Performance Simulation of the Stabilization Fund of Electric Power in Uruguay with and without Smart Grid Controlled Responsive Demand

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Abstract--**Uruguay has a high hydroelectric power generation, creating a strong dependency between electricity generation and water situation. In periods of low rainfall must resort to more expensive electricity generation, such as thermal generation or to the imported electricity generation, with the consequent negative impact on the economy. To mitigate the effects of water stress on public finances, the Energy Stabilization Fund (FEE for its acronym in Spanish) was created. The contributions and the use of FEE are triggered by the actual hydraulic generation of electricity system compared with the expected hydro generation (quarterly and/or annual). In this paper we analyze and compare the performance of the FEE with or without smart grid controlled responsive demand. We conclude that the implementation of an aggressive participation of Controlled Responsive Demand has not impact on the requirements of the FEE.**

Index Terms-- **Energy, Simulation, Management, Power, System.**

I. Nomenclature

RD: Responsive Demand.

II. Introduction

This paper presents the simulation results of the performance of the Fund for Stabilization of Energy (FEE for its acronym in Spanish). The FEE is an instrument created by Law No. 18719 of December 27, 2010, which aims to reduce the exposure of public finances to the risk of costs of supplying electricity demand in the country.

The two most important sources of variability of the cost of supplying the demand are hydroelectric generation and the cost of petroleum-based fuels.
In situations such as the one that occurred in 2008 which was a year of very low hydraulic generation with a price of a barrel of oil that rose above 140 USD/barrel, the cost of supplying the demand was more than twice the expected value, impacting negatively the public accounts in a significant way.

Nowadays, 60% of electricity generation in Uruguay comes from four hydroelectric plants installed on the two main rivers. The hydraulic power effluent has a high volatility due to rainfall. The energy not supplied by the hydroelectric system or alternative renewable sources must be supplied with thermal power generation or imported energy.

The installed capacity of hydroelectric plants is 1,500 MW. In addition to hydropower, the country has 1,000 MW of thermal power plants based on petroleum fuels with an average generation cost of 200 USD/MWh. Uruguay's power demand was 10,000 GWh in 2012 and has an estimated growth of 3.5% per year. Hydro generation can be from 9600 GWh in years of good rains to only 4500 GWh in drought years.

Uruguay is radically changing its energy mix incorporating large amounts of wind, solar and biomass. These energies have the characteristic of being reliable when considering a year integration window (there are no years of poor wind or sun) while considering an hourly or daily integration window show a great variability. Uruguay has hydro system for filtering the intra-weekly variations besides being strongly interconnected with its neighbors. The incorporation of non-conventional renewable energies changes the cost exposure in a significantly way. Non-conventional renewable energies are being incorporated into Power Purchase Agreements (PPAs) based on securing an energy price. This means assuming a fixed cost not correlated with rainfall or oil prices.

It is expected that in the future the availability of low cost energy packets will be usable by new demands such as manageable intensive irrigated agriculture or a fleet of electric cars. A simulation of the evolution of the FEE with and without this manageable demand is shown in this work.

III. Methodology

The SimSEE [1] tool was used to simulate the FEE. SimSEE is a simulation platform for the optimal operation of the system power generation. For modeling of the main stochastic processes (contributions hydraulic dams, oil price value, wind and photovoltaic generation) the CEGH [2] models available in the SimSEE platform itself were used.

The rules of uses (withdrawals and contributions) to FEE created by the existing legal framework were modeled, and 1000 MonteCarlo realizations of stochastic optimal operation of the generation system in time horizon from 2015 to 2018 were simulated.

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There were two simulations performed: the first one was made without smart grid controlled responsive demand. The other was made with the 30 % of the total demand with controlled responsive demand. This controlled responsive demand has a utility function associated of 100 USD/MWh for any hour of the day. This means that the operator is free of shift the Resposive Denmand (RD) to the more convinient hour of the day.

IV. Results

The FEE acts as a storage of money to be used when the in periods of poor hydro generation. The required volume of the storage is called VCOF (Volumen de Cobertura del Fondo for its acronyms in Spanish). Every three months the withdrawals and contributions from and to the FEE are computed and an effective amount of stored money result in the FEE.

The evolution of the minimum level of the FEE for the period 2015-2017 is shown in Fig.2 for the 1,000 simulated chronicles and for the two scenarios, with and without the RD. As can be appreciated there are not significantly differences between the two cases.

The other relevant value to see is the VCOF and it is shown in Fig.1. It is a difference in the first year of 7 MUSD in a total of 149 MUSD. The result is that the system with aggressive RD need a bit more of VOCF for the first year.

V. Conclusions

The main conclusion is that the implementation of a Responsive Demand program that permit that 30% of the system load can be considered as a shiftable load has not effects over the risk exposure of the electrical sector.

VI. References

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VII. Biographies

María Cristina Álvarez, was born in Montevideo, Uruguay, on Mayo 18, 1971. She received the Electrical Engineer degree in 2002. She worked in UTE Distribution from 2002 to 2007, form 2007 to 2009 in the URSEA and since December 2009 works in ADME as a staff engineer.

Lorena Di Chiara was born in Montevideo, Uruguay, on November 7, 1977. She received the Electrical Engineer degree in 2003. She worked in UTE Distribution from 2003 to 2009 and in National Energy Directorate (DNE) from 2009 to 2014. Since December 2014 she works in ADME as a staff engineer.

Pablo Soubes was born in Montevideo, Uruguay, on February 12, 1982. He received the Electrical Engineer degree in 2012. Recent jobs includes working in UTE on the Electromechanical Projects Management Area in 2012 and on Planning and Technical Secretary Management Area from 2013 to 2014. Since December 2014 he works in ADME as a staff engineer.

Ruben Chaer was born in Tacuarembó, Uruguay, in 1962. He received the Electrical Engineer degree in 1990 and the Master's Degree in Electrical Engineering in 2009 from the University of the Republic of Uruguay. He is currently Professor at the Institute of Electrical Engineering and manager at the ADME the Administration of the Electrical Market of Uruguay..

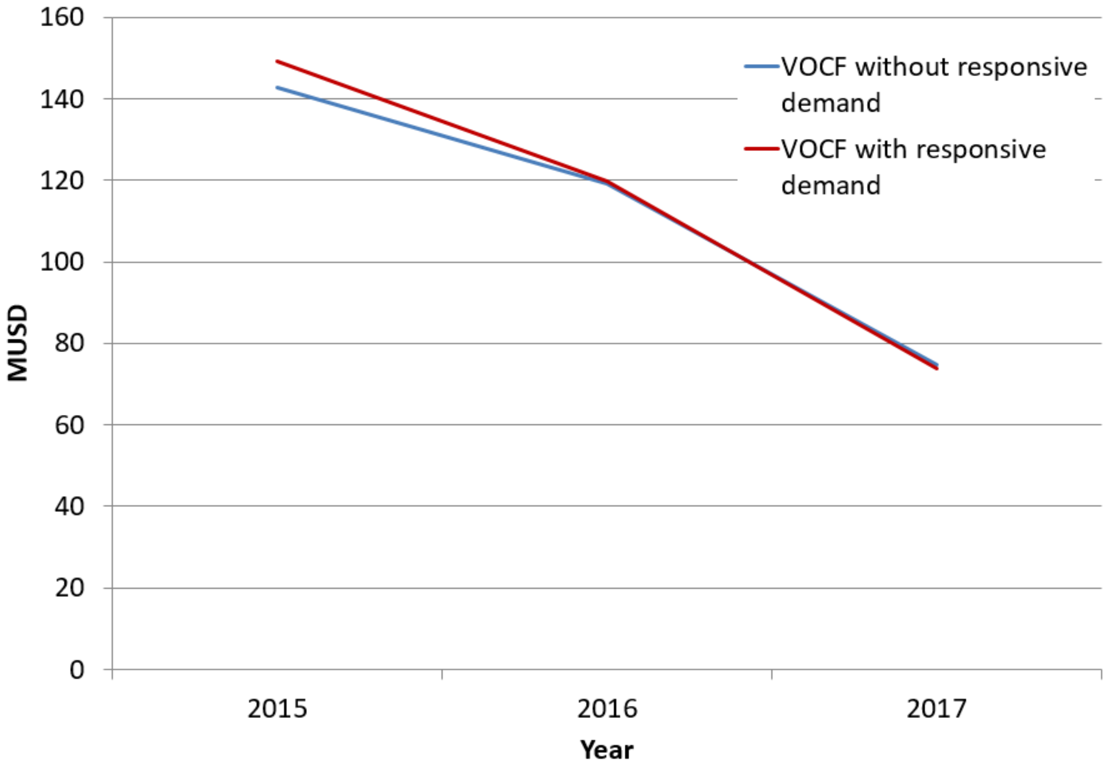

Fig. 1: VCOF for 2015-2017

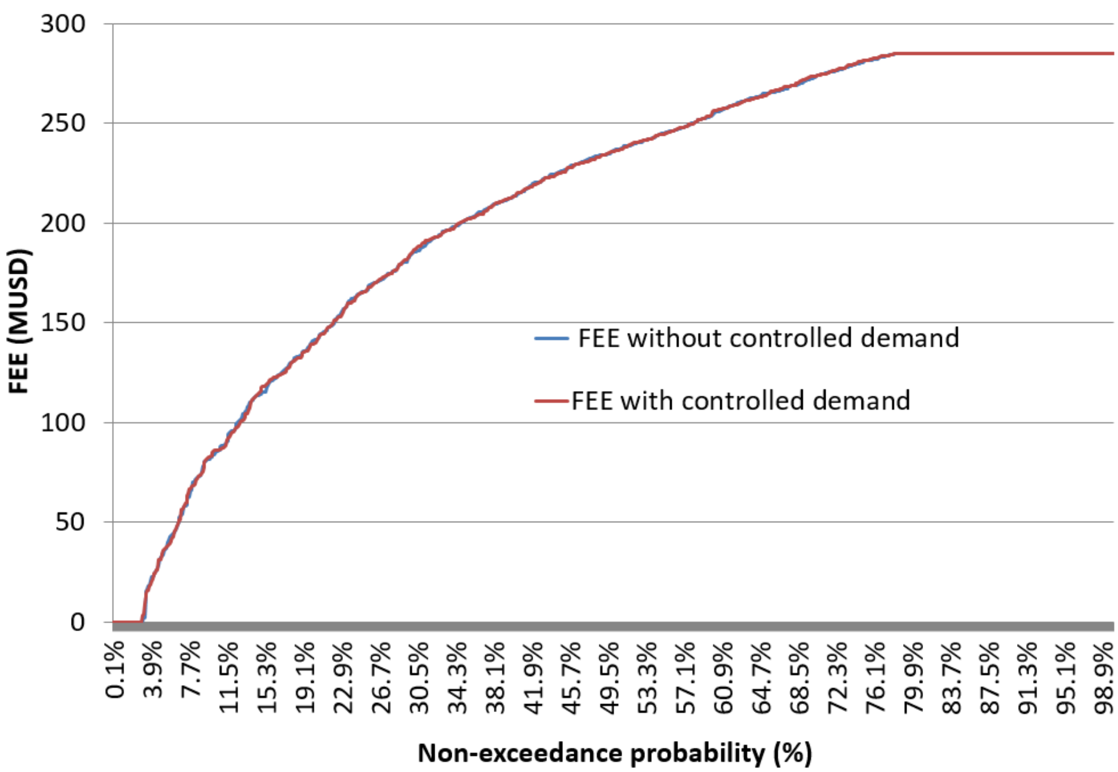

Fig. 2: Minimum FEE for 2015-2017