

## Feasibility and Functioning of Large Wind Power Plants

Because of the intermittent nature of wind and its dependence on weather conditions, wind power output cannot be guaranteed at any particular time. In addition to dispatching-challenges requiring alternative reserve margins, wind power generates various disturbances in a grid network. Such disturbances include ‘flickers’, short frequency variations, harmonics and reactive power which require compensation. This constitutes a major barrier for the integration of wind power into the grid.

The use of HVDC technology tends to stabilize power grids by sheltering them from interferences related to wind energy generation. When an HVDC link is embedded in the existing Alternating Current (AC) grid network, it allows the transmitted power to be ‘dialed up’ and even modulated in response to inter-area power oscillations. The HVDC line dramatically improves power flow controllability in the interconnected networks by providing greater stability and system security. In a cascading AC fault, the HVDC interconnection acts as a firewall and stops the propagation. Hence, the transfer of large quantities of wind energy from the Saharan coasts through the Sahara Wind HVDC line will help stabilize the grid network and thereby contribute to an increased wind energy production on both ends.

The environmental benefits are significant since we are using a wind energy source to stabilize additional amounts of renewable energies integrated into the extreme points of a grid network. When considering synergies that could be derived through wind energy storage technologies, then the use of fossil fuels as back-up options can be put into question. An economically viable non-carbon related energy transition would, in this case, be validated.

Power fluctuations of wind farms occur for short periods of time, such as a few seconds or minutes, or periods of time of a couple of hours. The smaller these fluctuations are, the easier they can be handled by other power plants in a grid system to meet the demand. However, these fluctuations decrease with an increasing number of turbines in a larger catchment area since their production is never entirely correlated.

Large-scale wind power generation modeling used by central grid operation centers rely on the observation of representative samples for system demand control. These can be made at the scale of a wind farm, at cluster levels or even through individual turbines. The instantaneous production of these samples are then extrapolated to the total feed-in power output of a large supply area with satisfactory results.

Accurate monitoring and forecasting of power inputs from all wind turbines into the grid significantly improves the acceptance of wind power as a reliable, clean energy source. This also increases considerably its market value.

The predictability of renewable energies is no greater problem than that of the load, and will continually improve using satellite weather and remote sensing technologies. The management of power loads will improve significantly using smart grid technologies. More flexible and responsive, smart grids will bring complementarity and added value to the integration of renewables in the grid as well. Traditional base load plants powered by lignite or nuclear fission will hardly fit into a sustainable future electricity supply for that matter, as their inertia prevents them from covering peak load demands most appropriately.