**Impact of Demand Response in the Brazilian Energy System using LEAP Model**

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# Overview

# Demand response is defined as the change in electricity use by consumers from the normal consumption pattern in response to changes in energy price or the receipt of incentives to induce lower energy at higher price points or when reliability of the system is impaired. Demand response can improve system adequacy and substantially reduce the investment need to meet peak demand, shifting consumption to times of low demand and adding stability to the system.

# This article will present a methodology for modeling demand response in the LEAP model - the Low Emissions Analysis Platform, is a widely-used software tool for energy policy analysis and climate change mitigation- until the year 2050 in Brazil. Furthermore, the impact of demand response on generation expansion will be presented, informing which energy sources will be most impacted with the introduction of this mechanism.

# Environmental externalities will also be modeled, and in this way it will be shown which energy source will be most impacted in this new scenario with demand response.

**Methods**

# In this article the LEAP model will be used. LEAP has been adopted by thousands of organizations in more than 190 countries worldwide. LEAP is an integrated, scenario-based modeling tool that can be used to track energy consumption, production and resource extraction in all sectors of an economy.

# To insert data into the model, the main sources of research in Brazil in the energy and economic areas were used, such as PDE, BEN and PNE, prepared by the Energy Research Company – EPE.

# Five scenarios were developed, which are listed below:

# Scenario 1 - Baseline

# Scenario 2 – DR - Baseline + Demand Response

# Scenario 3 – “Lighthouse” – Baseline + Demand growth of: 6% in Household, 5% in Industry, 5% in Commercial and 4% in Others

# Scenario 4 - “DR\_Lighthouse” - “Lighthouse” + Demand Response

# Scenario 5 – “Impact\_CO2” - “DR\_Lighthouse” + Environmental Externalities

# Results

# The main results related to the expansion of generation for Brazil until the year 2050 will be presented in the five scenarios analyzed. The main focus of the article - and subject of analysis in each of the scenarios analyzed - is to analyze the change in Brazil's generation park with the introduction of demand response, comparing it with the reference scenario.

# In general, a sudden decrease in the expansion of thermal generation was observed over the study horizon, which is an important result for the study area. A decrease in nuclear source expansion was also observed over the study horizon.

# This result reinforces the importance of demand response to meet the peak demand of the energy system, simultaneously contributing to the reduction of greenhouse gas emissions. In the scenario with greater energy demand for the study horizon, the impact of the demand response is even greater, reinforcing the importance of the mechanism if the country has greater economic development over the study horizon.

**Conclusions**

# The results found in this methodology are extremely important for the energy sector in Brazil, showing that demand response is a robust mechanism, with good development in energy markets around the world and which can have an important impact on the sector in Brazil. Some points can be highlighted in relation to the study:

# Demand response - modeled in LEAP - changed the generation expansion and operation in Brazil until 2050;

# Thermal generation was the type with the greatest impact, mainly natural gas and nuclear;

# The greater the energy demand, the greater the impact of demand response on generation expansion;

# Emissions modeling has had a strong impact on the operation and expansion of energy sources;

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