



Empresa de Pesquisa Energética

# Energy Efficiency in Power Sector in Brazil

Brazil, a Country in which energy efficiency is already a reality in Power Sector

---

**Giovani Machado**

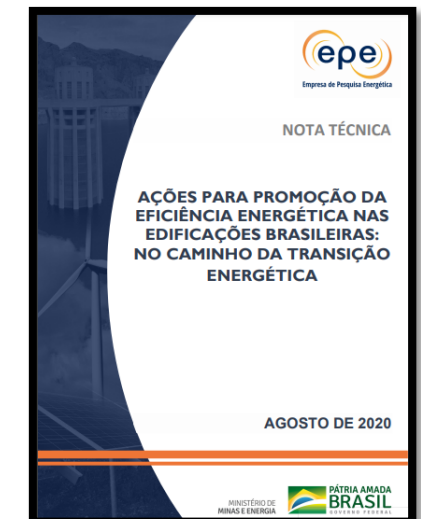
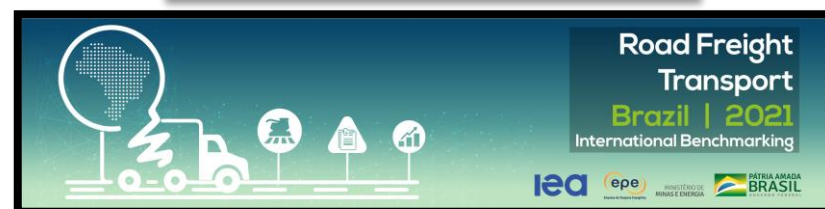
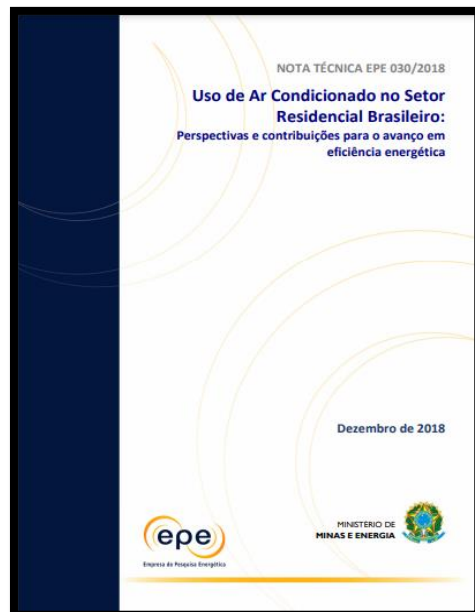
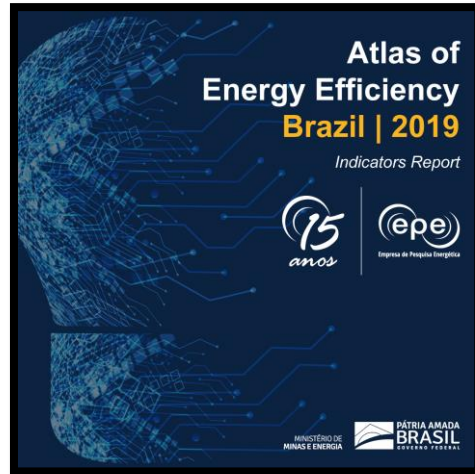
Director for Energy Economics and Environmental Studies | EPE

4 November 2021

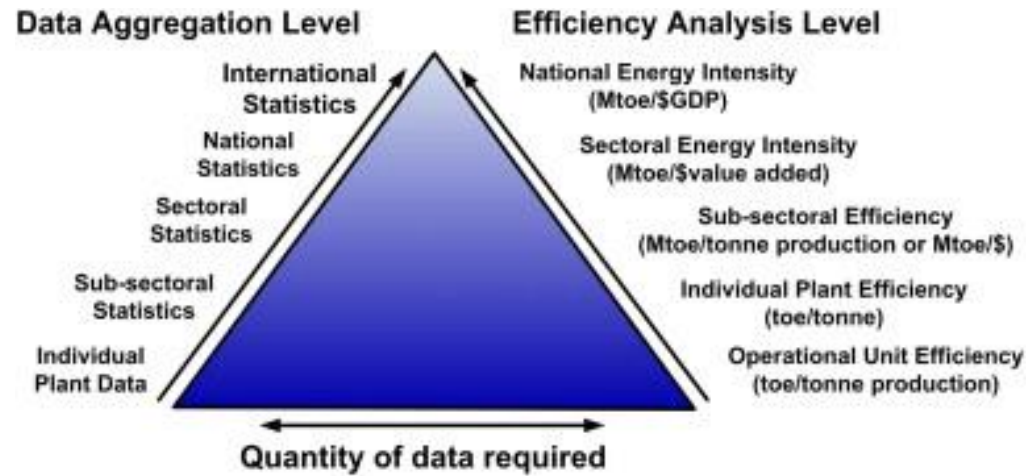
MINISTÉRIO DE  
MINAS E ENERGIA



# Recent EPE Energy Efficiency studies



# Concept matters! How to measure energy efficiency?



Source: <https://www.sciencedirect.com/science/article/abs/pii/S0959652612006580>

**Energy Intensity** measures que total energy supply by unit of product or activity. When aggregated for the country: **TES/GDP**

**Energy Efficiency** measures service or physical product obtained by unit of energy used. When disaggregated by kind of service or product:  $m_i/FEU_j$ , where “m” is the service or the physical product “i” and FEU is the final energy use of energy source “j” ( $\sum FEU_j =$  Total Final Energy Use for the service or product).

To understand concept is fundamental: difference between energy intensity and energy efficiency

## HOW EFFICIENCY AFFECTS ENERGY INTENSITY

Efficiency improvements in processes and equipment and other explanatory factors can contribute to observed changes in energy intensity.

Two separate effects are other explanatory factors: structural changes and behavioral factors, which are further discussed below.

Declines in energy intensity are a proxy for efficiency improvements, provided a) energy intensity is represented at an appropriate level of disaggregation to provide meaningful interpretation, and b) other explanatory and behavioral factors are isolated and accounted for.

Energy efficiency refers to the activity or product that can be produced with a given amount of energy; for example, the number of tons of steel that can be melted with a megawatt hour of electricity.



Office of  
**ENERGY EFFICIENCY & RENEWABLE ENERGY**

<https://www.energy.gov/eere/analysis/energy-efficiency-vs-energy-intensity>

# Focus of “energy efficiency”: systemic vs. Technical

## What is the target?

TES/  
GDP

To reduce the **Energy Intensity** of Brazil?  
To reduce the **Energy Intensity** of sectors?

$m_i /$   
FEU<sub>j</sub>

To increase **Energy Efficiency** of service or product?  
To increase **Energy Efficiency** of industrial processes/end-use?

Policies on competitiveness, industry, technology, energy, efficiency, education, income distribution, etc.



Changes on GDP's structure, trade specialization, basket of products, technologies & processes, energy matrix, etc.

Policies, programs and targets on energy efficiency by branch / end-use

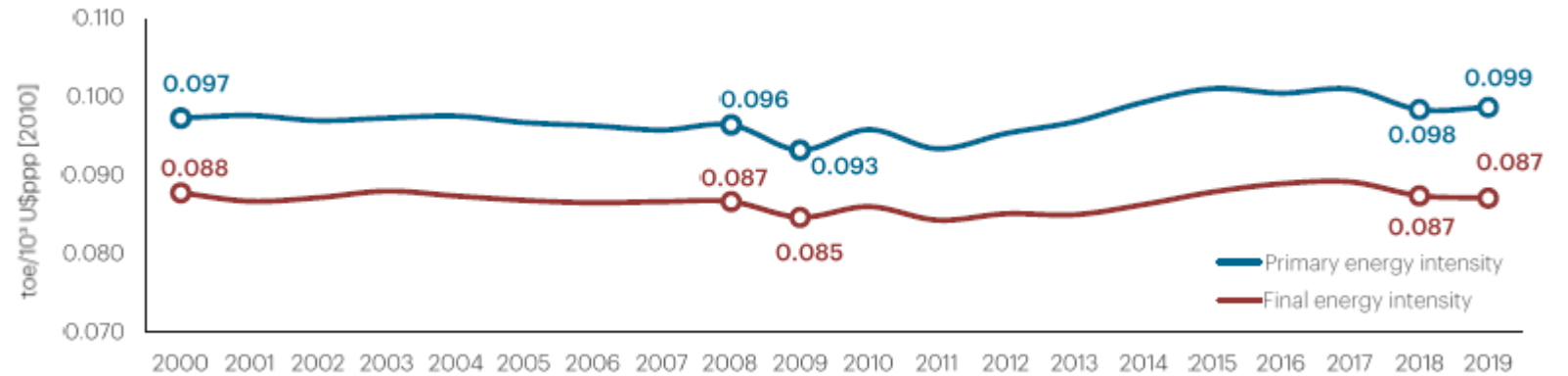


Action plans, mechanisms of incentives and/or regulations, norms and stakeholders' engagement

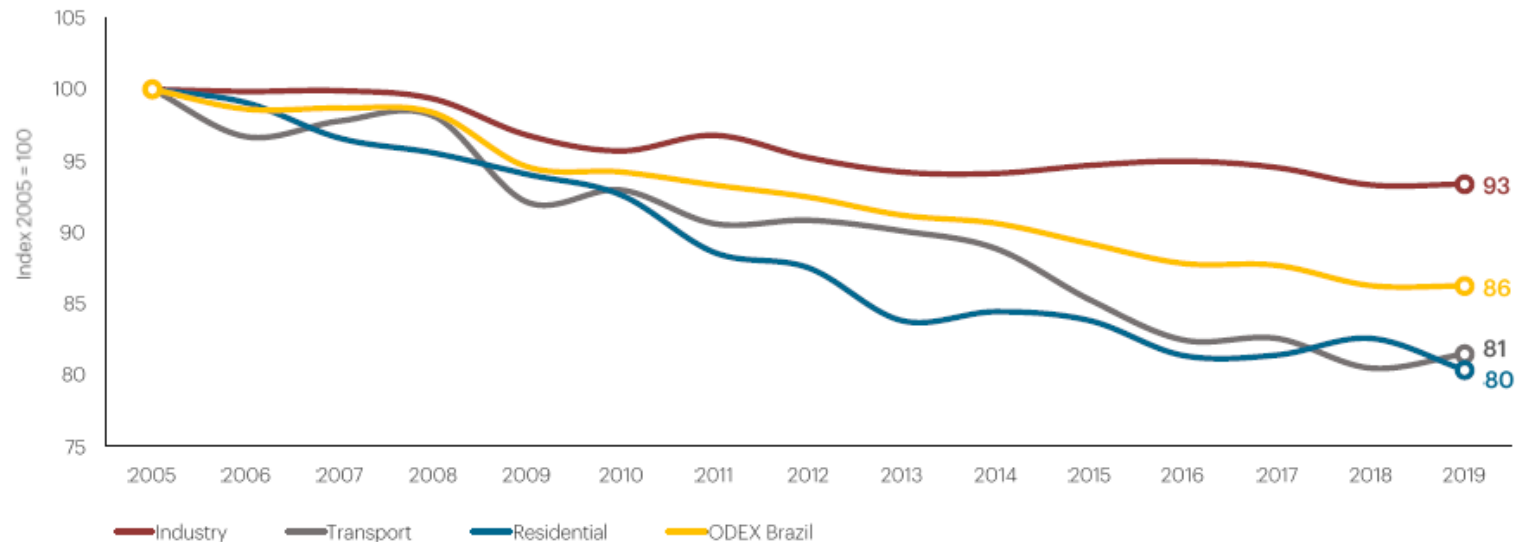
# Concept matters! How to measure energy efficiency?



Energy intensity is basically stable over time in 2000-2019



ODEX Energy efficiency gains in Brazil: 14% in 2005-2019

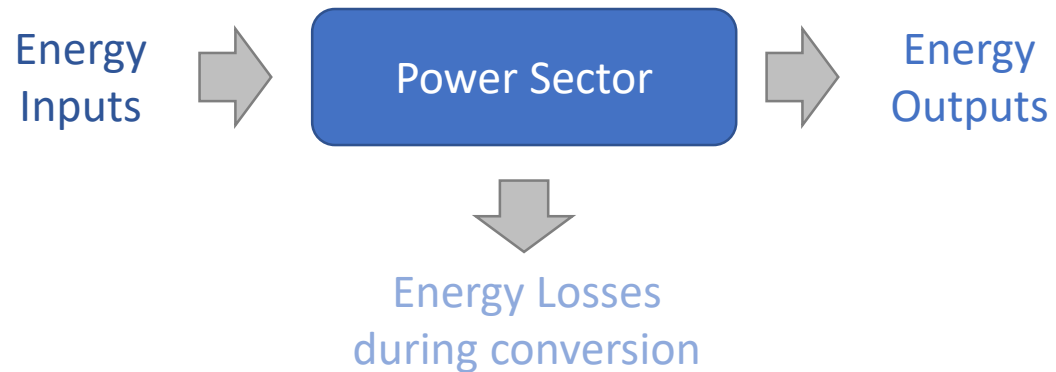


Note: ODEX is the index used in the ODYSSEE-MURE project to measure the energy efficiency progress by main sector and for the whole economy.  
<https://www.odyssee-mure.eu/publications/other/odex-indicators-database-definition.html>

# Energy efficiency in the Brazilian Power Sector (transformation centers)



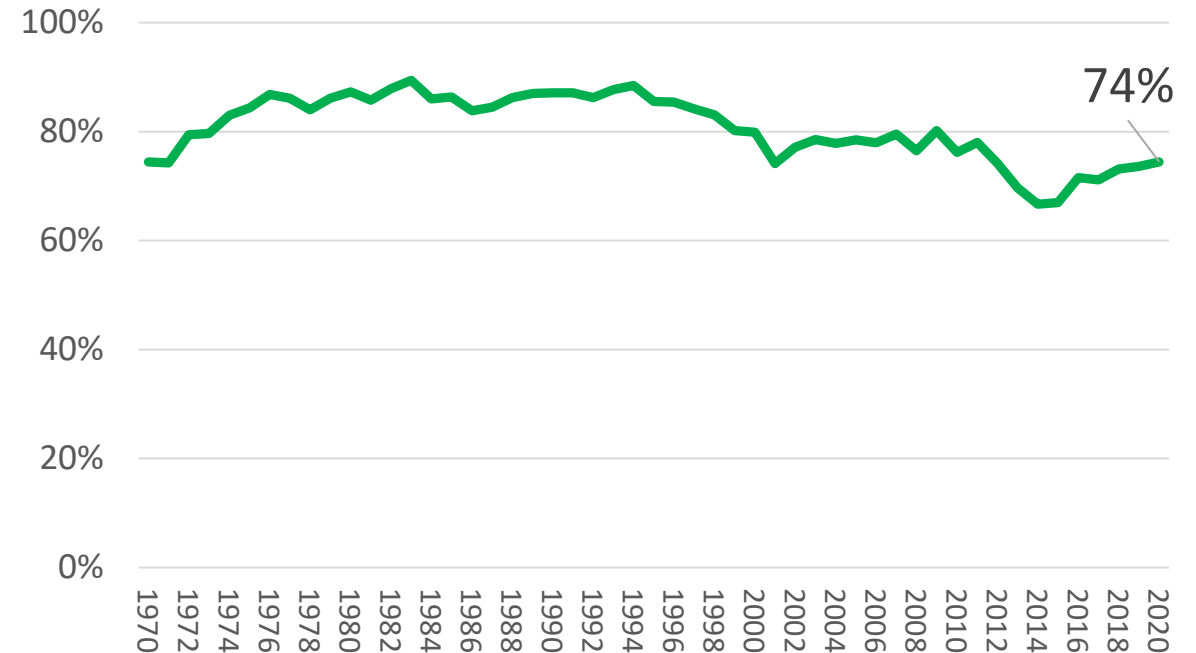
Energy efficiency in Power Sector (transformation centers):  
Electricity Generation / Energy Inputs (TES) %



First Law of Thermodynamics:  $E_i = E_o + E_L$

Energy Efficiency =  $(E_o/E_i) \times 100$ .

Energy Efficiency in the Brazilian Power Sector (transformation centers)

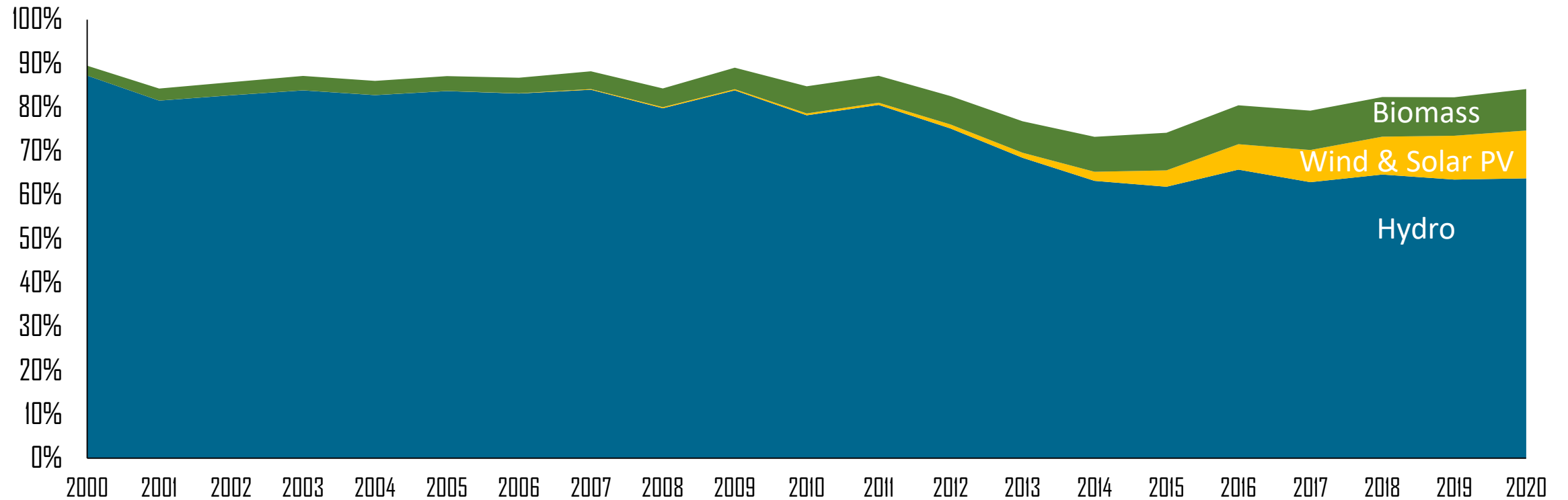


Brazil is among the world's top efficient countries!

# Share of renewables is key to energy efficiency in Power Sector



Renewables bring high energy efficiency standards to the power sector of Brazil



Source: EPE (2021) - Energy Balance of Brazil

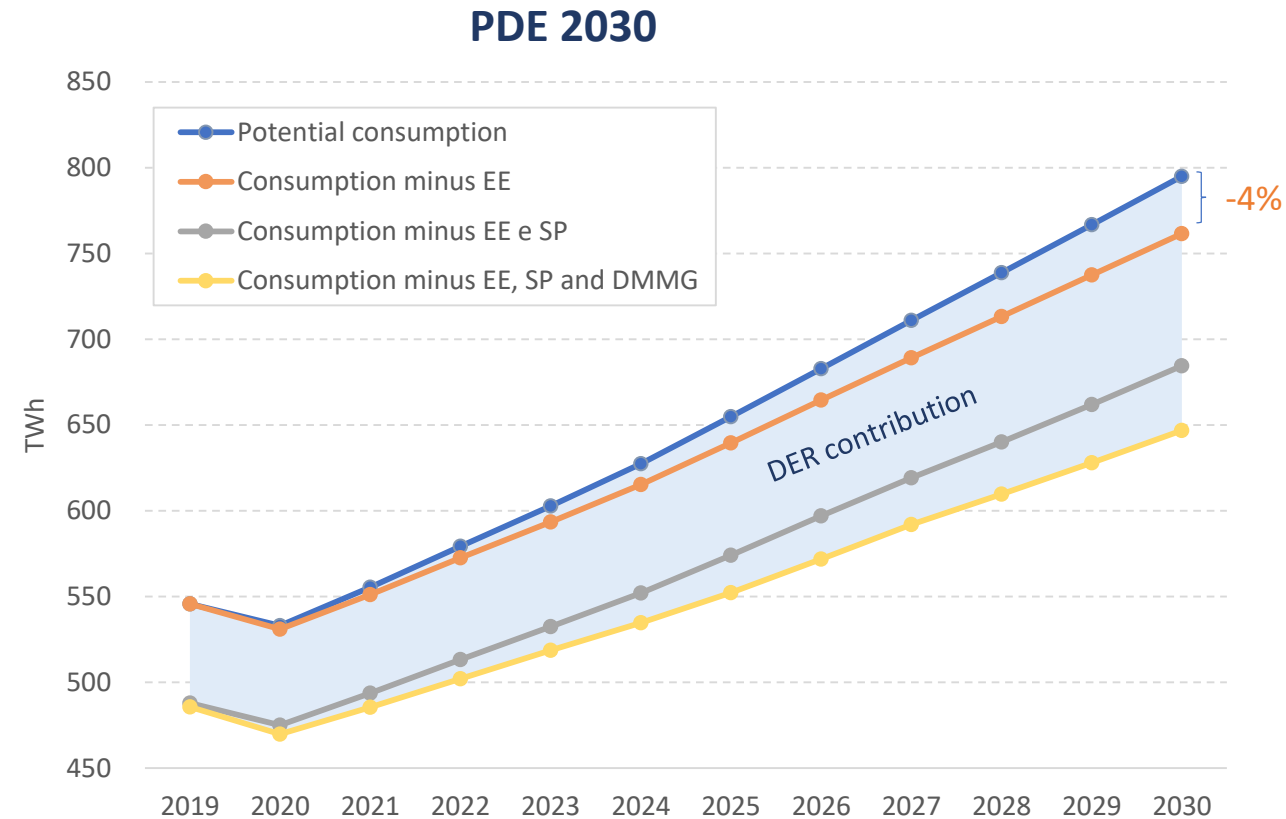
# Energy efficiency Forecast in the Brazilian Power Sector (end-users)



Energy efficiency in Power Sector (end-user):  
Efficiency gains / Potential Energy Use [without EE]  
(%)

## Frozen Efficiency baseline approach:

1. Take a base-year;
2. Measure the energy efficiency;
3. Forecast potential energy use based on a frozen efficiency baseline;
4. Forecast expected energy use considering the efficiency gains;
5. Calculate the ratio: efficiency gains / potential energy use.



\* EE = Electrical efficiency gains  
SP = Self Producers Not Injected in Electricity Network  
DMMG = Distributed micro and mini-generation  
DER = Distributed Energy Resources

Considering 2013 as a base-year, **energy efficiency gains is over 8% in 2030**. Additional policies & programs are on the way.



- **Concept** of energy efficiency **matters** to define the appropriate policies, measures, programs and plans
- **Energy intensity** of Brazil is **stable**, while **ODEX Brazil** for the country is **improving**
- **Energy efficiency in Brazilian Power Sector** (transformation sector) is **high due to renewables**
- There are **high potential for energy efficiency** in Brazil, but policies & programs have to **address the right target** to get the proper benefits and to avoid frustration
- Brazil has been establishing **measures & programs to achieve 10% of energy efficiency gains** related to **power sector (end-users) by 2030**, as mentioned in the informative annex of its NDC
- **Information is key** and **digitalization will bring huge opportunities** for measuring, monitoring and managing energy demand & efficiency gains in order **to get the best of energy efficiency investments** in industry, services, households and other sectors

**To avoid misinterpretation about effectiveness of energy efficiency policies & programs, bear in mind that energy efficiency usually brings rebound effect for low and mid-income levels' households.**



[www.epe.gov.br](http://www.epe.gov.br)

MINISTÉRIO DE  
MINAS E ENERGIA



PÁTRIA AMADA  
**BRASIL**  
GOVERNO FEDERAL

**Thank you for  
your attention!**