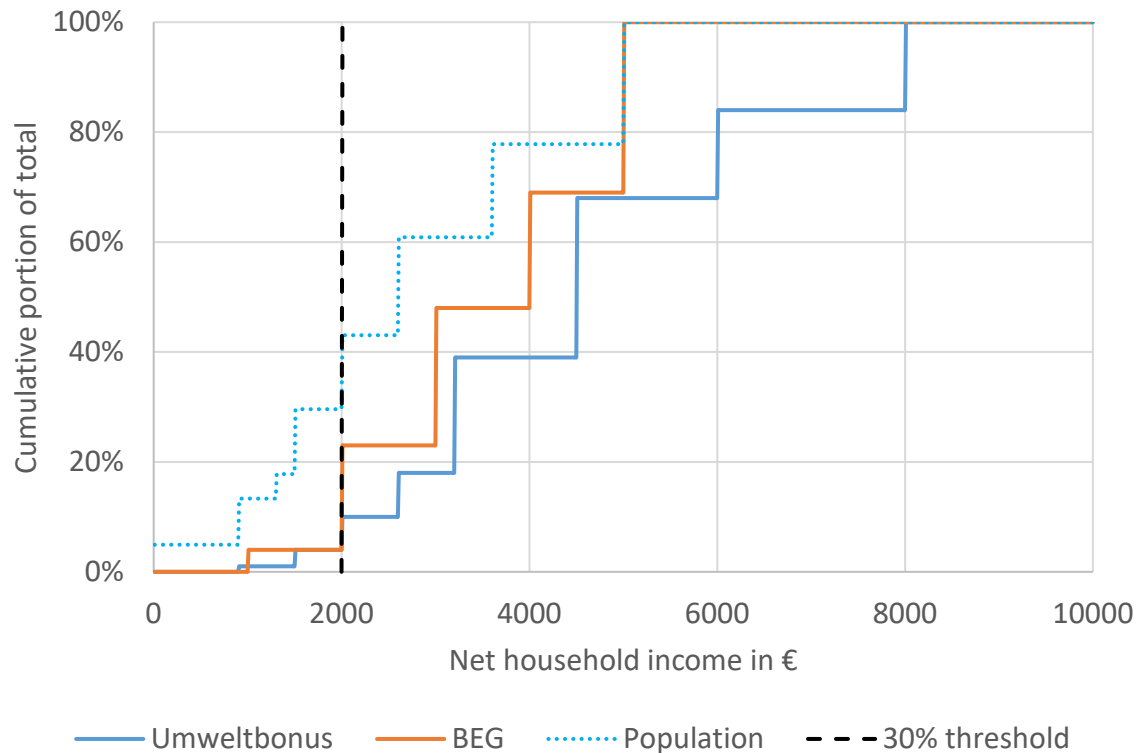
- Employment effects mainly affect skilled workers, but especially in bottleneck professions, skilled workers are needed
- Around 21% (BEG) and 16% (Bonus) of jobs were in bottleneck professions (e.g., plumbing, heating)
- Some employment effects may have occurred outside Germany due to global supply chains

Additional jobs disaggregated to job requirements in full-time equivalents for BEG and Environmental Bonus, also accounting for bottleneck professions.

Source: own calculations.

FTE = Full-Time Equivalent

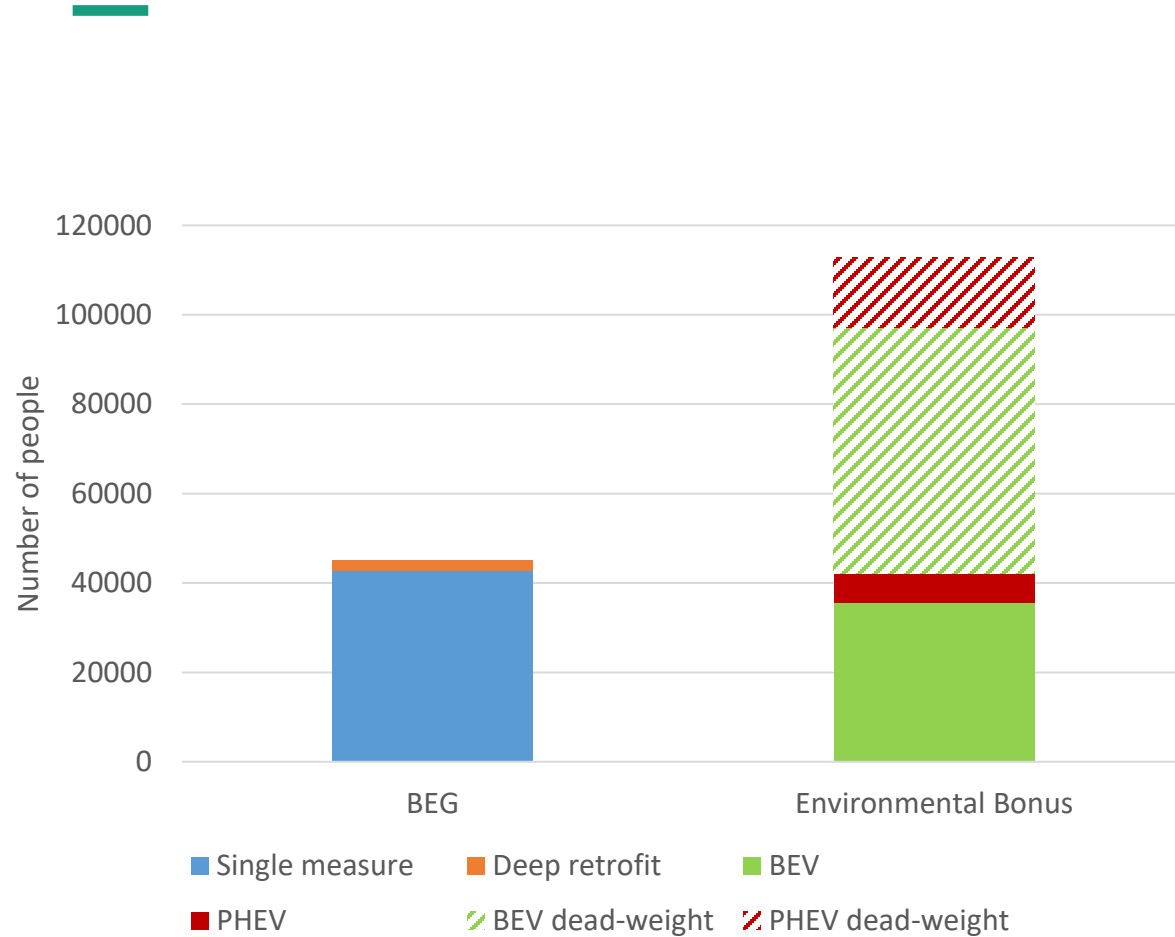
Distributional Effects: Who receives the Benefits?



- Only 4% of recipients from BEG and Environmental Bonus are in the lowest 30% income group
- Upper income quintile accounts for ~33% (BEG) and ~50% (Bonus) of beneficiaries
- Higher-income households receive larger grants, especially in the residential sector
- BEG WG is used more by young, well-educated, high-income individuals, BEG EM shows greater social diversity among recipients
- Regional uptake is concentrated in wealthier western states; Eastern Germany underrepresented.

Cumulative share of recipients by income bracket compared to general population (last income brackets of general population and BEG start at household incomes of 5000€). Source: own calculations.

Energy and Transport Poverty Alleviation: Who was lifted out of Deprivation?



- BEG lifted ~45,000 people out of energy poverty; Environmental Bonus ~42,000 (adjusted for deadweight)
- Most BEG impact comes from individual measures (BEG EM), especially in rented housing
- Energy-poor owner-occupiers are often unable to access subsidies; housing associations play a key role in reaching vulnerable groups
- Environmental Bonus results are less reliable due to voluntary overspending and unclear cost-effectiveness
- Uncertainty remains due to data gaps on rent increases and tenant income levels

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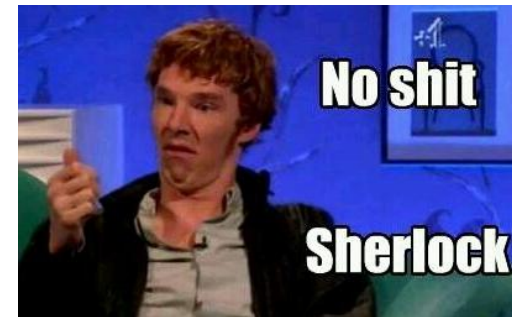
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Co-Benefits and Evaluation Challenges – Where do we go from here?

- A universal impact model enables evaluation beyond GHG and energy savings while being transferable and applicable for ministries
- Co-benefits like employment and energy/transport poverty alleviation make policy impacts more tangible
- Balancing simple vs. complex indicators is key to robust and usable assessments
→ Simple indicators allow comparability; complex ones offer deeper insights but require more data
- Flexibility in indicator selection helps tailor evaluations to policy type and data availability
- Holistic evaluation supports evidence-based, inclusive policy design aligned with EU goals
→ Could be expanded for further co-benefits (such as impacts on health)

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Thank you for your attention!

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Quantifying employment effects and skill intensity

Quantification of additional employment effects

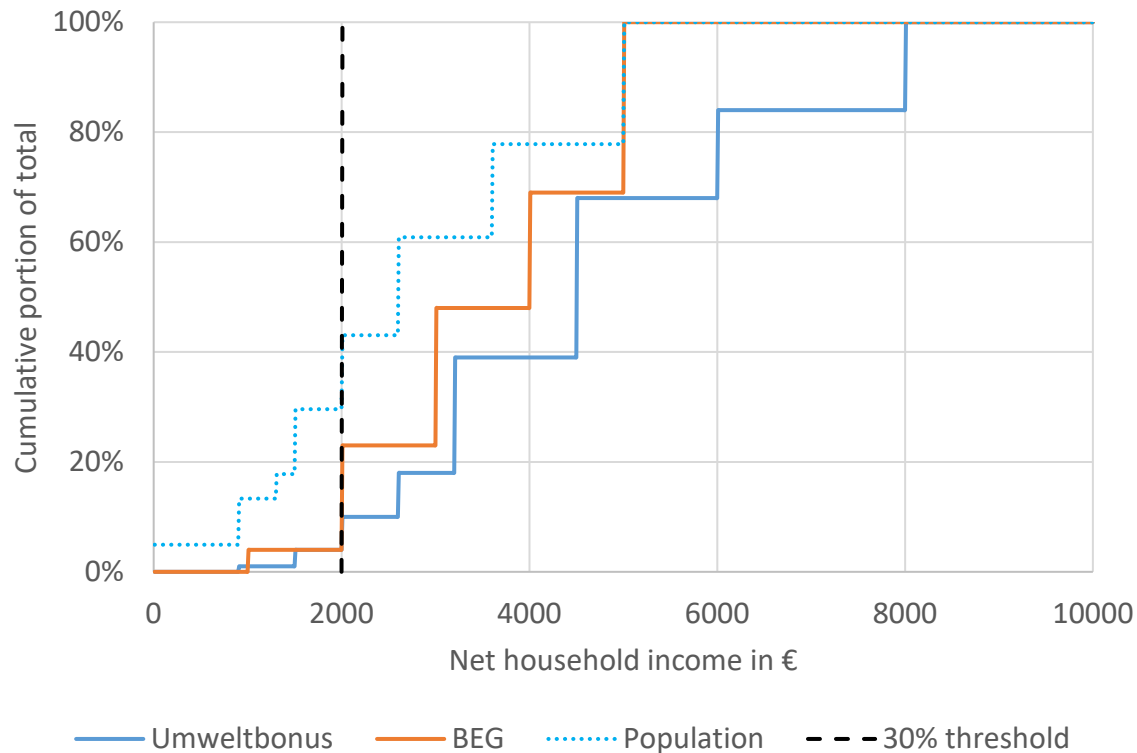
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$$\Delta EMP_m = (1 - DW_m) \cdot \left[DP_{m,I} \cdot \begin{pmatrix} I_1 \\ I_2 \\ I_3 \\ \dots \\ I_n \end{pmatrix} - DP_{m,L} \cdot \begin{pmatrix} L_1 \\ L_2 \\ L_3 \\ \dots \\ L_n \end{pmatrix} \right] \cdot \begin{pmatrix} k_1 \\ k_2 \\ k_3 \\ \dots \\ k_n \end{pmatrix}$$

Skill intensity

- Refers to the types and levels of skills required or fostered by policy interventions
- Energy efficiency policies shift demand toward technical, vocational, and managerial roles
- Analysis based on employment shares by skill level and bottleneck professions
- Input-output modeling links jobs to labour market dynamics

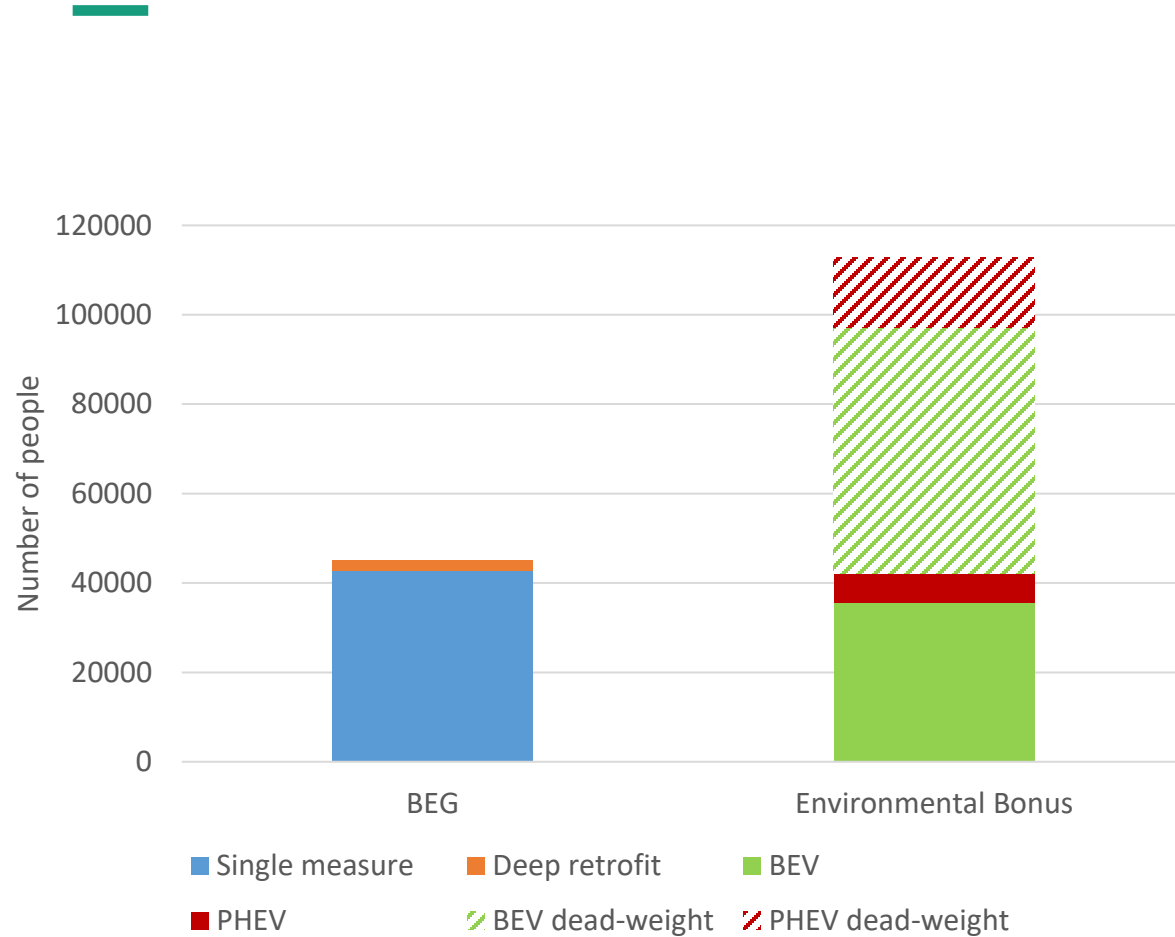
Revealing Inequities: Distributional Gaps in Policy Outcomes



- Only 4% of recipients from BEG and Environmental Bonus are in the lowest 30% income group.
- Higher-income households and western German states disproportionately benefited
- BEG individual measures helped more diverse social groups, especially in rented housing
- BEG lifted ~45 000 people out of energy poverty; Environmental Bonus ~42 000 (adjusted for deadweight effect)
- Results show uncertainty due to assumptions and limitations in income and rent data

Cumulative share of recipients by income bracket compared to general population (last income brackets of general population and BEG start at household incomes of 5000€). Source: own calculations.

Energy and Transport Poverty Alleviation: Who was lifted out of Deprivation?



- Only 4% of recipients from both programmes belong to the lowest 30% income group
- Higher-income households and western German states disproportionately benefited
- BEG individual measures helped more diverse social groups, especially in rented housing
- BEG lifted ~45 000 people out of energy poverty; Environmental Bonus ~42 000 (adjusted for deadweight effect)
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Cumulative share of recipients by income bracket compared to general population (last income brackets of general population and BEG start at household incomes of 5000€). Source: own calculations.

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Key Findings: Employment and Distribution Effects

- BEG and Environmental Bonus generated ~500,000 FTEs, including bottleneck professions.
- Distributional effects are weak: only 3–4% of funds reached the bottom 30% income group.
- Both programmes lifted ~40,000 people out of energy/mobility poverty.
- Co-benefits provide more relatable metrics than traditional KPIs.

Reflections:

- The impact model supports evaluation of environmental and socio-economic effects.
- Simple indicators allow comparability; complex ones offer deeper insights.
- Trade-offs include data needs vs. usability, and accuracy vs. accessibility.
- Holistic evaluation helps avoid unintended inequalities and supports inclusive policy design.
- Aligns with EU-level reporting and funding priorities (e.g., EED, Social Climate Fund).