Bulletin de la Société Royale des Sciences de Liège, Vol. 86, *special edition,* 2017, *p.* 543 - 549

Modeling and simulation of wind turbines and responsive loads in smart grids

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Abstract

In order to implement demand response programs appropriate equipment must be provided to subscribers at any moment be aware of the price of electricity and the price of electricity at different times to an appropriate response to reduce their costs to the network, that This would reduce consumers will demand at peak times. Smart grid using two-way communication and transmission of information to consumers as well as the use of advanced measurement system, reasonable structure has provided for the full implementation of demand response programs. In this paper, a wind turbine that is connected to a smart grid responsive loads to consider and examine the systems in the grid.

Keyword: wind turbine , responsive loads, smart grids

1. Introduction

The awareness of depletion of fossil fuels, the desire of energy independency, and global warming have increased the interest in renewable energy sources. Because the conversion process into electricity has in general a lower energy density, its capacity per unit does not equal nuclear,

coal- and gas-fired power plants, and when implemented as Distributed Generation (DG) it is often connected to the medium- and low- voltage grid (MV/LV) in smaller unit sizes. As a result, the topology of the power system is changing. The total electric energy consumption is still growing due to the development of the global gross domestic product. Besides, the introduction of the heat pump and the electric car will in future also contribute to a higher electric demand. The combination of more unconventional controlled power generation connected to the MV and LV grid, and a higher electric demand have increased the interest in and the desire of a smart grid. A smart grid is defined as: “Electricity networks that can intelligently integrate the behavior and actions of all users connected to it - generators, consumers and those that do both – in order to efficiently deliver sustainable, economic and secure electricity supplies” [1].

Instead of controlling wind power by the wind farm operator, wind power could be controlled by the smart grid to converge wind power with the e.g. electric car storage facilities. This research will outline the methodology to mitigate the impact of wind power by controlling wind turbines within a smart grid. Wind power does not automatically follow a load curve and conventional power has to balance the power system's nominal frequency. This research describes a general methodology to calculate wind power fluctuations and proposes a possible role for the smart grid to mitigate the impact of wind power to frequency fluctuations within a power system. Marco et al. [12] In 2010, a general study about renewable energy and the development and planning they did. The general information about the distribution of energy in the network as well as the control and planning of energy systems is given. Also, specifically in the case of wind turbines used in wind farms and Way they control material is presented. Muljadi and colleagues [14] In 2006, in a study the power produced by the wind farm will be qualitative characteristics examined. The energy quality characteristics of wind power energy to consumers has been analyzed. Random significant effects on power output also be provided to subscribers is studied.

2. Smart grid constraints

Balance of power

The total production capacity of power plants and the power injected into the grid must be equal to the sum of consumption plus grid capacity reservations system. In other words, the first constraints is the balance between production and consumption guarantees.

$$\sum_{i=1}^{N_{Generation}} P_{Generation} = \sum_{i=1}^{N_{Load}} P_{Demand} + P_{Reserve} \quad (1)$$

Power generation units

Each of the power plants within a certain range can be generated ‹in other words upper and lower limits constraint the production units guarantees.

$$P_{min} < P_G < P_{max} \quad (2)$$

rate of change of power plants

All units have a certain loading rate, and changes from hour to hour production rate can be certain that the rate of change of slope is called the loading rate.

$$P^t - P^{t+1} < R_{up} \quad (3)$$

$$P^{t+1} - P^t < R_{down} \quad (4)$$

The objective function :

$$\min = \sum_{t=1}^{n} COST^t = \sum_{t=1}^{n} A \quad (5)$$

$$A = \sum_{i=1}^{Nwind} \left(C_{wind}^t . (P_{wind})\right) + \sum_{i=1}^{Nsolar} (C_{solar}^t . (P_{wind})) +$$

$$\sum_{i=1}^{Nmicroturbin} (C_{microturbin}^t . (P_{wind})) + \sum_{I=1}^{Nsolar} (C_{garaj}^t . (P_{gajr}) + C_{Grid}^t . (P_{Grid}^t)$$

i: indexed units

t: index t is the time in hours

C^t_{wind}: The cost of wind power generation units

P_{wind}: Wind power unit production

C^t_{solar}: The cost of solar power generation unit

P_{solar}: Solar module production capacity

$C^t_{microturbin}$: The cost of power generation Microturbines

$P_{microturbin}$:MicroturbinesProduction capacity

C^T_{garaj}: The cost of power generation of electric vehicles

P_{garaj}: Electric car production capacity

C^t_{grid}: The cost of buying power from the grid

3. Simulation results

The problem is that a smart grid that contains many sources of distributed generation is connected to the network via bus PCC. If the production of the smart grid will not be able to meet the load demand at any time and spinning reserve requirements, the rest of the grid load must be purchased at a price that is the same time and if the surplus can be sold at any time to grid was. Figure 1 shows the hourly load profiles and energy prices in the network. The network on a daily basis are as follows:

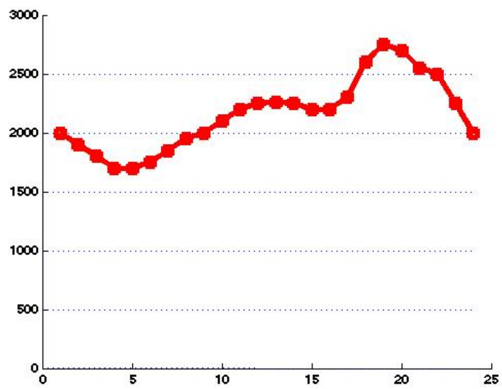

Fig. 1: Total of 24 hours smart grid bars

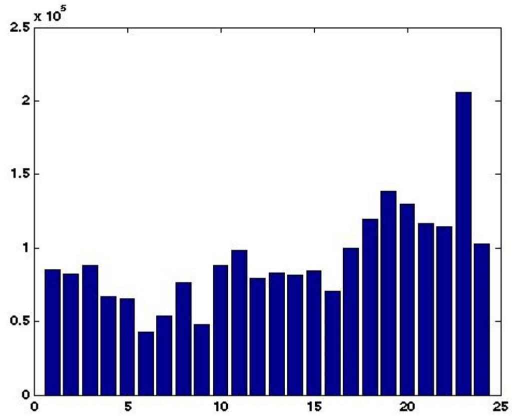

Fig. 2: Price hourly production capacity Smart Grid

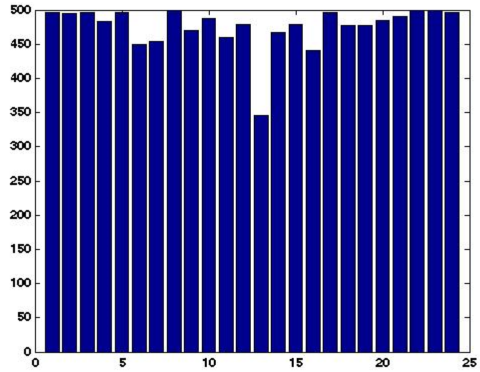

Fig. 3: Power purchased from the grid

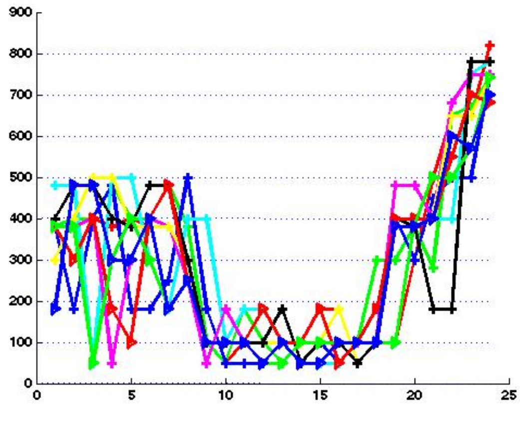

Fig. 4: Wind power unit with 10 scenarios for production in 24 hours

Figure 4 using Monte Carlo techniques derived from the production of antibodies. In this way, according to the scenario generation and Monte Carlo techniques of wind power output for different times at the same time just 10 scenario is that, as is clear in the hours close to the night wind speed and as a result of the unit production of wind is.

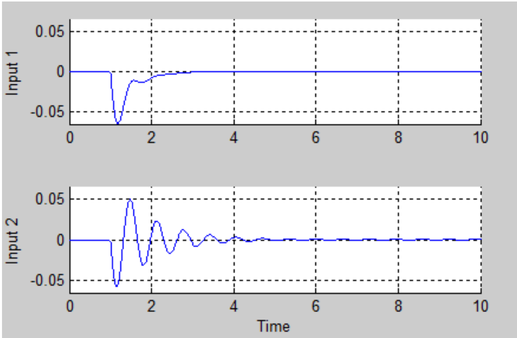

Fig. 5: Fluctuations in the grid frequency

Figure 5 shows the grid frequency fluctuations. Given that this study evaluated responsive loads generated by wind turbines in the smart grid has been responsive to this output indicates that the variation in time of about 2 seconds, almost a full swing, and after this time the volatility of gradually reduced to zero. The objective function is provided in the amount of power generated by all components of the smart grid is a network of 37 bus loads that must meet the energy shortage in the smart grid by wind turbines are supplied. This load, when the network will fall injected about a series of changes that these fluctuations are gradually reduced to zero.

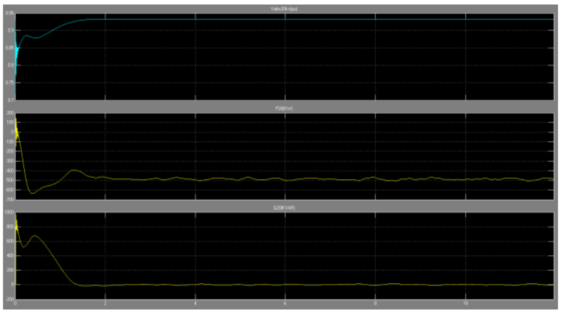

Fig. 6: Active power and reactive power variation curve of grid Voltage

Figure 6 shows the changes of active power and reactive power grid voltage. This curve shows the change in active power smart grid responsive loads gradually increased due to reactive power grid vice versa gradually reduced to zero.

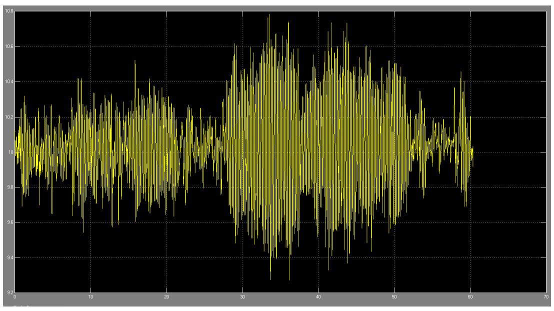

Fig. 7: variation curve of inlet turbines wind speed

Figure 7 shows The variation curve of wind speed at the turbine inlet. The graph is as an input to the wind turbine for the production. This figure is proof of the fact that grid production capacity have nearly straight with wind speed at the turbine inlet, but in this simulation we have been able to respond to fluctuations loads generated by wind turbines and voltage active in the smart grid that almost harness and reactive power generated by the wind turbine to reach a relative stability .

4. Conclusion

This paper first examines the purpose and the function has been connected to the smart grid and how much of the power of a network is to be produced by wind turbines is specified. Because when a system load connected to a network that the network provides a range of fluctuation of the fluctuation can damage grid, The charge produced by a production grid called responsive loads, so that when the bars are logged in grid , the damping system reaches zero and grid system reach to relative stability.

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