Brazilian Bioethanol Science and Technology Laboratory

CNPEM

A Brief History and Present Situation of the Export of Electricity to the Grid by Sugarcane Industries in Brazil

ISSCT Coproducts Workshop

Manoel Regis L. V. Leal
Brazilian Bioethanol Science and Technology Laboratory (CTBE)
National Research Center for Energy and Materials (CNPEM)

Mauritius, November 30 – December 3, 2015

Outline

- History
- Sugarcane in the energy matrix
- Commercial alternatives
- Future: potential, demand, barriers
- Economic impact of EE
- Final comments

Brief History of Cogeneration in Sugar/Ethanol mills

- **Before 1975**: steam pressure mostly in the 10 to 22 bar range; use of firewood to supplement bagasse and part of electricity purchased from the grid
- **First step**: self sufficiency with steam conditions at 22 bar/ 320 ° C
- **Second step**: steam pressure increase to 45 – 65 bar to generate surplus power for sale
- **After 2007**: nearly all boilers sold with steam pressure above 60 bar and targeted surplus 60 kWh/tc and above; increase in CEST systems
- **State of the art technology available**: electrification of mills' drivers, fluidized bed boilers, regenerative cycle, steam conditions up to 140 bar/ 545 ° C, trash collection and use starting

Legal Framework

- Privatization of the power sector in the mid 1990's, creation of the Independent Power Producer (IPP) and opening the transmission/distribution grid to IPP's were fundamental changes to enable surplus electricity sales
- Institutional and technical problems are inhibiting the realization of the technical potential

Sugarcane as an Energy Source

- Sugarcane became the second most important primary energy source in Brazil (behind oil)
- This situation tends to improve in the future if its full potential is pursued, especially in power generation
- Ethanol is a consolidated alternative, but electricity is still struggling for its future

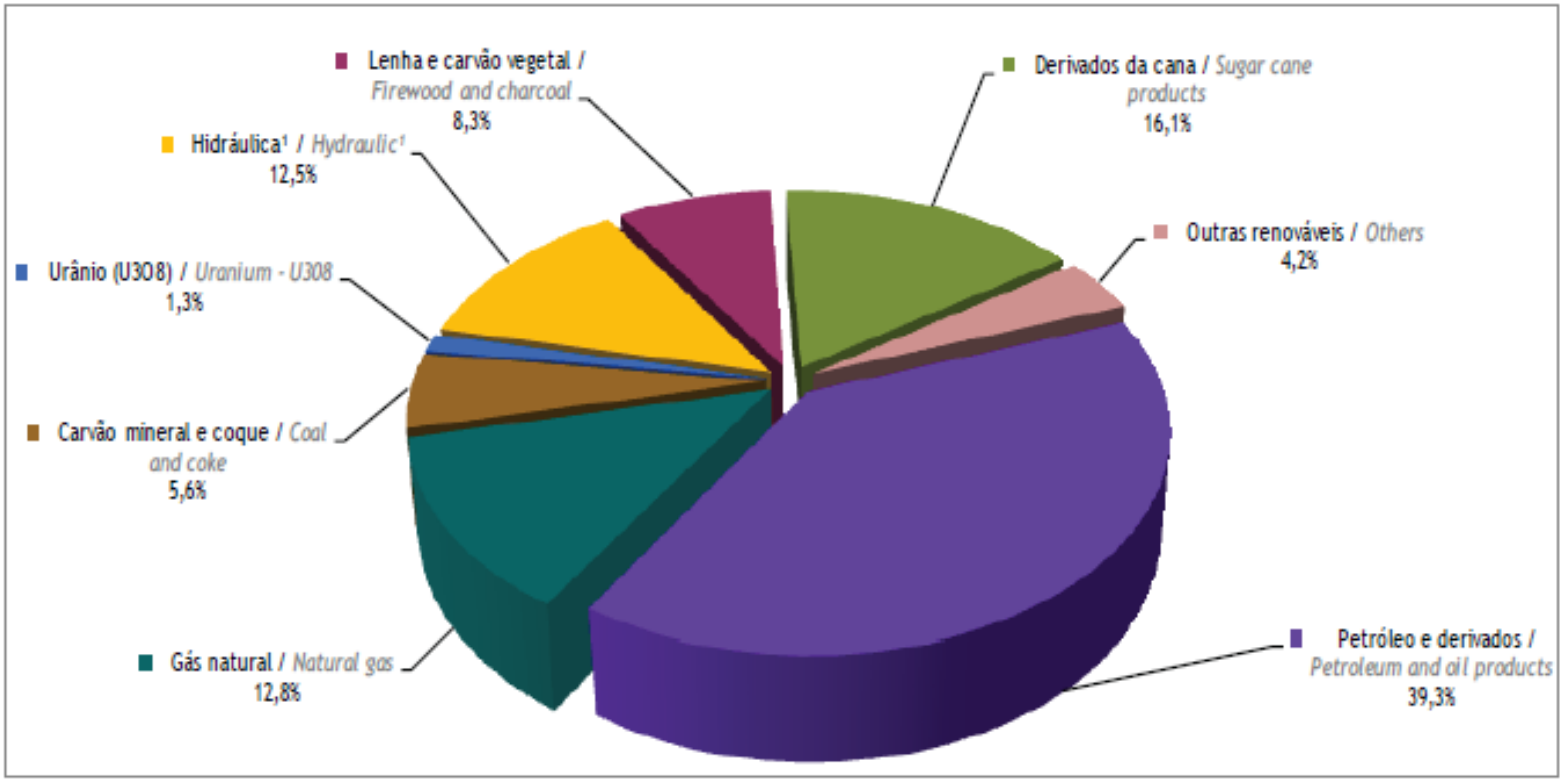
Brazilian Bioethanol Science and Technology Laboratory

CNPEM

Primary Energy Supply in Brazil

Gráfico 1.3.b – Oferta Interna de Energia

Chart 1.3.b – Domestic Energy Supply

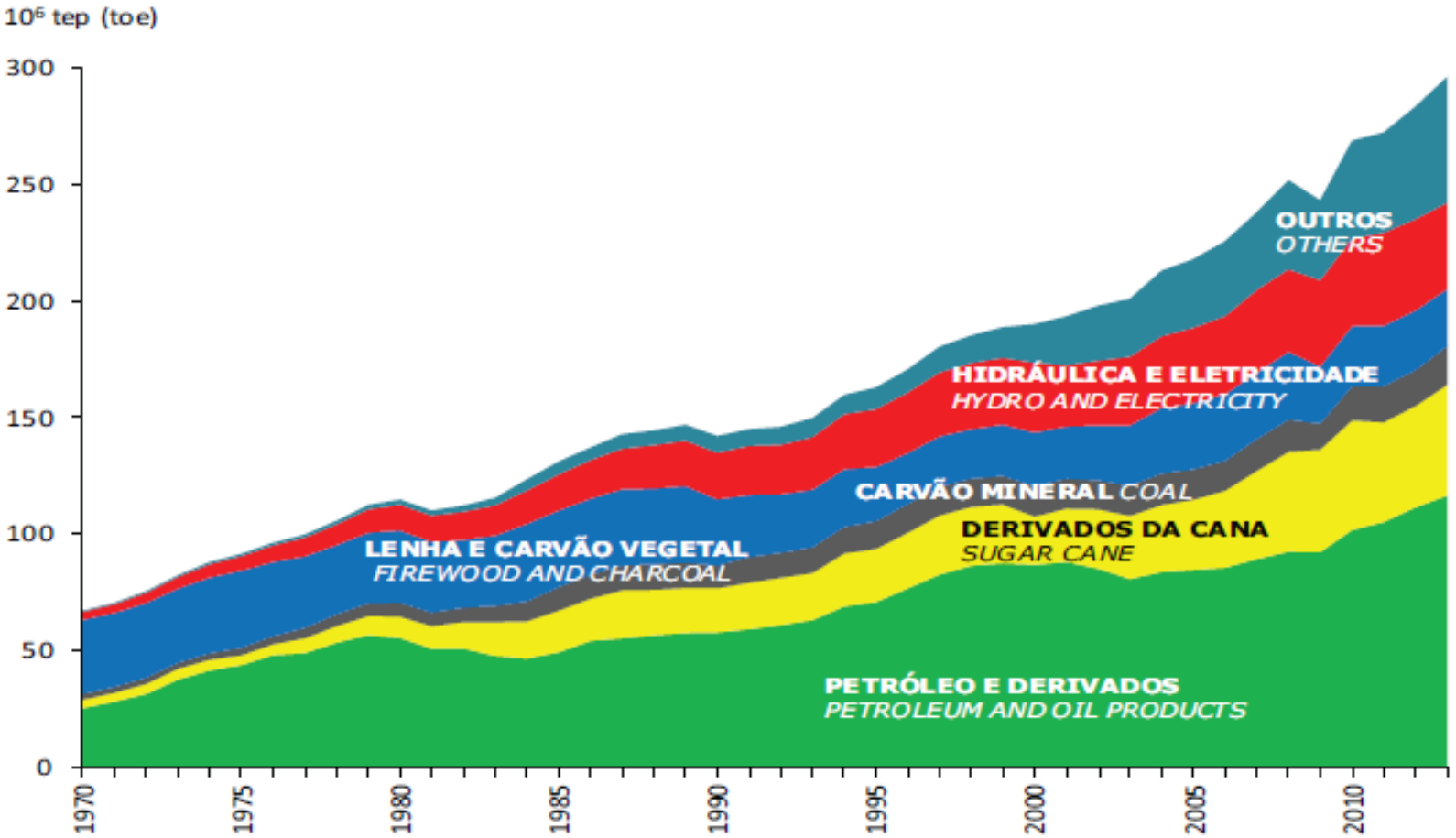


¹ Inclui importação de eletricidade oriunda de fonte hidráulica. 1 kWh = 860 kcal (equivalente térmico teórico - primeiro princípio da termodinâmica). Ver Anexo VI.6 - Tratamento das informações. / *¹ Includes electricity imports originated from hidraulic sources. 1 kWh = 860 kcal (physical equivalent - First Principle of Thermodynamics). Look Appendix VI.6.*

Brazilian Bioethanol Science and Technology Laboratory

CNPEM

Brazil Primary Energy Supply History



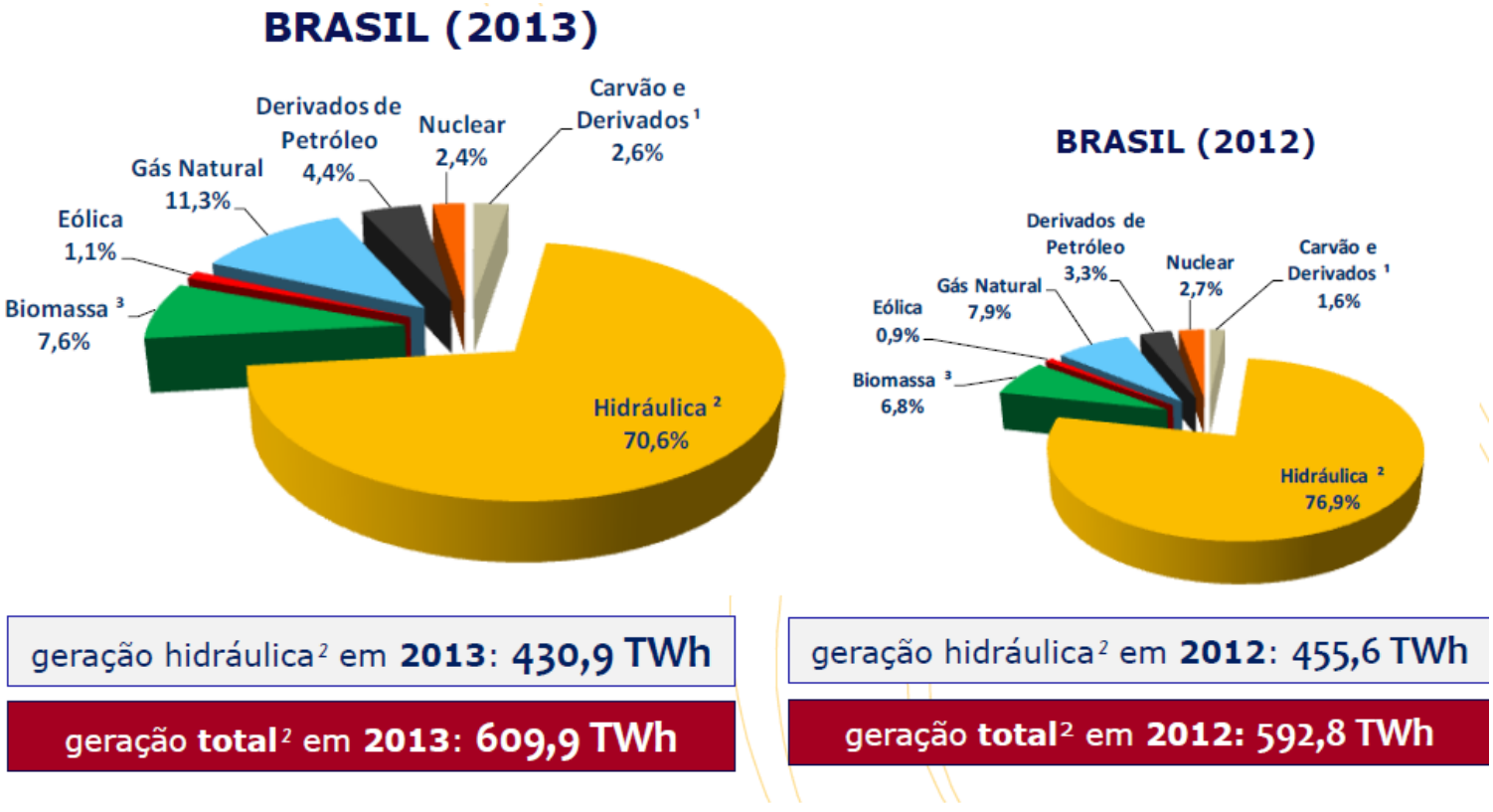
Installed Capacity by Source

Source Type	Installed Capacity (MW)	%
Hydro	90,303	65.3
Fossil	26,523	19.2
Bagasse*	**10,383**	**7.5**
Wind	6,455	4.7
Nuclear	1,990	1.4
Other sources	2,604	1.9
Total	138,258	100.0

*Note: Total biomass installed capacity of 12,976 MW (9.7%)

Source: ANEEL, 2015

Recent Past Trends

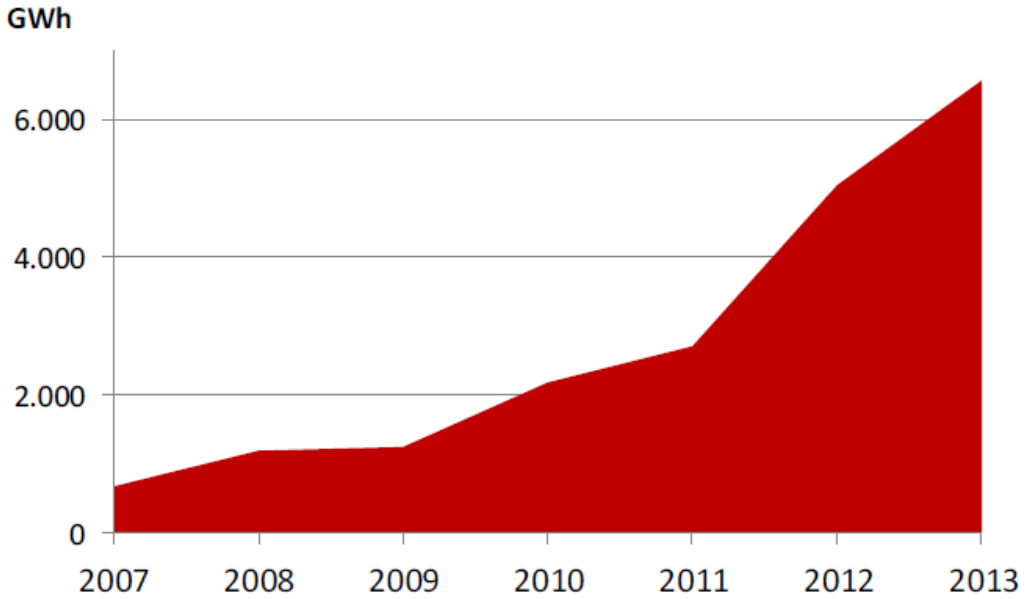


Due to the drought, the hydro participation is being overtaken by thermal

Wind Power Evolution

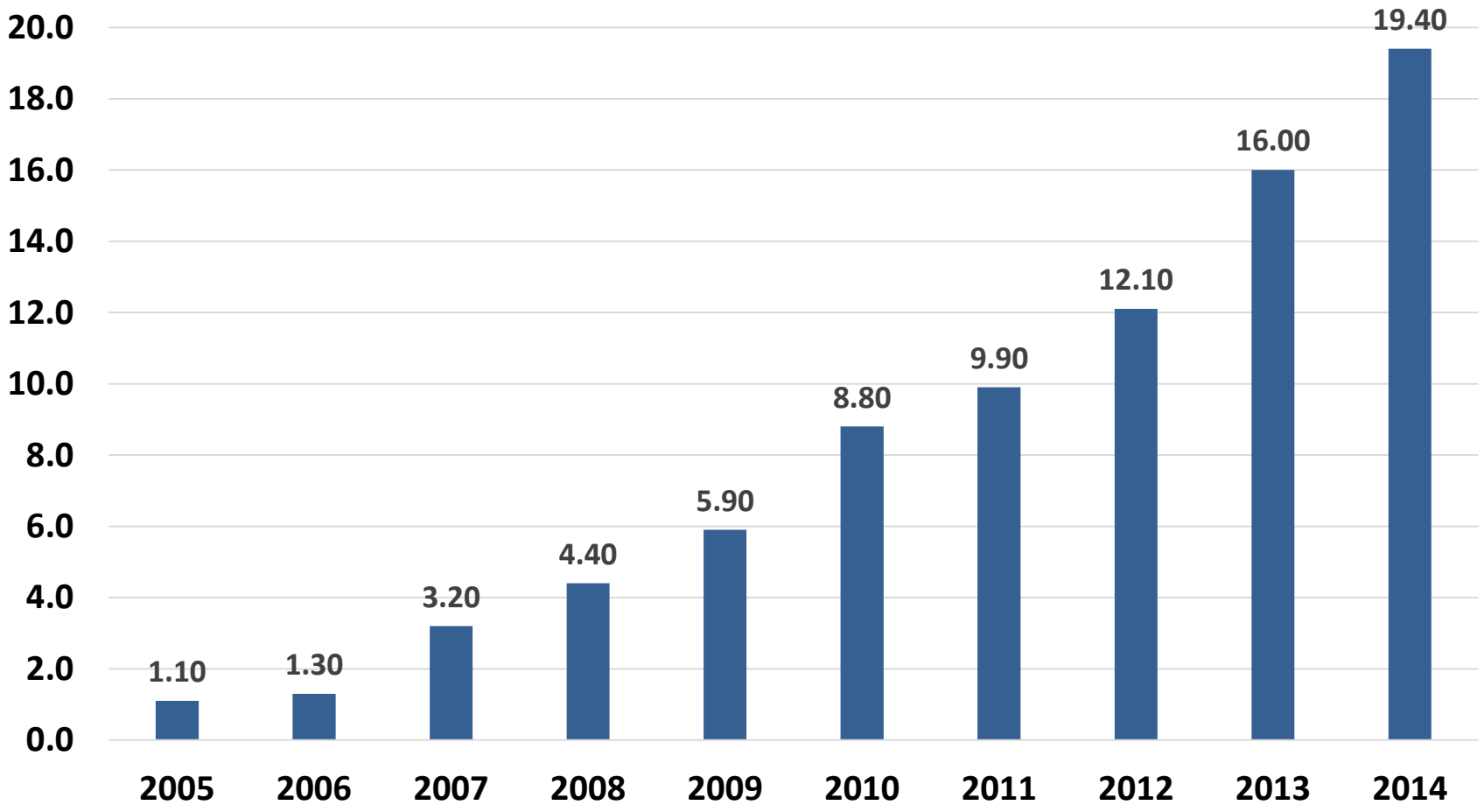
em GWh

2007	2008	2009	2010	2011	2012	2013	Δ 13/12
663	1.183	1.238	2.177	2.705	5.050	6.576	30,2%



epe
Empresa de Pesquisa Energética

Evolution of EE Supply to the Grid by the Mills (TWh)



Source: MME (2015). Produced by UNICA (2015).

Wind Versus Biomass Power

- Wind power in Brazil is the fastest growing renewable source for power generation
- It became the main competitor to biomass due to institutional flawed policies (e.g. dispatchability, interconnection with the grid, transmission costs, etc.)
- In reality, the two sources are not competitors since they have different characteristics; the institutional framework is being corrected
- We need all renewable sources and what is necessary is good planning

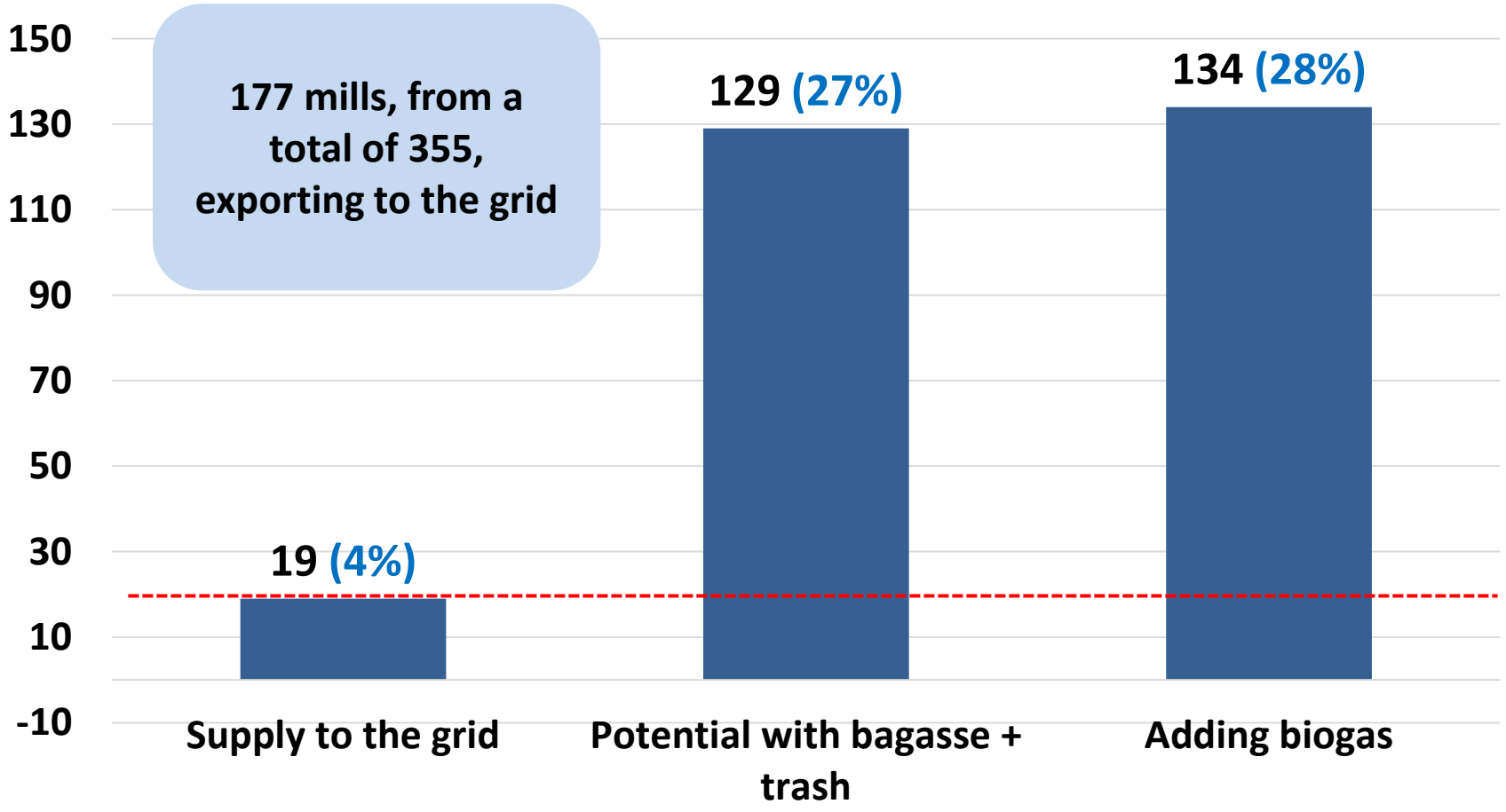
Mill EE Generation Profile (MW_{avg})

Year	Total EE	Self Consumption	Surplus EE	%Surplus
2005	875	749	126	14.4
2006	954	811	143	15.0
2007	1267	901	366	28.9
2008	1386	883	503	36.3
2009	1605	935	670	41.7
2010	2553	1551	1002	39.2
2011	2539	1406	1133	44.6
2012	2861	1480	1381	48.3
2013*	3564	1844	1720	48.3

* Estimated values based on 2012 profile; 170 mills sold EE

Source: RPA News, 2014

Mills Bioelectricity Technical Potential to the Grid (TWh)



Source: EPE (2015). Produced by UNICA (2015).

Brazilian Bioethanol Science and Technology Laboratory

Commercialization Environments

Regulated Contracting Environment (RCE)

MME – Ministério de Minas e Energia

ANEEL – Agência Nacional de Energia Elétrica

ccee

Federal Auction

Bilateral Contract

Distribution Companies

Captive Consumers

07/2015: 75% Consumption of SIN

Free Contracting Environment (FCE)

Bilateral Contract

Spot Market

ccee

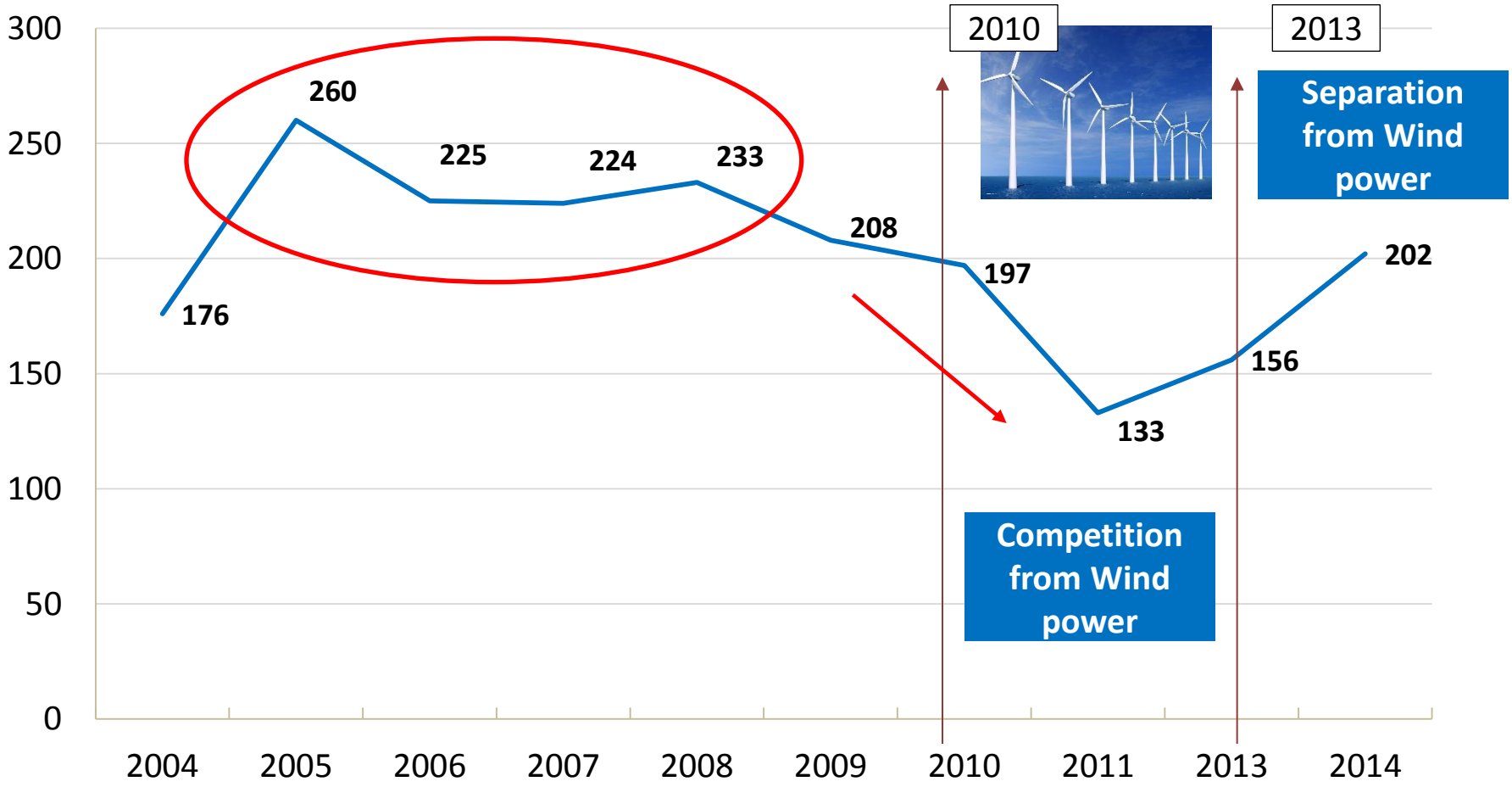
Special or Free Consumer

Energy Marketing Company

07/2015: 25% Consumption of SIN

Source: UNICA (2015).

Average Auction Prices (R$/MWh, Jan 2015)



Source: UNICA, from CCEE (2015).

Contracted EE in 2014 Auctions

Figura 7: MW Contratado

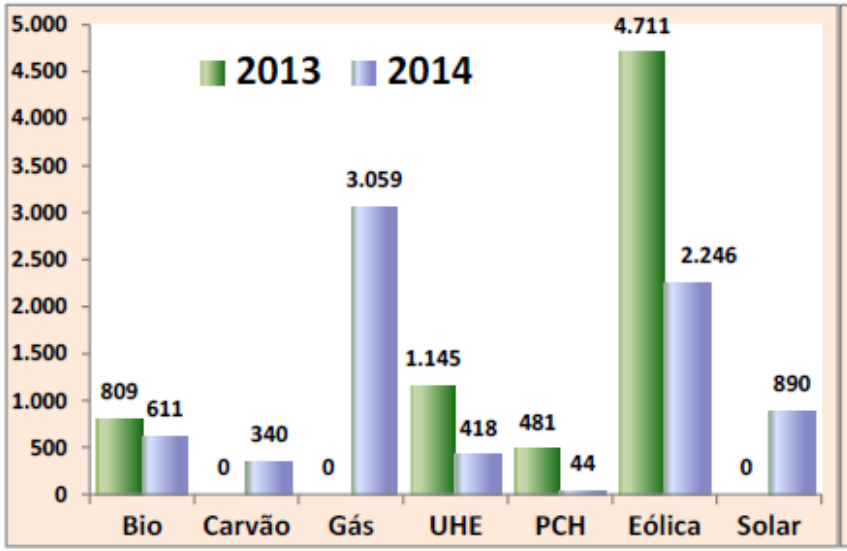
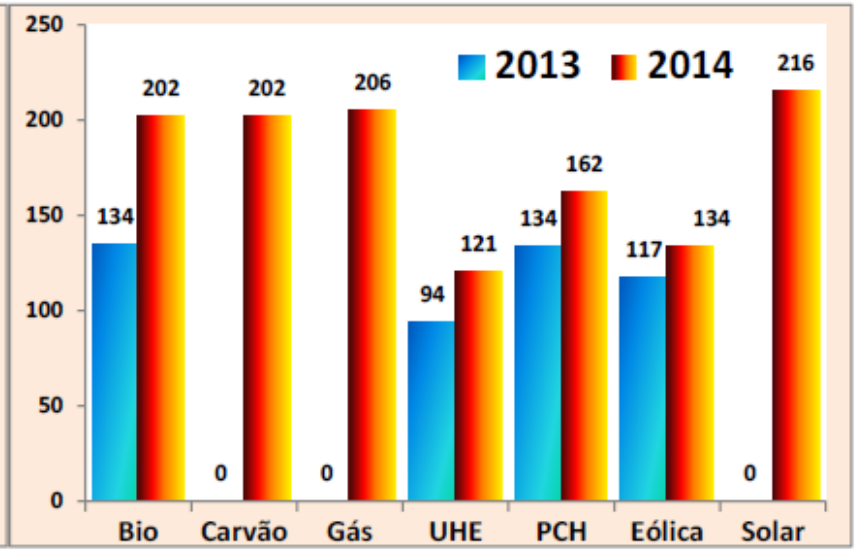


Figura 8: Preço Médio (R$/MWh)



Source: EPE, 2015

In 2014, one LER (Reserve Energy) and two LEN (New Energy) auctions took place for a total 7,607 MW contracted.
For the first time, Solar Energy had a significant participation.

Estimated Future Capacity to Add – Aug/2015 to Dec/2018

Plant Type	Power (MW)
Hydro	11,000
Small hydro	1,000 to 1,500
Wind	4,000 to 6,000
Solar	2,000 to 3,000
Biomass	4,000 to 5,000
Fossil (thermal)	3,000 to 5,000
Total	25,000 to 31,500

Estimated Investment: R$ 116 billion

Source: EPE, 2015

Existing Barriers to Bioelectricity

- **Institutional**
  - Investment in interconnection to the grid totally born by the mills
  - Direct competition with non dispatchable renewables
  - Old/New energy definition
  - Other
- **Technical**
  - Trash collection with adequate quality, quantity and cost
  - Feeding and burning trash in existing bagasse boilers
  - Operation year round

Technical Problems

- Increase capacity factor by operating in the offseason and when the milling stops
- Find a supplemental fuel to bagasse: trash, eucalyptus, biomass sorghum, energy cane, other
- Find an alternative feedstock for ethanol production in the offseason: sweet sorghum, corn
- Improve trash quality and reduce costs
- Trash feeding and burning in existing bagasse boilers

Brazilian Bioethanol Science and Technology Laboratory

Product Revenues (1 TC)

CNPEM

Product	Production			Prices	Total Values (R$/TC)		
Sugar	65 kg/TC			R$ 0.75/kg	48.75		
Anhydrous ethanol	42 L/TC			R$ 1.36/L	57.12		
Sugar and ethanol					105.87		
Electricity (kWh/TC)	30	60	120	R$ 200/MWh*	6.00	12.00	24.00
Total Production Value					111.87	117.87	126.87
Increment due to electricity (%)					**5.7**	**11.3**	**22.7**

* Spot price can reach R$ 380/MWh

Important Aspects for the Future of Bioelectricity

- **Positive points**
  - With the drought, spot prices surpassed R$ 800/MWh in 2014
  - Separate auctions for wind and biomass
  - Small improvements in trash collection and use
  - EE proved to be an important source of revenues during low sugar and ethanol prices periods
  - Slow progress in new hydro power projects (licensing difficulties)
  - The government commitment in maintaining sugarcane participation level in the energy matrix (INDC for COP 21)
- **Negative points**
  - Low investment capacity due to the crisis
  - Institutional and technical problems still prevailing

Final Comments

- Surplus power sale is becoming an important source of revenues
- The sugarcane sector must work hard to solve the persisting technical and institutional problems
- The way out of the crisis must include EE sales and the mills are ware of that

Thank you for your attention!

regis.leal@bioetanol.org.br