Grid Edge Technologies:

THE FUTURE OF ELECTRICITY DISTRIBUTION

Walmir Freitas

University of Campinas – UNICAMP

http://www.dsee.fee.unicamp.br/~walmir

Grid-edge technologies: definitions and contextualization

Greentech Media: *The grid edge comprises the **technologies**, **solutions** and **business models** advancing the transition toward a **decentralized** and **distributed** grid structure.*

World Economic Forum: *Three trends of the grid edge transformation: **electrification**, **decentralization** and **digitalization**.*

ABB: *An ecosystem of **distributed energy capabilities**, **digital solution** and **services** to maximize customer value and retention.*

3D Concept

Decentralization

Decarbonization

Digitalization

Siemens: *Grid edge is where the **consumer**, **prosumer** and the **intelligent grid** interact. This transition is driven by **digitalization**, **decentralization** and a global call for **decarbonization**.*

IEEE: *Grid edge is one of the **most exciting emerging technology transitions**... It will connect utilities, technology providers, policymakers, and key stakeholders worldwide to advance a **clean energy** future while preserving the grid's **reliability** and **affordability**...*

Grid-edge technologies: 3D concept

- ✓ **Business model: from SERVICE to MULTIPLATFORM**
- ✓ **New regulatory framework**

NEW

3D Concept

Decentralization

Key technologies/ solutions:

- ✓ Distributed energy resources
- ✓ Demand response
- ✓ Microgrids
- ✓ Transactive energy

Key players:

- ✓ Adaptive prosumers (active customers)
- ✓ Third-party integrators/service suppliers (nonregulated)

Digitalization

Key technologies/solutions:

- ✓ Smart meter
- ✓ Communication/computing (IoT)
- ✓ Automation, supervision, protection, and control
- ✓ Energy market

Key players:

- ✓ Third-party integrators/ service suppliers
- ✓ Software and solution developers

Decarbonization (Electrification)

Key technologies/solutions:

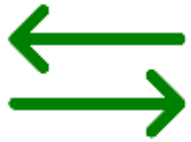
- ✓ Electric mobility
- ✓ Electric heating/cooling systems
- ✓ Energy efficiency
- ✓ Renewable generators

Key players:

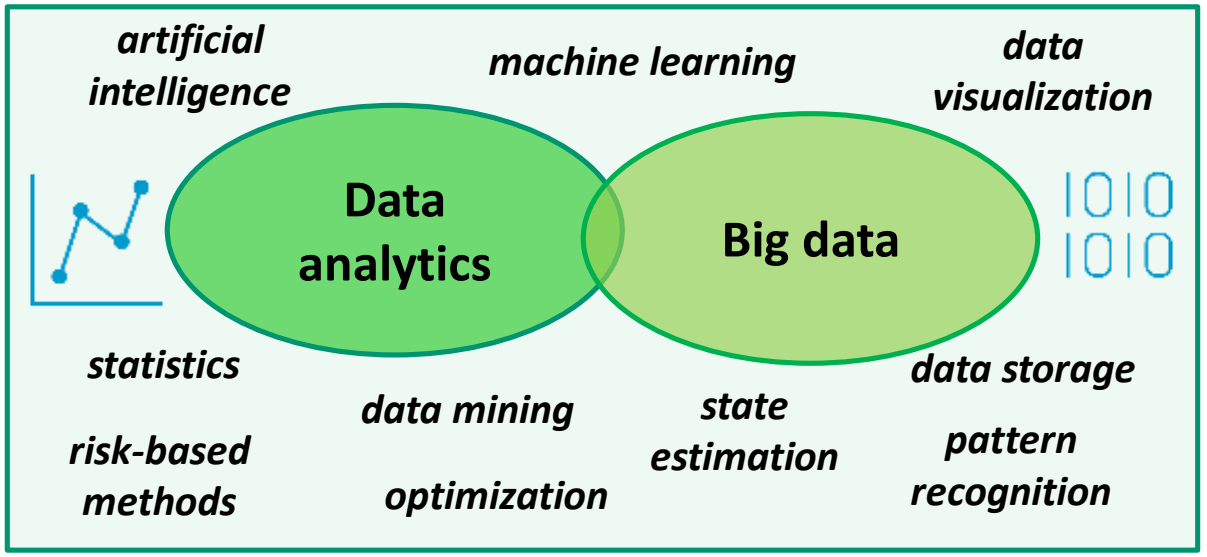
- ✓ Third-party integrators/ service suppliers
- ✓ Independent Producers
- ✓ Utilities (Grid)

Grid-edge technologies: distribution systems

Active, supervised distribution systems (grid-edge technologies)



Data Science



Potential applications (macro)

- ✓ Active asset management
- ✓ Risk-based methods for planning/operation
- ✓ Active system/equipment condition monitoring
- ✓ New services, business, and market models

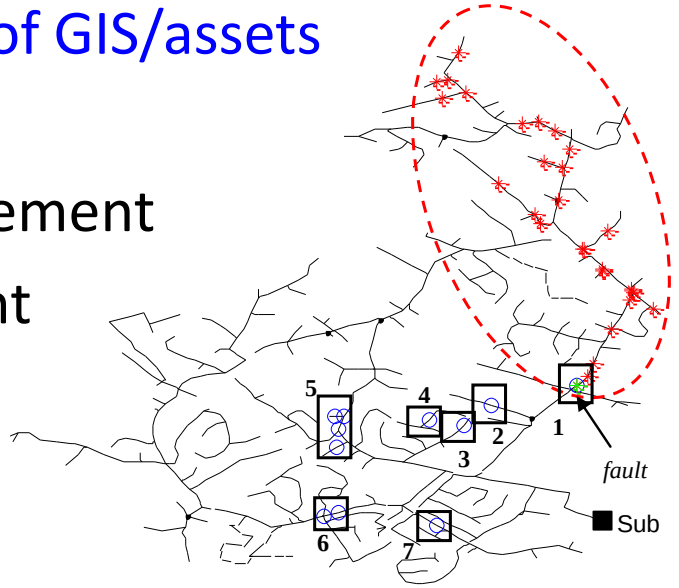
Potential data sources

- ✓ AMI (**smart meters**)/SCADA
- ✓ PQ and waveform measurement units
- ✓ **Utility databases** (GIS, commercial etc.)
- ✓ Weather stations
- ✓ Demographic/economic database

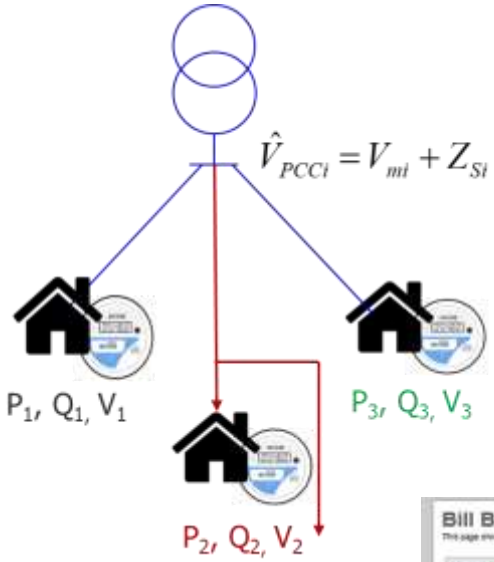
Grid-edge technologies: smart meter – potential applications

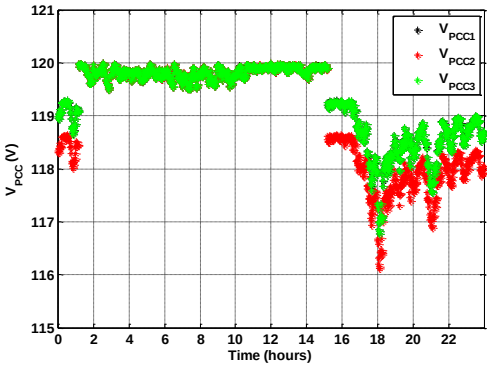
Smart meter: potential applications

- ✓ Automated management of GIS/assets databases (BDGD)
- ✓ Non-technical loss management
- ✓ Technical loss management
- ✓ Fault location
- ✓ Load curve modeling
- ✓ Load modeling
- ✓ Customer load disaggregation
- ✓ Active system/equipment condition monitoring
- ✓ DER hosting capacity
- ✓ Other to be defined



Fault Location





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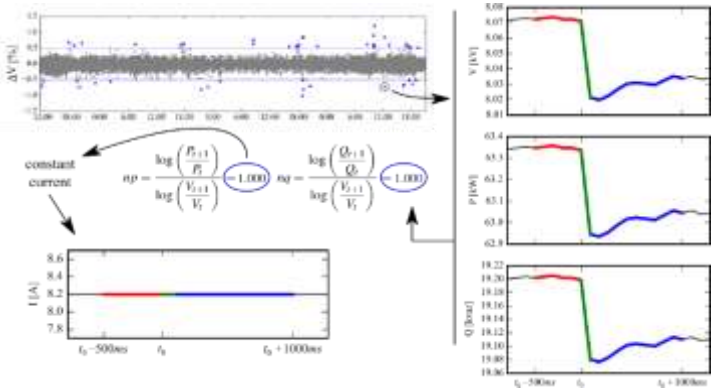
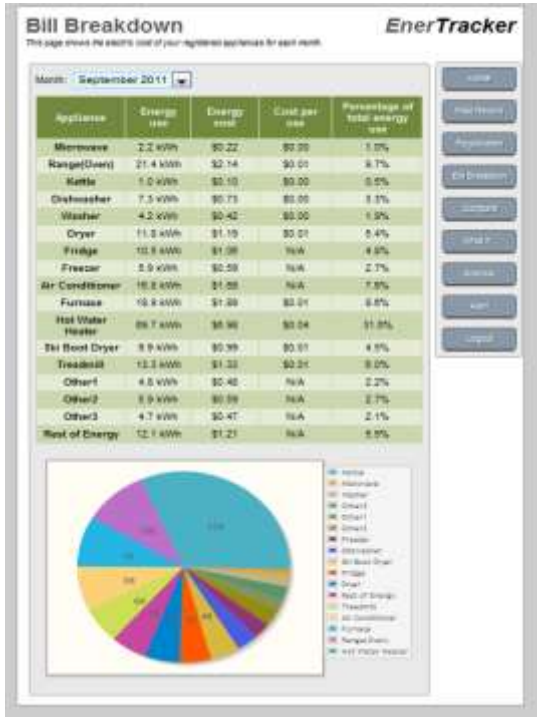


Load modeling



Load disaggregation

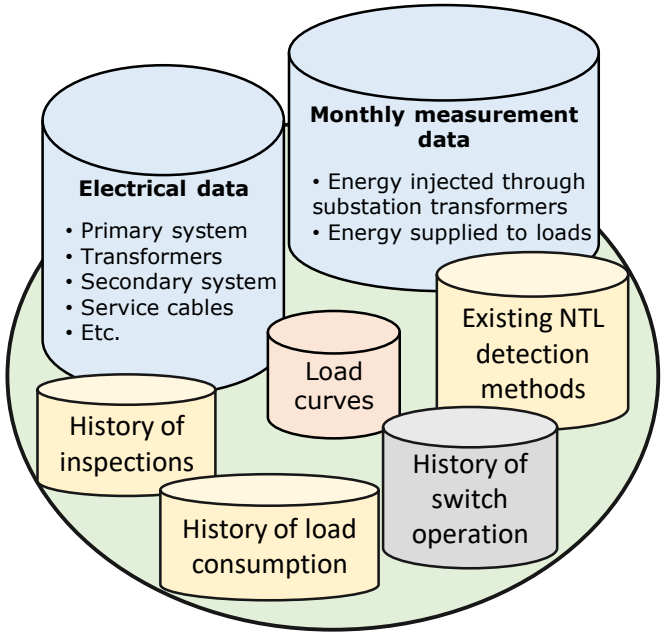
Grid-edge technologies: smart meter – GIS and other related databases (BDGD)

Issue: Utilities GIS/Assets database presents errors and inconsistencies due to:

✓ incorrect/manual data registration

✓ absence of data or update

✓ line/transformer parameter variations due to weather conditions and equipment aging



Relevance: these databases are the core for:

✓ technical decisions

✓ economic decisions

✓ regulatory decisions

✓ asset management

Idea: Combine customer smart meter data and data analytics to automatically correct:

✓ MV and LV system topology

✓ line and transformer parameters

✓ customers phase connection

✓ status of switches

✓ regulators/compensators settings and parameters

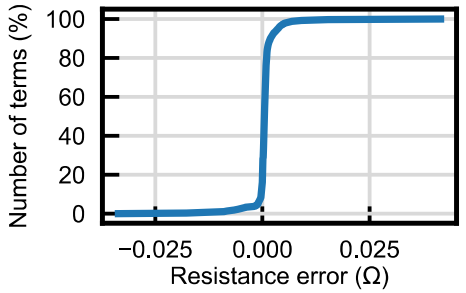
Grid-edge technologies: smart meter – GIS and other related databases (BDGD)

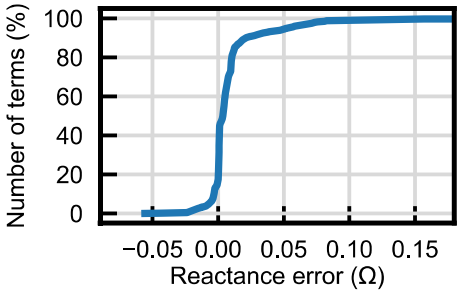
Real case: MV/LV system with 5,000+ customers (87% residential) and 190 MV/LV transformers

Topology and phasing

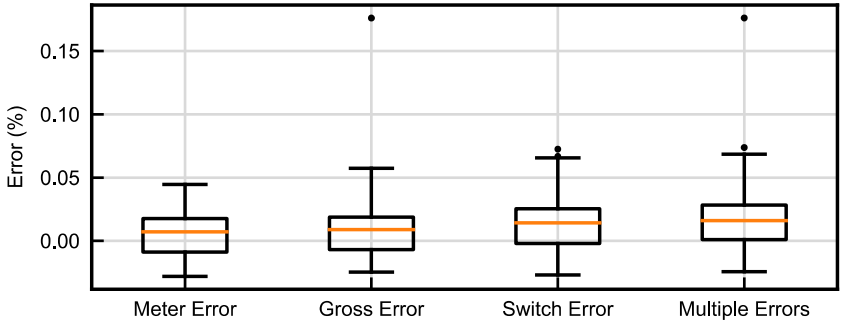
Metric	High-Precision Scenario (%)		
Resolution (min)	15	30	60
Branch	92	92	91
Line length	87	88	87
Phasing	100	100	100

Line parameters

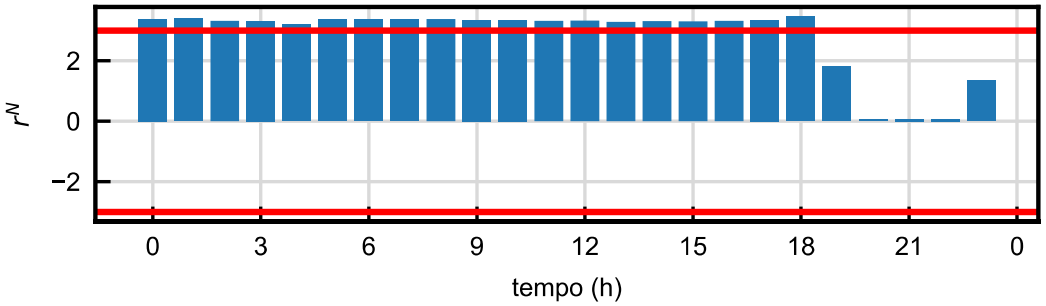




MV/LV transformer tap: 100% accurate



Capacitor bank status



Control settings and operation period

Setting		Days		
		1	3	7
V_{sup} (V)	11,775	11,787	11,791	11,790
V_{inf} (V)	11,625	11,609	11,617	11,612
V_{ref} (V)	11,700	11,698	11,704	11,701
B (V)	1.5	1.77	1.73	1.77
Q_{ON} $(kvar)$	1,200	1,196<Q<1,208	1,202<Q<1,189	1,202<Q<1,187
Q_{OFF} $(kvar)$	800	801	805	807

A platform for integration of smart grid technologies: one of the largest living labs in Latin America

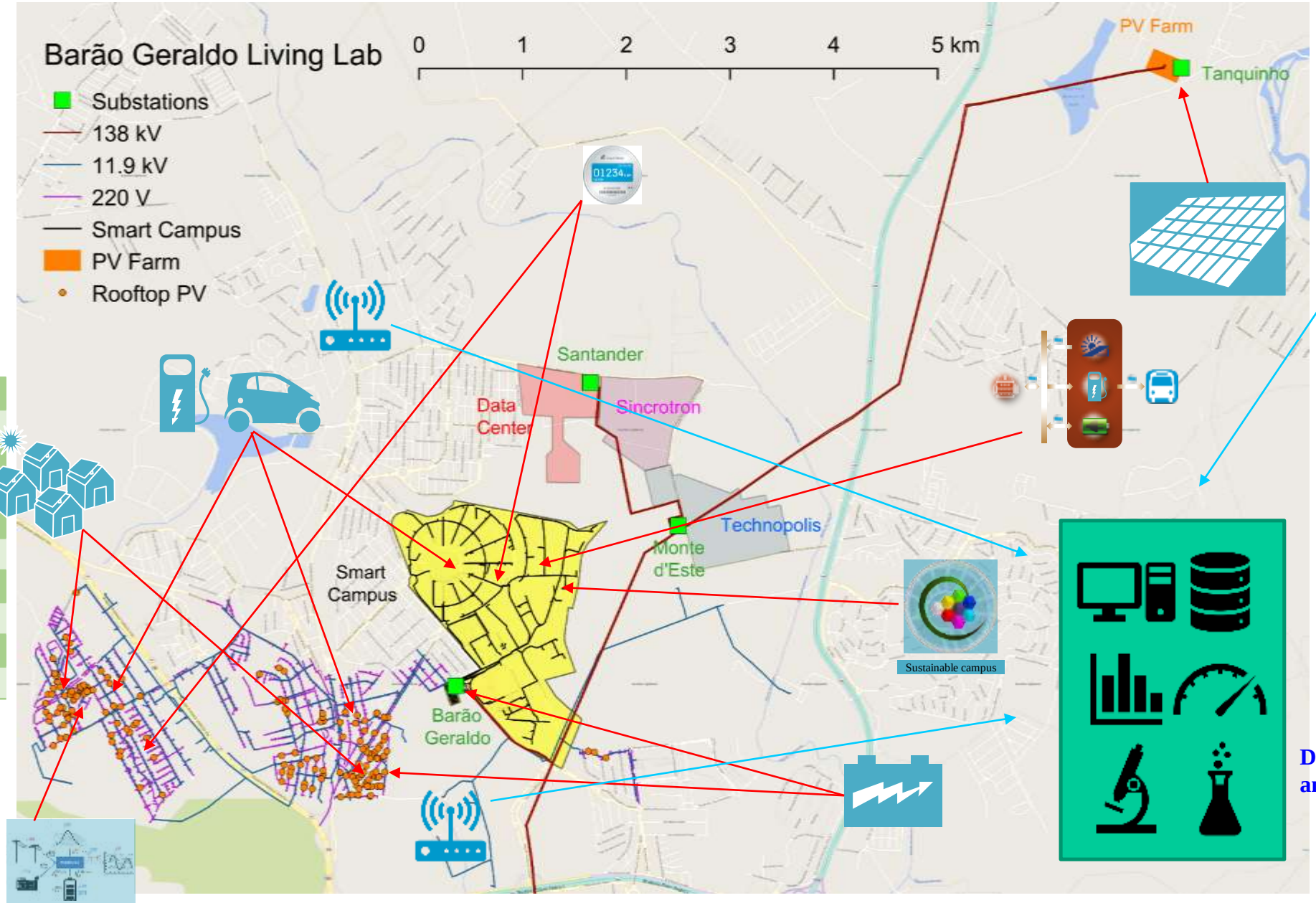
Technologies

PV generators
Electrical vehicles
Storage systems
Smart meter
Electronic-based regulators
Microgrids
A-DMS
Data analytics / Big data

Projects

PA3012: PV rooftop
PA0060: Electric mobility
PA3018: Energy storage
PA3048: Technical losses
PA3047: Volt/var
PA2030: Load disaggregation
PA3032: Sustainable campus
PA3043: Electric bus
CS3060: Electromobility
PA3058: Microgrids

Investment:
~R$ 180 million



Comments

- ✓ Due to uncertainties, variabilities and unpredictability of demand and generation, economic and environmental concerns, the electrical energy systems of the future will be planned and operated based more and more on risk-based methods, stochastic approaches and active (predictive) philosophies
- ✓ Data analytics will be essential for the future of the electrical energy systems
- ✓ Smart meters (and other sensors) are one of the core technologies to promote this paradigm change (more killer applications can make this solution a business case)
- ✓ Models and methods must be developed considering the availability and quality of data

worse than make a decision with no data, it is to make a decision with bad data

Thank you

walmir@unicamp.br