

Summary of Wind Turbine Generators for Simulation

| Wind Turbine Generator | | | Power Flow Characteristics | | Dynamic Simulation Models | |
|------------------------|----------------|-------------------|--|-----------|---|---|
| Manufacturer | Model | Type ¹ | Reactive Power ² | LVRT | PSLF | PSSE |
| Bonus | 1.3-62, 2.3-82 | FSIG | Machines are 0.9 pf lagging. Can be supplied with an automatic power factor correction. Additional switched capacitors improve power factor. | Available | Use generic induction machine model, motor1 | See NM72 but without pitch control. |
| NEG Micon | NM72 | FSIG | Machines are 0.9 pf lagging. Additional switched capacitors improve power factor. | | Use generic models: genwri – for wound rotor induction machine, tlin1 for under voltage/freq protection | CIMTSS for the induction generator, TWIND1 for wind gusts and ramps, TSHAFT2 for two-mass shaft system, NM72AE - the aerodynamic energy conversion, TMPTCH-pitch control, voltage relay – VTGTRP, use generic FRQTRP for freq trip. |
| Vestas | V47-600 kW | FSIG | | | Use generic models: genwri – for wound rotor induction machine, tlin1 for under voltage/freq protection | V47 Wound Rotor Induction Generator - VS47A, Generator Aerodynamic – VSAERA, Pitch Angle Control – VSPCHA, Wind Gust and Ramp – WGUSTA, 2-Mass Shaft - W2MSFA, Under / Over Voltage Generator Bus Disconnect Relay – VTGDCA, Under / Over Frequency |

¹ FSIG – fixed speed induction generation, DFIG – doubly-fed induction generator, VSIG – variable speed induction generator.

² Qlimits at rated active power and nominal voltage at the WTG transformer LV terminals.



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| | | | | | | Generator Bus Disconnect Relay - FRQDCA |
| Mitsubishi | | FSIG | | | Use generic models: genwri – for wound rotor induction machine, tlin1 for under voltage/freq protection | Use generic model: CIMTR1 |
| Vestas | V80-1.8 | Variable Slip IG | Mechanically-switched pf correction (PFC) capacitors sized to compensate the reactive power consumption of the machine over a range of power output. At rated power, all capacitors are on, and the system runs at about unity power factor. For the 1800 kW V80 machine, the PFCs total 900 kVAr. | | genwri - generator model, exwtg1 - field resistor control, wndtrb - wind turbine, pgwtg.p - protection model and optional windgust.p. | V80 Wound Rotor Induction - VS80A. Other models, see V47. |
| GE | 1.5 | DFIG ³ | Reactive control through WindVar system. MVA = 1.67, for which Qmax = 0.493 MVar ⁴ and Qmin = -0.726 MVar. | Available | gewtg - generator model, exwtge - converter control, wndtge - wind turbine model, gpwtg.p - generator protection and optional wndgust.p. | Doubly-Fed Induction Generator – GEDFA, Active Rotor Control (rotor side converter control) – GECNA, Aerodynamic – GEAERA, Pitch Angle Control – GEPCHA, Wind Gust and Ramp – WGUSTA, 2-Mass Shaft - W2MSFA, Under / Over Voltage Generator |
| GE | 3.6 | DFIG ⁵ | Reactive control through WindVar system. MVA = 4, for which Qmax = 2.08 MVar and Qmin = -1.55 MVar. | Available | | |

³ Equipped with a solid-state voltage-source converter AC excitation system. The AC excitation is supplied through an ac-dc-ac converter. For the GE 1.5 machine it is connected directly at the stator winding voltage.

⁴ In certain installations, Qmax = 0.726 MVar.



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| Manufacturer | Model | Type ¹ | Reactive Power ² | LVRT | PSLF | PSSE |
| | | | | | | Tripping Relay - VTGTPA Under / Over Frequency Generator Tripping Relay - FRQTPA |
| Vestas | V82, V80- 2.0, V90, V100, V120 | DFIG | WTG operates at .091 pf. PRM feature controls reactive power up to 0.95 pf. Additional capacitors may be required depending on installation | Available | Not available | |
| Gamesa | G87 | DFIG | Adjustable power factor operation ranging from 0.95 lagging to 0.95 leading at the generator low voltage terminals. To meet the requirement of being capable to run at a power factor of 0.95 capacitive at the point of interconnection, switched capacitor banks will be necessary. | | Not available | G8XDFG – DFIG, G8XAER - Blade aerodynamics model, G8XCNT - Machine control model, G8XPTC - Blade pitch angle control model, TWIND1 - Wind gust and ramp model, G_FRTP - Under (57Hz) / over (62Hz) frequency generator tripping model, G_VTRP - to represent a voltage/time curve, under / over voltage generator tripping model |
| Enercon | | VSIG | | | | |
| GE | 2.x | VSIG | Connects to the grid through a frequency converter. For the 2.5 machine, MVA = 3, for which Qmax = 1.45 MVar and Qmin = -1.07 MVar. | Available | gewtg - generator model, exwtge - converter control, wndtge - wind turbine model, gpwtg.p - generator protection and optional wndgust.p. | |

⁵ See previous footnote. For the GE 3.6 machine the converter is connected to a third winding on the main unit step-up transformer.



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| Bonus | 2.3-82 VS, 2.3-93, 3.6-107 | VSIG | +/- 0.90 pf If the wind turbine is in voltage control mode, then it is necessary to specify a voltage control setting rather than the reactive power setting. | Available | Not available | S3M602 (proprietary model) ⁶ |

⁶ Requires a reduced time step.

