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Renewable Energy Brazil

April 2013

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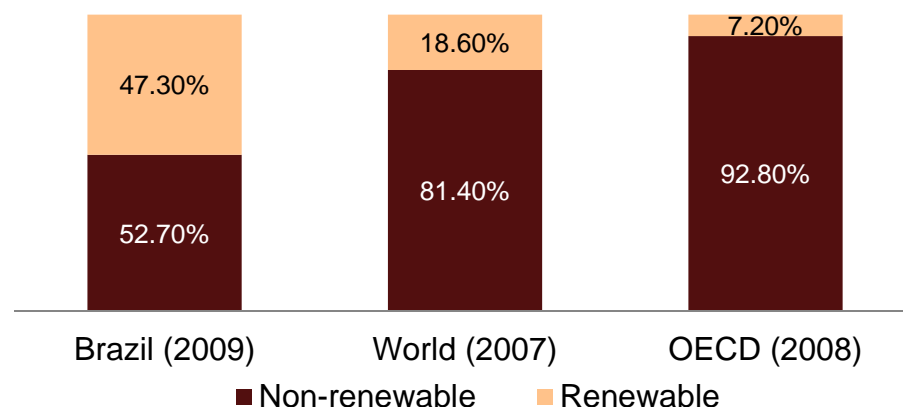
Summary

1. Brazilian Renewable Energy Overview
2. Wind energy
3. Biomass
4. Small Hydro
5. The organized contract auctions for renewable energy
6. Why to Invest on Renewable Energy in Brazil

Brazilian Renewable Energy Overview

Energy Supply Structure

- Brazil has one of the cleanest energy matrices in the world, **47% of the overall energy production comes from renewable sources**
 - ✓ The **worldwide** average is about **19%**



Source: BEN 2010

- **Over 80% of the electricity generation installed capacity** in the country (121,823 MW) comes from renewable sources

Brazilian Renewable Energy Overview

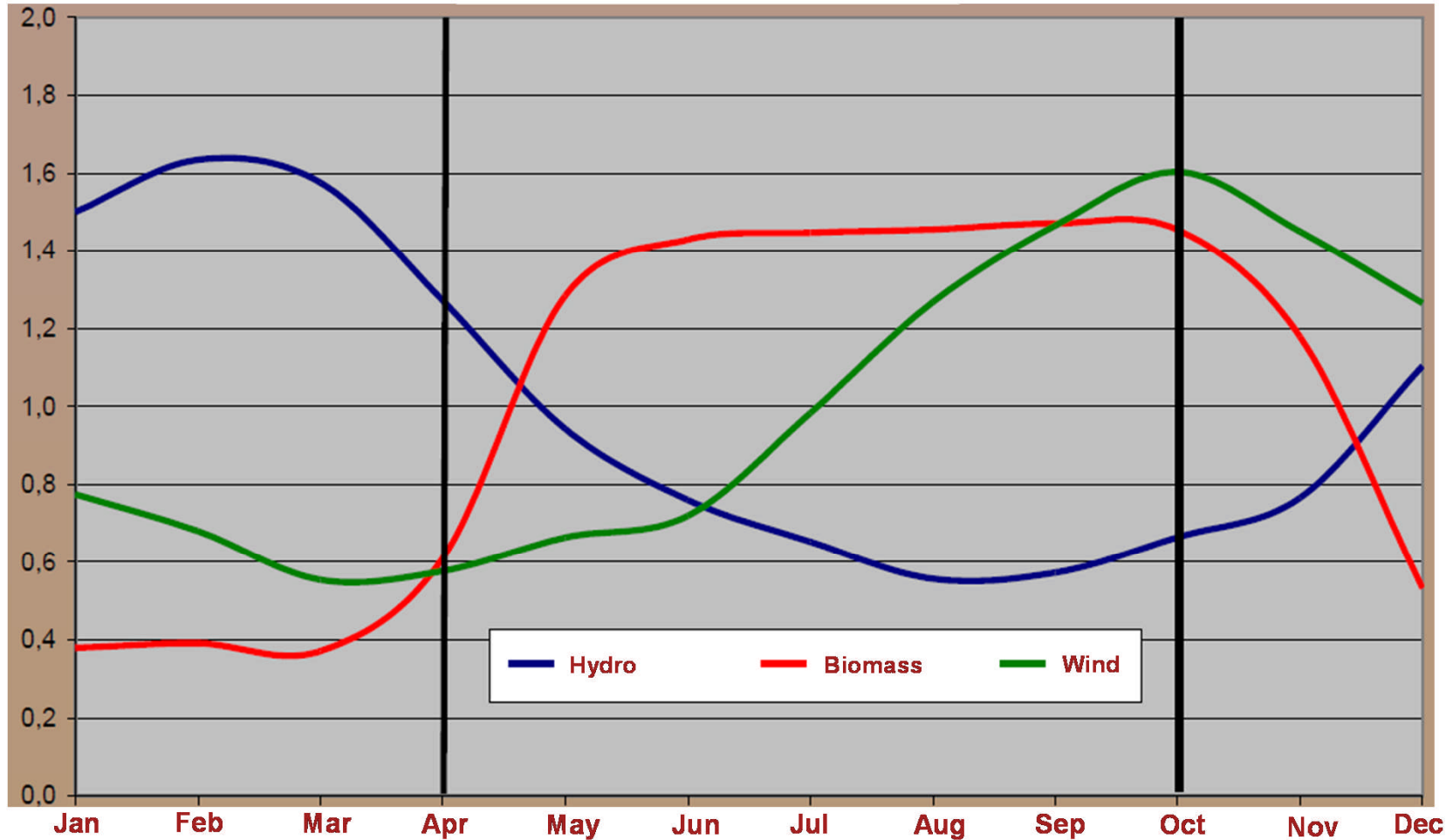
- 85% of the renewable electricity generation capacity comes from **hydro sources**:
 - ✓ Large plants in cascade over different basins
 - ✓ Large reservoirs
- During the last five years **three other renewable resources** have become competitive for large-scale generation expansion:
 - ✓ **Wind power**
 - ✓ **Small hydro**
 - ✓ **Biomass**
- In 2011 the other renewable sources installed capacity totalizes **13,700 MW** and by the end of 2013 is estimated an increasing of **5,900 MW**, currently **under construction**

Brazilian Renewable Energy Overview

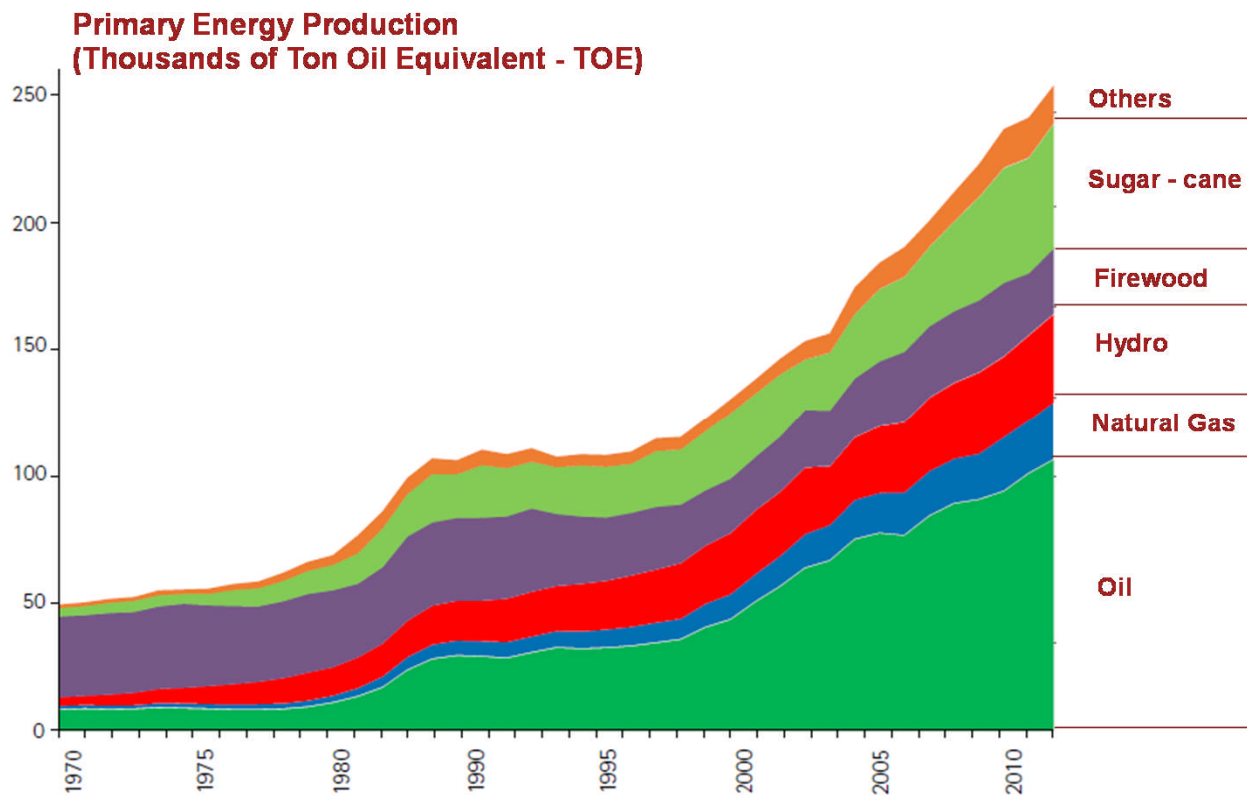
- Brazil's hydro reservoirs and the countrywide transmission grid provides flexibility to modulate seasonal and intermittent generation
- Complementarity generation with hydro:
 - ✓ Hydro and wind (in the Northeast region of the country)
 - ✓ Hydro and bioelectricity (in the Southeast region of the country)

Brazilian Renewable Energy Overview

Complementarity of Biomass and Wind Energy with Hydro



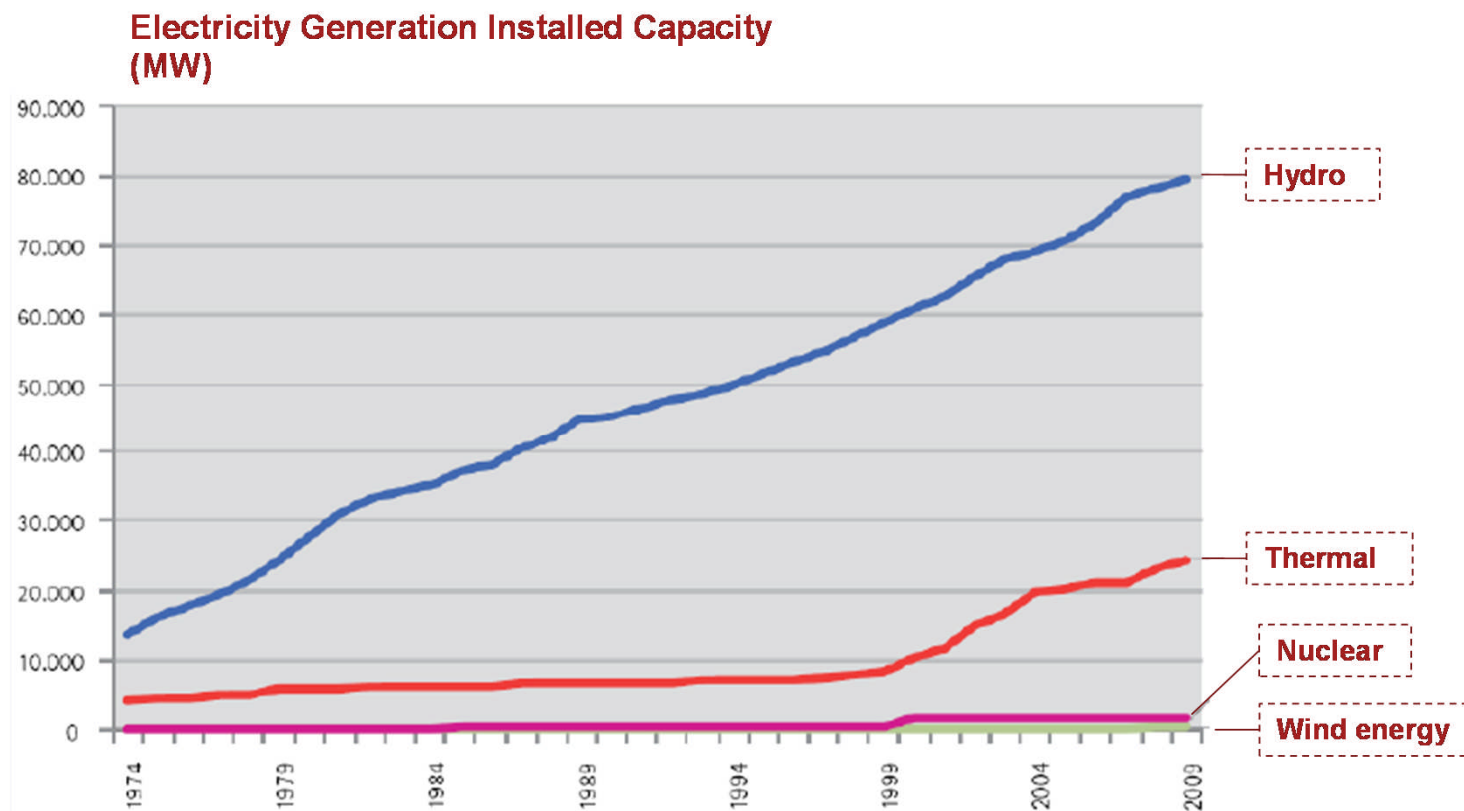
Brazilian Renewable Energy Overview



| | 2002 | ... | 2011 | CAGR |
|------------------------------|----------------|-----|----------------|-------------|
| Oil | 74,927 | | 108,976 | 4.3% |
| Natural Gas | 15,416 | | 23,888 | 5.0% |
| Hydro | 24,604 | | 36,837 | 4.6% |
| Firewood | 23,645 | | 26,322 | 1.2% |
| Sugar Cane | 25,279 | | 43,270 | 6.2% |
| Others | 5,055 | | 11,200 | 9.2% |
| Total (thousands TOE) | 168,926 | | 250,492 | 4.5% |

Source: BEN 2011, Chapter 1 Energy Analysis and Aggregated data

Brazilian Renewable Energy Overview



Source: BEN 2011, Chapter 2 - Energy Supply and Consumption by Source

| | 2002 | | 2011 | CAGR |
|-------------------|---------------|------|----------------|-------------|
| Hydro | 64,473 | | 82,459 | 2.8% |
| Thermal | 13,813 | | 31,243 | 9.5% |
| Nuclear | 2,007 | | 2,007 | 0.0% |
| Wind power | 22 | | 1,426 | 59.0% |
| Total (MW) | 80,315 | | 117,135 | 4.3% |

Brazilian Renewable Energy Overview

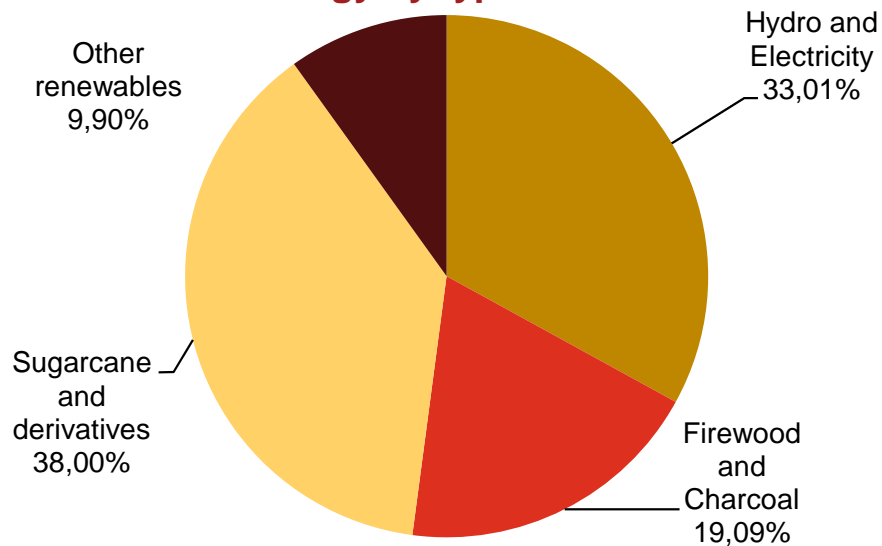
Renewable Energy on the Brazilian Energetic Matrix

In 2012

In 2021

Energetic Matrix 2012

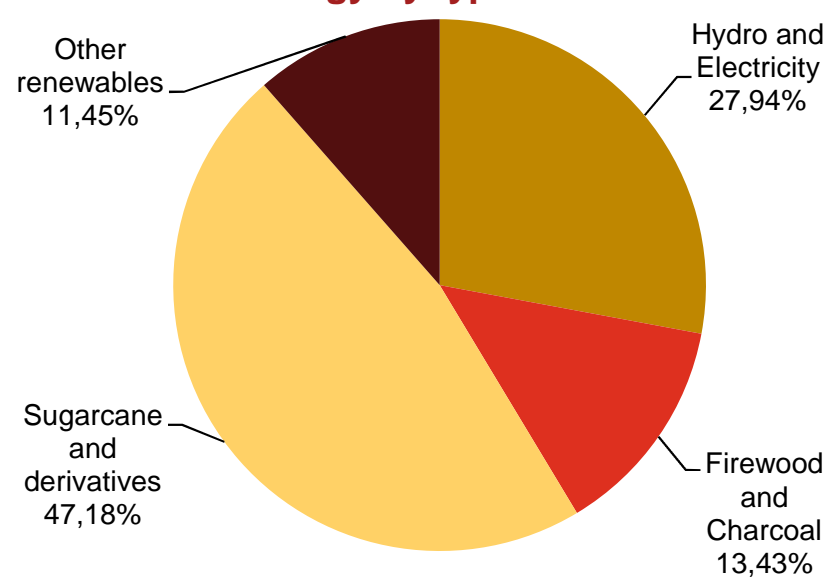
Renewable Energy by type of source



Source: PDE 2012 - Results

Energetic Matrix 2021

Renewable Energy by type of source



Source: PDE 2012 - Results

Brazilian Renewable Energy Overview

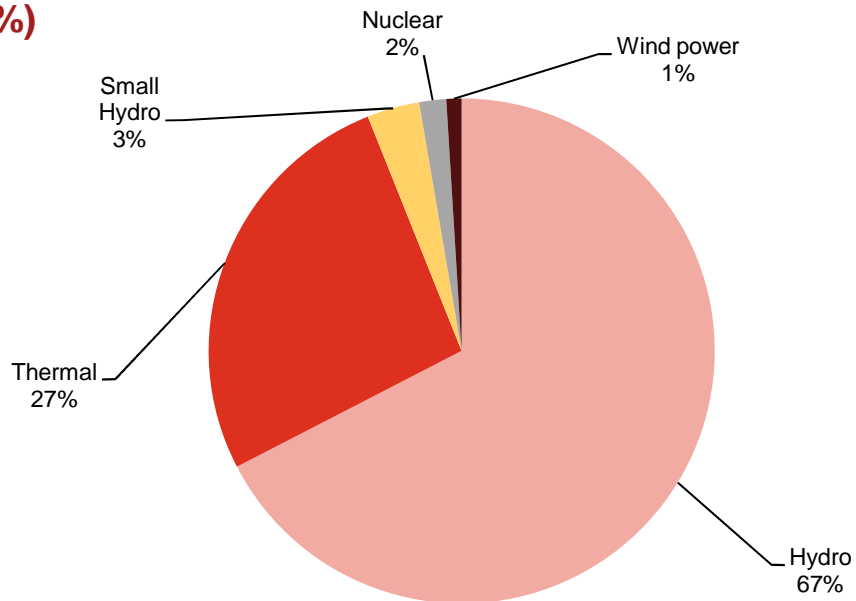
| Source | Authorized and Contracted Plants | | Planned plants | | Total | |
|--------------------------|----------------------------------|---------------|----------------|---------------|--------------|---------------|
| | Billion US\$ | % | Billion US\$ | % | Billion US\$ | % |
| Hydro | 20.5 | 34.8% | 33.7 | 56.7% | 54.1 | 45.8% |
| Small Hydro-Biomass-Wind | 16.7 | 28.4% | 24.4 | 41.1% | 41.1 | 34.8% |
| Thermal | 10.8 | 18.4% | 0.7 | 1.1% | 11.5 | 9.7% |
| Nuclear | 3.1 | 5.3% | - | 0.0% | 3.1 | 2.6% |
| Natural Gas | 1.5 | 2.6% | 0.7 | 1.1% | 2.2 | 1.8% |
| Coal | 1.2 | 2.0% | - | 0.0% | 1.2 | 1.0% |
| Oil/diesel | 5.0 | 8.5% | - | 0.0% | 5.0 | 4.2% |
| Total | 58.7 | 100.0% | 59.4 | 100.0% | 118.1 | 100.0% |

Source: PDE 2011

- This ten years plan (2012-2021) requires an investment of approximately US\$ 118.1 billions, of which US\$ 58.7 billions have already been assigned through energy auctions.
- Within this plan, the remaining US\$ 59.4 billion are to be invested throughout the next ten years on Hydro, Small Hydro, Biomass and Wind energy plants.

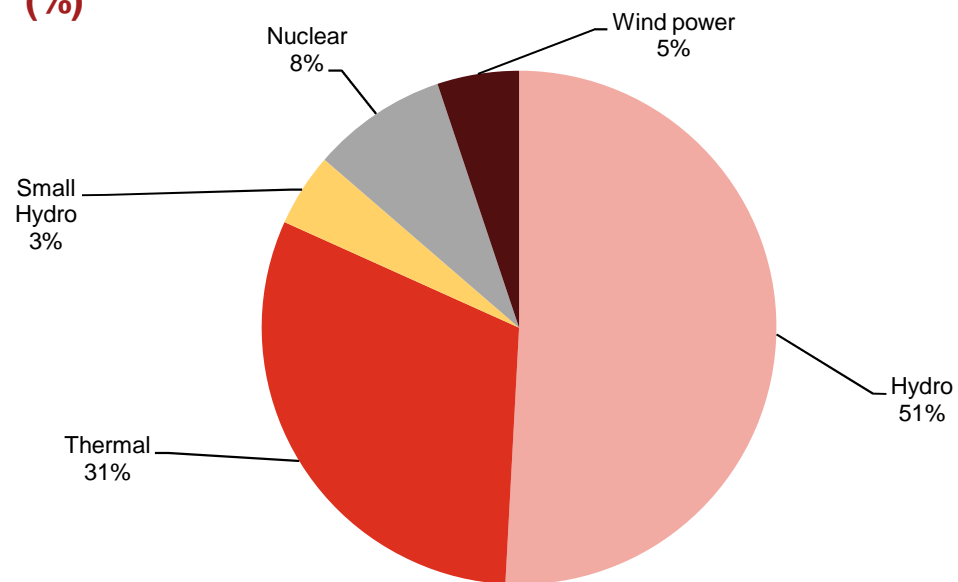
Brazilian Renewable Energy Overview

Power Plants in Operation in 2011 (%)



Source: ANEEL

Power Plants under Construction in 2011 (%)



Source: ANEEL

| | Operation | Construction | Total |
|--------------------|----------------|---------------|----------------|
| Hydro | 77,742 | 8,053 | 85,795 |
| Thermal | 30,581 | 4,892 | 35,473 |
| Small Hydro | 3,857 | 729 | 4,586 |
| Nuclear | 2,007 | 1,350 | 3,357 |
| Wind power | 1,114 | 813 | 1,927 |
| Total (MWh) | 115,301 | 15,837 | 131,138 |

Source: ANEEL

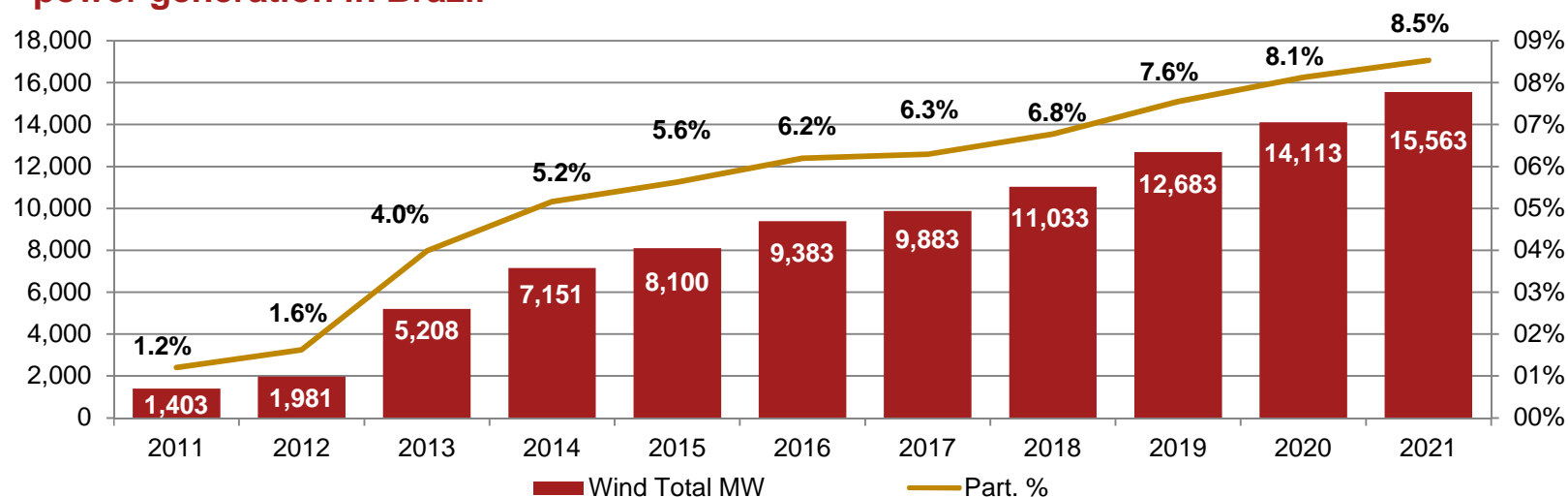
Wind Energy

- Currently 59 wind farms are in operation, mostly concentrated in the Northeast and South regions;
- The milestone of 1,000 MW was achieved in June 2011;
- In 2021 the installed wind capacity in Brazil should be on order of 15,500 MW (8.5% of the total energy, compared to 1.2% current).
 - ✓ Other countries in Europe uses around 10%;

Source: Moody's, National Agency of Electricity (ANEEL), Globo Natureza, GWEC.

Wind Energy

Participation of wind energy installed capacity of power generation in Brazil



Source: PNE 2011, Chapter III – Electricity generation

- BNDES (National Development Bank of Brazil), has signed or is in the process of signing around 51 contracts of direct and indirect funding, totaling US\$ 2 billion for the deployment of 1,369 MW. Another 44 operations are in analysis, with applications for funding of around US\$ 1.7 billion

Wind Energy

| Country (MW) | Electricity generation Installed Capacity | | Main generating source in 2008 | Wind generating Installed Capacity | | |
|--------------|--|-----------|-----------------------------------|---------------------------------------|---------|-------|
| | 2008 | 2020 | | 2008 | 2020 | CAGR |
| Brazil* | 102,949 | 173,645 | 85% hydro | 398 | 14,113 | 34.6% |
| Russia | 224,240 | 235,000 | 68% thermal | 17 | 7,000 | 65.2% |
| India | 177,376 | 290,000 | 80% thermal | 10,243 | 16,000 | 3.8% |
| China | 797,078 | 1,313,000 | 77% thermal | 12,170 | 99,000 | 19.1% |
| World | 4,624,767 | 5,796,000 | 82% hydro | 121,000 | 398,000 | 10.4% |

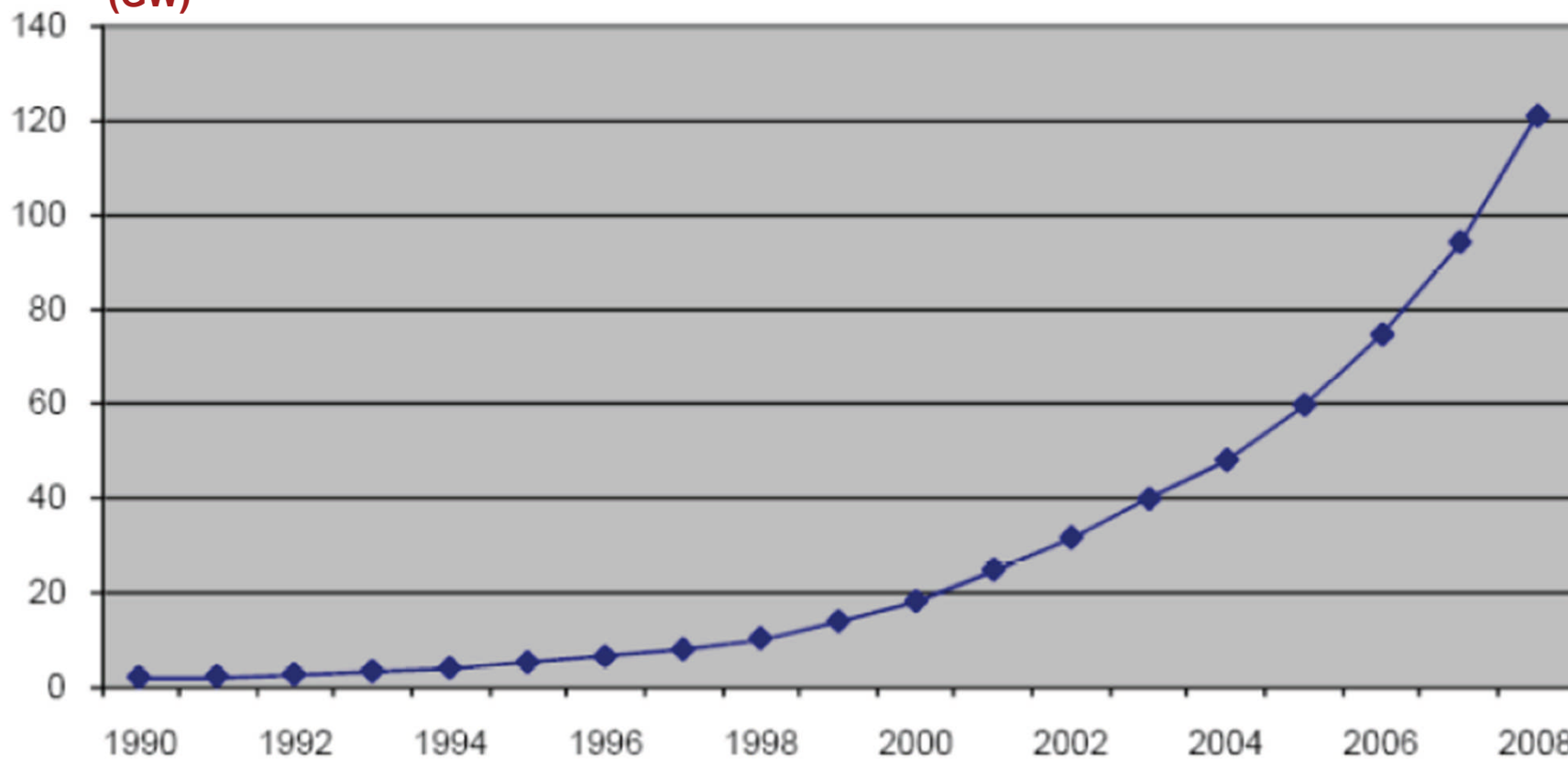
Source: BEN 2011 - Energy Supply and Consumption by Source

U.S. Energy Information Administration (EIA), International Energy Statistics database

(*) PDE 2011

Wind Energy

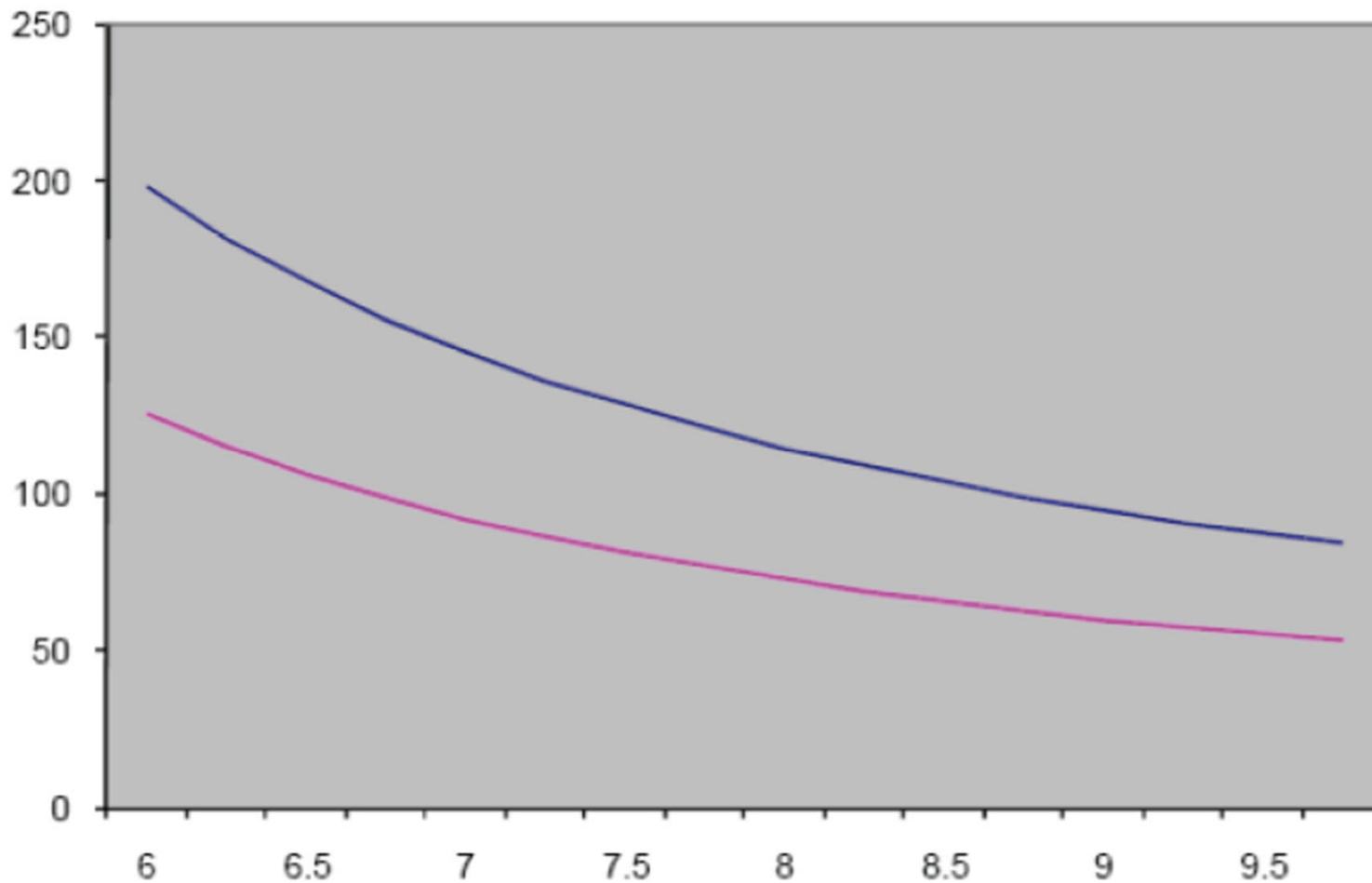
Growth of World wind energy generating capacity (GW)



Source: World Energy Council

Wind Energy

Onshore wind energy generation cost (US\$/MWh) by Wind speed (m/s)

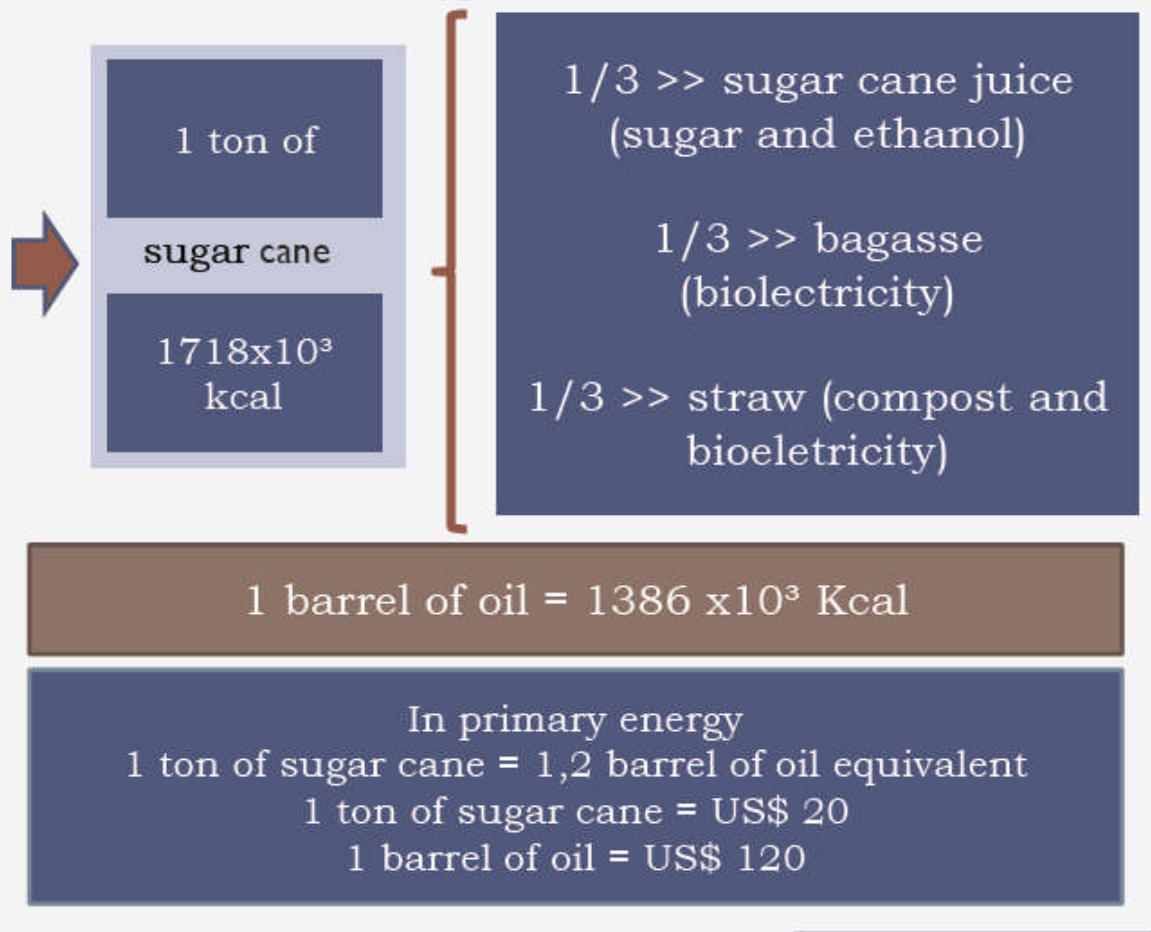


Source: World Energy Council

Wind Energy

- Wobben – Enercon (Germany) -> São Paulo
- Alstom (France) -> Bahia
- Gamesa (Spain) -> Bahia
- GE (USA) -> São Paulo e Bahia
- Impsa (Argentina) -> Pernambuco e Bahia
- Vestas (DM) -> Ceará
- MTOI -> Santa Catarina
- 3 coming from China 
 - Sinovel
 - Gouldian
 - Goldwin

Biomass



Source: União da Indústria de Cana de açúcar (UNICA)

Biomass

- Sugarcane production is concentrated on **Center-South** and **Northeast regions** of Brazil.
- U.S. Environmental Protection Agency (EPA) classified Brazilian sugarcane ethanol as **capable of reducing greenhouse gas (GHG) emissions by at least 50% compared to gasoline;**
- Processed Residues from sugarcane (**bagasse and straw**) are alternatives for **generating electricity.**
- **Bioelectricity** supplied to the national grid could increase from 5% in 2012 to **up of 18% of the Brazilian energy grid by 2021,**

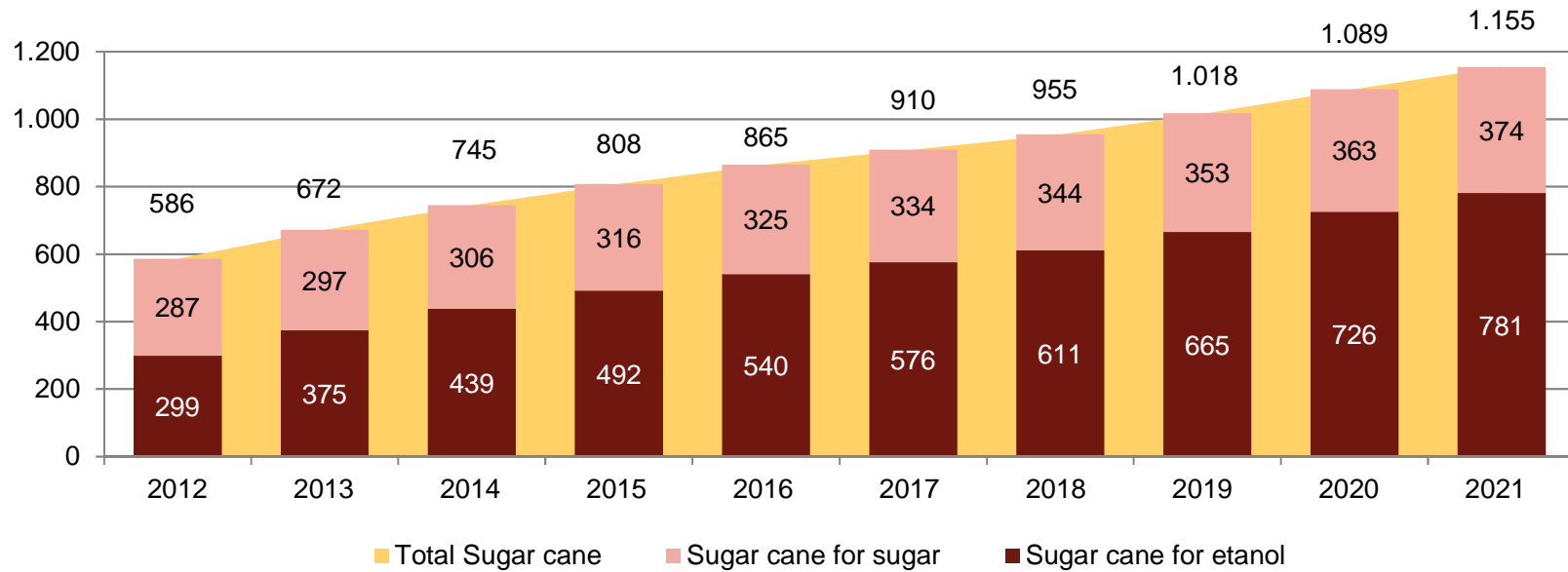
Biomass

- Increasing the **annual reduction in emissions** generated by the use of ethanol and bioelectricity in Brazil **from 46 million tons of CO₂ equivalent reached in 2011, up to 112 million tons by 2020.**

- Biomass is an strong option to **deal with the unpredictable behavior of rainy periods** along the year:
 - ✓ In March 2013, at the end of the rainy period the hydro power plants located on **Southeast and Middle West reservoirs (70% of Brazilian water reservoirs)** were operating at **49.9% of its capacity.**
 - ✓ In comparison to the previous three years, when the reservoirs operated at **82.9% (2010), 83% (2011) and 78.5% (2012).**
 - ✓ In March 2013 the Northeast region the reservoirs were operating with 42% of its capacity. In March 2012 was 82%;

Biomass

Sugar cane total demand projection (Million of Ton)



Source: BEN 2012 - Energy Supply and Consumption by Source

| | 2012 | | 2021 | CAGR |
|--|------------|------|--------------|-------------|
| Sugar cane for ethanol | 299 | | 781 | 11.3% |
| Sugar cane for sugar | 287 | | 374 | 3.0% |
| Total Sugar cane (Million of ton) | 586 | | 1,155 | 7.8% |

Small Hydro

- The Small Hydro classification is related with the following characteristics:
 - Location: Installed on reservoirs that does not permit the water flow regularization,
 - Generation installed capacity
 - ✓ Beyond 1 MW
 - ✓ 1.1 MW to 30 MW,
 - ✓ Above 30 MW

Small Hydro

| River Basin | Hydro Resource generation Potential (MW) | | | |
|--------------------------------|--|------------------------|---------------|----------------|
| | Amazon | Tocantins/ Araguaia | Others | Total |
| Exploited potential 2011 | 835 | 12,198 | 64,744 | 77,777 |
| Potential expansion until 2015 | 12,153 | 2,428 | 5,563 | 20,144 |
| Potential expansion 2015-2020 | 16,943 | 1,600 | 5,000 | 23,543 |
| Potential expansion 2020-2030 | 44,200 | 3,200 | 5,000 | 52,400 |
| Total (MW) | 74,131 | 19,426 | 80,307 | 173,864 |

Note:

1. Exploited potential includes plants in operation, under construction and commissioned
2. Excludes Itaipu's exceed production imported by the Brazil
3. Figures indicate only 50% of binational power plants
4. The generating potential of small hydro plants is not taken into account.

Source: PNE 2030 - Hydro generation

| Plant potential | Small Hydro Plants generation Potential (MW) | | | | | |
|------------------------------|--|------------|--------------|--------------|--------------|---------------|
| | North | North-east | Central-west | South-east | South | Brazil |
| Known potential ¹ | 773 | 706 | 2,808 | 3,275 | 2,899 | 10,461 |
| Theoretical potential | 4,763 | 155 | 3,911 | 3,625 | 3,000 | 15,454 |
| Total (MW) | 5,536 | 861 | 6,719 | 6,900 | 5,899 | 25,915 |

Source: CERPCH

(¹) does not includes plants in operation

The organized contract auctions for renewable energy

- Contract auctions are integrated into the regulatory framework since 2004
- Regular auctions offer mid- and long-term contracts ahead of delivery, in an exclusive “investment market” for new capacity
- Original motivation was price disclosure and efficiency in the procurement process (reduction of asymmetric information)

The organized contract auctions for renewable energy

- 62,000 MW of new capacity contracted since 2005 for future delivery
 - ✓ 25 auctions for new capacity, including 8 renewable energy auctions
 - ✓ 443 new generation projects from all types of technologies
 - Gas, renewable, conventional & large hydros, etc
 - ✓ 60% renewable in total (40% is conventional hydro & 20% other renewable)
 - ✓ Average price: ~70 US\$/MW
 - ✓ US\$ 300 billion in contracts

The organized contract auctions for renewable energy

- Regular (yearly) auctions exclusive for new energy
 - ✓ Volumes to contract (regulated consumers pay) and centralized procurement (economies of scale) is organized by the government
 - ✓ Standardized long-term energy contracts offered, backed by firm energy
 - ✓ Technology-neutral but the government can interfere in the candidate projects with policy decisions:
 - ✓ has been used to organize project-specific auctions (e.g. large hydros), to avoid oil- and coal-fired generation as candidate supply and to contract renewable

The organized contract auctions for renewable energy

Auctions schedule

2008 - 2011

2012

2013

2014

2015

2016

2017-2021

All the closed auctions during the period 2008-2011, listed below, are planned to be concluded and delivered by 2015:

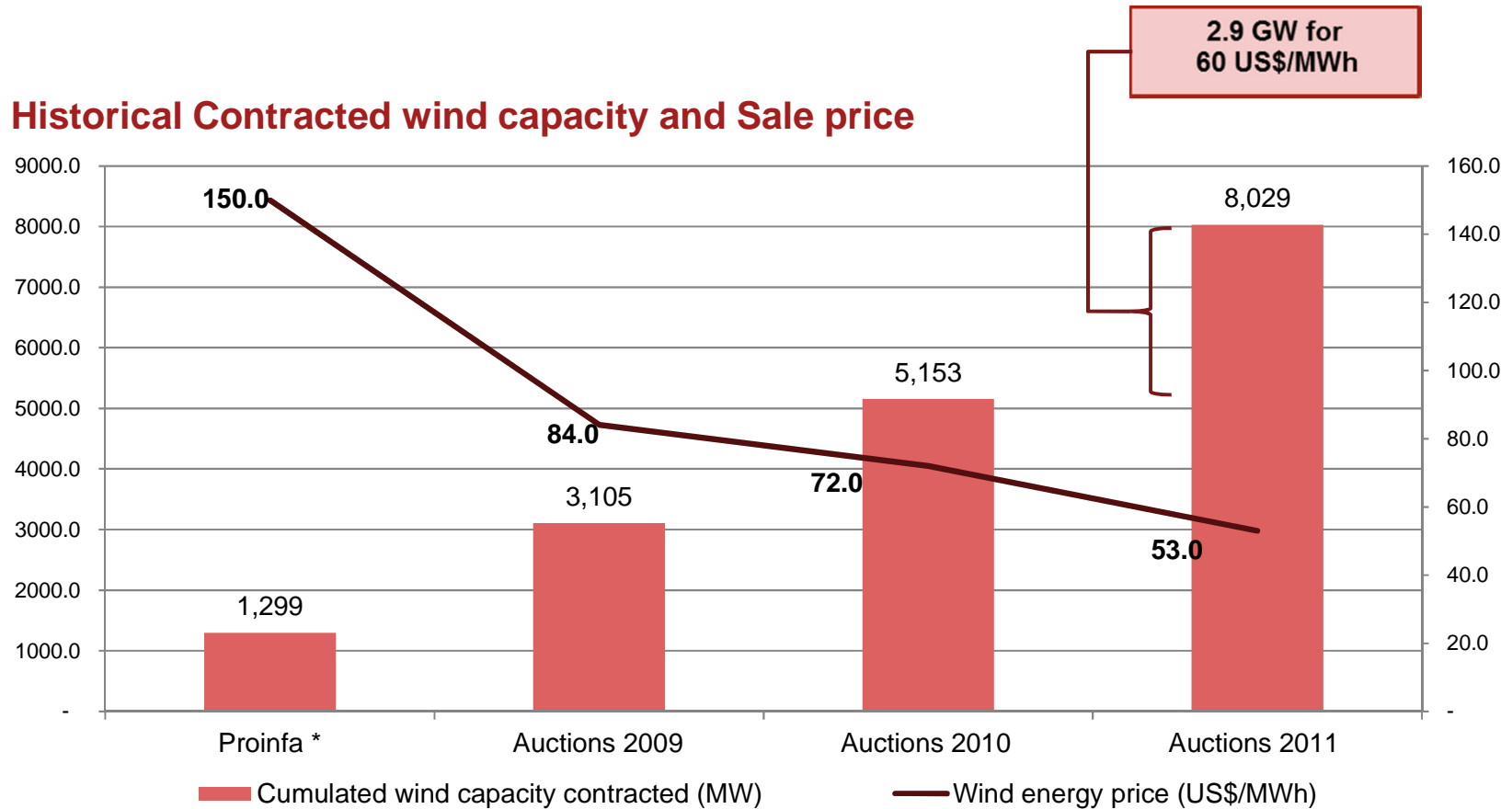
- In 2012: A-5/2007, S. Antonio, A-3/2009
- In 2013: Jirau 2008, A-5/2008, 2nd LFA 2010
- In 2014: A-3/2011
- In 2015: 10 A-5/2010, 11 A-5/2010, B.Monte, A-3/2012.

By now it just was programmed to close one Auction in 2013 (A-3/2013) which should be concluded and delivered in 2016.

Source: EPE

The organized contract auctions for renewable energy

Historical Contracted wind capacity and Sale price



Source: CCEE

(*)Proinfa was the first RES support mechanism in the country, based on feed-in rate (administratively set)

Why to Invest on Renewable Energy in Brazil

- Vast energy potential
- Renewables sharing 45% of energy matrix
- Consumption average annual growth of 5,3%
- 6,000 MW of new generating capacity per year until 2020
- Large experience in engineering, construction and operation of power systems
- Major producer of sugar cane, alongside with India
- Major biofuels producer
- Largest exporter and second largest producer of ethanol
- Large areas available for agricultural expansion

Thank you

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