**Pakistani Transmission Grid Model**

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**Description of data file**

Data file named ‘’ptgm.xlsx’’ contains 5 sheets that are also in CSV format. Each sheet contains different columns which are described below.

1. **Nodes sheet / ptgm\_nodes.csv**

This sheet / CSV file contains 10 columns

|  |  |
| --- | --- |
| Column (name) | Description |
| A (nid) | It contains integer index used within this model to identify each node. |
| B (osm\_id) | OSM ID of the nodes is provided in this column. |
| C (name) | It contains name of the substation or power plants. |
| D (type) | It indicates the type (substation or power plant) of the node. |
| E (lat) | Latitude, geographical position of the node. |
| F (lon) | Longitude, geographical position of the node. |
| G (nominal\_power\_output) | It contains the nominal power output of a power plant in unit Megawatt (MW). |
| H (population) | The estimated population supplied by corresponding node. |
| I (fraction\_of\_population) | Fraction of the total population of Pakistan being supplied by this node. |
| J (fraction\_of\_total\_consumed\_power) | Fraction of the total Pakistani power consumption at this node in unit Watthour (Wh). |

1. **Links sheet / ptgm\_links.csv**

This sheet / CSV file contains the list of links (edges) of the graph. The following columns are described

|  |  |
| --- | --- |
| Column (name) | Description |
| A (lid) | It contains integer index used to identify each link. |
| B (osm\_id) | OSM ID of the link is used in this column. |
| C (nid1) | The ID of the node where the link stats. |
| D (nid2) | The ID of the node where the link ends. |
| E (voltage) | The voltage of the link. In the latest model we consider only 220 kV and 500 kV. Unit: Volts (V). |
| F (cables) | The number of the cables in the circuit. Typically a multiple of 3 due to 3-phasic AC circuits. |
| G (wires) | The number of ‘’ wires’’ each cable is split into. Note: This information is so far missing from OSM data of Pakistan. |
| H (length\_direct) | The direct displacement between start and end node of the link. |

1. **Cities sheet / ptgm\_cities.csv**

This sheet / CSV file contains the list of major Pakistani cities. This data has been used to estimate what share of power is consumed by each node in this model by exercising a simple nearest-neighbor search for each city among the set of nodes.

The following column are described

|  |  |
| --- | --- |
| Column (name) | Description |
| A (cid) | It contains an integer index used within this model to identify each city. |
| B (name) | The name of cities. |
| C (population) | Population of the city |
| D (province) | Name of the state/province in this city is located. |
| E (lat) | Latitude, geographical position of the city. |
| F (lon) | Longitude, geographical position of the city. |
| G (closest\_distance) | Distance to the closest node. Unit: Kilometes (km). |
| H (closest\_substation\_index) | Index of the closest node. |

1. **Industries sheet / ptgm\_inductries.csv**

This sheet / CSV contains list of 100 major Pakistani industries. The columns of the sheet are described below.

|  |  |
| --- | --- |
| Column (name) | Description |
| A (iid) | It contains an integer index used in this model to identify each industry. |
| B (name) | Name of the industry. |
| C (city) | Name of the city in which the industry is located. |
| D (closest\_substation\_index) | It contains name of the closest node. |

1. **State sheet / ptgm\_states.csv**

This sheet / CSV file contains the list of Pakistani state / provinces. The following columns are described below.

|  |  |
| --- | --- |
| Column (name) | Description |
| A (sid) | It contains an integer index used in this model to identify each state / province. |
| B (name) | The Name of the state / province. |
| C (population) | The number of citizen in this state. |

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**List of data sources**

1. **The OpenStreetMap project (OSM)**

The OpenStreetMap project, <http://www.openstreetmap.org/> . OpenStreetMap data is licensed under the Open Data Commons Open Database License (ODbL), see <http://www.openstreetmap.org/copyright> for more information. (c) OpenStreetMap contributors. The alternative OSM inferface provided byhttp://www.flosm.de/ has also been used**.**

1. **Google Maps**

Aerial photography provided by Google Maps has been used to correct and extend the data provided by the OpenStreetMap project, especially for "filling the gaps" in the OSM data. <http://www.google.de/maps> .

1. **citypopulation.de**

The list of major Pakistani cities and their population have been taken from <http://www.citypopulation.de/Pakistan-20T.html> by Thomas Brinkhoff. The data is published under a Creative Commons Attribution 3.0 Unported license (CC BY 3.0).

1. **scribd.com**

The list of major Pakistani industries has been taken from the book "List of 100 Companies of Pakistan" by Humayun Maqbool (2009), <http://www.scribd.com/doc/12487960/List-of-100-Companies-of-akistan> . scribd.com is an online publishing network. This book has been published under an "attribution non-commercial" license.

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**Abbreviations**

**OSM:** The OpenStreetMap project, <http://www.openstreetmap.org/>