

Successful Integration of Wind Generation: Comments on AWEA Petition

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Wind Generation Interconnection

Constraints:

- Wind Generation has some significantly different grid performance characteristics
- Not all wind generation technology is equivalent
- Wind generation technology and practice are evolving rapidly

Challenge: Provide interconnection standards that:

- Maintain system reliability
- Fairly allow adaptation of new generation technologies

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GE Position:

- GE supports the provisions of AWEA Petition regarding LVRT, power factor range and voltage regulation
- Interconnection standards must be allowed to evolve with understanding, technology and practice
- The AWEA petition is the first step towards a more comprehensive and specific grid code
- It is reasonable to demand a high level of performance from wind generation
- It is a reasonable goal to aim for performance on a par with other 'conventional' resources, recognizing that identical performance is neither desirable nor necessary

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Low Voltage Ride-Through:

- In most cases, LVRT prevents the undesirable disconnection of wind-turbine-generators (WTGs) that can result from grid disturbances
- Other countries and systems have found that LVRT is required to enable secure grid operation at high levels of wind penetration
- The during- and post-fault dynamic performance of Wind Farms equipped with LVRT is demonstrably superior to that of conventional generation in many applications
- GE is presently offering WTGs in the US market that comply with this provision of the AWEA petition

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Voltage Control and Power Factor Range:

- Participation of Wind Farms in the regulation of voltage on the grid enhances system security and quality of supply
- It is a critical issue for large scale wind penetration on weak grids, which are typical of many attractive remote wind sites
- Voltage Control and Power Factor Range is a *Wind Farm* level issue, that is not solely a function of individual WTG capability
- Requirements for Voltage Control and Power Factor Range should be subject to similar equipment considerations as other types of generation (e.g. over-excited with high grid voltage)
- GE is presently offering *Wind Farm* equipment *and* WTGs in the US market that can comply with this provision of the AWEA petition

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Looking Forward:

- The provisions of the AWEA petition are a good start
- US practice and understanding is evolving; countries with the most experience, such as Germany, UK, and Denmark, are actively expanding their grid codes to account for higher penetration and evolving wind technologies. The E-ON specification is emerging as the industry de facto standard
- The next frontiers will include:
 - Curtailment and other active power controls
 - Forecasting
 - Participation in renewable friendly market structures

GE takes grid integration seriously: we are actively advancing the state-of-the-art to make wind generation a good citizen on the grid

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Fault Ride-Through (LVRT) - Background

Need for LVRT

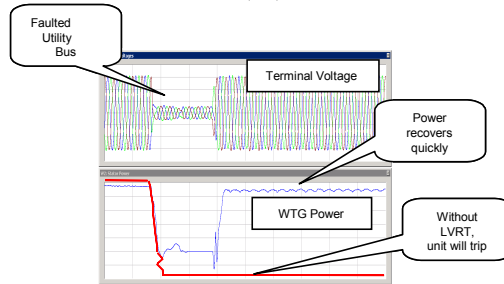
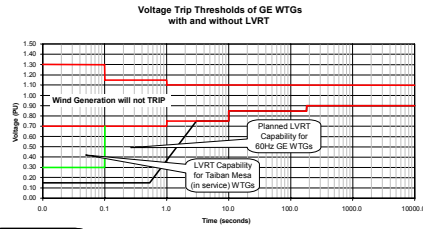
- > Increase in wind power penetration
- > Wind farm tripping is no longer acceptable or tolerable

Traditionally, wind turbines tripped as voltage dropped to 70% or less

Transmission system faults result in voltage dips at the wind farm.

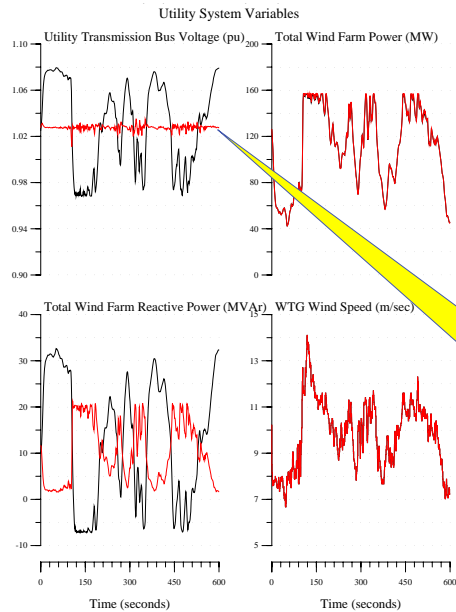
LVRT requires

- > improved control functions
- > the ability of all components to operate properly at reduced voltage



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Voltage Regulation - Background



voltages and flows at Utility Point-of-Interconnection:
GE's Wind Volt-Ampere-Reactive supervisory control, WindVAR, meets system requirements
Comparison: with (red) vs. without (black)

Very clean voltage on the host utility grid bus

