

Wind System Modelling



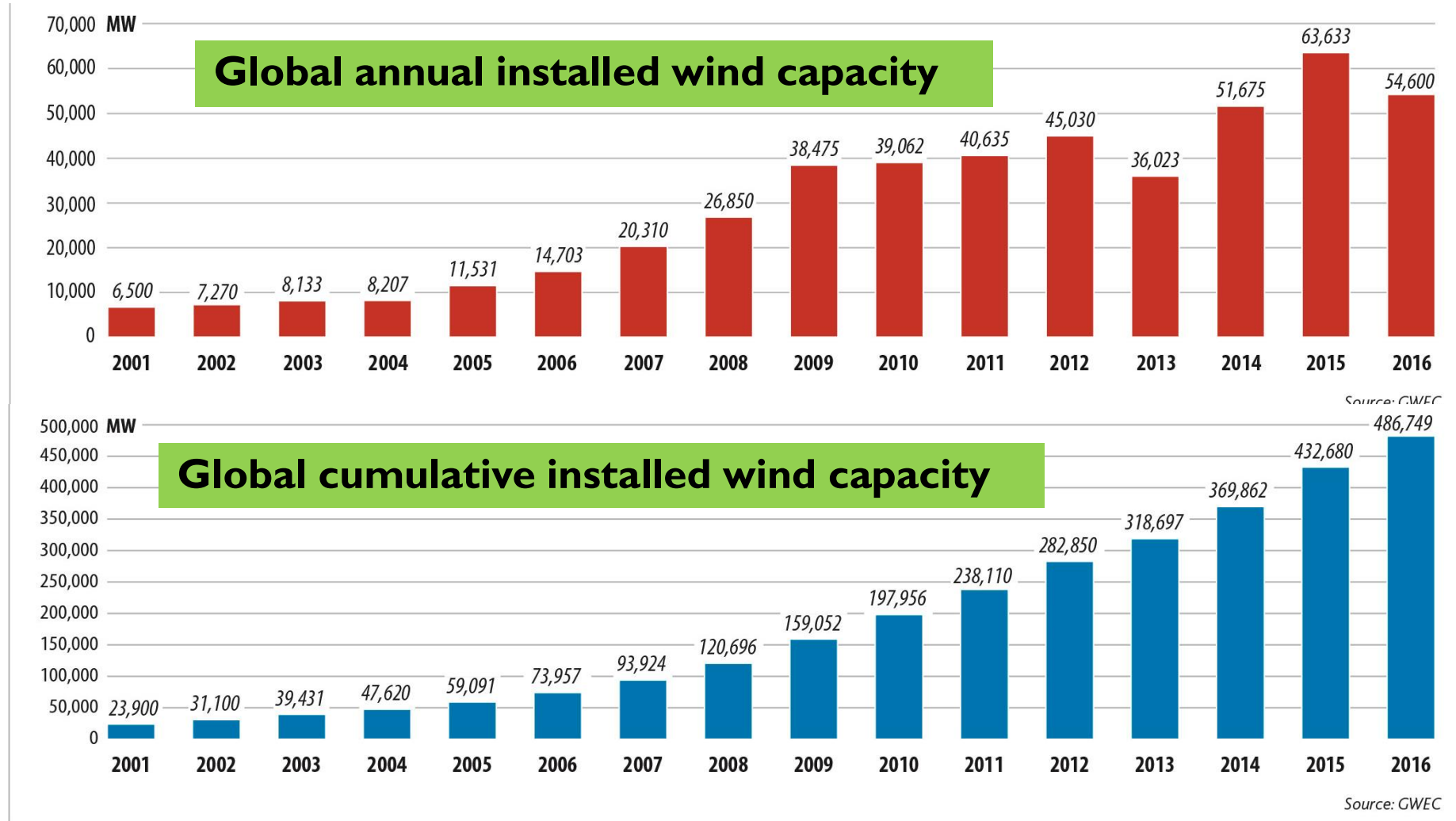
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**1st international conference on
Large-Scale Grid Integration of Renewable Energy in India**



- Wind turbine generator types
- Wind power generation models: level of details
- Standard wind turbine generator models
- Aggregated model of wind power plant
- Wake effect model: detailed vs simplified
- conclusion



Wind turbine generator types

Type 1 wind turbine generator

Advantages

robust

simple

cheap

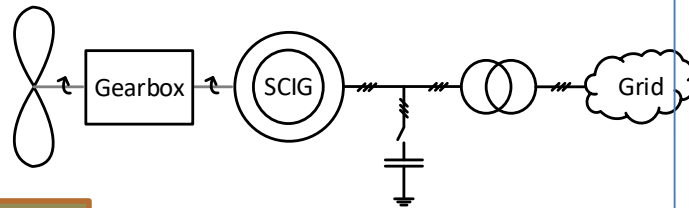
Disadvantages:

Fixed speed

Reactive comp.

uncontrollable

Maintenance



Type 2 wind turbine generator

Advantages

robust

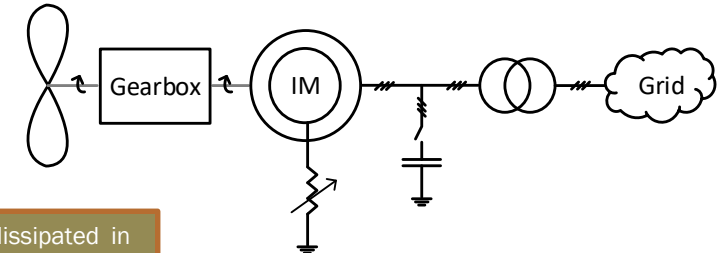
Disadvantages

Narrow speed range

Reactive comp.

maintenance

Power dissipated in R_{ex}



Type 3 wind turbine generator

Advantages

Wide Speed range

No compensation

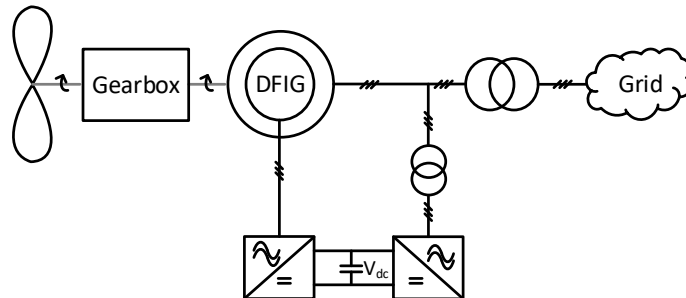
Power decouple

Disadvantage

Maintenance

Complex

Expensive



Type 4 wind turbine generator

Advantages

The widest Speed range

No compensation

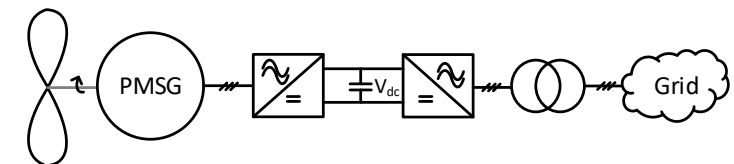
Power decouple

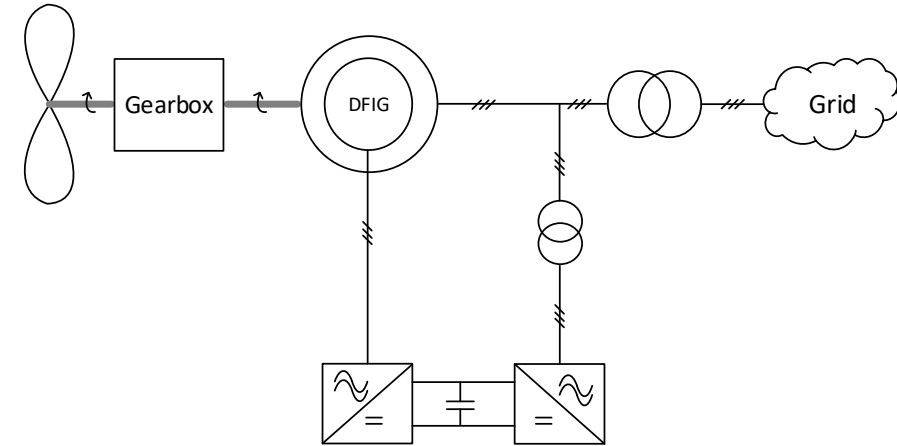
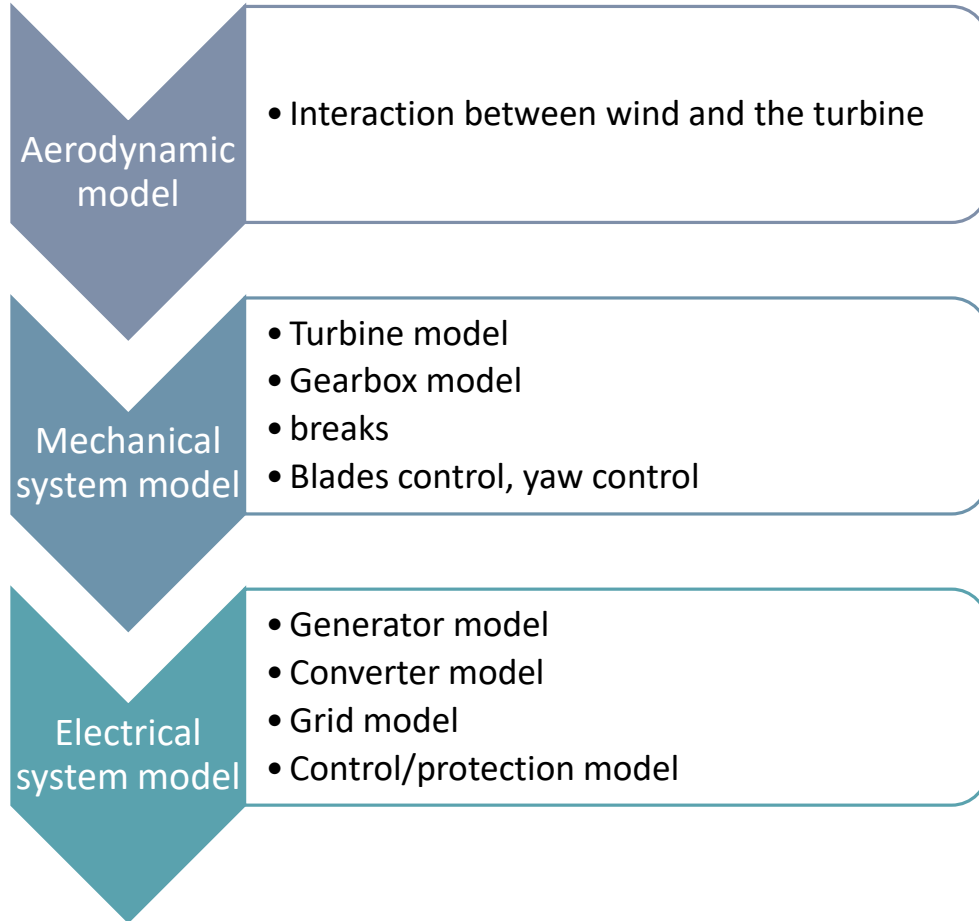
Gearbox-free

Disadvantages

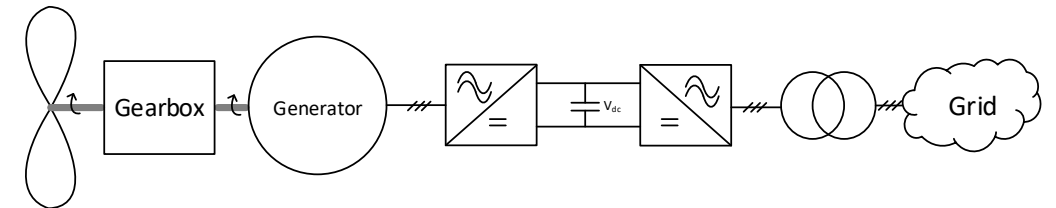
Complex

Expensive

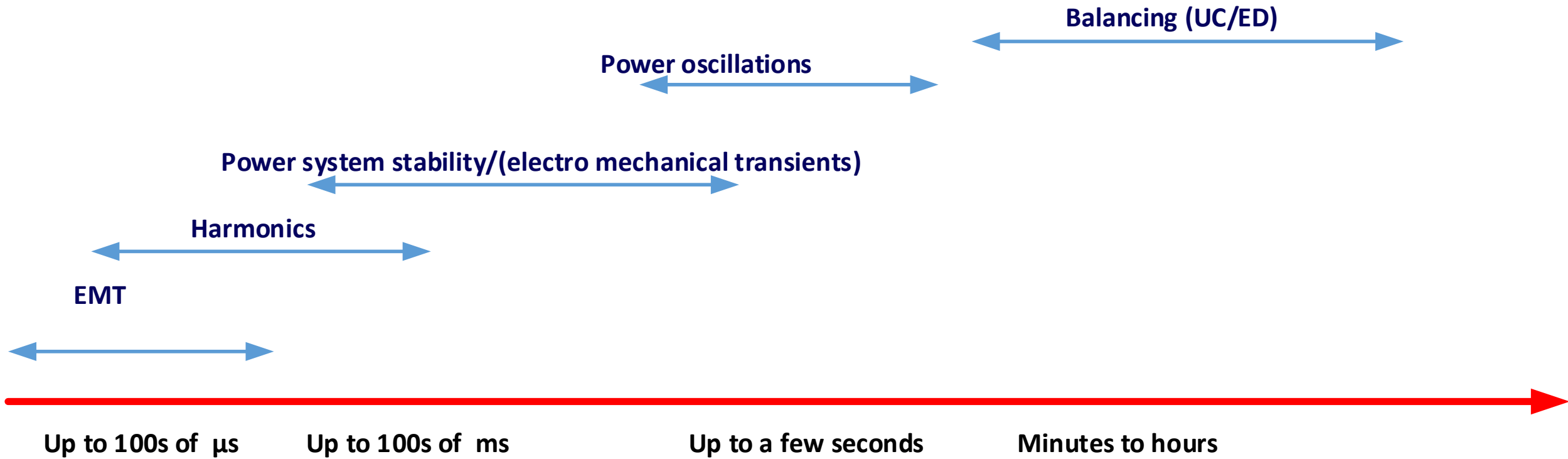


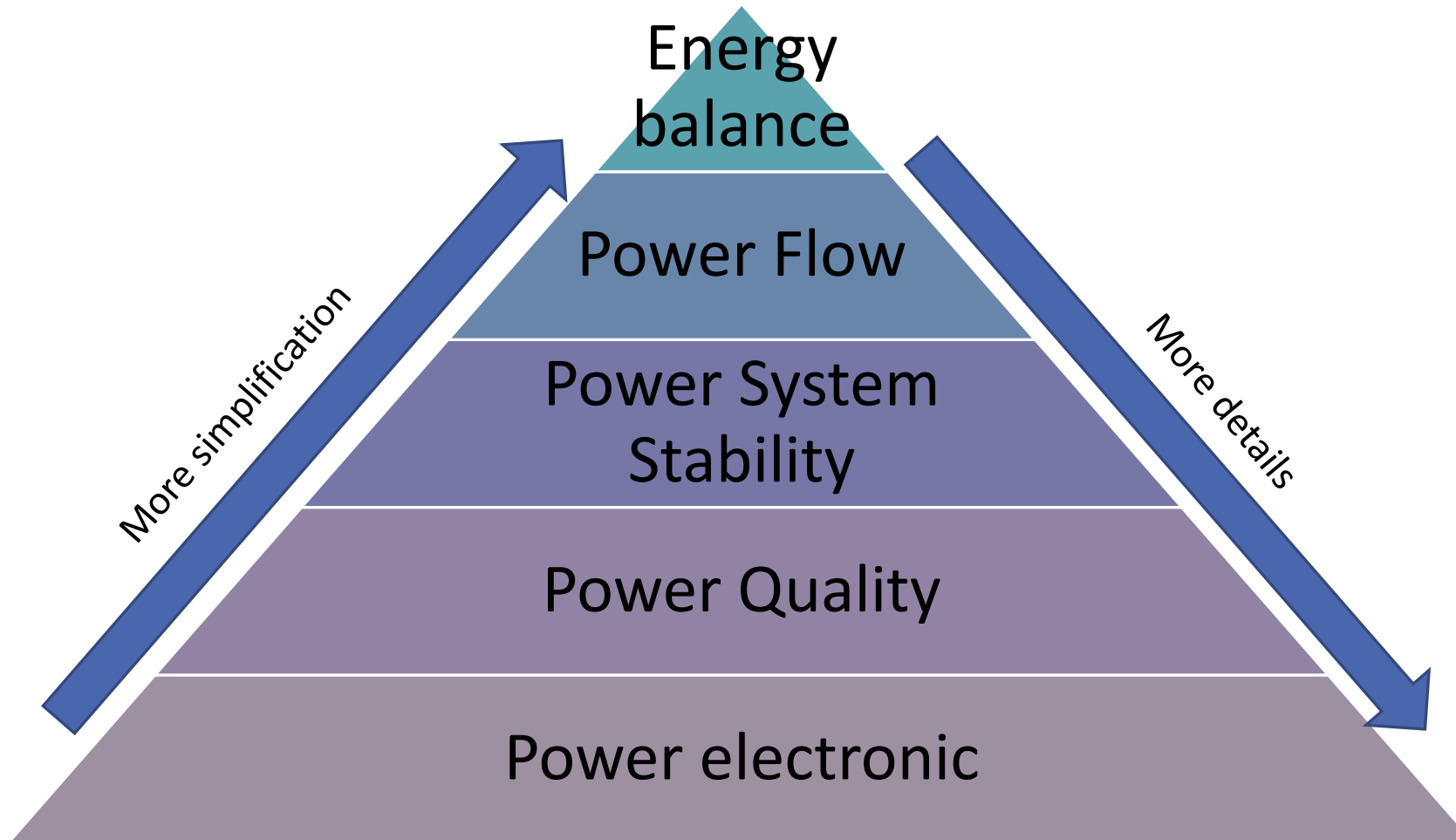


Type 3



Type 4



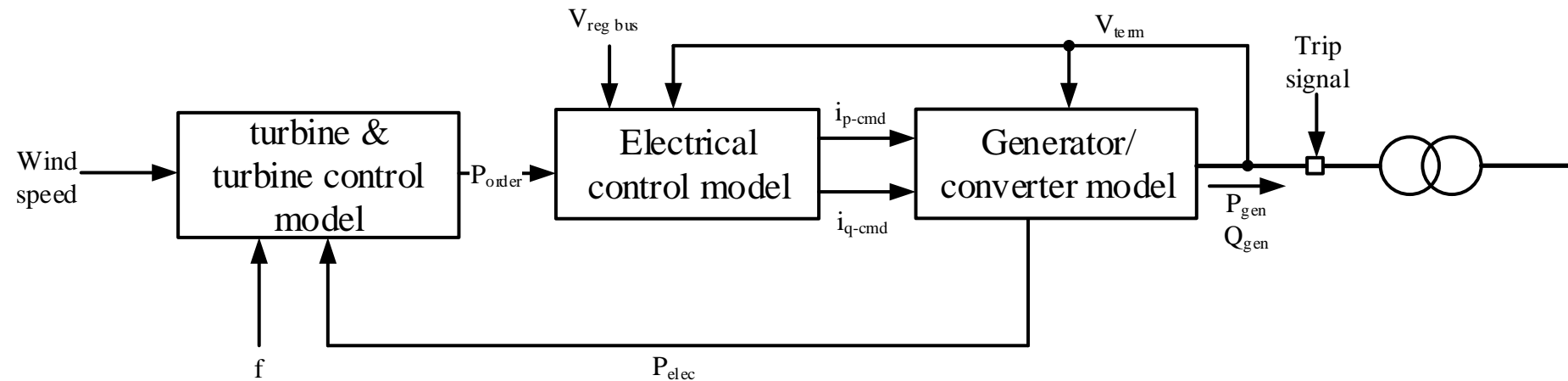




➤ Wind turbine models :

- GE Model
- NREL Model
- Fortmann et.al. model
- WECC Model
- IEC 61400-27-1

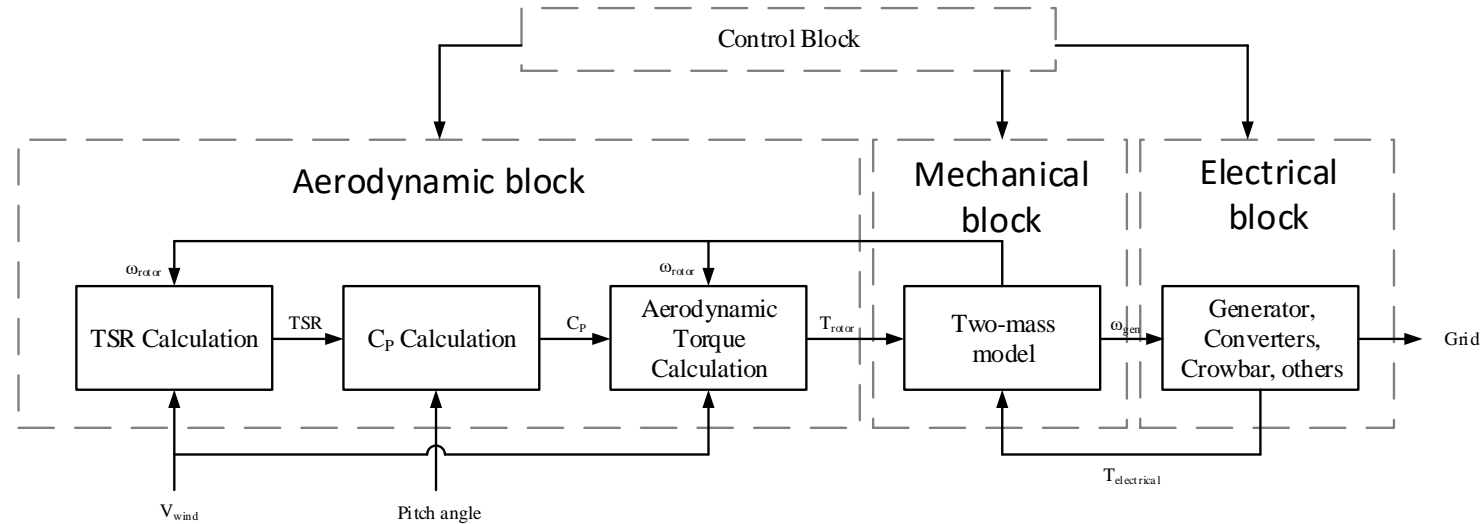
GE model



N. W. Miller et al. 2003.

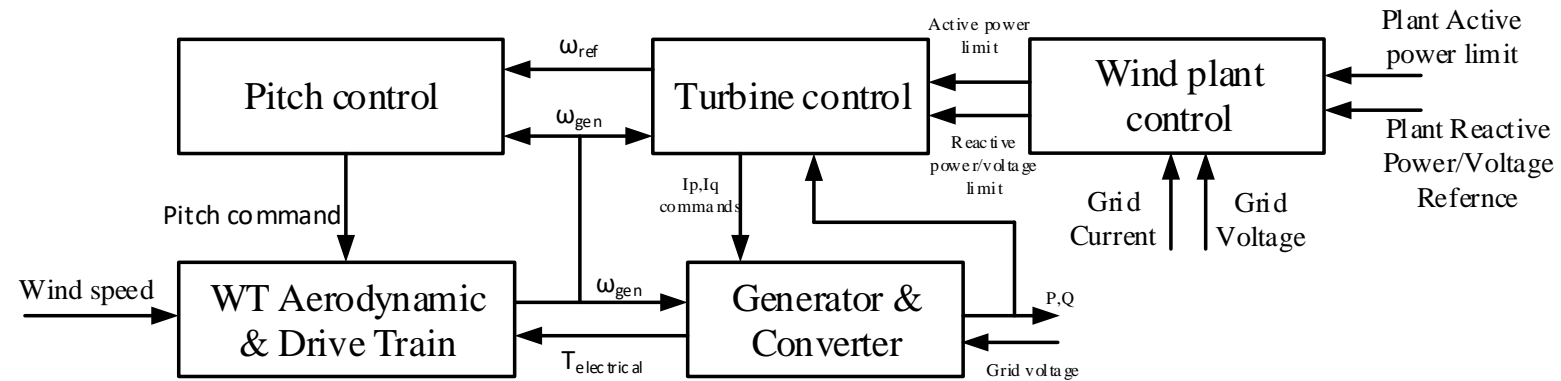


NREL model



M. Singh et al. 2011

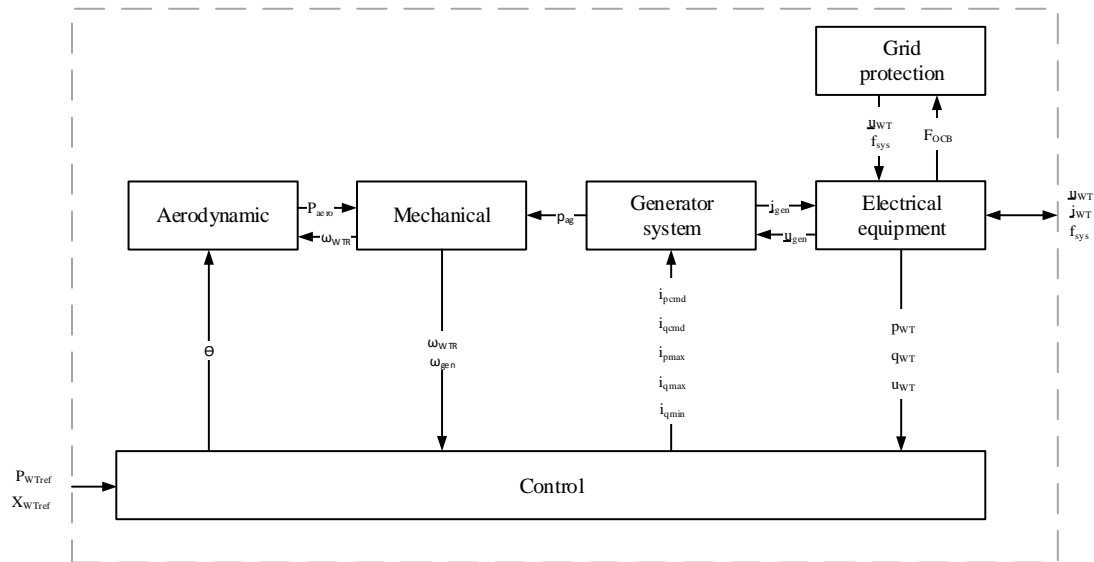
Fortmann model (adopted in IEC model)



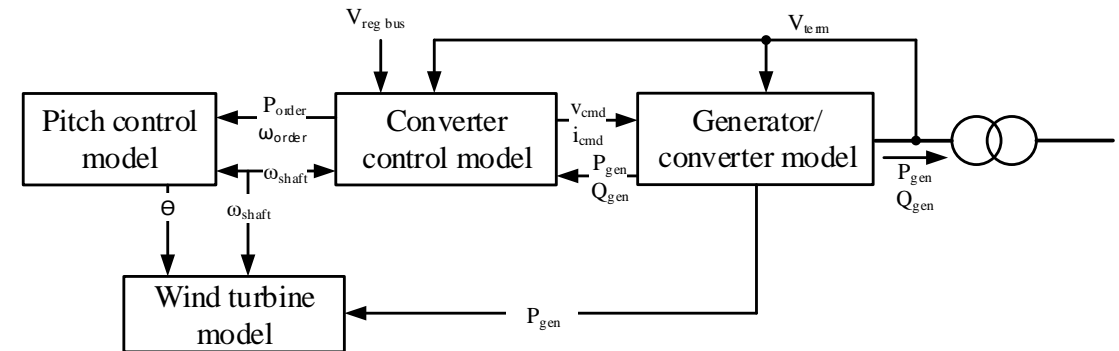
Fortmann et.al. model 2014



IEC 61400-27-1 type 3

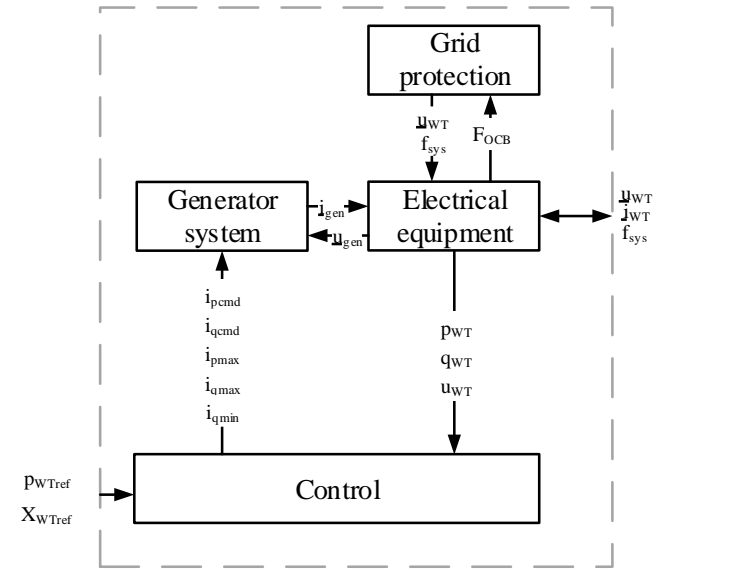


WECC type 3

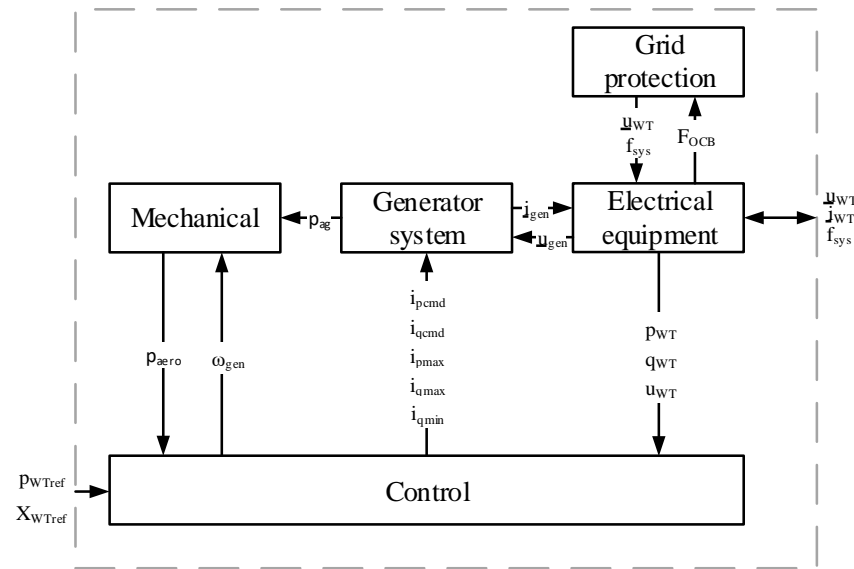




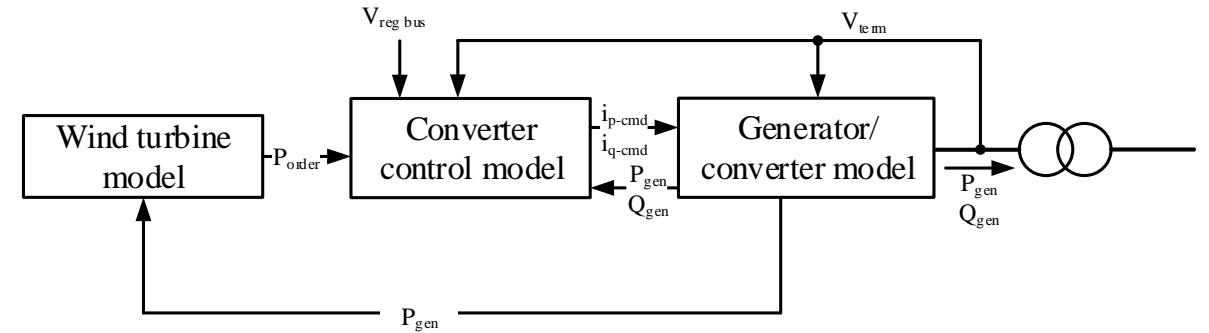
IEC 61400-27-1
Type 4A



IEC 61400-27-1
Type 4B



WECC Type 4

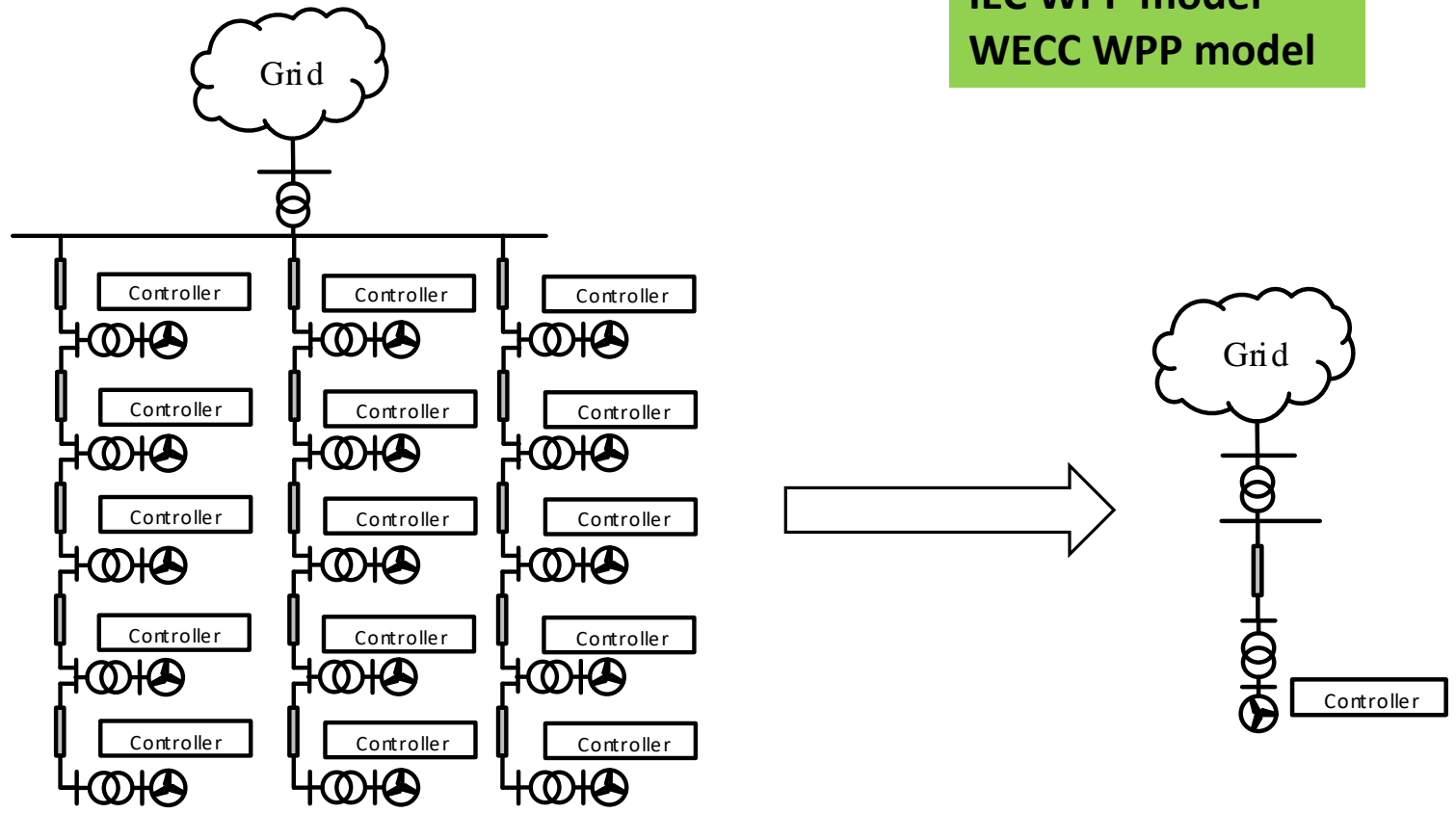


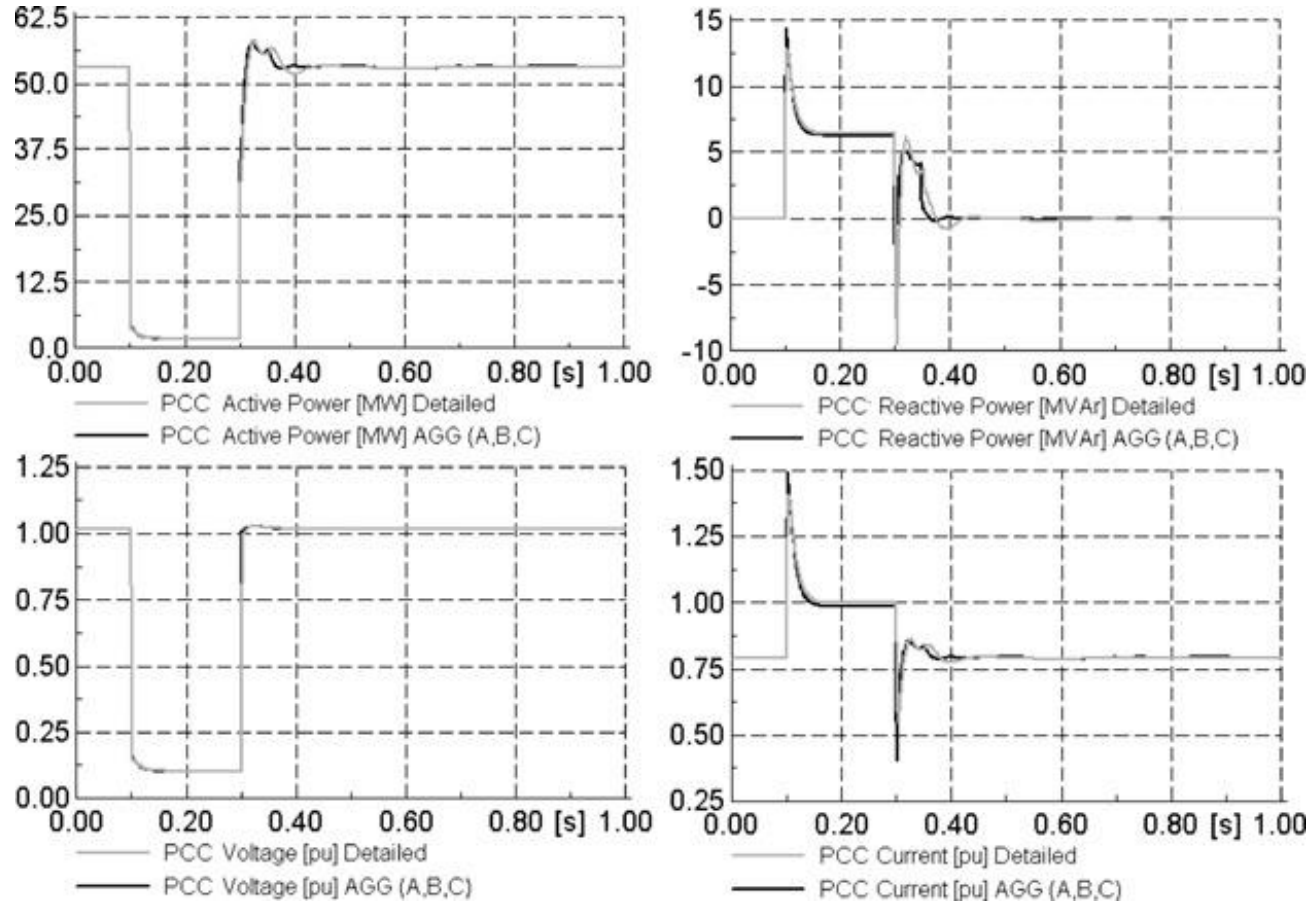


- Detailed model of wind farm:
 - Difficult to implement in large scale wind integration studies-more complex and high computational burden.
- A simple aggregated model that ease the computational effort while maintaining accuracy close to that of a detailed model.
- Aggregated model Vs detailed model:
 - Losses
 - Wake effect
 - Dynamic performance

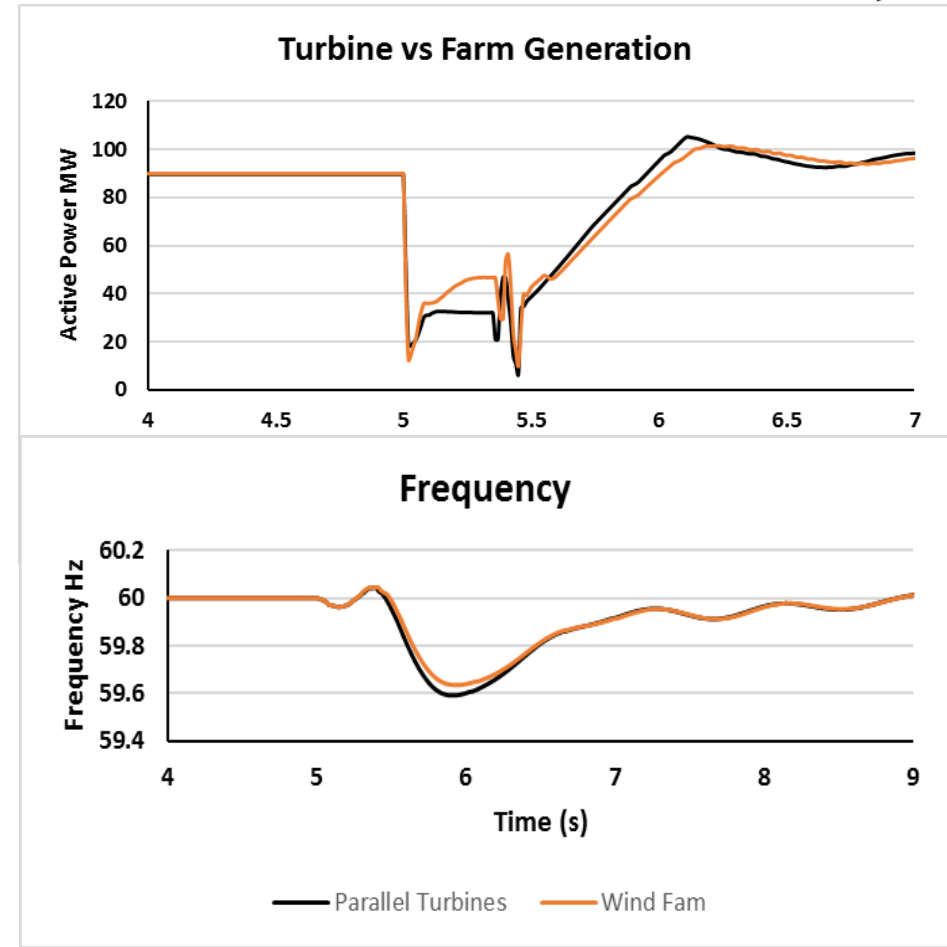
IEC WPP model
WECC WPP model

- Aggregation approaches:
 - Equivalent circuit aggregation
 - Probabilistic clustering
 - Fuzzy clustering
 - Dynamic clustering
 - others

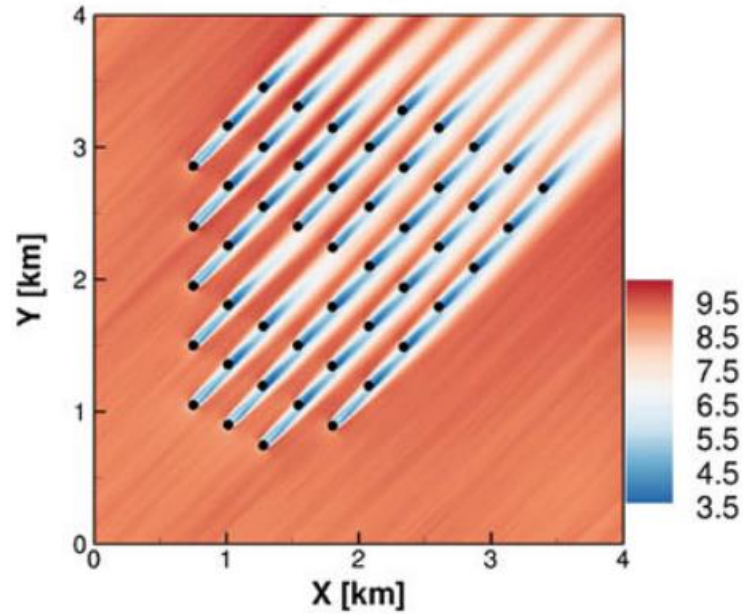




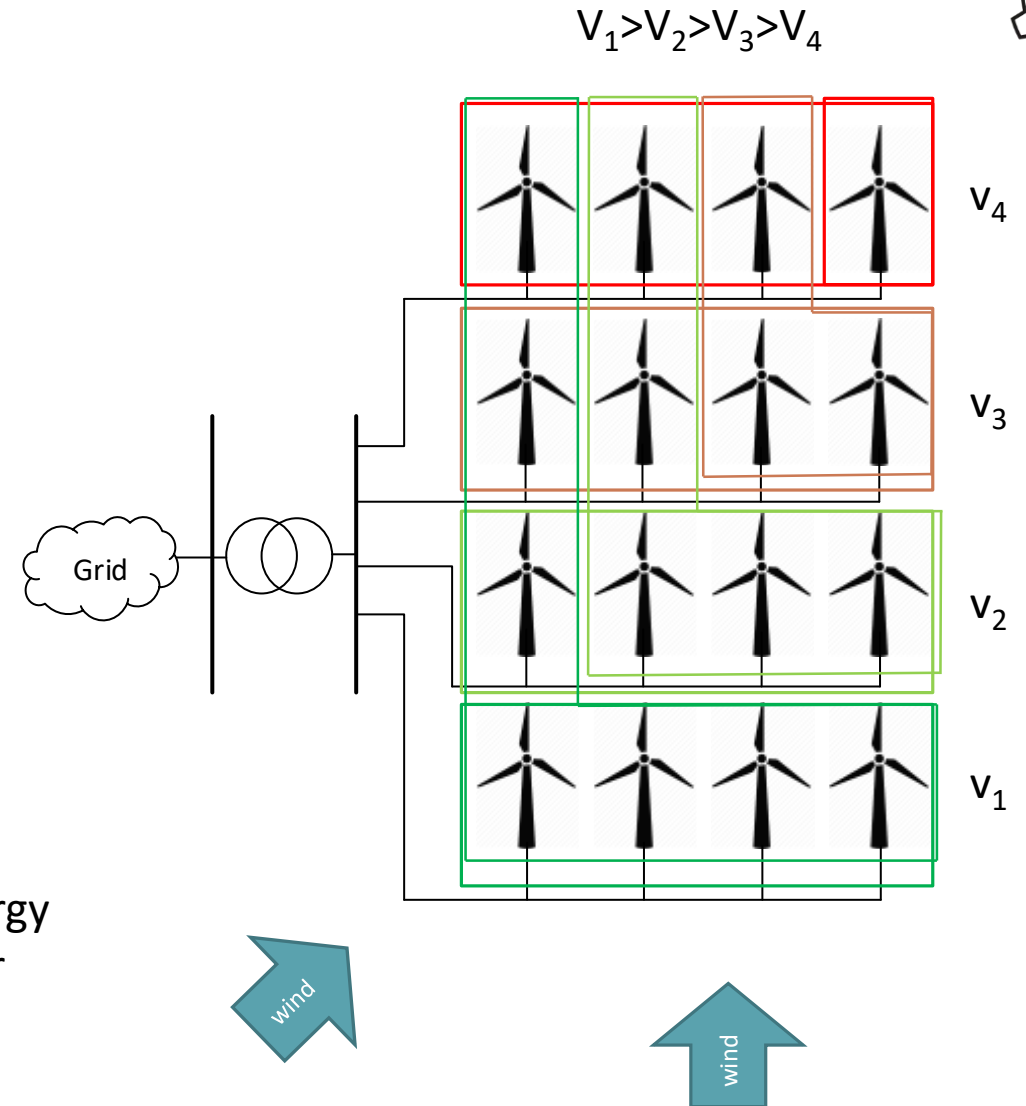
A case study on 100 MW detailed Vs simplified aggregate model, 2017



J. Conroy et. al., 2009



*Source: www.hkftechnology.com



- Different wind speeds →
- Different active power generation
 - Different rotational energy
 - Different reactive power reserve



- An overview of standard wind turbine generator/plant models is presented.
- While there are many detailed models available, generic models which are simplified, less complex and have good accuracy level, are more widely used
- Wake effect, if ignored, can impact model accuracy.
- Harmonisation of different models can be a better way forward



Thank you