Power Grid Model

A High-Performance Distribution Grid Calculation Library
Summary

• Power Grid Model: an open-source project for distribution power system calculation.
  - [https://github.com/alliander-opensource/power-grid-model](https://github.com/alliander-opensource/power-grid-model)

• In this presentation
  - Why a new project?
  - What is Power Grid Model?
  - How does it perform?
  - Deployment inside Alliander
  - Road to open-source
Who are we? Who am I?

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Traditional workflow for power system analysis

Modern workflow for power system analysis

Publish results

Database

Programming/scripting

Cloud deployment

input_data = import_data()
model = Model(input_data)
result = model.calculate()
What makes a good power system calculation model/library?
## Why a new library?

<table>
<thead>
<tr>
<th>Feature</th>
<th>Commercial software</th>
<th>Existing open-source solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power system calculation functionalities</td>
<td>Good</td>
<td>Good</td>
</tr>
<tr>
<td>Asymmetric calculation support</td>
<td>Good</td>
<td>Mediocre</td>
</tr>
<tr>
<td>Easy to use and well documented software API</td>
<td>Mediocre</td>
<td>Good</td>
</tr>
<tr>
<td>Performant on large dataset and/or batch calculation</td>
<td>Depends?</td>
<td>Mediocre</td>
</tr>
<tr>
<td>Efficient parallelization</td>
<td>Depends?</td>
<td>Mediocre</td>
</tr>
<tr>
<td>Cross-platform and scalable in cloud</td>
<td>Mediocre</td>
<td>Good</td>
</tr>
</tbody>
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Alliander in-house library: Power Grid Model

• Power System Calculation Functionalities
• Symmetric and asymmetric calculation
• Power flow
  • Newton-Raphson
  • Iterative current (equivalent to backwards/forwards for radial network)
  • Linear current (approximation)
  • Linear impedance (approximation)
• State estimation
  • Iterative linear method
Alliander in-house library: Power Grid Model

- Efficient implementation in C++
  - Native shared-memory multi-threading for parallelization in batch calculations
- API in Python
  - Stable and easy-to-use
  - Well-documented
- Cross-platform
  - Publish binary Python packages in official PyPI
  - [https://pypi.org/project/power-grid-model/](https://pypi.org/project/power-grid-model/)
  - Built for Windows (x64), Linux (x64/arm64), macOS (x64/arm64)
Model Validation

- Validation of the library against reference models with 80+ test cases
  - Hand calculation
  - Vision
  - Gaia
  - PowerFactory
  - PandaPower
- Continuous validation as part of CI pipeline in GitHub Actions
Performance Benchmark

- Compare performance of Power Grid Model and PandaPower
  - [https://github.com/alliander-opensource/power-grid-model-benchmark](https://github.com/alliander-opensource/power-grid-model-benchmark)
- 1000 nodes radial network
- Time-series symmetric and asymmetric power flow calculation in 1000 steps
- Testing environment: Intel i7-8850H, 40 GB RAM, single-thread in Linux (WSL)
- Library version: power-grid-model 1.4.0, pandapower 2.10.1
Performance Benchmark

Relative performance for symmetric calculation

- PandaPower Newton-Raphson: 1
- PGM Newton-Raphson: 25
- PGM Iterative Current: 45
- PGM Linear Impedance: 68
- PGM Linear Current: 69
Performance Benchmark

Relative performance for asymmetric calculation

- **PandaPower Newton-Raphson**: 1
- **PGM Newton-Raphson**: 69
- **PGM Iterative Current**: 247
- **PGM Linear Impedance**: 242
- **PGM Linear Current**: 486

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Current Deployment

- Data conversions
  - CIM
  - Vision
  - GridCal
  - Gaia (pending)
  - PandaPower (pending)
Current Deployment
A fundamental building block for Alliander

- Deployed in 10+ applications inside Alliander

- Grid planning
- Automatic network design
- Monitoring asset allocation
- Active congestion management
- …?
Road to Open Source

• Power Grid Model is an open-source project
  - [https://github.com/alliander-opensource/power-grid-model](https://github.com/alliander-opensource/power-grid-model)

• Ways of collaboration and contribution
  - Use the library, give feedback, report bugs
  - Provide validation test cases
  - Improve Python API
  - Improve C++ core (new algorithms and models)

Road to Open Source

- Current active partners
How to get started?

1. Check out Alliander Open Source website

2. Visit Power Grid Model Github community
   https://github.com/alliander-opensource/power-grid-model

3. Mail the team: dynamic.grid.calculation@alliander.com

4. Tutorial workshop
   https://github.com/alliander-opensource/power-grid-model-workshop

Power Grid Model TSC & maintainers

- Tony Xiang (Chair)
- Werner van Westering
- Peter Salemink
- Bram Stoeller
- Nitish Bharambe
- Jonas van den Bogaard

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