

Reliability Assessment of Wind Farms

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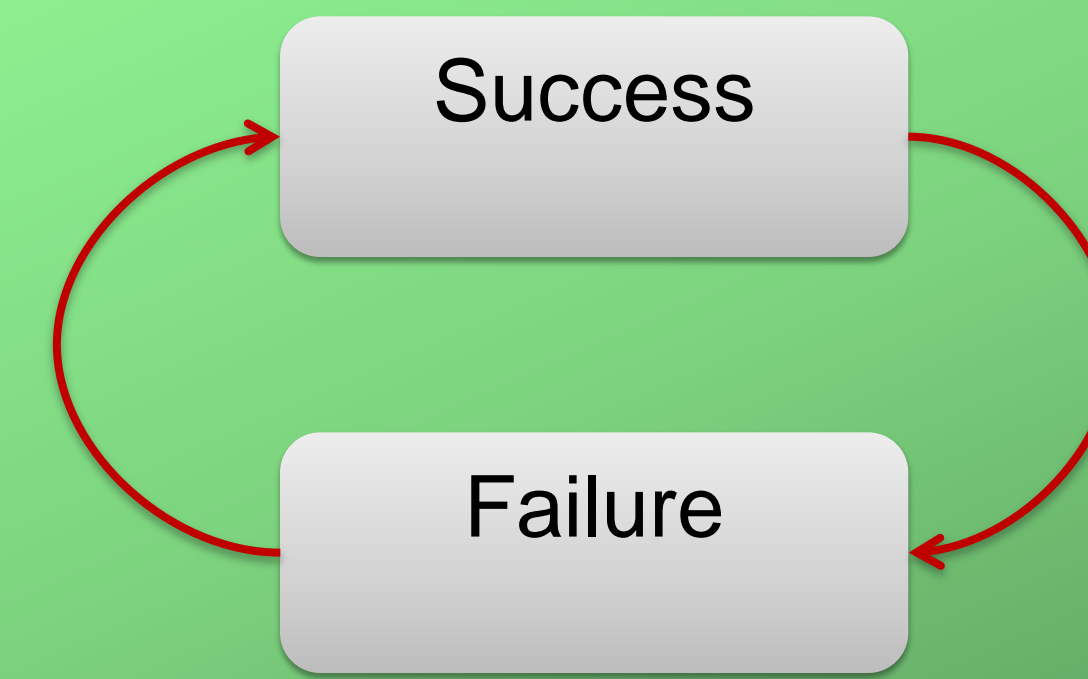


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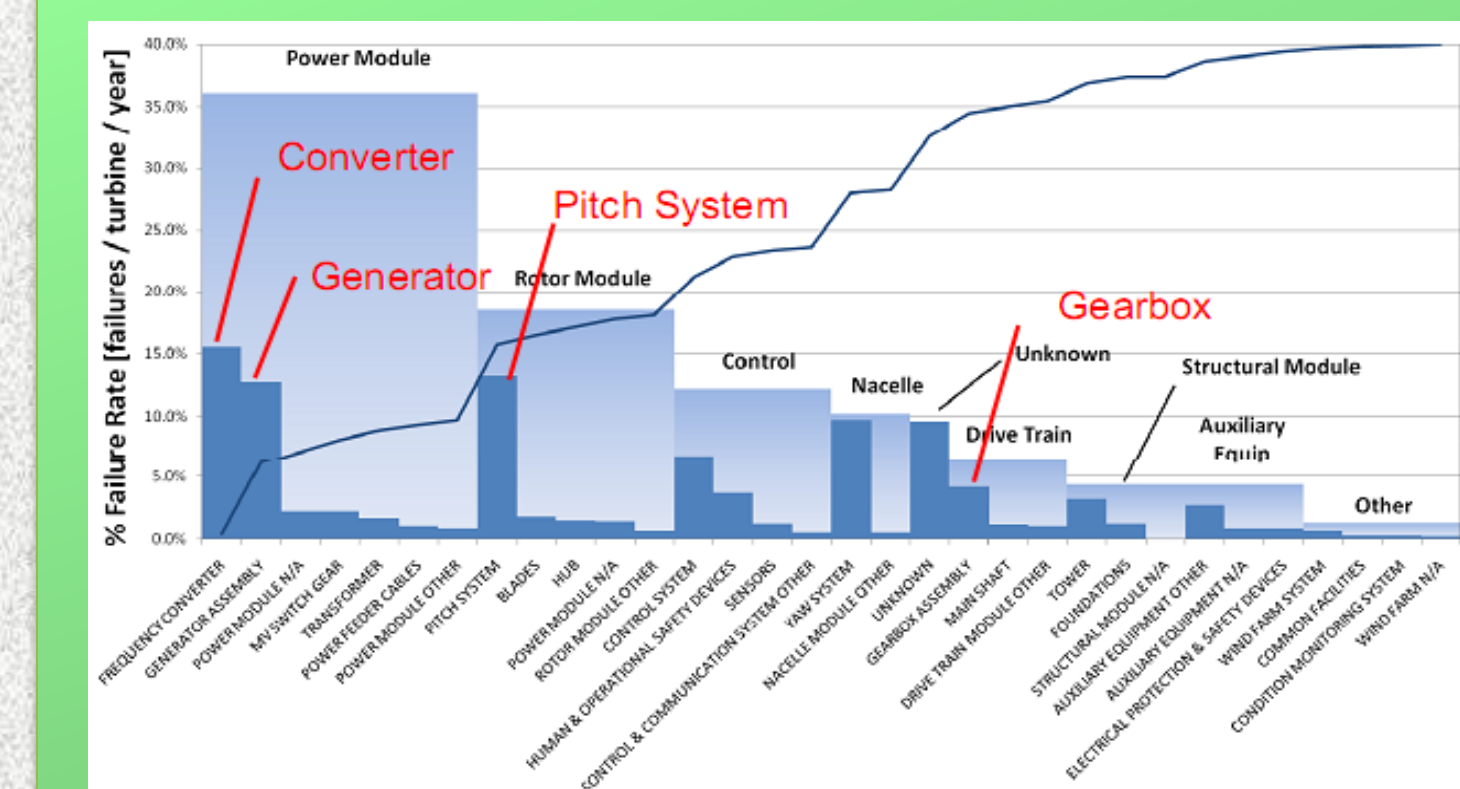
Significance of Wind Farm Reliability Study

- Effect of stochastic behaviour of wind source on electricity generation.
- Viability of many rotating and moving parts of WT to failure.
- Installation of the WT in high elevation and exposed to stochastic weather changes.
- Growth of wind energy penetration in the power generation system.
- Variety of wind turbine models and designs in the market.

Component Reliability

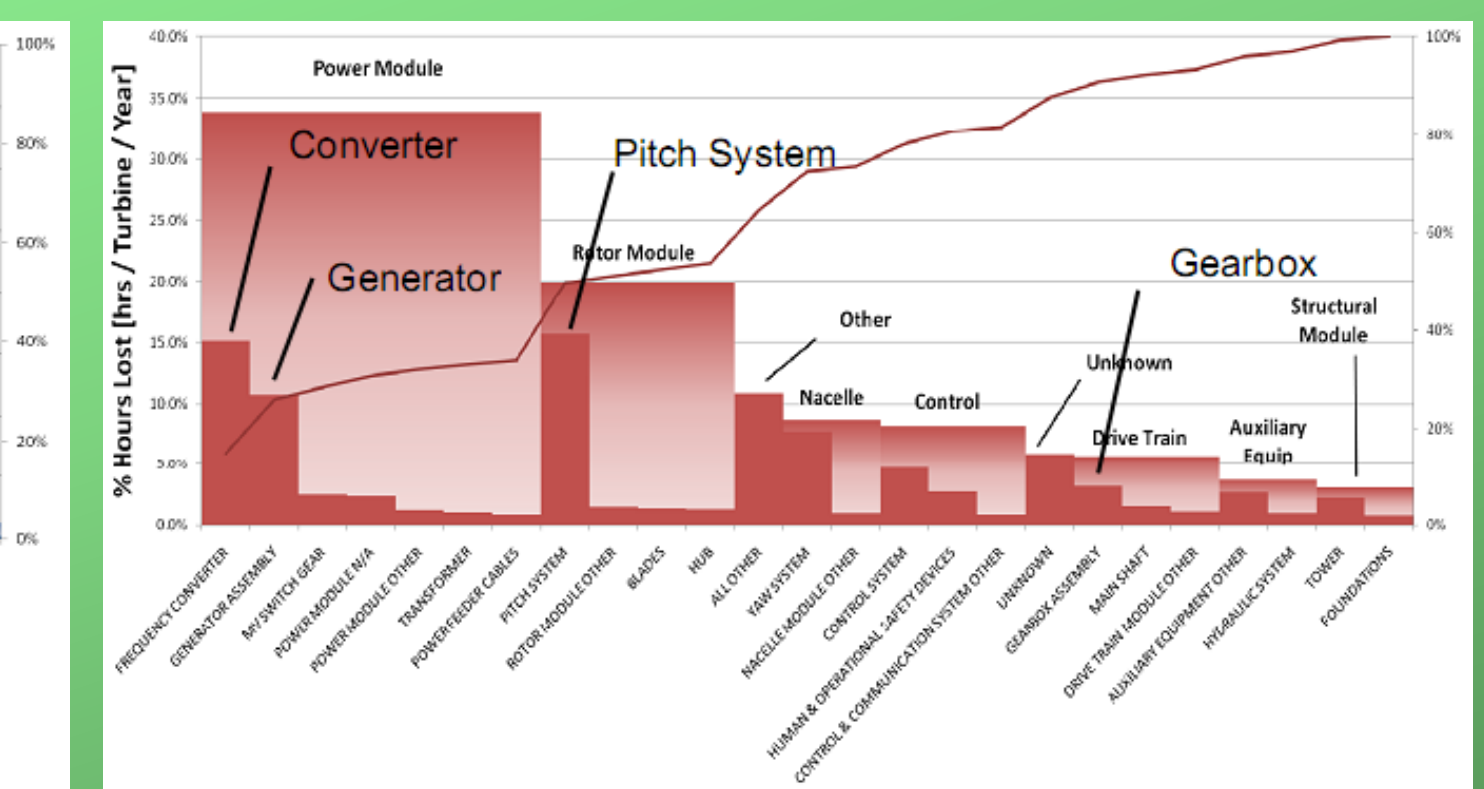


Failure Rate



Source: <http://docs.wind-watch.org/Wilkinson-slide15.jpg>

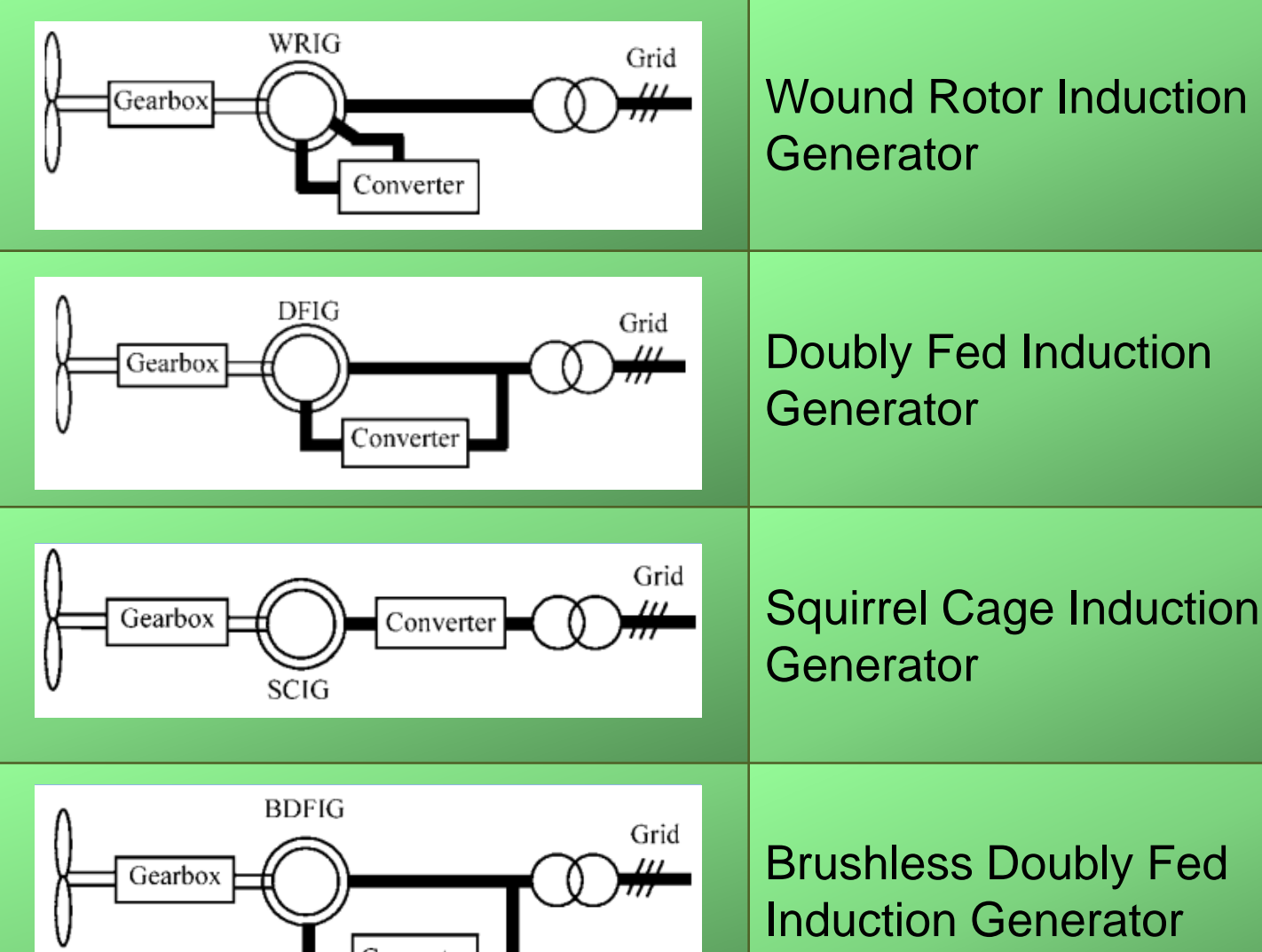
Repair Duration



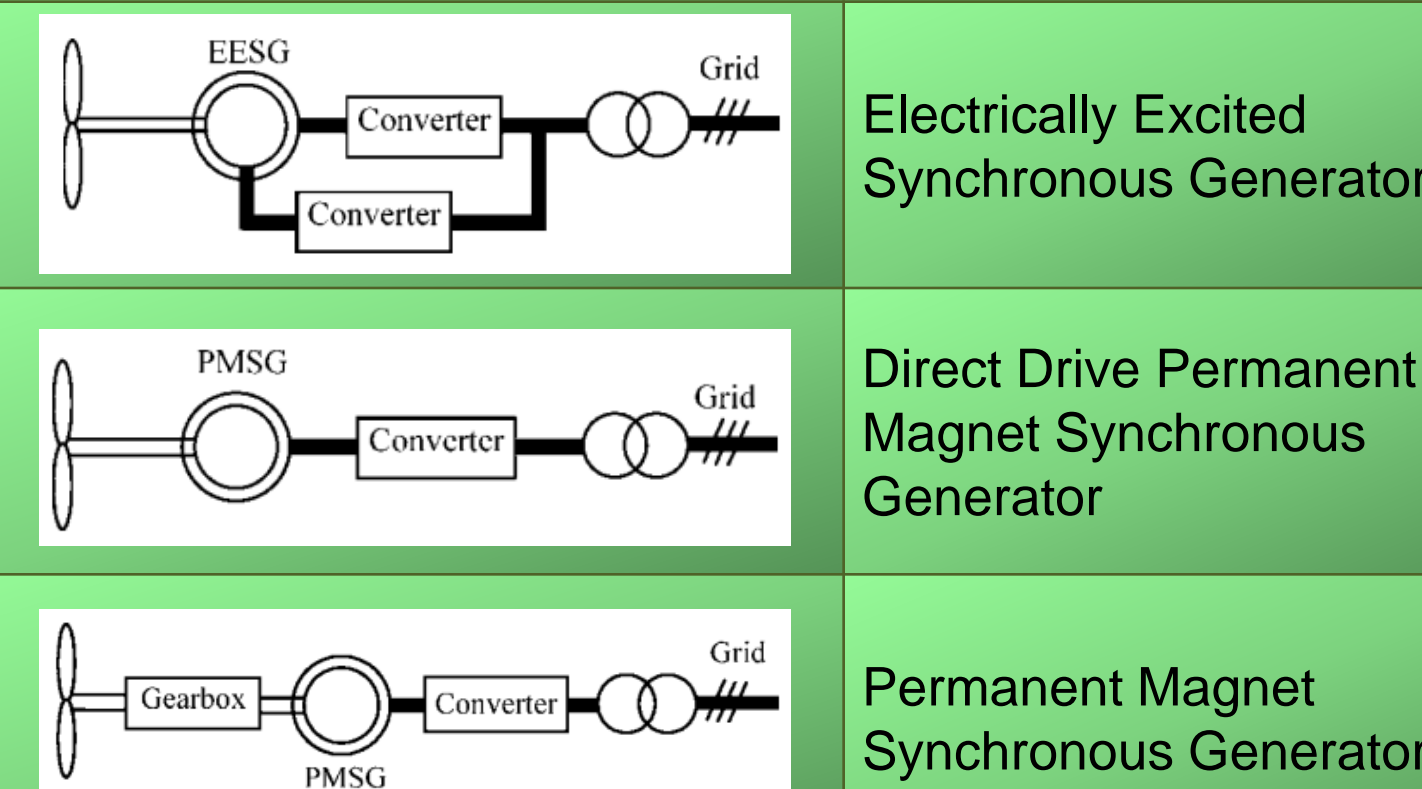
Source: <http://docs.wind-watch.org/Wilkinson-slide16.jpg>

Generator Models

Induction Generator

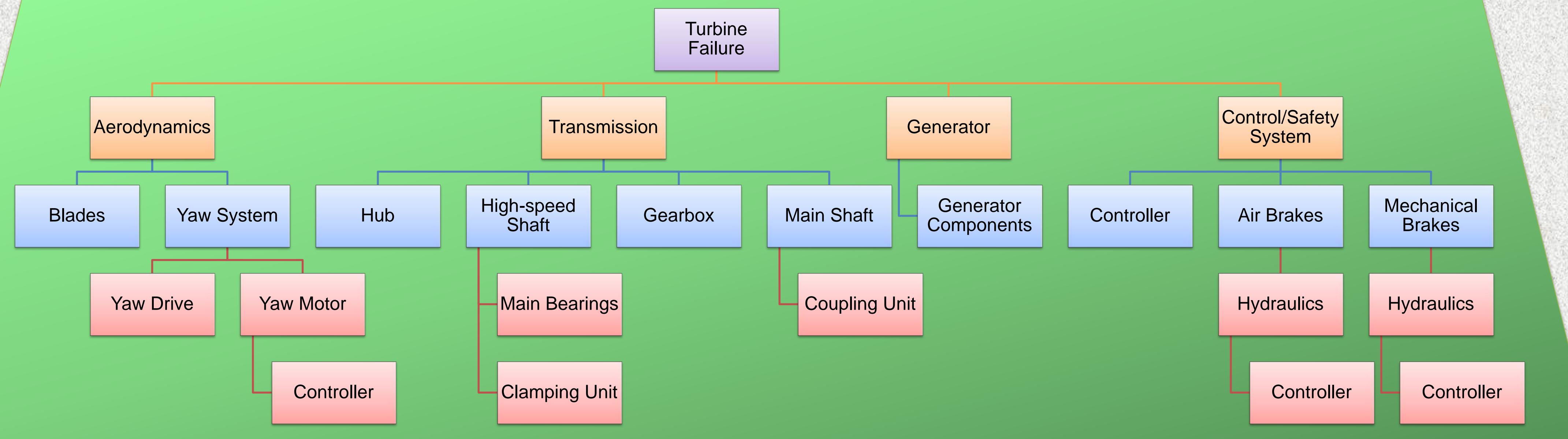


Synchronous Generator

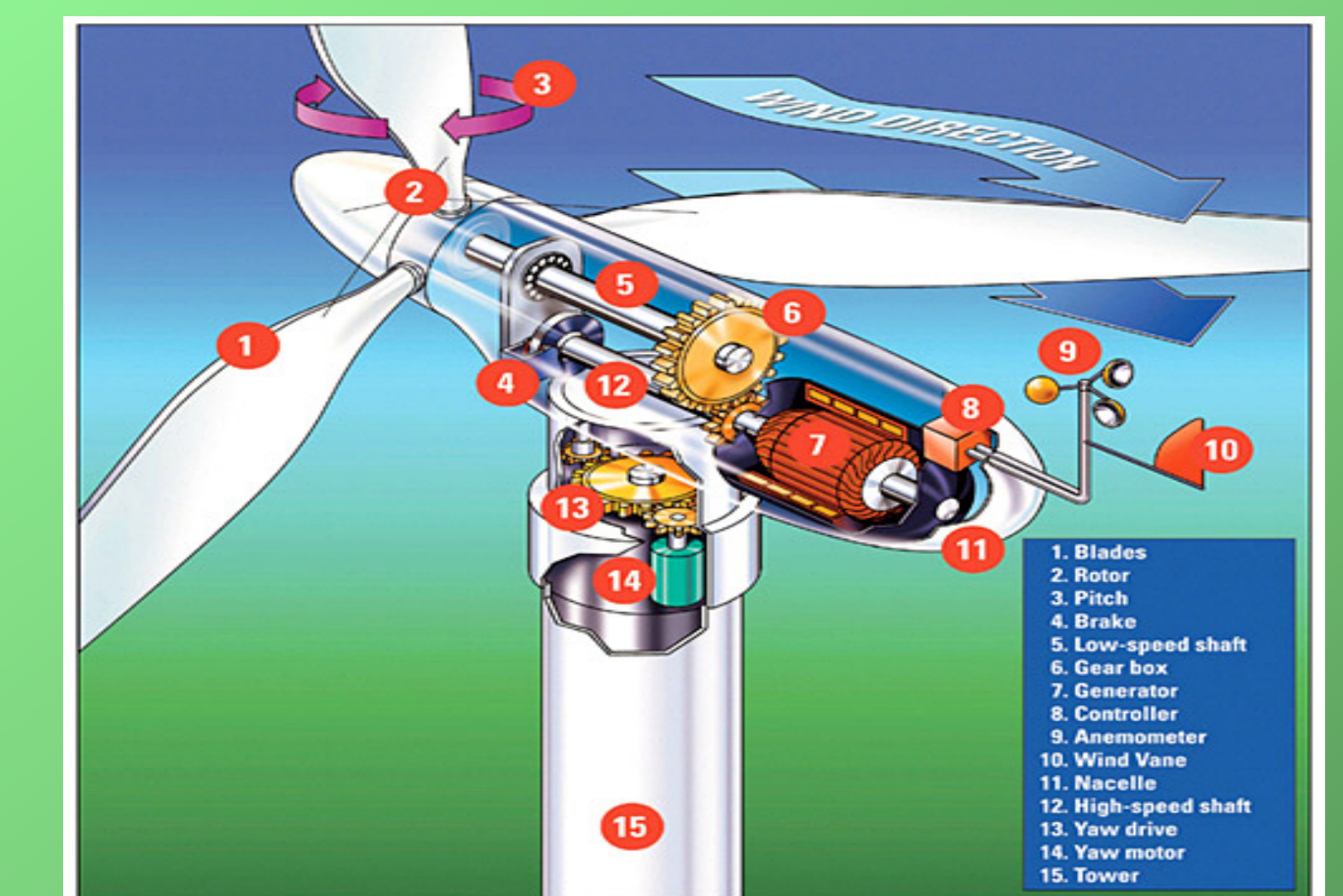


Source: Overview of different wind generator systems and their comparisons (Li, H.)

Wind Turbine Reliability

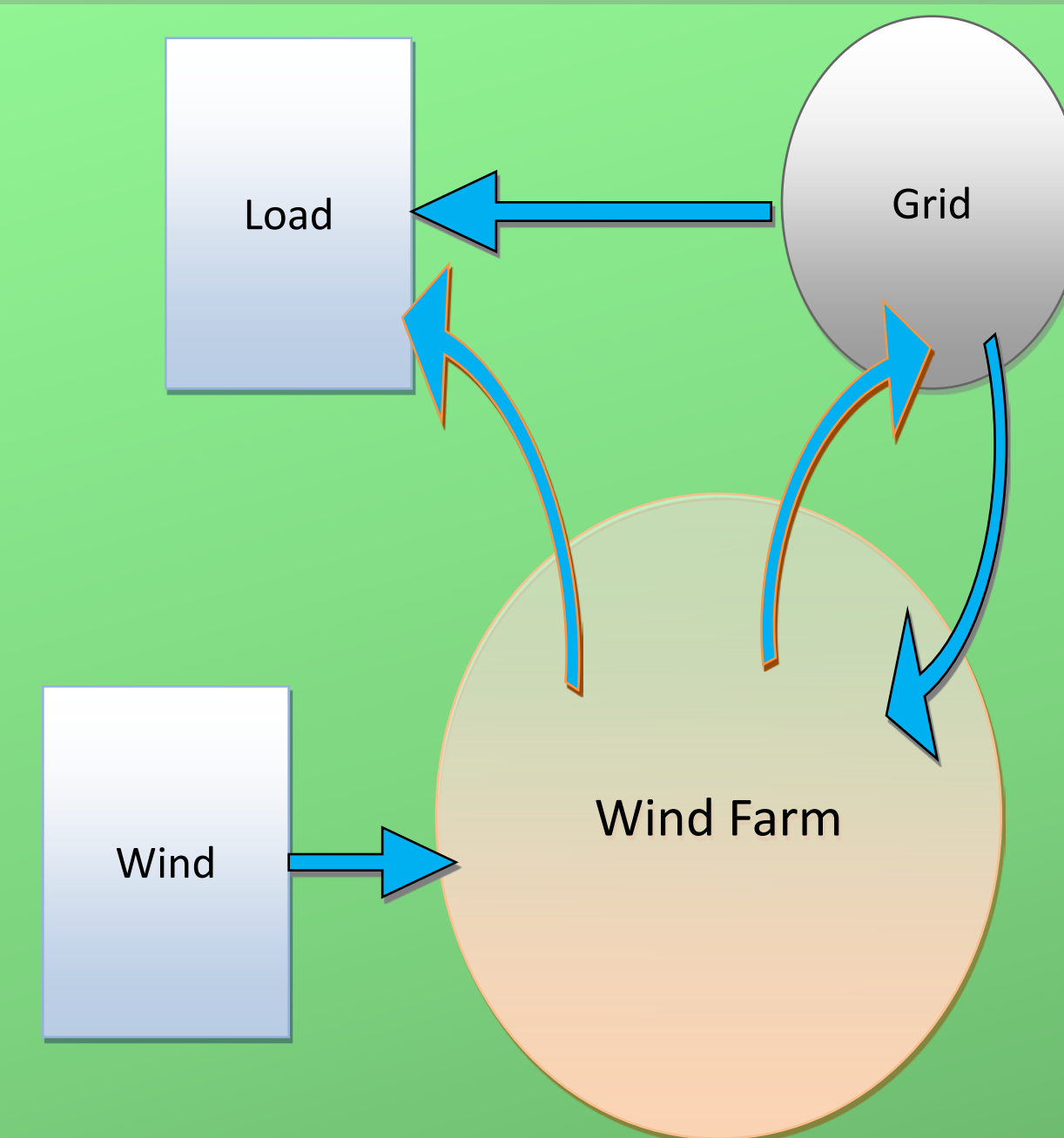


Wind Turbine Subassemblies and Models

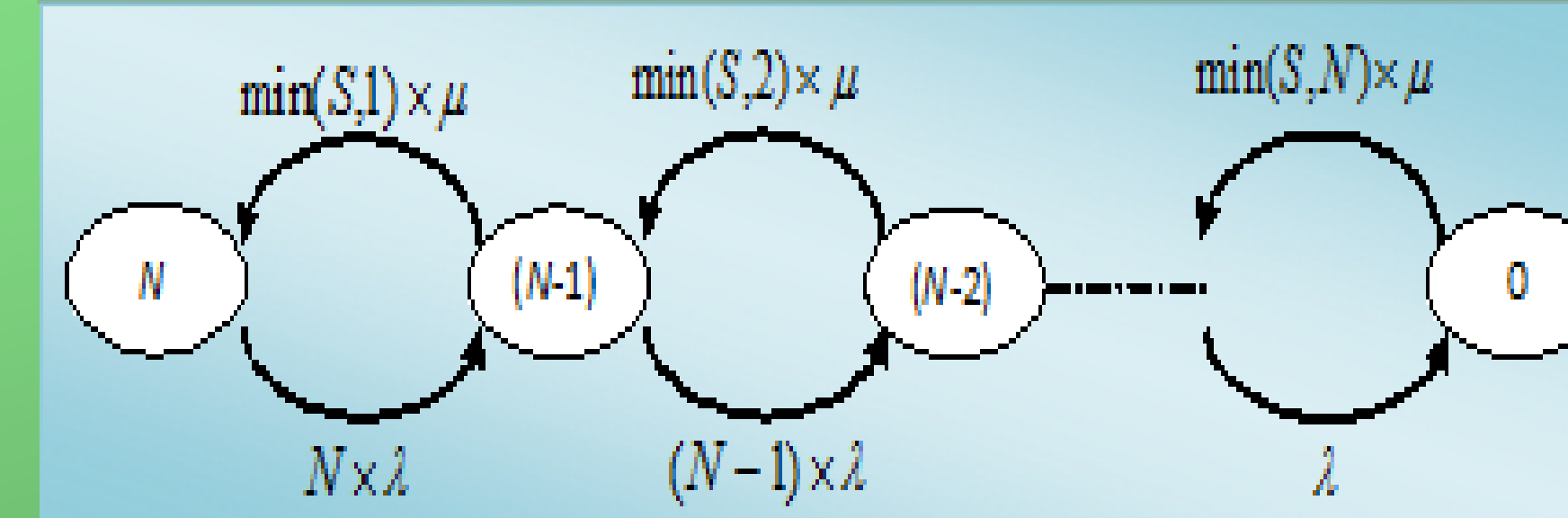


Source: www.alternative-energy-news.info

Wind Farm Reliability



Wind Farm Markov Model



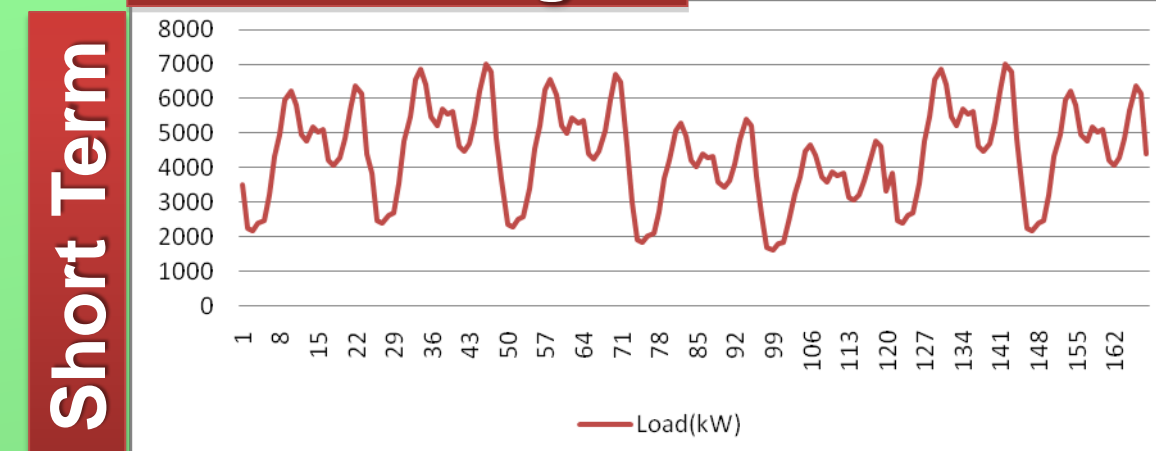
Wind Farm



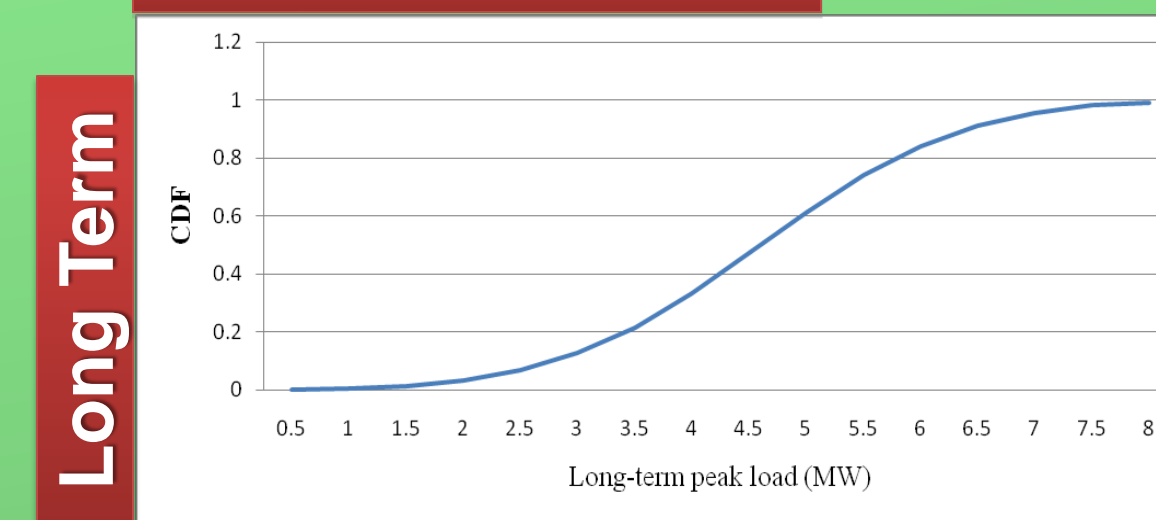
Source: <http://windpowerfacts.net/wind-power-info/>

Results and Conclusion

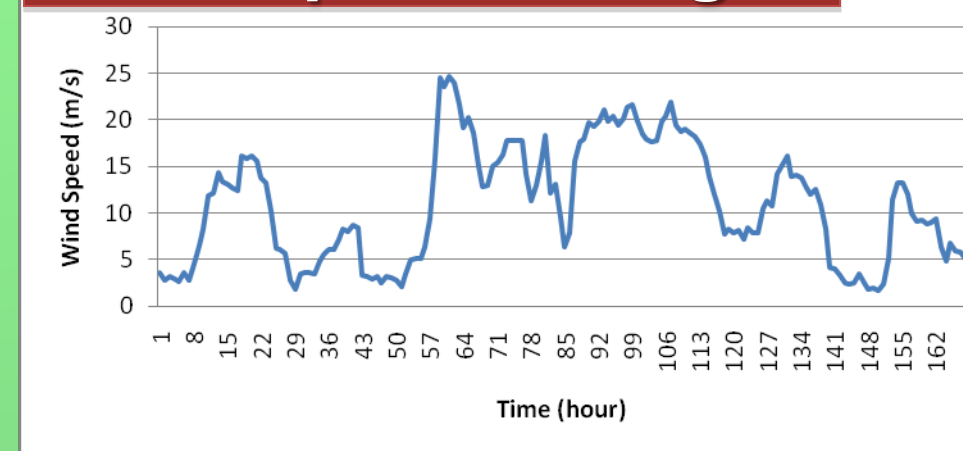
Load changes



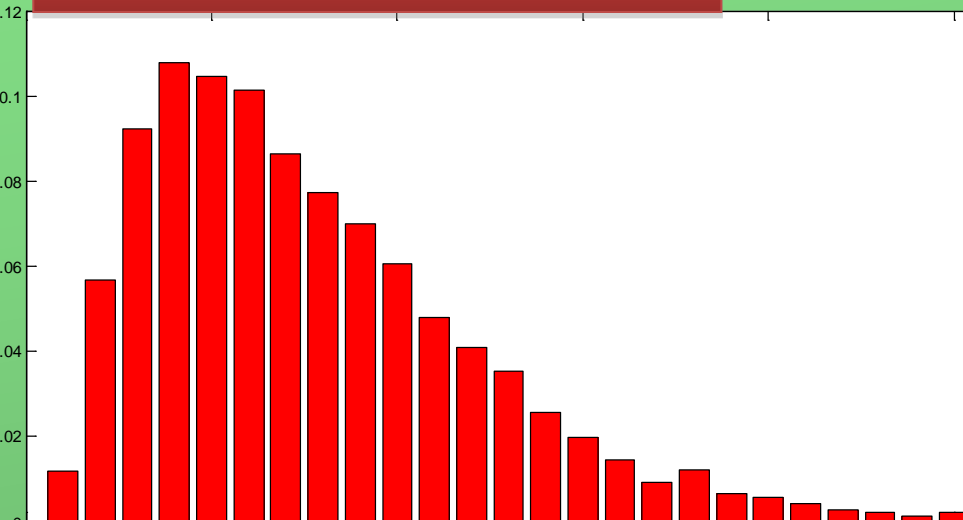
Load Distribution



Wind Speed Changes



Wind Distribution

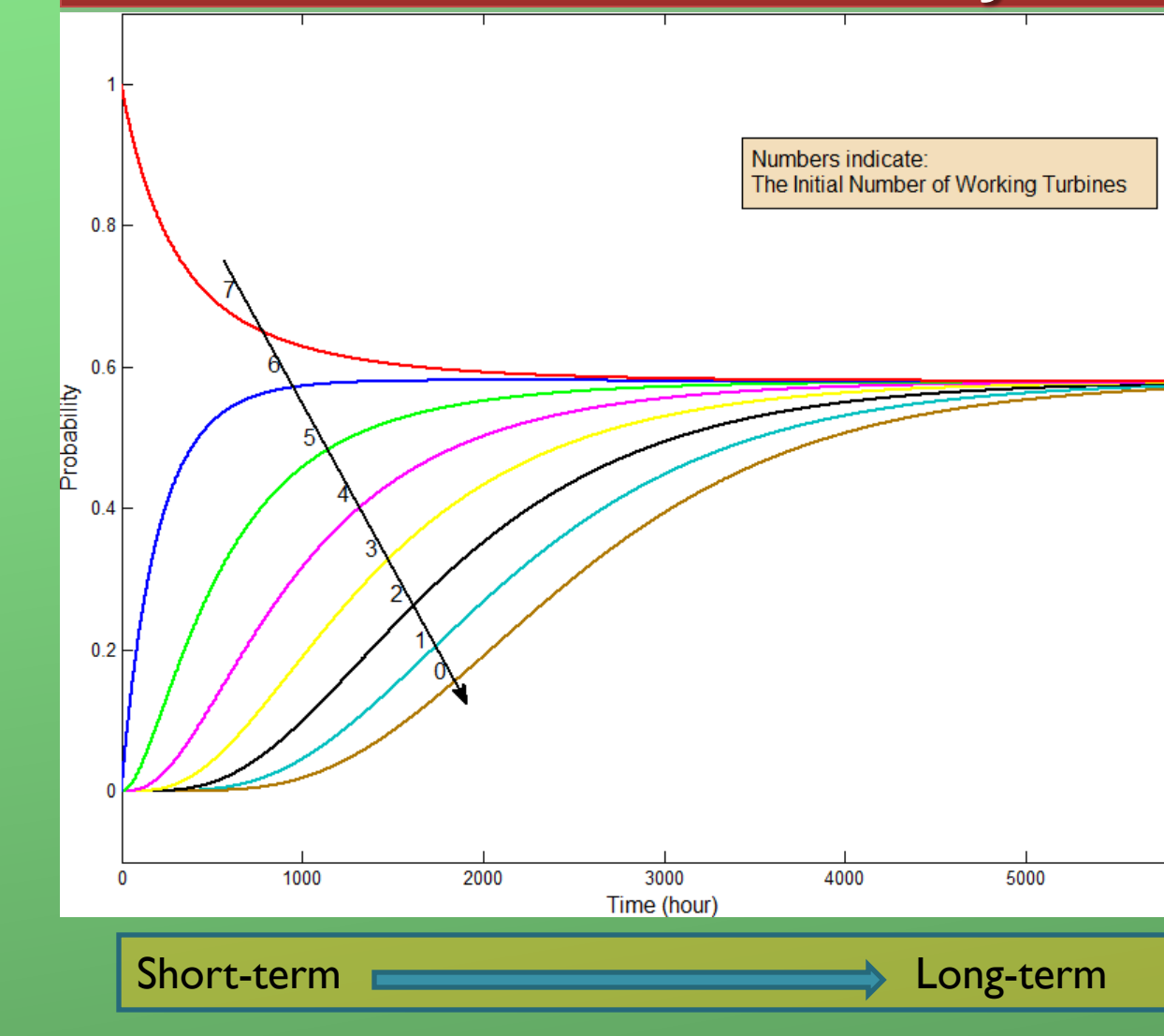


Wind Farm Reliability Indices

Initial Number of working turbines	LOLE (hours/week)	ESWE (MWh/week)	LOEE (MWh/week)
0	168	0	705.8
1	164	0.7	567.3
2	152	14.9	442.3
3	124	57.2	345.4
4	93	145.4	294.4
5	80	265.7	276
6	76	388.3	263.4
7	75	489.5	254.7

study Period	LOLE (hours/year)	ESWE (GWh/year)	LOEE (GWh/year)
one year	5860	9.9	20.5

Wind Farm Availability



Conclusions

- Reliability and Availability of wind farms were assessed considering :
 - Wind turbine failures.
 - Wind speed variations.
 - Load changes.
- According to the results, wind farm should be connected to a grid or a storage system in order to supply the loads reliably.
- Based on the proposed model, wind farm owner can estimate the surplus/ required amount of energy in their short-term and long-term study and plan accordingly to maximize their profits.