

Methods for comprehensive assessment of DER hosting capacity

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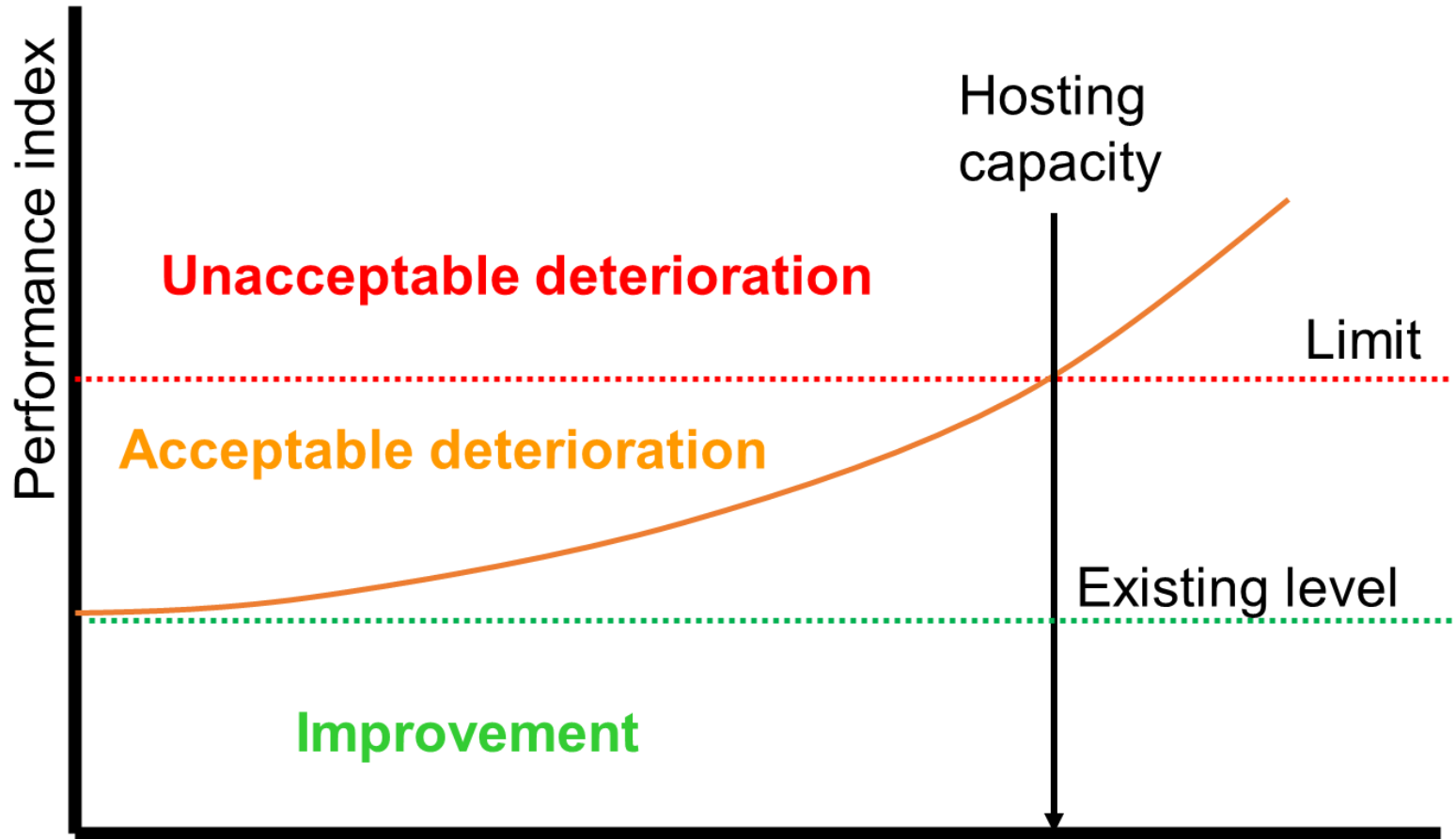
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Agenda

- ✓ Hosting capacity: simple definition
- ✓ Methods: deterministic, stochastic, analytical
- ✓ Sample of application for a distribution utility – LV systems
- ✓ Final comments

Hosting capacity: a simple definition



Source: March 2004, Brussels, EU-DEEP project meeting (Prof. Math Bollen - Luleå University of Technology Skellefteå, Sweden)

Hosting capacity: deterministic, stochastic or analytical approaches

All approaches are useful for different applications, for example:

HV/MV distribution systems

- ✓ Few large/medium size DERs per feeder
- ✓ **Well-known characteristics:** point of connection, capacity, parameters, operation characteristics, connection by using three-phase transformers

Deterministic/analytical approaches are typically suitable

LV distribution systems:

- ✓ Hundreds of small size DERs per feeder
- ✓ **Unknown characteristics:** point of connection, capacity, parameters, operation characteristics, direct connections of three-phase, two-phase and single-phase DERs

Stochastic/analytical approaches are typically necessary

Utility perspective for planning and operation: specific, local area studies with high/medium precision

Regulatory agencies perspective for policy-decision: extensive, wide-area studies with reduced precision

Stochastic analysis: how simple/sophisticated should it be? – LV systems

Model: as simple as possible:

- ✓ Processing time
- ✓ Availability and quality of data

Simulation tool: time-series multi-phase power flow

Simulation method: Monte Carlo

Stochastic variables

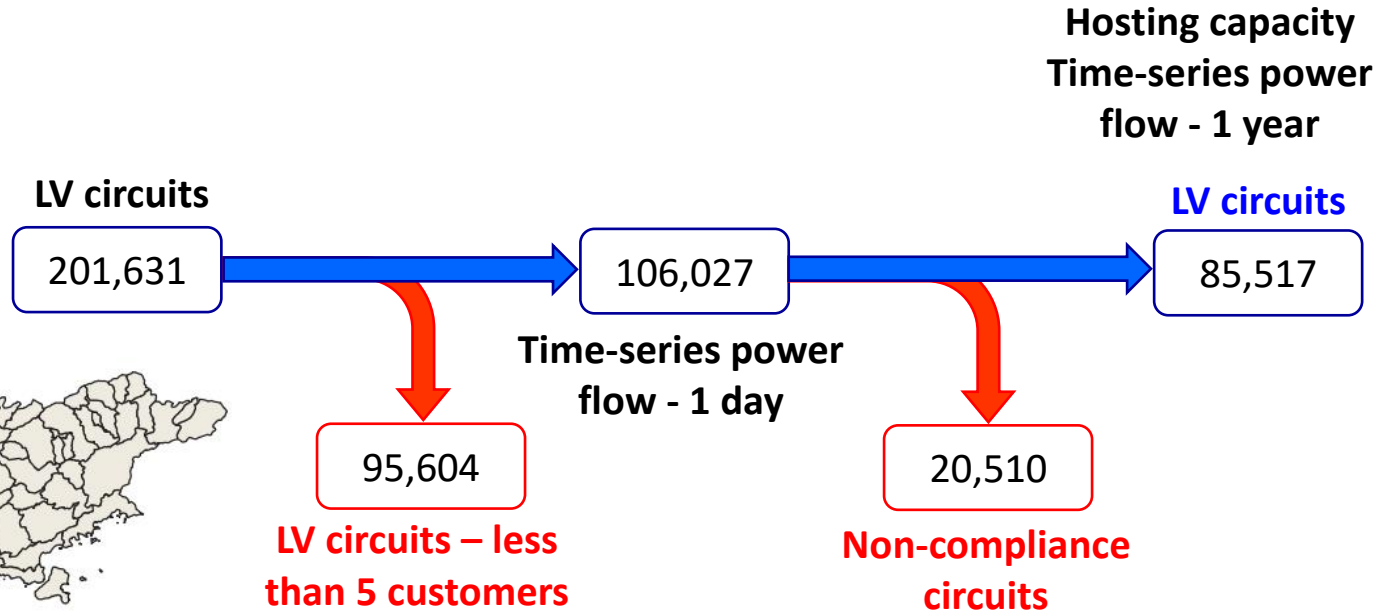
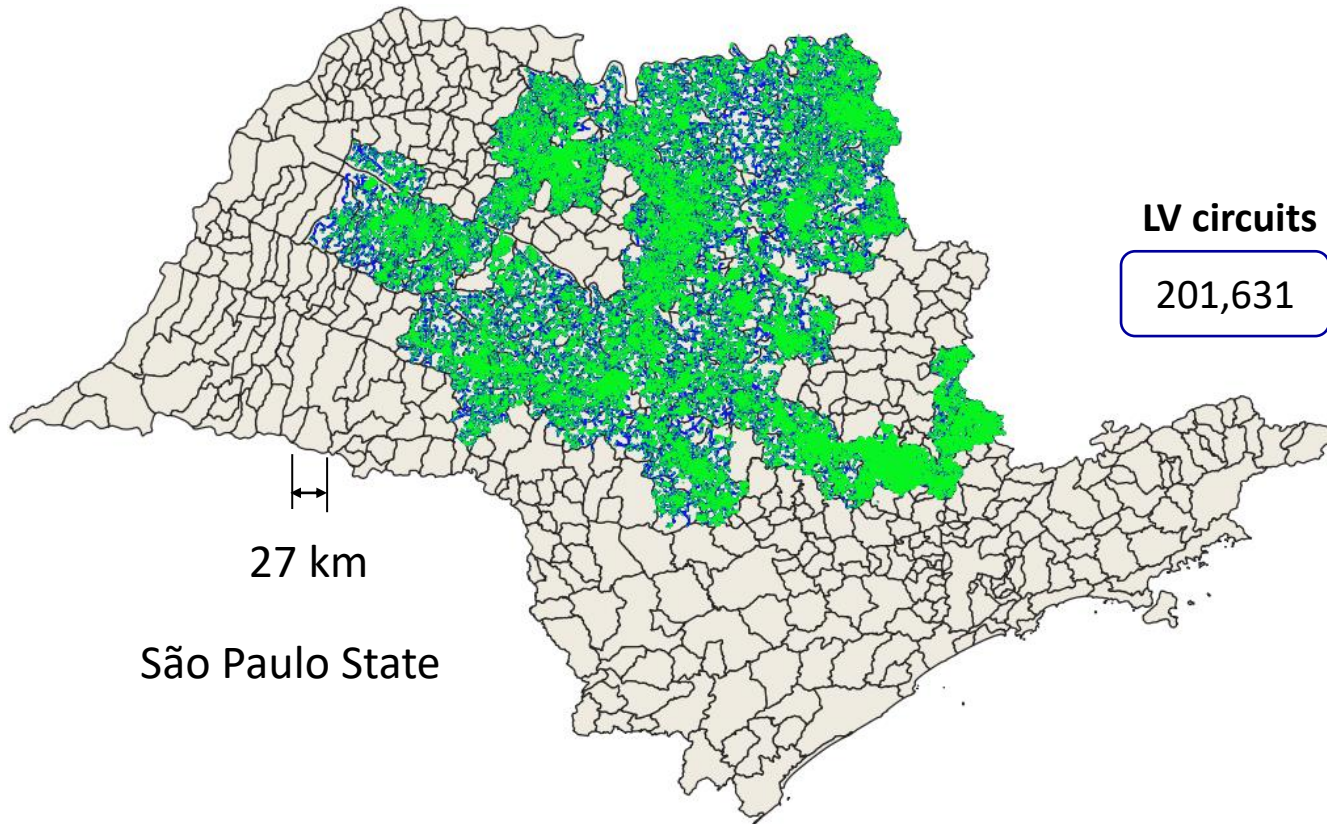
Rooftop PVs

- ✓ Location
- ✓ Three-phase, two-phase, single-phase PVs
- ✓ Phasing and voltage level
- ✓ PV Capacity

EV slow chargers

- ✓ Location
- ✓ Three-phase, two-phase, single-phase chargers
- ✓ Phasing and voltage level
- ✓ EV characteristic: battery capacity (energy and power) and state of charge

Real case application: CPFL Energy



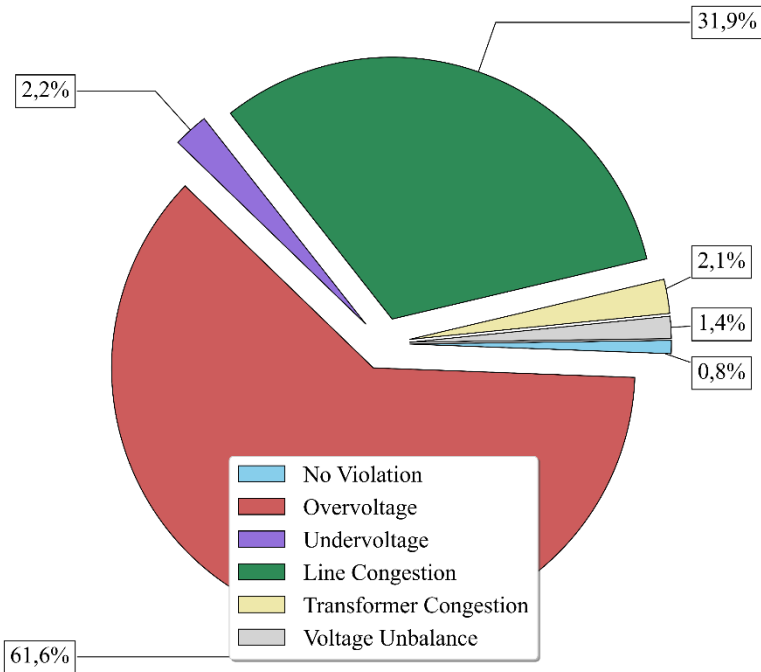
Medium voltage circuits

Low voltage circuits

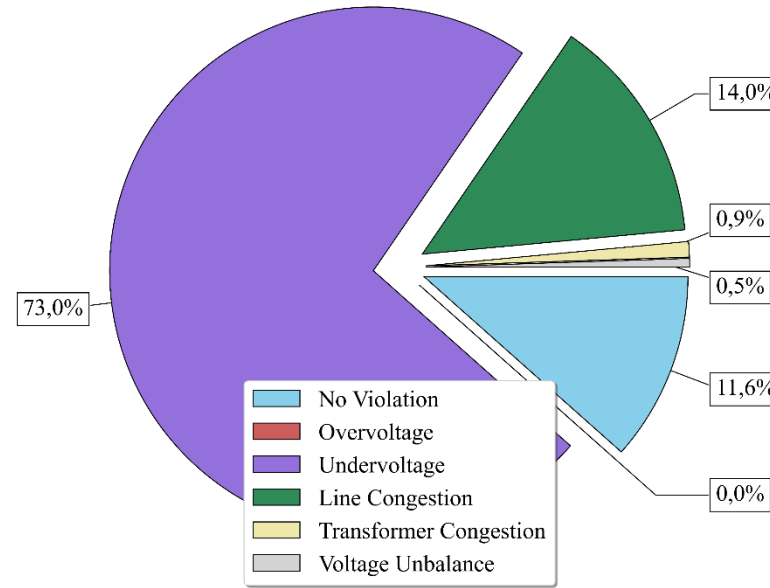
- ✓ +85,000 low voltage circuits
- ✓ +220 cities
- ✓ +3 millions of customer units (+7 millions of inhabitants)

Real case application: main restrictions

Rooftop PVs



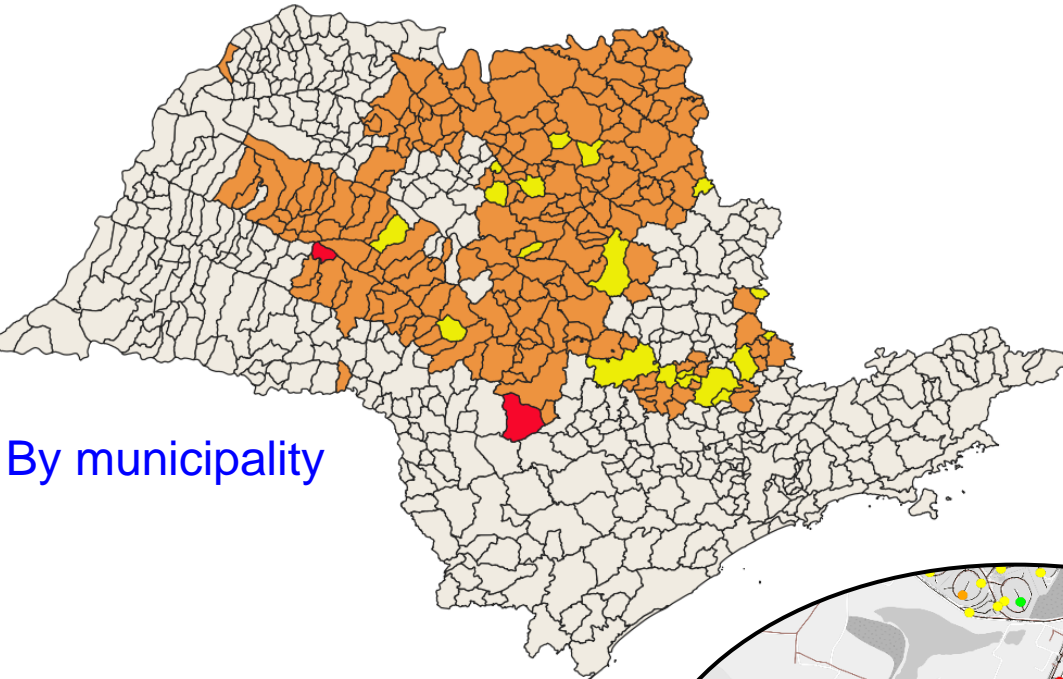
EV slow charger stations



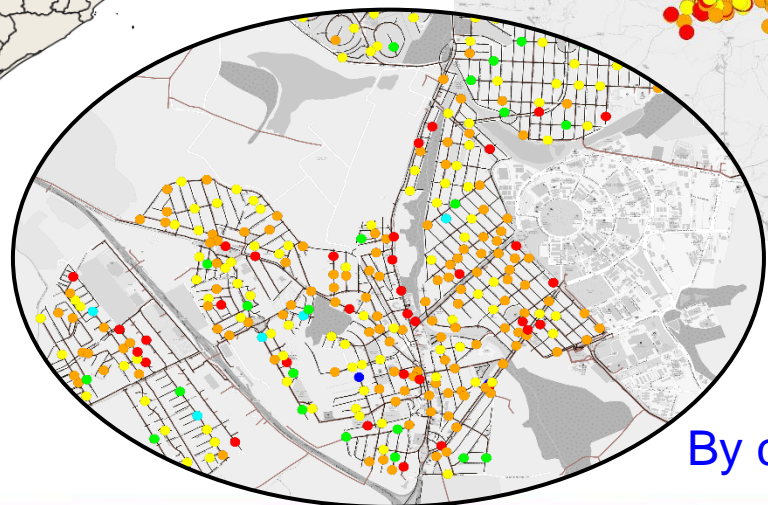
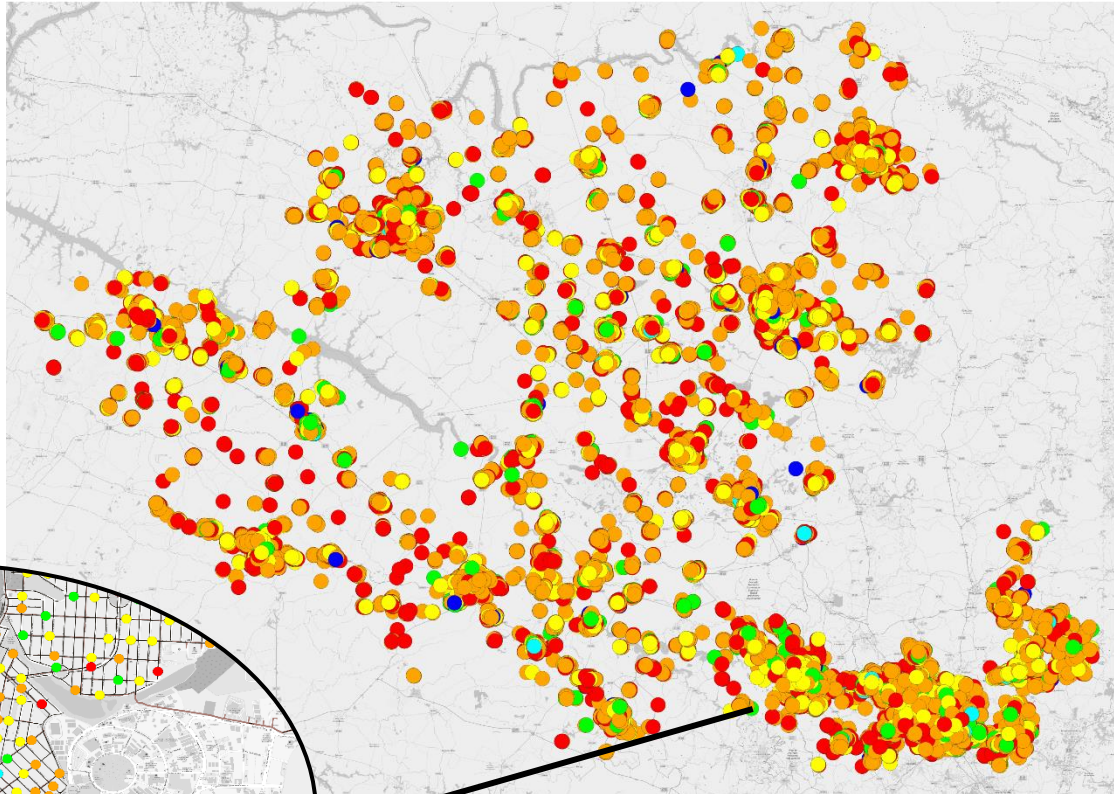
Metrics

- ✓ Overvoltage: >1.05 (3% of period)
- ✓ Undervoltage: <0.92 (3% of period)
- ✓ Line congestion: $>$ nominal capacity (5% of period)
- ✓ Transformer congestion: $> 150\%$ nominal capacity
- ✓ Voltage unbalance: $> 3\%$ (5% of period)

Real case application: mapping



By municipality



By circuit/feeder

By substation/transformer

Final comments

- Hosting capacity is a **powerful metric** for utilities, regulatory agencies and policy-makers
- **Deterministic, analytical and stochastic** approaches are suitable for **different purposes**
- **Stochastic approaches** are powerful for analyses of **rooftop PV** and **EV slow charger** (higher **uncertainties**)
- The model should be developed considering the availability and quality of data (**worsen that make a decision with no data, it is to make a decision with bad data**)

More information:

- ✓ R. Torquato, D. Salles, C. O. Pereira, P. C. M. Meira, W. Freitas, "A comprehensive assessment of pv hosting capacity on low voltage distribution systems," **IEEE Transactions on Power Delivery**, vol. 33, p. 1002-1012, 2018.
- ✓ T. Barbosa, J. C. G. Andrade, R. Torquato, W. Freitas, F. C. L. Trindade, "On the use of EV hosting capacity for management of low-voltage distribution systems," **IET Generation Transmission & Distribution**, vol. 14, p. 2620-2629, 2020.

Thank you

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