Planning for Interconnection of Wind Plants based on Net Maximum Capacity

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Agenda

• Generator Interconnection Study Process
• Interconnection Planning based on Net Maximum Capacity (NMC)
• Implications of NMC to the Interconnection Study Procedure
• Generator Interconnection Procedure & Agreement Recommendations
Generator Interconnection Study Process
Generation Interconnection Process Background

*Promote completion of wholesale electricity and promote equal transmission access*

**FERC Order 888 (‘96)**
1. Provided detailed guidelines for non-discriminatory transmission service

**FERC Order 889 (‘97)**
1. Required web-based open access policy (OASIS) promoted electricity market competition

**FERC Order 2003-C (‘03-‘05)**
1. Remove interconnection inefficiencies and lack of standard process
2. Created standardized interconnection agreement and procedure (LGIA/P)
   - Generating plants > 20 MW
   - Specific requirements for wind plants
Large Generator Interconnection Procedure (LGIP)

Details provided at time of filing:
- Group Installed capacity (GIC)
- Turbine type, #, rating
- Equipment make, model
- Simulation model

SIS uses initial equipment specifications (GIC) submitted during interconnection filing

Situations may require re-evaluation of SIS
1. Increase in capacity
2. “Equipment change”
Scenario leading up to SIS Re-evaluation

Some reasons for changing turbine equipment...
1. New hardware/control features can increase plant capacity/functionality
2. Economic and grid performance incentives
   • During project development (Request -> Agreement)
   • After commercial operation

When does a project need to be re-studied for changes to equipment or plant capacity beyond those submitted during interconnection filing?

Short comings...
Order 2003 is ambiguous as to clearly define what constitutes Re-study or Request
1. Material Modification (*4.4)
   o shall mean those modifications that have a material impact on the cost or timing of any Interconnection Request with a later queue priority date
2. Plant Increases (*4.4.1)
   • The incremental increase in plant output will go to the end of the queue for the purposes of cost allocation and study analysis

Consequences to project
1. Queue position - additional study cost & time
2. Project feasibility – transmission reinforcements needed between initial SIS and restudy

Interconnection Planning based on Net Maximum Capacity
Definitions: Wind Facility GIC vs. NMC

1. Group Installed Capacity (GIC) (*)
   o Gross total of real power (name plate) of all WTG’s

2. Net Maximum Capacity (NMC) (*)
   o Maximum Power at Revenue Meter
   o NMC = GIC – plant losses

3. Losses
   o Balance of plant losses
     • Electrical (transformers & collector system)
     • Equipment unavailability (forced or schedule outage)
   o Turbine operational losses
     • Wake
     • Environmental (icing, temperature extremes, blade fouling)

* NERC Generator Availability Data Systems (GADS) Wind Turbine Generation Data Reporting Instructions, Effective January 2011, Version 1.1.0., Appendix D,
GIC Planning (current practice)

Limitations of GIC Planning...

SIS should define allowable NMC limit at POI

SIS assumes GIC... all units at full capacity

Turbine down + Facility losses = significant Production loss at POI!
NMC Planning + self curtailment

**Current (GIC)**

- SIS Limit 13 MW
- NMC of 12.8 MW from facility losses AND Only 11.4 MW at POI due to down turbine
- 9 x 1.5 MW turbines GIC = 13.5 MW

**Proposed (NMC)**

- Self-Curtail NMC
- Add another 1.5 MW OR Use 1.6 MW Turbines + Self-curtail GIC > 13.5 MW
- NMC = 13 MW

Self-curtailment ensures output at POI does not exceed 13 MW limit!
Field Data Illustration of Self-curtailment

Field measurements from 30MW wind plant in Hawaii (2007)

Ramp rate limit enforced when curtailment is released

- Illustrates self-curtailment ability (to NMC limit):
- If permitted can be used as Spinning Reserve

2 Hours
Implications of NMC to the Interconnection Procedure
Interconnection Implications using NMC

When does a project need to be re-studied for changes to equipment or plant capacity beyond those submitted during interconnection filing?

**Categories of Upgrades**
- **Control**: software updates enhance the operational flexibility using the same hardware
- **Hardware**: wind turbine ratings, turbine type, or even turbine vendor

**SIS Consequences**
- **Short circuit**: circuit breaker capability limitation
- **Power flow**: equipment thermal overload or voltage violations
- **Stability**: equipment instabilities or insufficiently damped response

**Decision to Refile Interconnection Request?**
Under certain circumstances equipment changes may not impact SIS and thus are not a material modification

**NO** – software power boosting upgrade + self-curtailing (i.e. no hardware changes)
  - Essentially identical short circuit contribution, power flow, and dynamic response

**YES** - Changing equipment vendors may change how converter hardware protects during a fault and can significantly impact short circuit contributions

Ultimately decision is up to transmission operator.
Case Study of Equipment Upgrades + NMC

- WECC simulation model (western United States) represents an actual operating case
- High wind penetration (~1 GW) in remote locations (power transmission over long distance)
- Two transmission paths allowed power export

NMC (control upgrade)

150MW WTG plant vs. 150MW WTG plant w/ WindBOOST (160MW capacity curtailed to 150 MW)

- 6 cycle bolted fault near generation & clear of one of two main transmission export paths
- Forces wind power radial (significant changes in voltage and flow of power)
LGIP & LGIA Recommendations
Suggestions & Observations

- **LGIP/A should allow NMC and not just GIC**
  - We suggest that only total **output at POI (NMC)** be considered in place of **plant capacity (GIC)**
  - SIS may not be materially affected by NMC

- **Plant level self-curtailment is not a departure from industry standards**
  - Thermal technologies already implement concept of self-curtailment
  - Steam, gas turbines operate with higher turbine nameplates and curtail at POI to match power dispatch request
Thank You

imagination at work