Grid of the Future Symposium

Impacts of the Decentralized Wind Energy Resources on the Grid



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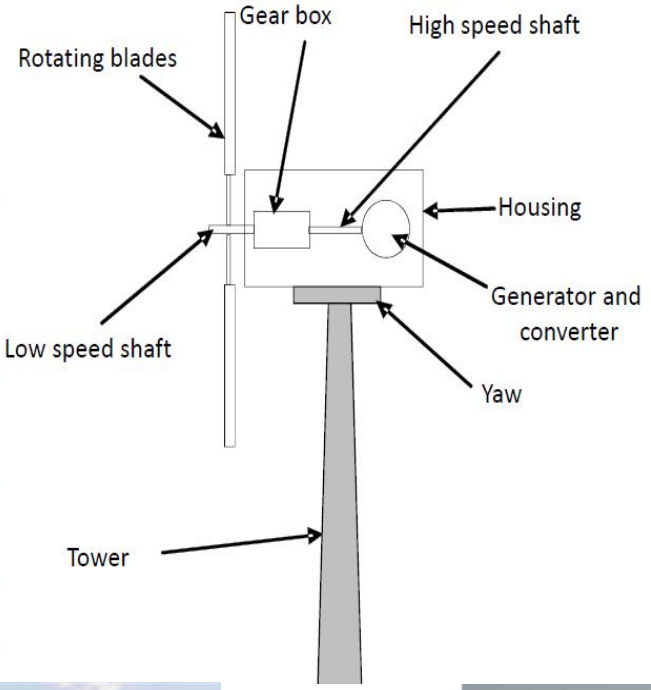
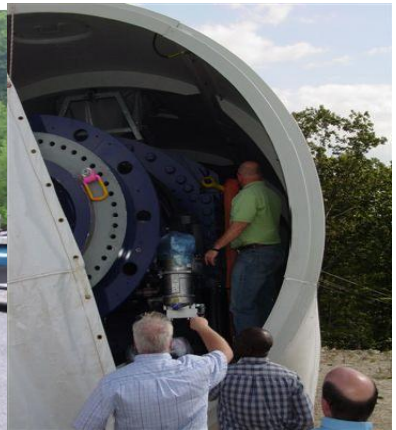
Topics

- Wind Turbine Structure
- Type I Wind Turbine: Squirrel Cage Induction Generator (SCIG)
- Impacts of Type I Wind Turbine on the Grid
- Type II Wind Turbine: Wound Rotor Induction Generator (WRIG)
- Type III Wind Turbine: Doubly Fed Induction Generator (DFIG)
- Type IV Wind Turbine
- Type V Wind Turbine: Shaft Speed controlled
- Conclusion

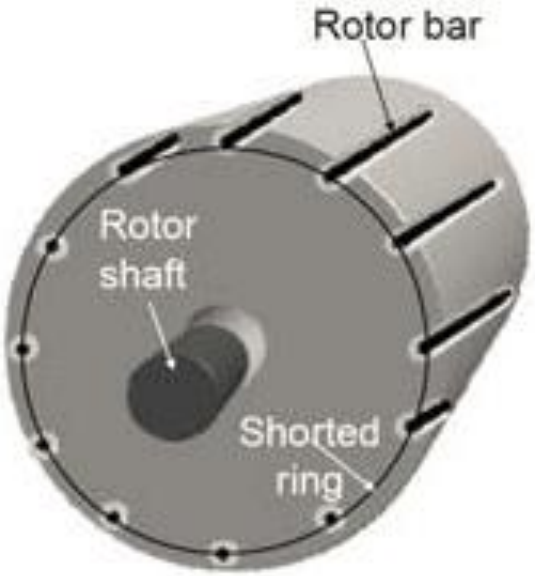
Wind Turbine Structure





GE 3.6MW

Type I Wind Turbine:
Squirrel Cage Induction Generator (SCIG)

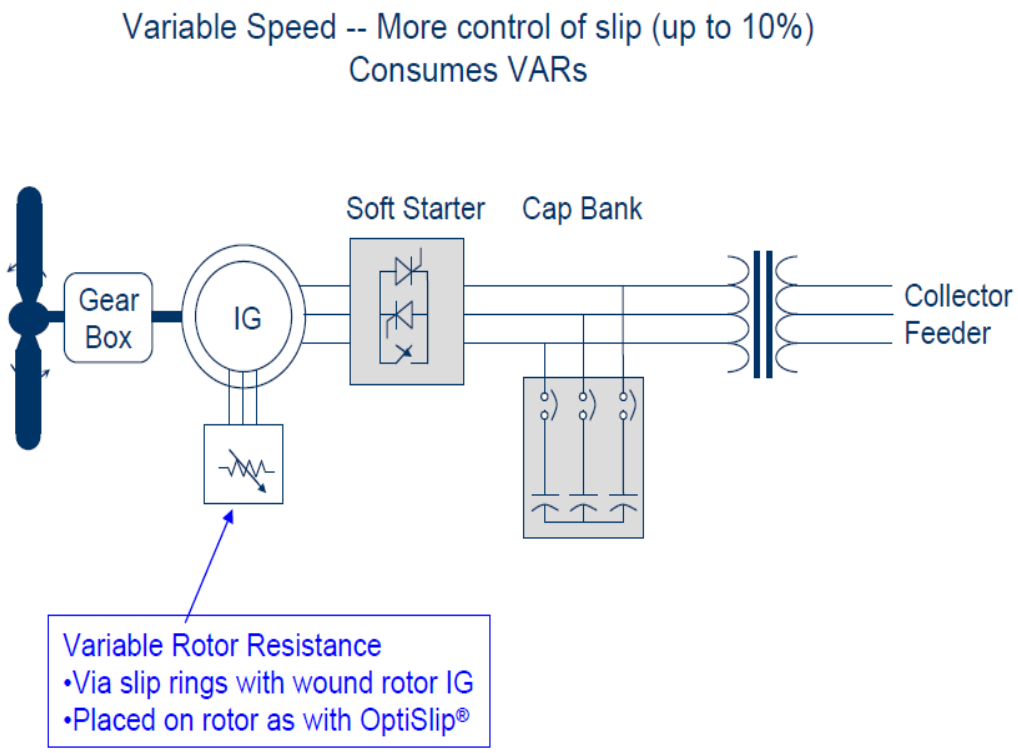


- The SCIG generates electricity when it is driven above synchronous speed.
- The difference between the synchronous speed and the operating speed is measured by slip.
- Normal operating slips for an induction generator are between 0% and -1%.
- No control on the rotor current

Impacts of Type I Wind Turbine on the Grid

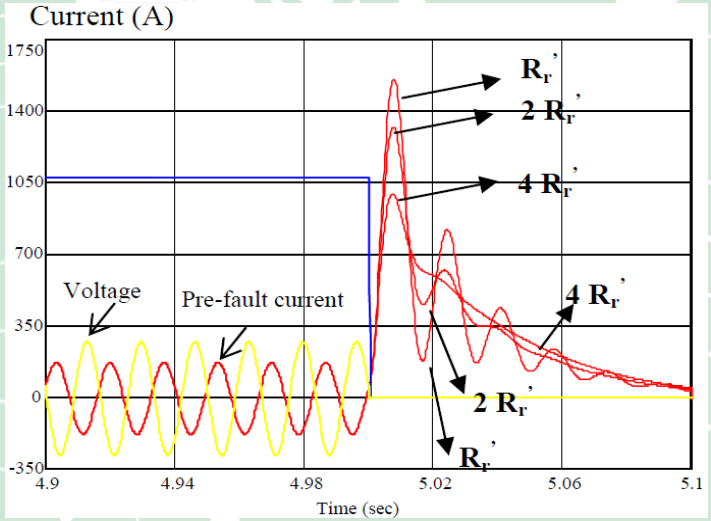
- Flicker
- Power Factor
- Self Excitation in the island condition
- OV on the ungrounded systems (during L-G faults)

Type II Wind Turbine: Wound Rotor Induction Generator (WRIG)



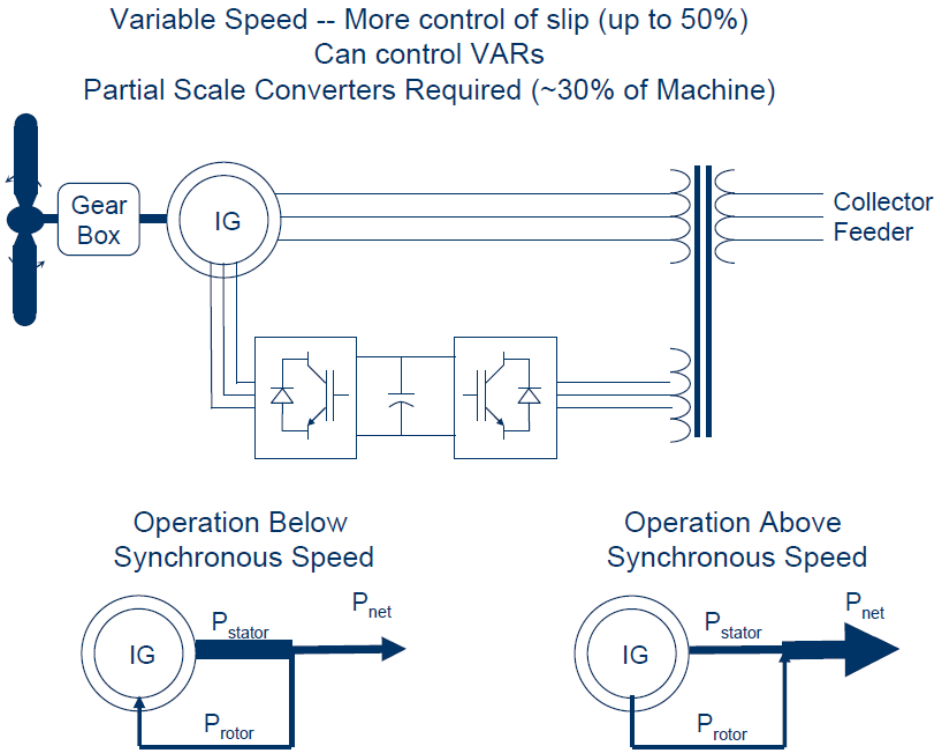
Type II wind turbine (Wound Rotor Induction Generator)

- SCIG is a WRIG with shorted resistance.
- The impacts of WRIG on the grid are similar to those of the SCIG.



Type II wind turbine fault current contribution for a 3LG fault

Type III Wind Turbine: Doubly Fed Induction Generator (DFIG)

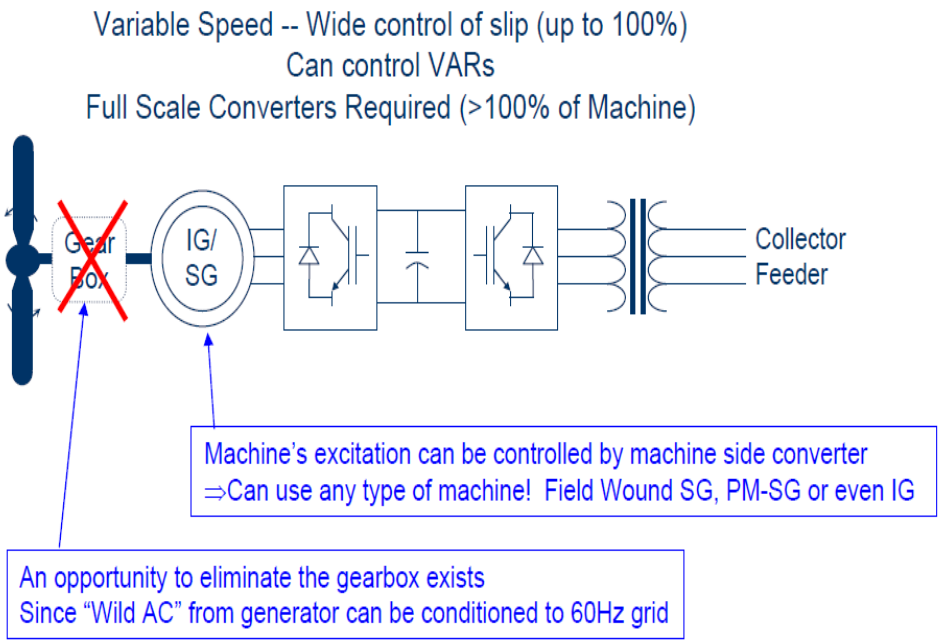


Type III wind turbine (Doubly Fed Induction Generator)

- The rotor speed is allowed to vary between 0.3 slip to - 0.3 slip, thus, the power converter can be sized to about 30% of rated power (partial rating).
- The power quality concerns are similar to those of the type I.
- Additional protection concern: Type III wind turbine might keep contributing to the 3LG fault

Type IV Wind Turbine

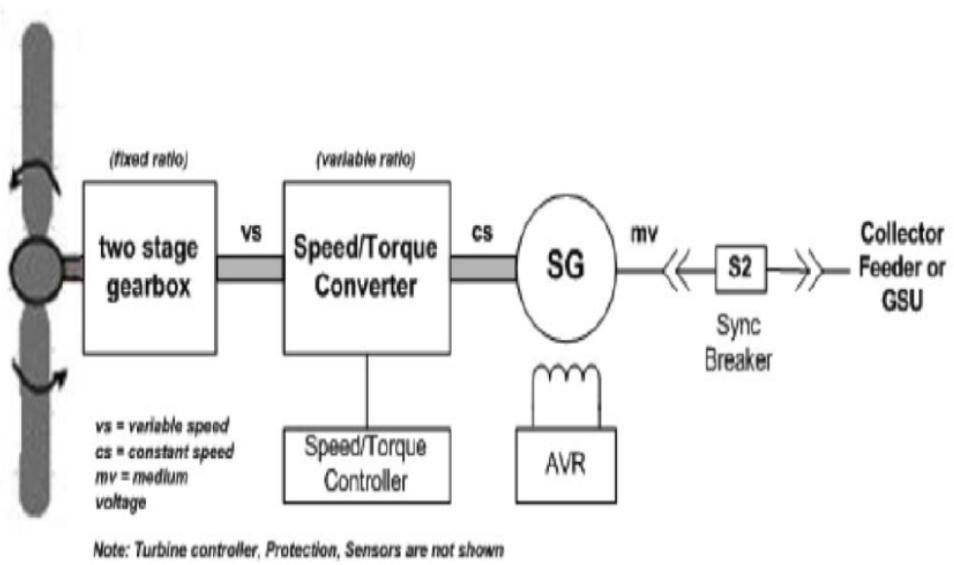
Synchronous or induction generator connected to the grid through a full power converter



Type IV wind turbine

- Permanent magnet synchronous generator is the most common generator
- Generator will always contribute to any type of fault because the flux is being created continuously by the permanent magnets
- Voltage Controlled Over Current (51C) relay is recommended to detect the fault.
- The power quality concerns are similar to those of the type I.

Type V Wind Turbine



- The control scheme is on the mechanical part of turbine (Shaft speed control)
- The power quality and protection impact of the type V wind turbine is similar to those of the Type IV.

Conclusion

- The structure of a Wind Turbine is presented.
- Various types of Wind Turbine Generators are discussed.
- The impacts of the Decentralized Wind Generators on the system power quality and protection are addressed.
- Solutions to resolve the adverse impacts of the Wind Generators on the grid are recommended.

Thank You

Questions?