Chapter 15
Application of Synchro-Phasor Measurement Unit in Smart Grid Including Renewable Energy

Meriem Mahboubi
Signals and Systems Laboratory, IGEE, University M'hamed Bougara of Boumerdes, Algeria

Abderrahmane Ouadi
INELEC, Boumerdes, Algeria

ABSTRACT

Renewable energy is one of the most abundant energies in our planet. In order to satisfy the world demand of electrical energy, solar and wind energy may be used. Identical to all other types of power generation plants, the integration of these renewable energy sources in smart power grid has an impact on its operation. Thus, when the electrical power is injected into the power grid by these energy sources, the system electrical parameters must be well monitored for synchronization purpose. This can be accomplished with the aid of synchro-phasors measurement units. The phase angle of the utility is a critical parameter for the operation of power devices feeding power into the grid such as PV and wind energy inverters. There are many techniques to obtain the grid phase angle such as the zero-crossing detection and the orthogonal phase locked loop. This research work discusses the use of PMUs (Phasor Measurement Unit) for providing this important parameter to system synchronization in the case of high penetration of solar or wind energy in the power grid.

INTRODUCTION

Renewable energy is being progressively integrated with ambitious targets of renewable energy integration set at national/regional levels. Solar PV and wind power sources are the front-runners among available renewable energy sources. However, as the penetration of renewable generation increases, the impact on power system dynamics is becoming increasingly apparent, and will become a more integral part of system planning and renewable integration studies. Historically, power systems have been based

DOI: 10.4018/978-1-7998-4027-5.ch015

around large synchronous generators connected to a strongly meshed transmission network, with the dynamic characteristics of such systems being well understood and monitored. However, renewable generation stations, particularly in the form of wind and solar generation, are increasingly universally connected via power electronic interfaces, may well be connected to the distribution network, or weaker parts of the network, may offer new control capabilities, and, of course, is subject to the variability and uncertainty associated with local and regional weather patterns. The time variability and non-dispatched nature of wind generation may pose substantial challenges, particularly at higher levels of penetration, including an increase in regulation costs and incremental operating reserves, but they can also lead to increased opportunities for energy storage, demand side response, cross border interconnections, and other flexibility measures.

On the other hand, evolution of synchrophasor measurement technology, using Phasor Measurement Units (PMUs) for data measurement has opened a vast number of potential applications in the power system world, ranging from monitoring, protection, and control to enhance the smartness and efficiency of power systems. PMU-based Wide Area Monitoring Protection and Control (WAMPAC) can play a vital role in secure and stable integration of renewable energy, particularly in grid operation under high share of renewable (Phadke, A.G., 2008; Bentarzi. H., 2010). PMUs make the power system smarter and reliable has attracted many researchers to have further development in this area. Significant efforts have been dedicated to the development of efficient and precise measurement algorithms. The development of global positioning system (GPS) technology has overcome the synchronizations' difficulties and lead to the development of phasor measurement unit (PMU). PMU is a measurement device, developed in mid 1980s. It measures the electrical quantities such as voltage and current at node in the power system where it has been installed. It provides the real time phasor parameters of these quantities such as magnitude, frequency, phase angle and rate of change of frequency (ROCOF). The provided voltage and current signals by PMU from the grid may be used be to monitor completely the power system that it is observable at any moment.

Data provided by PMUs are generated at different locations, in real synchronized time. They are time stamped for synchronization by a reliable and accurate time source; the Global Positioning System (GPS) (A.G. Phadke, 2006).The objective of this chapter is to use synchrophasor measurements to solve islanding problem in a network including high penetrations of solar energy generation by performing a continuous monitoring in order to disconnect and connect the islanded generator.

LITERATURE SURVEY

In the late seventies, the oil crisis caused a drastic increase in the demand of renewable energy sources. This increase has been driven by the remarkable advantages offered by these kind of energy sources namely free resource, infinite reserve and clean conversion process. However, till today, the fuel is still the main source of energy in most power generating systems. While, global warming and energy policies have become a hot topic worldwide. Developed countries are trying to reduce their greenhouse gas emissions. For instance, the European union has committed to reduce their greenhouse gas to at least 20% levels before 1990 and to produce no less than 20% of its energy consumption from renewable sources by 2020 (European Commision, 2020). In fact, the secured and safe integration of renewable energy (RE) resources including wind and solar energy to the main grid is one of the biggest challenges for the world energy sector today (Ahmada, T., 2020).