



CITCEA · Centre d'Innovació Tecnològica
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I International
Conference in
Energy Innovation

GRID CONNECTION OF WIND PARKS

**Centre for Technology Innovation in Static
Converters and Drives
Polytechnic University of Catalonia**

GRID INTEGRATION OF WIND PARKS - A New Challenge for Power Grids

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CO-AUTHORS: Antoni Sudrià, Joan Rull, Samuel Galceran, Gabriel Gross



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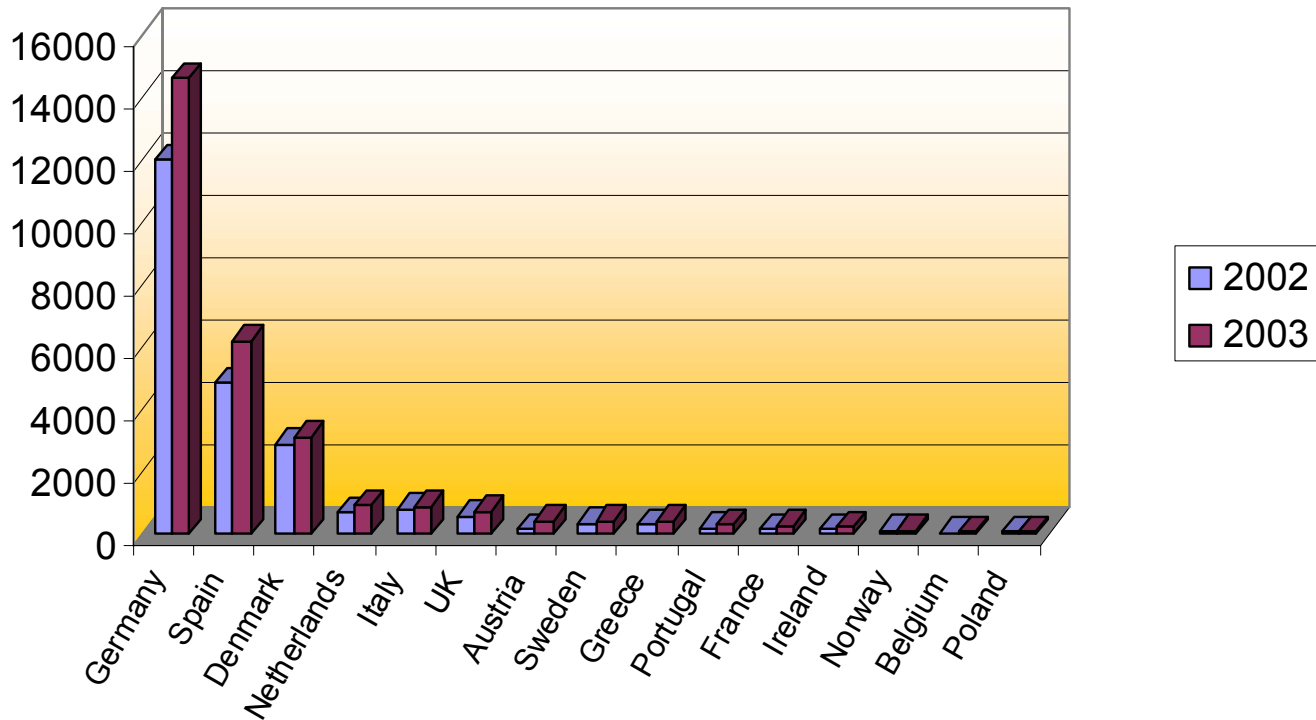
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GRID CONNECTION OF WIND PARKS

Some Facts About Wind Energy in Spain

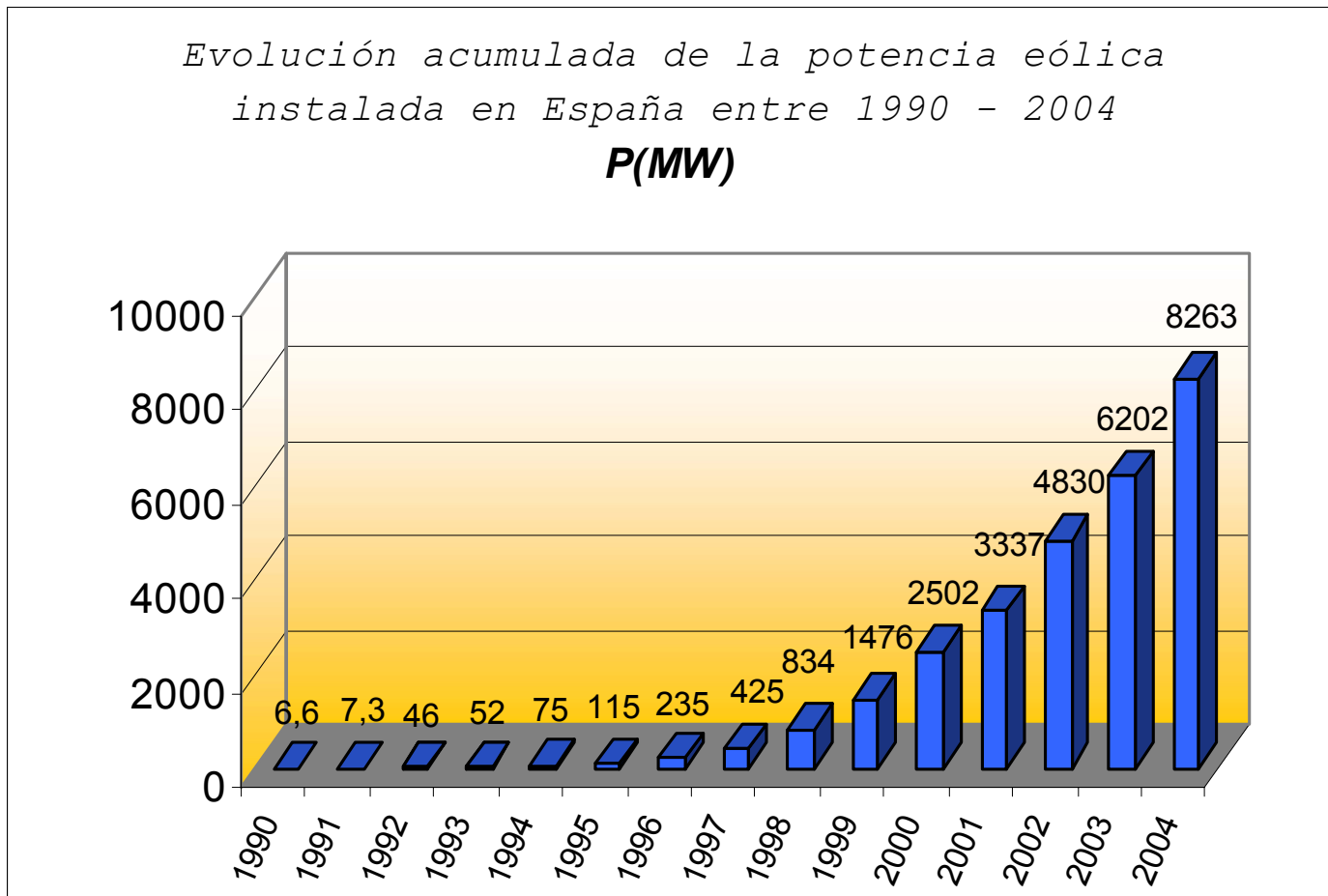
*Evolución acumulada de la potencia eólica instalada en Europa
en 2002 y 2003 en P (MW)*





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Some Facts About Wind Energy in Spain

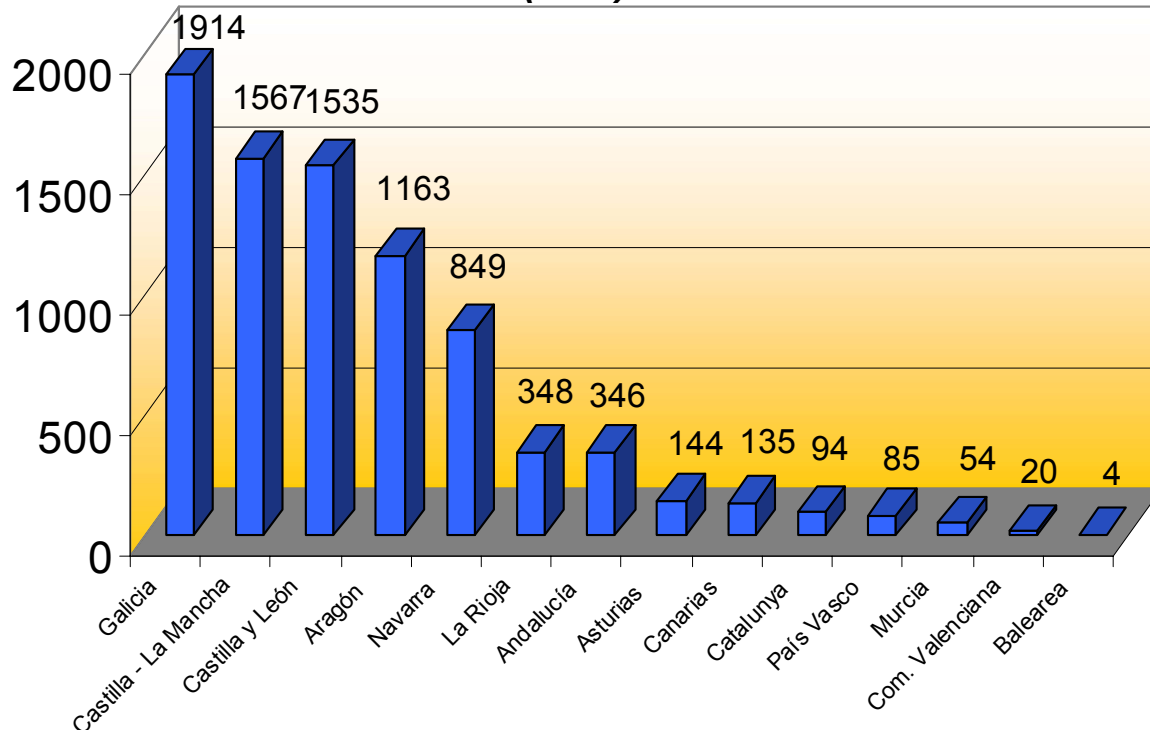




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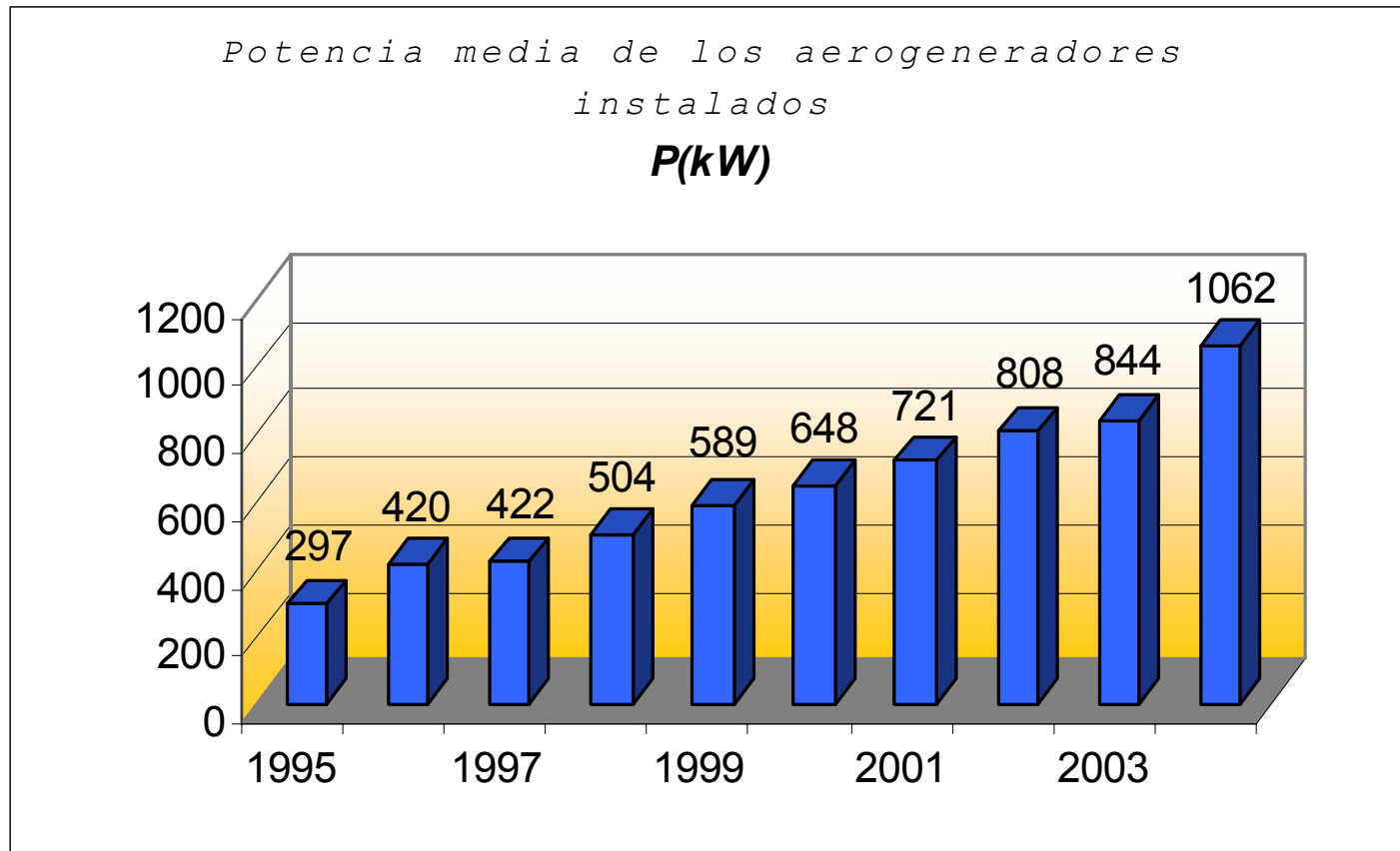
Some Facts About Wind Energy in Spain

*Distribución territorial de la potencia instalada acumulada en
2004
P(MW)*





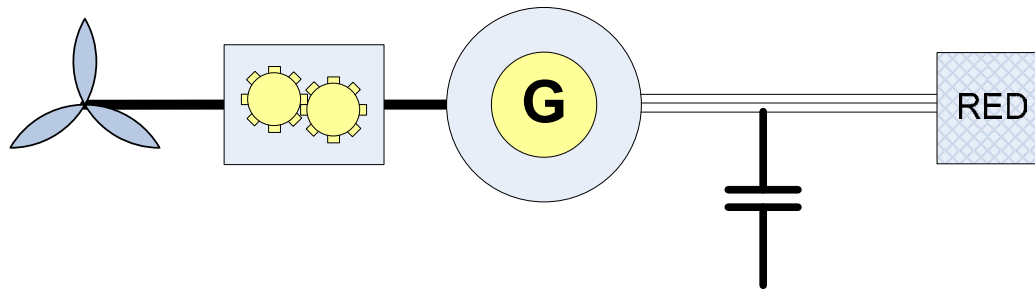
Some Facts About Wind Energy in Spain





Wind Turbine Technologies

- Danish concept/ constant speed
- Induction machine as generator
- Needs reactive compensation for voltage regulation
- Flicker generation is important in weak grids
- Can contribute to fault current

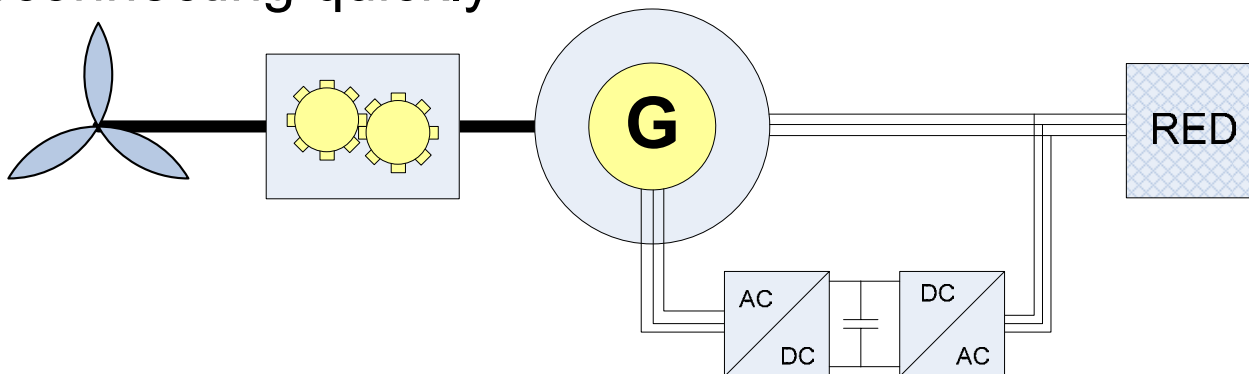




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Wind Turbine Technologies

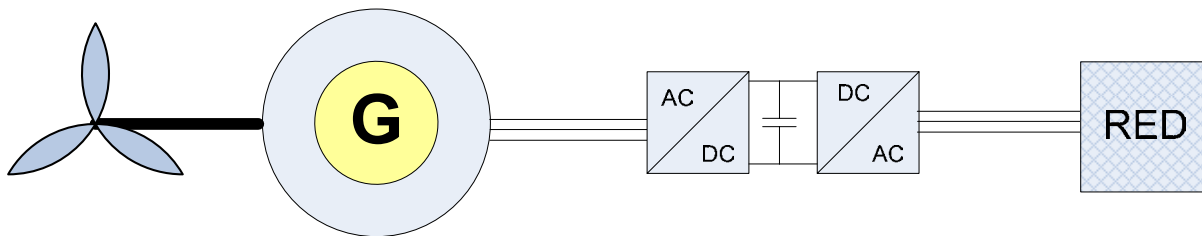
- Variable speed/Double Fed Induction Machine as generator
- Needs converter for rotor
- Can generate reactive power
- Flicker generation is not important
- Can contribute to fault current, but the protection is disconnecting quickly





Wind Turbine Technologies

- Direct drive/ without gear box
- Needs converter for rated power
- Can generate reactive power
- Harmonics
- Can not contribute to fault current

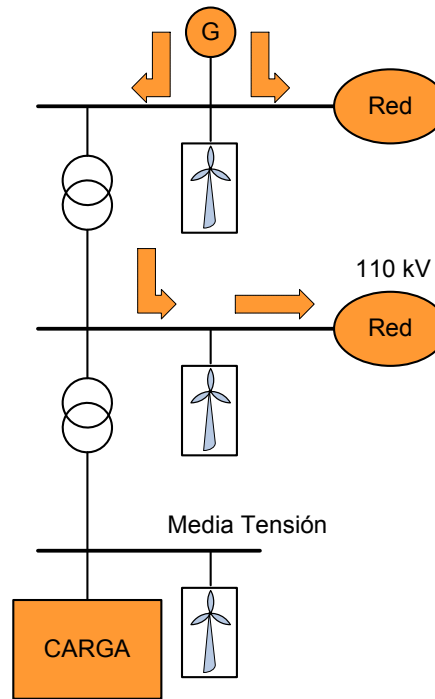




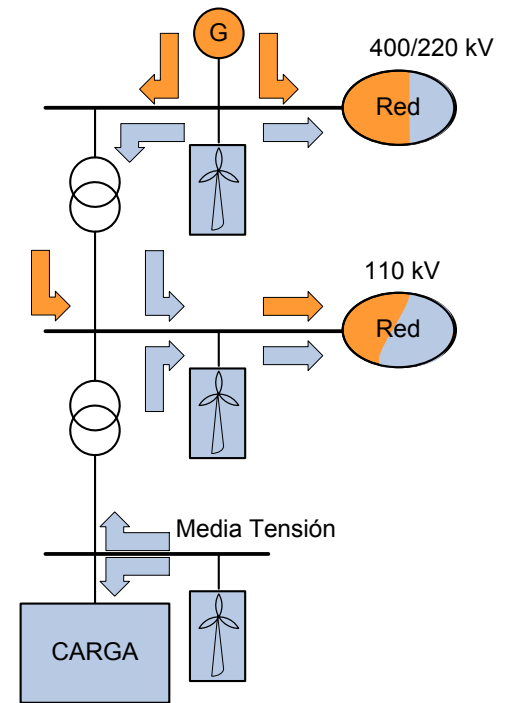
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What does high wind power production mean for power grids?

High wind power production modifies power flow of grids.



Sin energía eólica



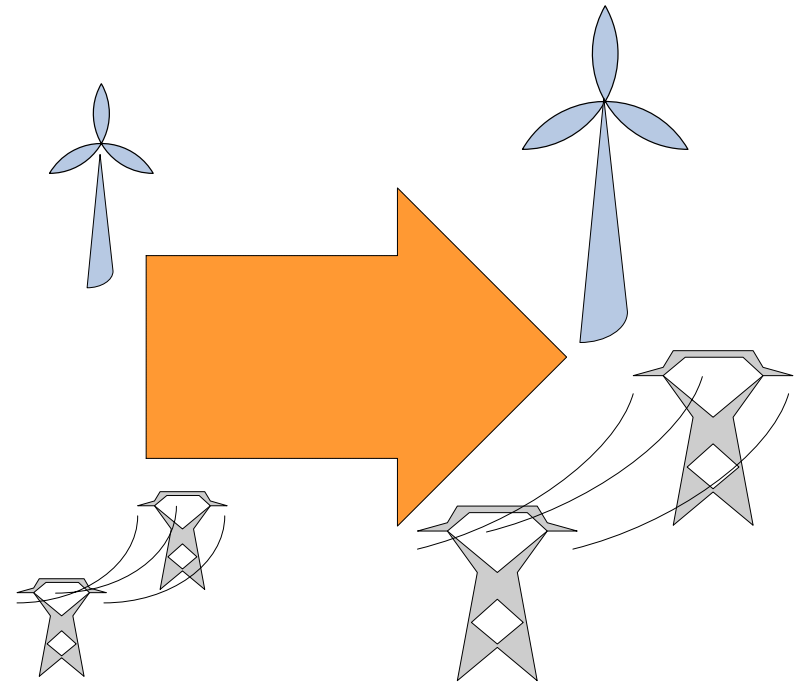
Con producción eólica



GRID CONNECTION OF WIND PARKS

Wind Power Production and Power Grid

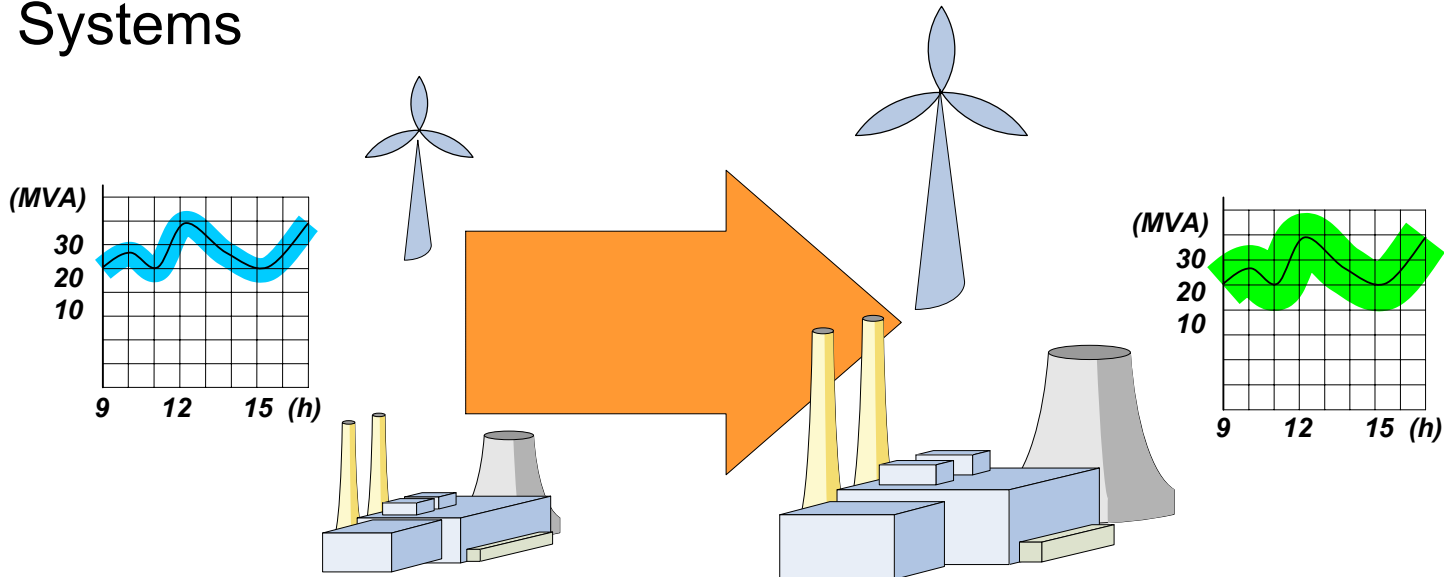
- Wind farms are very often placed in regions with hardly any power grid infrastructure
- Grid extension may be necessary to evacuate produced wind power





Spinning Reserve Band

- Spinning reserve are power plants who attend power demand deviation
- Wind Power Generation can vary
- More Spinning Reserve Band is needed in Power Systems

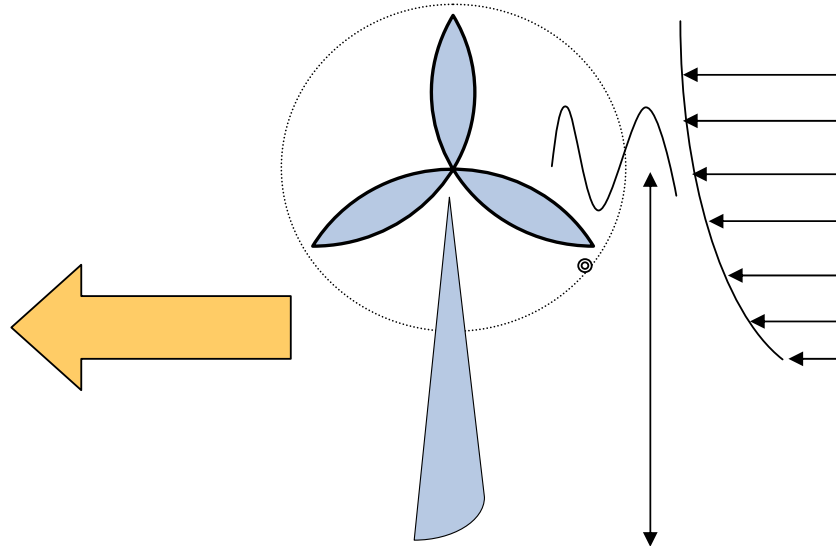
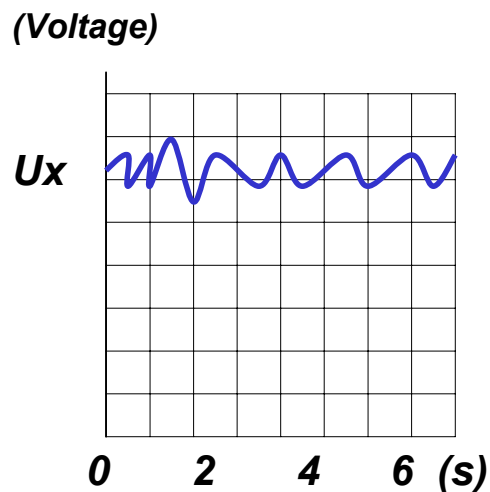




Wind Turbine and Flicker

Flicker is a fast and periodic variation of the voltage

- Wind turbine startup causes voltage variation
- Wind turbine startup causes Flicker
- Wind gusts cause active power fluctuation and Flicker



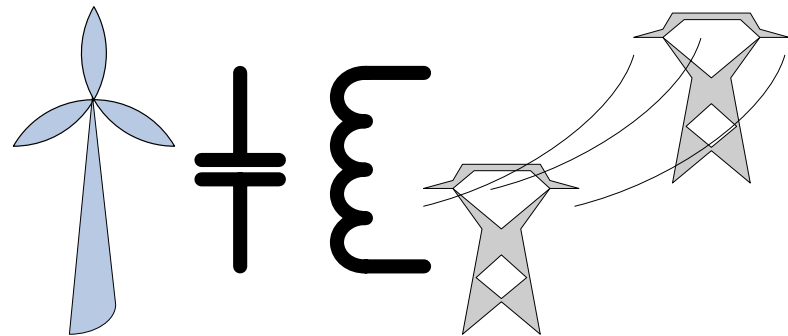


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Wind power and voltage regulation

- Modern wind parks can participate in voltage regulation by reactive power production
- Royal Decree 436 incentives reactive power control

Reactive Power Complement				
Power Factor		Bonus in %		
		Peak	Plain	Vale
Ind	< 0.95	-4	-4	8
	<0.96 and ≥ 0.95	-3	0	6
	<0.97 and ≥ 0.96	-2	0	4
	<0.98 and ≥ 0.97	-1	0	2
	<1 and ≥ 0.98	0	2	0
Cap	1	0	4	0
	<1 and ≥ 0.98	0	2	0
	<0.98 and ≥ 0.97	2	0	-1
	<0.97 and ≥ 0.96	4	0	-2
	<0.96 and ≥ 0.95	6	0	-3
	< 0.95	8	-4	-4

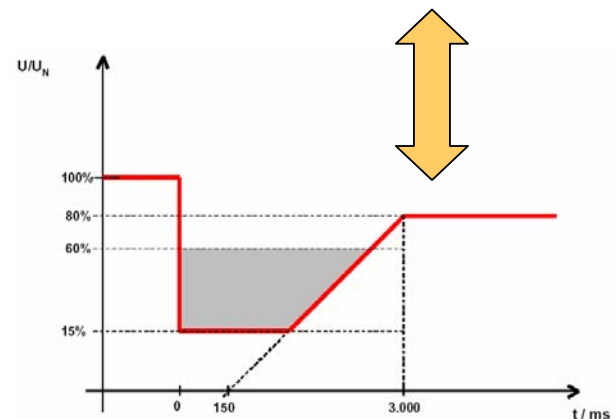
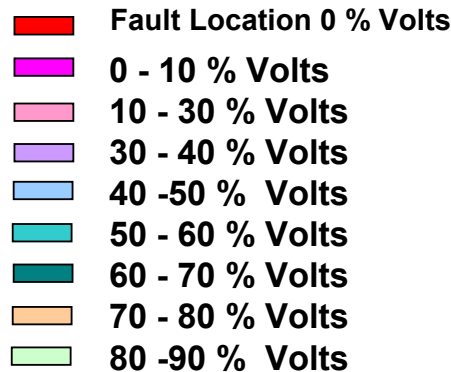
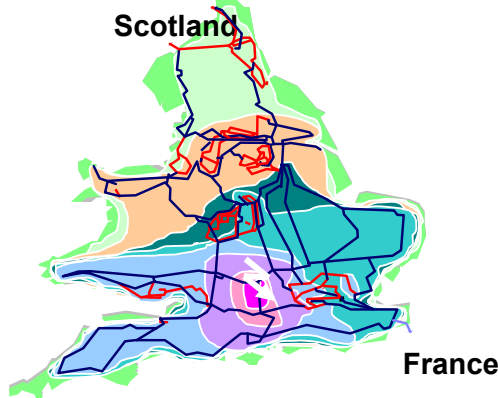
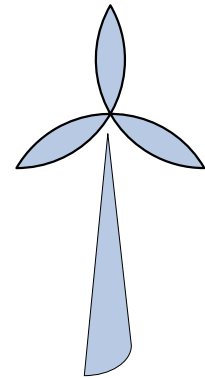




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Voltage Dips Impact on Wind Turbines

- Wind turbines may support power grids during mayor faults
- Wind turbines may stay connected during voltage dips
- Royal Decree 436 defines voltage dip ride through



(Johnson, 2003, <http://local.iee.org/ireland/Senior/Wind%20Event.htm>)



GRID CONNECTION OF WIND PARKS

Wind Power Integration- A new challenge for power grids

- Reactive power & voltage control capability
- Quality of electricity injected into network
- Protection requirements
- Ride-through of voltage dips to avoid cascading outages
- Transient Stability of Power Grids



GRID CONNECTION OF WIND PARKS

Wind Power Integration- A new challenge for power grids

- Spinning Reserve Capacity
- Grid extension
- Limits for wind power penetration

Power electronics is the enabling technology



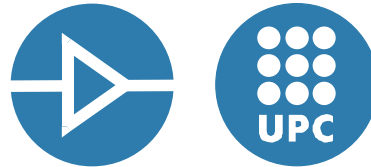
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Thank you for your attention!



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