



## PAC World is your forum

The field of protection, automation and control of electric power systems is changing not only because of the wide spread use of microprocessor based devices, but also due to the requirements for reduction in pollution and the skyrocketing oil prices.

**Distributed energy resources (DER) are considered one of the solutions.**

THE INTRODUCTION OF MULTIPLE sources of electric power of different types and with a wide range of power output represents a new challenge that our industry needs to deal with. Until recently electric power plants were mainly large, utility owned facilities. Their characteristics and behavior under different system conditions has been studied for many years. This resulted in the development and implementation of accurate mathematical models used in steady state and dynamic stability programs, as well as for the calculation of short circuit currents and voltages used for the setting and coordination of protection relays.

The existence of a limited number of generators typically connected to the electric transmission system and no generators connected to the distribution system allowed a fairly clear distinction in the protection philosophy for these two main types of systems. The transmission system, as discussed in the PAC World Winter 2008 issue, is protected by devices or systems capable of detecting not only that the fault is in the zone of protection, but also to determine the direction of the fault – forward or reverse. All of this is necessary because of the availability of fault current sources both in front of and behind the protection device.

Since there are no sources in front of the distribution protection devices, typically such systems are protected by non-directional relays. The introduction of distributed energy resources connected to the system requires changes in the protection philosophy for distribution feeders. Things are further complicated by the fact that the behavior of various types of DERs is very different from the synchronous generators that we have been dealing with for so many years. Wind generators are not simple synchronous or induction machines – in some cases they have a dual excitation system that makes them behave differently when a short circuit fault occurs. At the same time DERs that use inverters are not a source of short circuit current.

We also need to keep in mind that small DERs are being connected not to the distribution system, but at the low voltage level of the system. The predictions that the number of photovoltaic DERs, micro hydro generators, or other small sources, including electric vehicles, will increase significantly and become a factor to be considered for the control of the electric power system during wide area disturbances. The existing control principles during normal system conditions

or disturbances are not designed to operate a system with wide and deep penetration of DERs of different sizes, operating principles and connection to all levels of the electric power system.

All of the above made us focus in this issue of the magazine on the impact of distributed generators on the protection and control. The change in the protection principles applied at the distribution level, as well as the development and implementation of a hierarchical Intelligent Grid will allow us to deal with these challenges. The advancements in computer and communications technology provide us with tools that will make it possible to learn more about the behavior of industrial, commercial and residential loads under different conditions, as well as to design and implement new methods for protection and control not only at the distribution level, but all the way to the individual appliances in our homes.

*Nobody thinks that this will be easy.* It requires that we change the way we think about the electric power system, get out of the box of conventional protection, automation and control and move into the future – the era of distributed energy resources.

**There is nothing permanent except change**

*Heraclitus - 6th century BC*