Advanced Distribution System Techniques to cope with Massive Penetration of Photovoltaic Power Generation

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Abstract

In Japan, penetration of photovoltaic (PV) power generation is growing up rapidly by feed in tariff (FIT) started from 2012 to relieve global environmental issue and energy security issue including the case of supply power stoppage by disaster etc. Overall introduction capacity of PV reaches about 30GW at the end of 2015. The rapid penetration increase may affect power quality, safety and stable operation of the utility grid. As for distribution system, distribution line voltage rise due to reverse power flow from PV becomes a severe problem. Because distribution system operator cannot be estimated overall power generation of PV systems interconnected to the distribution line, over load problem on the distribution line may occur caused by disconnection of the PV systems when distribution line route switch due to distribution line fault etc. Moreover, wide area islanding phenomena with plural distribution feeders may occur in the event of upper transmission line fault etc.

Cooperating with Japanese electric utility companies, CRIEPI is now developing and demonstrating new advanced distribution system techniques as a smart grid concept in order to resolve above technical issues. Utilization of advanced voltage regulators using power electronics device, communication system and sensor system which monitors distribution line voltage and power flow are taken into account in the development. Reactive power control method of each power conditioning subsystem (PCS) of PV systems such as residential system, large MW scale system and so on is also being investigated to enhance reliability of the voltage control in distribution line. To date, CRIEPI developed and proposed a cooperative control method of the voltage regulators in distribution line and reactive power of PCS, a proper coordinated method of secondary transmission line protection system and distribution line protection system to prevent wide area islanding phenomena etc. A practical estimation method of overall power generation of PV systems interconnected to a distribution line using only load flow information from distribution line sensor is also developed

In the presentation, various impacts of massive interconnection of PV system on operation and protection of Japanese distribution system are introduced. The concept of proposed advanced distribution system and detailed developed techniques to cope with the issues are described.