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Forecast of long-term electricity consumption of the industrial sub-sector of pulp and paper in Brazil using a bottom-up approach

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Abstract

The subsector of pulp and paper presented in 2013 an electric power consumption of 9.3% of electricity consumption in the industrial sector in Brazil. It experienced a significant growth of production in the last 20 years, exceeding 160%, and their consumption of electricity increased by 130%, reaching the level of 19,594GWh. Due to its characteristics, with a known structure and production processes, and its importance in the country's industrial sector, this subsector was selected for study in this paper, to evaluate the behavior of its long-term annual electricity demand, at the horizon of 20 years ahead, in energy efficiency scenarios through bottom-up approach. This approach is data intensive and requires data with good quality; it consists of a hierarchical structure that enables to check how specific actions can affect the results at each level and its effect on higher levels.

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1. Introduction

The annual projection of long-term electricity consumption is very important for planning and development of a country or region. This information is very important in decision making for companies and organizations operating in the planning of power systems.

Models have been used to make such projections, using different techniques, statistics [1-2], computational intelligence [3], combination of different techniques [4], to name but a few. On some models, the decomposition of the main variable in appropriate components is made, which are analyzed individually and then aggregated to return to the main variable [5-6]. For example, in a region that can be divided into sub-regions, their energy demand could be decomposed by the energy demands of each sub-region; these sub-regional energy demands would then be analyzed and the projection of energy demand in the region resulting from the aggregation of individual projections of sub-region demand [5-6]. This decomposition of variables can be made at various levels.

Observing whether a variable is decomposed into components or not, two treatment approaches can be identified, called bottom-up and top-down [1,5-7]. Modeling top-down treats the variables of interest as whole, providing direct results for these variables. In the bottom-up model, the variables of interest are separated into components, for which a treatment is applied, and the results from these components are then accumulated to compose the variables of interest.

In comparing these two types of modeling, it is observed that the top-down uses a smaller amount of data to achieve the results, however, the interpretation of the influence of some external agents in such results is less explicit. Already the bottom-up allows a better interpretation of the influence of external factors in the results at the expense of a larger amount of data. The modeling bottom-up, therefore, is data intensive and requires data with good quality; increasing the number of detail levels increases its complexity [2].

The aim of this work is to apply the modeling bottom-up in the industrial subsector of pulp and paper in Brazil and evaluate the behavior of its long-term annual electricity demand by the year 2035, in energy efficiency scenarios.

1.1. The Brazilian Subsector of Pulp and Paper

The industrial sector accounted for 40.7% of electricity consumption in Brazil in 2013, reaching a value of 210,193GWh[8]. It is divided into eleven subsectors according to the activity performed, considered the National Energy Balance (BEN), according to the Company rating of Energy Planning (EPE): pig-iron and steel, non-ferrous metals and other metallurgical, pulp and paper, chemical, foods and beverages, cement, iron-alloys, mining and pelletization, textiles, ceramics, other industries [8].

The paper and pulp subsector presented in 2013 an electric power consumption of 9.3% of the electricity consumption of the entire Brazilian industrial sector. It experienced a significant growth of production, 162%, from 1991 to 2013 [9]. It is currently ranked among the top ten world producers of pulp and paper [9] and played an important role in the Brazilian economy in 2013, both in terms of GDP (0.33%) and the value added of industry (1.8 %) [8]. In the same period, the consumption of electricity increased by 130%[8], reaching 19,594GWh. In Fig. 1, it is presented the evolution of the electricity consumption of pulp and paper sub-sector in Brazil (Fig. 1a) and the specific consumption of electricity (Fig. 1b). Fig. 1b shows that the specific consumption of electricity has oscillated over time, but it is falling which points the use of other energy fonts in production.

Due to its characteristics, with a known structure, defined production processes and importance in the industrial sector, the pulp and paper subsector was selected for study in this paper, using bottom-up approach of its electricity demand considering long scenarios time frame.

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