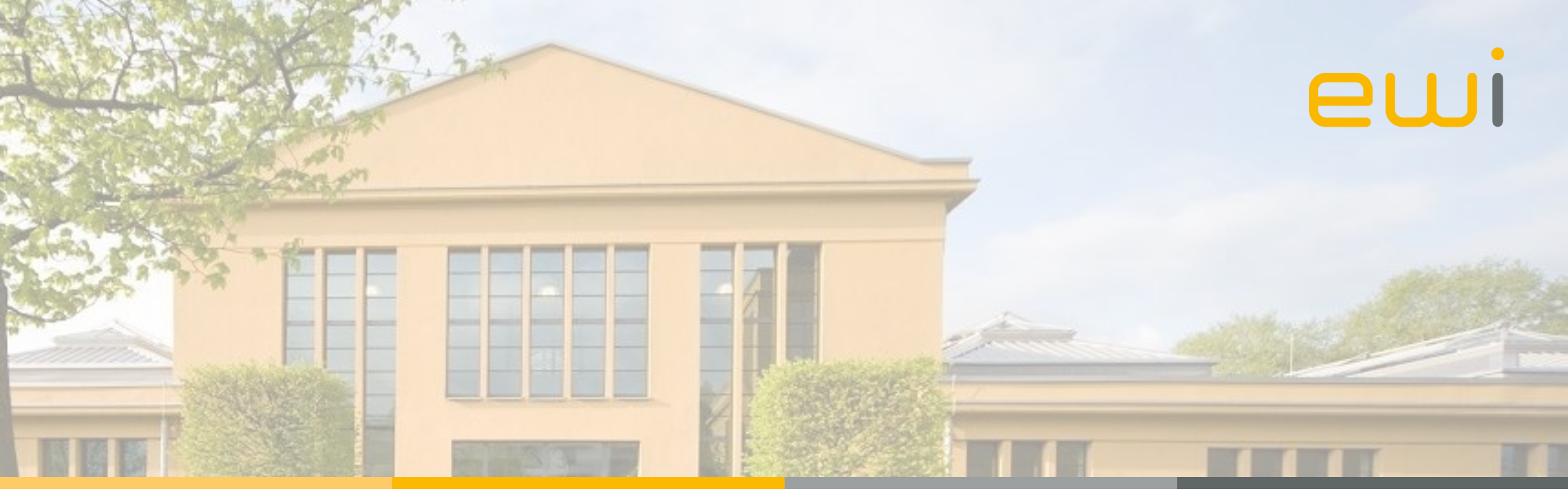

Pareto-efficient Interconnector Expansion: Hansa PowerBridge

Strommarkttreffen | Internationaler Stromhandel | Statkraft

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Despite the benefits of cross-border integration, projects have been rejected due to distributional issues

Cross-border Integration of Electricity Markets

- Integrated markets improve market efficiency and stability
- Previous literature highlights distributional issues: consumers in the importing country win, and consumers in the exporting country lose (and the other way around for producers)
- Compensation mechanisms have been discussed, but concrete design and quantitative assessment are missing

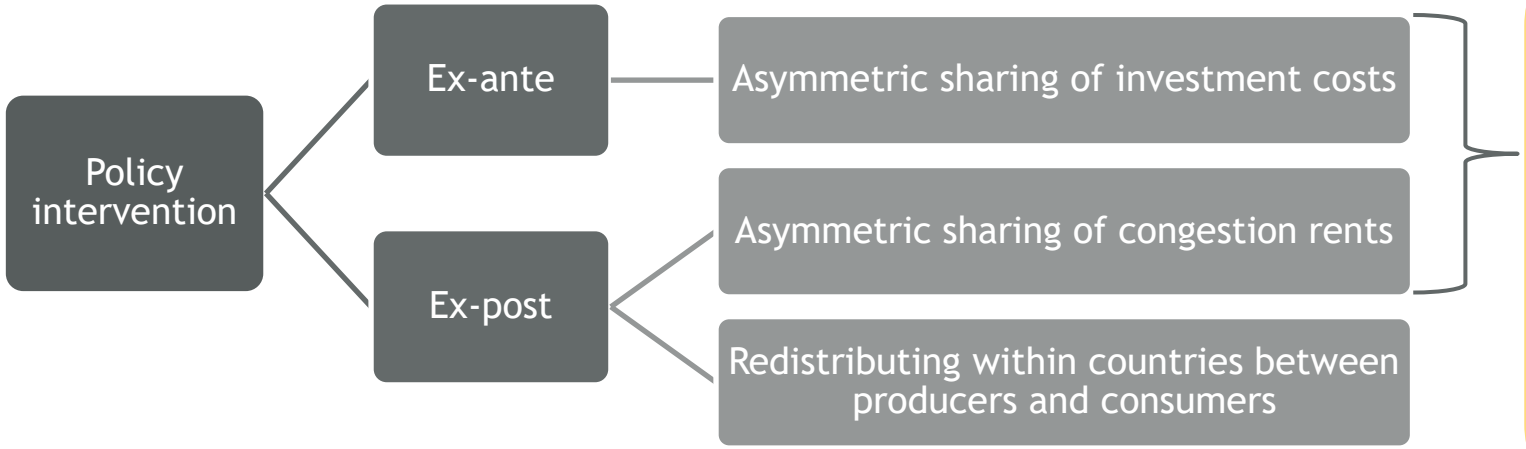
Case Study of Hansa PowerBridge:

- 2nd interconnector between Sweden and Germany (SE-DE): 700 MW capacity and about € 600 M invest
- Equal sharing of investment cost and congestion rent between SE (Svenska Kraftnät) and DE (50 Hertz)
- Initially planned for commissioning in 2025/ 2026
- The Swedish government rejected the project in June 2024 due to distributional issues (among others)

50Hertz: Hansa PowerBridge
https://www.50hertz.com/en/Grid/Griddevelopement/Offshoreprojects/HansaPowerBridge/

Can we design a redistributive policy that ensures Pareto efficiency for a welfare-enhancing interconnector expansion?

Policy options: Ex-ante vs. ex-post policy intervention



Application for the case study:

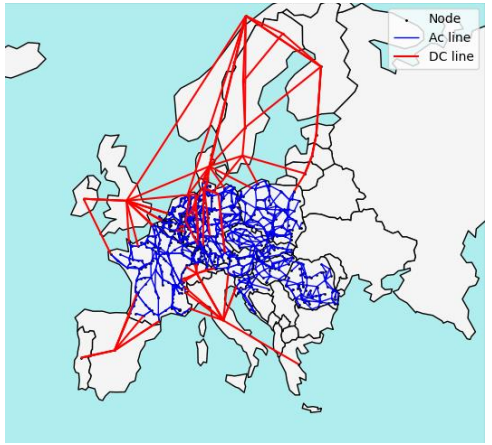
Can we share the investment cost and congestion rent in a way that achieves Pareto efficiency?

- If yes, is this robust to price and volume shocks on energy markets?
- If no, what about alternative policies?

Model and scenarios: Optimizing power plant dispatch under network constraints

Model

- Detailed electricity system model with a high-resolution DC load flow calculation of the Central European transmission grid SPIDER (Schmidt & Zinke 2020, Zinke 2023)
  - Spatial model extension incl. introduction of four bidding zones in Sweden
- SPIDER is applied as a dispatch model, minimizing the variable costs of electricity generation
  - Exogenous* regional distribution of the demand and installed capacity



Reference scenario

- Focus on the year 2035
- Demand, capacity, and fuel prices based on TYNDP 2024 (Global Ambition scenario, weather year 2009)
  - Incl. current capacity targets, e.g. RES targets in Germany
- Compare producer, consumer, and congestion rents with and without Hansa PowerBridge

Sensitivities

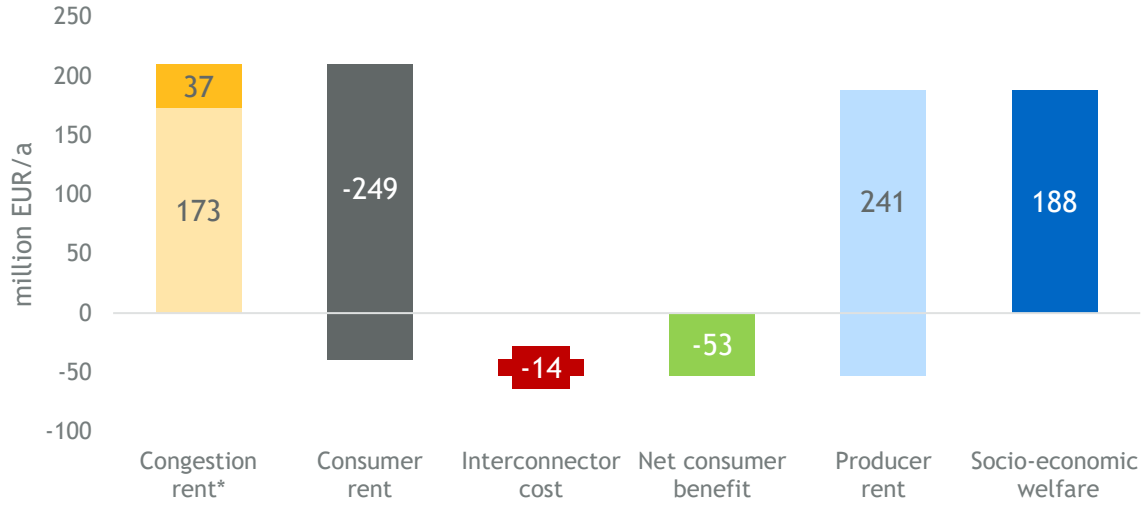
- Price shocks:
  - High gas price: 100 vs. 21.5 EUR/MWh
- Volume shocks:
  - Low hydro SE: -50 % availability
  - RES delay DE: Assuming average growth rate between 2017 and 2021

*Regional distribution of H2-ready power plants in Germany is optimized within the brownfield options.

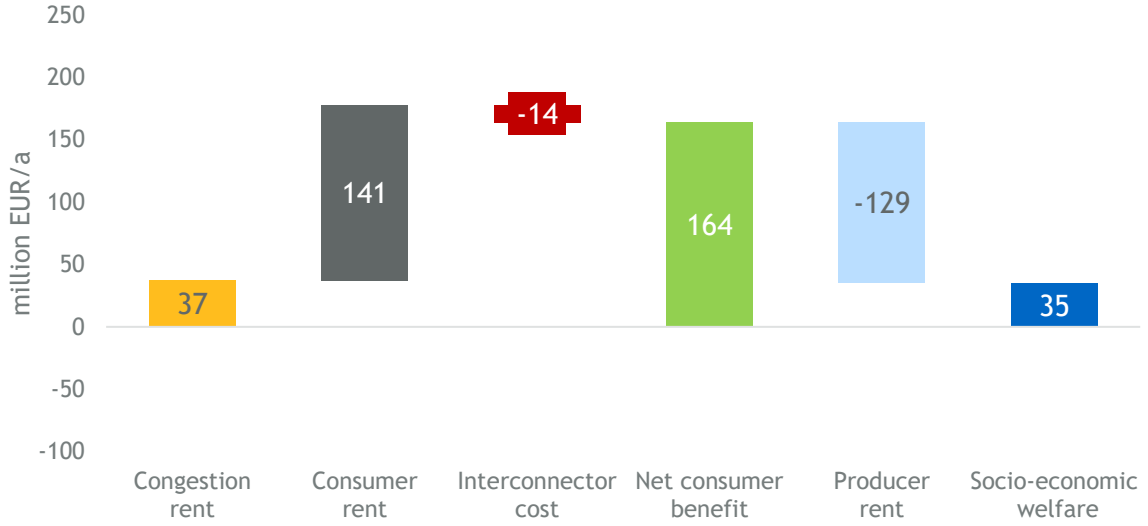
Preliminary results: Under equal cost and benefit sharing, net consumer benefit in Sweden is negative

Reference scenario & 50-50 (DE-SE) sharing of congestion rent and investment cost

Sweden



Germany



Key findings

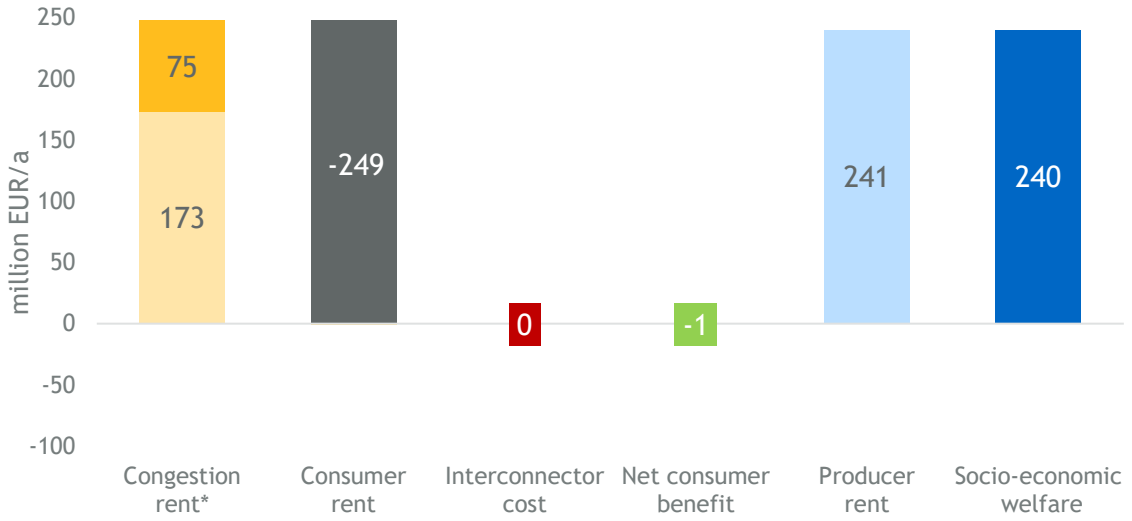
- Net consumer benefit in SE decreases – despite large inner-Swedish congestion rents; net consumer benefit in DE increases
- In turn, producers in SE achieve a surplus, while producers in DE incur losses
- Positive socio-economic welfare (SEW) for SE and DE indicates Pareto efficiency at the national level, although SEW in SE is significantly higher than in DE

*173 million euro of congestion rent arising in Sweden can be attributed to inner-Swedish congestion.

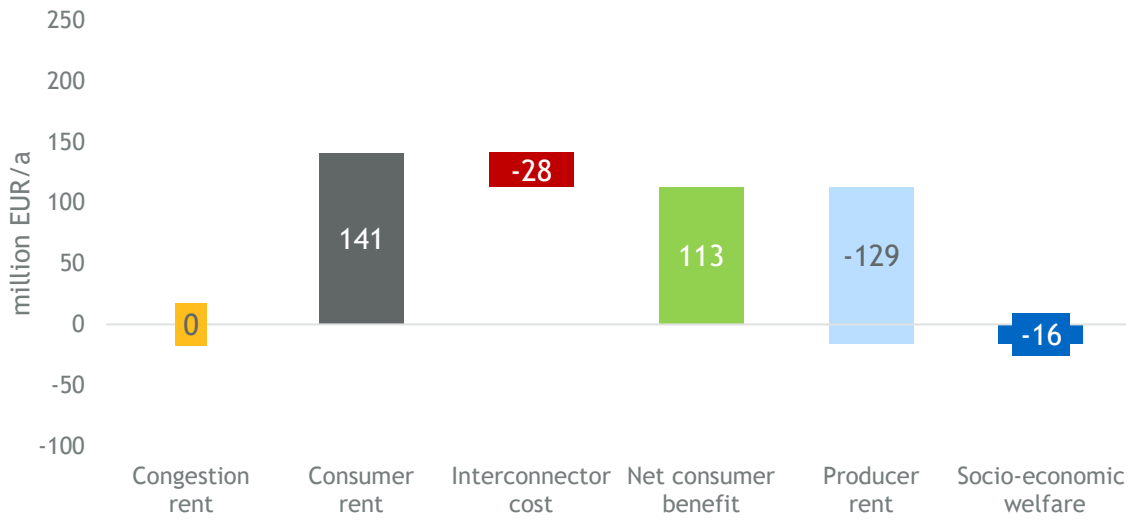
Preliminary results: Asymmetric cost and benefit sharing can mitigate the losses of Swedish consumers

Reference scenario & entire congestion rent to Sweden and entire investment cost to Germany

Sweden



Germany



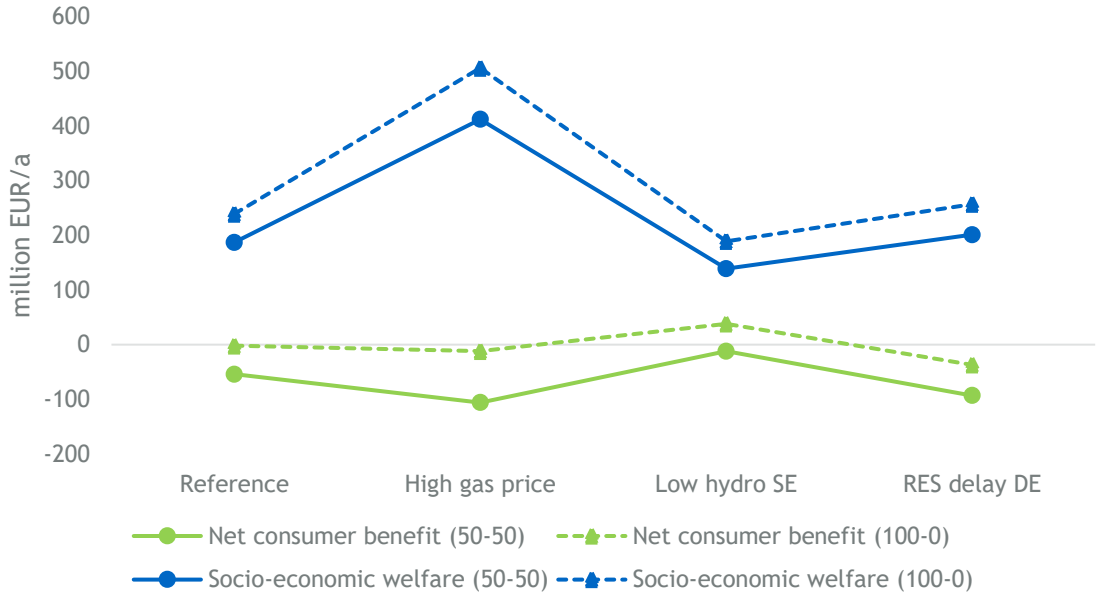
Key findings

- Under the most extreme variant of asymmetric cost and benefit sharing
  - Net consumer benefit is (almost) positive in both countries → Pareto-efficiency on the consumer level
  - A strong positive SEW in SE and a slightly negative SEW in DE → no Pareto-efficiency on the national level

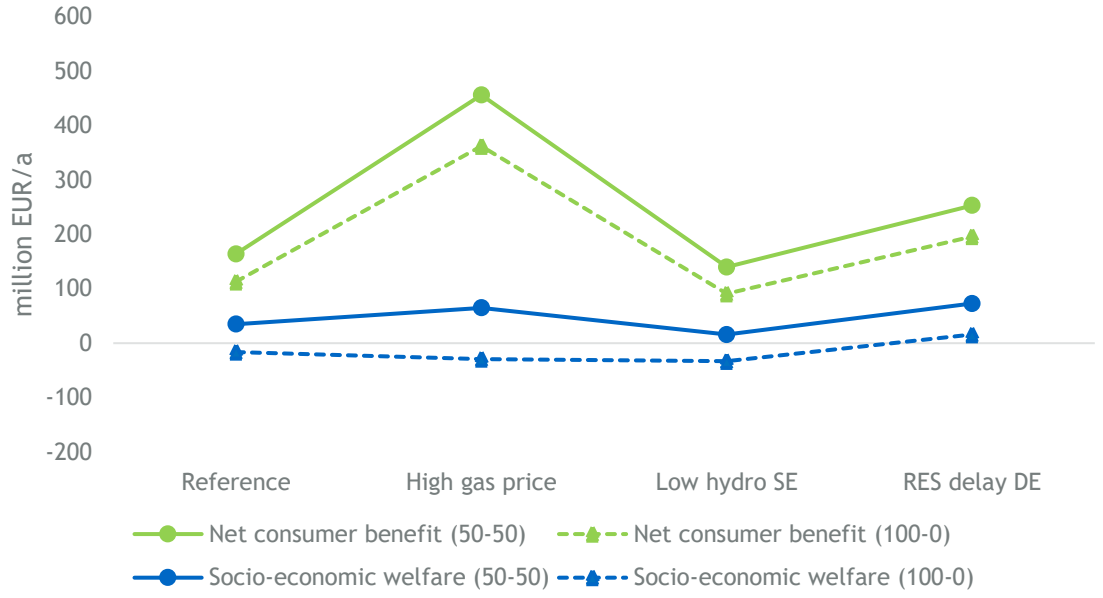
*173 million euro of congestion rent arising in Sweden can be attributed to inner-Swedish congestion.

Preliminary results of equal and asymmetric cost and benefit sharing are robust to price and volume shocks

Sweden



Germany



Key findings

- Results of equal and asymmetric cost and benefit sharing are robust
- Net consumer benefit in SE is close to zero under the asymmetric cost and benefit sharing, while net consumer benefit remains positive in DE
- Across sensitivities, SEW in SE is clearly positive under both equal and asymmetric cost and benefit sharing, while SEW often becomes negative in DE under asymmetric cost and benefit sharing

Key preliminary findings and next steps

Key preliminary findings

- Under equal cost and benefit sharing:
  - Net consumer benefit in SE decreases, while net consumer benefit in DE increases
  - Producers in SE achieve a surplus, while producers in DE incur losses
  - Positive SEW for both DE and SE across all sensitivities indicates Pareto efficiency at the national level
- Under asymmetric cost and benefit sharing:
  - Both redistribution of investment costs and congestion rents can be sufficient to offset consumer losses in SE
  - This, however, results in a negative SEW in DE
- Positive SEW in both countries under equal cost and benefit sharing suggests potential for inner-country redistribution

Next steps

- Further robustness checks, e.g., higher interconnection within SE, bidding zone split in DE
- Consideration of redistribution through current RES subsidy schemes and state-owned producers (Vattenfall)
- Analysis of further potential ex-post policy interventions such as inner-country redistribution

Institute of Energy Economics at the University of Cologne

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