



**Empresa de Pesquisa Energética**

Uma Empresa do Ministério de Minas e Energia



## **OUTLOOK FOR ALTERNATIVE RENEWABLE ENERGY IN BRAZIL**

*XIX Annual Latin American Energy Conference - The La Jolla Conference*

*Renewable Energy Plenary*

*Institute of the Americas*

**Mauricio T. Tolmasquim**  
**CEO**  
**Energy Research Office - EPE**

May 11<sup>th</sup>, 2010



# ENERGY SUPPLY STRUCTURE IN BRAZIL: AN EXAMPLE FOR THE WORLD

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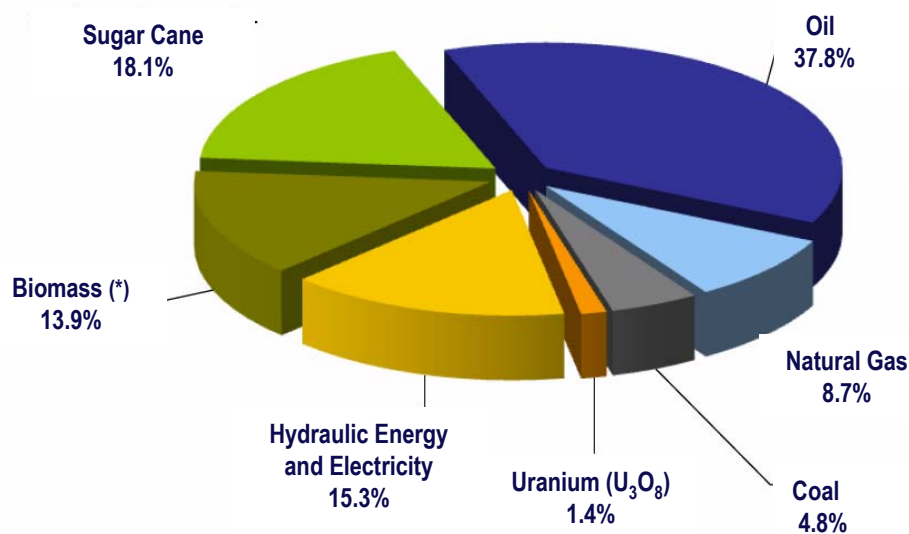


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# ENERGY SUPPLY STRUCTURE

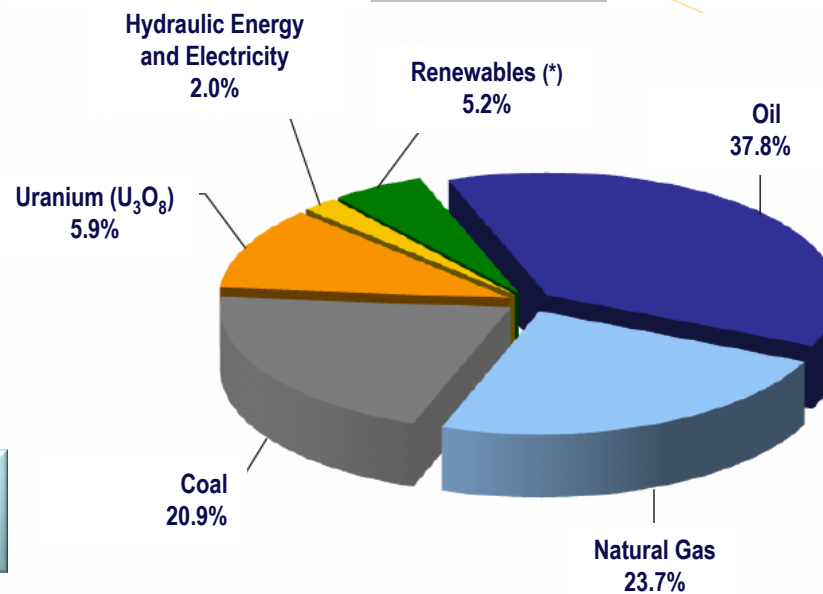
## BRAZIL X WORLD

BRAZIL 2009



(\*) includes firewood, charcoal and other

OECD 2008



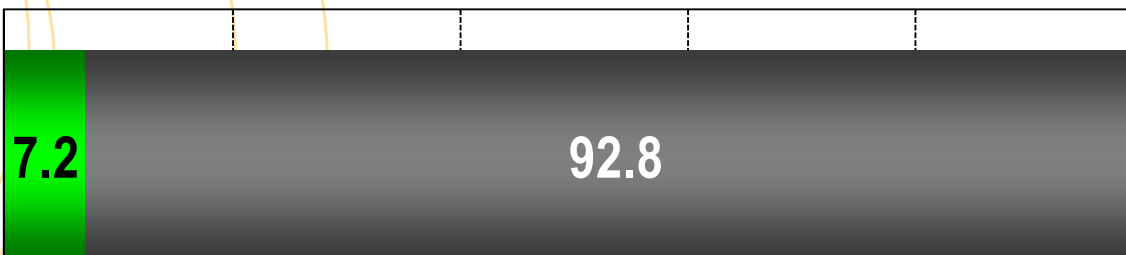
(\*) includes renewable fuels, waste, solar power, wind power, geothermal and other

**Renewables in the Energy Matrix =  
(Hydraulic + Sugar Cane Products + Biomass) = 47.3%**

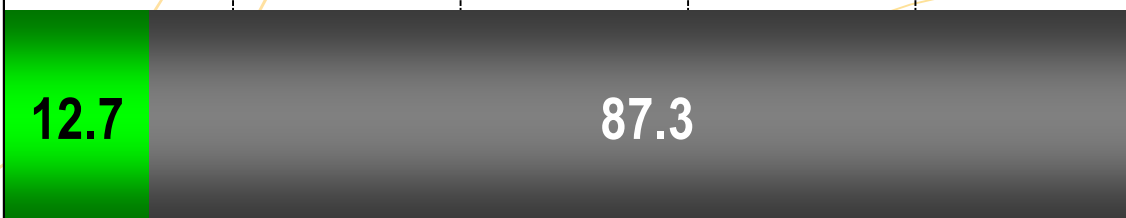
# QUALITY OF THE ENERGY MATRIX

## BRAZIL X WORLD

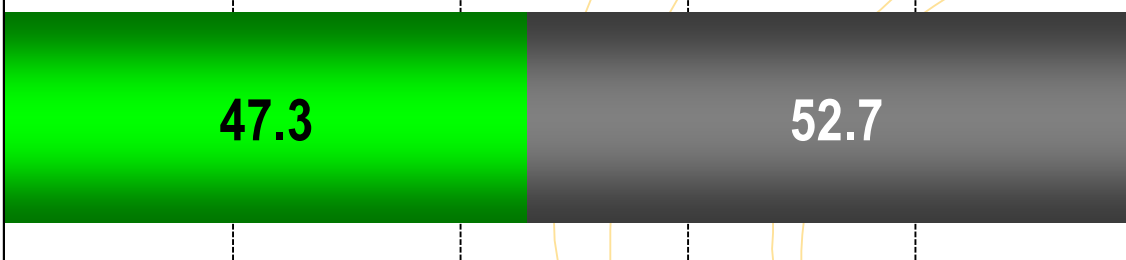
OECD Countries  
(2008)



World (2007)



Brazil (2009)



■ Renewable  
■ Non-Renewable

20% 40% 60% 80% 100%

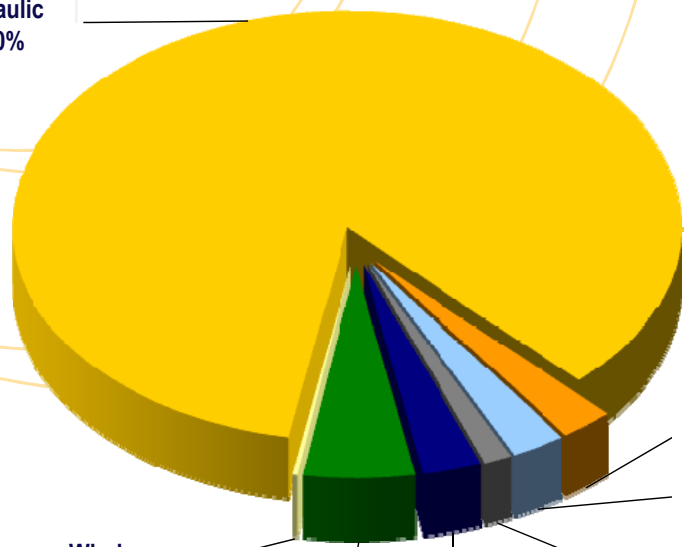
Sources: EPE [BEN 2010 - Preliminary Results] and  
IEA [Key World Energy Statistics - 2009]

# ELECTRIC POWER SUPPLY STRUCTURE

## BRAZIL X WORLD

**BRAZIL 2009**

Hydraulic  
85.0%



Wind  
0.24%

Biomass (\*)  
5.4%

Oil  
2.9%

Coal  
1.3%

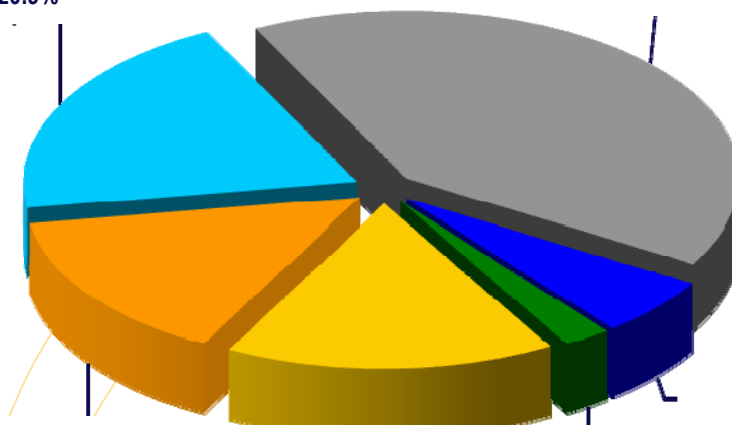
Nuclear  
2.5%

Natural Gas  
2.6%

**90.6%  
Renewable**

**WORLD 2007**

Natural Gas  
20.9%



Nuclear  
13.8%

Hydraulic  
15.6%

Other  
2.6%

Oil  
5.6%

**18.2%  
Renewable**

(\*) mainly generated from the co-generation with sugar cane

Sources: EPE [BEN 2010 - Preliminary Results] and  
IEA [Key World Energy Statistics - 2009]



# **WE CAN KEEP OUR “CLEAN” ENERGY SUPPLY STRUCTURE**

**HYDRAULIC  
SUGAR CANE BIOMASS  
ALTERNATIVE RENEWABLE SOURCES**



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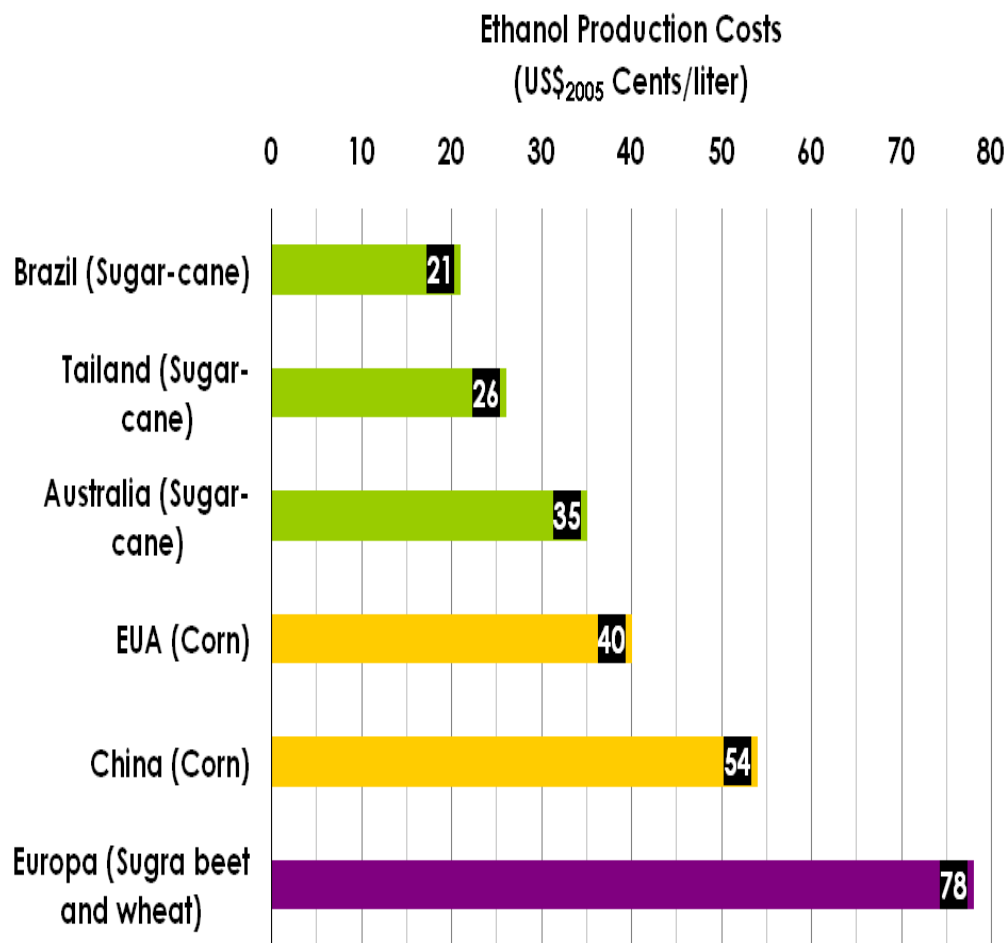


# SUGAR CANE BIOMASS

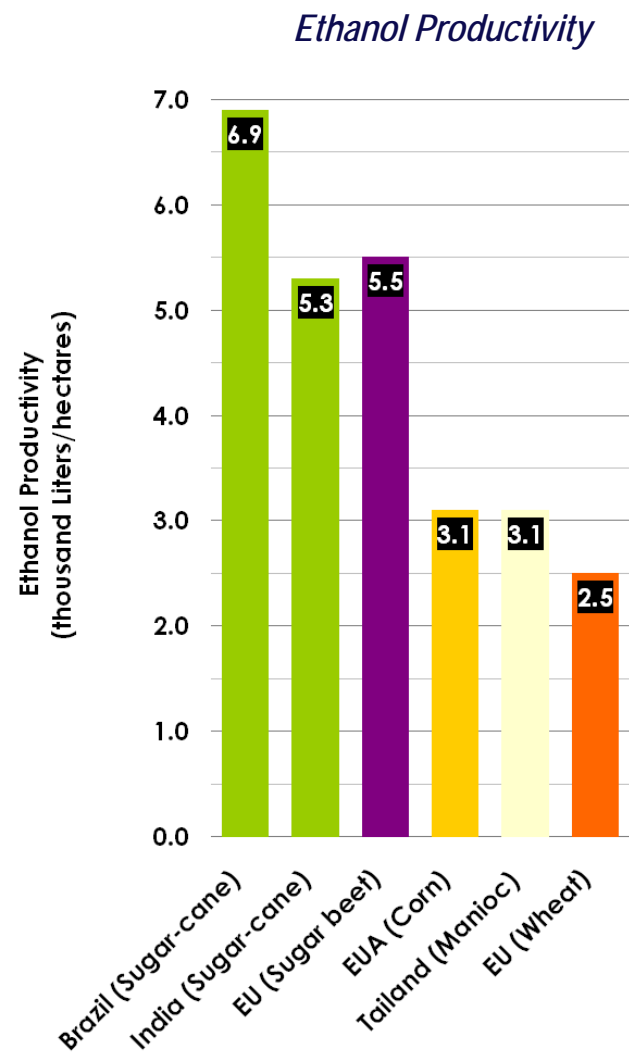


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# ETHANOL PRODUCTION COSTS



Source: O. Henniges and J. Zeddies, "Economics of Bioethanol in the Asia-Pacific: Australia-Thailand-China", in F.O.Licht's *World Ethanol and Biofuels*, vol. 3, n. 11, 2005.



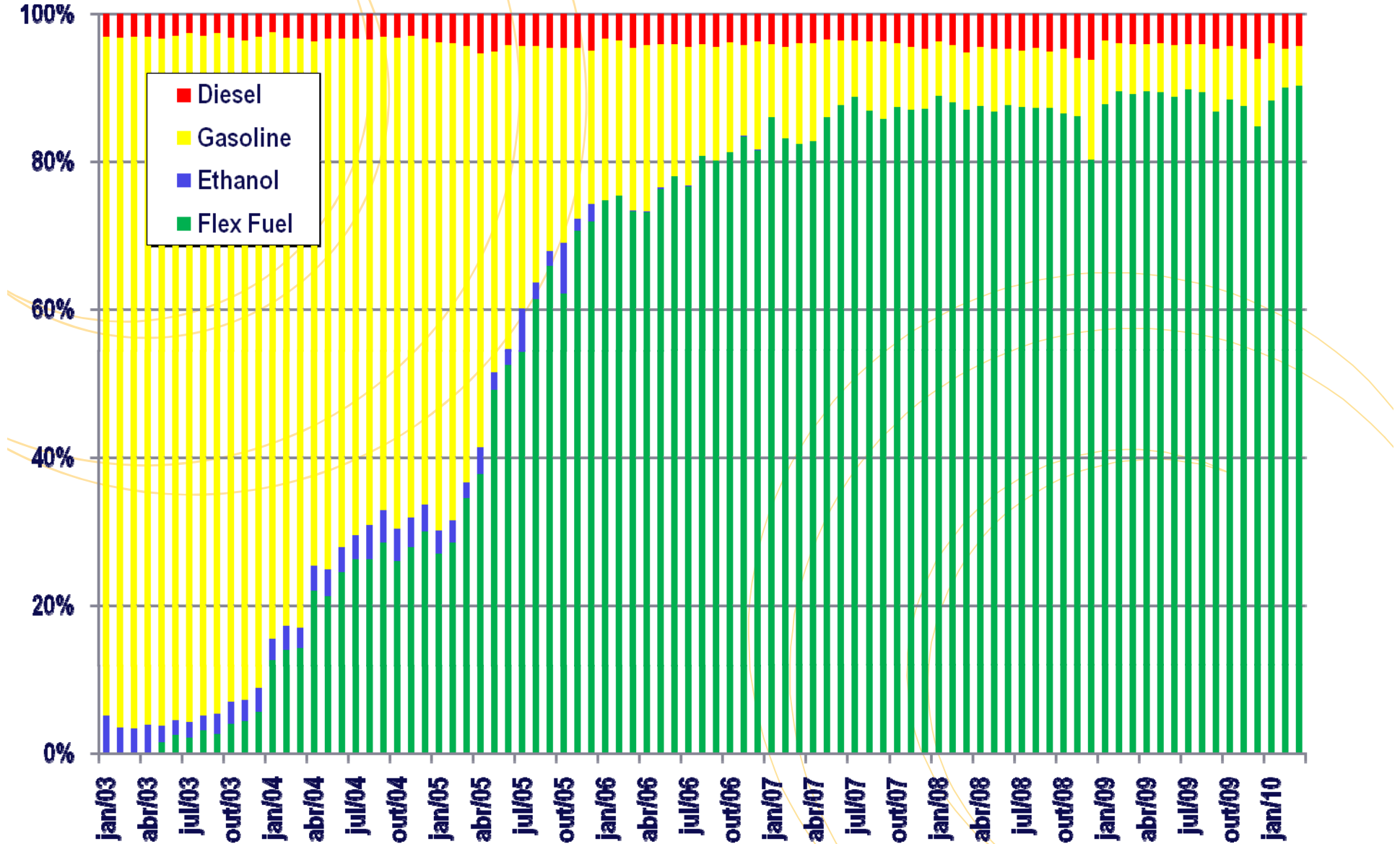
Source: IEA (2005) and MTEC



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# FLEX FUEL SHARE - BRAZIL

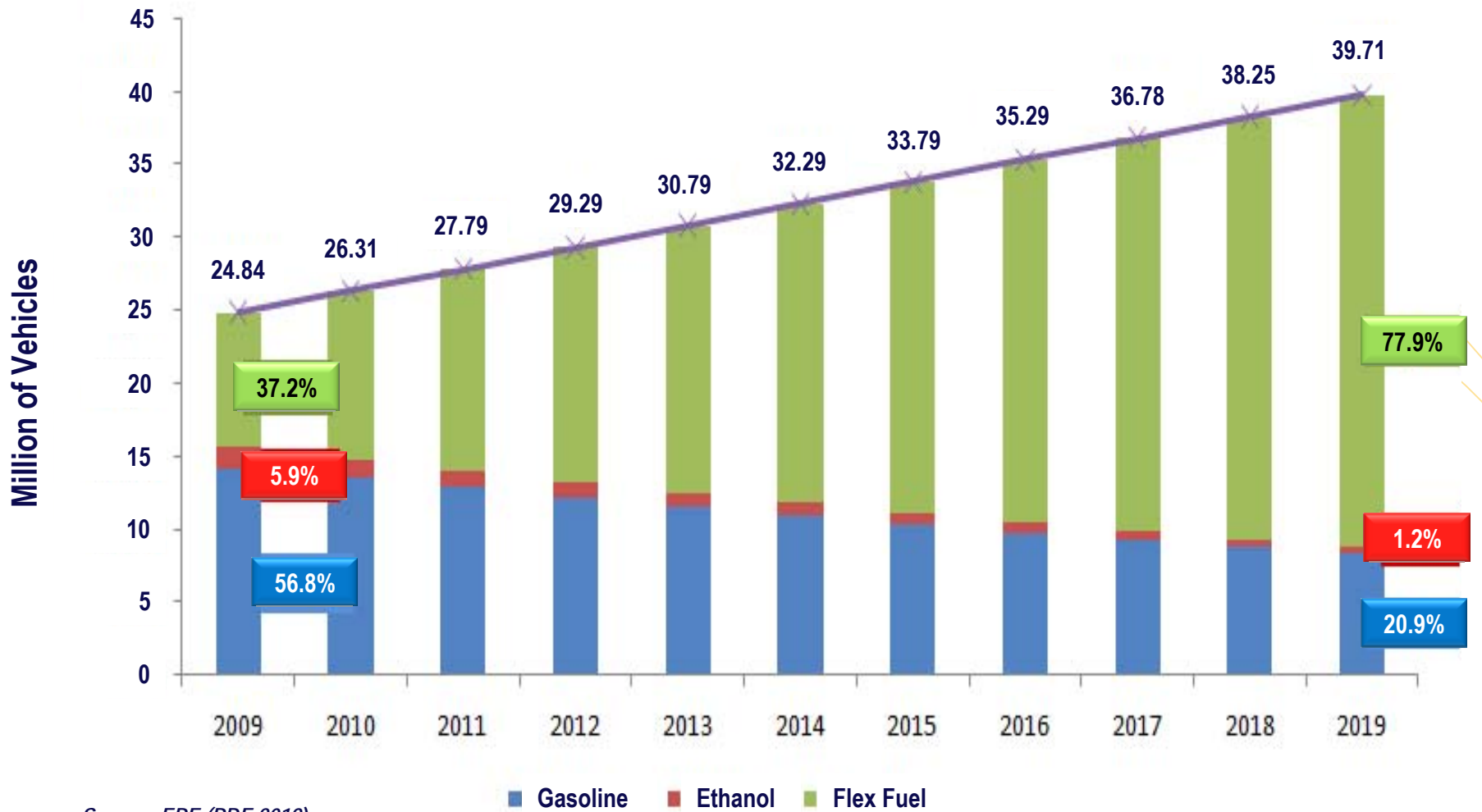
## LIGHT VEHICLES SALE



Source: ANFAVEA - Monthly Bulletin of Biofuels - April 2010

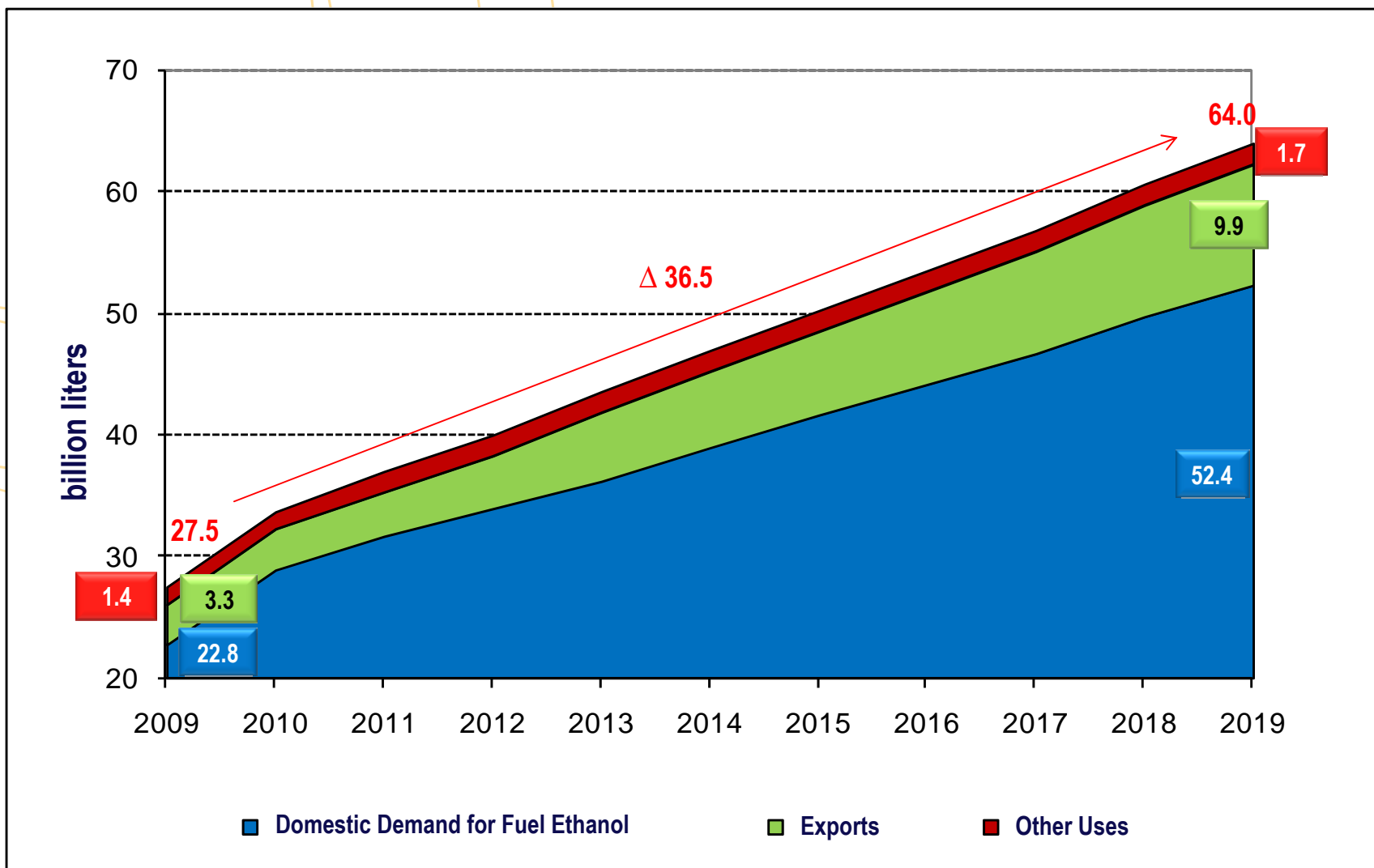
# FLEET BY FUEL - BRAZIL

## LIGHT VEHICLES



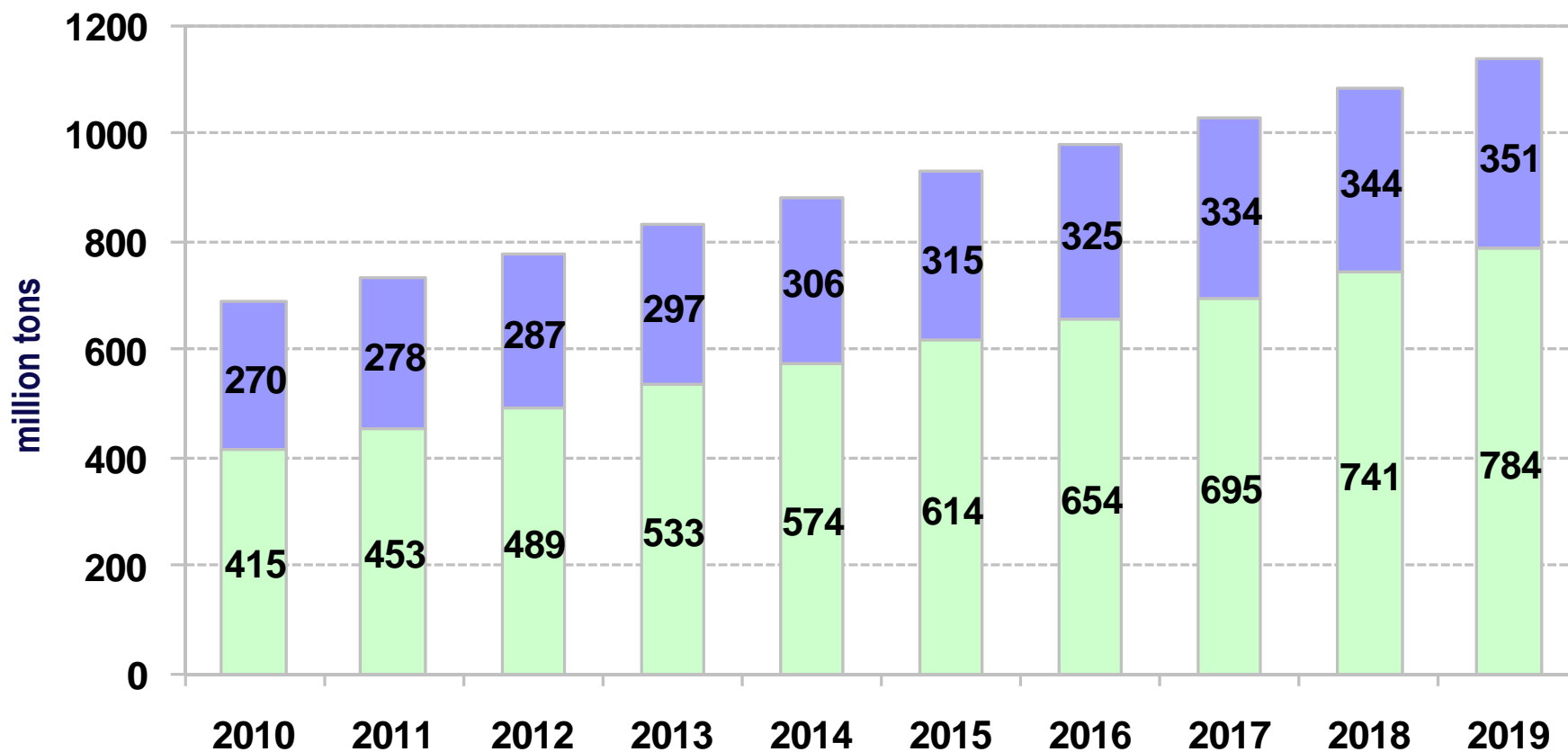
Source: EPE (PDE 2019)

# TOTAL DEMAND FOR ETHANOL PROSPECTS



Source: EPE (PDE 2019)

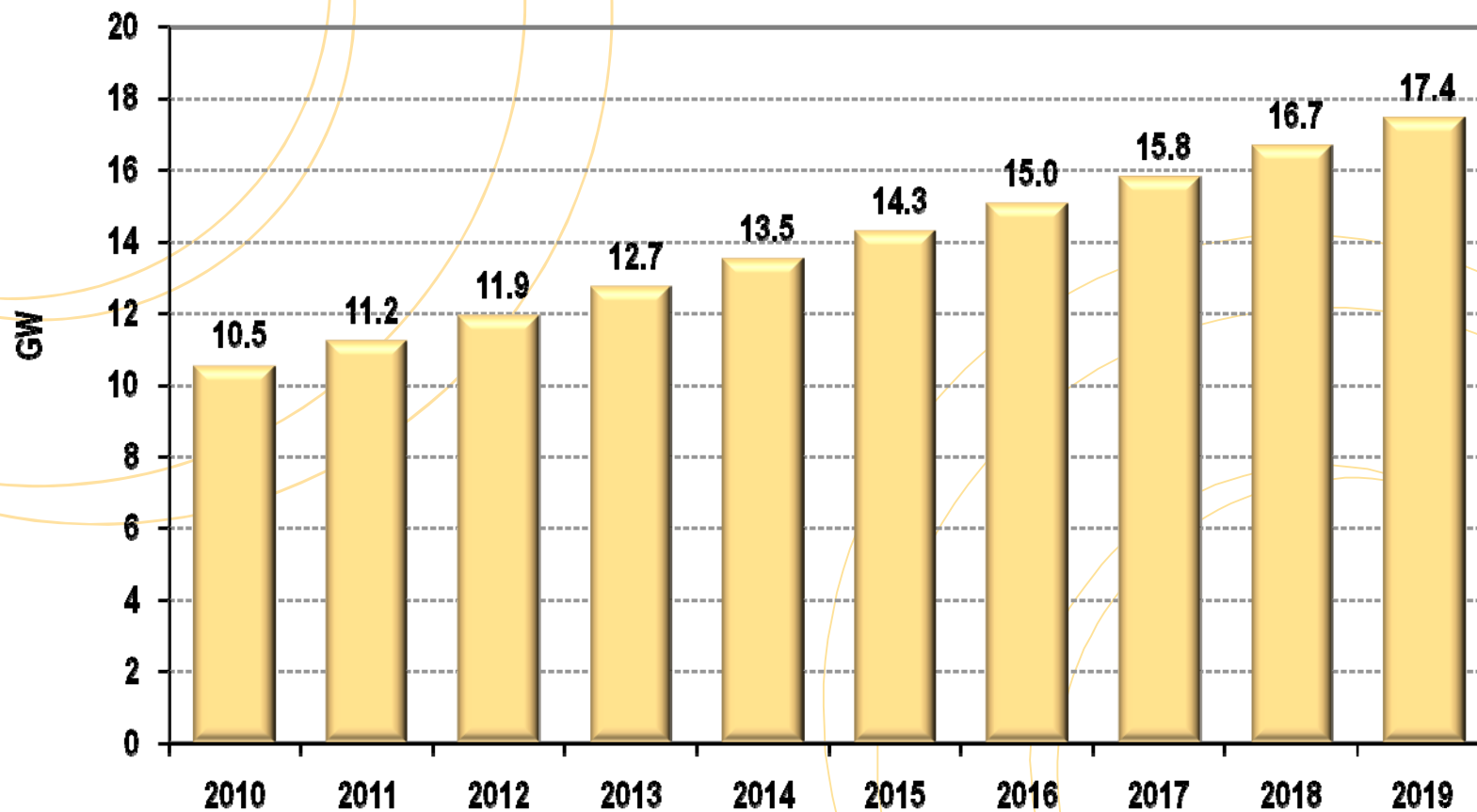
# SUGAR CANE DEMAND PROSPECTS



Source: EPE (PDE 2019)

■ Sugar Cane for Ethanol
 ■ Sugar Cane for Food

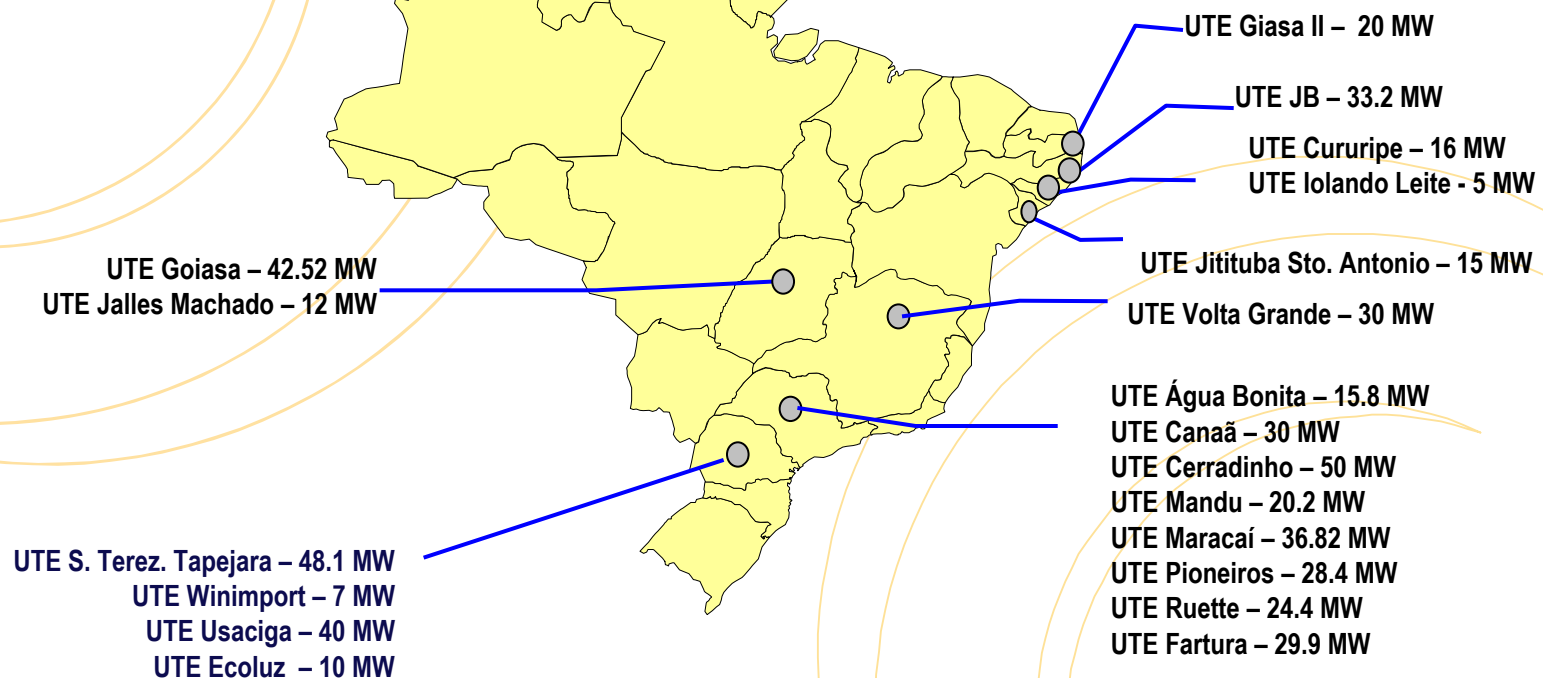
## COGENERATION POTENTIAL FROM SUGAR CANE BAGASSE



Source: EPE (PDE 2019)

The estimated cogeneration potential in  
2019 is about 89.1 TWh

## 20 BIOMASS THERMAL POWER PLANTS IN OPERATION [ 514 MW ] RESULT OF THE INCENTIVE PROGRAM FOR ALTERNATIVES SOURCES (PROINFA)



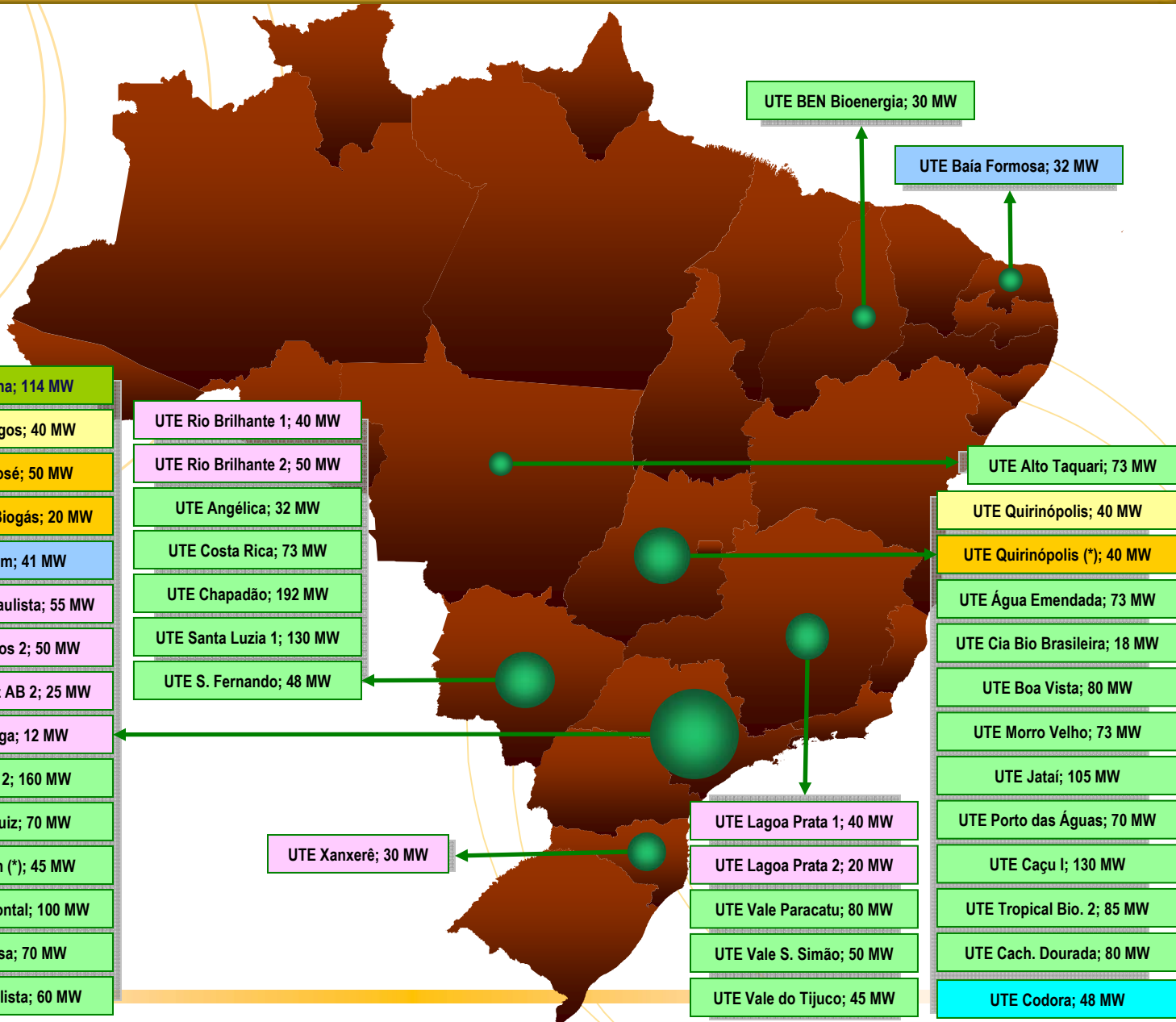


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# 58 BIOMASS THERMAL POWER PLANTS [3,515 MW] RESULTS OF NEW ENERGY AUCTIONS 2005-2009

- 1<sup>st</sup> New Energy Auction
- 2<sup>nd</sup> New Energy Auction
- 3<sup>rd</sup> New Energy Auction
- 1<sup>st</sup> Alternative Energy Auction
- 1<sup>st</sup> Reserve Auction
- 7<sup>th</sup> New Energy Auction
- 8<sup>th</sup> New Energy Auction

(\*) Capacity Expansion



UTE Costa Pinto; 66 MW	UTE Paraúna; 114 MW
UTE Rafard; 43 MW	UTE Interlagos; 40 MW
UTE Colorado; 34 MW	UTE São José; 50 MW
UTE Santa Isabel; 40 MW	UTE S. João Biogás; 20 MW
UTE Quata; 54 MW	UTE Bonfim; 41 MW
UTE Ferrari; 27 MW	UTE Florida Paulista; 55 MW
UTE S. João B. Vista; 70 MW	UTE Pioneiros 2; 50 MW
UTE Sta. Cruz AB 1; 25 MW	UTE Sta. Cruz AB 2; 25 MW
UTE Ester; 30 MW	UTE Iacanga; 12 MW
UTE Clealco Queiroz; 35 MW	UTE Cocal 2; 160 MW
UTE Ferrari (*); 35 MW	UTE São Luiz; 70 MW
UTE Barra Bioen.; 136 MW	UTE Bonfim (*); 45 MW
UTE Biopav 2; 140 MW	UTE Conq. Pontal; 100 MW
UTE Dest. Andrade; 33 MW	UTE Decasa; 70 MW
UTE Noble Energia; 30 MW	UTE NO Paulista; 60 MW

UTE Rio Brilhante 1; 40 MW
UTE Rio Brilhante 2; 50 MW
UTE Angélica; 32 MW
UTE Costa Rica; 73 MW
UTE Chapadão; 192 MW
UTE Santa Luzia 1; 130 MW
UTE S. Fernando; 48 MW

UTE BEN Bioenergia; 30 MW
UTE Baía Formosa; 32 MW
UTE Alto Taquari; 73 MW
UTE Quirinópolis; 40 MW
UTE Quirinópolis (*); 40 MW
UTE Água Emendada; 73 MW
UTE Cia Bio Brasileira; 18 MW
UTE Boa Vista; 80 MW
UTE Morro Velho; 73 MW
UTE Jataí; 105 MW
UTE Porto das Águas; 70 MW
UTE Caçu I; 130 MW
UTE Tropical Bio. 2; 85 MW
UTE Cach. Dourada; 80 MW
UTE Codora; 48 MW
UTE Lagoa Prata 1; 40 MW
UTE Lagoa Prata 2; 20 MW
UTE Vale Paracatu; 80 MW
UTE Vale S. Simão; 50 MW
UTE Vale do Tijuco; 45 MW
UTE Xanxerê; 30 MW

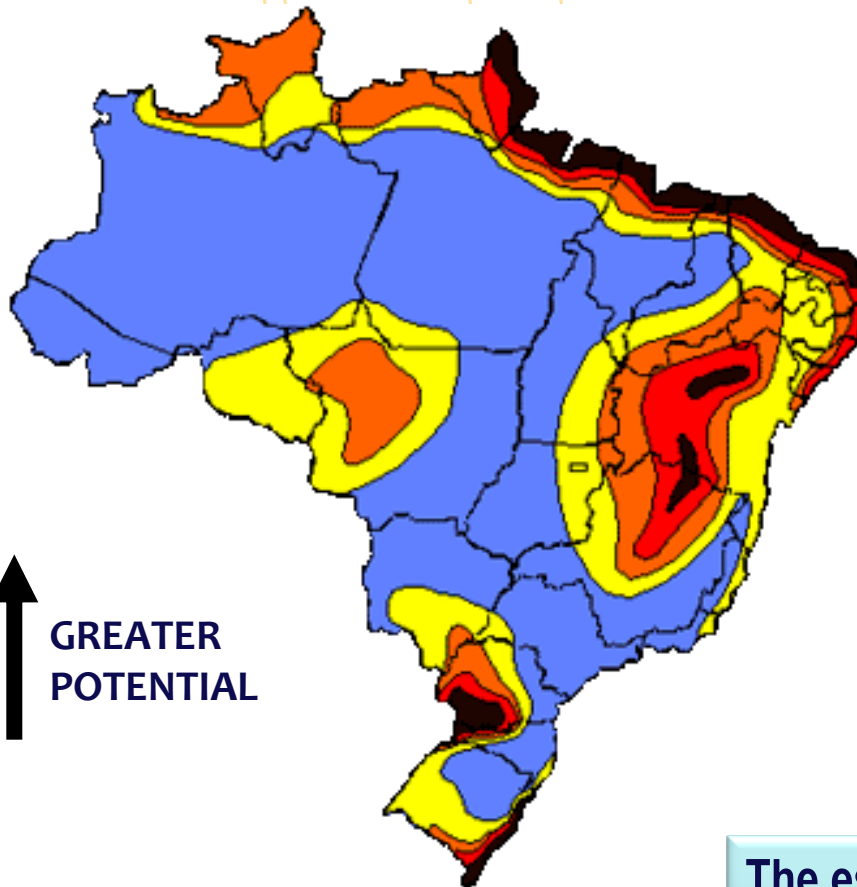


# WIND



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# BRAZILIAN WIND POWER POTENTIAL



**Estimated Potential  
(CEPEL-2001)  
143.5 GW  
- 50 m towers -**

**The estimated generation potential is about  
271 TWh, as much as 53% of the actual  
electricity supply in Brazil [ 509 TWh ]**

## SECOND RESERVE AUCTION - WIND (2009)

➤ <b>Date</b>	<b>December 14<sup>th</sup>, 2009</b>
➤ <b>Registration for the Auction</b>	<b>13,341 MW / 441 projects</b>
➤ <b>Initial Price</b>	<b>108 US\$/MWh</b>
➤ <b>Medium Price</b>	<b>84.8 US\$/MWh (21.5% discount)</b>
➤ <b>Operation</b>	<b>Until July 1<sup>st</sup>, 2012</b>
➤ <b>Contracts</b>	<b>20 years</b>
➤ <b>Capacity</b>	<b>1,806 MW</b>
➤ <b>Energy</b>	<b>6.9 TWh</b>
➤ <b>Projects</b>	<b>71</b>
➤ <b>Total amount transacted</b>	<b>11.2 US\$ billion</b>

## SECOND RESERVE AUCTION - WIND (2009)

location	number of projects	number of wind turbines	number of blades	capacity (MW)	energy (TWh)	capacity factor (%)
BA	18	255	765	390	1.6	46.4%
CE	21	295	885	543	2.0	41.6%
RN	23	361	1,083	657	2.6	45.3%
RS	8	108	324	186	0.6	38.3%
SE	1	17	51	30	0.1	35.0%
<b>TOTAL</b>	<b>71</b>	<b>1,036</b>	<b>3,108</b>	<b>1,806</b>	<b>6.9</b>	<b>Cf<sub>med</sub> = 43.5%</b>

Source: EPE

# WE STARTED TO USE OUR WIND POWER POTENTIAL

## Evolution of installed capacity in Brazil, 2003-2012



Sources: Electricity Atlas, 2<sup>nd</sup> ed.. Brasília: ANEEL, 2005,  
Global Wind 2009 Report GWEC 2010 and EPE (PDE 2019).

➤ **Registration for the Auction**

Source	Projects	Capacity (MW)
Wind Power Plants	399	10,569
Small Hydro Power Plants	18	255
Biomass – sugar cane bagasse	55	3,518
Biomass – wood waste	2	57
Biomass – other sources	4	131
<i>Total</i>	<b>478</b>	<b>14,529</b>

Source: EPE



# NATIONAL ENERGY EXPANSION PLAN FROM 2010 TO 2019

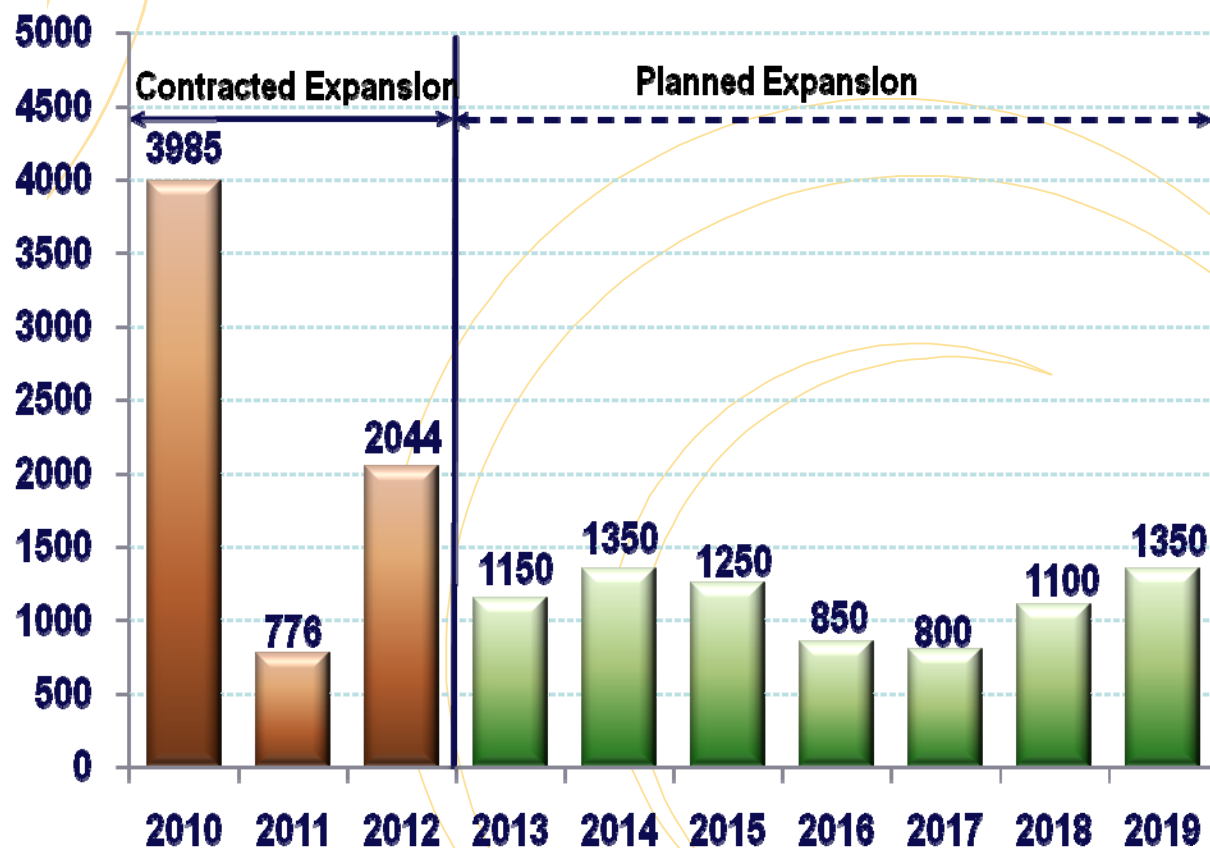
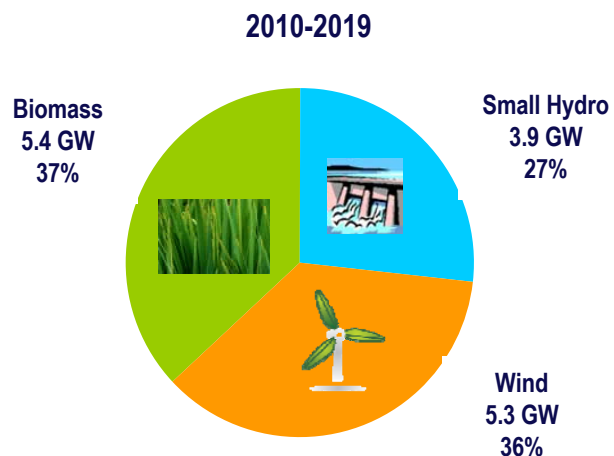
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# ALTERNATIVE RENEWABLE POWER EXPANSION - 2010-2019

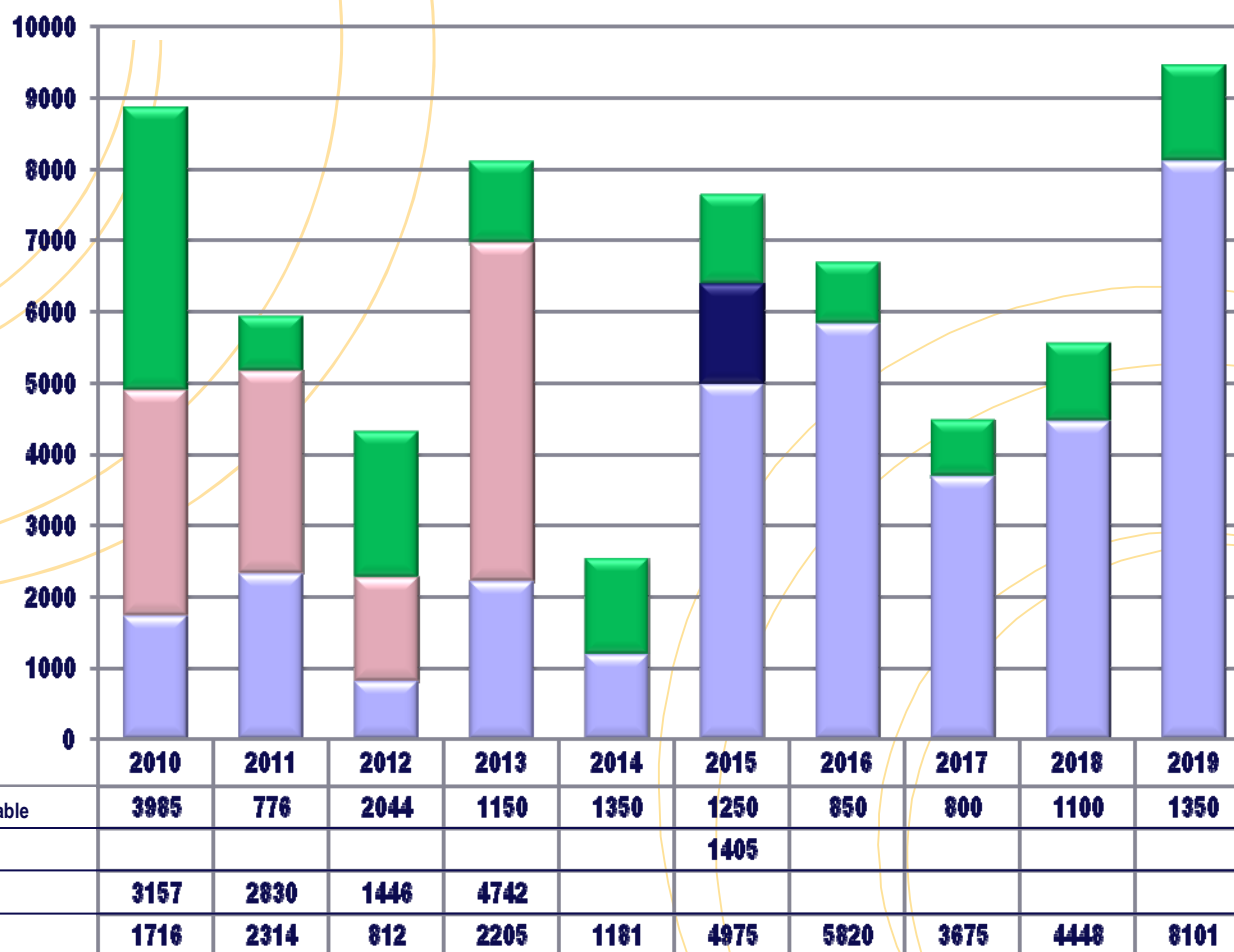
## 14,655 MW



Source : EPE (PDE 2019)

# NATIONAL POWER CAPACITY EXPANSION - 2010-2019

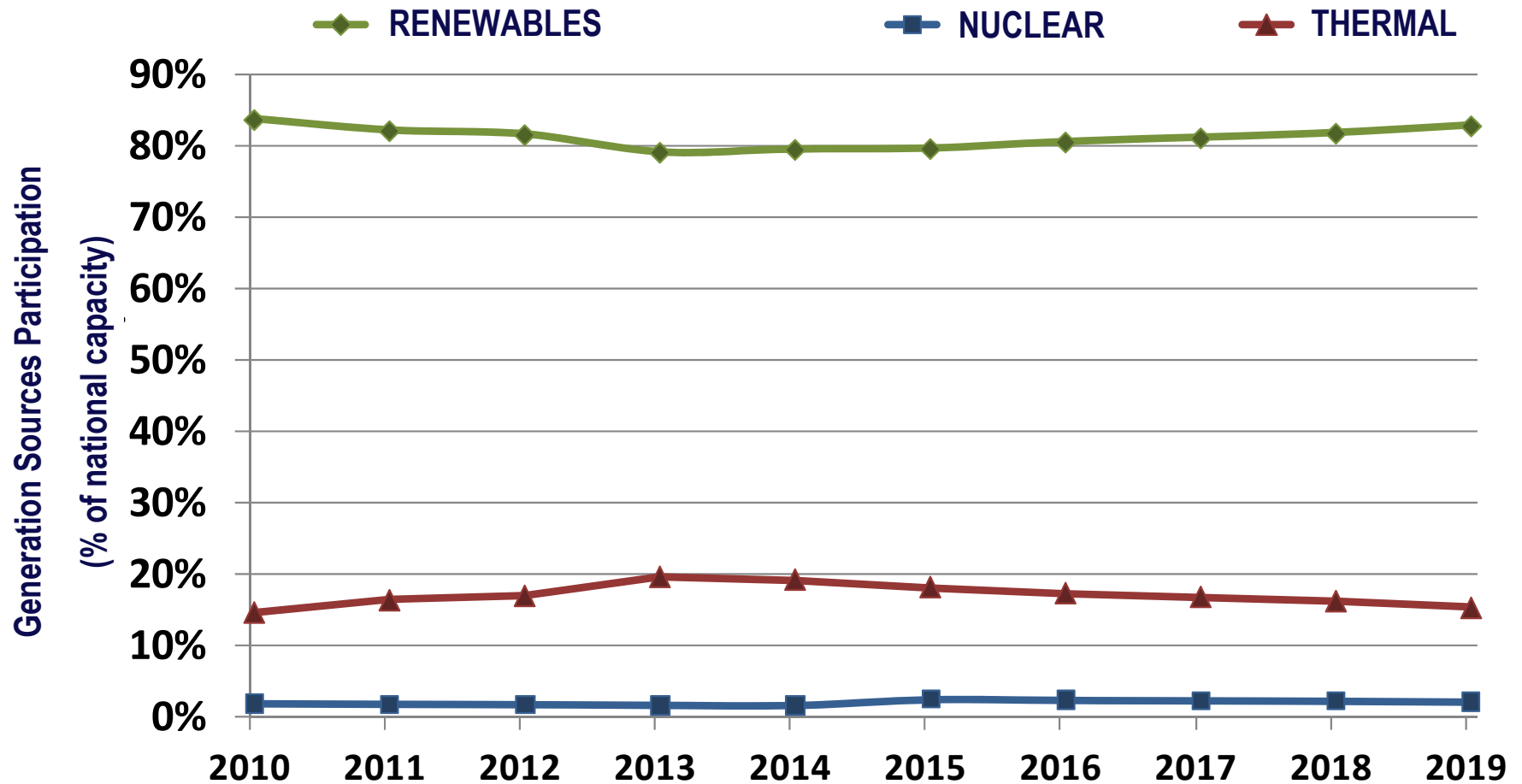
## 63,482 MW



14,655 MW - 23.1%  
 1,405 MW - 2.2%  
 12,175 MW - 19.2%  
 35,247 MW - 55.5%  
**63,482 MW**

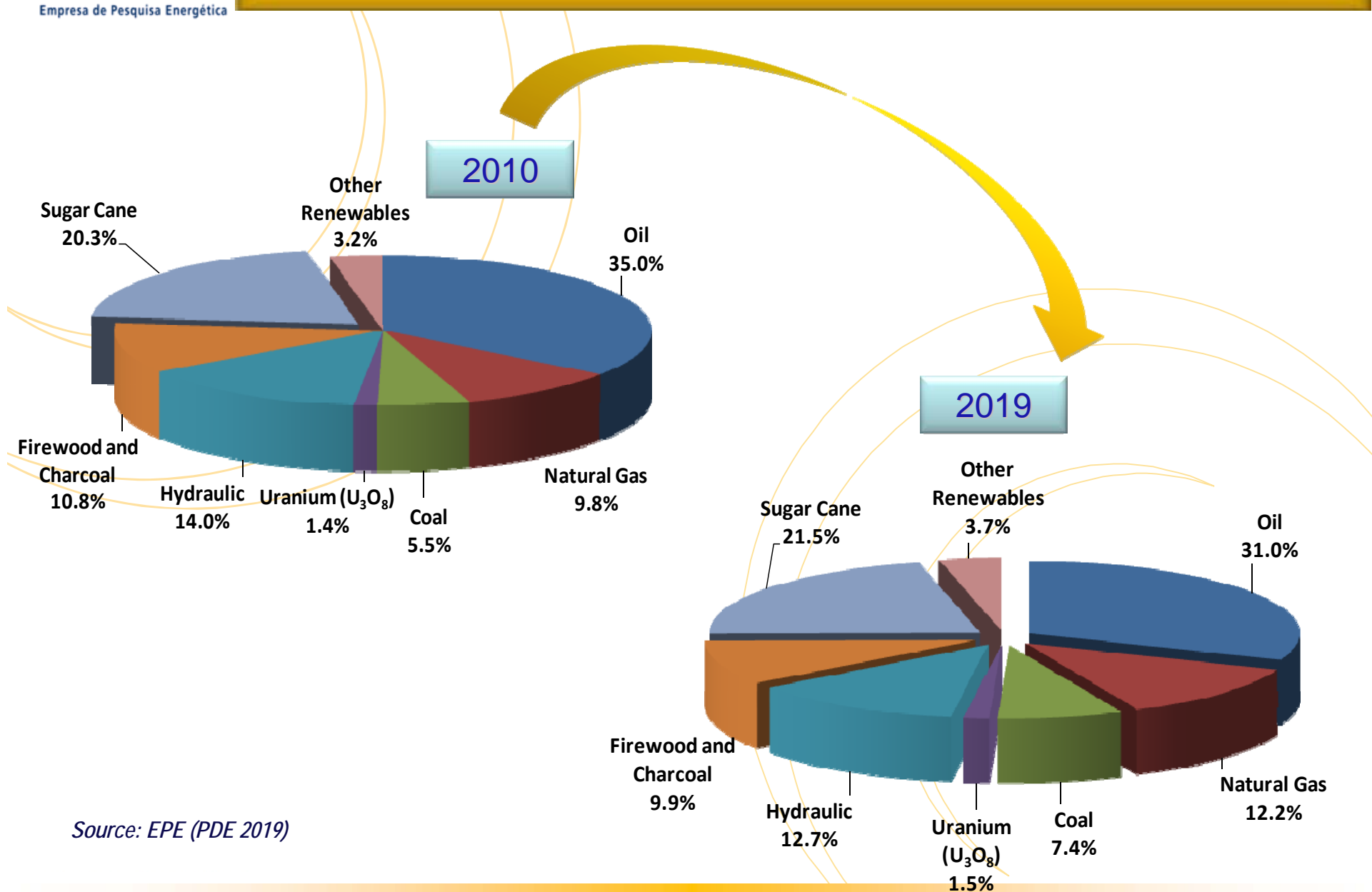
Source: EPE (PDE 2019)

## EVOLUTION OF THE GENERATION SOURCES SHARE ON ELECTRIC POWER SUPPLY STRUCTURE



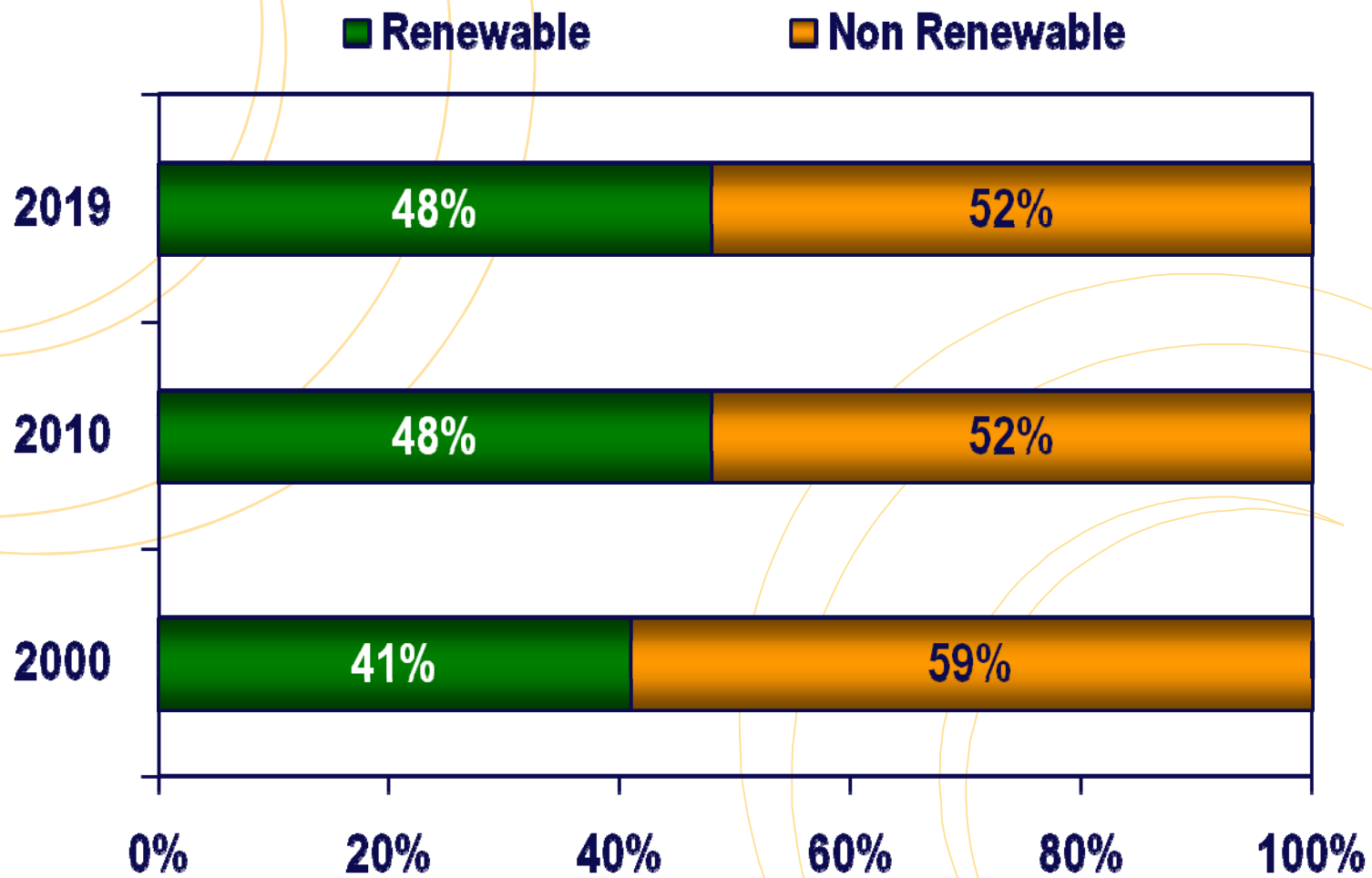
Source: EPE (PDE 2019)

# ENERGY SUPPLY STRUCTURE PROSPECTS



Source: EPE (PDE 2019)

## QUALITY OF THE ENERGY MATRIX RENEWABLE X NON-RENEWABLE



Source: EPE (PDE 2019)



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*(Energy Research Office)*

**Ministry of Mines and Energy**