Impacts of Photovoltaic Micro Generation and Regulatory Arrangements

R&D Energisa Group

Rio de Janeiro, 17th october 2017

GRUPO ENERGISA

Grupo Energisa at a Glance

9 power distribution concessions and 2 transmission lines (greenfield)

Net Revenues (2016)

R$10.4 billion

Customers

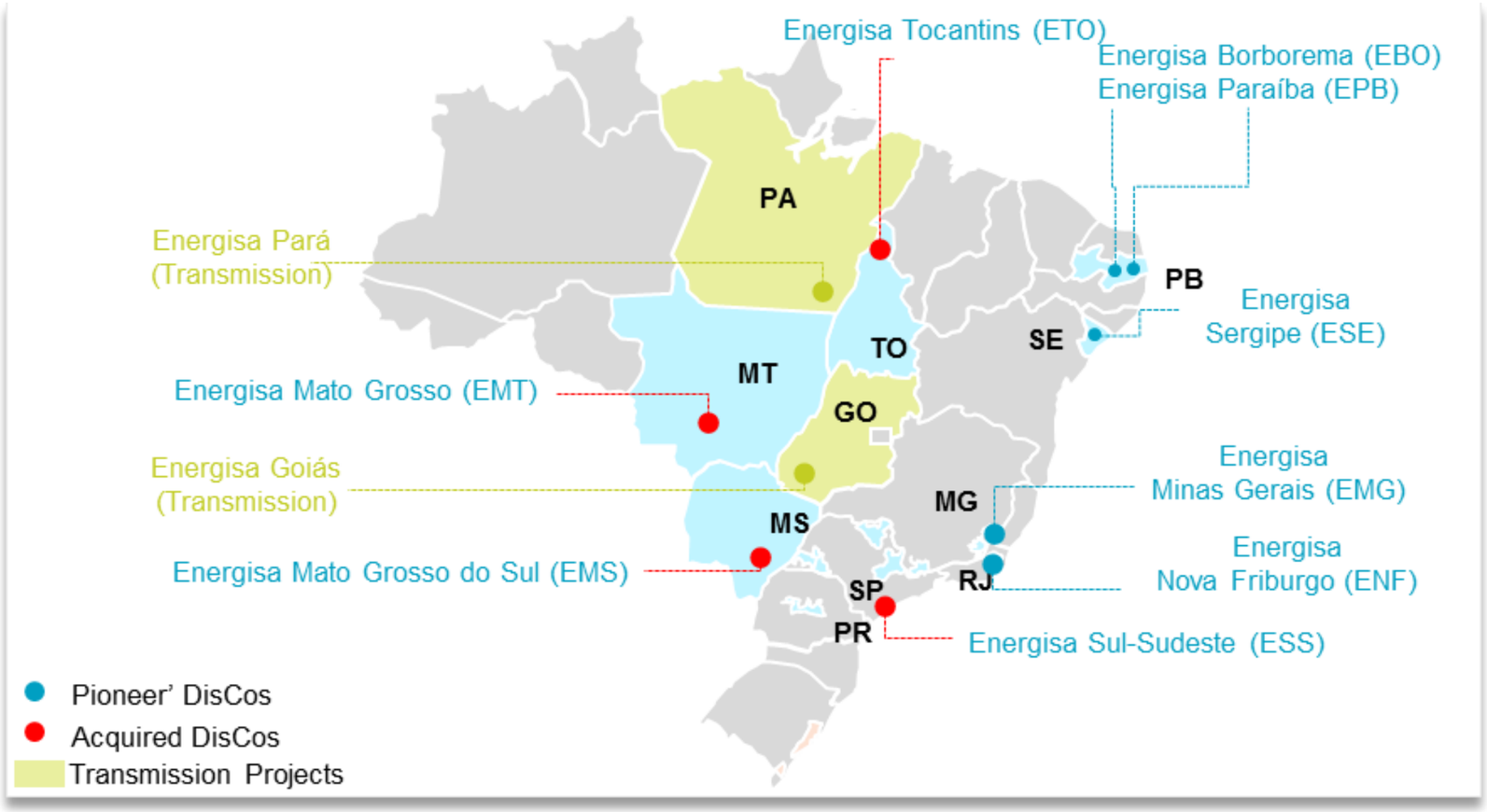
6.6 million

People Served
(8.1% of Brazil's Population)

16.3 million

Total Area Covered
(19.1% of Brazil's Territory)

1,630 thousand Km²



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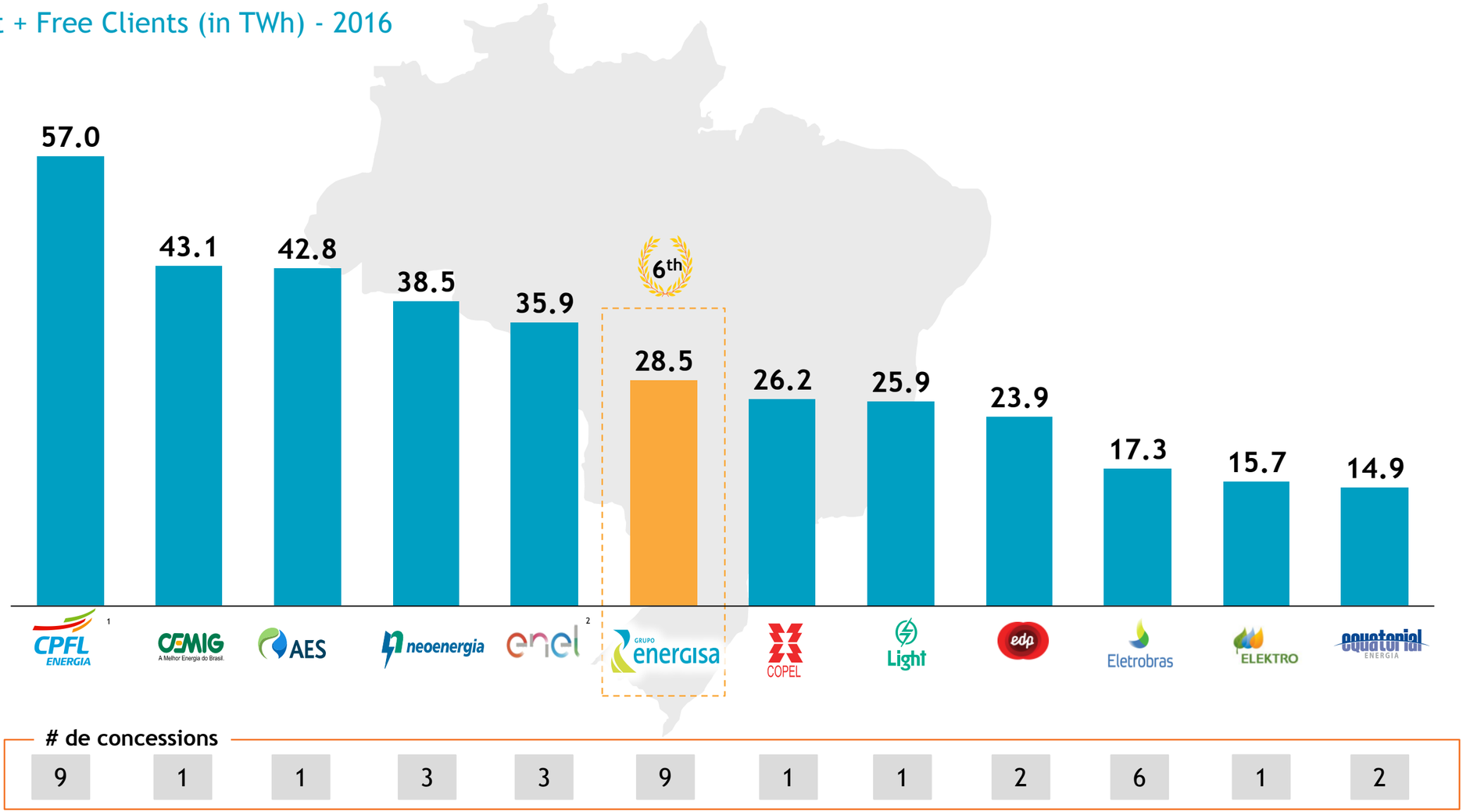
#6 among the largest distribution companies and #5 largest among private companies

Captive market + Free Clients (in TWh) - 2016



Source: Companies' reports
[1]Considers 100% of AES Sul
[2]Considers 100% of CELG (12.0 TWh)

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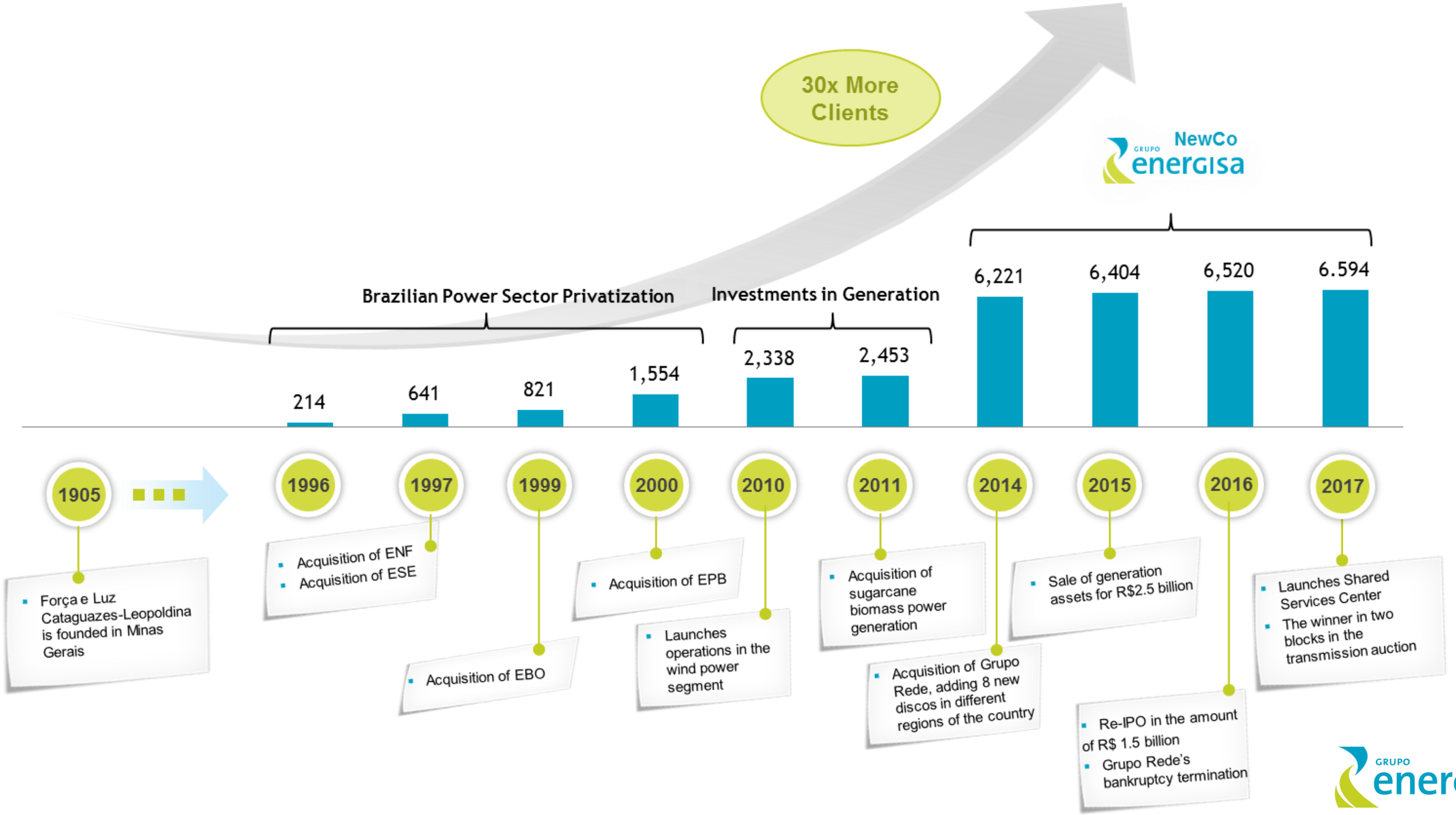
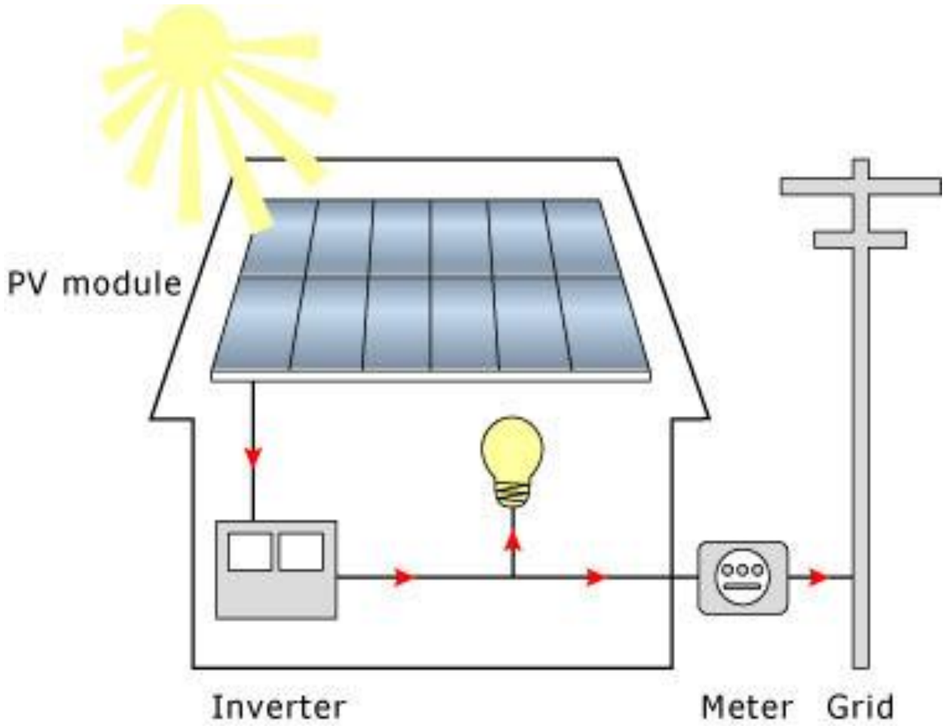
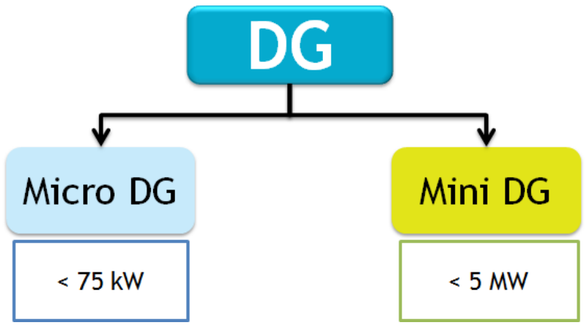
112 years of experience in the Brazilian utilities sector



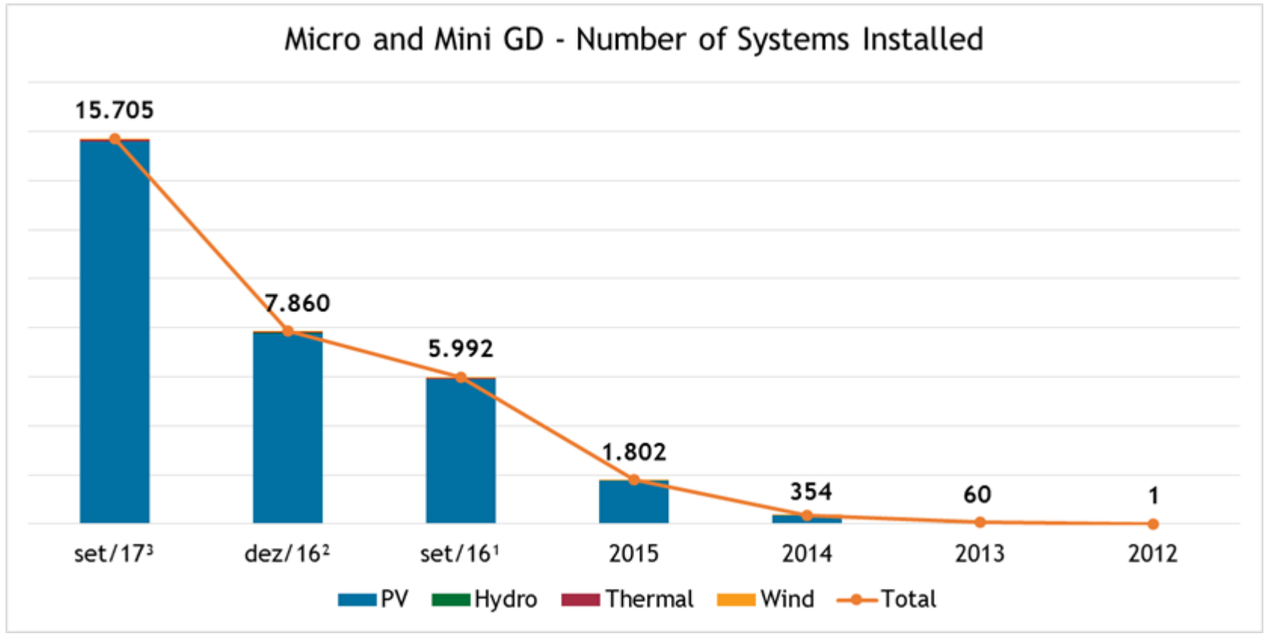
Brazilian NEM – Resolução ANEEL nº 482/2012

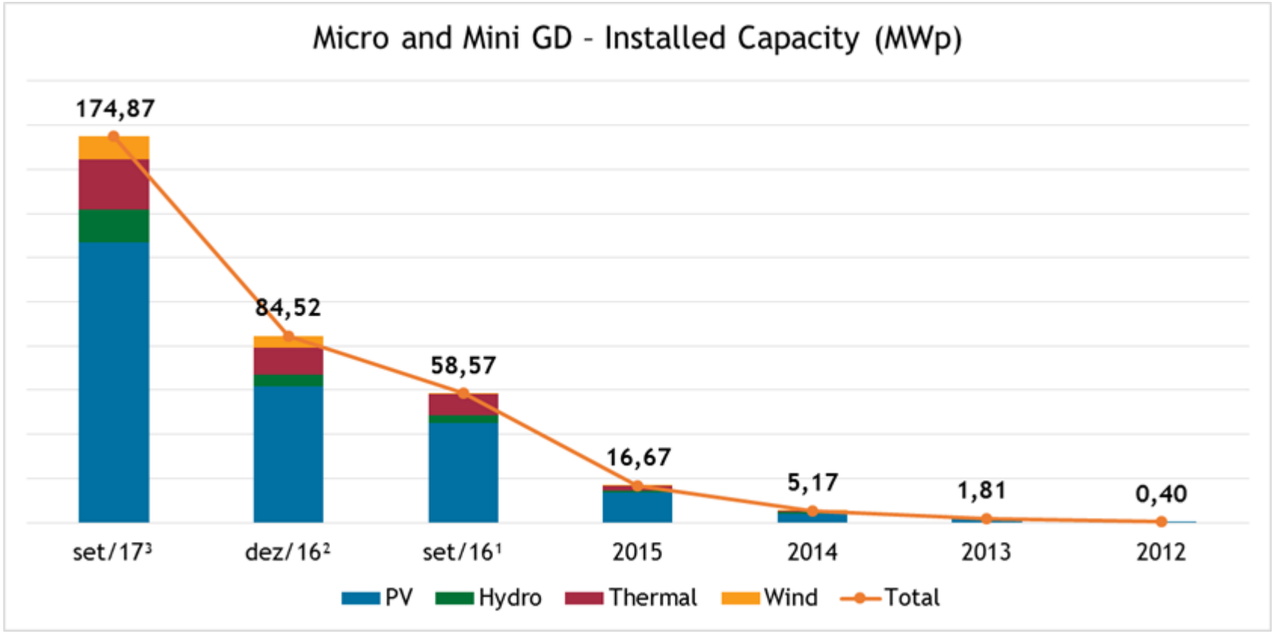




- Consumers can carry over credit for generation exported for the grid during 5 years.
- Credit could be adjusted proportionally in case of hourly rates differences.
- Community ownership and consumption in a different place from generation are allowed (within the utility concession area).
- Simplified interconnection application.
- LV consumers pay a small monthly fee (availability cost not linked to capacity or interconnection cost) and HV consumers pay a traditional demand contract.
- Network enhanced costs could be shared with consumers depending on sitting, sizing, voltage.

Brazilian DERs deployment from 2012-Sept.2017





R&D Project *Impact of DERs Deployment*: Motivation

- As seen in other countries, the Brazilian distribution sector is expecting profound changes caused by technological innovation and consumer behavior.

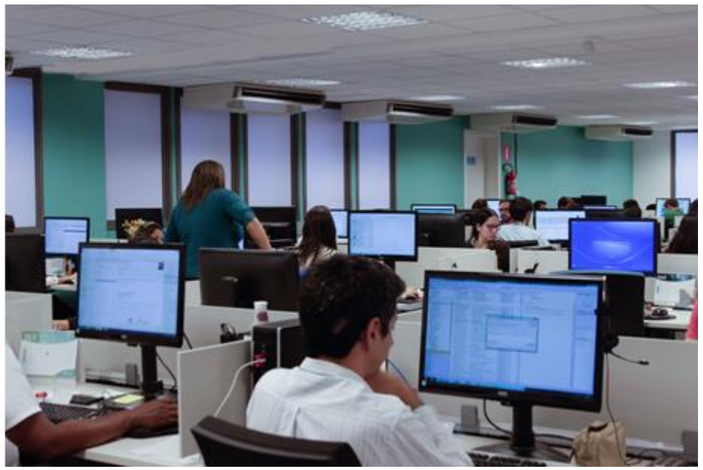
- Important factors have contributed for these changes:
  - increasing participation of renewable generation sources (solar, wind, cogeneration).
  - deployment of distributed energy resources (DER)
  - DERs cost reductions *versus* electricity rates increase.
  - energy efficiency (lightning, refrigeration, motors), demand side response and other behind the meter technologies.
  - technology advancement in storage, electric vehicles, internet of things, smart meter, smart grid.

- New investment required and additional complexity throughout the grid may not be included in the utilities' rates or not correct allocated for rate payers.

- Spiral of death: DGPV change the business model causing risks for utilities revenue and non-PV owners.

ENERGISA/GESEL/UFRJ - R&D Project: targets

- Learn with international experience (technical mission in USA and Europe).
- Identify correctly the risks and benefits of DERs deployment.
- Build a *discounted cash flow* model to valuate the company over DERs impact, *cost shift* to consumers and government impact (eviction of taxes).
- Provide opportunity to address stakeholders about our concerns for a feasible regulatory framework to Brazilian utilities and non-PV consumers.
- Discuss a new business model considering the wide deployment of DERs.



R&D project: current stage

- 04 scenarios of DERs Deployment (low to high diffusion): assess electric power systems and financial impact (consumers, prosumers, distributors and government).
- Rate design: simulate options to lower impact on utilities and reduce cost shifting to consumers.
- Financial modelling: checking the accuracy of tariff options.
- Sectorial advocacy: preparing for public hearings with active participation offerings contributions based on real facts and data
  - ✓ 2017: CP nº 033 - Improvement of the Legal Framework of Brazilian Electrical Sector (Energy and Mines Ministry).
  - ✓ 2018: CP nº XXX – Improvement of the REN nº 482/2012 (ANEEL).
  - ✓ 2019 (?): CP nº XXX - Binomial Tariff.

Impacts of Photovoltaic Micro Generation (I - Technical)

Voltage regulation
distributed generation raises the voltage locally, potentially beyond the acceptable/regulatory range

Reverse power flow
can create control and protection problems if settings are not properly configured

Equipment wear and tear
increased power flow variation affected electromechanical actuators and could cause premature replacement

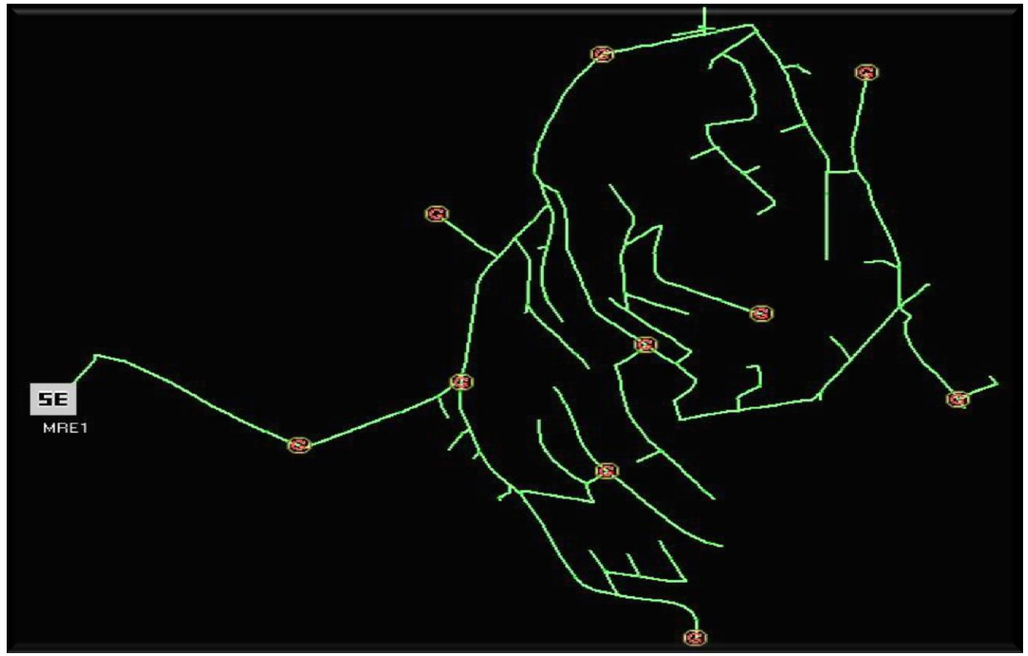
Photovoltaic variability
voltage fluctuations caused by short-timescale PV variability on distribution feeders

Protection
challenges in detecting and locating faults (e.g.: relay desensitization)

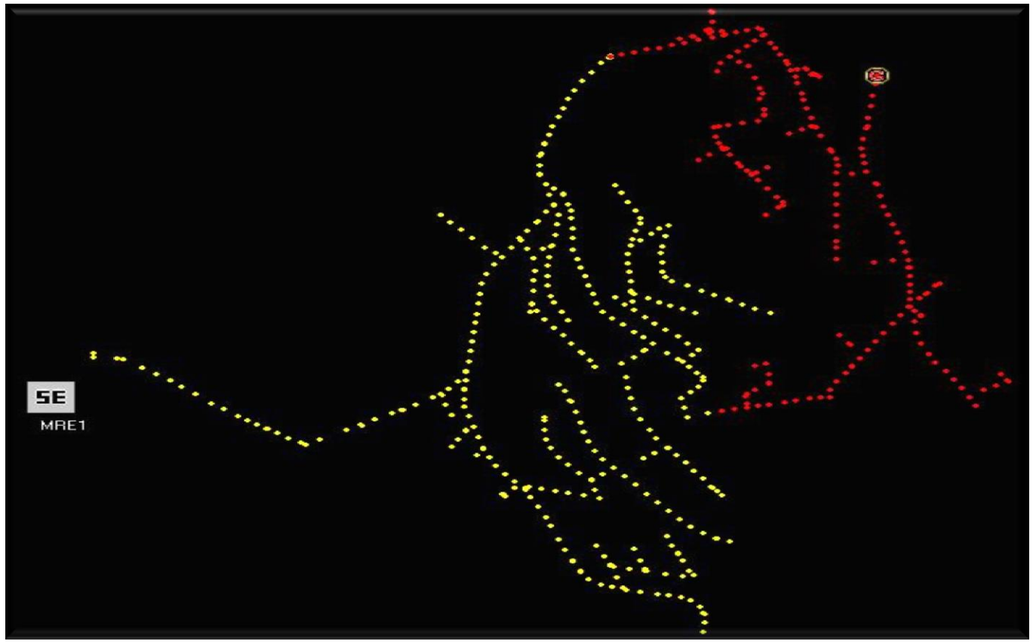
Unintentional islanding
equipment damage and safety concerns

Impacts of Photovoltaic Micro Generation (I - Technical)

Feeder simulation with micro PV installed in 10 different points: no technical constraints



Feeder simulation with mini PV in a single point: voltage constraints

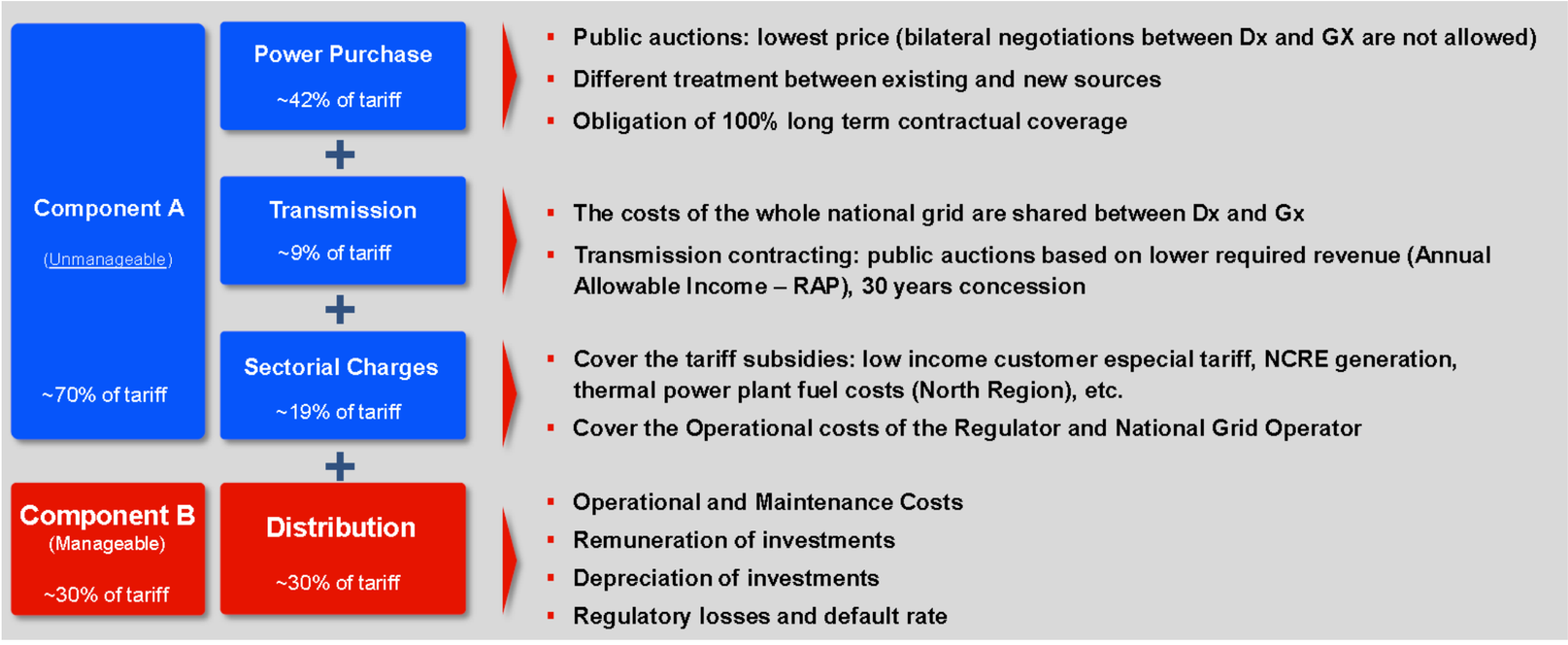


Impacts of Photovoltaic Micro Generation (I - Technical)

- ✓ The R&D simulations have showed that the main impacts of PV are related to Mini Generation. In the case of Micro Generation sparsely located and in small scale, impacts are practically non-existent or easy to address technical solutions.
- ✓ Rural feeders are more susceptible to impacts related to the presence of DG, while urban feeders are virtually not affected by insertion of DG, except in cases of generation located at the end of feeders (increase technical losses).
- ✓ The location of GD in feeders proved to be an important factor with respect to the impacts of the insertion of DG (end of the feeder x scattered along the feeder).
- ✓ The electrical losses in the distribution systems are reduced in the presence of DG. However, for accentuated levels of penetration or proximity with the substation the result can be reversed.

Impacts of Photovoltaic Micro Generation (2 - Regulatory)

- ✓ The Brazilian Distribution Model is *Price-Cap*, costs divided between manageable and non-manageable. There's no assured rate of return.
- ✓ In the Brazilian NEM configuration grid costs are not integrally payed by the PV owners.
- ✓ The current rule applicable to photovoltaic micro-generation net metering policy promotes:
  - an initial **subsidy** (from distributor → prosumer) and
  - a permanent **cost shifting** (prosumer → non-PV owners).



Distributed Energy Resources Policies

Regulatory Enhancement Points

- ✓ Rate design (cost shifting reduction)
- ✓ Additional investment and OPEX
- ✓ Generation ownership by distributors
- ✓ Ancillary services (e.g.: storage)

- ✓ Community projects
- ✓ Studies to be carried out by consumers
- ✓ Rules to commerce and sharing the generated energy (e.g.: rooming)

- ✓ Damage caused to equipment
- ✓ Defining uniform standards and procedures
- ✓ Smart meetering
- ✓ Interconnection of distribution systems

- ✓ Hosting capacity
- ✓ Island operation
- ✓ Advanced inverter

Conclusions for a R&D Project

Distributed Energy Resources

- ✓ The impacts and benefits of REDs need to be properly assessed to guide the policy makers and reduce subsidies allocated to prosumers.
- ✓ Utilities must be allowed economic-financial sustainability in order to provide a reliable, safe and universal service for all consumers.
- ✓ Correct allocation of costs to users of the grid is required.
- ✓ Consumers need to have adequate regulatory signal to make proper financial analysis of the alternatives (the past must be predictable).
- ✓ Regulatory framework of REDs can not cause a *un-optimization* of the energy sector.
- ✓ Innovation and new business models should be incentivized without subsidies.

Obrigado!

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