PRR Comments

PRR Number	830	PRR Title	Reactive Power Capability Requirement

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Market Segment	Investor Owned Utility (IOU)

Comments

Oncor Electric Delivery Company LLC is very pleased to support ERCOT's independence and objectivity in maintaining reliability in operations and planning activities. Oncor supports ERCOT's efforts to maintain system reliability with PRR830 and provides the following material and attached documents.

For the bulk power system to operate reliably, it must be designed and operated based on the following principles:

* The total generation (MW & Mvar) at any moment must be kept equal to total electricity consumption and losses on the system

* The electricity is allowed to flow through the transmission system in accordance with physical laws and cannot be directed to flow through specific lines

* The system must be designed with reserve capacity in generation (MW & Mvar) and transmission to allow for uninterrupted service when contingencies occur

Voltage, a pressure-like quantity, is a measure of the electromotive force necessary to maintain a flow of electricity on a transmission line. Voltage fluctuations can occur due to variations in electricity demand, lack of reactive reserve and to failures on transmission equipment. Constraints on the maximum voltage levels are set by the design of the transmission line and station equipment. If the maximum is exceeded, short circuits (faults), radio interference, and noise may occur. Also, transformers and other equipment at stations and/or customer facilities may be damaged or destroyed. Minimum voltage constraints also exist based on the power requirements of the customers and lack of reactive reserve. Low voltages cause inadequate operation of equipment and may damage motors.

Voltage on a transmission line tends to "drop" from the sending end to the receiving end and varies based upon the flow. The voltage drop along the AC line is almost directly proportional to reactive power flows and line reactance (impedance). The line reactance increases with the length of the line. Capacitors and inductive reactors are installed, as needed, on lines and in stations to, in part; control the amount of voltage drop or rise. This is important because voltage levels and current levels determine the power that can be delivered to the customers.

A variety of reactive power (Mvar) producing equipment exists. They can generally be broken down into two categories; "Dynamic Resources" and "Static Resources". The total production of reactive power must equal customer demand plus losses under normal, fault and contingency conditions.

Small Mvar production shortages will result in degradation of grid voltage, while larger Mvar production shortages lead to severe low voltage or collapse. Over production Mvar results in high voltage with possible long term damage to grid facilities, generation equipment and customer facilities. Reactive power must be constantly produced/absorbed locally and cannot be transported over long distances. Reactive energy (Mvar) cannot be transmitted as far as real energy (MW). This is primarily due to the bulk electric transmission line impedances which have a naturally large X to R ratio usually in the range of 5 to 25.

High voltage transmission lines are a local source of shunt reactive energy (line charging). This local reactive energy source is similar to a fixed static capacitor connected to each end of the line. However, reactive Mvar losses on heavily loaded transmission lines often exceed the local static reactive energy produced by line charging. Large X to R ratios produces significant difference in MW losses compared to Mvar losses. Due to this X to R ratio Mvar losses are typically 5 to 25 times higher than MW losses and are constantly varying.

Generators, static var compensators (SVCs), static compensators (STATCOMs), other Flexible AC Transmission Systems (FACTS) and synchronous condensers provide dynamic reactive power with various time responses to quickly changing system conditions.

Under low voltage conditions, static capacitors used in stations (and line charging) do not produce maximum reactive power as reliably as dynamic self excited power equipment because capacitor reactive power output depends on substation voltage. Capacitor reactive power output changes in proportion to the square of voltage magnitude. For example if substation voltage declines from 100% to 90% of nominal voltage, static reactive power output declines from 100% of capability to 81%. Low voltage also increases Mvar needed by motor loads further degrading the voltage.

Dynamic reactive resources are used to adapt to rapidly changing conditions on the transmission system, such as faults, sudden loss of generators or transmission facilities. In contrast switched static devices are typically used to adapt to slowly changing system conditions such as daily and seasonal load cycles and changes to scheduled transactions.

Static capacitor resources have lower capital cost than dynamic devices, and from a systems point of view, static capacitors are used to provide normal or intact-system voltage support. Locating static capacitors and dynamic reactive devices near to reactive load/losses, increases their effectiveness. Dynamic reactive resources are used to adapt to rapidly changing conditions on the transmission system, such as sudden loss of generators, faults or transmission facilities.

An appropriate combination of both static and dynamic resources is needed to ensure reliable operation of the transmission system under normal and changing conditions.

Revised Proposed Protocol Language

None proposed