



Seminario de Electrónica Industrial

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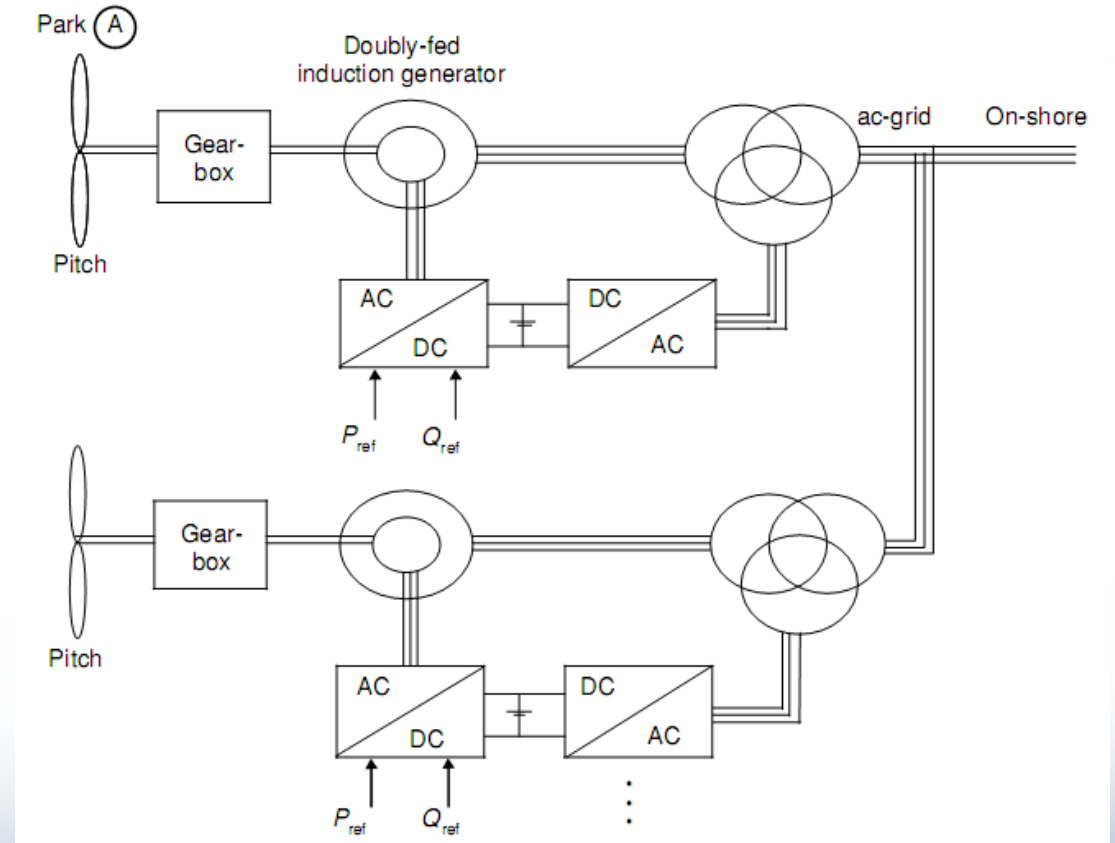
Parques eólicos y conexión a la red.

Valparaíso, Junio de 2010

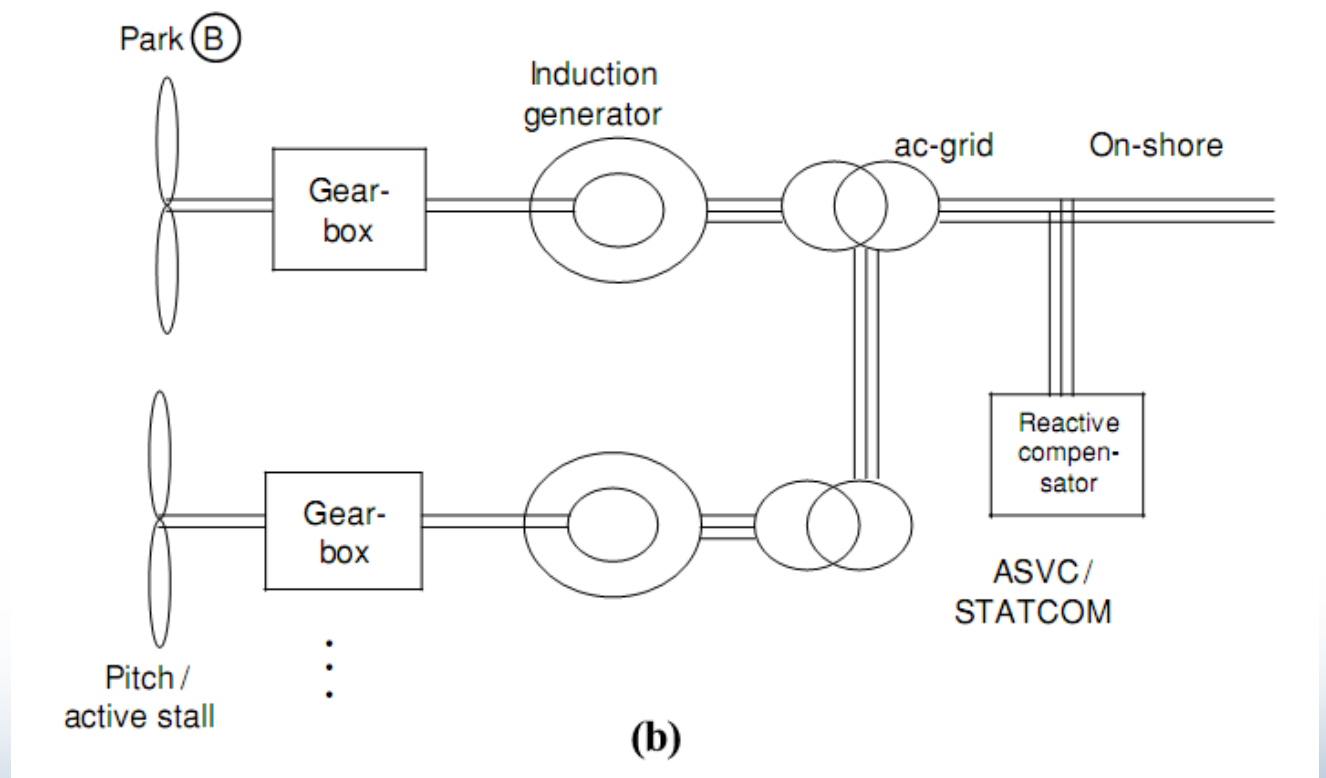
- Altas demandas dinámicas:
 - Control de frecuencia y voltaje
 - Control de potencia activa y reactiva
 - Respuesta rápida ante transientes y fallas de la red
 - Ejemplo: reducir potencia desde el valor nominal al 20% de éste en 2s
- Rol clave de la electrónica de potencia

- Control de potencia activa y reactiva
- Puede operar en velocidad variable

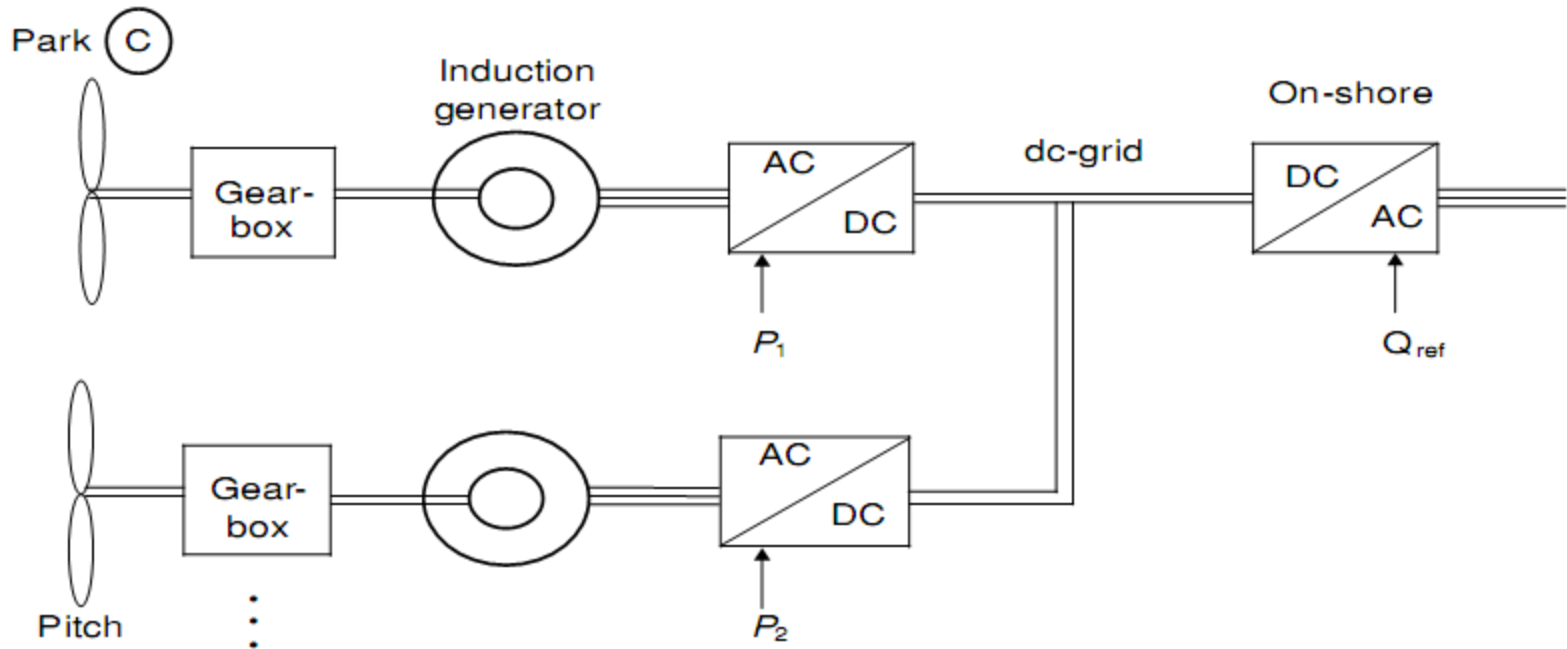
- Aplicado en Dinamarca, planta 160MW offshore



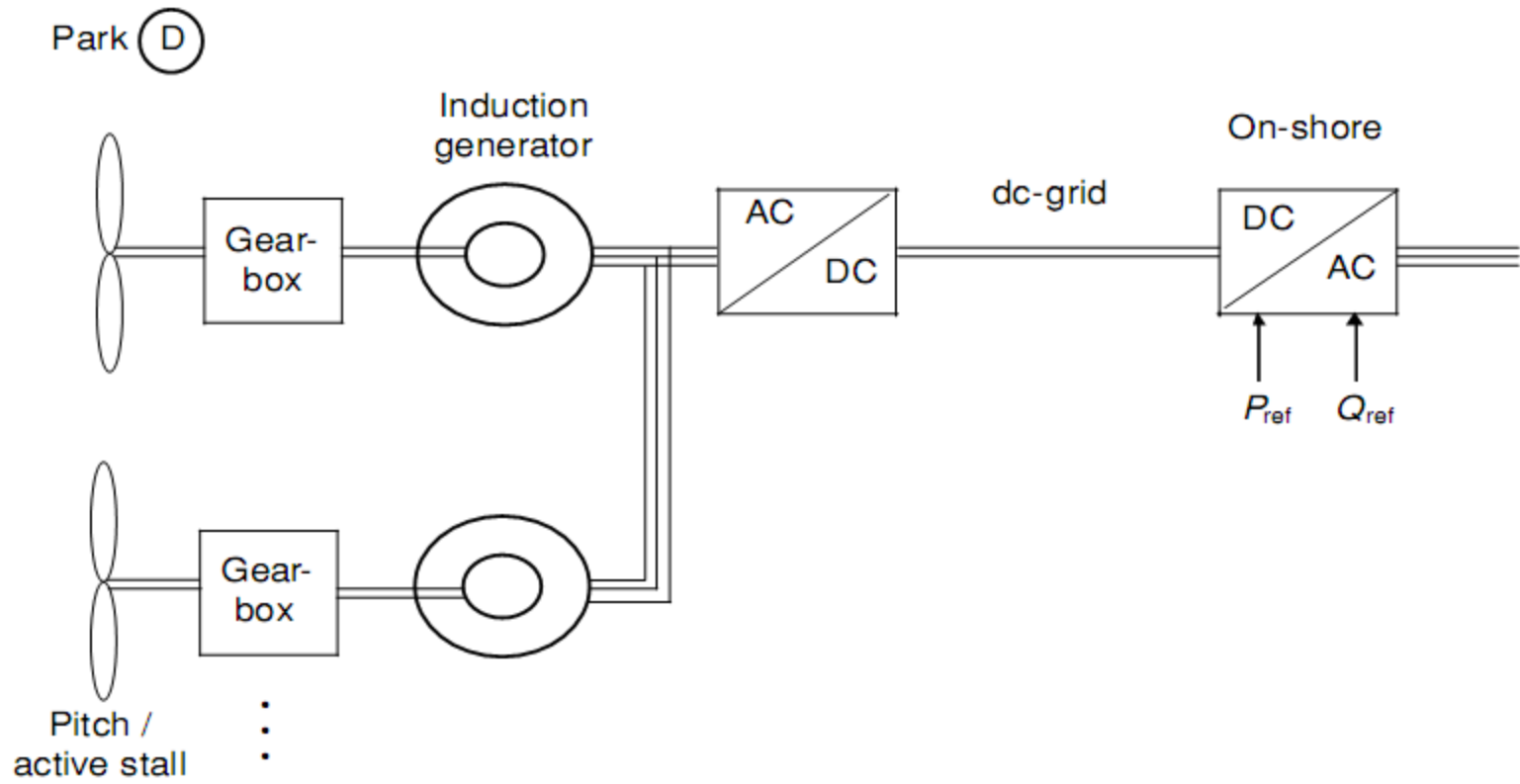
- Parque con generadores de inducción
- Control de potencia reactiva via STATCOM



- Transmisión DC



- Transmisión DC



Configuración	Parque A	Parque B	Parque C	Parque D
Control individual de velocidad	SI	NO	SI	SI
Control potencia act. electrónicamente	SI	NO	SI	SI
Control potencia reactiva	SI	NO	SI	SI
Ancho de banda control	10-100ms	200ms to 2s	10-100ms	10ms to 10s
Función stand-by	SI	NO	SI	SI
Necesita partidior suave	NO	SI	NO	NO
Rolling capacity	SI	Parcialmente	SI	SI
Redundancia	SI	SI	NO	NO
Inversión	++	+	++	++
Mantención	++	+	++	++

- Operate a wind farm/wind turbine like a power station/plant
- **Grid Code:** Technical document containing the rules governing the operation, maintenance, & development of the system defined at the Point of Common Coupling – PCC (not turbine specific)

- **Steady state**
 - Frequency /Power control
 - Low/high frequency support
 - Voltage support/reactive power compensation
 - Power Quality, flicker, harmonics
- **Transient /dynamic state**
 - Fault ride through, to stay connected during low voltage on the grid
 - Ramp rate
- **Communication /power dispatch**
 - Reliable communication
 - Wind forecasting
 - Participate power market

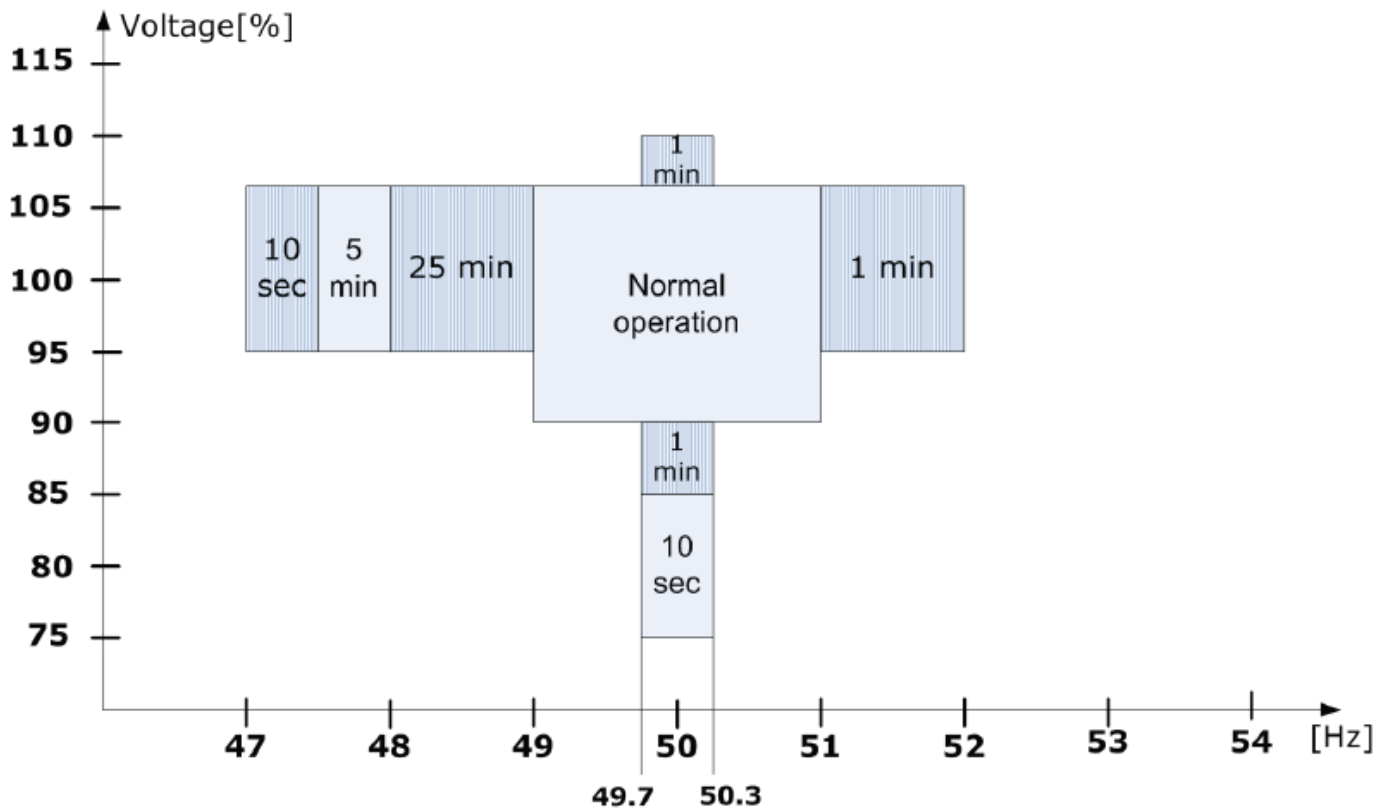
- **Europe:** The grid codes of Europe are affected by the fact that the grid has traditionally been strong and stable – but the fact that the wind power penetration has been increasing - LVRT (Low Voltage Ride Through) has entered the scene and most grid codes at least specifies LVRT requirements as defined by the German E.ON. In Spain, Scotland and Ireland the grid codes exceeds the “standard” requirements.
- **Australia & New Zealand:** Are characterised by a weak and unstable grid with frequency variations from -10 % to +6 % (in extreme) and -6 % to +4 % (more common). Voltage control and site dependent requirements are standard
- **North America:** Characterised by a large number of “smaller” power systems requiring local control capabilities such as voltage control. The PF range is more standardised as 0.9c to 0.9i.

- Exigencias:
 - Control de voltaje
 - Control de potencia
 - Low voltage ride-through
 - Modelos con simulación

[AESO] Canada	Wind Power Facility - Technical Requirements (Draft proposal)
[CER] Ireland	Wind farm Transmission Grid Code Provisions - A Direction by the Commission for Energy Regulation
[Eltra] Denmark	Vindmølleparker tilsluttet net med spændinger over 100 kV
[E.ON] Netz Germany	Netzanschlussregeln- Hoch- und Höchstspannung
[ESB] National Grid Ireland	Wind Code Changes - Distribution Code Modification Proposal Form
[REE] Spain	Operation procedures for the electrical system. PO 12.1, 12.2 and 12.3
[NECA] Australia	National Electricity Code - Version 1.0 Amendment 8.6
[NGC] National Grid	The Grid Code - Issue 2, revision 16
[Vattenfall] Germany	Netzanschluss- und Netznutzungsregeln der Vattenfall Europe Transmission GmbH
[VDN] Germany	Transmission Code 2003- Netz- und Systemregeln der deutschen Übertragungsnetzbetreiber
[Western Power] Australia	Technical Code Version 1

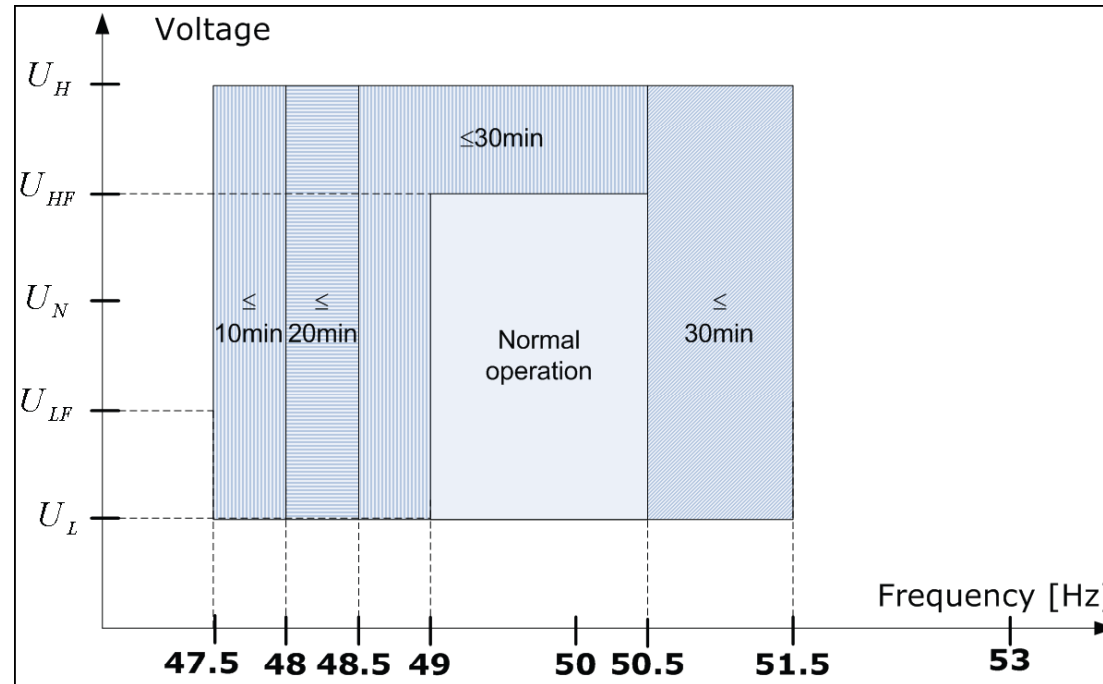
- Eltra – Denmark.

Voltages and frequencies used for design of a wind turbine with voltages below 100 kV



- E-On – Germany.

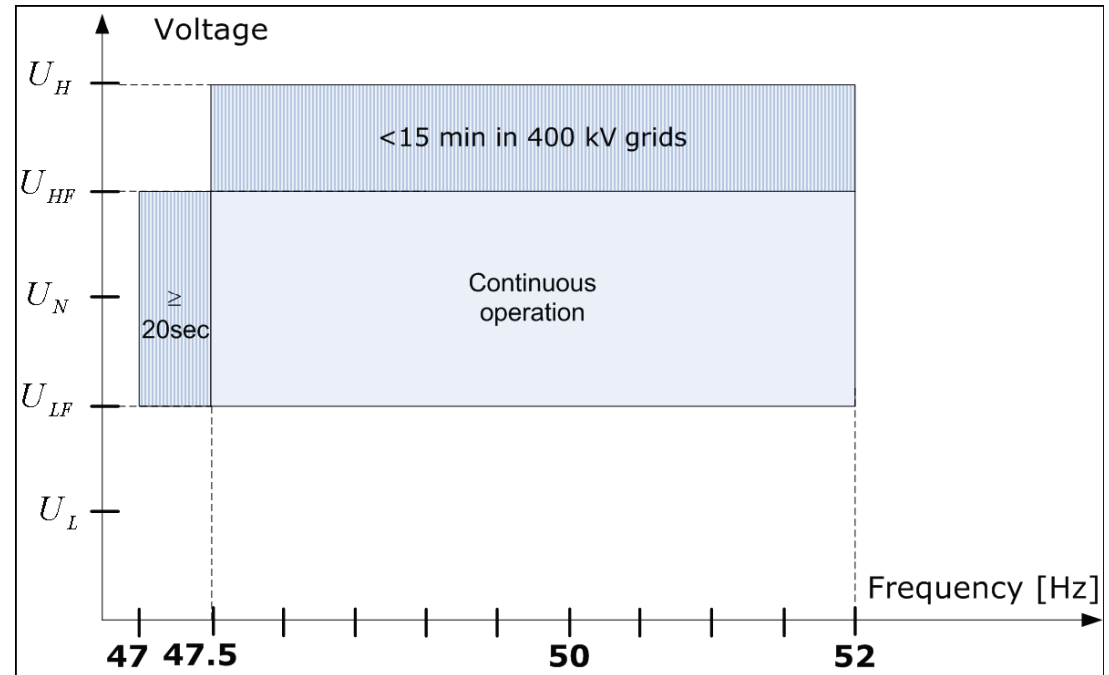
Voltage and frequency range for generating units in the E-On grid.



	Nominal voltage	Lower limit U_L	Lower limit full load U_{LF}	Upper-limit full-load U_{HL}	Upper limit U_H
Transmission	110 kV	96 kV	100 kV	123 kV	127 kV
	220 kV	193 kV	210 kV	245 kV	253 kV
	380 kV	350 kV	360 kV	420 kV	440 kV

- Great Britain

Voltages and frequencies in GB grid



	Nominal voltage	Lower limit U_L	Lower limit full load U_{LF}	Upper-limit full-load U_{HL}	Upper limit U_H
Transmission	< 132 kV	-	(-6%)	(+6%)	-
	132 kV	-	(-10%)	(+10%)	-
	275 kV	-	(-10%)	(+10%)	-
	400 kV	360 kV (-10%)	380 kV (-5%)	420 kV (+5%)	440 kV (+10%)

Gracias por su atención...



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