UVIG Fall Technical Workshop

Voltage Considerations When Integrating Wind and Solar (Variable Energy Resources)

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VOLTAGE AND ITS IMPORTANCE

Maintaining adequate voltage on the Bulk Power System is critical

- Low voltage can propagate causing wide spread collapse
- High voltage can damage equipment and is a safety issue

Maintaining adequate voltage on the Distribution System is critical

- Reduce customer outages and duration
- Sustain adequate customer power quality

VOLTAGE AND ITS IMPORTANCE

Adequate voltage is maintained by managing reactive resources

- Reactive resources can provide and/or absorb reactive power
  - Dynamic synchronous resources
  - Dynamic non-synchronous resources
  - Static resources
  - HVDC specifically Voltage Source Converters
  - Line compensation
  - Load Power Factor

Key is coordinating these resources between the transmission and distribution systems, need to find the "optimal solution" while integrating VER

VOLTAGE AND ITS IMPORTANCE

The Bulk Power System should not impose a reactive burden on the distribution system and conversely the distribution system should not impose a reactive burden on the Bulk Power System

In a well coordinated system there should not be excessive reactive transfer between the two systems

Key - This must be addressed as part of integration of VER especially when it is installed on the distribution system (behind the meter)

REACTIVE SUPPORT FROM VER

Utility connected Wind and Solar has the potential to provide essential reliability services including inertia, frequency response, ramping flexibility and reactive support

- Understand what capabilities Wind and Solar bring to the table (OEM)
- Understand what the system needs are at the point of interconnection (POI)
- Coordinate the planning, building and operation of Wind and Solar to maintain system reliability

Reactive Support and Voltage Regulation may or may not be provided by all VER

- Lack of specificity in Interconnection Studies
- Physical limitation of equipment
- Gap between planned equipment and ”as built” equipment
- Operations challenges
- Ramifications of FERC Order 827

INTERCONNECTION STUDY CONSIDERATIONS

Did the Planners Consider Every Possibility?

Operating Characteristics to Consider:

- *What kind of interconnection requirements are part of the overall study process?*
- *What are the reactive requirements at the POI?*
  - Base conditions “all-line in” 8760 hrs.
  - What are contingency requirements?
- *How does the VER provide lead/lag Mvar?*
  - Constant power factor?
  - Constant Mvar?
  - Regulate to a voltage setpoint?

INTERCONNECTION STUDY CONSIDERATIONS

How "weak" is the transmission system at the POI?

How are VER coordinated with other Bulk Power System reactive devices, e.g., series compensation, static devices, dynamic devices, etc.?

How do reactive requirements vary over various load levels?

How is the VER coordinated with the local distribution systems?

- Step down transformation from the Bulk Power System?
- Capacitors installed as part of managing load power factor?
- Distribution voltage regulators?

What entity determines how all this is accomplished?

- Planners, Operators, Developers, OEM, etc.

FOOD FOR THOUGHT

All Wind and Solar Planning Analysis and Integration Efforts Flow into Operations, i.e.,

What are some consequences of "missing the boat"?

FOOD FOR THOUGHT

Depend on how "weak" the system is that the VER is connected to, facility out conditions may cause significant operational issues

- Introduce significant dispatch restrictions, i.e., congestion

If the VER does not have voltage regulators with coordinated droop control that may impact operation (constant power factor or constant Mvar is generally not desirable)

Could result in a negative impact on surrounding Distribution systems

- End result in inappropriate Mvar flows in to our out of the Bulk Power System

FOOD FOR THOUGHT

Depending on how the reactive capability of the VER is deployed may have negative interaction with other reactive devises, typically VER "fighting" other regulation devises or adverse control interactions:

- Dynamic and static resources
- Transformers
- Series compensation
- etc.

ERSWG

Initial efforts to quantify voltage and reactive trends on a Balance Authority wide basis

Effort at trending did not work well due to "local" nature of supply, demand and transportation of reactive power

NERC and System Analysis and Modeling Subcommittee develop a reactive planning and operation guideline

- Soup to nuts "industry best practices" on planning and operation the Bulk Power System from a voltage and reactive standpoint

MORAL OF THE STORY

Coordinate, coordinate, coordinate…..

The manufacturers, the transmission/distribution planners and operators, and the Wind and Solar developers must all sit down at the table and consider multiple scenarios of operation to ensure both distribution and transmission remain robust and reliable

No one can operate in a silo!

Questions?