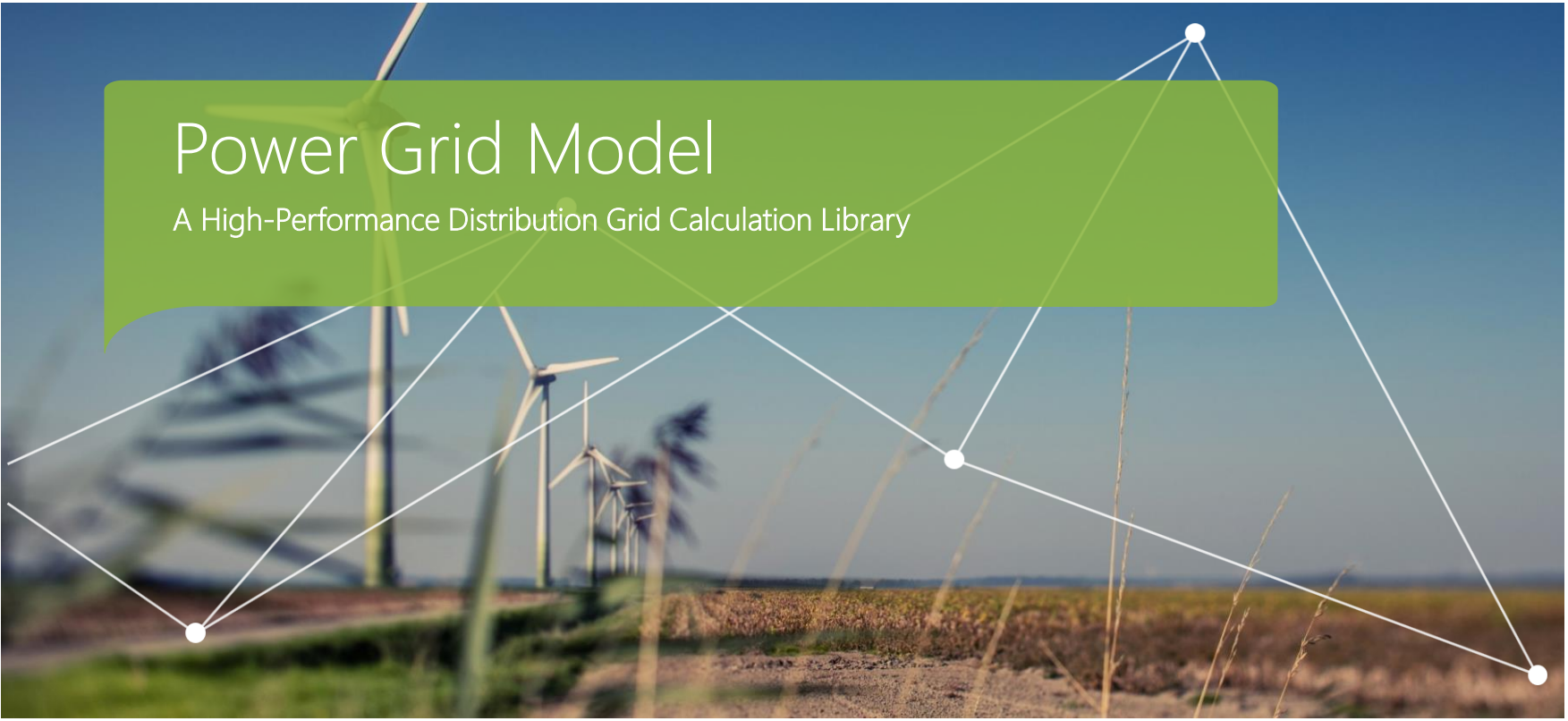

Power Grid Model

A High-Performance Distribution Grid Calculation Library

Tony Xiang, PhD | tony.xiang@alliander.com

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Summary

- Power Grid Model: an open-source project for distribution power system calculation.
  - 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?

Yu (Tony) Xiang, PhD

Lead Scientific Engineer
Chapter Advanced Analytics
@Alliander

Guest Lecturer
@Eindhoven University of Technology

Peter Salemmink, MSc

Data Scientist
Chapter Advanced Analytics
@Alliander

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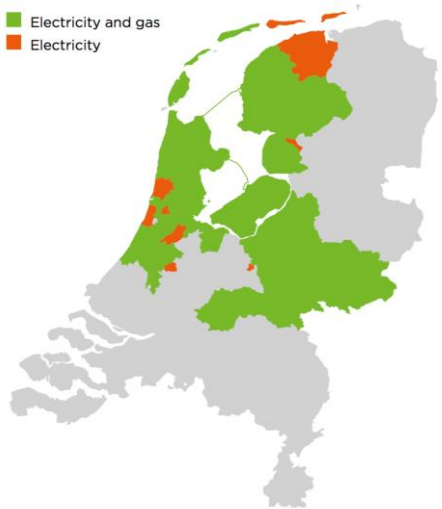
Electricity grid length
92,000 km
91,000 km in 2019

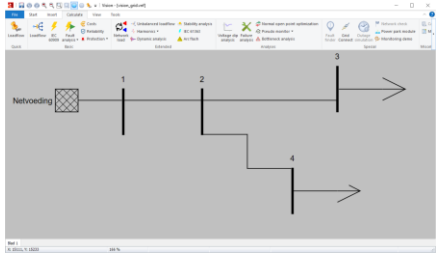
Gas grid length
42,000 km
42,000 km in 2019

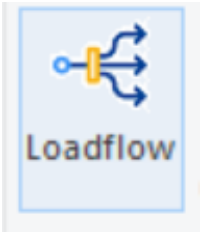
Number of customer connections
5.8 million
5.8 million in 2019

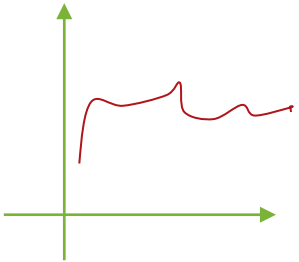
Number of employees
5,881 FTEs
5,703 FTEs in 2019



Traditional workflow for power system analysis







Data files

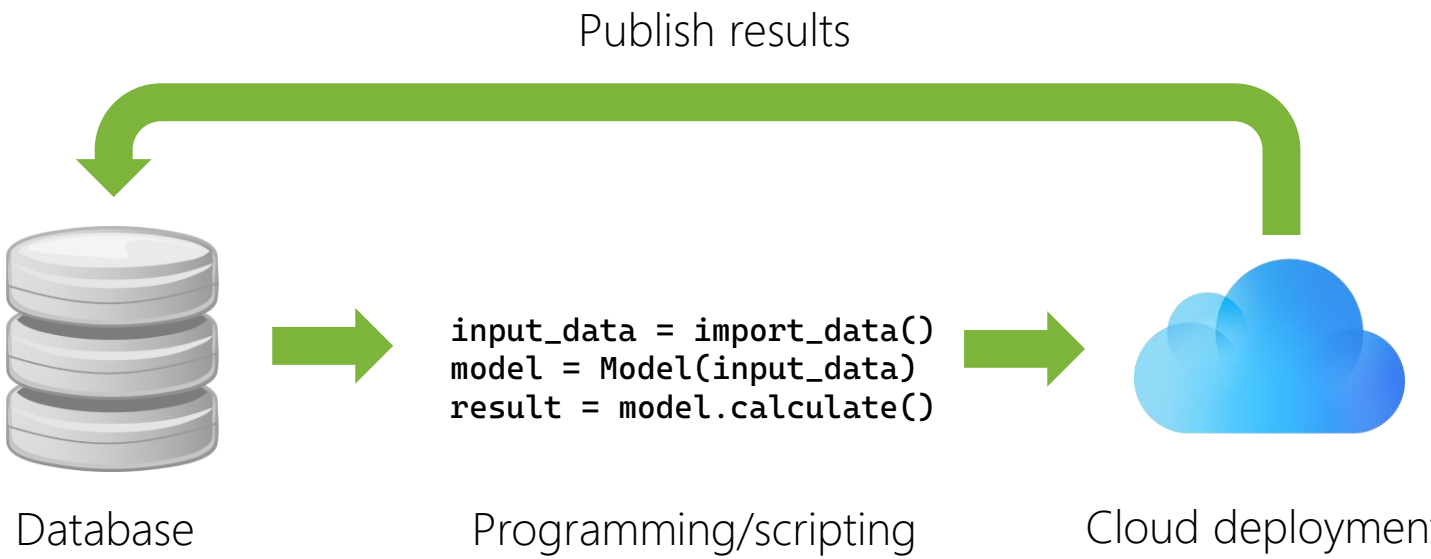
Commercial software*

Built-in function*

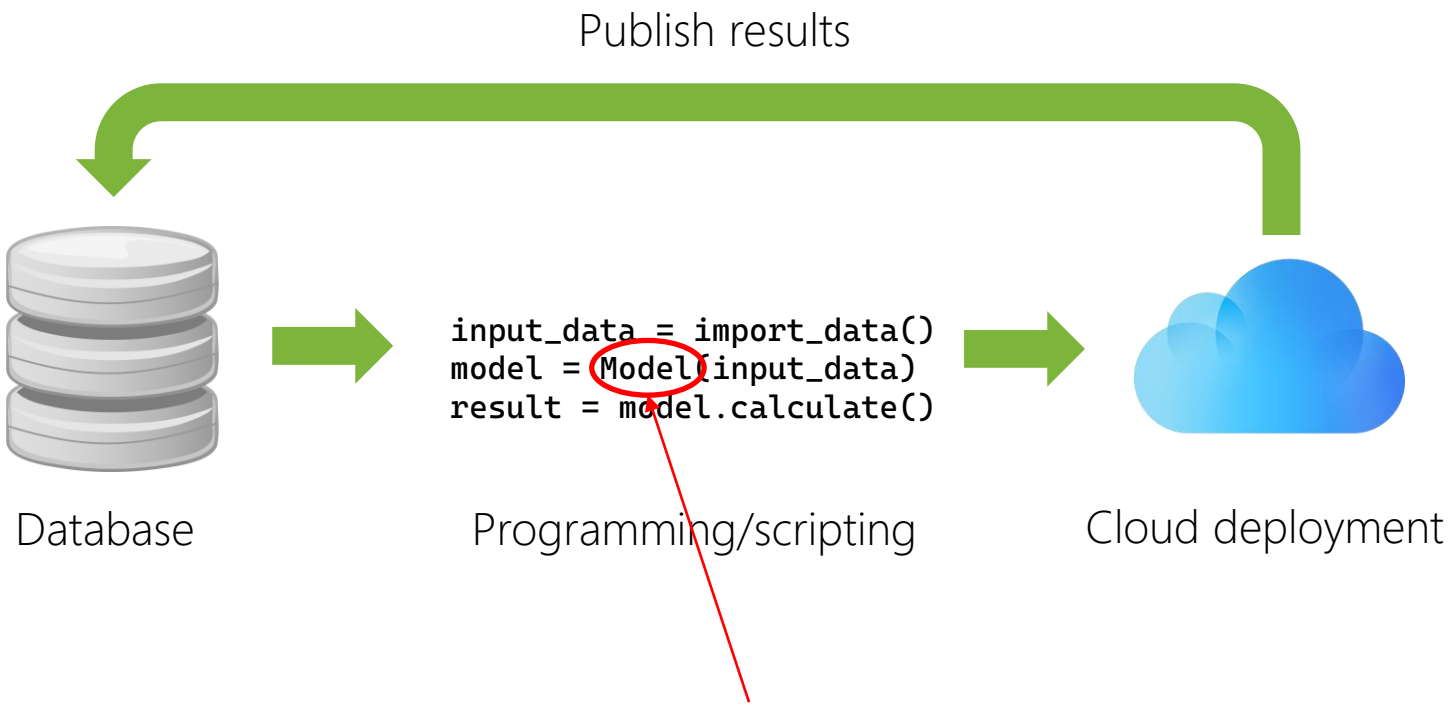
Results

* https://www.phasetophase.nl/en/vision-network-analysis.html

Modern workflow for power system analysis



Modern workflow for power system analysis



What makes a good power system calculation model/library?

Why a new library?

	Commercial software	Existing open-source solution
Power system calculation functionalities	Good	Good
Asymmetric calculation support	Good	Mediocre
Easy to use and well documented software API	Mediocre	Good
Performant on large dataset and/or batch calculation	Depends?	Mediocre
Efficient parallelization	Depends?	Mediocre
Cross-platform and scalable in cloud	Mediocre	Good

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/
  - Built for Windows (x64), Linux (x64/arm64), macOS (x64/arm64)

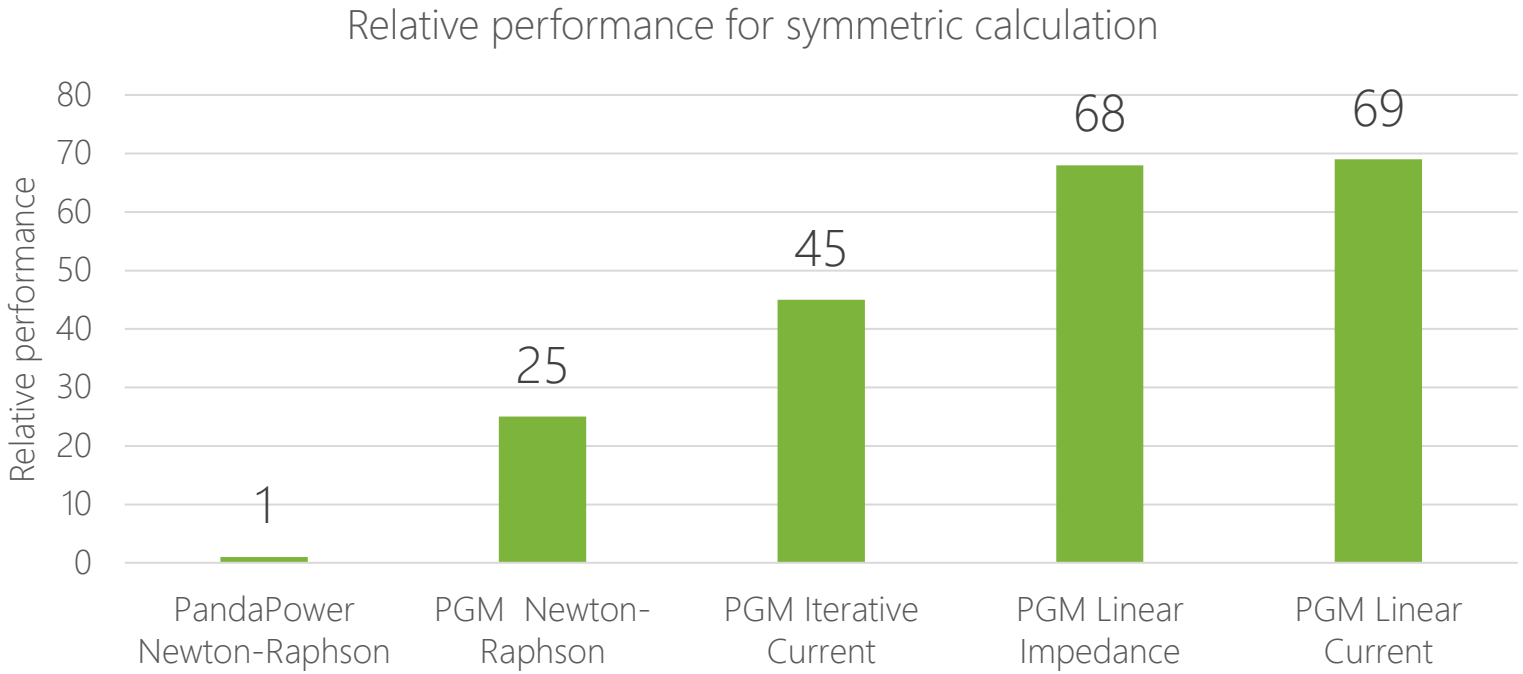
Model Validation

- 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

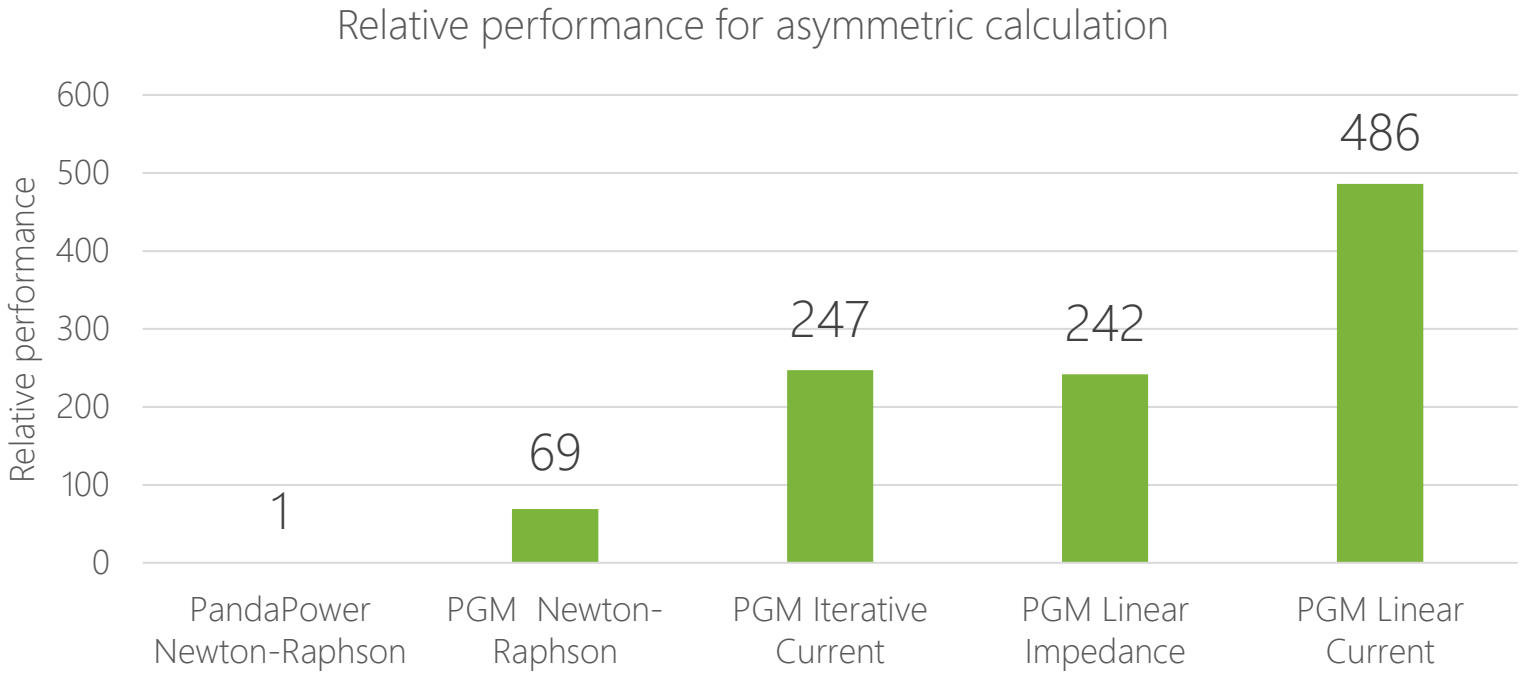
Performance Benchmark

- Compare performance of Power Grid Model and PandaPower
  - https://github.com/alliander-opensource/power-grid-model-benchmark
  - 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



Performance Benchmark



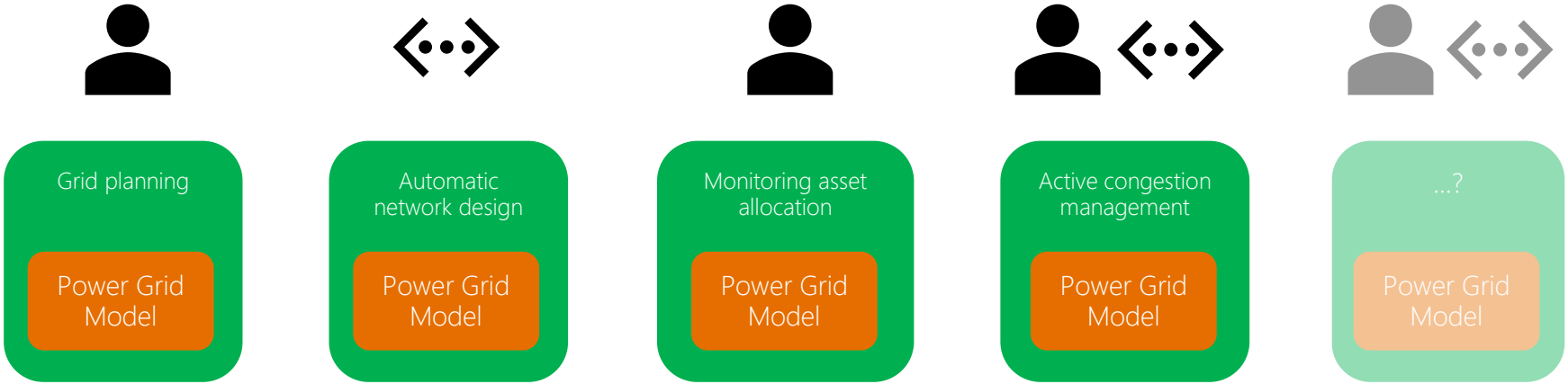
Current Deployment

- Data conversions
  - CIM
  - Vision
  - GridCal
  - Gaia (pending)
  - PandaPower (pending)

Current Deployment

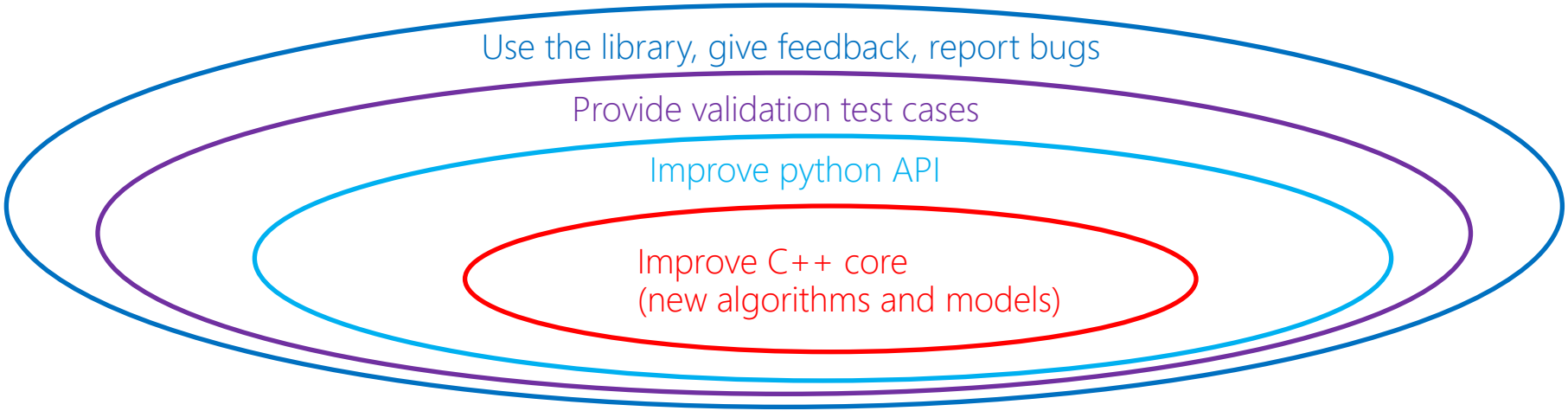
A fundamental building block for Alliander

- Deployed in 10+ applications inside Alliander



Road to Open Source

- Power Grid Model is an open-source project
  - https://github.com/alliander-opensource/power-grid-model
- Ways of collaboration and contribution



https://github.com/alliander-opensource/power-grid-model/blob/main/CONTRIBUTING.md

Road to Open Source

- Current active partners

How to get started?

Check out Alliander Open Source website
https://www.alliander.com/en/open-source/

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

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

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