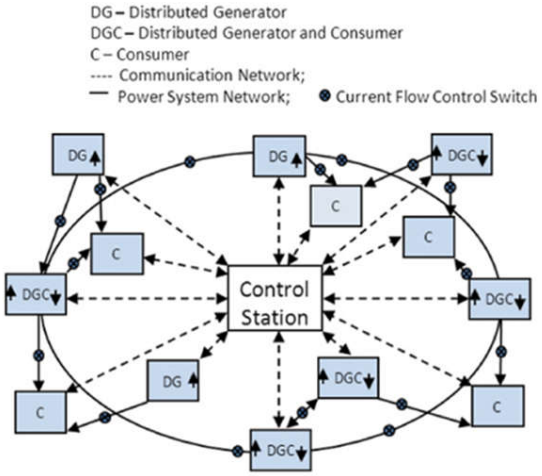
How Corona Discharge Affect Smart Grid

Smart Grid – a dynamic electrical system where at any moment power flows from an available generating station to consumers and the network architecture gets constantly reconfigured to meet momentary power needs and power availability. The direction of power flow in the transmission lines are constantly changing. It is characterized as frequent “make” and “break” dynamic architecture.

The idea behind smart grids is increasing efficiency, availability and reducing cost. Therefore, it is expected that in a smart grid faults will be identified and solved and automatically heal by themselves. The quality of power and voltage rate is expected to be constantly monitored and managed. Consumption will be optimized and minimized and adjustable to peak and off-peak demand periods.

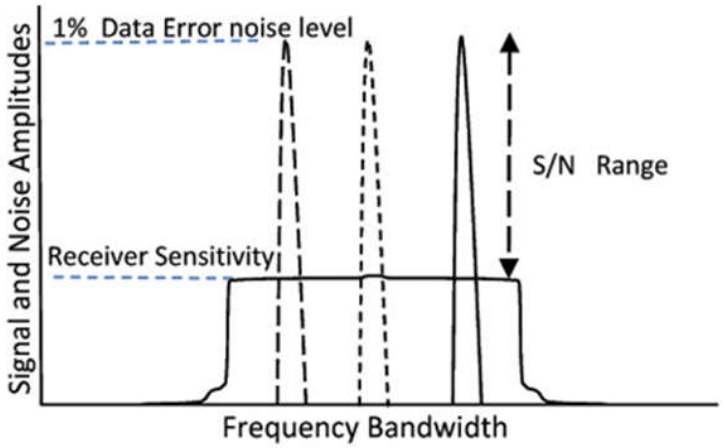
Reliable operation of a Smart Grid means constant on going synchronization and compensation processes that are heavily dependent on communication. To ensure that a multi-users and multi-generators system sustains voltage levels, frequencies and steady state, safely and efficiently it must be controlled. As such, the anticipated load and the available power at any moment must be known, or else any short circuit may lead to a voltage dip and when fixed to oscillations. Accordingly, in a chaotic state, a loss of a generating station will drop voltage while a loss of load will result in a voltage rise.



A conceptual architecture of distributed generator system

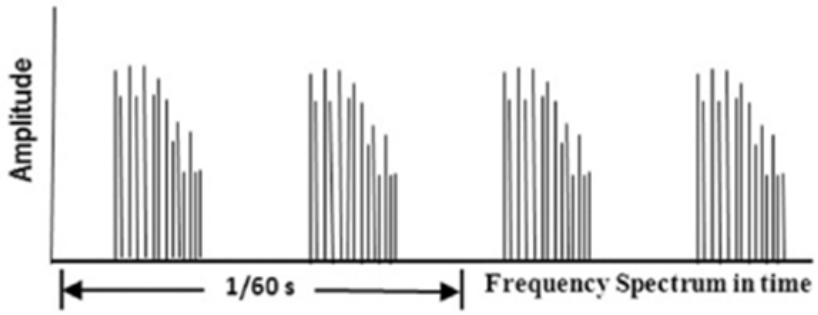
Like a neural system, there should be a flowing exchange of information between a controlling brain and the entire grid elements through synaptic communication lines. Communication in smart grid is wireless and highly susceptible to noise, produced by the power lines due to the frequent changes in routing and due to corona partial discharges. Electrical noise that exceeds some threshold will affect timely information flow, decision making processes and control system function.

Electrical noise can originate in consumer loads such as electronic devices, or in natural events like lightning. Most typical noise sources such as voltage fluctuations, switchgear noise, and power surge are lower than 100MHz, while, corona and arcing or lightning produce noise that extends up to 2GHz. In fact, corona is renowned as one of the major radio frequency (RF) interference nuisance due to its prolonged radiation of periodic broadband spectrum. A study conducted in a 26kV substation with corona discharge using a broadband bi-log antenna and a spectrum analyzer showed that corona radiation levels extend to 1000MHz. The measured noise power level received from the antenna near 1GHz was -65dBm at a 25 meter distance. If Modern wireless receivers using typical antenna are capable of processing signal levels lower than the thermal noise levels (-114dBm/MHz at room temp). But, the overall signal to noise ratio is important. Once a certain noise threshold level is reached the error rate increases with the increase of noise. Corona noise level is too high for the cellular receiver as seen in the graph:



Corona noise level vs. receiver sensitivity levels

Consequently, since corona discharge and arcing produce electrical power noises that can degrade the smart grid wireless communication they must be taken into account before planning the system. Corona level of noises is prone to grow during extreme weather conditions, when most power outages most likely occur, and for EHV transmission lines the level get higher and can reach 2GHz. Using low sensitivity wireless communication devices may be a solution, or using a broadband wireless communication system might minimize interference, or selecting a secure modulation technique such as WiMax – wireless metropolitan area network (MAN) providing high speed fixed/mobile internet access, and LTE – Universal Mobile Telecommunications Systems (UMTS) mobile networking providing for enhanced multimedia services. In any case, communication is the foundation for controlling a smart grid in general and distributed generation system in particular, and corona is a major concern.



Corona radiation spectral distribution within a single phase AC power

Works Cited

Moongilan, D. (n.d.). Retrieved from http://incompliancemag.com/corona-noise-considerations-for-smart-grid-wireless-communication-and-control-network-planning/