

SciGRID – An Open Source Model of the European Power Transmission Network

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Introduction

As of today **only limited data of the structure of the European transmission networks is available** for research and related purposes. The lack of such data complicates scientific attempts to analyse, characterise and compare high resolution energy system models.

SciGRID aims at building an open source model of the European power transmission network. In addition to the **data**, the **methods** developed for building the model and a **detailed documentation are published under suitable licenses free of charge.** It is intended for research purposes to foster and improve both existing and future in-house codes or models.

Here we briefly sketch the general approach and present the **recent release SciGRID v0.1.** In addition, we present first results on a **decomposition of transmission networks by net separators.**

The SciGRID Approach

SciGRID is based on transmission network data available from **openstreetmap.org** available under the Open Database License (ODbL). This data is, however, optimised for mapping and *a priori* not appropriate for power routing. In SciGRID therefore three steps need to be taken:

- Filtering of data with reduction to relevant information
- Construction of abstracted model by defining vertices and links
- Validation with other models

In contrast to earlier attempts towards power transmission models taken at different institutes, SciGRID

- is **confined to data sources** which are consistent with a **free distribution of the derived data** (e.g. OpenStreetMap),
- aims for a **sustainable use of the data** by encouraging updates of the initial data source for updates of the SciGRID model, and
- provides **all relevant information, codes and data** under licenses compatible with free scientific and commercial use.

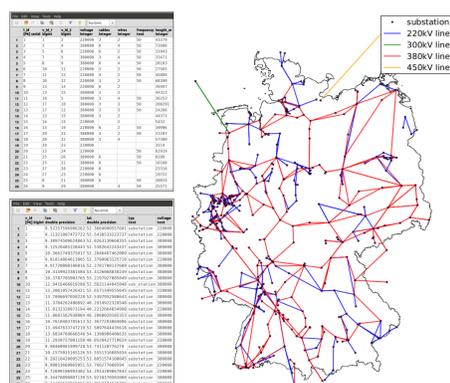
Hence, it is intended to provide a **consistent power transmission model, which can serve as a reference data set for different applications in science and beyond.**

SciGRID Release v0.1 (June 2015)

Version 0.1 of the SciGRID code was released on June 15th 2015 and is available for download. The release includes:

- complete **code and scripts** for the generation of a power transmission model from OpenStreetMap-data (planet.osm.pbf)
- detailed **documentation** of the procedure and assumptions
- the **data set** for the German power transmission network

Fig. 1: Model of the German transmission network as distributed with v0.1 of SciGRID. *Left panels:* Excerpt of the databases of links (top) and vertices (bottom) including key information for modeling such as electrical links parameters and positions of the vertices. *Right panel:* Cartographic representation of the data set with respective voltage levels.



Network Decomposition

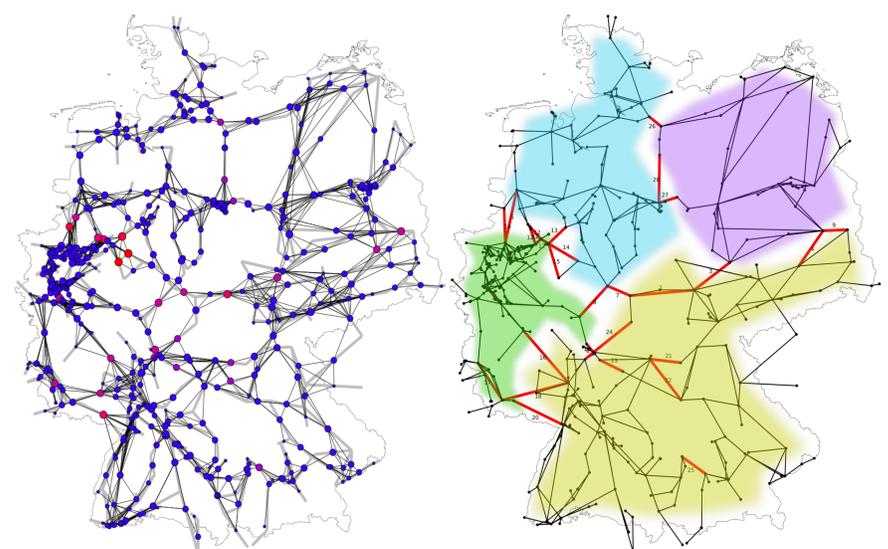


Fig. 2: Decomposition of the German power transmission network. *Left panel:* Largest connected component as hypergraph H with 442 vertices and 595 nets (grey) and its representation as net intersection graph (NIG) with 595 nodes and 2144 edges. The color code of the nodes in the NIG reflects their respective betweenness centrality measure (red color indicates high betweenness centrality). *Right panel:* Network decomposition by iteratively removing the top 28 nodes in the NIG (node-cut). Nodes in the NIG correspond to nets in H (red). The resulting four partitions are colored.

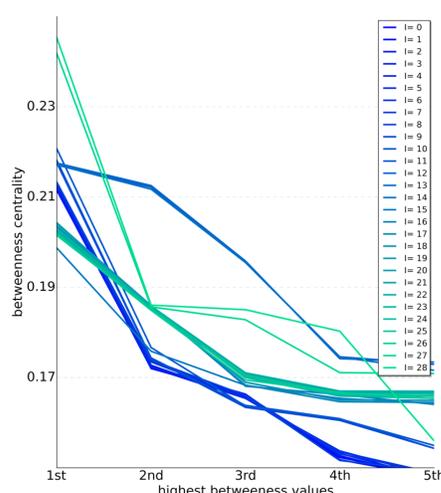


Fig. 3: Ordered iterated relative betweenness centralities upon node removal.

Strategy for Decomposition:

- Transmission network data represented as **hypergraph H**
- Removal of multiple nets** connecting the same vertices
- Partition of net intersection graph (NIG)** through a node separator by **iteratively removing** the node in NIG with the highest relative betweenness centrality [1]
- Node separator in NIG represents a **net separator** in H

Conclusions and Outlook

- SciGRID** is available and currently covers the **German transmission network.** Expansion to Europe depends on OSM coverage.
- Network can be **decomposed using betweenness centrality measure.** Systematic survey of alternative measures intended.
- Evaluation of maximal flow between partitions and identification of **optimal level of abstraction of large scale power networks.**

Reference and Acknowledgements

Further information on the SciGRID project is available from the project homepage, <http://www.scigrd.de>. Version 0.1 of program code, data and documentation is available for download there.

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