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Weather Sensitivity of Electricity Demand in West African Megacities

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As highlighted in a number of regions worldwide, electricity demand can have a significant dependence on weather. In the present work, we explore this weather sensitivity for Megacities of West Africa. We more especially seek 1) to understand the factors that determine the day-to-day variations of electricity demand, 2) to understand how these variations depend on air temperature and relative humidity and 3) to estimate the fraction of the demand that can be explained by the weather, both at the annual scale or for some specific large consumption events.

Our analysis is based on time series of hourly consumption data made available by the National Electricity Companies for eight West African capitals (Abidjan, Accra, Dakar, Lomé, Cotonou, Ouagadougou, Bamako, and Niamey) and for Libreville in Central Africa. Depending on the city considered, time series cover a period of 4 to 10 years (e.g. 2008-2017). Variables used to predict the mean daily consumption are daily Cooling-Degree-Days (CDD) and a daily index of air humidity, the population connected to the power system and the type of day in a week. CDD are estimated for a threshold comfort temperature optimized for the region and are obtained from an effective air temperature optimized to account for the thermic inertia of buildings.

Whatever the city, the mean daily consumption highlights an important increasing trend, partly explained by the population increase. It depends a lot on the type of day with lower value on Saturdays and Sundays/holidays. The sub daily profile of the consumption is highly dependent on the type of day too. The sensitivity of the consumption to the temperature is large whatever the city. The sensitivity to humidity varies a lot from one city to the other. When the temperature threshold is 24°C, the fraction of the consumption which is due to weather is up to 20% at the annual scale and up to 26% for the maximum daily consumption events.

Based on these analyses, it was possible to propose a fairly effective daily prediction model for each of the above-mentioned cities. The explained variance explained with the model varies from 70 to 92 %. This work is expected to enlighten the different actors of the energy sector in West and central Africa for a better prediction of the electricity demand and a better management and planning of the electricity system.

Kondi Akara G., Diedhiou, A., Hingray, B. 2016. Weather sensitivity of electricity consumption in Cotonou, and Abidjan, two coastal Megacities in Western Africa. International workshop on « evolving energy models in emerging economies. Post COP21, Ahmadabad, Gujarat, India, 12-14 Dec. 2016. 16p