Balancing Cost Savings and Import Dependence in Germany's Industry Transformation

Toni Seibold, Fabian Neumann, Falko Ueckerdt & Tom Brown | ecemp | 17th Oct 2025

Motivation

- High energy prices and ambitious climate targets in Germany
- Energy-intensive industries face relocation pressure ('renewables pull')

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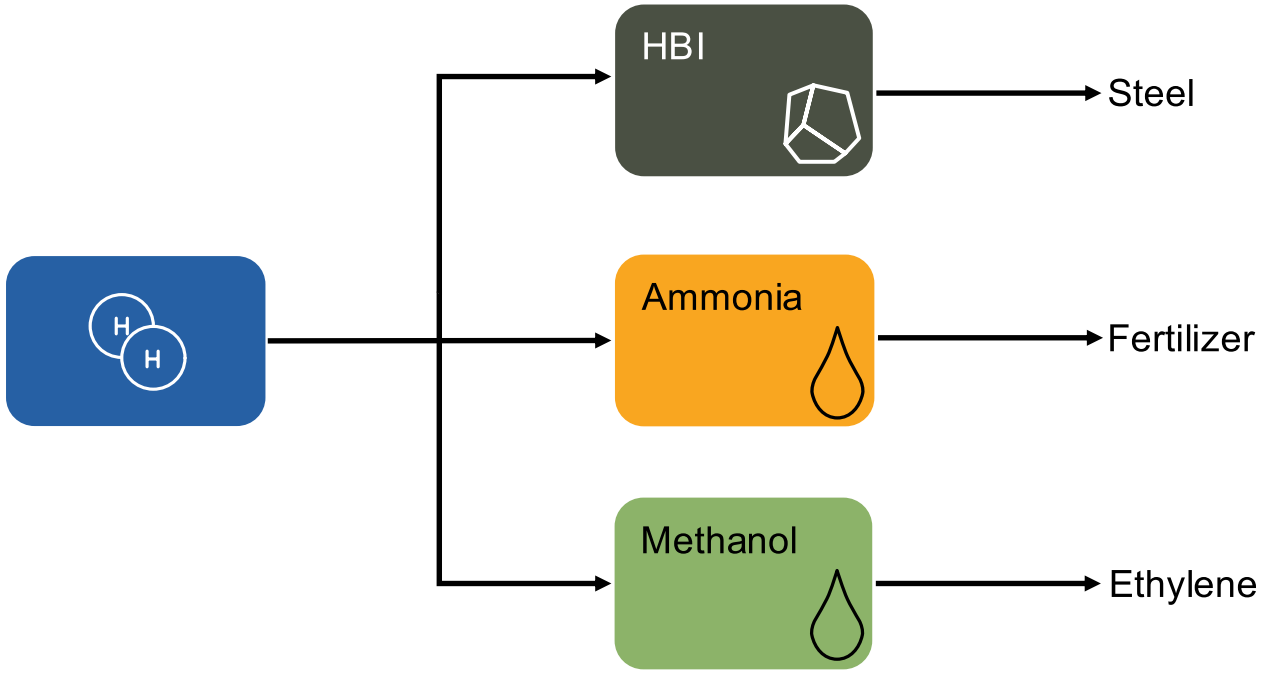

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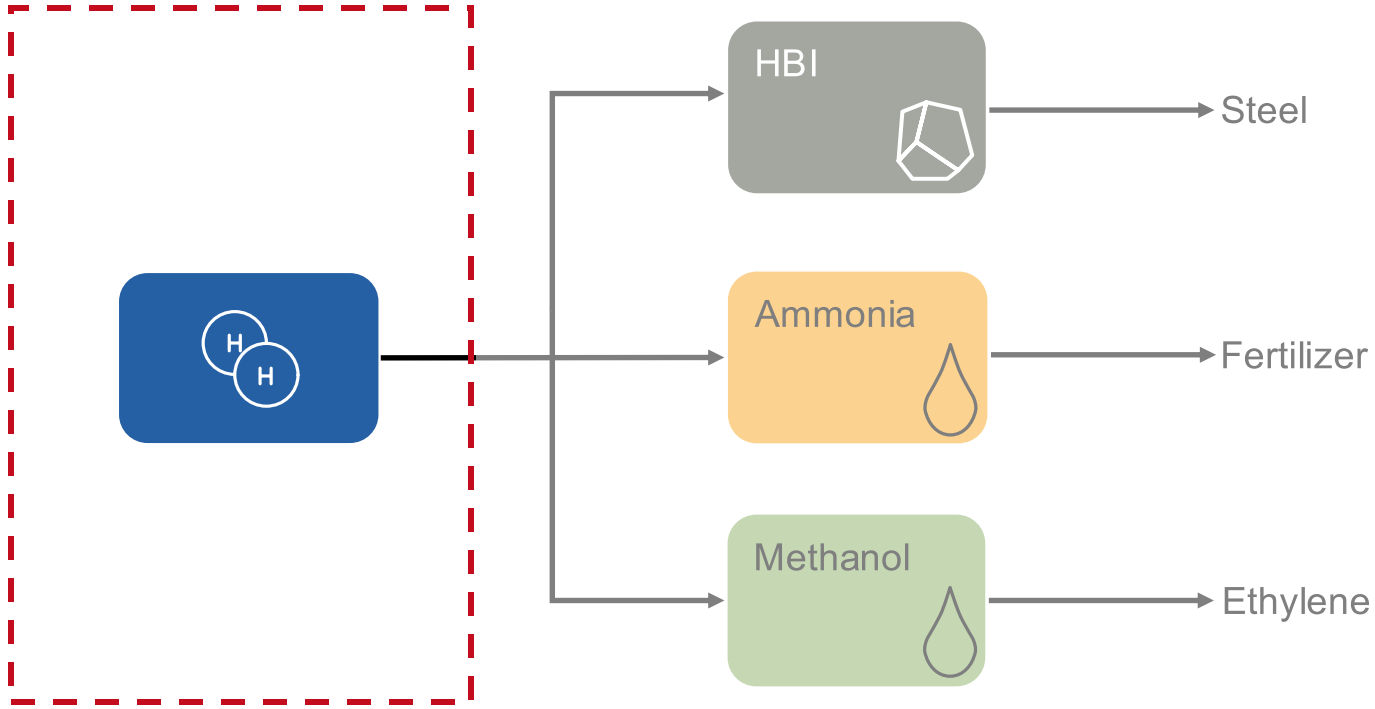

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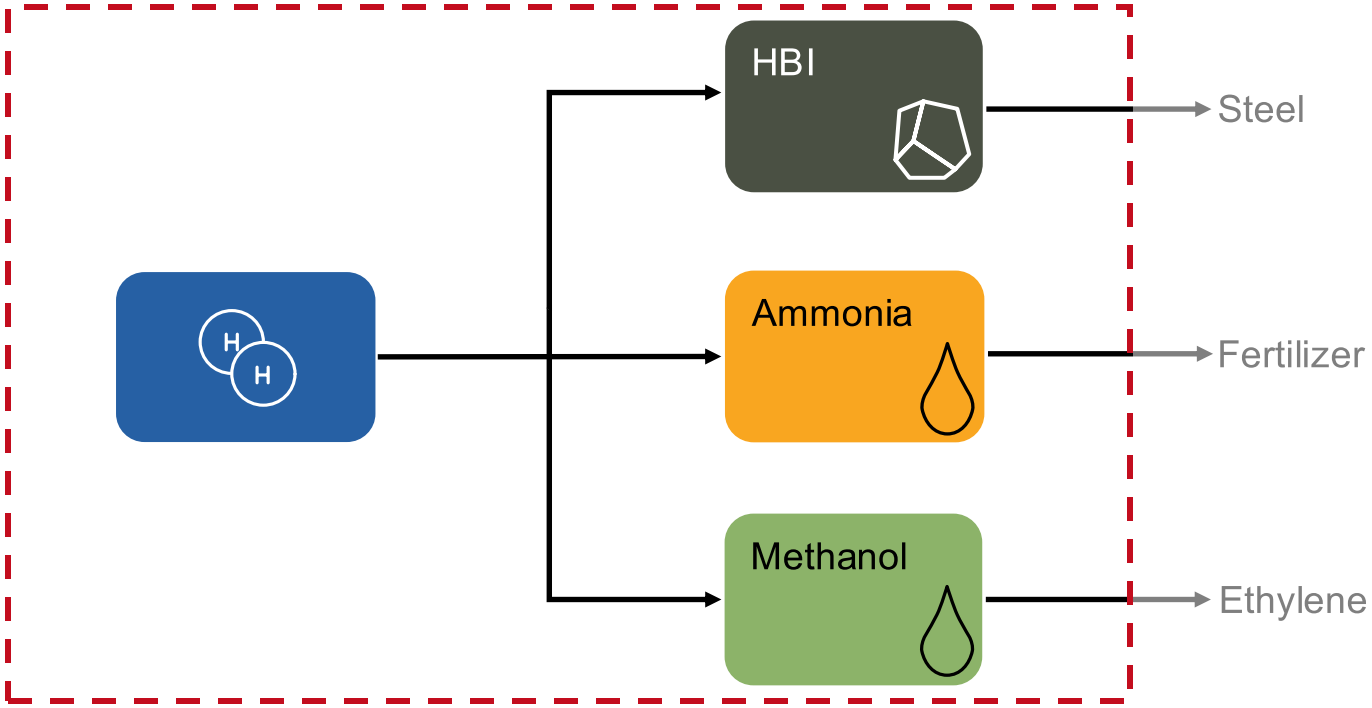
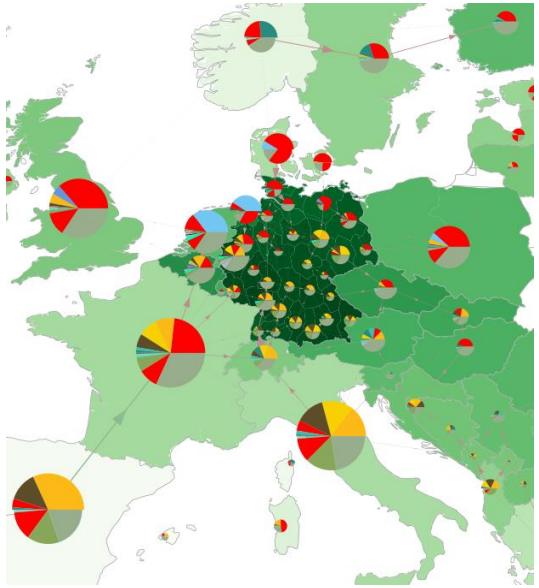


Methods

Energy system model PyPSA-DE



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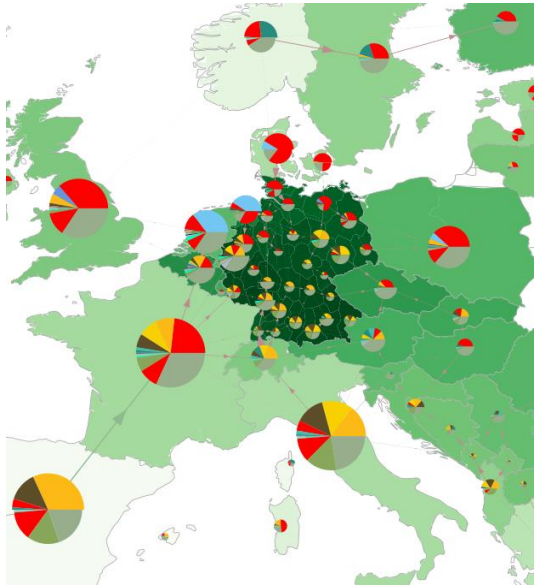

PyPSA-DE

- 30 nodes for Germany, 1 node each for other countries
- Sector-coupled
- 4-hourly (time-segmented) resolution
- Greenfield optimization
- Zero CO_2 emissions
- 200 Mt of CO_2 sequestration potential

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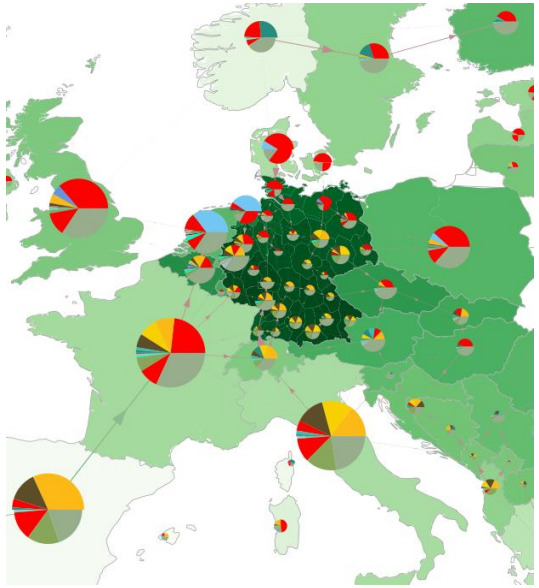
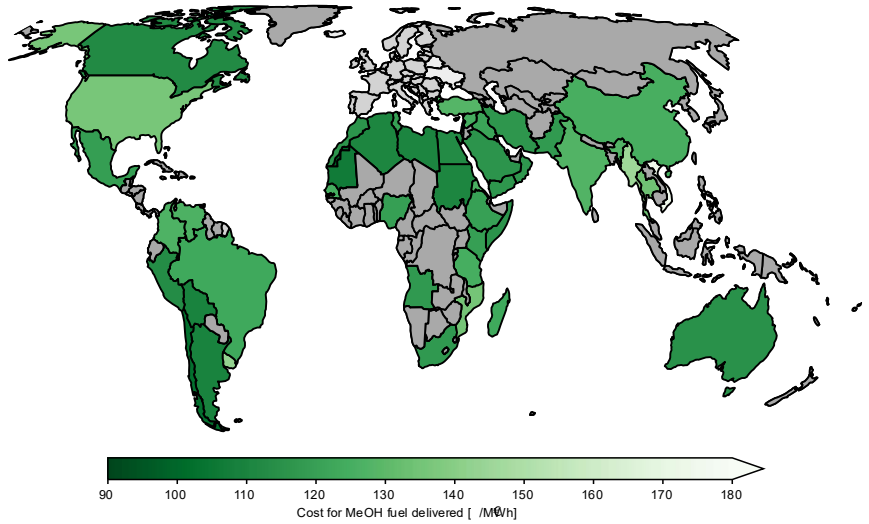


PyPSA-DE

Supply chain model TRACE



TRACE

Same technology parameters and weather year data

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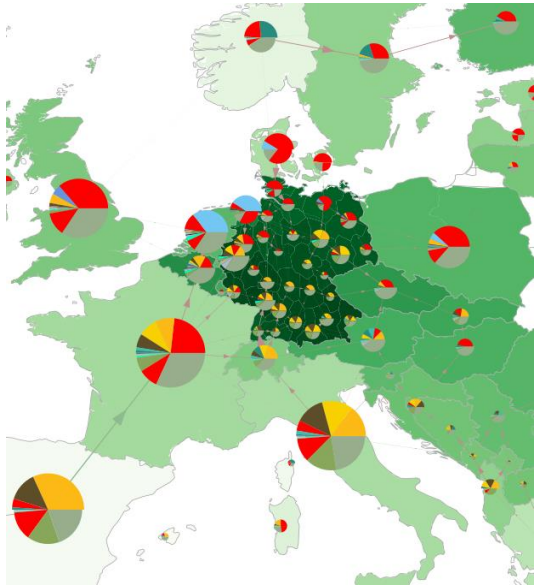
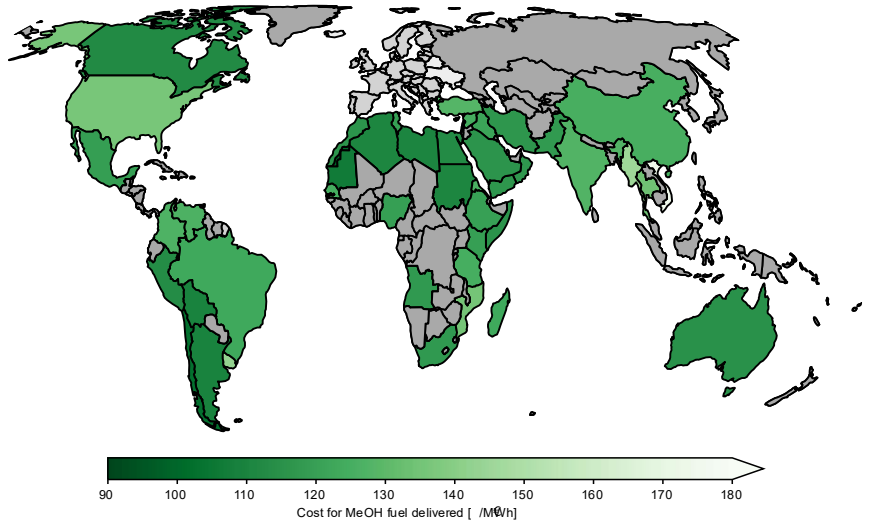


PyPSA-DE

Prices for non-European imports

H_2
Fischer-Tropsch
Methanol
Ammonia
Hot Briquetted Iron

Supply chain model TRACE



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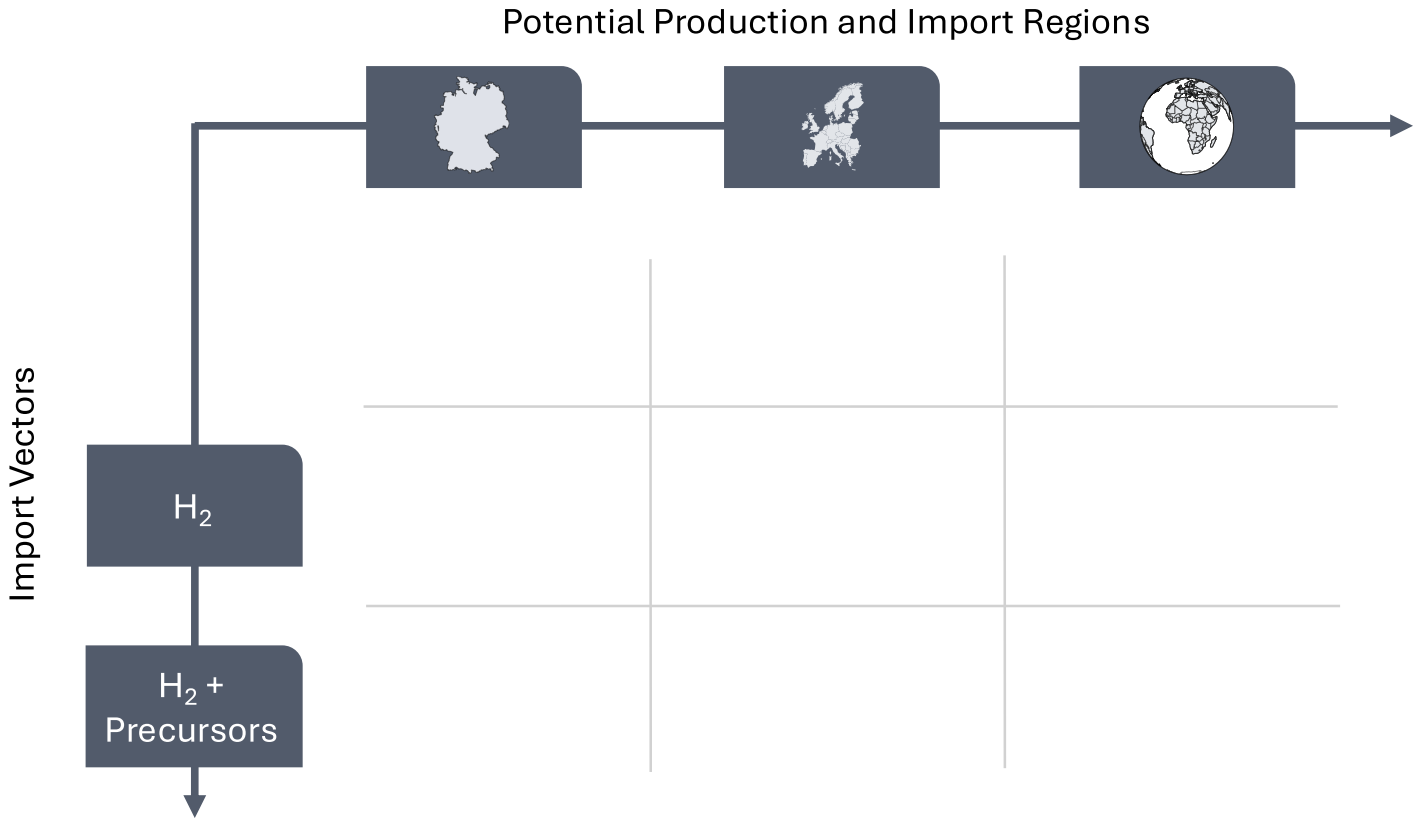
Research Questions

- What is the **cost difference** between non-European imports and domestic production?
- Does the import from **European partners** offer a **compromise** between competitiveness and energy security?
- What impact does the import of hydrogen and precursors have on **infrastructure needs**?

Scenario Overview



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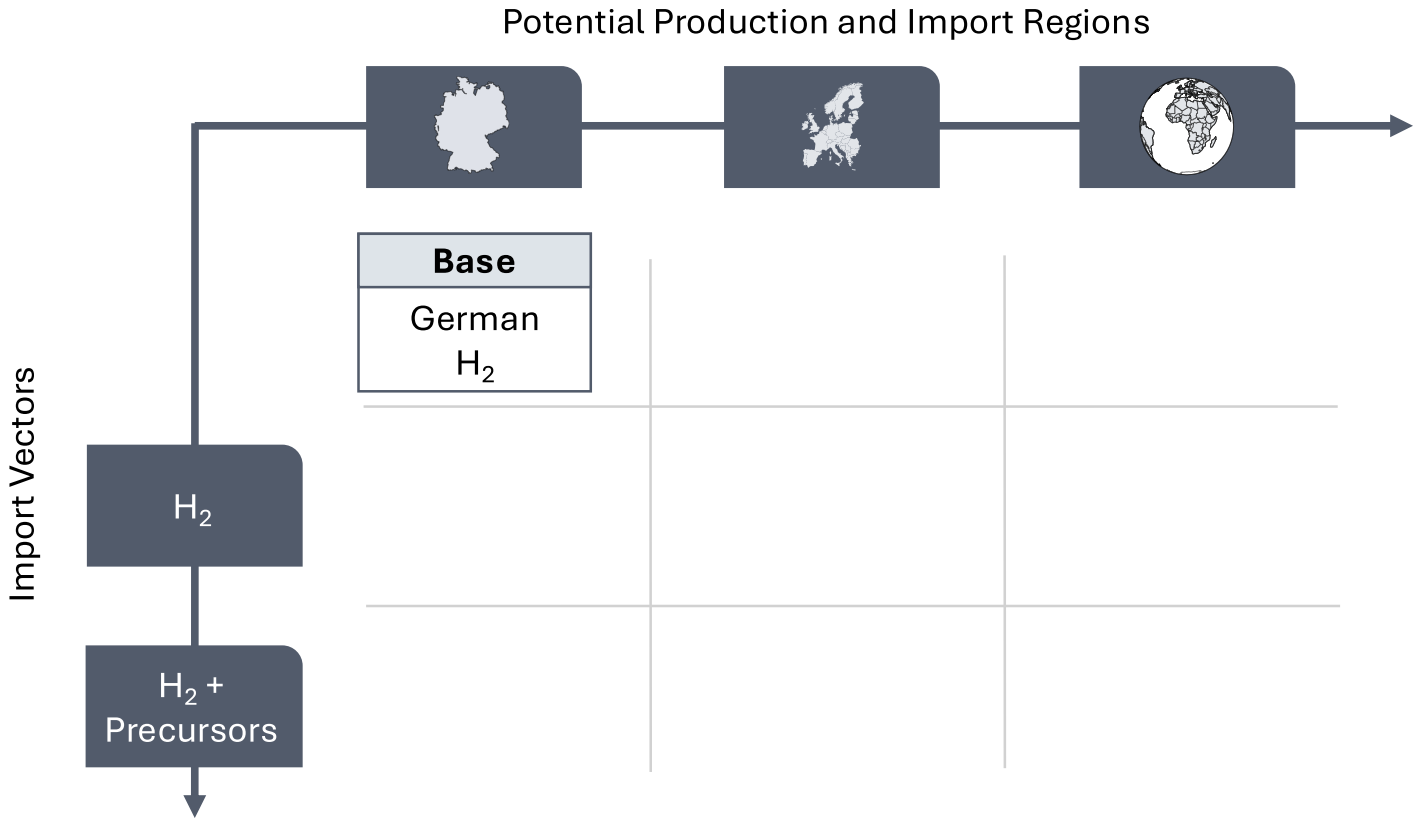

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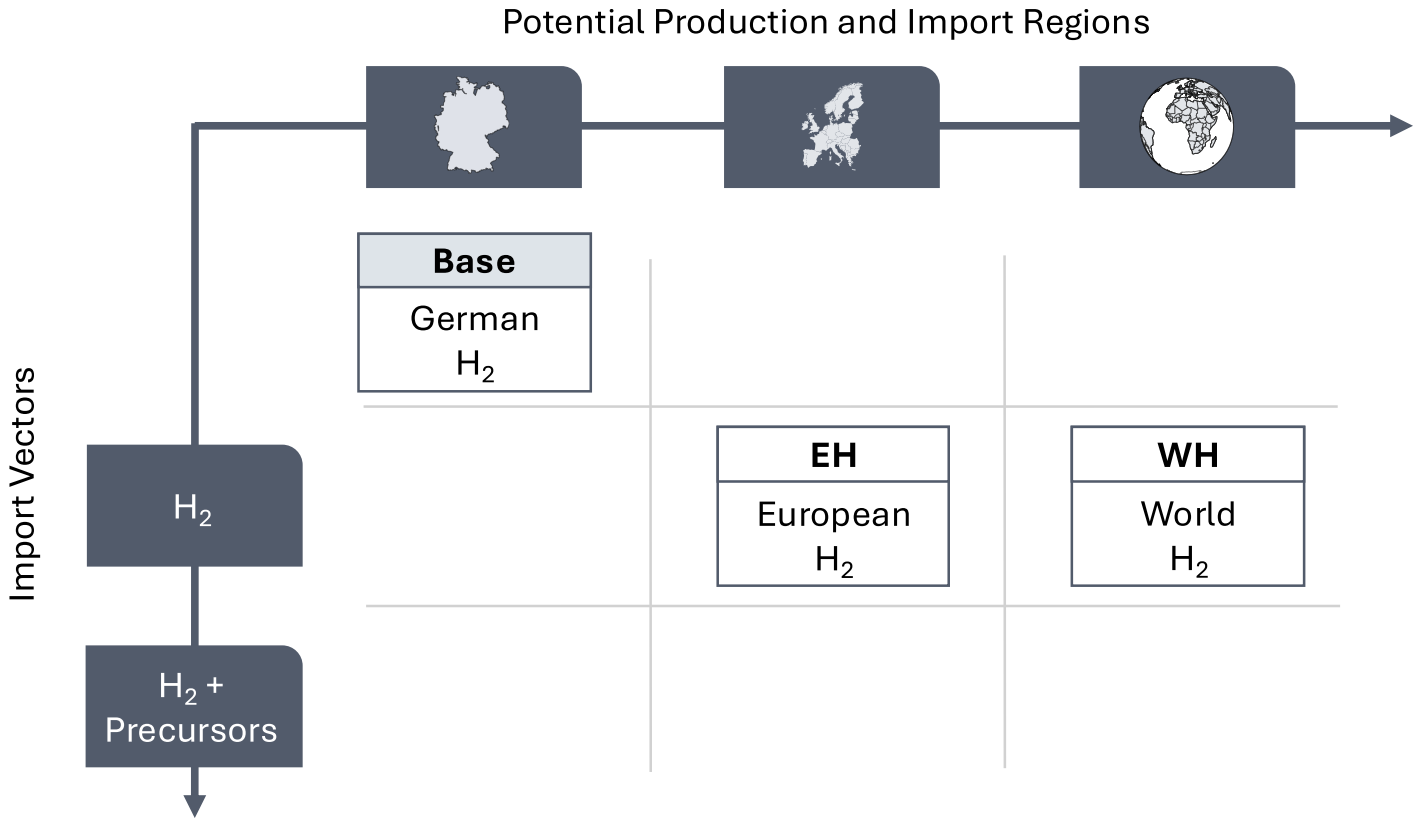

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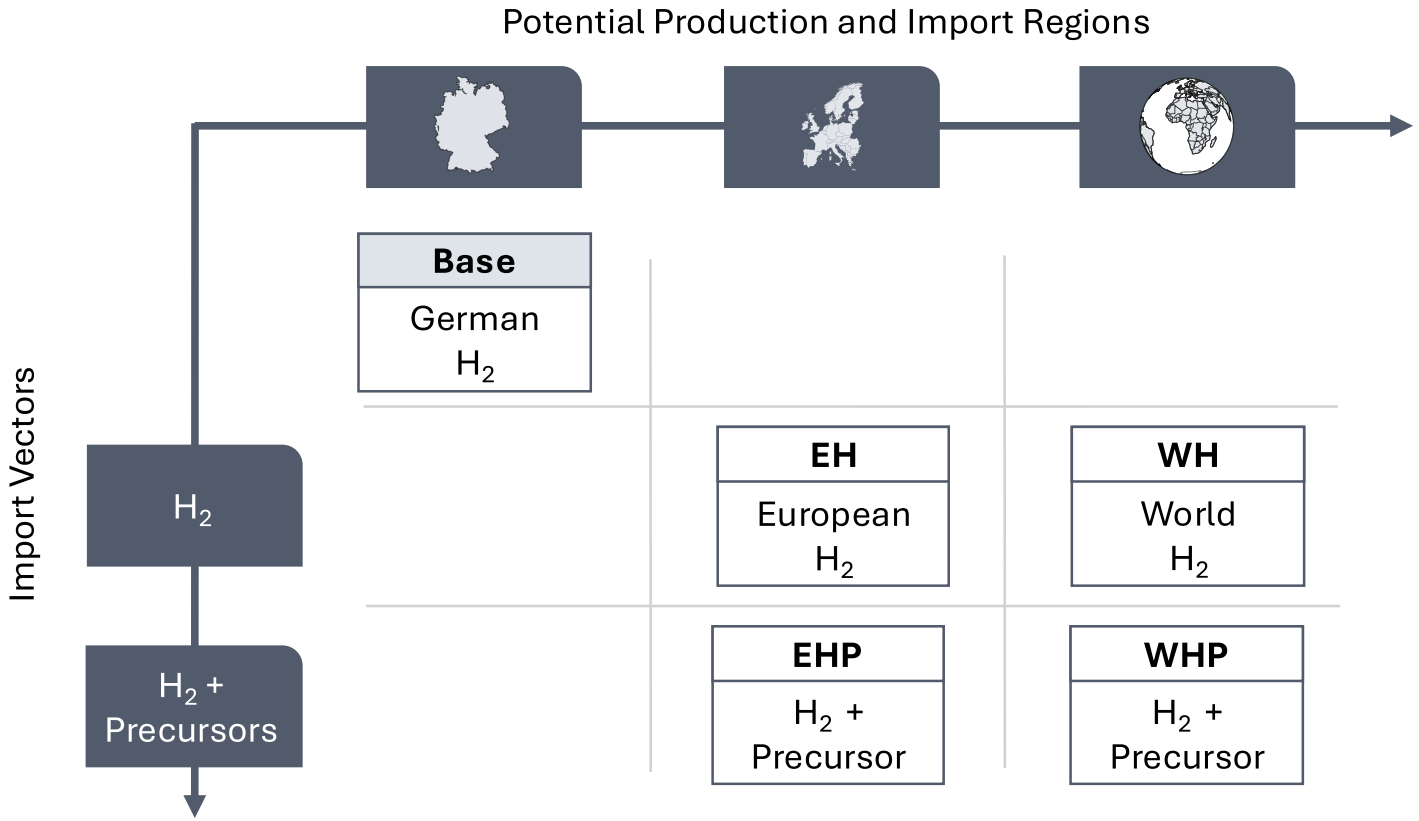

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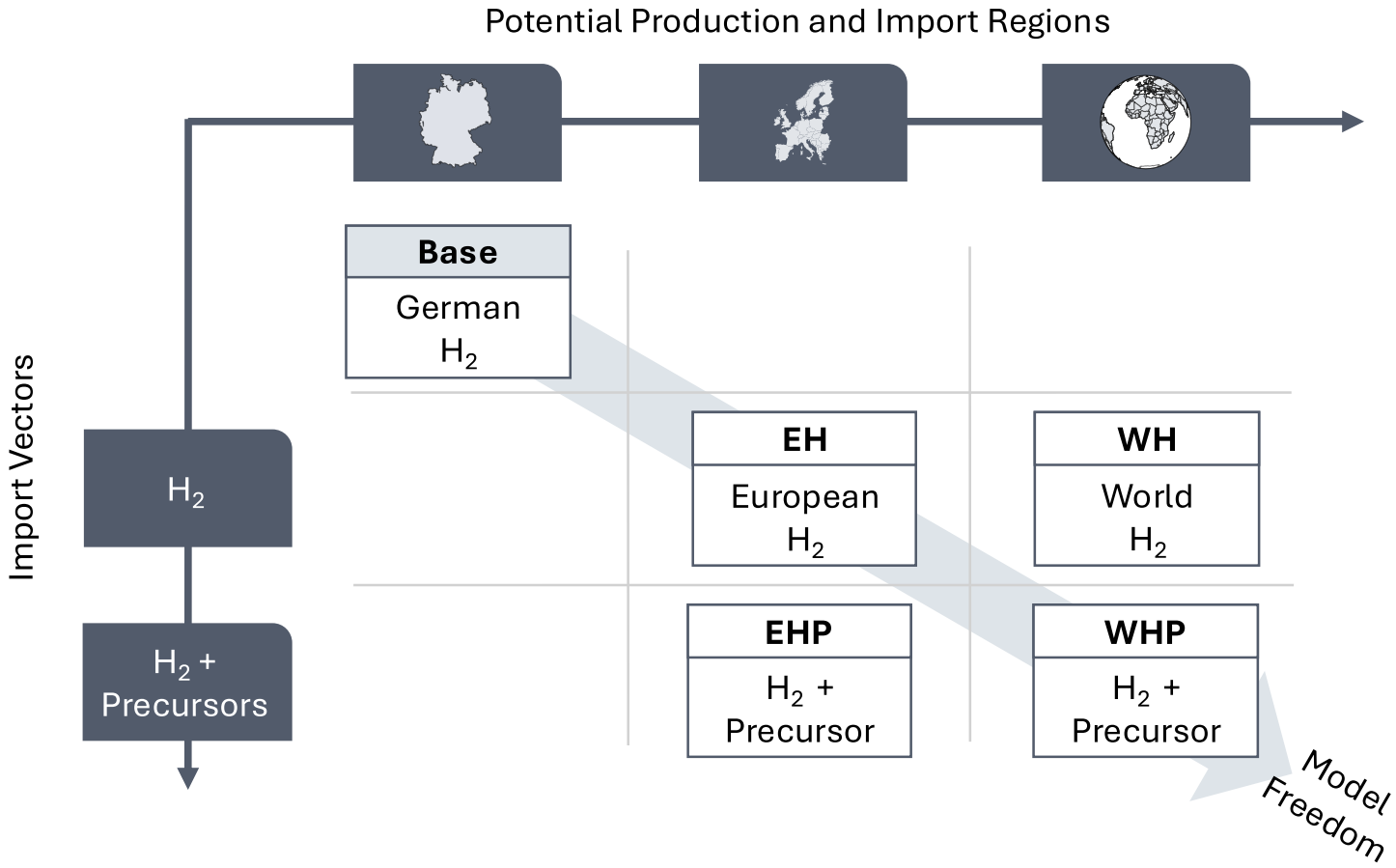
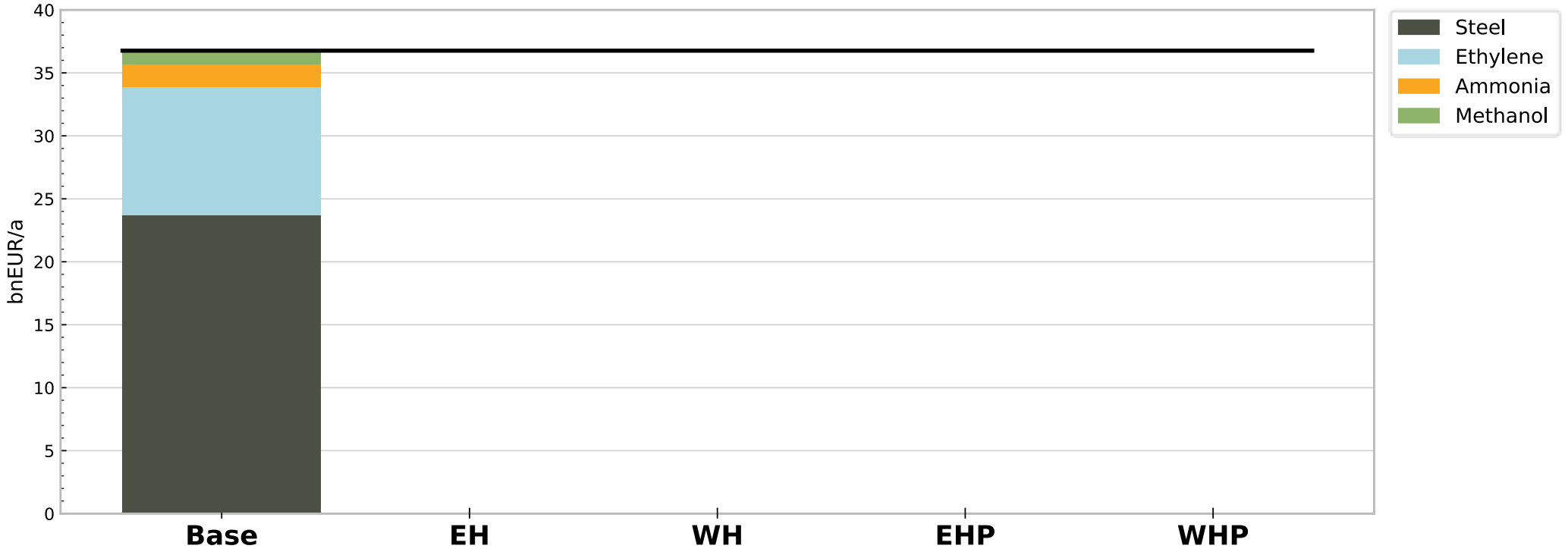


Industry Costs



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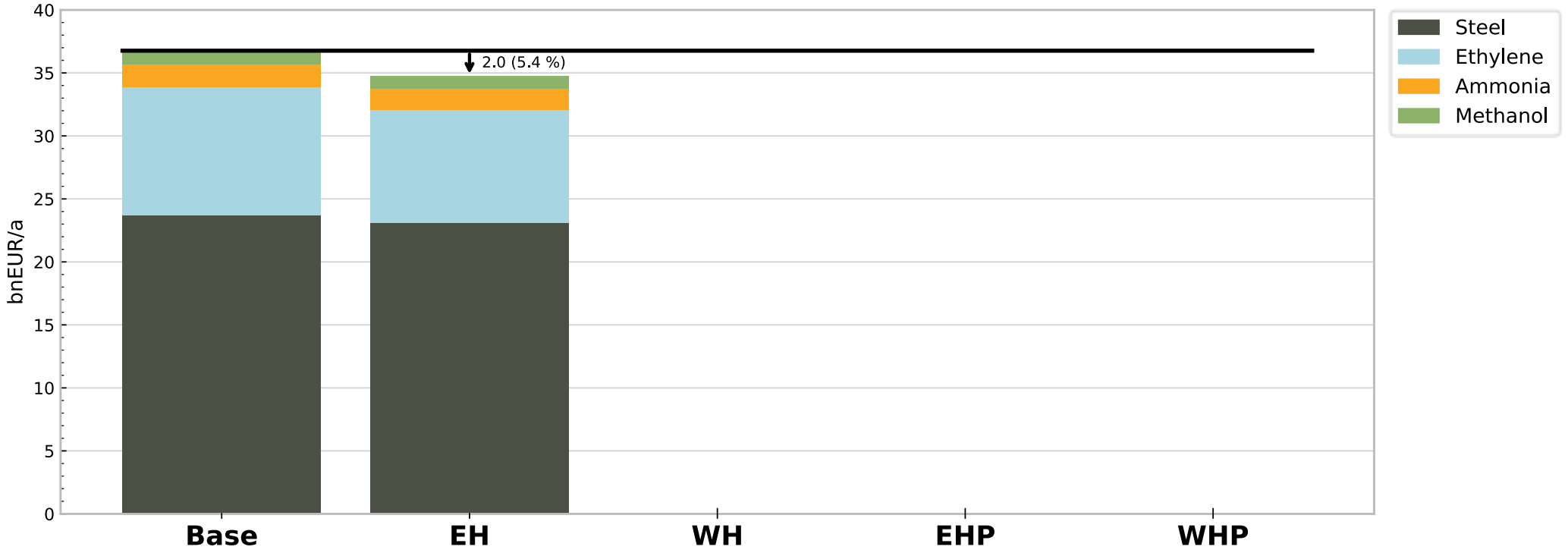

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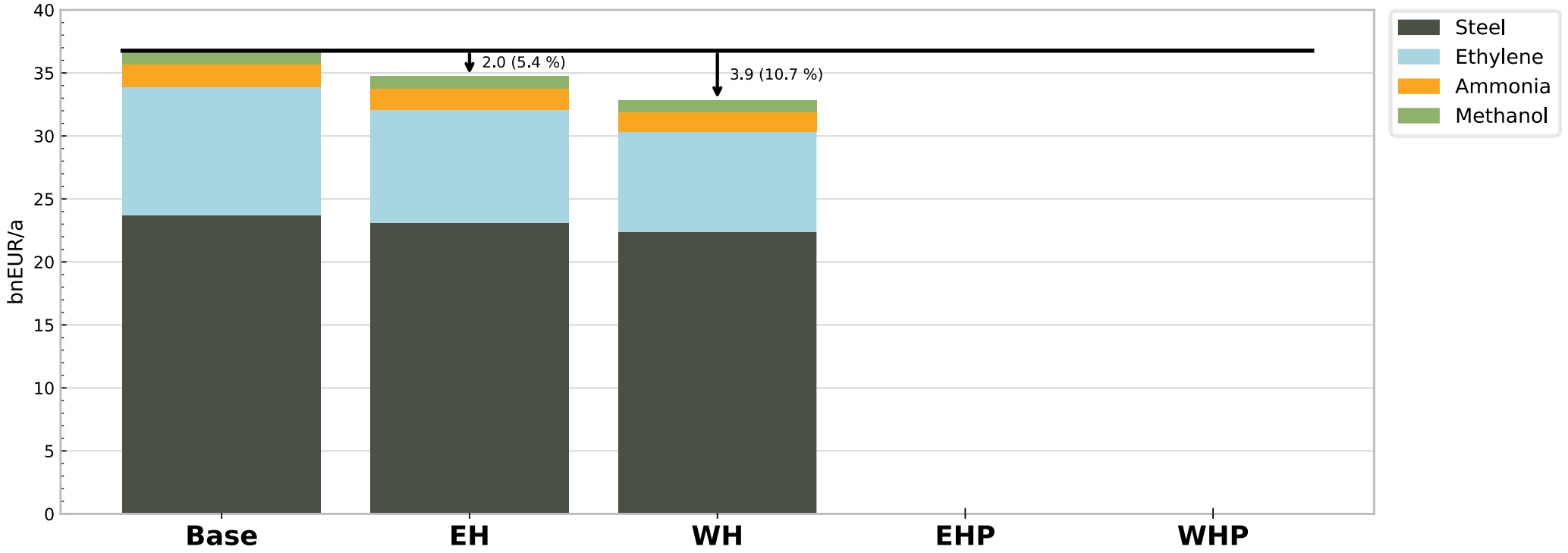

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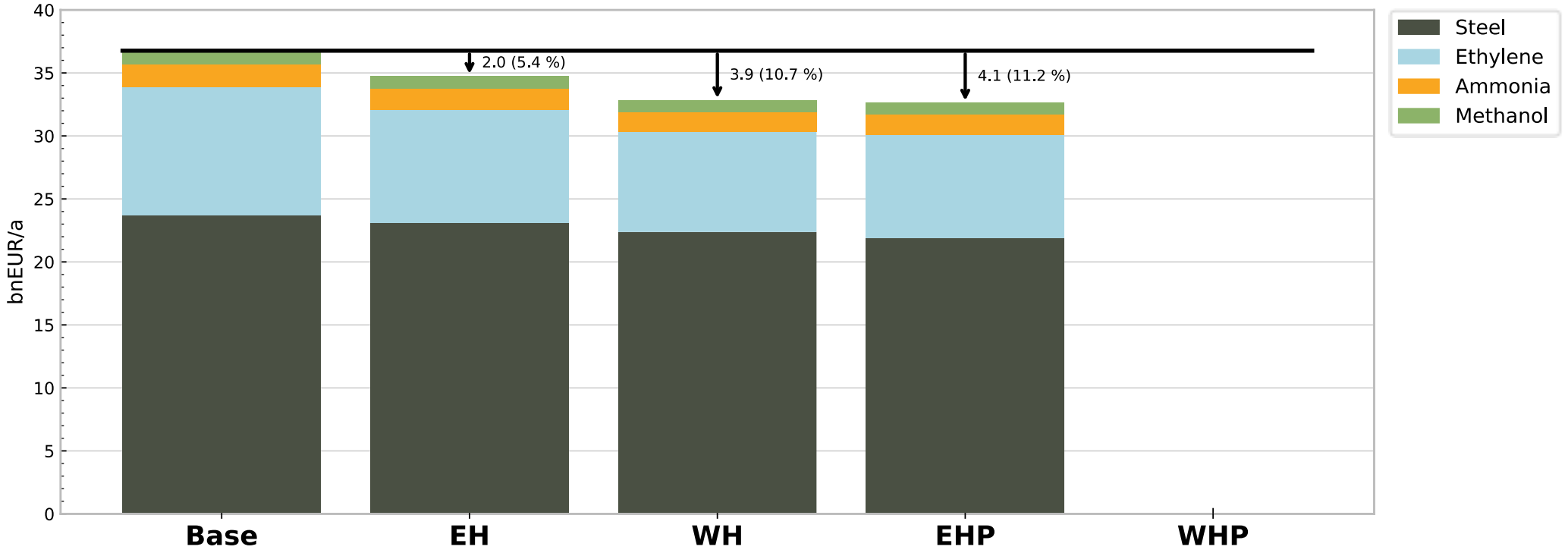

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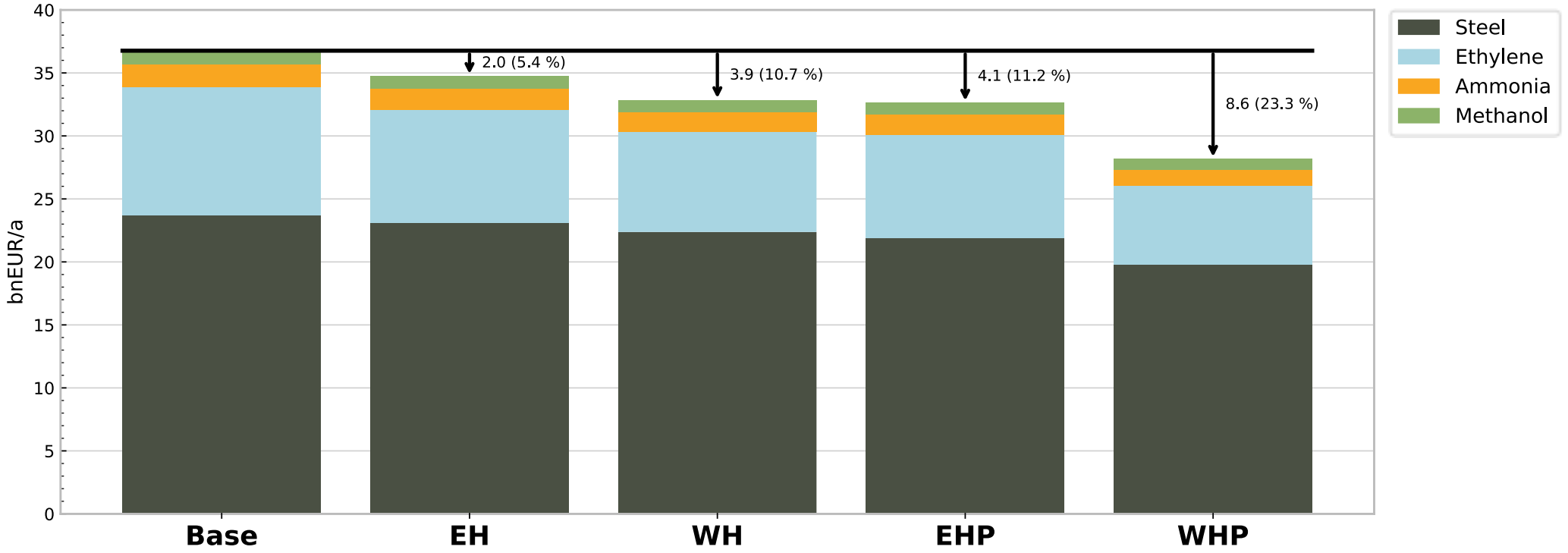
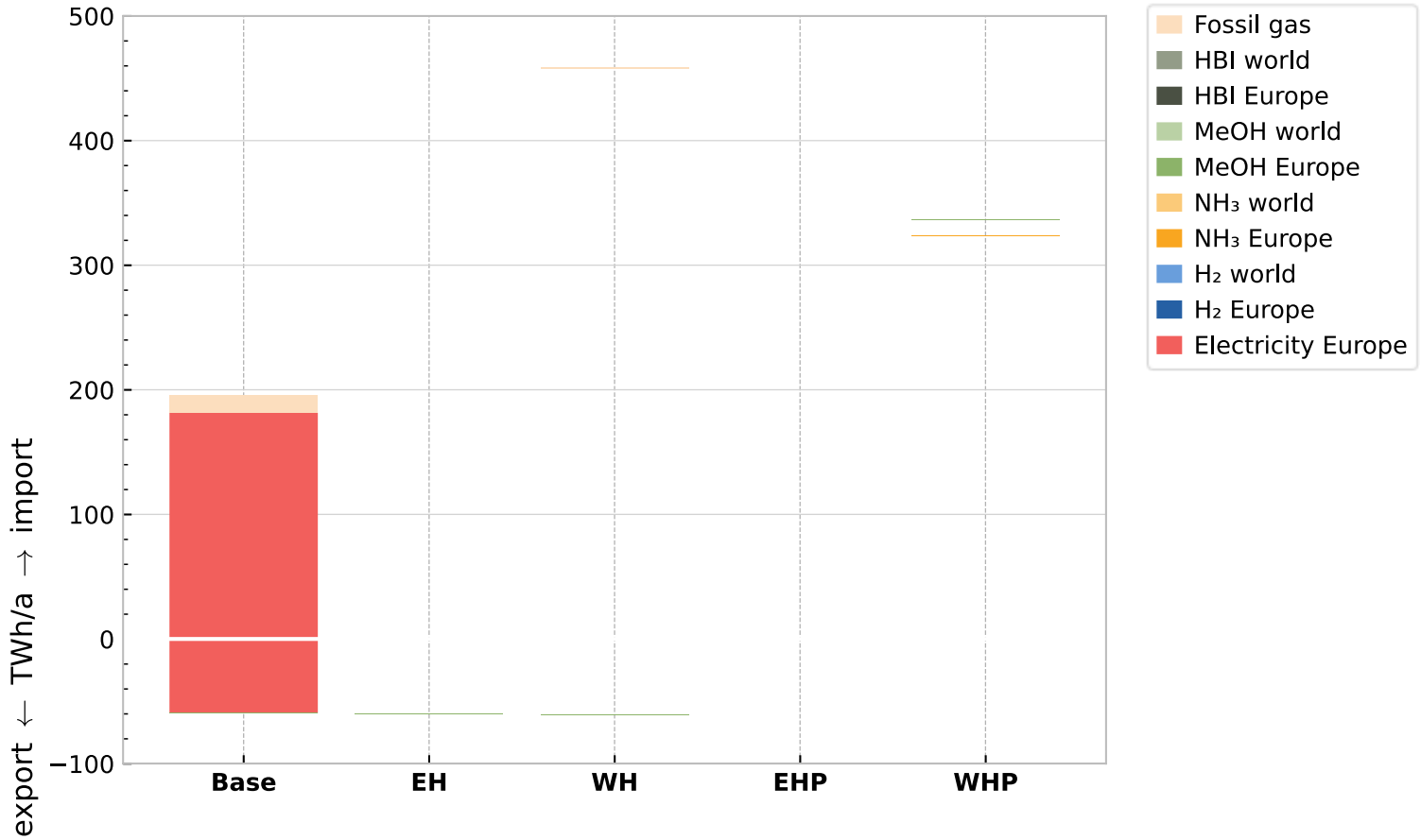


Import Balance Germany (excl. transport sector)



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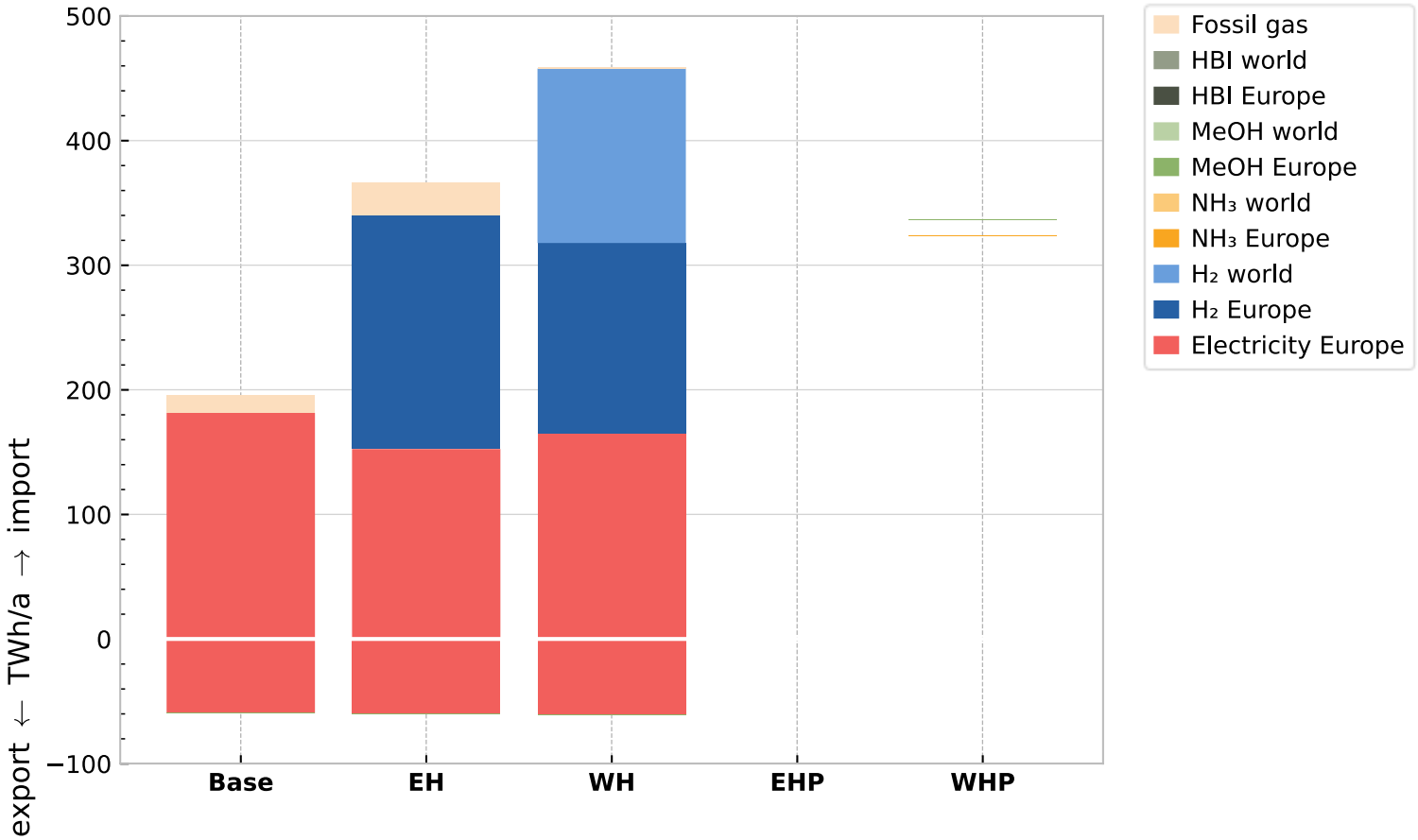

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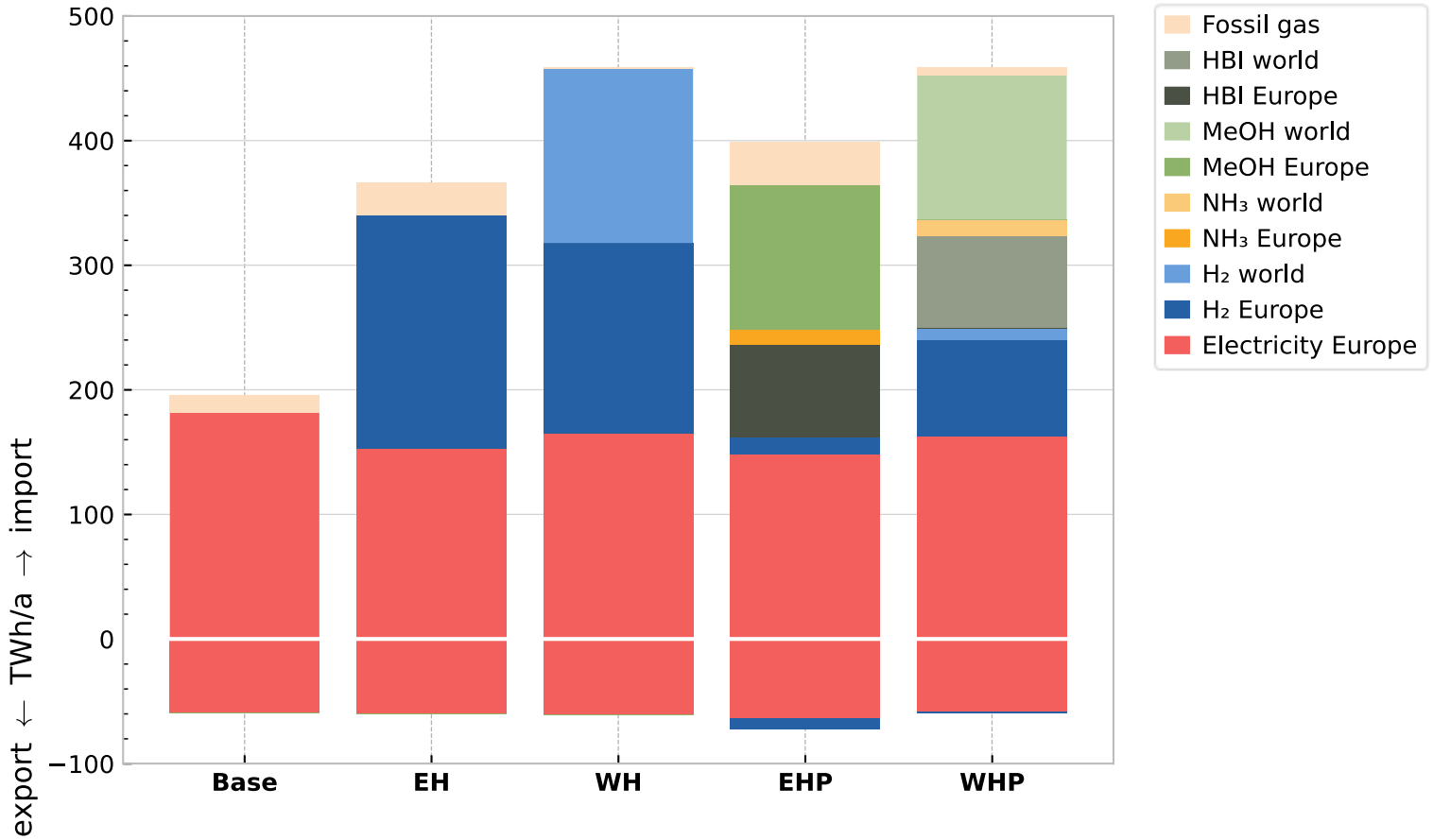
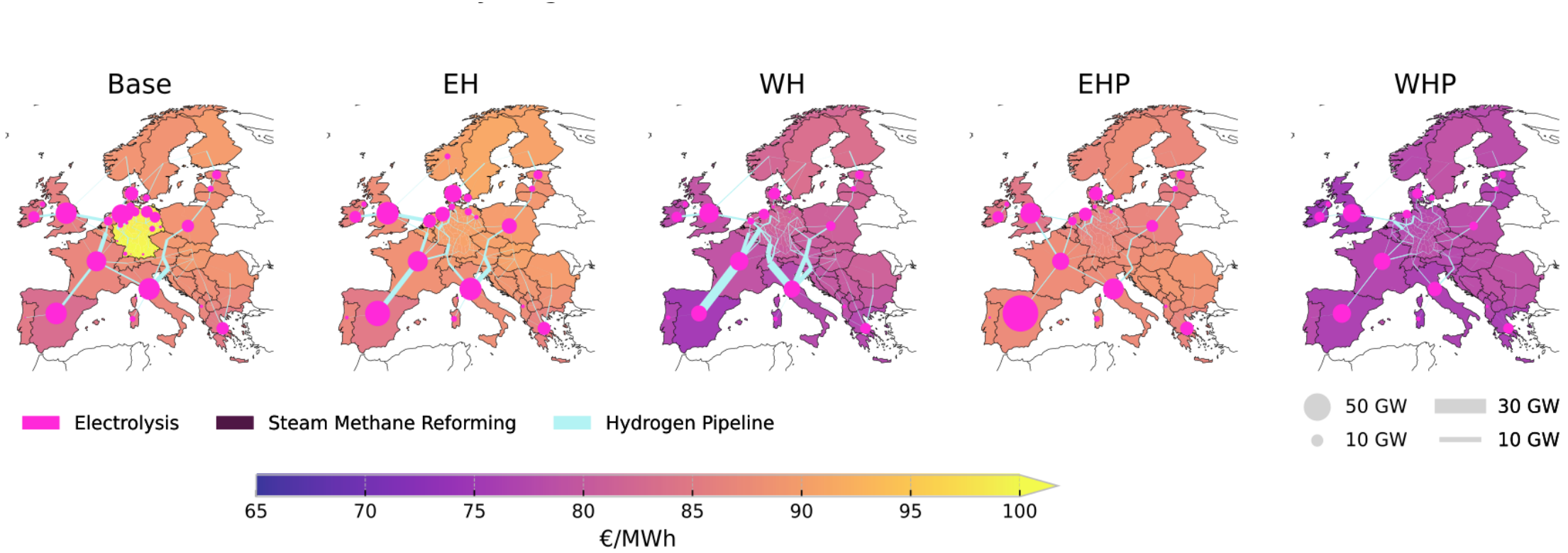
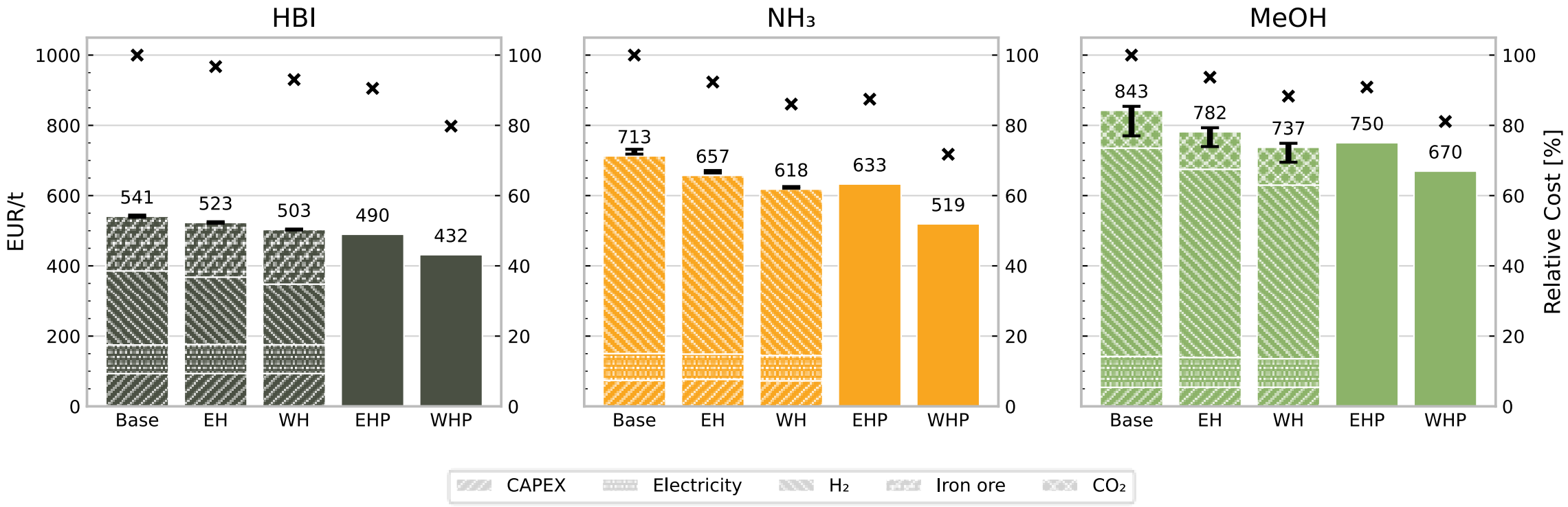


Reduced need for H_2 infrastructure



Precursor prices Germany



Conclusion

- Precursor import preferred over hydrogen import
- **Non-European imports** lead to substantial cost savings of **8.6 bnEUR/a (-23.3 %)**
- European imports reach **47.7 %** of those savings
- Precursor import from (non-)European partners **reduces need for hydrogen infrastructure** and **lowers hydrogen prices**

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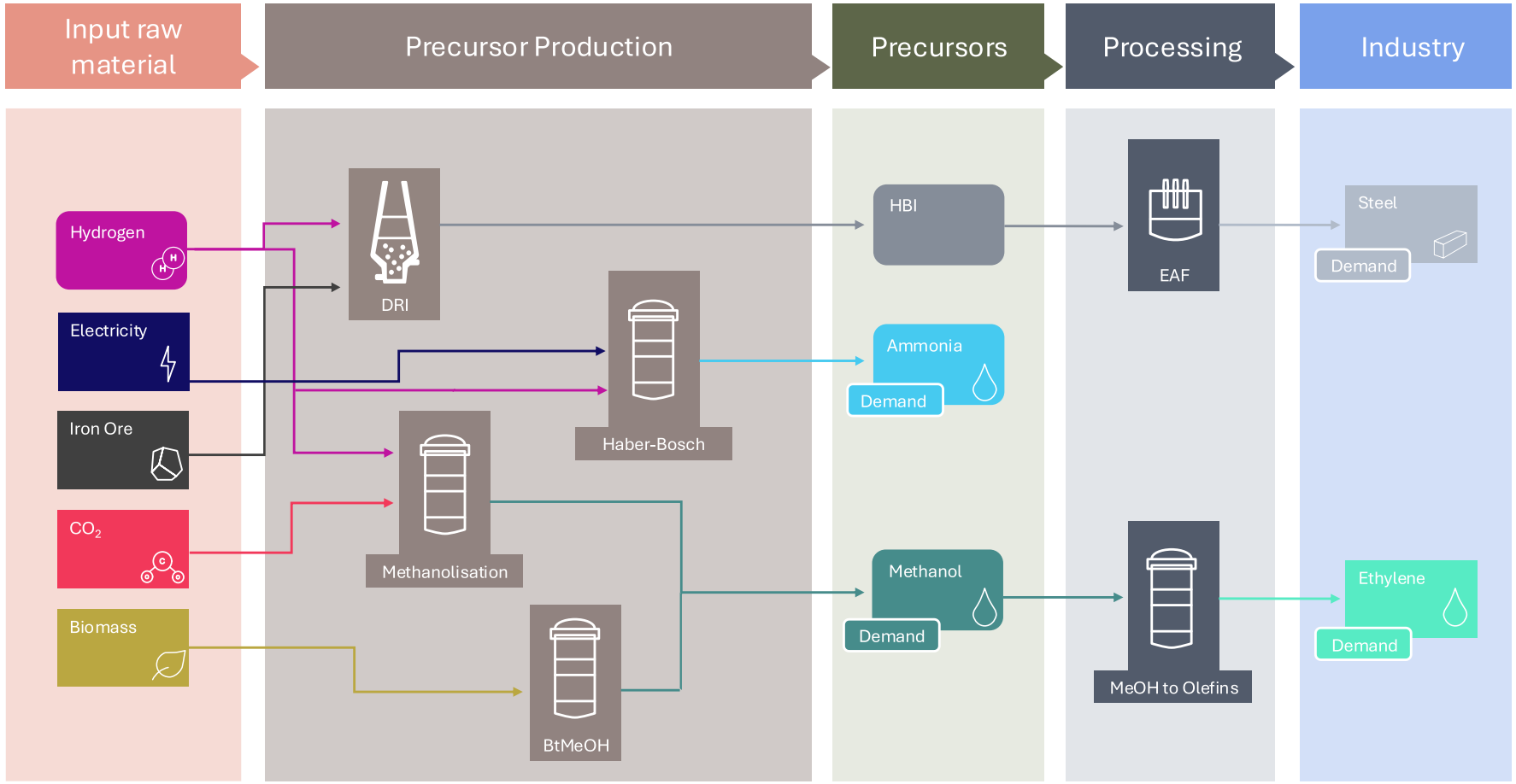
Preprint available on arxiv.org

KOPERNIKUS Ariadne PROJEKTE The Future of Our Energy

Federal Ministry of Research, Technology and Space

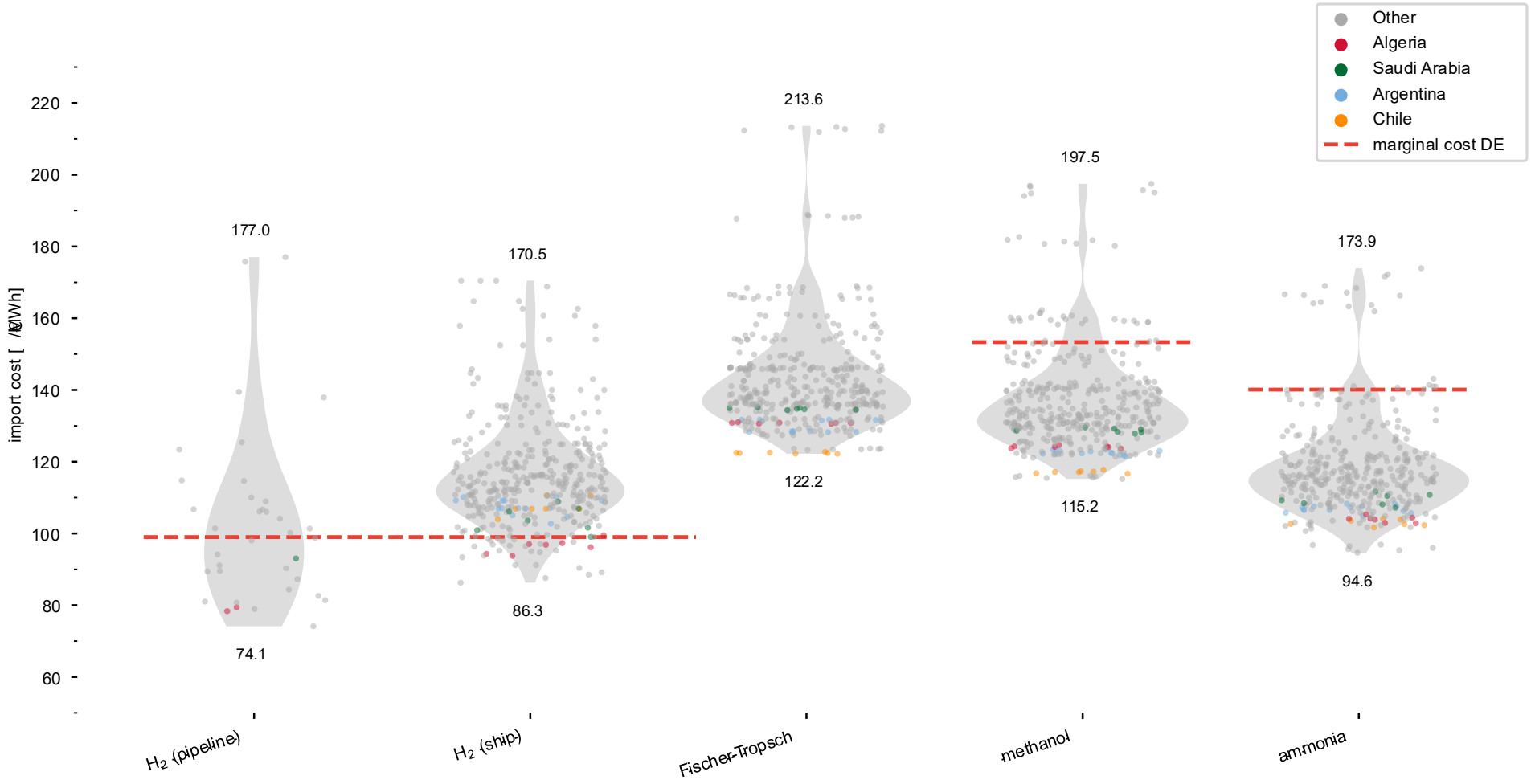
ENSYS Digitaler Wandel in Energiesystemen

Backup: endogenous industry implementation

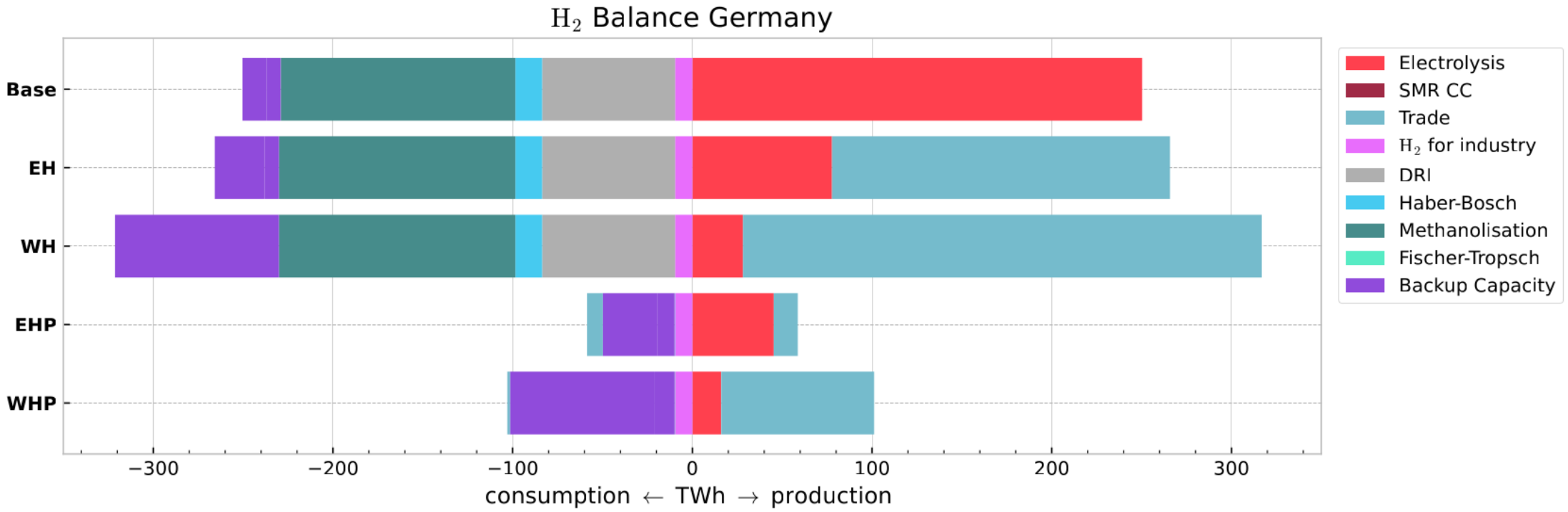


Import in EHP/WHP Scenario

Backup: supply chain model marginal prices



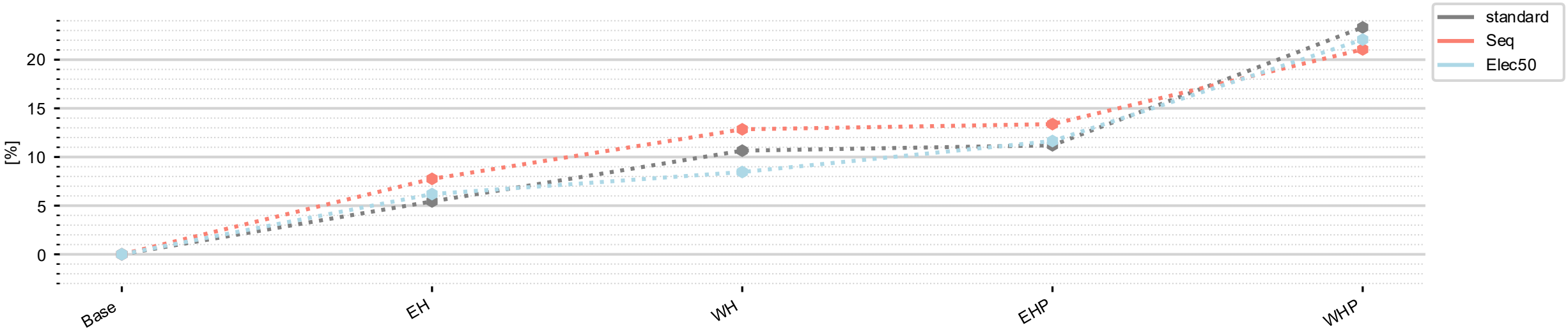
Backup: German hydrogen balance



Backup: sensitivities

- Higher sequestration potential in Europe (Seq)
- Lower investment costs for electrolysis units (Elec50)
- WACC of 10% in non-European countries (Wacc10)
- High solar land availability in Europe (HighSol)

Backup: sensitivities cost savings



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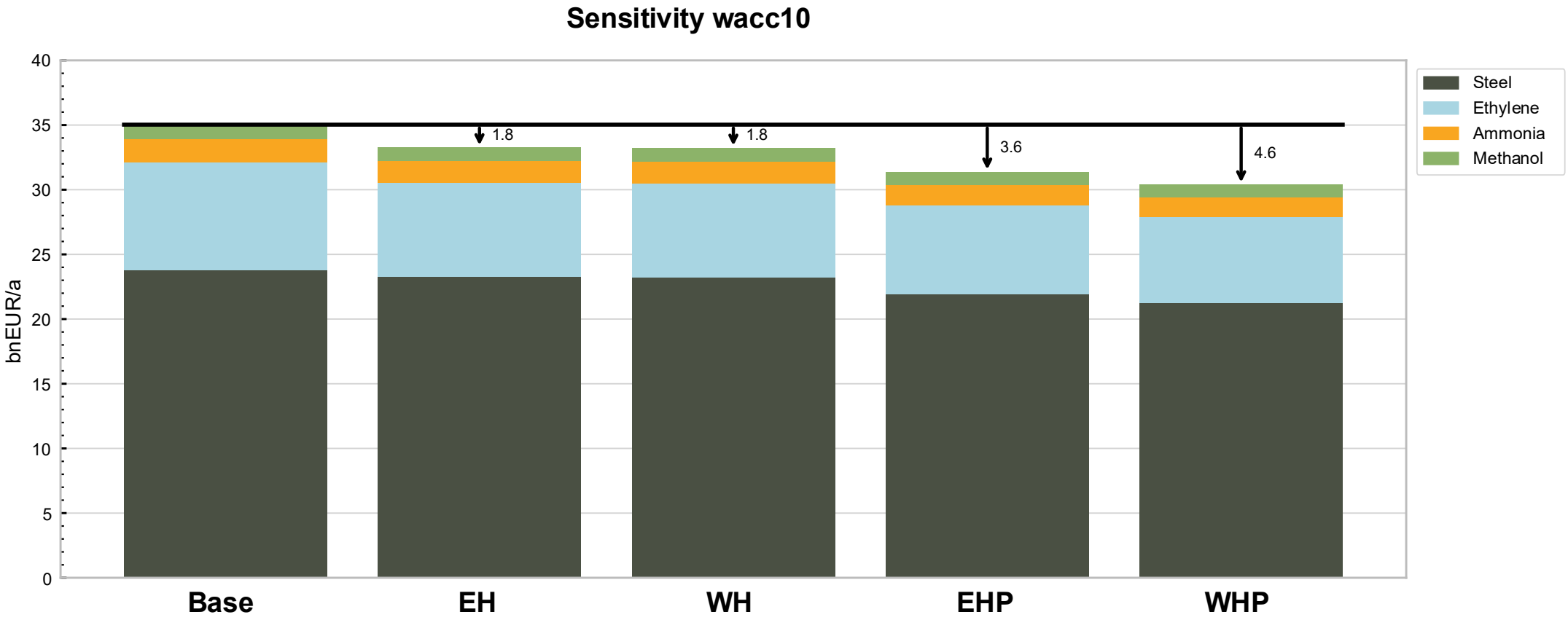

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