



## ENERGY EFFICIENCY AS A DISTRIBUTED ENERGY RESOURCE (DER)

Distributed Energy Resources (DER) are defined as electricity generation and/or storage technologies located within the boundaries of the area of a particular distribution utility, usually connected to consumer units (behind-the-meter).

In addition, this definition has often been expanded to include **energy efficiency**, demand response (DR) and demand side management (DSM).

## HOW CAN WE MEASURE ENERGY EFFICIENCY?

### ENERGY INTENSITY

It is defined as the amount of energy required per unit of product or activity, which in the aggregate level would be, for example:

$$\frac{\text{Total Energy Supply}}{\text{GDP}}$$

### ENERGY EFFICIENCY

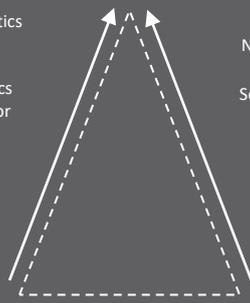
Energy efficiency increases when a given service level is provided with less energy while maintaining comfort or when the service level increases for a given amount of energy.

$$\frac{\text{Energy Service}}{\text{Energy Final Consumption}}$$

For more detailed and assertive analyses related to energy efficiency, a higher level of disaggregation is required and, therefore, a greater volume of data is needed.

#### DATA DISAGGREGATION LEVEL

International Statistics  
National Statistics  
Sectorial Statistics  
Subsectorial Statistics  
Data by consumer or Industrial plant



#### LEVEL OF ENERGY EFFICIENCY ANALYSIS

National Energy Intensity (Energy/GDP)  
Sectorial Energy Intensity (Energy/Added Value)  
Subsectorial Efficiency (Energy/ton or Energy/ Added Value)  
Efficiency by unit (Energy/ton)  
Efficiency of operating unit (Energy/ton)

REQUIRED DATA VOLUME

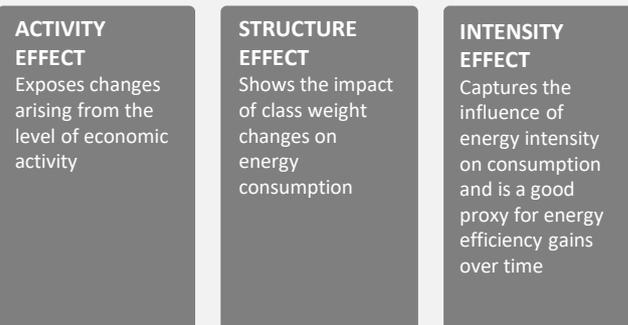
Source: Adapted from Vkhorev, Greenough e Brown (2013): *An advanced energy management framework to promote energy awareness*. Available at: <https://bit.ly/3J1qFm>

## ENERGY EFFICIENCY vs. ENERGY INTENSITY

Generally, reductions in energy intensity may indicate energy efficiency gains in the economy. However, energy efficiency is associated with gains in processes and equipment.

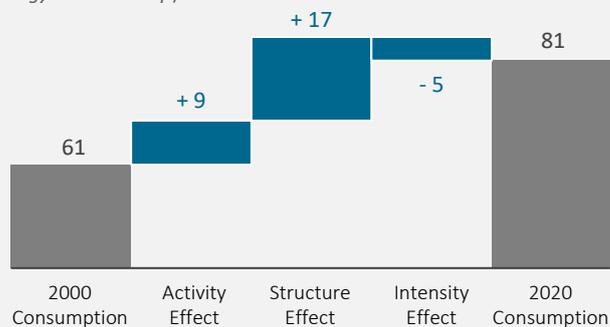
In productive sectors, energy efficiency refers to activity or production processed from the use of a given energy level. For example, the energy used to produce one ton of primary aluminum.

The variations in energy consumption observed over time in a country or a given sector can be decomposed into three main effects:



## DECOMPOSITION OF BRAZILIAN INDUSTRIAL ENERGY USE (2000-2020)

(energy use in 10<sup>6</sup> tep)



Note: Real application. It is worth mentioning that the amounts of variations of each effect do not necessarily follow the proportions and directions presented.

## CONCEPTUAL CLARIFICATIONS

- Energy use is also influenced by other factors such as weather, consumer behavior etc.;
- It is essential understanding the limitation on using the energy intensity indicator as *proxy* for energy efficiency due to the strong influence of the structure effect and its impact mainly in periods of economic crises;
- The intensity effect is directly influenced by energy efficiency gains from equipment replacement, behavioral changes and industrial processes.



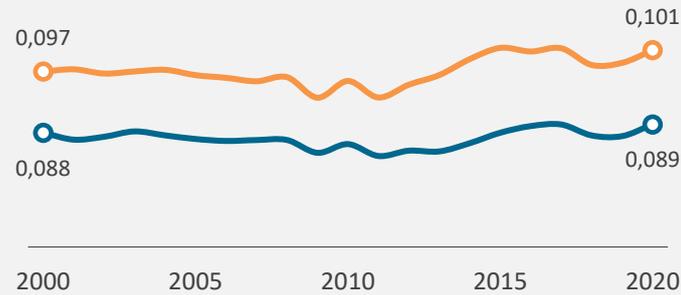
## HOW CAN THE USE BY SECTOR INFLUENCE THE EFFICIENCY OF THE ECONOMY?



A large variation in sectoral participation tends to influence energy intensity. ODEX is an indicator that determines the evolution of energy efficiency. It can be aggregated by sector or for the economy as a whole. ODEX by sector is based on unit use indexes by sub-sector, weighted by their share in the total energy use of the sector. Using this technique, the energy efficiency measure is not influenced by the structure effect, which can be very useful to monitor energy efficiency improvements and the effectiveness of policies and for international comparisons.

### ENERGY INTENSITY

(Energy/GDP)

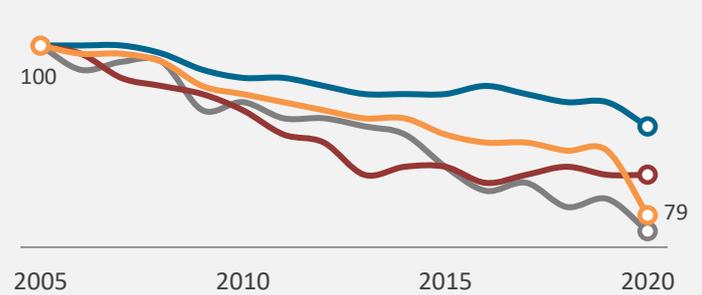


- Energy Intensity on Gross Domestic Supply
- Energy Intensity on Final Consumption

National energy intensity can be calculated based on energy use from sectors. But it can still be based on the Gross Domestic Supply, *i.e.* all the energy needed to move the country's economy, which also includes use in the processes of energy transformation.

### ODEX

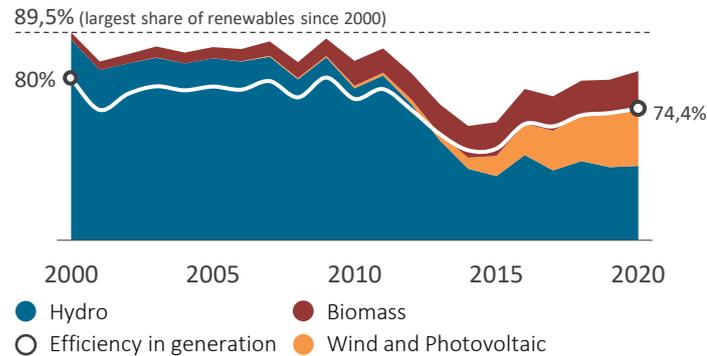
(Index)



- Industry
- Household
- Transportation
- ODEX Index

In the ODEX methodology, the variations in efficiency indices in each use sector influence the overall index, but eventual changes in its sector weights over time (*structure effect*) have no impact. For more information, see the *Atlas of Energy Efficiency Brazil 2021*, available on: <https://bit.ly/3DSscup>

### EFFICIENCY IN THE ELECTRICAL SECTOR vs. RENEWABLES' SHARE

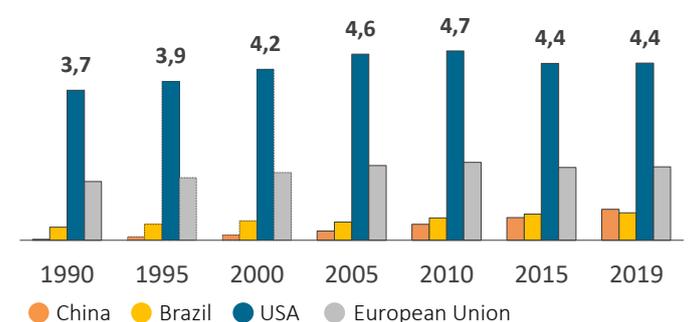


Source: EPE (Brazilian Energy Balance)

In recent years, hydropower has not kept pace with the growth of electricity demand. Other renewable sources have partially occupied this space. In the case of non-thermoelectric renewables, 100% efficiency is considered in the transformation of electricity, which influences the maintenance of Brazil at a prominent level in efficiency in electricity generation. For more information, see the Efficiency on Transformation Fact Sheet: <https://bit.ly/3O8KRKa>

### PER CAPITA ELECTRICITY HOUSEHOLD USE

(MWh/inhabitant)



Source: Own elaboration, based on (Brazilian Energy Balance), International Energy Agency and World Bank.

Per capita use of electricity in Brazil remains much lower than in developed countries and has recently been surpassed by China. This does not necessarily mean that the country is more efficient, but it does indicate that it is necessary to expand its infrastructure to meet the growing demand for goods and services, including access to energy, considering the UN Sustainable Development Goal 7 on energy (UN SDG 7).



### DIGITALIZATION AND ENERGY EFFICIENCY

Information is critical and digitization has brought great opportunities to measure, monitor and manage energy demand and efficiency gains. This allows changing procedures and habits, in addition to making better investments in energy efficiency in industry, services, homes and other sectors.



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