HANDLING THE INTERMITTENCE OF WIND AND SOLAR ENERGY RESOURCES, FROM PLANNING TO OPERATION. URUGUAY'S SUCCESS.

E. Cornalino, P. Sobes, F. Palacios, M.C. Alvarez (ADME)
E. Coppes, G. Casaravilla (UTE; IIE)
R. Chaer <rchaer@adme.com.uy>(ADME; IIE)

ADME is the Electricity Energy Administrator (or ISO) of Uruguay
UTE is the country's power utility.
IIE is the Institute of Electrical Engineering of the University of the Republica Oriental del Uruguay.

Overview

This work shows the planning process and the subsequent operation of the electro-energy system of Uruguay with installed wind and solar energy capacity similar to the peak demand of the system.

Uruguay is a country of just over three million inhabitants with an annual electricity demand of 12,000 GWh. To supply this demand, until 2010, Uruguay had a system of hydroelectric power plants with an installed capacity of 1450 MW, approximately 70 MW of energy generated on the basis of biomass and generation plants based on petroleum fuels.

The generation of the hydroelectric subsystem is random depending on the rainfall regime. Depending on whether the year is rainy or not, hydroelectric generation can vary with a uniform probability between 3500 GWh to 10000 GWh. The energy that was not supplied by the hydroelectric and biomass subsystem then varies between 1400 and 8000 GWh, which represents a percentage variation between 12 and 66% of the Demand. If all this missing energy is covered with fuel fired generation, the variability of the volume is added to the oil price variability.

Since Uruguay is not a producer of oil, the two above-mentioned variabilities imply a risk of supply costs of electricity demand that can impact more than 1% of the national GDP. As a way to mitigate this risk, the country's authorities implemented policies designed to diversify the generation matrix by promoting the installation of wind, solar and biomass power plants.

For the effective incorporation of the new sources of energy into the system, it was necessary to carry out a series of studies that allowed evaluating the pros and cons of each and establishing the necessary conditions to achieve an optimal investment plan.

As a result of that process, ending the 2017, 1500 MW of wind capacity and 220 MW of pv-solar capacity was in operation.

In this work, we present the series of studies and considerations in the planning process of the expansion of investments that allowed us to be aggressive in the incorporation of wind energy in the quinquennium 2010-2015 as well as the tools developed for the operation in 2017- 2018 of the new generation matrix.

As for the previous studies, the methodology applied for the optimization of investments with their results is shown, as well as detailed simulations of hourly steps that showed that the system would be governable.

Regarding the tools developed for the 2017-2018 operation, the VATES application is described, which is in continuous time integrating the real-time information of the operation with the forecasts of wind, solar and demand generation and performing the optimal stochastic dispatch of the following 72 h (results shown on the page of http://www.adme.com.uy)

Methods

For the simulation of the optimal operation of the system, the SimSEE platform was used [1]. For the modeling of stochastic processes in SimSEE, models of Gaussian Space Correlations with Histograms (CEGH by its initials in Spanish) are used [2]. The stochastic processes modeled include the water influxes to the lakes of the hydroelectric power plants and their dependence on the El Niño-Southern Oscillation phenomenon [3], the production of wind power plants [4] and solar plants distributed in the national territory [5] and the electrical demand [6].

The feasibility of the operation with different levels of wind and solar integration was verified through hourly pace simulations.

For the planning of investments, the Distributed Optimizer of Functions of High Cost of Evaluation (OddFace) was used [7].

For the operation of the system developed the tool VATES [8] currently in operation in ADME.

Based on the developed model and the ability to forecast in advance the availability of blocks of exportable energy and its price, a Gradual Integration Model was designed [9]

Results

The main result is the success in the incorporation of 1500 MW of wind energy and 220 MW of solar energy during 2013-2017.

As a result of the VATES software alignment, the forecast of the spot price of the following 72 hours is obtained. This the projection is continuously updated and can be used to incentivate the grow of new responsive demands.

Conclusions

In a continuosly changing world, planning for the long term is a challenge. Planning radical changes is even more difficult and the success in making things happen, without a doubt, is to have a bit of luck and enough knowledge to make responsible decisions. The power to change things is in the knowledge.

The intermittency of the wind and solar energies turned out to be a myth. The Uruguay system is a successful example that it is possible to operate a 100% renewable system.

The incorporation of non-conventional renewables as well as being environmentally friendly are an economic solution that manages to lower costs and reduce the risk of countries like Uruguay to the costs associated with petroleum-based fuels.

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