

# Compact, Validated Model Base for the German Energy System using Open Data

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**Energy system models are a basis for scientific debate and stimulate political discussions. Transparency and comprehensibility get compromised in large, complex models which rely on non-public data for their parametrization. We thus present a compact and validated model base for the today's multi-modal German energy system built exclusively upon open data.**

## Model

The model is composed of a compact representation of the technologies in the electricity, heat and transport sectors and their respective parametrization is built exclusively upon open data. It is formulated as a LP optimization problem, hence is compatible with different energy system modeling frameworks.

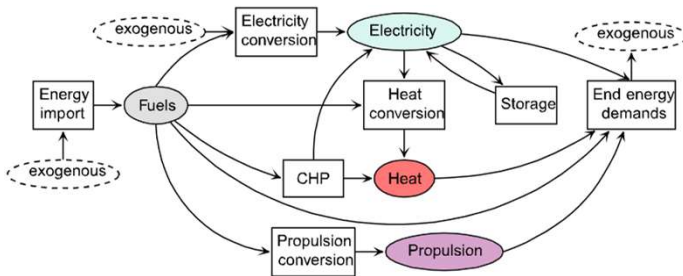


Fig. 1 Aggregated technology graph of the model base for the German energy system. Rectangles represent the conversion technologies groups and Ellipsis the energy forms groups. Dashed ellipsis represent the model Exogenous energy forms.

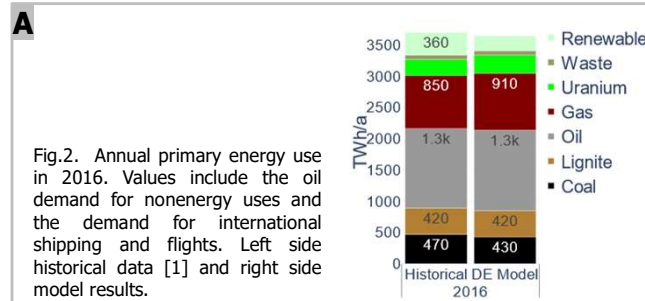


Fig.2. Annual primary energy use in 2016. Values include the oil demand for nonenergy uses and the demand for international shipping and flights. Left side historical data [1] and right side model results.

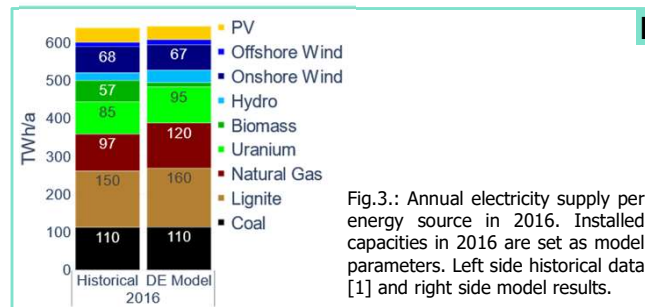


Fig.3.: Annual electricity supply per energy source in 2016. Installed capacities in 2016 are set as model parameters. Left side historical data [1] and right side model results.

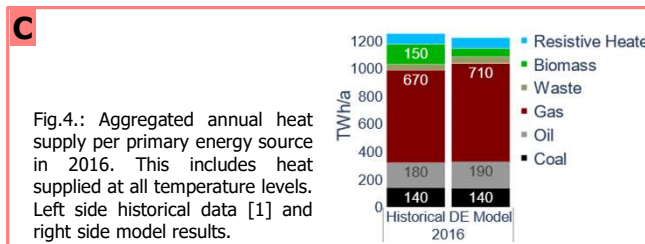


Fig.4.: Aggregated annual heat supply per primary energy source in 2016. This includes heat supplied at all temperature levels. Left side historical data [1] and right side model results.

## Results

The accuracy of the model was assessed by implementing with the open-source OSeMOSYS [2] framework and back testing it against the historical data [1] for the reference year of 2016.

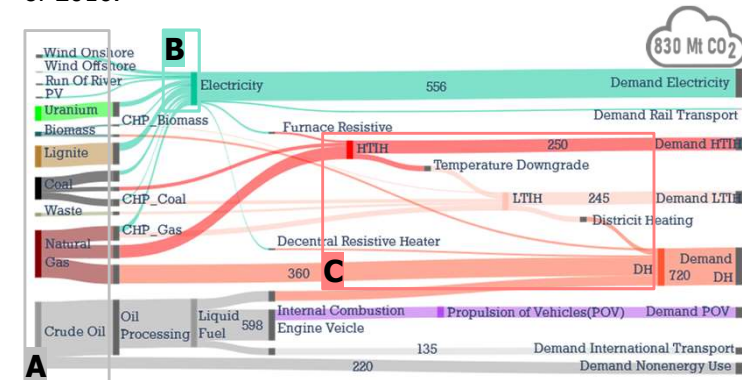


Fig. 5. Model results for the Energy Balance in 2016. Values in TWh. The model includes three forms of heat: High temperature industrial heat (HTIH), Low temperature Industrial Heat (LTIH) and Decentral Heat(DH). Losses are not represented. The Model's CO<sub>2</sub> balance covers the energy and industrial processes emission sectors. CO<sub>2</sub> emission from international transport (≈ 40 Mt) are already discounted.

## Outlook

The reduced complexity level adopted enables the use of solely open data, preserves model transparency and has proven itself as sufficient to reproduce the main aspects of the German energy system. Today the model could be extended to study the German energy transition for the future years until 2050.

