AÇÃO AMBIENTAL 2016

TECNOLOGIAS E PRÁTICAS

23 de novembro de 2016
Sede do Sistema FIRJAN – RJ

Ambiente regulatório e o investimento em energias renováveis no Brasil

Ricardo Gorini - EPE

Seminário FIRJAN: Tecnologias Eficientes e Energias Renováveis na Indústria

Rio de Janeiro, November 23rd 2016

The regulatory framework and the renewable investment in Brasil

O ambiente regulatório e o investimento em renováveis no Brasil

Ricardo Gorini

Director

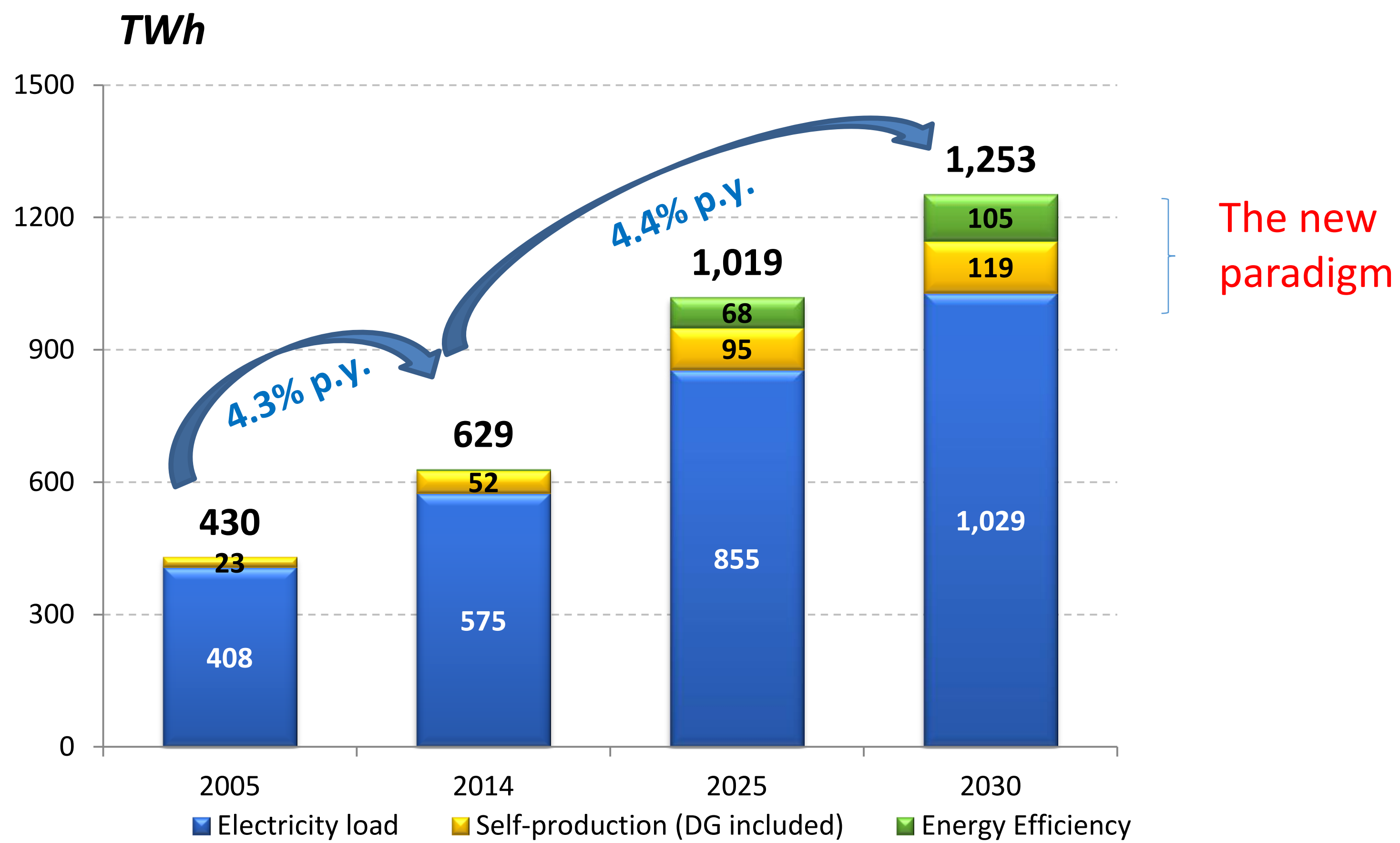
BRAZILIAN NATIONALLY DETERMINED CONTRIBUTION (NDC)

CONTRIBUTION	*Reduce greenhouse gas emissions by 37% below 2005 levels in 2025*
SUBSEQUENT INDICATIVE CONTRIBUTION	*Reduce greenhouse gas emissions by 43% below 2005 levels in 2030*
TYPE	*Absolute target in relation to a base year*
COVERAGE	*100% of the territory, economy-wide, including CO_2, CH_4, N_2O, perfluorocarbons, hydrofluorocarbons and SF_6*
REFERENCE	*2005*
TIMEFRAME	*Single-year target for 2025; indicative values for 2030 for reference purposes only*
METRIC	*100 year Global Warming Potential, using IPCC AR5 values*

Brazil's NDC is economy wide and therefore is based on flexible pathways to achieve the 2025 and the 2030 objectives.
In that sense, this presentation is meant to be for clarification purposes only.

TOTAL ELECTRICITY CONSUMPTION

Electricity consumption in Brazil will be twice until 2030 (compared to 2014). Energy efficiency and distributed generation will have fundamental role.

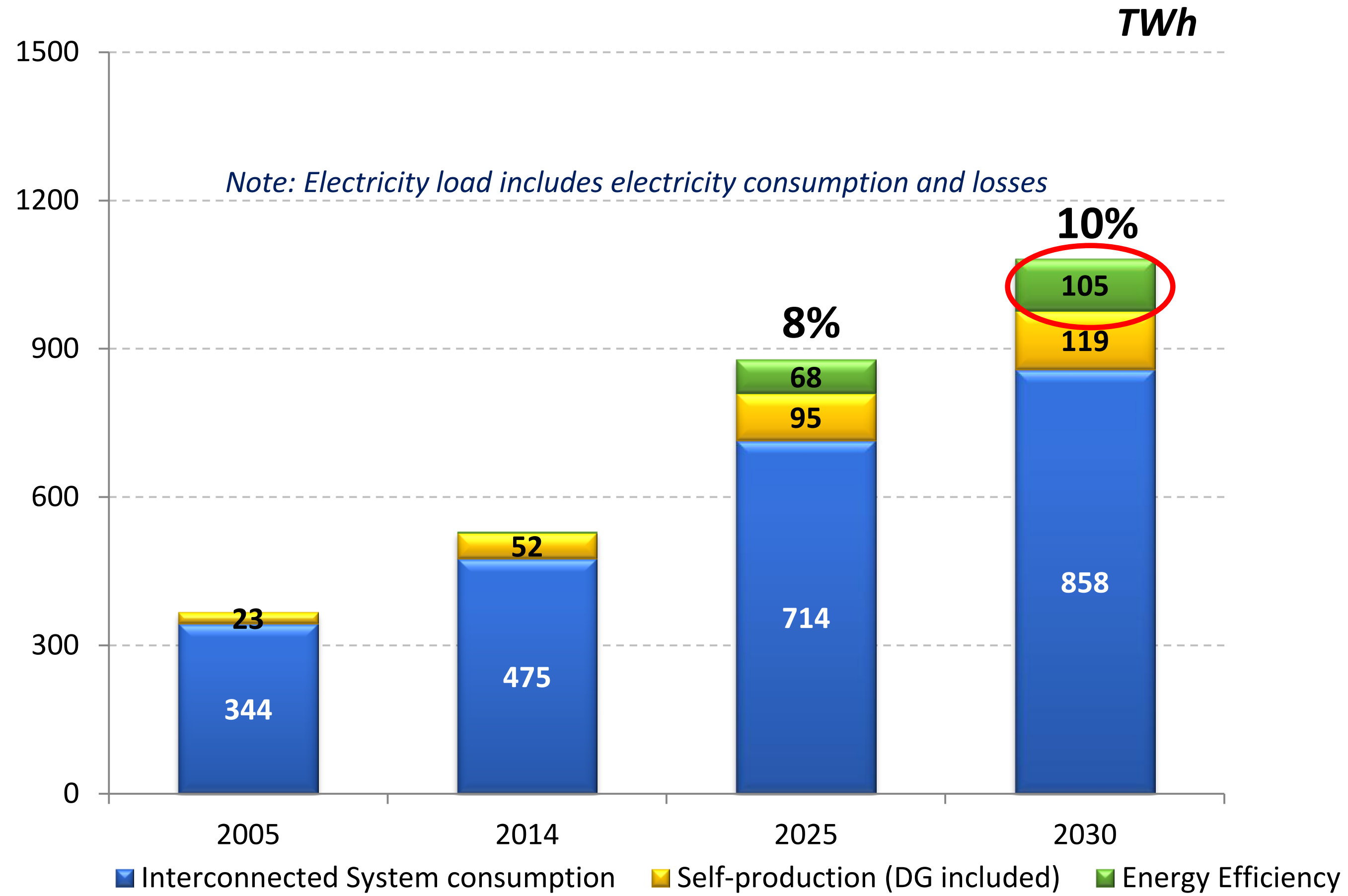


Source: EPE

Note: Electricity load includes electricity consumption and losses

ELECTRICAL EFFICIENCY

For the NDC: *Achieving 10% efficiency gains in the electricity sector by 2030.*

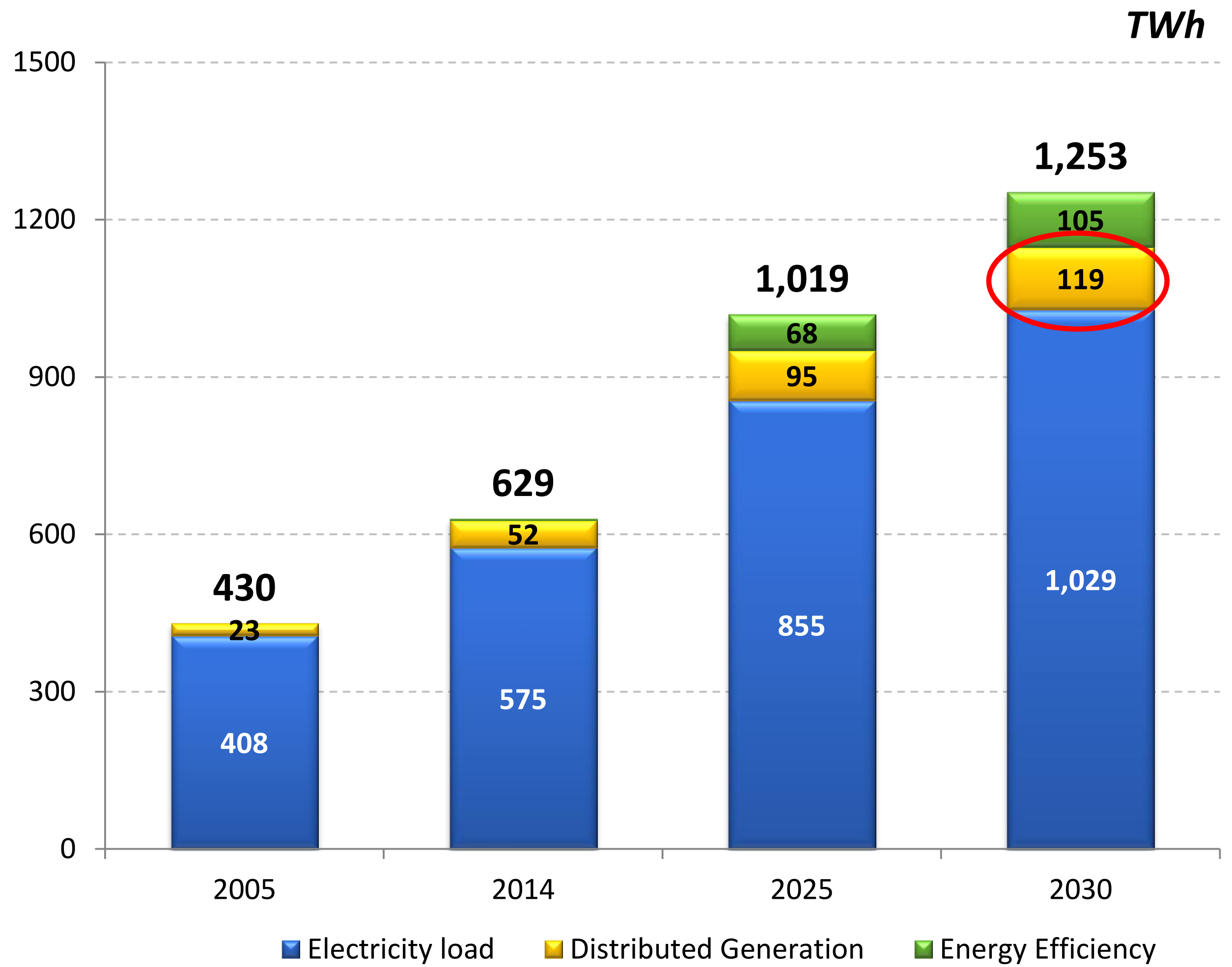


Source: EPE

Note 1: Refers to total electricity consumption. Losses are not accounted for energy efficiency estimates.
Note2: 2013 is the base-year.

DISTRIBUTED GENERATION

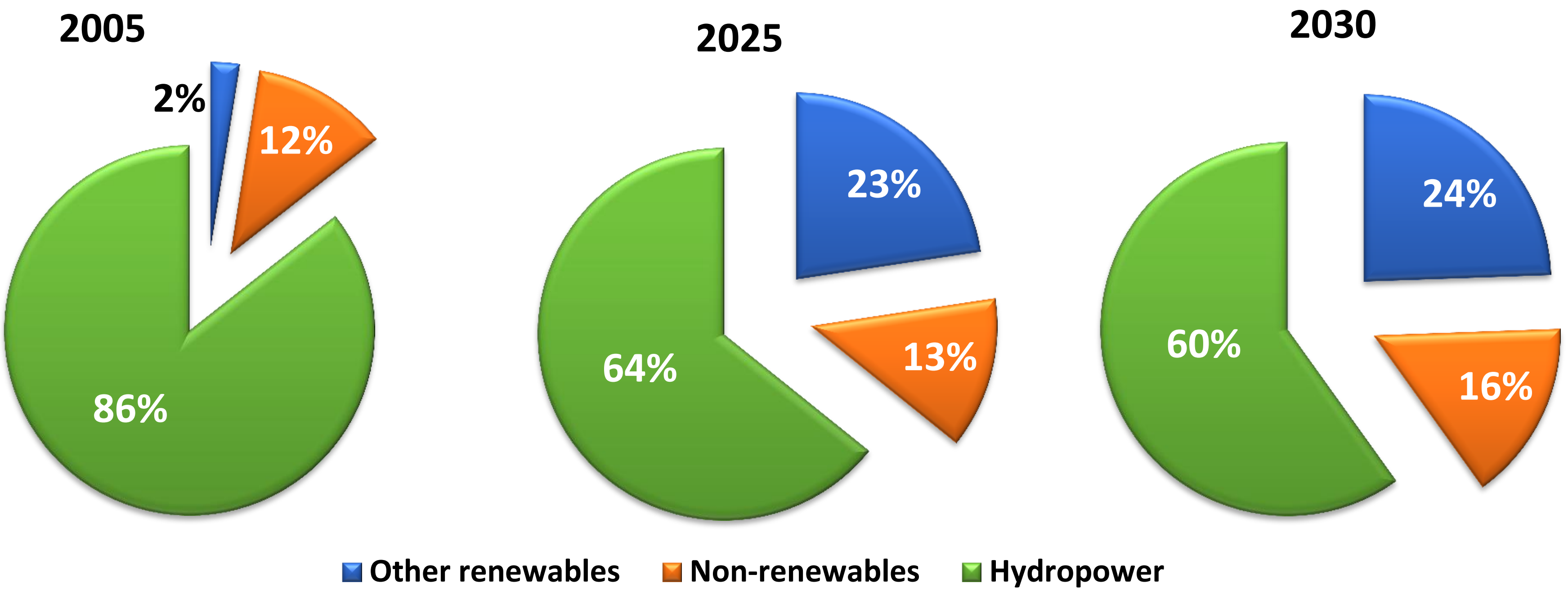
Distributed Generation contributes for about 10% of future electricity needs in Brazil



Source: EPE

RENEWABLES IN ELECTRICITY SUPPLY

For the NDC: *Increasing the share of renewables (other than hydropower) in the power supply to at least 23% by 2030 (share of wind, biomass and solar)*

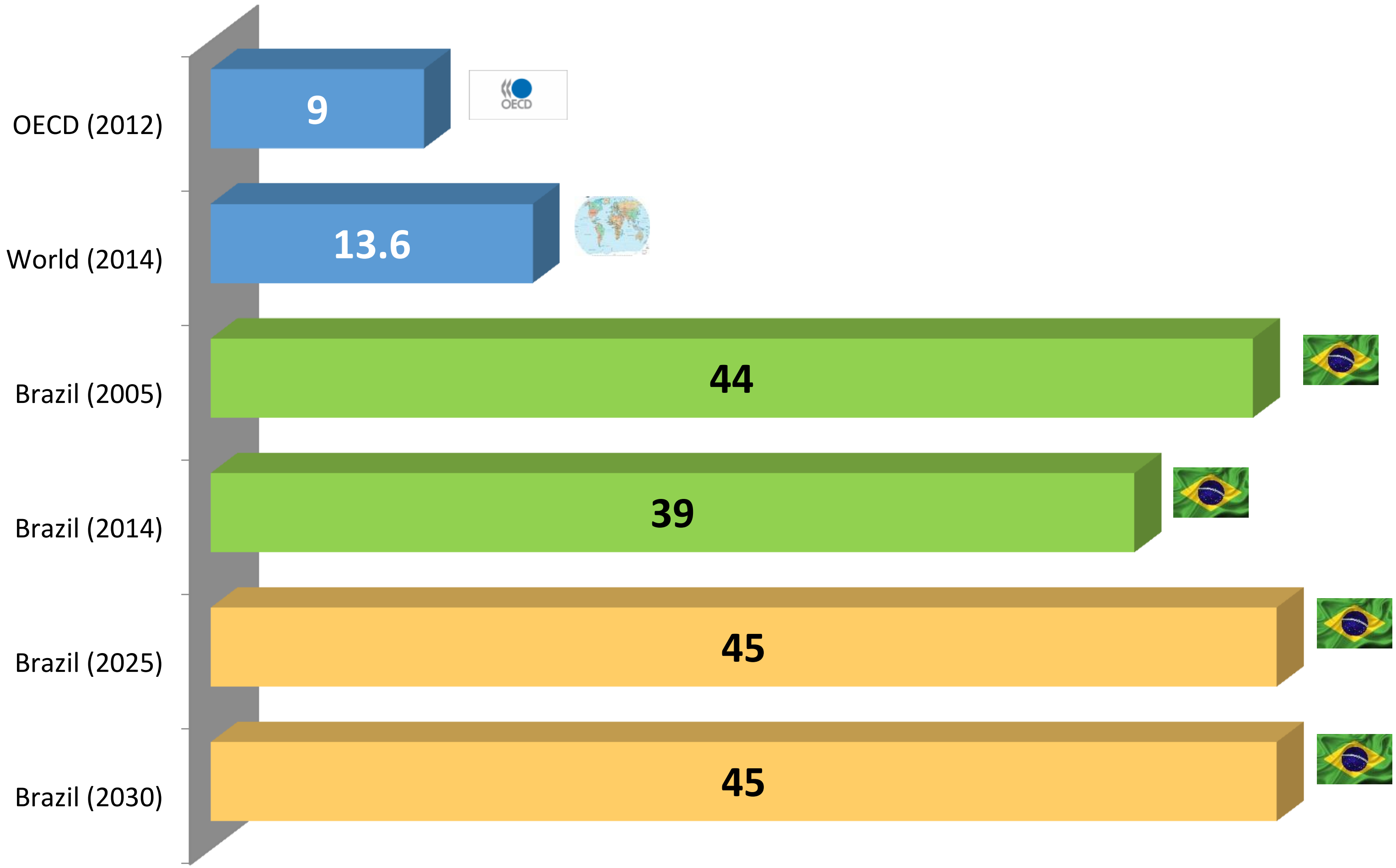


Share of renewables (other than hydropower) in 2030

Source: EPE

SHARE OF RENEWABLES ON ENERGY MATRIX

For the NDC: *Achieving 45% of renewables in the energy mix by 2030.*

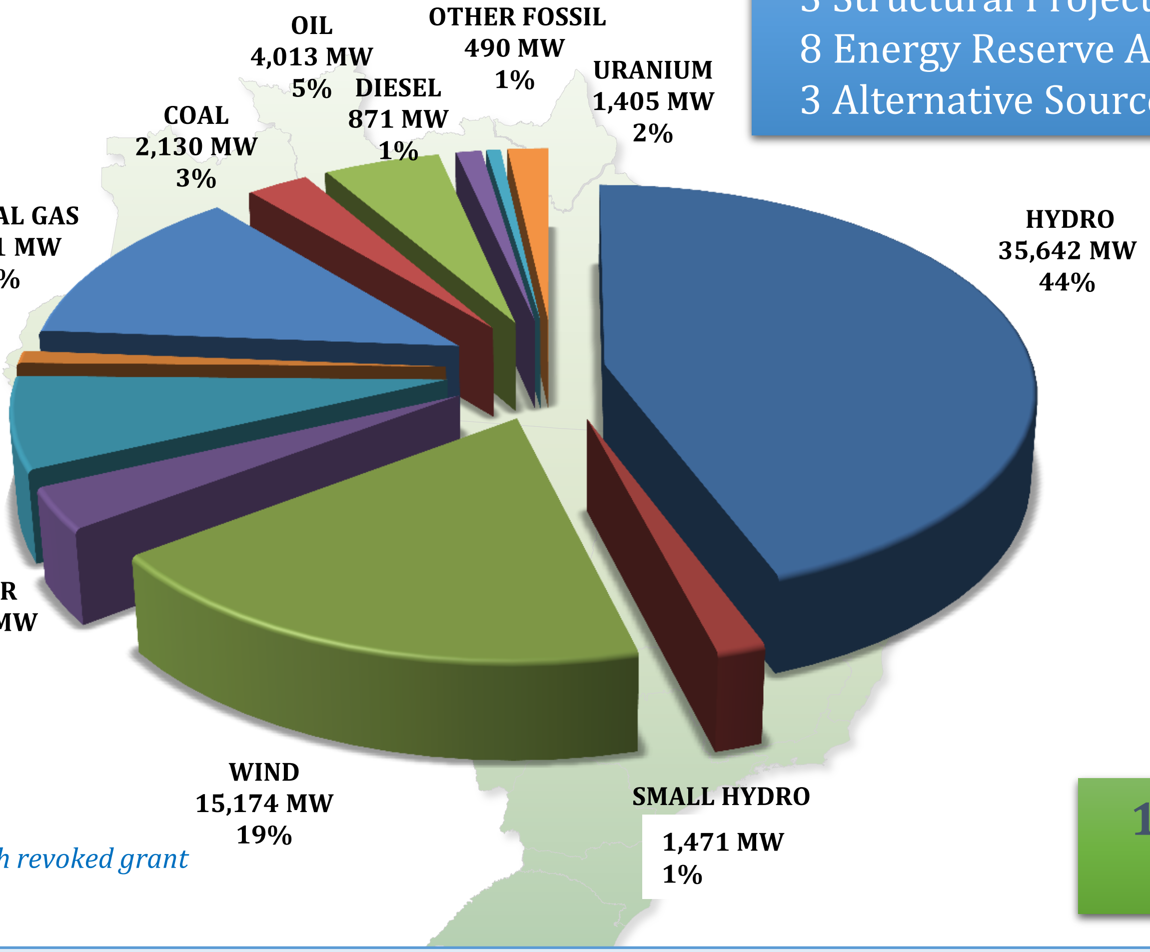


Source: EPE; IEA

Overview of Investment in RES in Brasil

POWER GENERATION AUCTION RESULTS 2005-2016

23 New Energy Auctions
- 3 Structural Projects Auctions
- 8 Energy Reserve Auctions
- 3 Alternative Source Energy Auctions



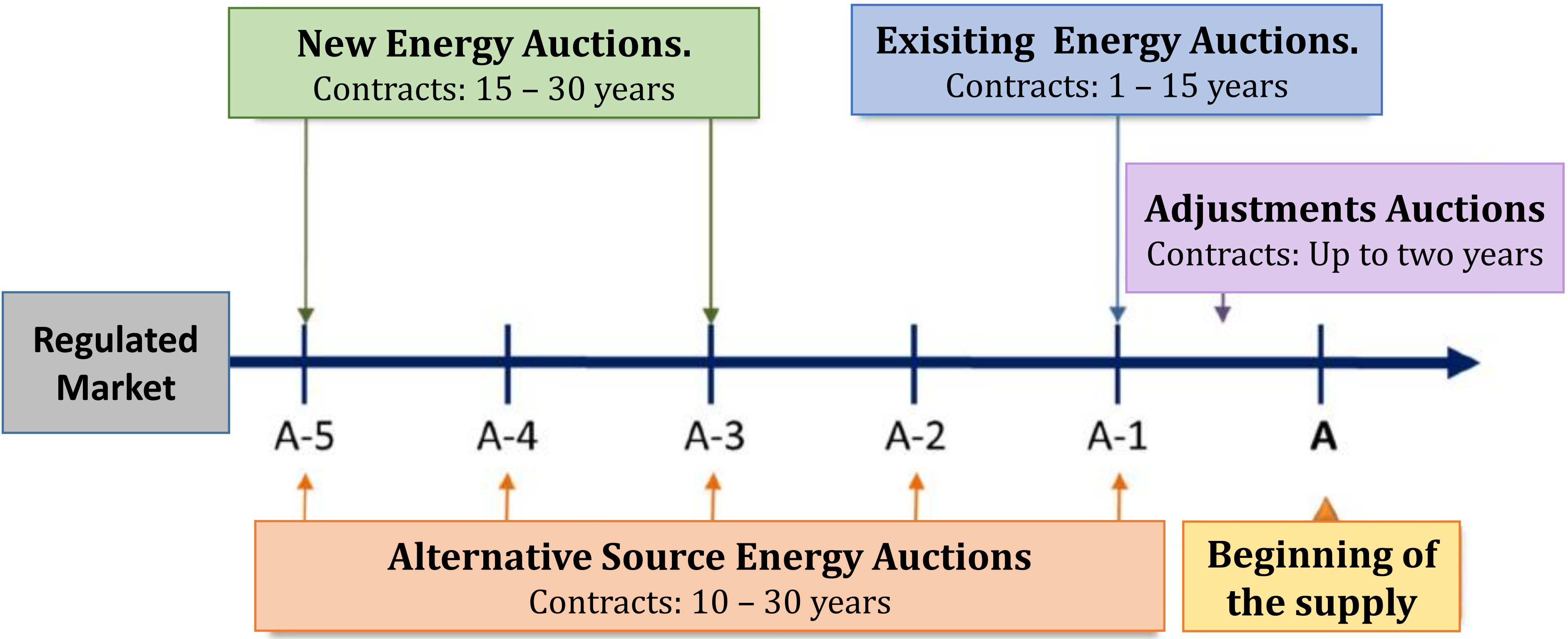
It is not considered plants with revoked grant

Source: EPE

1,084 PLANTS
92,084 MW

About 67% of contracted energy in Brazilian Power Auctions comes from Renewable Sources. The last auctions shows decline of large hydro power projects and rise in other renewables projects.

POWER GENERATION AUCTION (UTILITY SCALE)



THE DEBUT OF SOLAR ENERGY

1ST AUCTION
OCT, 2014

SUBMISSION

400 PROJECTS | 12,262 MWp

TECHNICAL QUALIFICATION

332 PROJECTS | 10,092 MWp

RESULTS

31 PROJECTS | 1,048 MWp

AVERAGE PRICE
8.8 US$ cents/kWh

2ND AUCTION
AUG, 2015

SUBMISSION

382 PROJECTS | 12,528 MWp

TECHNICAL QUALIFICATION

341 PROJECTS | 11,261 MWp

RESULTS

30 PROJECTS | 1,044 MWp

AVERAGE PRICE
8.4 US$ cents/kWh

3RD AUCTION
NOV, 2015

SUBMISSION

649 PROJECTS | 20,953 MWp

TECHNICAL QUALIFICATION

493 PROJECTS | 15,864 MWp

RESULTS

33 PROJECTS | 1,116 MWp

AVERAGE PRICE
7.8 US$ cents/kWh

DISTRIBUTED GENERATION TYPES IN BRAZIL

Main squemes for distributed power generation in Brazil

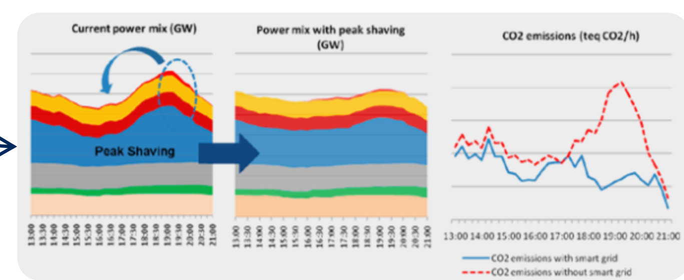
MINI AND MICRO-GENERATION (NET METERING)

LARGE SCALE GENERATION(SELL)

Distributed Generation Types

INDUSTRIAL SELF-PRODUCTION/CHP

PEAK GENERATION



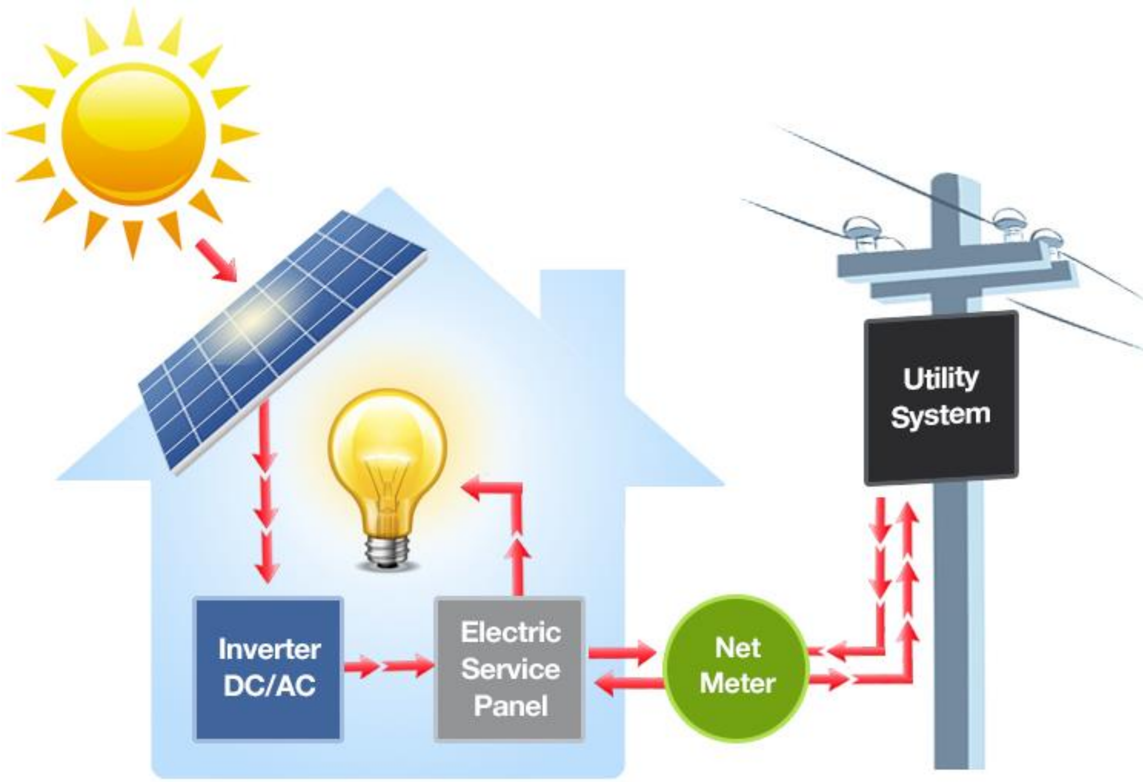
REGULATRY FRAMEWORK FOR DISTRIBUTED GENERATION IN BRAZIL

- Net Metering Model was approved in Brazil in 2012;

- In 2015 there was a review of the regulation, which brought several improvements, as:
  - higher power limit
  - new business models
  - reduced deadlines
  - standardization of procedures

- Valid for any renewable and cogeneration source

- Up to 5 MW (3 MW for hydropower)



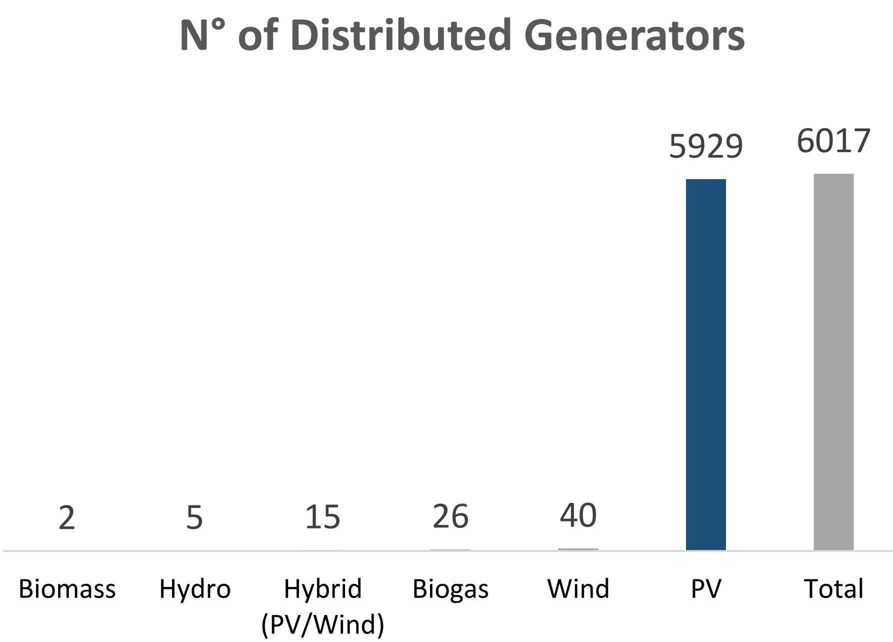
REGULATORY FRAMEWORK FOR DISTRIBUTED GENERATION IN BRAZIL

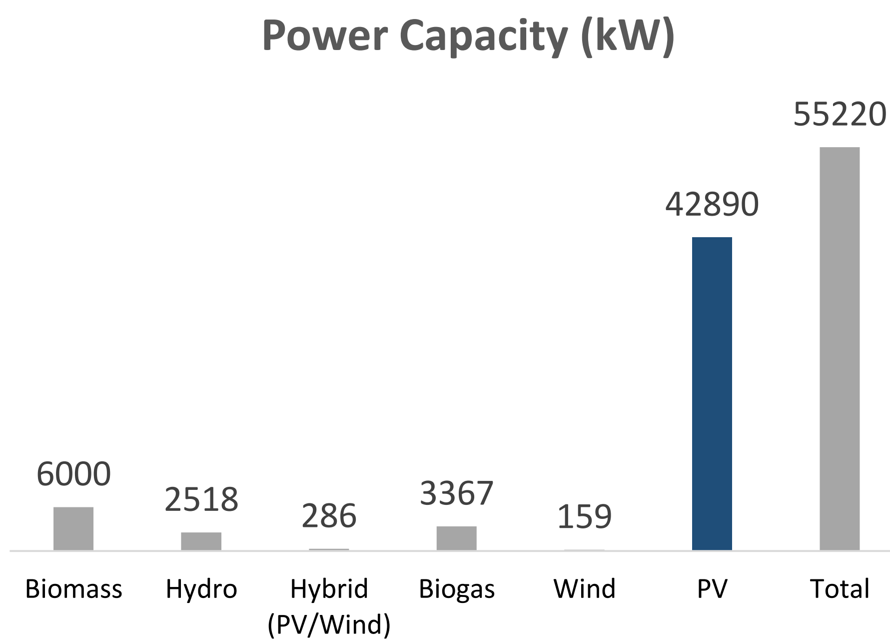
- Regulation allows generation and consumption in different places;
- It also allows the virtual net metering (multiple homeowners participating in the same metering system).

Community Solar

MINI/MICROGENERATION STATUS

- PV systems represents 99% of the total number of installations;
- PV systems represents 78% of the total installed capacity.



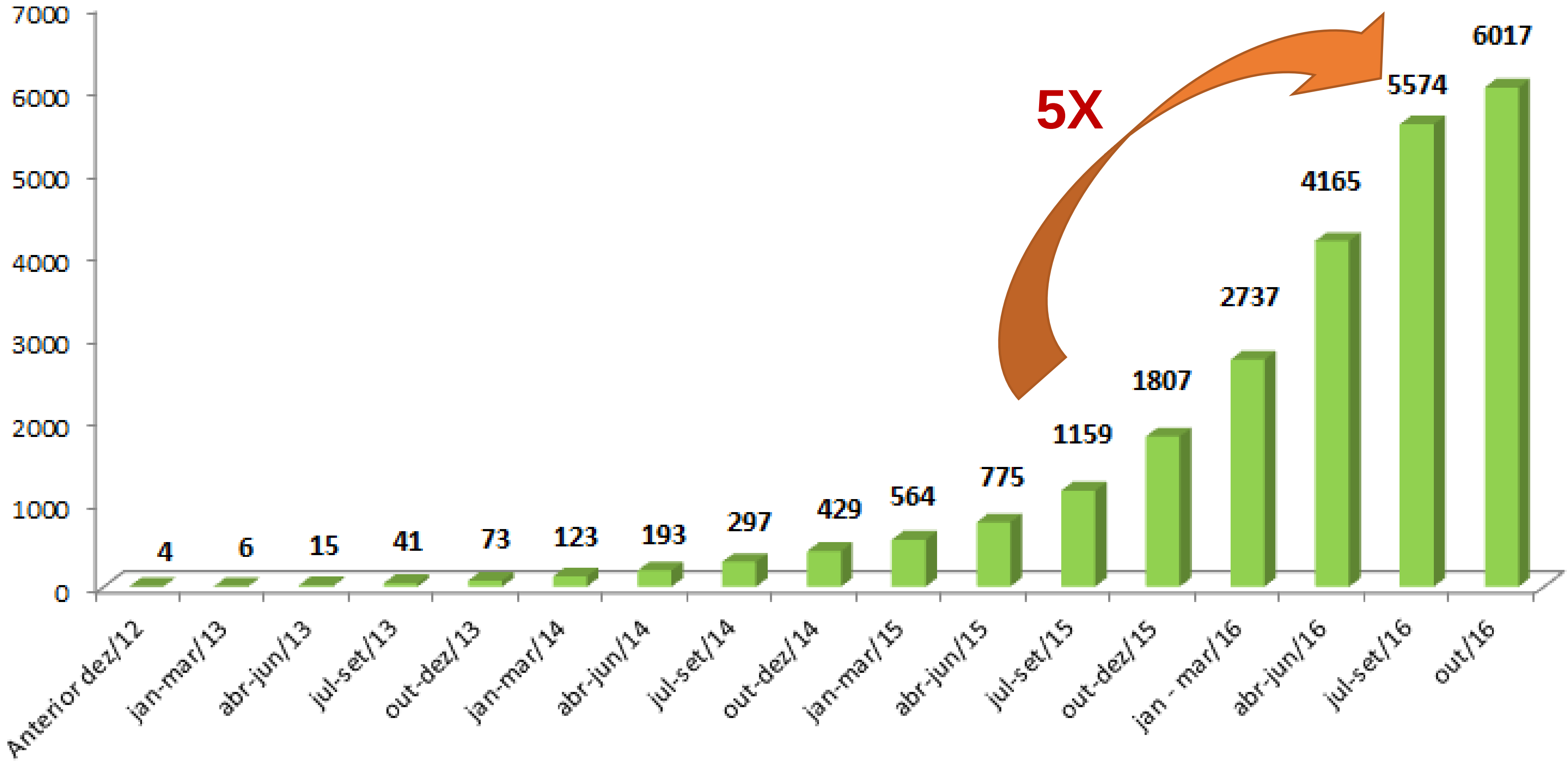


Updated on October/16

Reference: ANEEL

MINI/MICROGENERATION STATUS

Number of Distributed PV Systems is Starting to Take Off



Updated on October/16

Reference: ANEEL

LOCAL AUCTIONS HOLD BY UTILITIES (VRes)

- In addition to net metering, there is the possibility of selling power to distributors (usually in larger projects DG);

- Distributors may purchase energy distributed generation projects through auctions, up to 10% of their charge;

- Maximum price to consumer:
- PV: **US$ 0.128 / kWh** * (454 R$/MWh)
- Combined Heat and Power (CHP): **US$ 0.093 / kWh** * (329 R$/MWh)

- Distributor sets the term of the contract.

- It depends on the initiative of the distribution companies to buy.

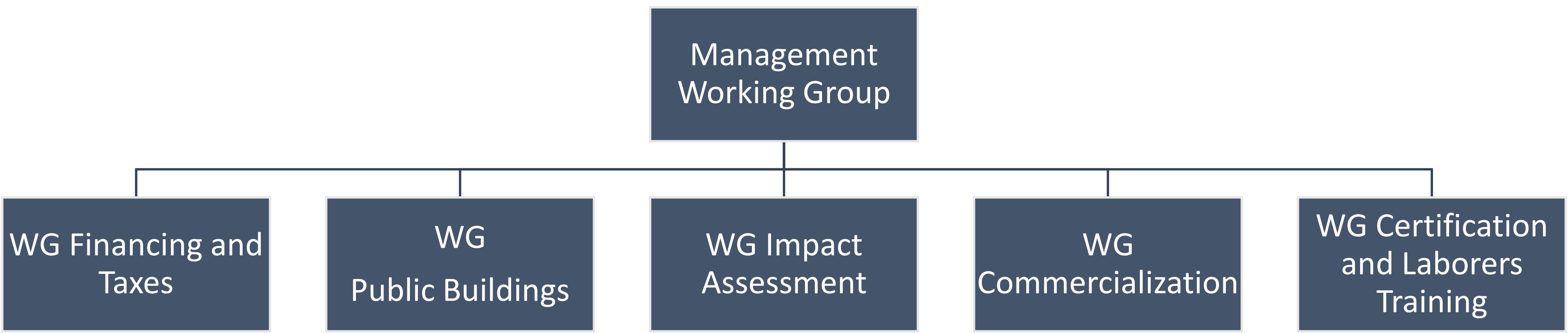
** Conversion rate: 1US$ = R$ 3.55*

ProDG

- Federal Program to foster renewable distributed power generation and cogeneration;

- Under the umbrella of the ProDG initiative, a working group (WG) has been created to identify means to meet the program objectives;

- It was divided into five specific working groups:



- Several recommendations were made by the working groups → on track to be implemented.

Challenge to meet the NDCs

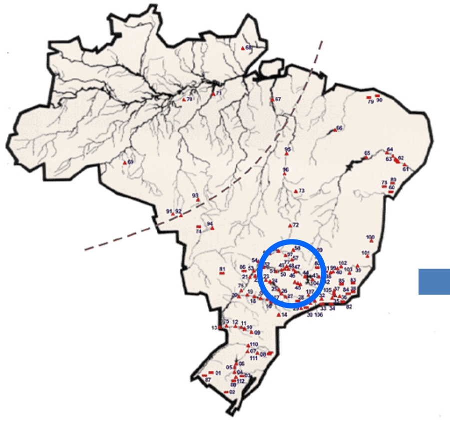
The role of hydros and RES

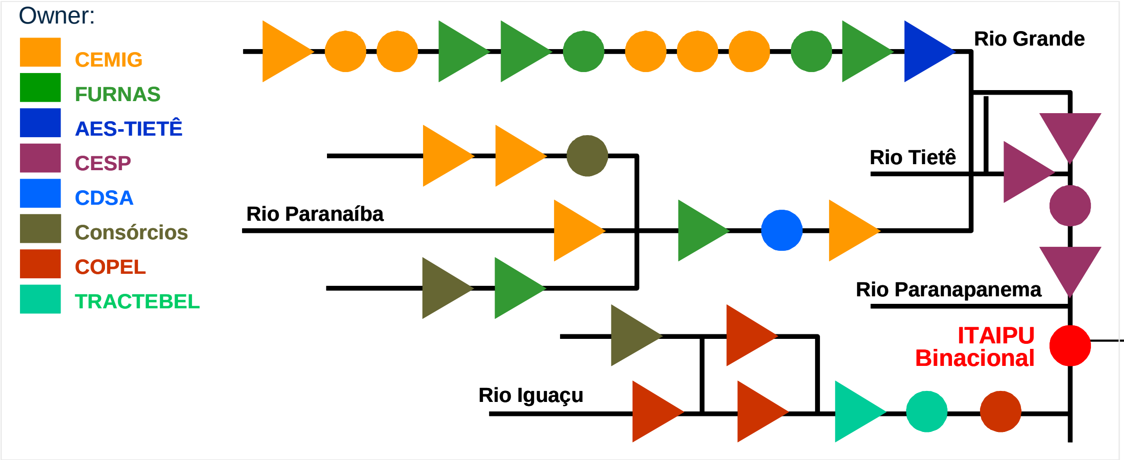
Background: the Brazilian NDC…
…and the role of hydro power to boost RES penetration

- Among other issues, the Brazilian NDC will aim to:
  - Achieve an estimated 45% share of renewables in the energy matrix by 2030;
  - Obtain at least a 66% share of hydropower in electricity generation by 2030, not considering self-produced electricity;
  - Expand the use of renewable energy sources (RES) other than hydropower in the total energy mix to between 28% to 33% by 2030;
- In other words, the Brazilian NDC recognizes that hydropower plays an important role to boost RES in the country
  - Same philosophy of the Chilean 2050 Energy plan, for example
- This presentation will discuss why hydropower is key to leverage RES and paths for a sustainable hydro development in the country

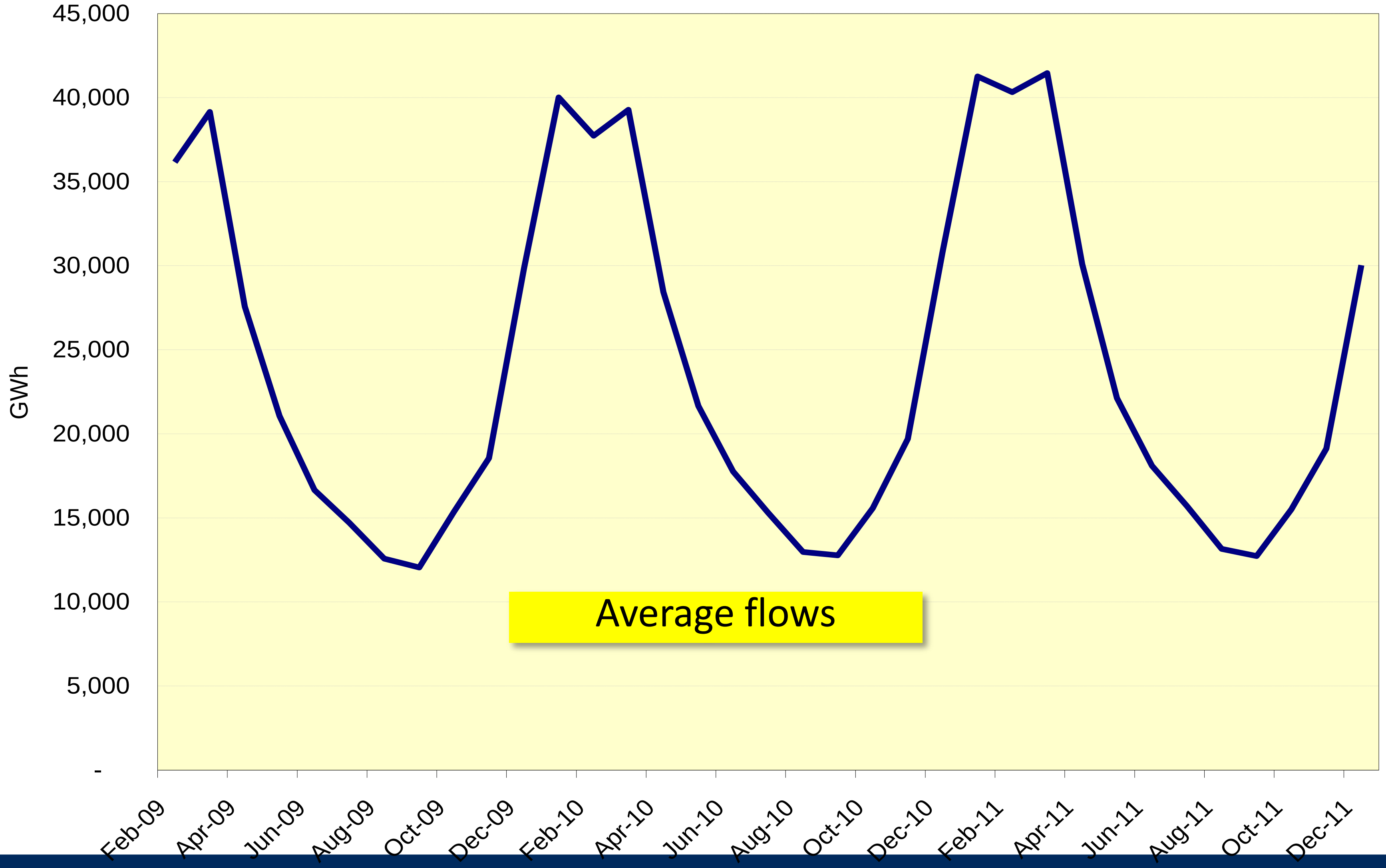
Hydro development in Brazil

- Installed capacity of the Brazilian power system: 150,000 MW
- Hydroelectric share (91 GW): 61% of installed capacity
- Hydro plants located in several river basins with significant storage capacity
- Cascaded hydro system with multiple ownership

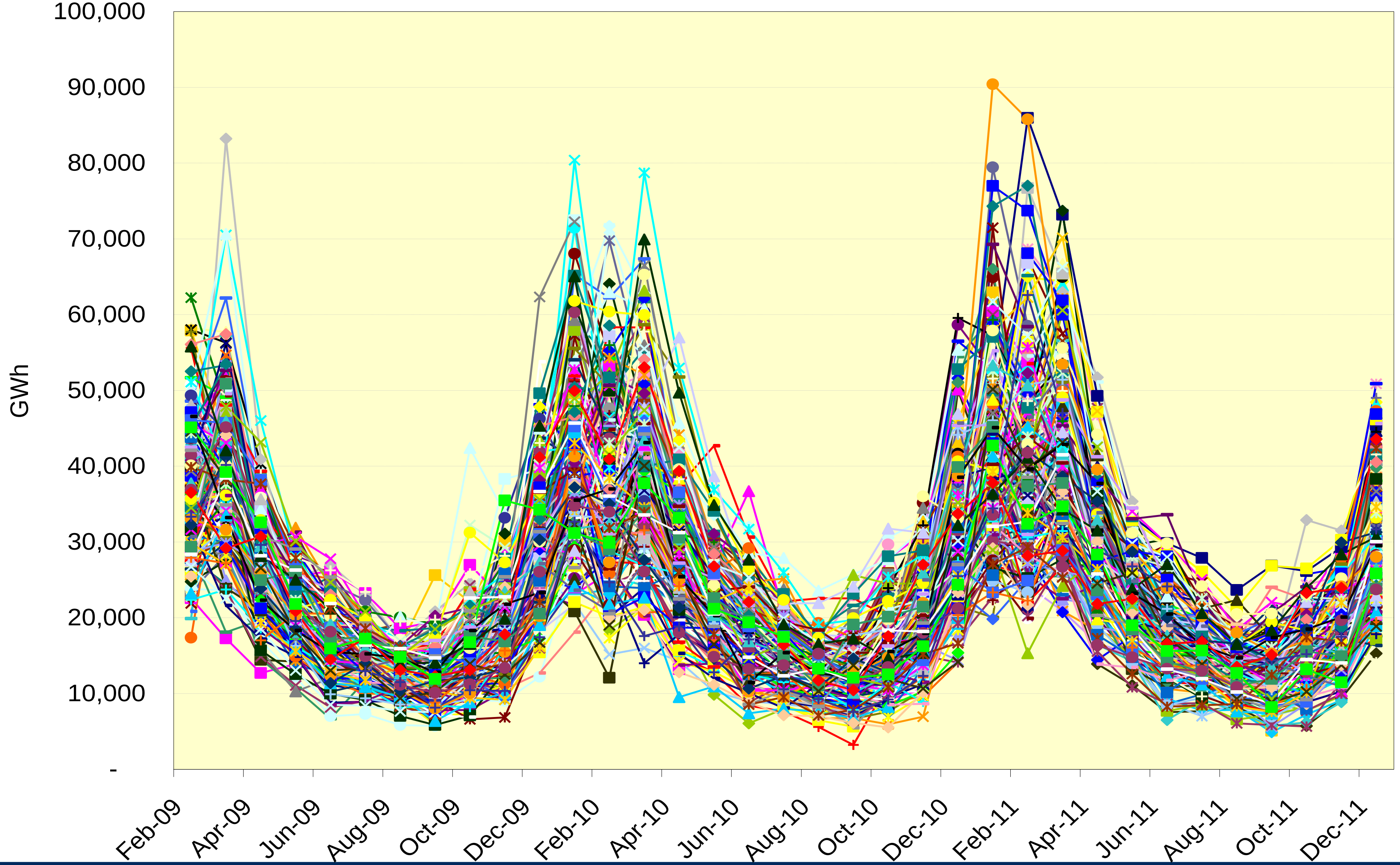




Hydros must deal with inflow variability

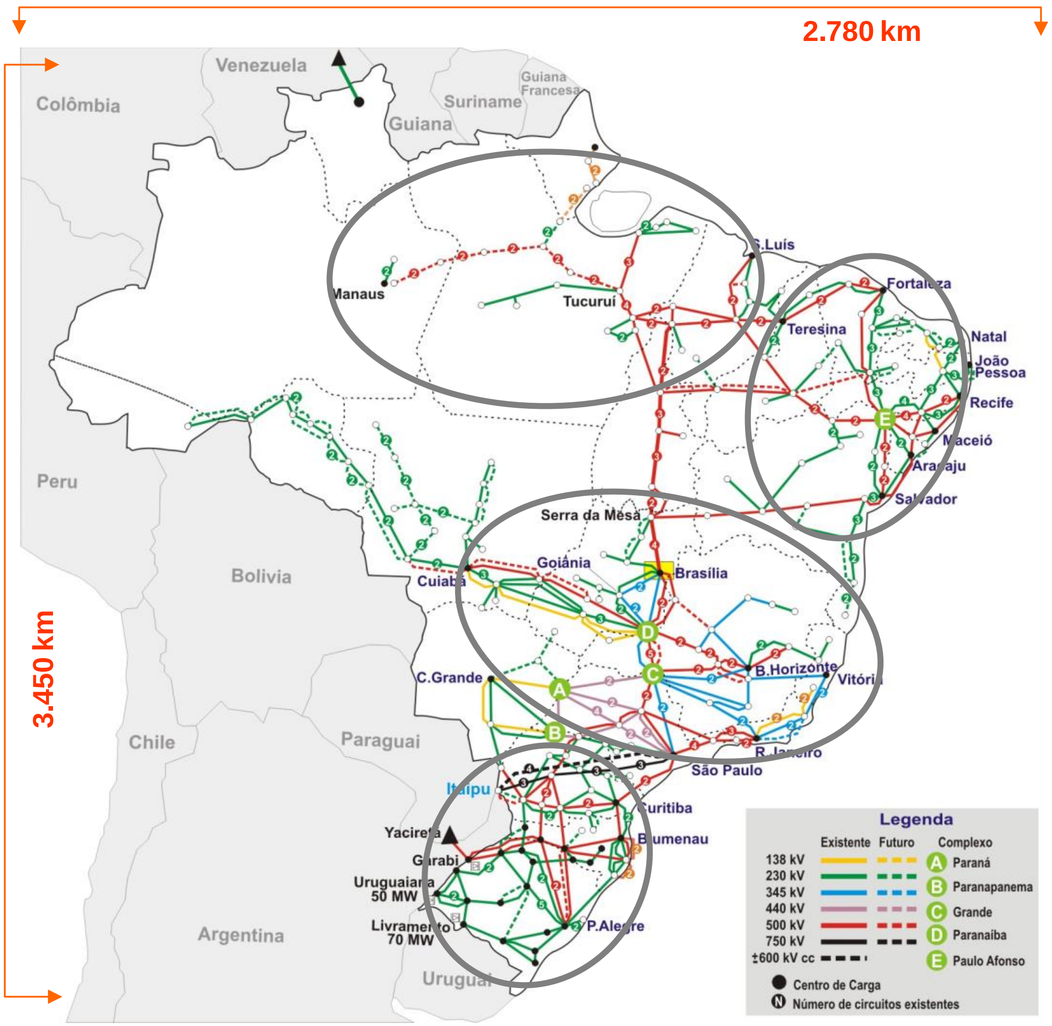


...and inflow uncertainty



How to deal with hydro inflow uncertainty?

1. Portfolio effect: diversification of basins
2. Transmission network
3. Hydro storage has a key role: store water in wet seasons for utilization in the dry season (or dry years)



RES have added a lot to this lanscape...

Small Hydro (P ≤ 50 MW, A ≤ 3km2)

Installed Cap: 5.700 MW

Potential: 18.000 MW

A large fraction of the Brazilian yet-to-be-developed hydro potential is from small hydro.

Wind Power

Installed Cap: 10.000 MW

Potential: Above 300.000 MW

Relative newcomer technology, but most competitive in recent auctions.

Biomass

Installed Cap: 12.900 MW

Potential: 53.000 MW

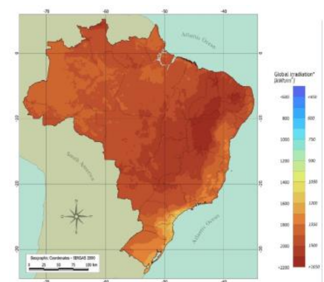
Nowadays a large fraction of the sugarcane bagasse is wasted in low-pressure boilers.

Solar PV

Installed Cap: 34 MW

Potential: No limit

A bet for the future as the radiation indices are high all over the country.



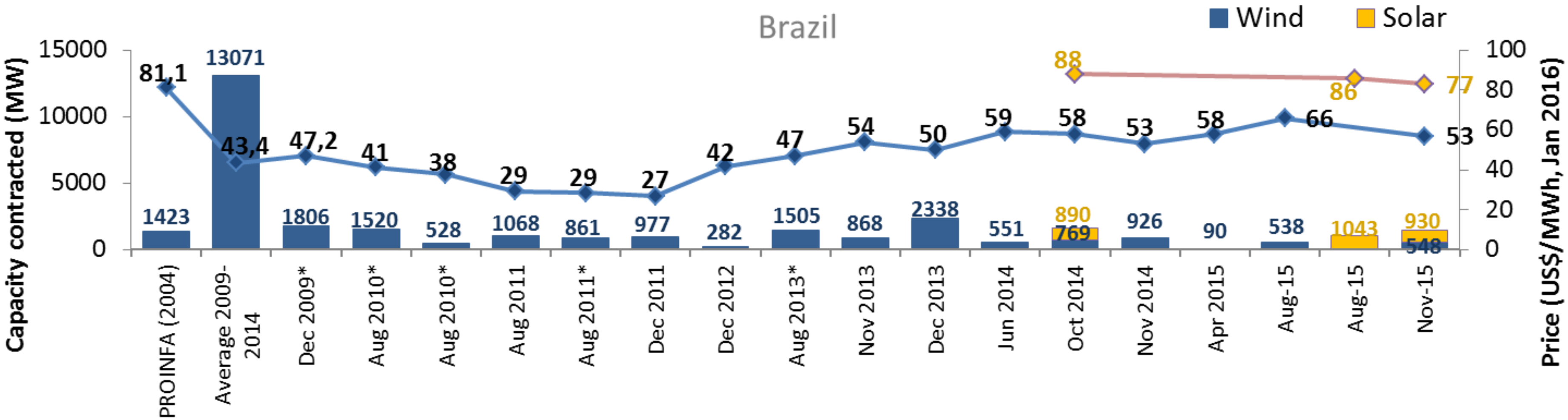
And today Brazil has a renewable portfolio

- RES are smaller scale projects
  - Diversifies construction (and other) risks
  - Smaller construction time
- Important attribute to “hedge” against load growth uncertainty
- Resource potential with geographical complementarity
- Location close to load centers
- Wide range of investors
  - Local capital
  - Investment (foreign) funds

A portfolio of hydros and renewables combines economies of scale and flexibility

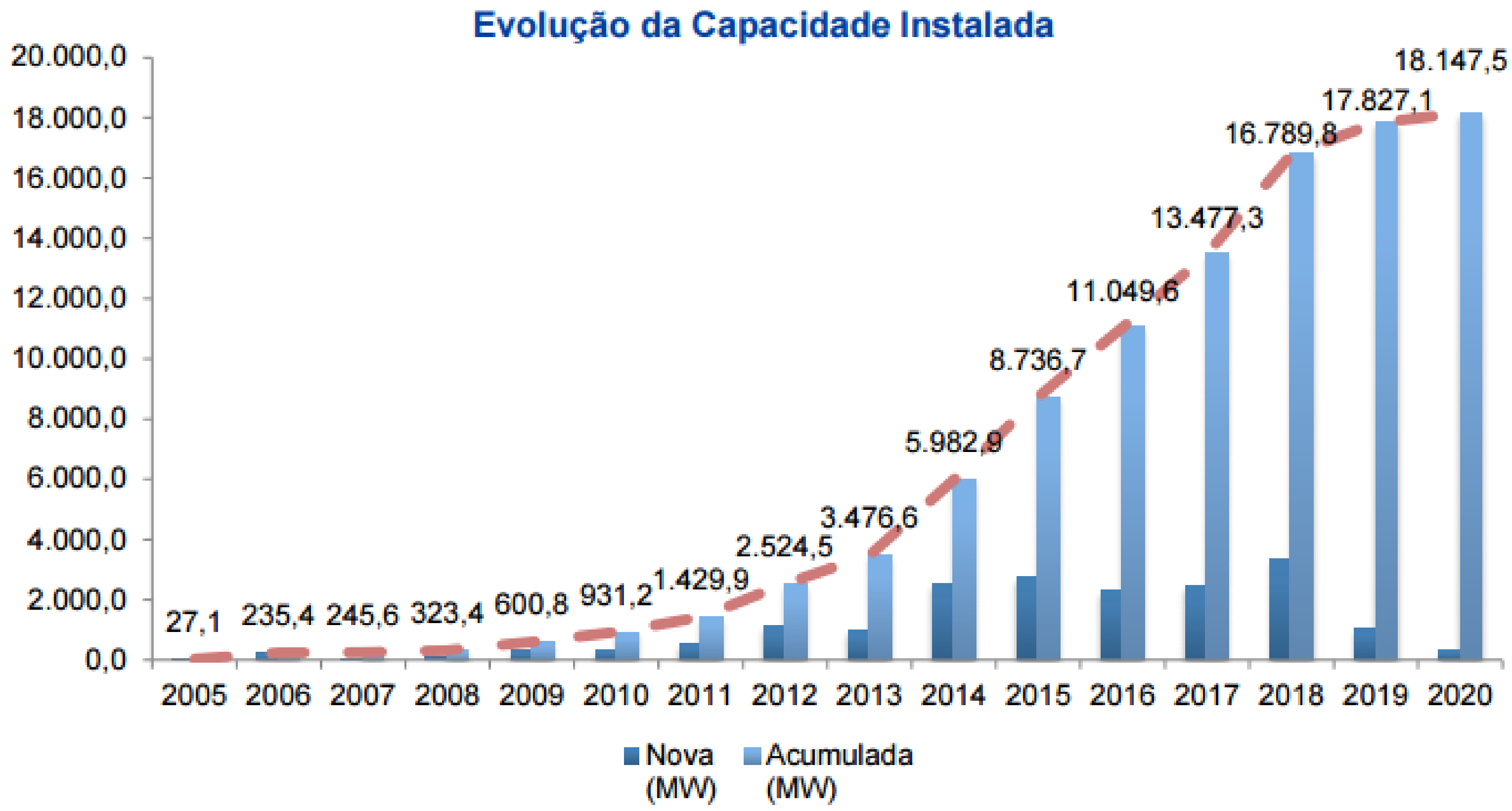
And renewables are competitive in Brazil

Brazil: wind prices have fallen **60%** from the Proinfa* times, wind capacity has risen **10-fold**



Example: wind capacity evolution

- 10 GW of wind capacity operating, additional 8 GW under construction



Why are RES competitive in Brazil?

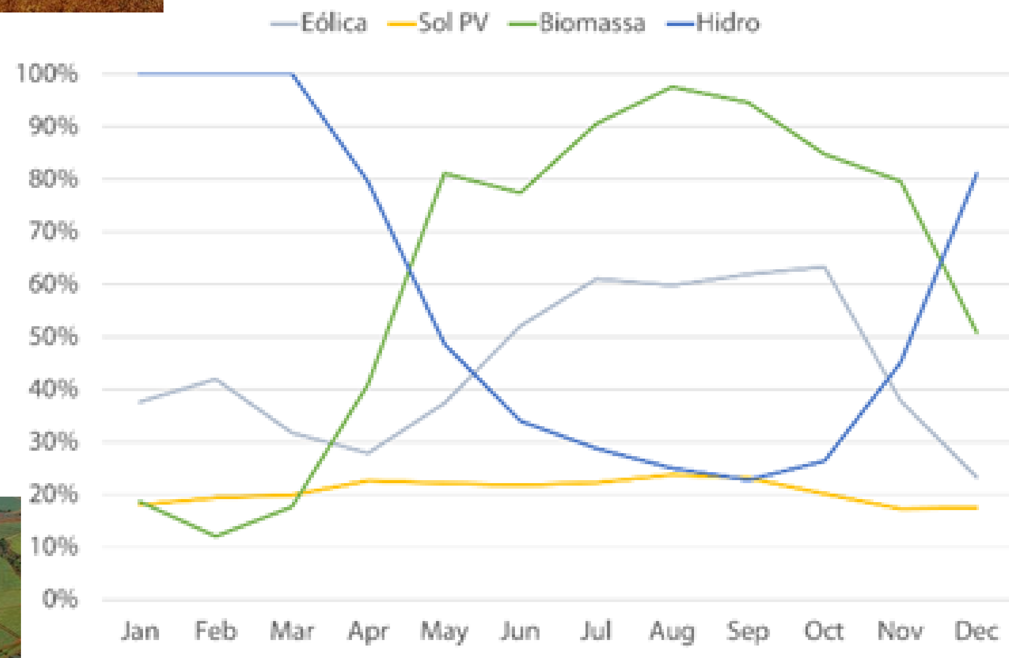
- In most coutries worldwide, renewables require subsidies
  - 120 billions in Germany, for example
- Reasons:
  - Variability in energy production
    - Wind + solar: ± 3 GW (15 min), ± 8 GW (60 min) in Germany
    - Back up with thermal generation
  - Difficulties to build transmission facilities
    - Example: Midwest in the US

Why was it different in Brazil?

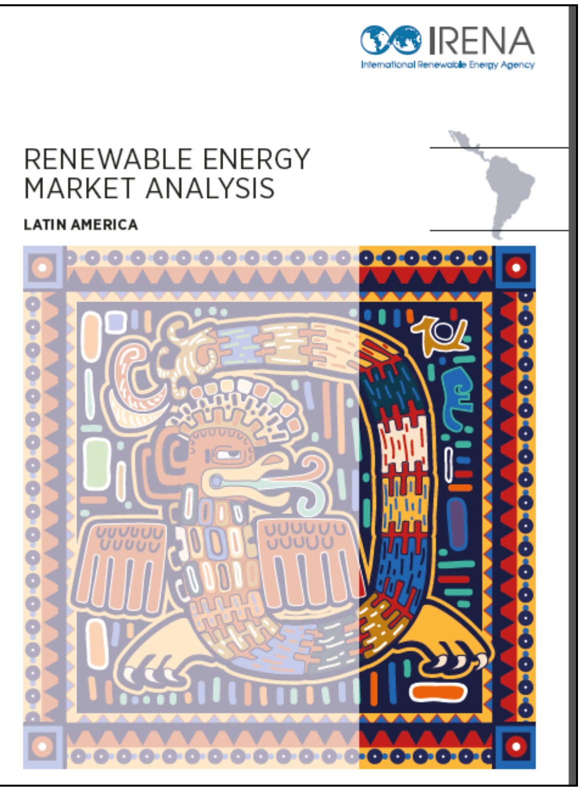
Answer: storage + transmission

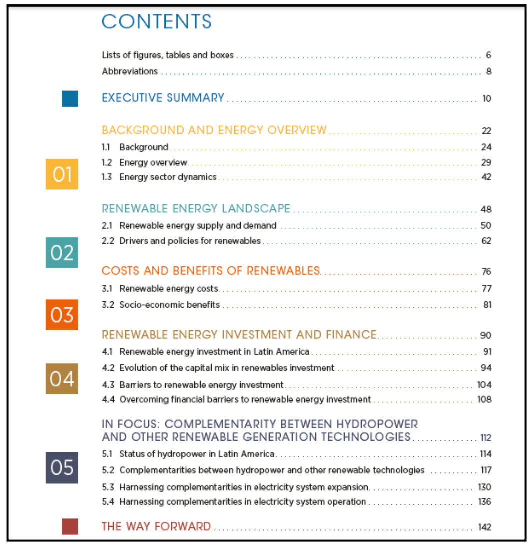
- Hydro reservoirs make up for production variability of wind/solar and seasonality of biomass
- Requires a robust transmission network, which was already build for the hydros
- The “energy warehouses” of hydroplants were essential for the economic feasibility of renewable energy sources in Brazil

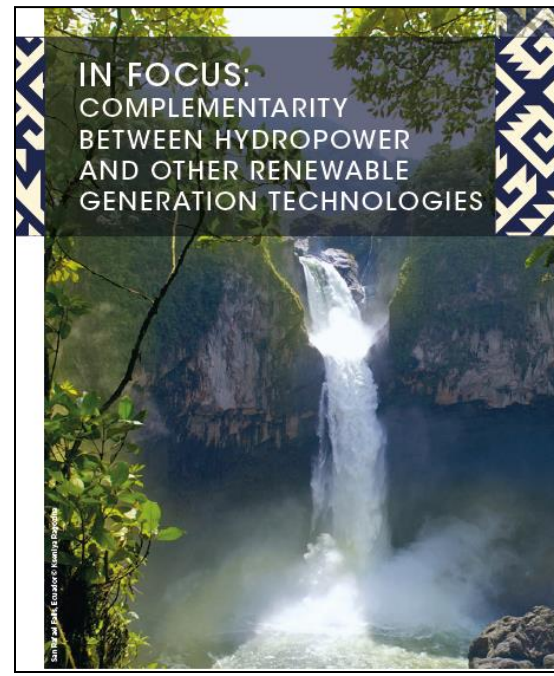
Bonus: production complementarity between hydro, wind, biomass and solar



These complementarities have been recognized internationally and recently (2016) enlightened…

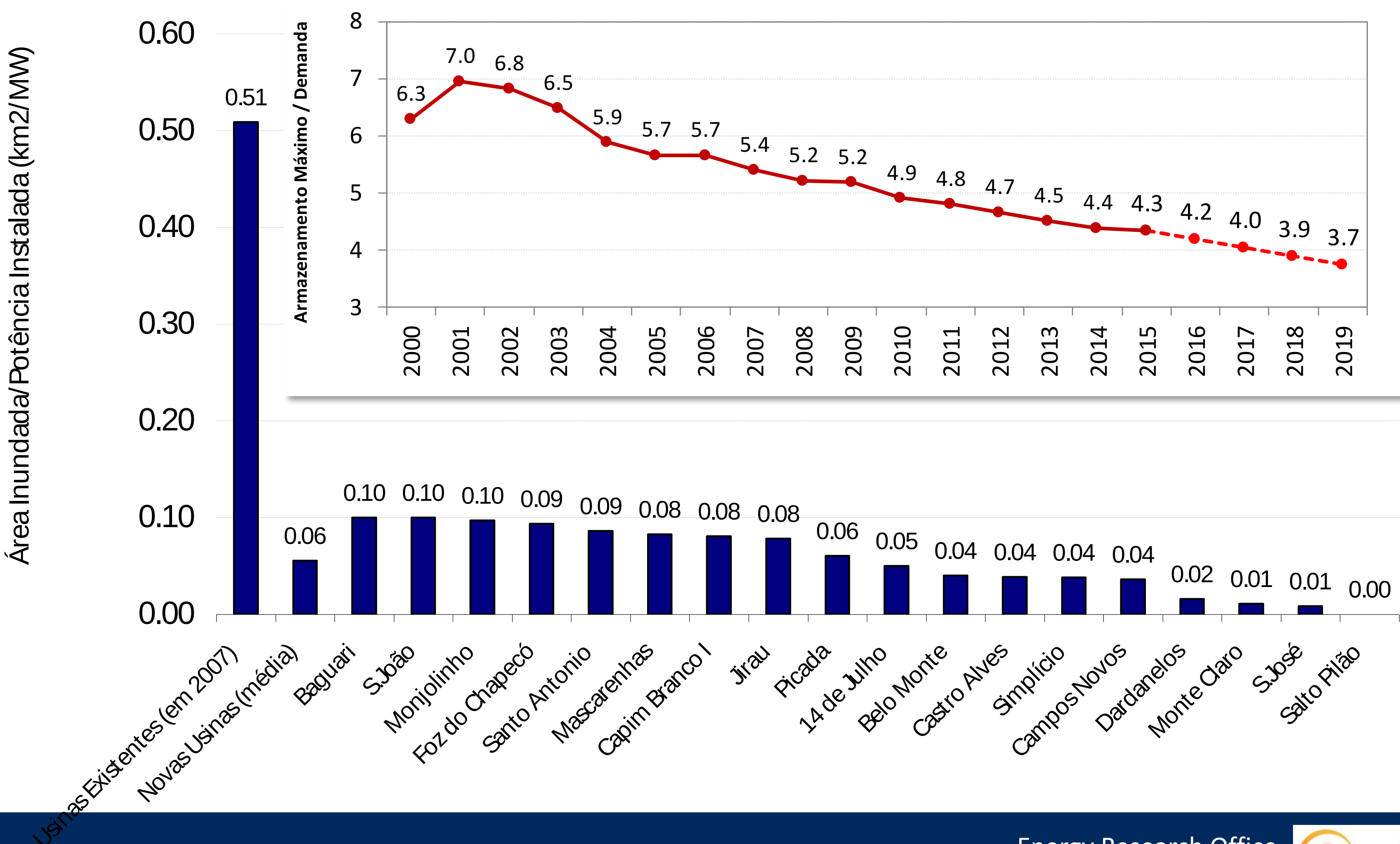



CONTENTS



Available at: www.irena.org

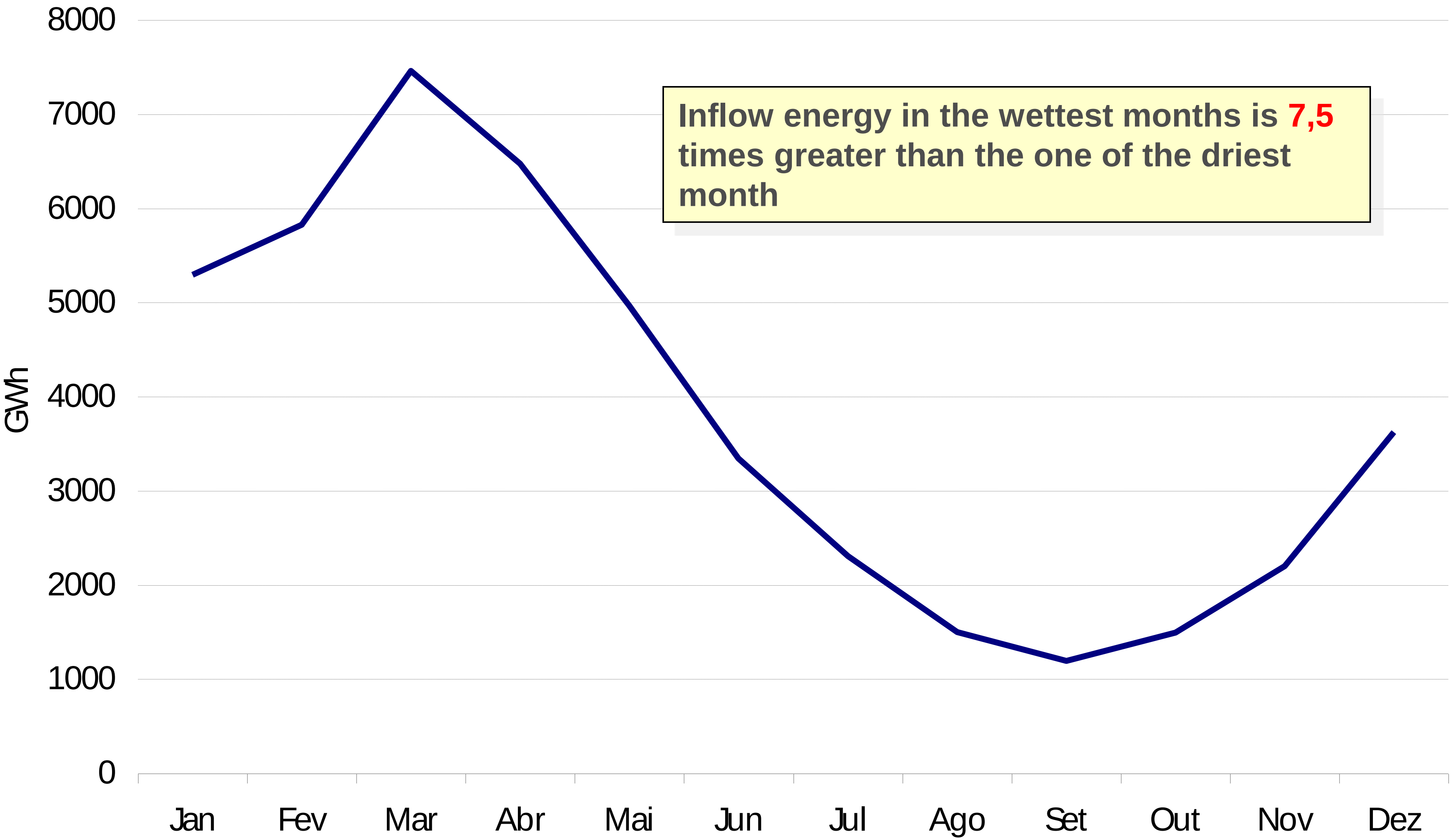
Trouble in Paradise: prohibition of reservoirs



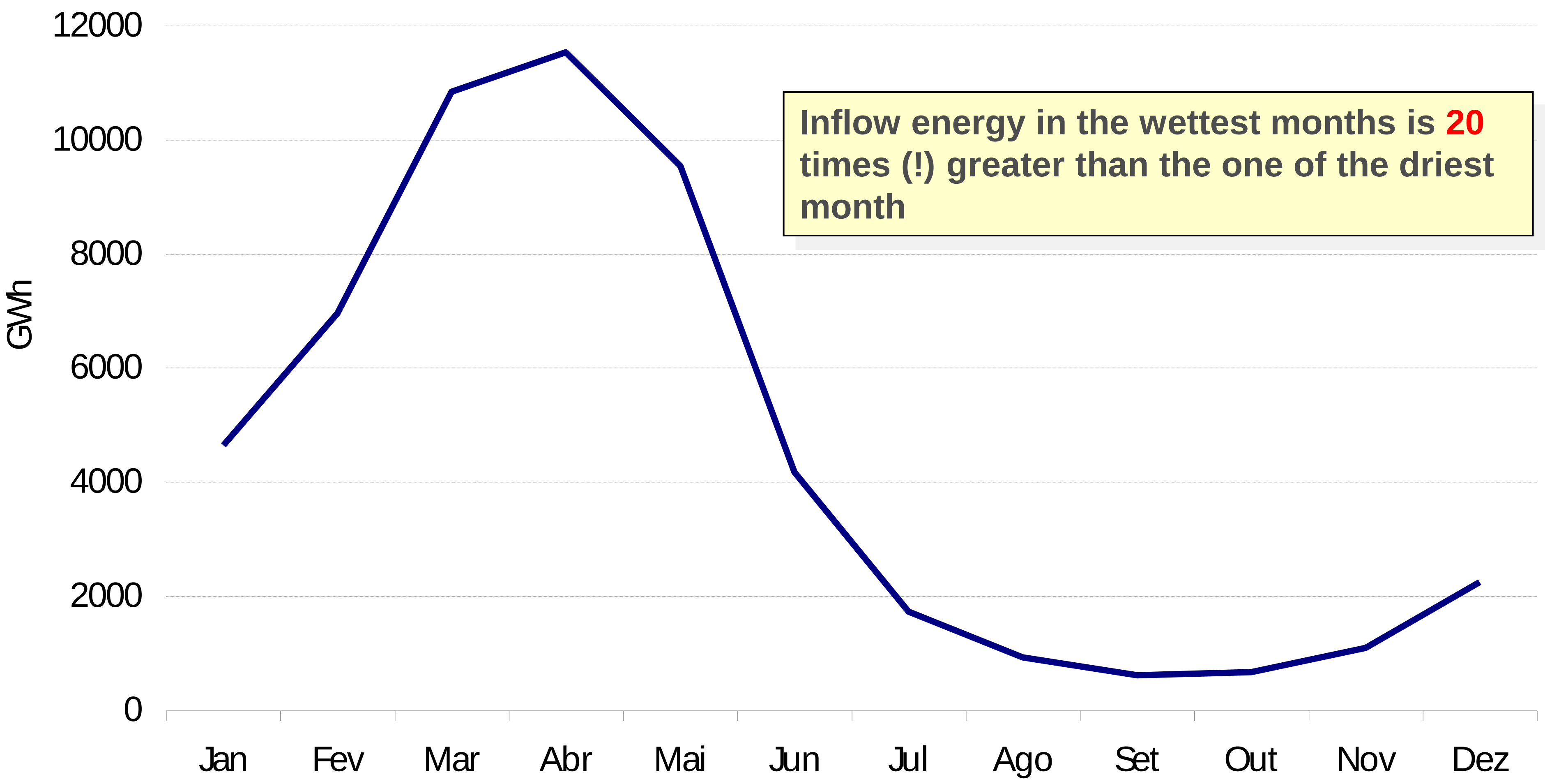
To make things worse… super run of the river hydros

- The lack of storage did not result from a technical-economical optimization of the projects but from social-environmental constraints
  - The three largest new hydro projects in Brazil – Santo Antônio, Jirau and Belo Monte, with 18 GW of installed capacity, are run of the river plants
- This lack of storage will have important implications in the system, since the variability of inflows to these plants is much greater than those of the existing plants

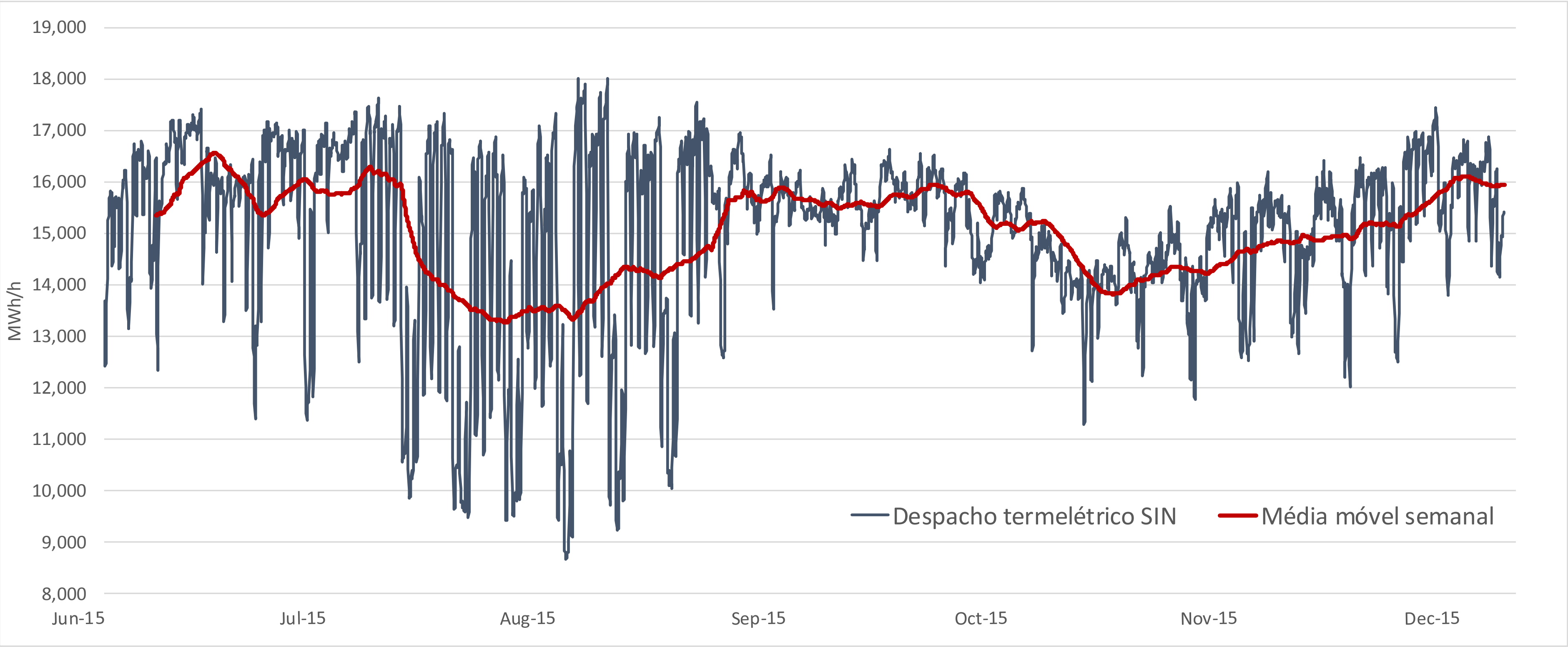
Example: Madeira river hydro plants



Example: Belo Monte hydro plant



Consequence: less flexibility + thermal dispatch



- Perspectives of the worsening of the situation in the future:
  - Wind variability in extreme events in 2016= 1 GW
  - Perspective is that in 2030 the wind variability may reach 8 GW

What can be done?

- Construction of cost-effective controllable (dispatchable) generation
  - Current solution in the world, see the many discussions held in Marrakech
  - RES can indeed be flexible in different time intervals
    - Examples include biomass, small hydros & wind, but scale is an issue
    - Hydros has been in the wish-list of the international community
- Investment in storage
  - Batteries to complement (back up) distributed RES production variability
    - Cost of batteries is still an issue to upscale it to mainstream
  - Again, hydro has been in the wish list of the international community
  - Pumped storage hydros - to complement (back up) mainstream RES production variability – has been the way in many countries

Example: US

energy.gov/eere/water/new-vision-united-states-hydropower

ENERGY.GOV
Office of Energy Efficiency & Renewable Energy

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Home » Information Resources » A New Vision for United States Hydropower

A NEW VISION FOR UNITED STATES HYDROPOWER

- Water Power Program
- About the Program
- Research & Development
- Funding Opportunities
- Information Resources
  - Publications
  - Hydropower Vision
  - Hydropower Basics

HYDROPOWER VISION INSIGHTS

Applying these foundational principles to both the quantitative and qualitative analyses in the *Hydropower Vision* led to several key insights regarding the role of existing and future hydropower in the U.S. power sector:

- Existing hydropower facilities have high value within the U.S. energy sector, providing low-cost, low-carbon, renewable energy as well as flexible grid support services.
- Hydropower has significant near-term potential to increase its contribution to the nation's clean generation portfolio via economically and environmentally sustainable growth through optimized use of existing infrastructure.
- Meeting the long-term potential for growth at potential sites that are not developed for hydropower is contingent upon continued commitment to innovative technologies and strategies to increase economic competitiveness while meeting the need for environmental sustainability.
- Significant potential exists for new pumped storage hydropower to meet grid flexibility needs and support increased integration of variable generation resources, such as wind and solar.
- The economic and societal benefits of both existing and potential new hydropower, as quantified in this report, are substantial and include job creation, cost savings in avoided mortality and economic damages from air pollutants, and avoided GHG emissions.

The *Hydropower Vision* analysis finds that with continued technology advancements, innovative market mechanisms, and a focus on environmental sustainability, U.S. hydropower could grow from its current 101 gigawatts (GW) to nearly 150 GW of combined electricity generating and storage capacity by 2050.

Read more about the ***Hydropower Vision Report*** and its findings on the future of hydropower in the United States.

Revisiting the discussion of hydro development

- The future of the electricity industry is towards a low-carbon matrix and RES are key to meet this goal
- Renewable portfolios will be key to this target and hydros are RES are complementary, not competitors, as resources towards a low-carbon Brazilian energy matrix
- Hydro development in Brazil needs to be revisited and carried out under a coordinated approach with the following long-term guidelines:
  - Hydro development as a driving force for sustainability, inclusiveness and social/environmental development
  - Coordination between the public, private, civil society and academic sectors to implement sustainability standards for hydro development
  - Local population benefiting (economically) from the hydro development
  - Communication is everything
- In other words, build the right dams, build the dams right

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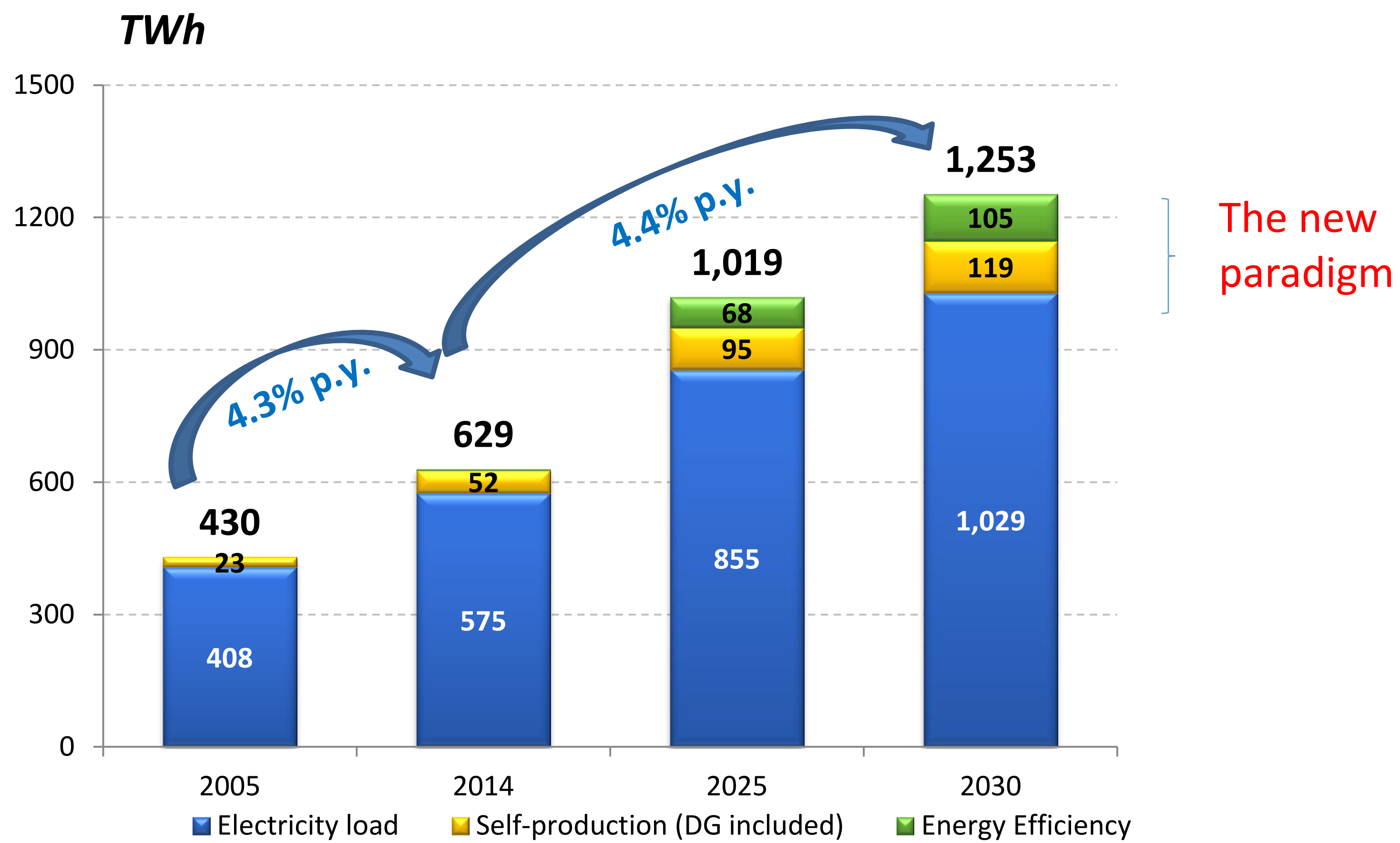
Current Development Actions: Energy Efficiency

(if time)

TOTAL ELECTRICITY CONSUMPTION

Electricity consumption in Brazil will be twice until 2030 (compared to 2014). Energy efficiency and distributed generation will have fundamental role.

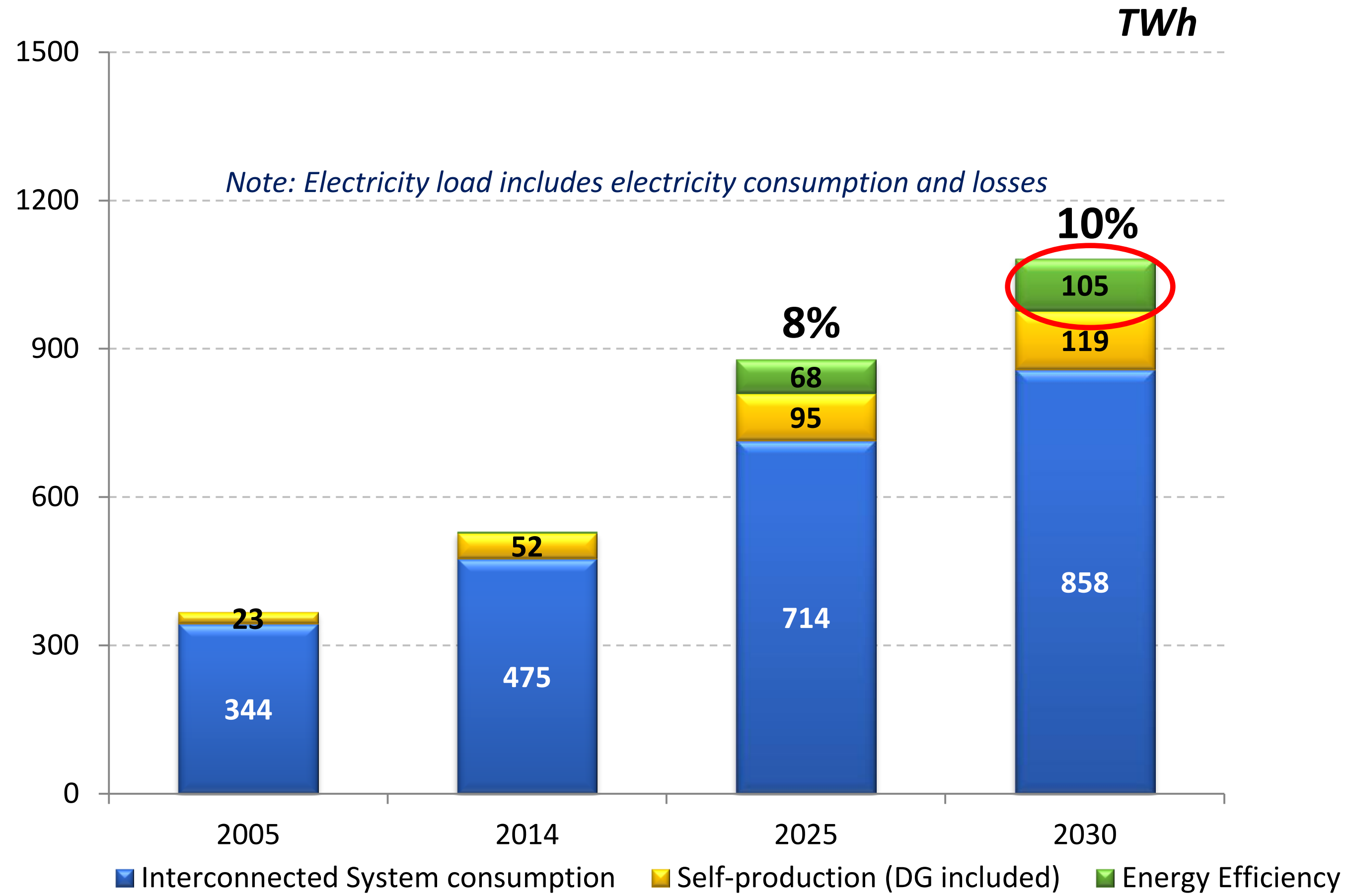


Source: EPE

Note: Electricity load includes electricity consumption and losses

ELECTRICAL EFFICIENCY

For the NDC: *Achieving 10% efficiency gains in the electricity sector by 2030.*

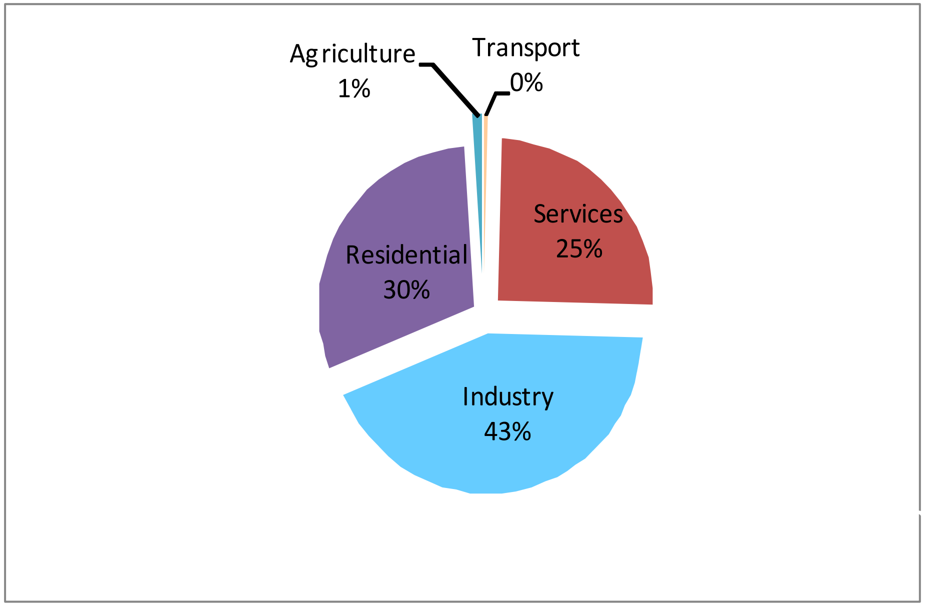


Source: EPE

Note 1: Refers to total electricity consumption. Losses are not accounted for energy efficiency estimates.
Note2: 2013 is the base-year.

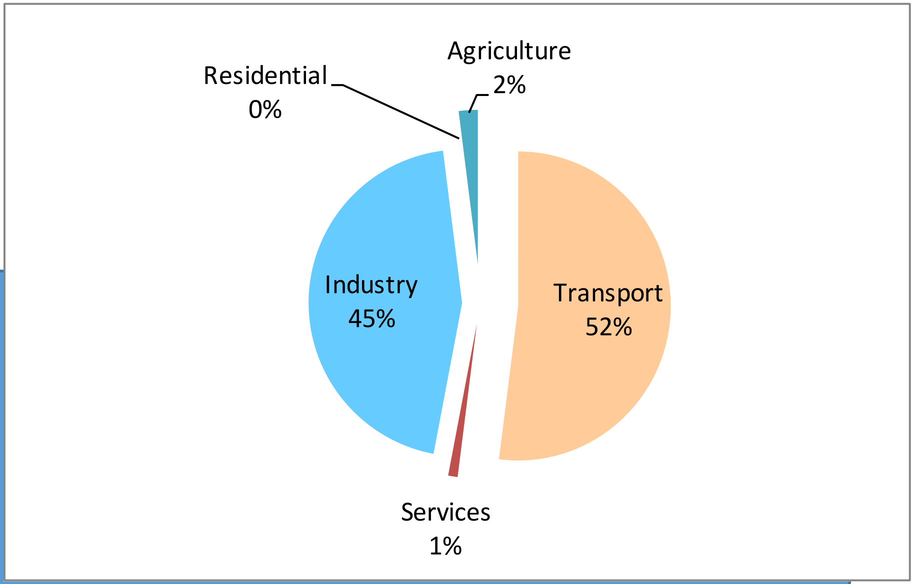
ENERGY EFFICIENCY 2030: ELECTRICITY CONSUMPTION

Contribution the overall electrical efficiency by sector



But considers also...

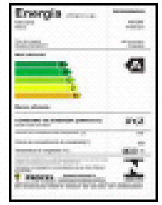
Contribution of each sector to the overall energy efficiency



Possible mechanisms:

- Labelling programs
- Demand response
- Energy Efficient Buildings
- Energy Auditing Programs
- Autonomous actions

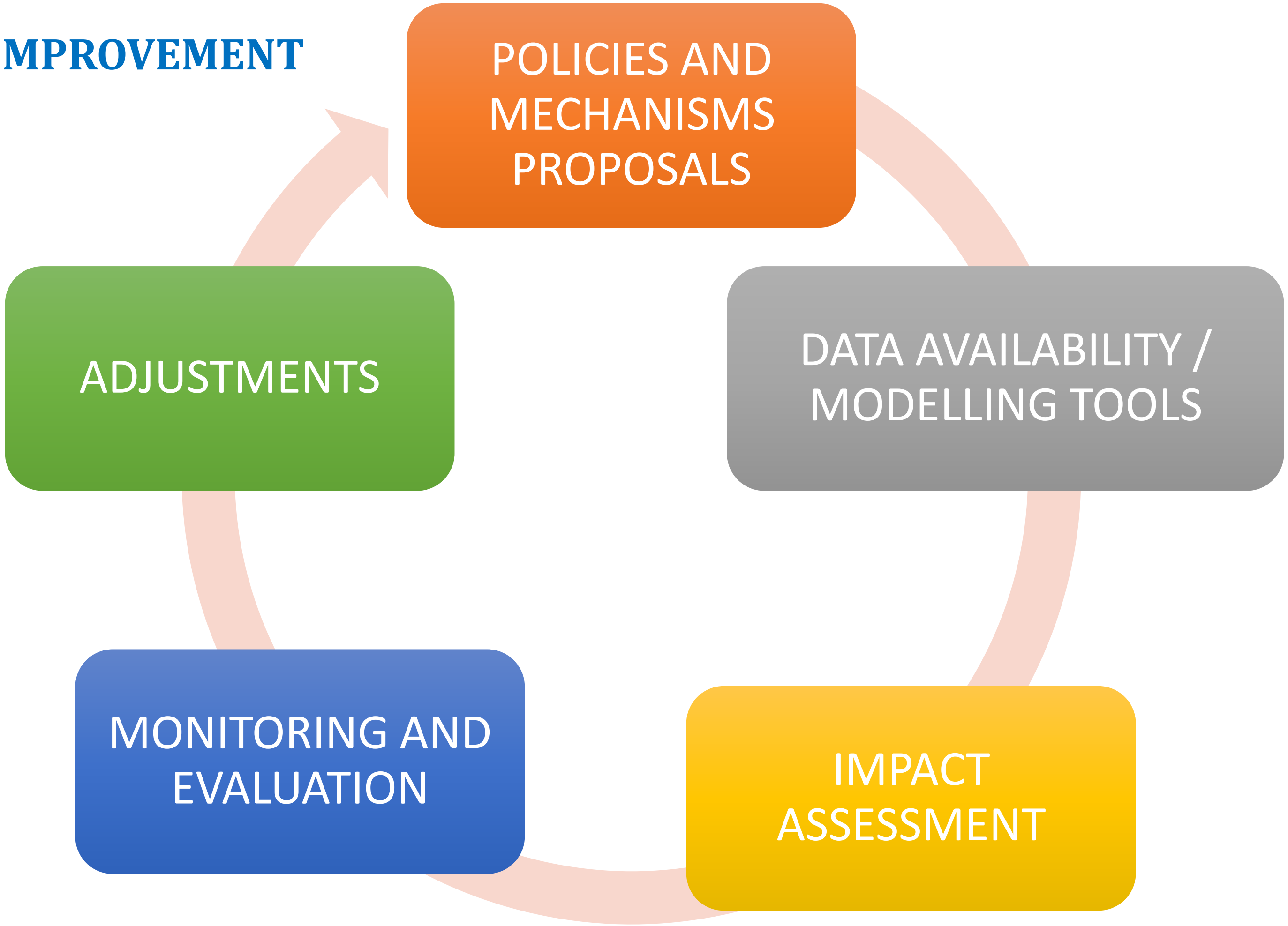
MAIN ACTIONS IN ENERGY EFFICIENCY IN BRAZIL



LABELLING PROGRAM	**PBE** INMETRO	**1984**
NATIONAL PROGRAMS OF ENERGY CONSERVATION (ELETRICITY AND FUELS)	**PROCEL**	**1985**
	conpet	**1991**
UTILITIES ENERGY EFFICIENCY PROGRAM	**PEE –** Programas de Eficiência das Concessionárias de Energia Elétrica	**2000**
MINIMUM EFFICIENCY STANDARDS Standards	**Lei de Eficiência Energética** (nº 10.295, de 17 de outubro de 2001)	**2001**

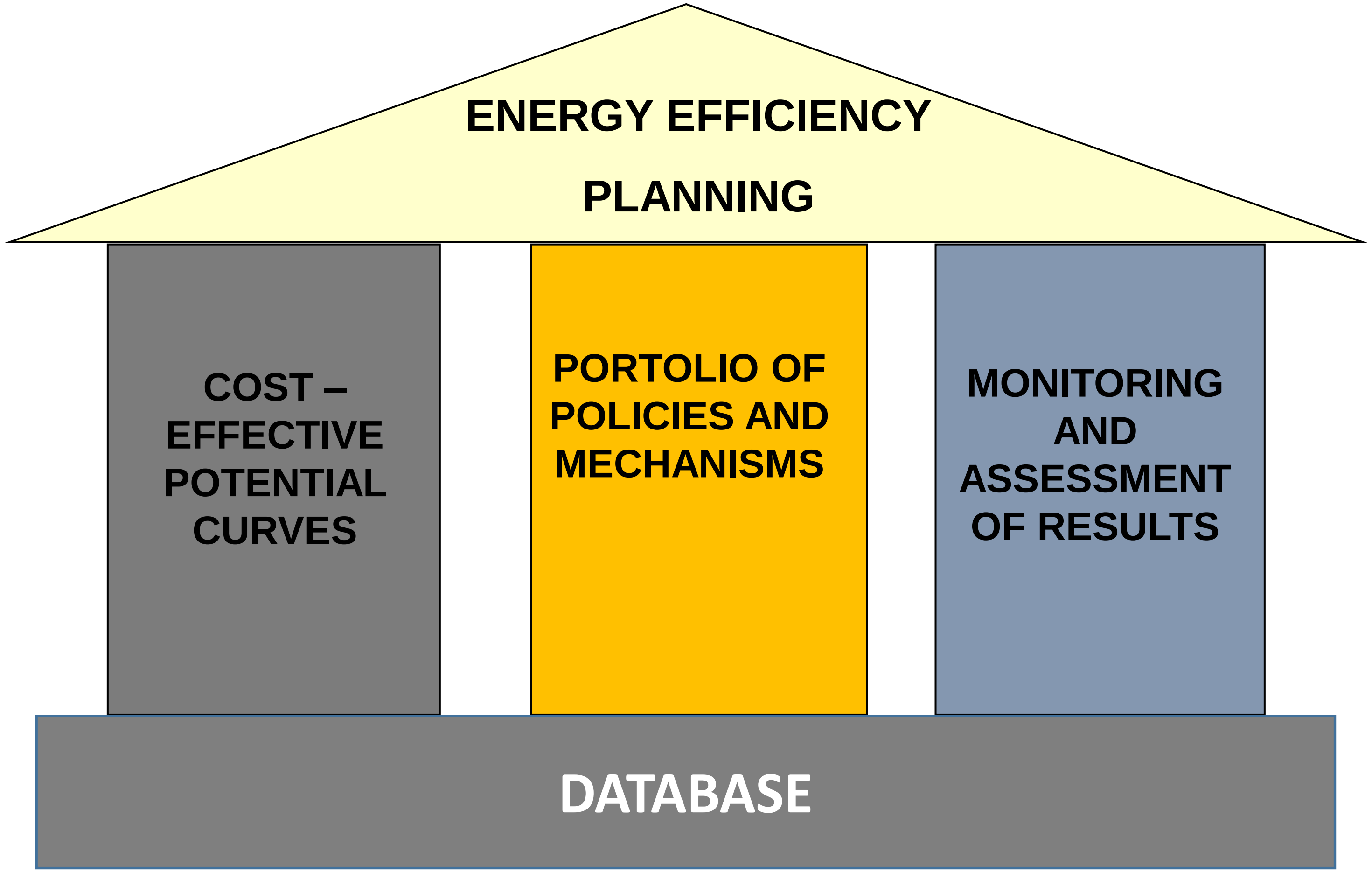
GENERAL APPROACH FOR ENERGY EFFICIENCY

- **CONTINUOUS IMPROVEMENT**

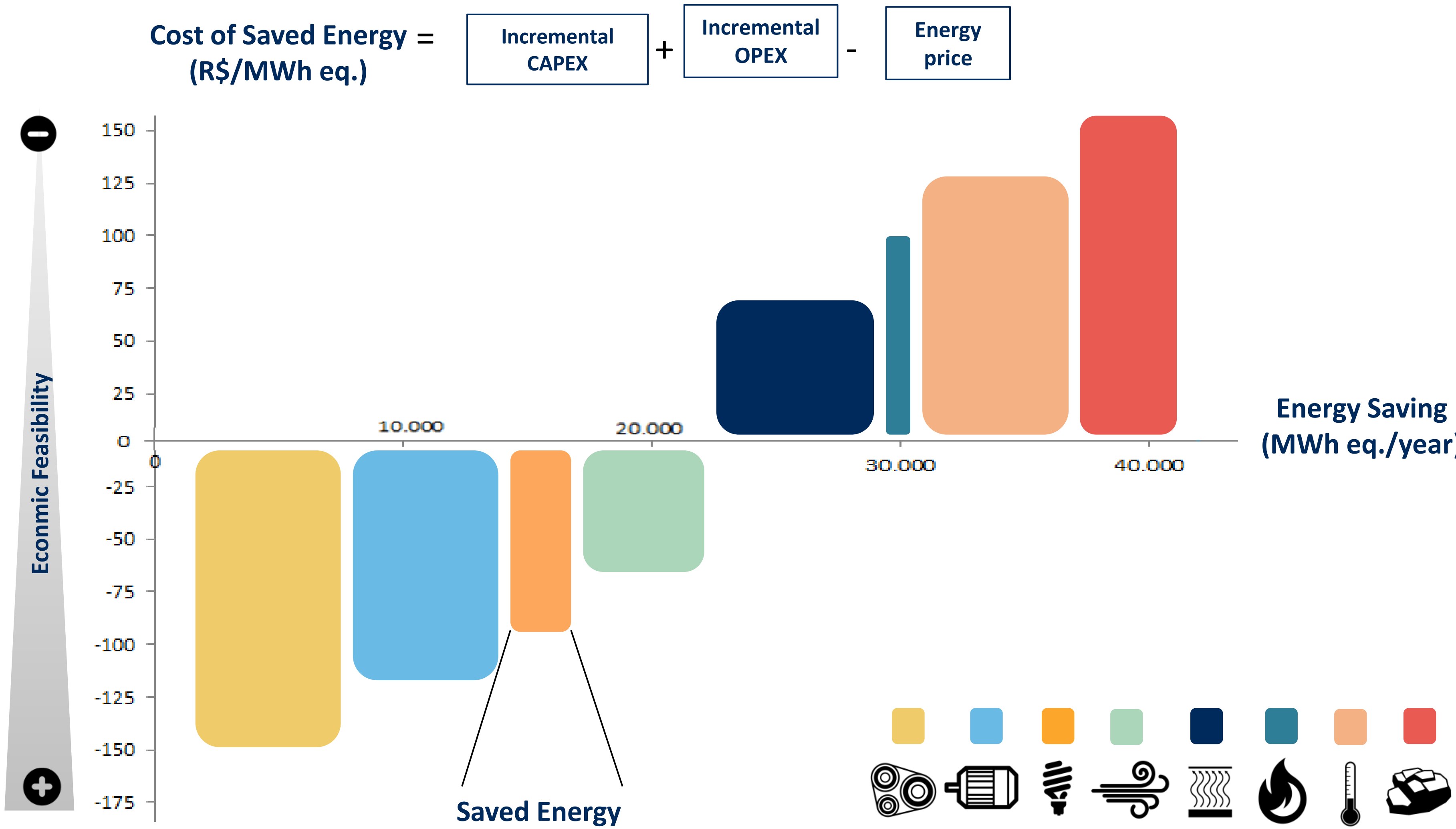


Source: Jannuzzi (2011). Implementing Energy Efficiency in Brazil.. Sinthesis Report.

GENERAL APPROACH FOR ENERGY EFFICIENCY



COST POTENTIAL CURVES FOR ENERGY EFFICIENCY



COST POTENTIAL CURVES FOR ENERGY EFFICIENCY

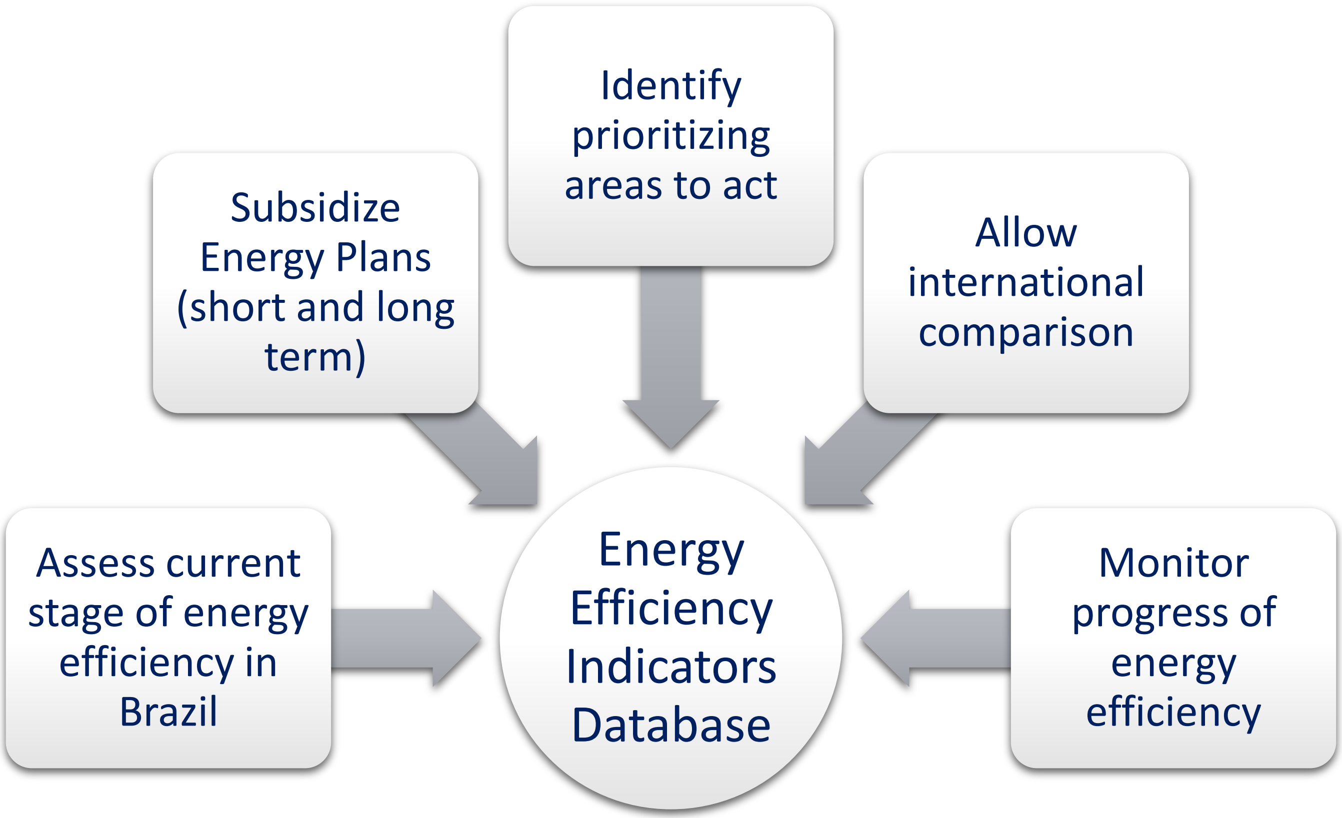
Developed Studies

- ✓ *Iron & Steel*
- ✓ *Ferro-alloys*
- ✓ *Pulp & Paper*
- ✓ *Ceramics*
- ✓ *Alumina*

- ✓ *Chemicals*
- ✓ *Food & Beverages*
- ✓ *Cement*
- ✓ *Mining*
- ✓ *Commercial Buildings*

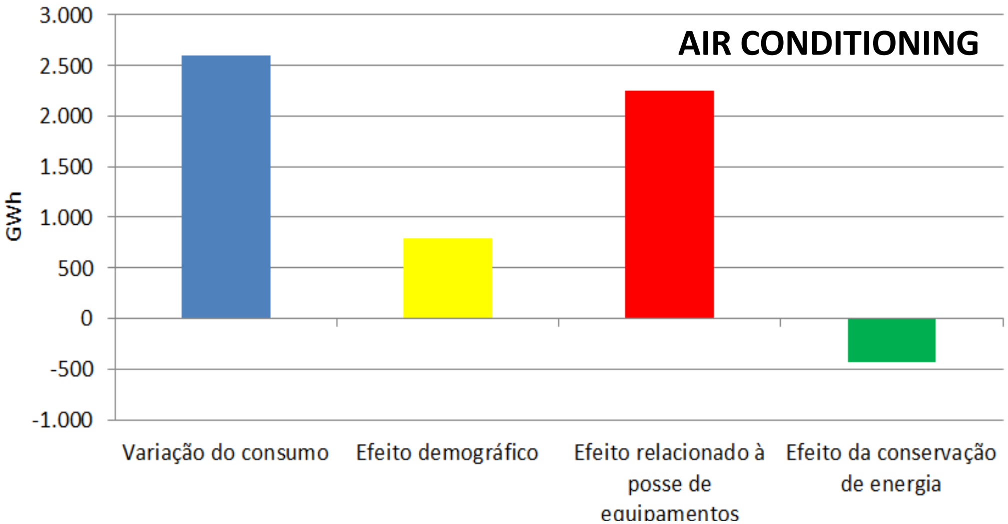
MONITORING PROGRESS OF ENERGY EFFICIENCY

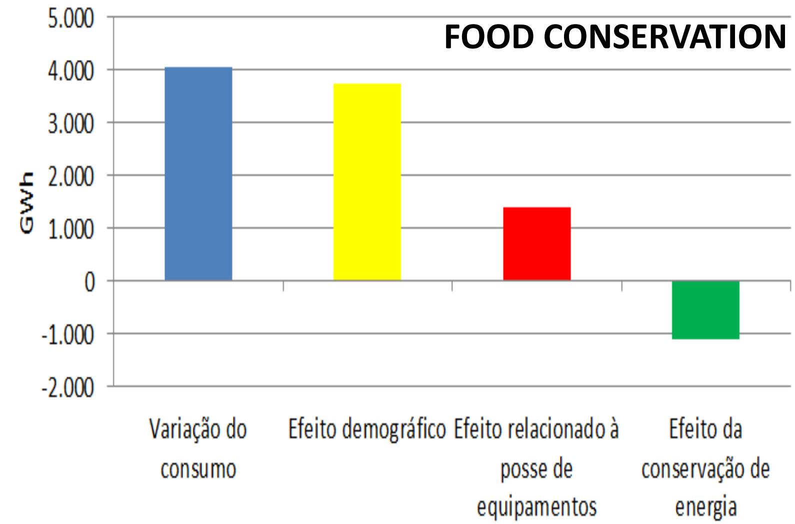
- **Evaluate impact of mechanisms and policies for Energy Efficiency in Brasil**

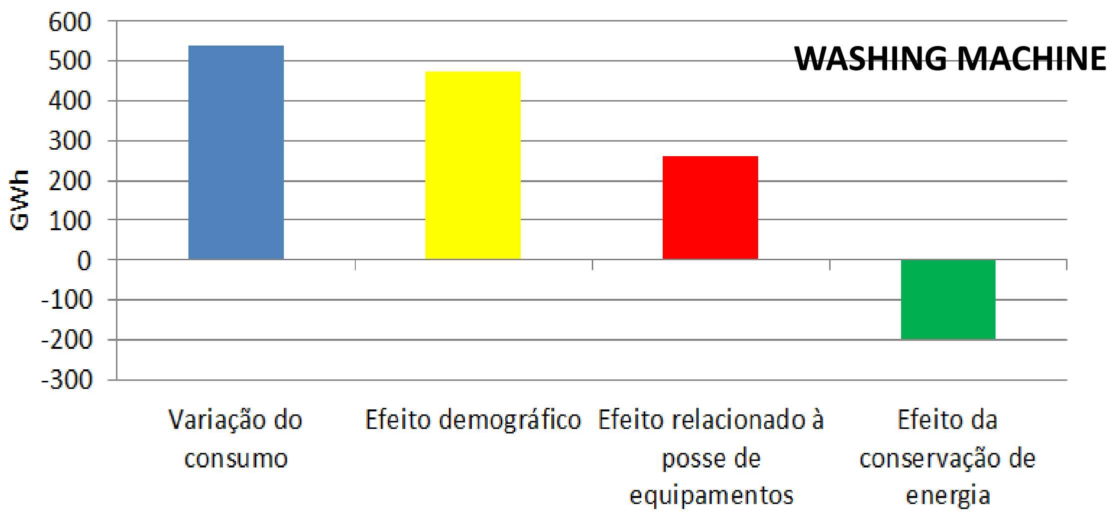


MONITORING PROGRESS OF ENERGY EFFICIENCY

- **HOUSEHOLD SECTOR**







Fonte: EPE (2014). Energy consumption in Brazil. Sectoral Analysis

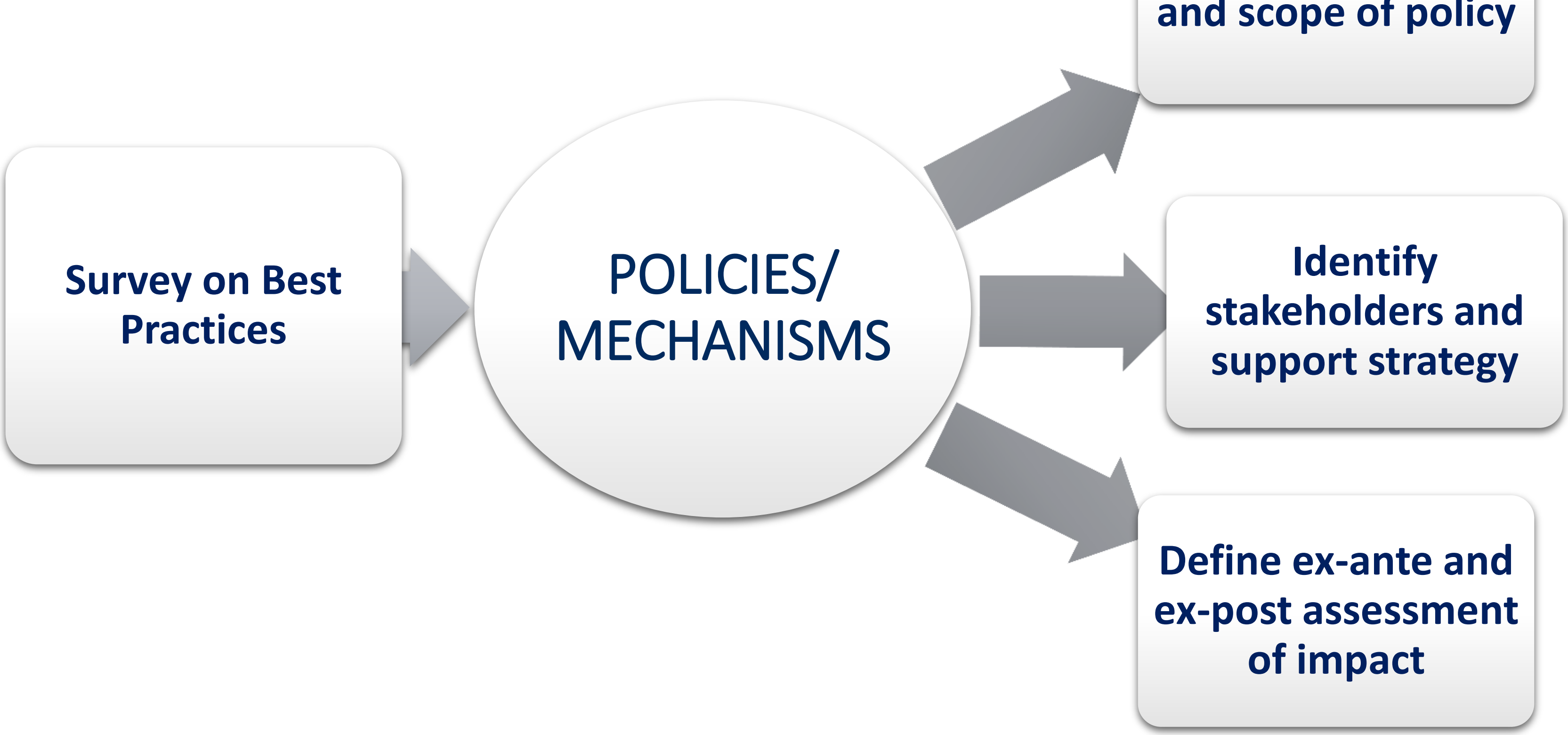
MONITORING PROGRESS OF ENERGY EFFICIENCY

- **CONCLUDED RESULTS**

- Stablishment of Energy Efficiency Indicators Database according to best practices (ODYSSSE)
- Publishing bi-anual reports on Energy Efficiency Indicators for Brazil

POLICIES/MECHANISMS PORTFOLIO FOR ENERGY EFFICIENCY

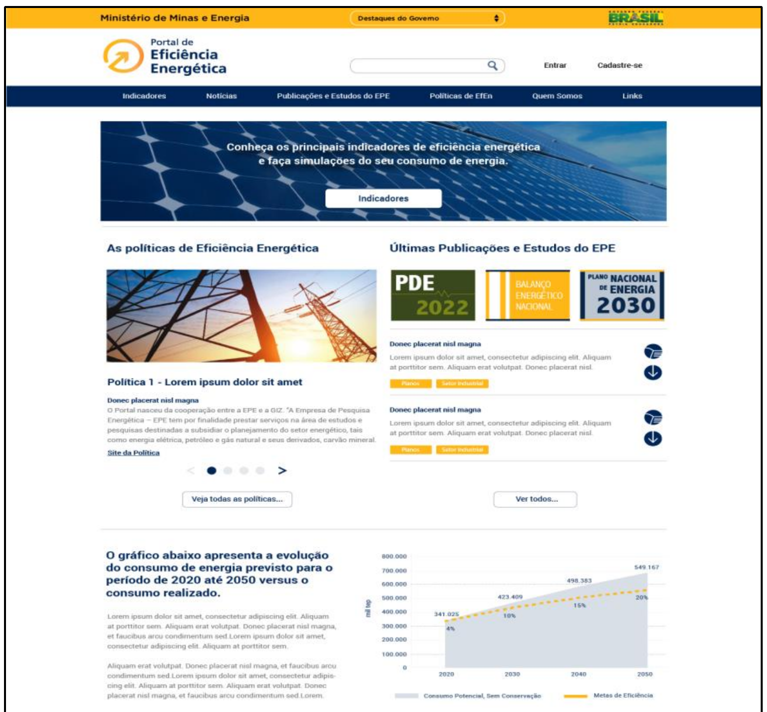
Energy policies customization in order to help energy efficiency action plan

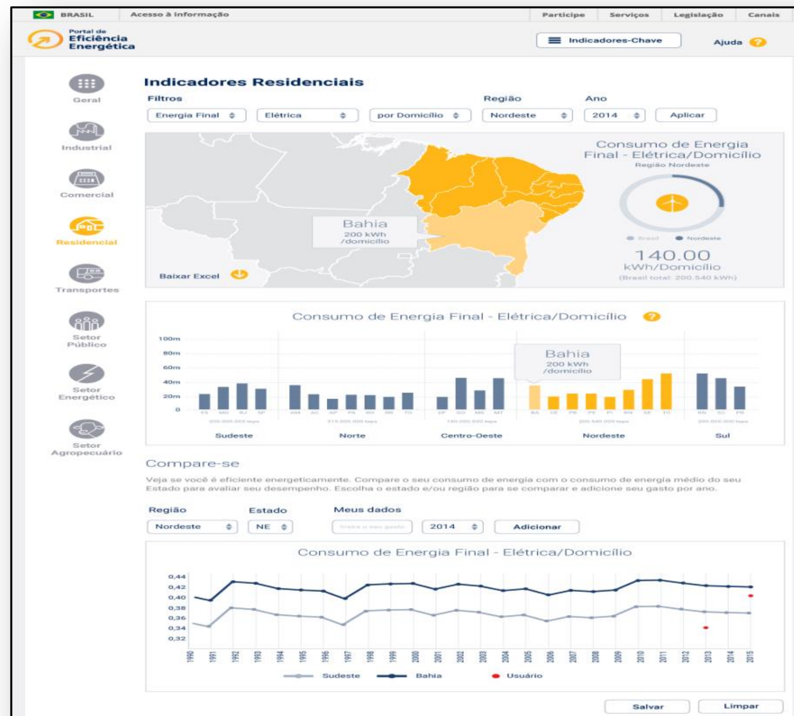


COMMUNICATION STRATEGY: EPE AS A HUB

- **SCOPE**
  - Intends to be a bi-diretional chanell on energy efficiency information (data, studies etc.)
  - Communication tool
  - Partnership to collect data from stakeholders

- **IN PROGRESS**
  - Conceptual project of website (concluded)
  - Next steps: Programming development





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