TECNOLOGIA EOLICA
CONAMA

MADRID

Noviember, 2014

Alberto Ceña

COORDINADOR DE LOS SERVICIOS TECNICOS

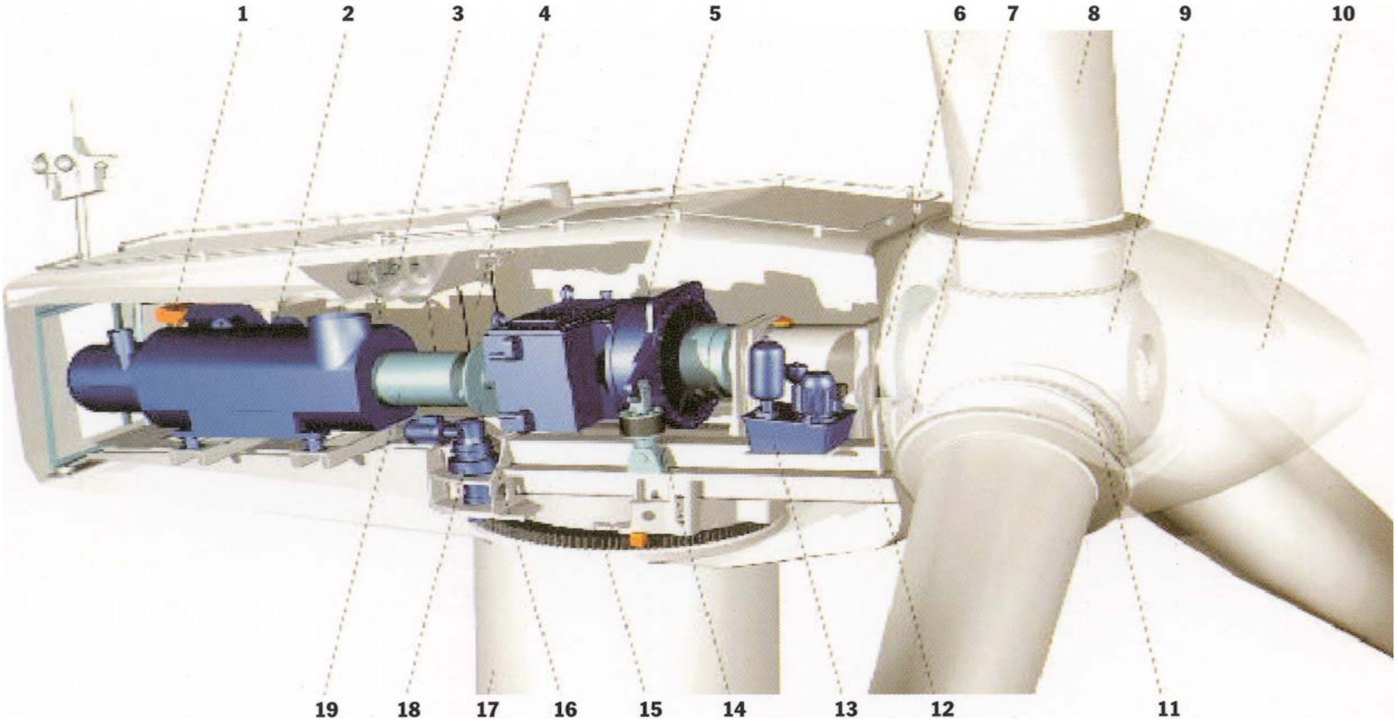
DIFERENTES SOLUCIONES PARA DISTINTAS APLICACIONES

Fuente: Norvento

PRINCIPALES COMPONENTES

- El aerogenerador capta la energía cinética del viento mediante un rotor, que la transforma en energía mecánica rotatoria que través de un tren de potencia pasa a un generador que la transforma en energía eléctrica.
- Normalmente el nivel de tensión de la generación es de 690 V (BT), aunque algunos llegan a 12.000 V (MT).

1 Polipasto
2 Generador
3 Sist. Refrigeración
4 Unidad Control Eléctrico
5 Multiplicadora
6 Eje principal
7 Sistema bloqueo rotor
8 Pala
9 Buje
10 Cono
11 Rodamiento pala
12 Bastidor
13 Sistema hidráulico
14 Amortiguador
15 Corona de giro
16 Disco de freno
17 Torre
18 Reductora de giro
19 Transmisión



Coeficiente de potencia

COEFICIENTE DE POTENCIA Cp

Se define como:

$$C_p = \frac{W}{\frac{1}{2} \cdot \rho \cdot A \cdot V_1^3} \qquad (5)$$

Representa: el rendimiento aerodinámico del rotor

Físicamente significa : LA POTENCIA QUE REALMENTE EXTRAE LA AEROTURBINA DEL VIENTO, DIVIDIDA POR LA POTENCIA DEL VIENTO.

Como la potencia W que extrae el rotor el rotor siempre va a ser más pequeña que la potencia del viento, el Cp en consecuencia será siempre menor que la unidad.

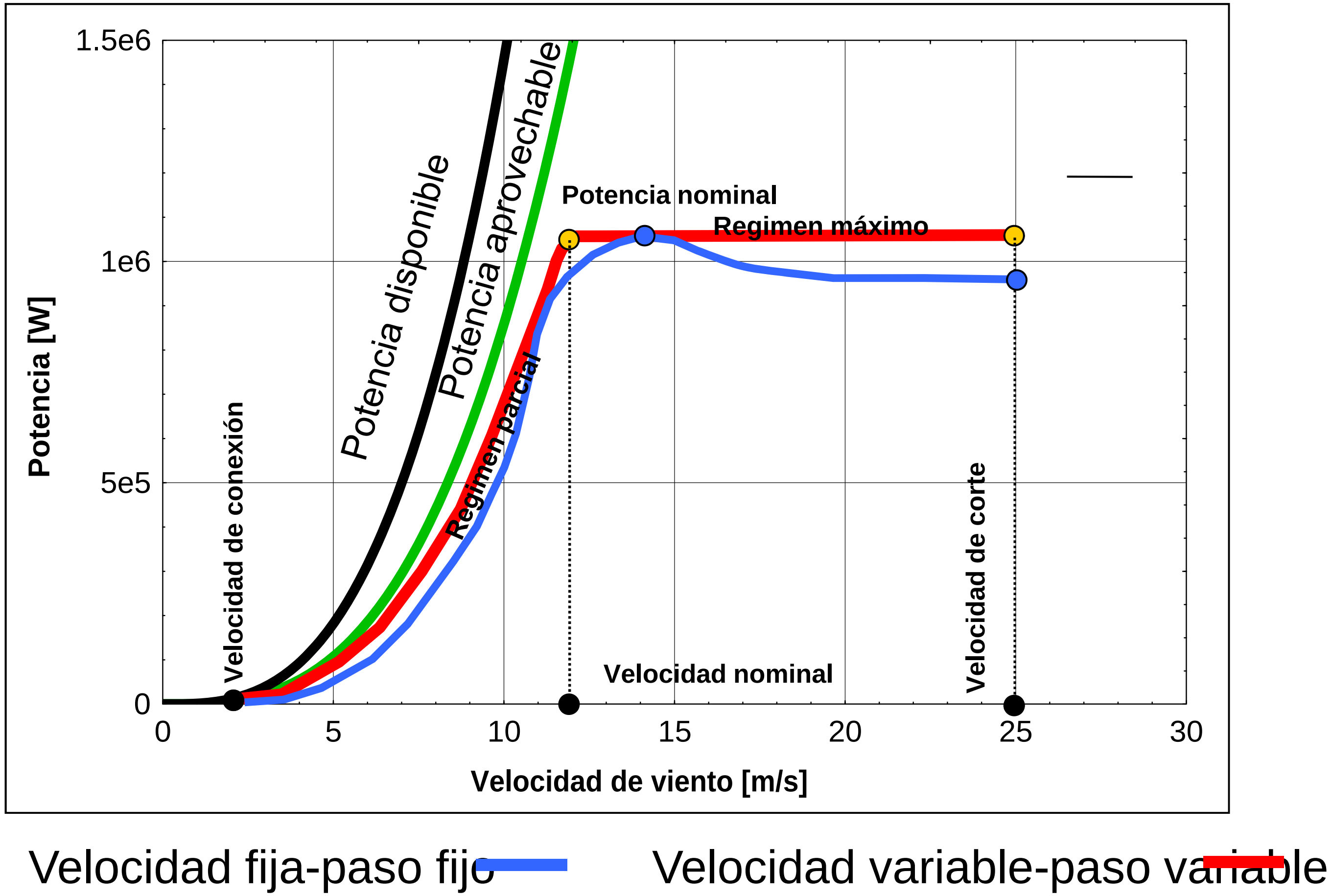
$$C_p \prec 1$$

Fuente: Fernando Arias - CIEMAT

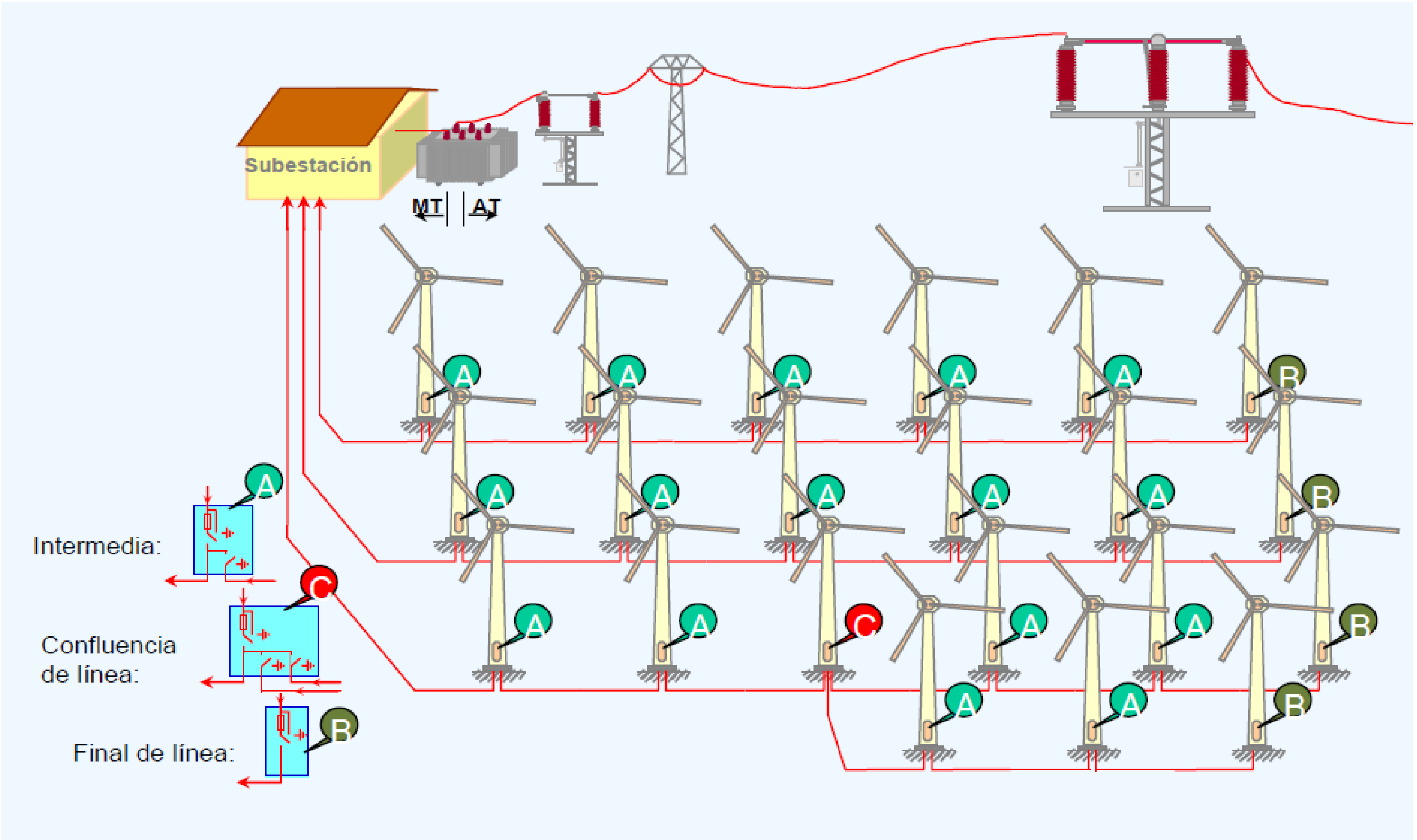
EL COMPORTAMIENTO DEL AEROGENERADOR

La curva de potencia.

clipper.pdf



CONFIGURACION DE UN PARQUE EOLICO

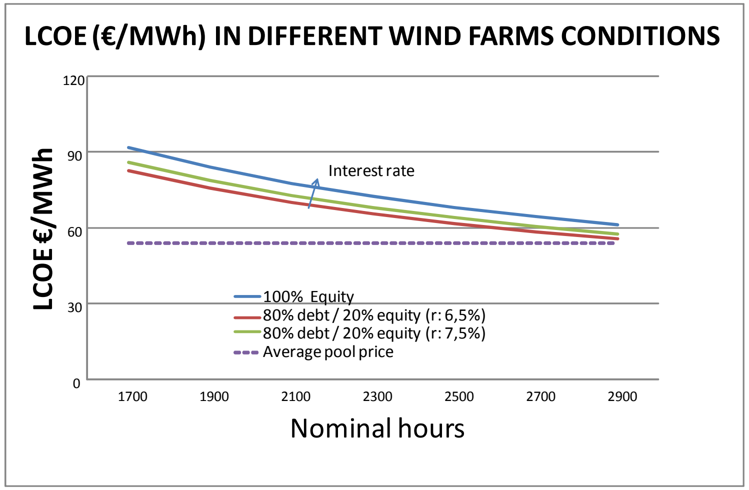


Fuente. EREDA

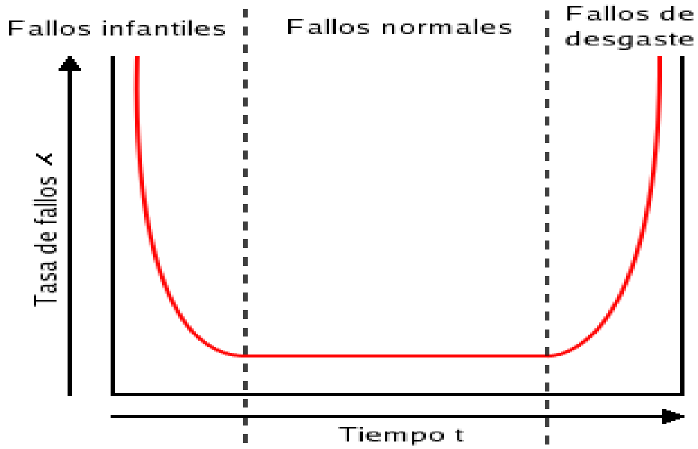
LOS PRINCIPALES RETOS

WIND SECTOR Key Challenges

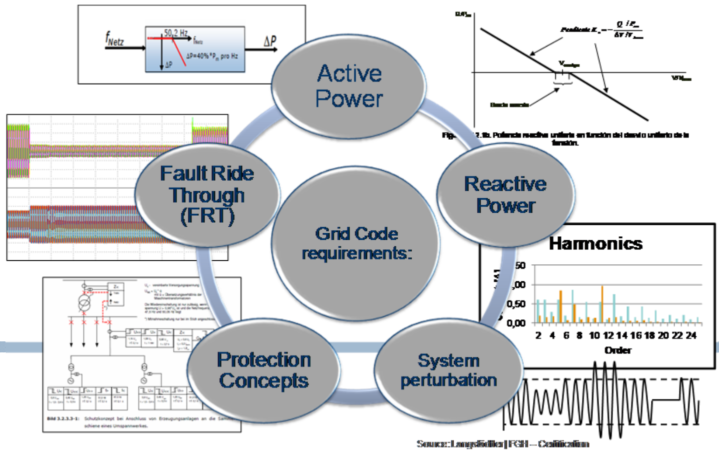
Cost reducion



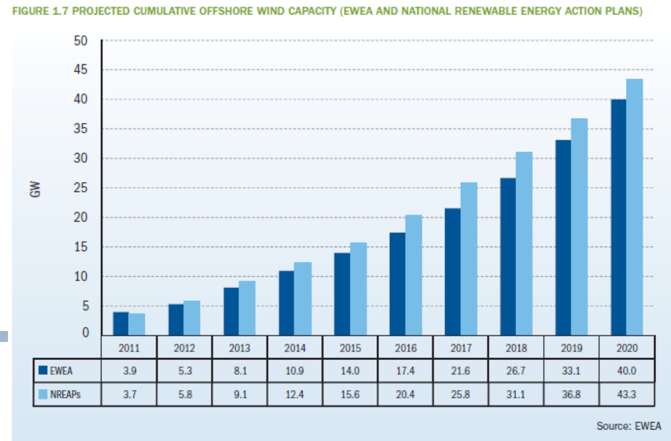
WTG availabilty



Grid integration



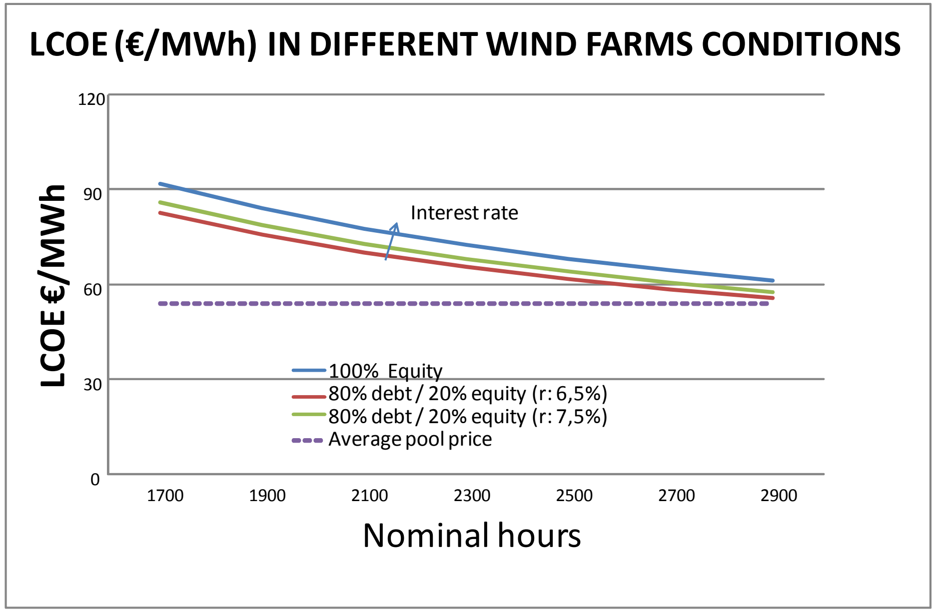
Offshore positioning



	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
EWEA	3.9	5.3	8.1	10.9	14.0	17.4	21.6	26.7	33.1	40.0
NREAPs	3.7	5.8	9.1	12.4	15.6	20.4	25.8	31.1	36.8	43.3

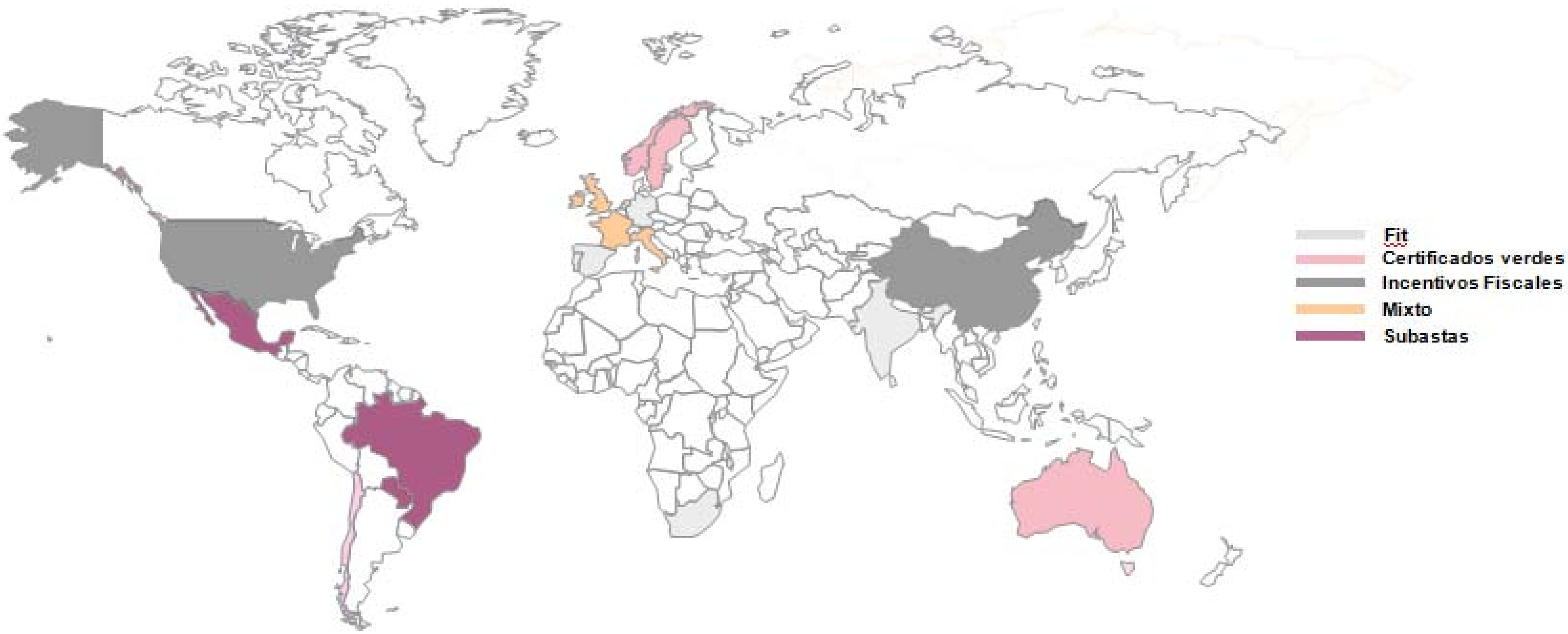
ECONOMIC CHALLENGE: REDUCION OF LCOE

Reduction of LCOE to compete (complement) PV installations and shale gas.



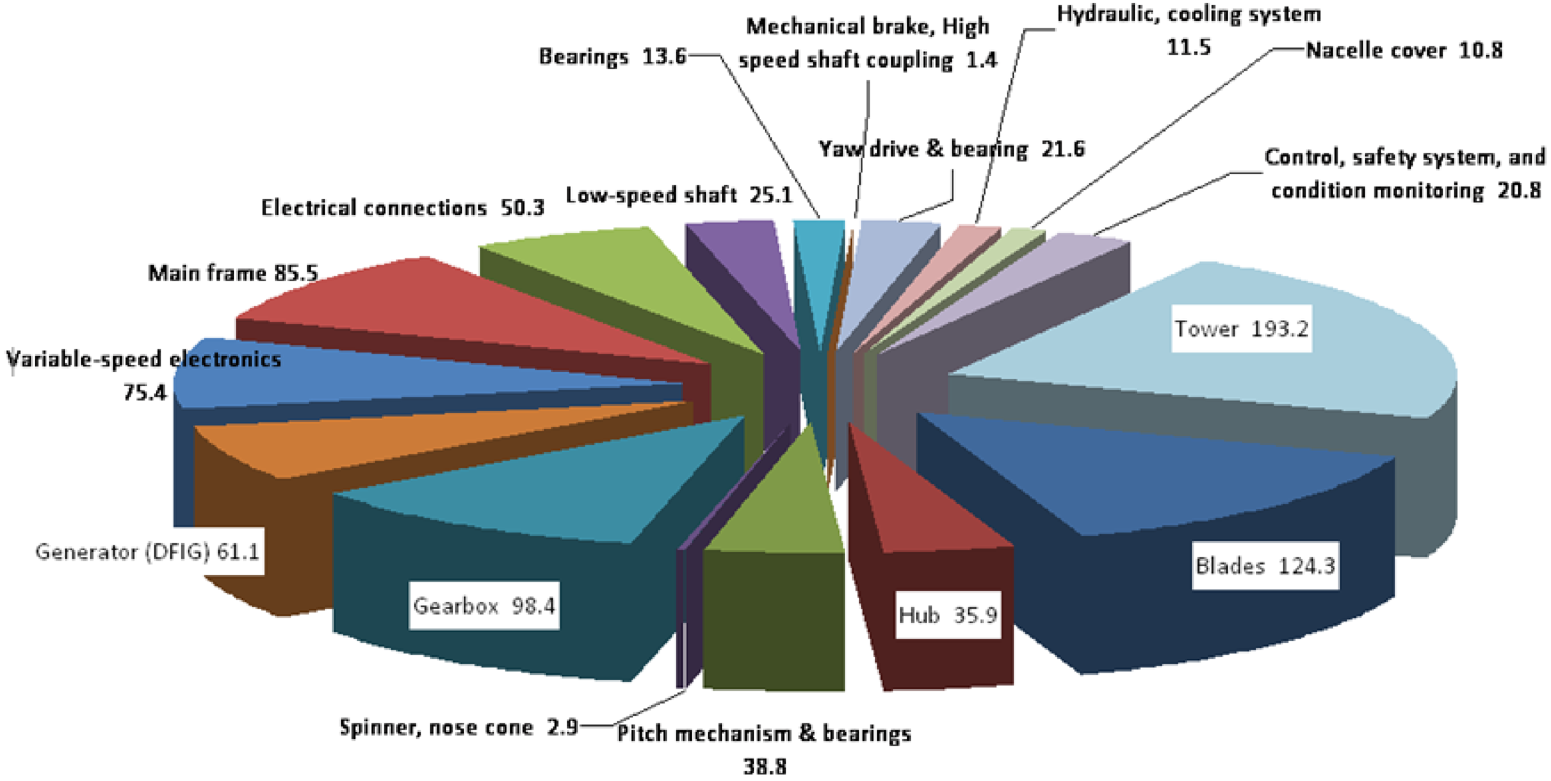
Decrease of CAPEX, increase of rotor diameter and diminution of weight. But without forget to keep the WF availability (progressive trend: extension of WTG life)

SPECIALLY IMPORTANT WITH THE CHANGE OF THE REGULATORY FRAMEWORKS. PROGRESSIVE ABANDONMENT OF THE FEED IN TARIFFS SCHEME



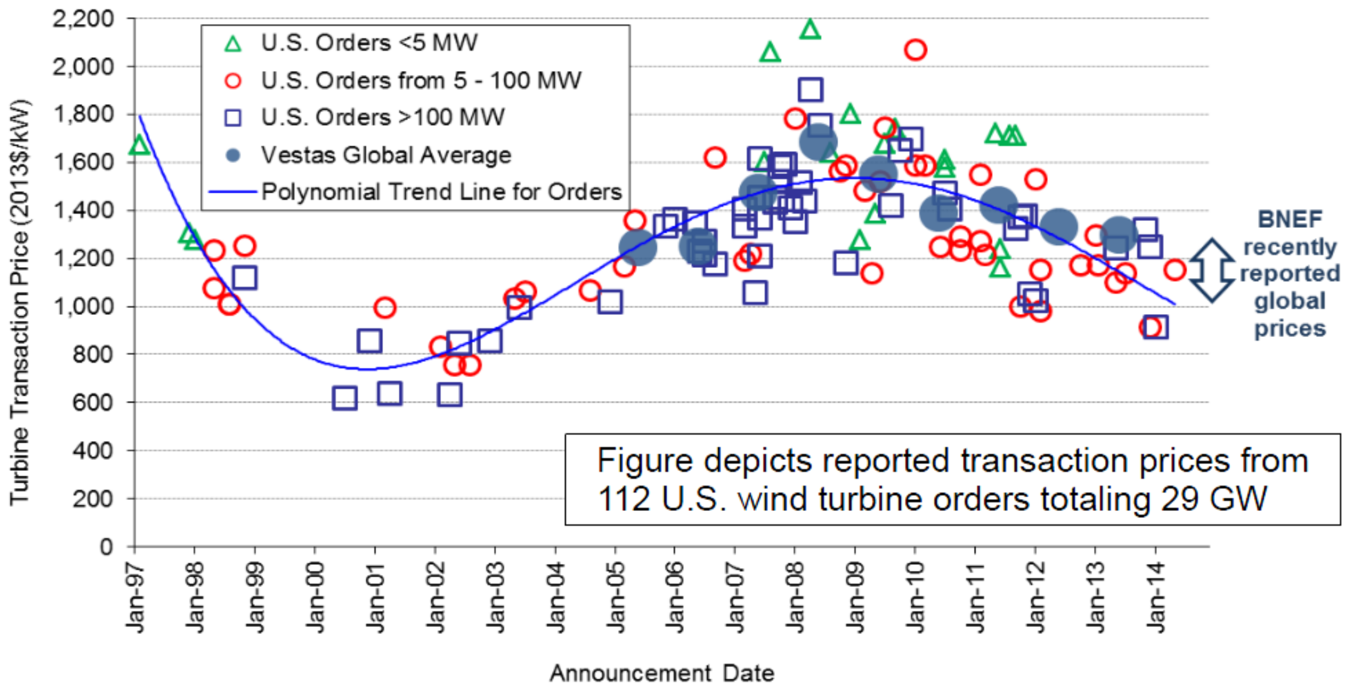
BUT THERE ARE NOT MANY OPTIONS: DIRECT DRIVE, LIGHTER TOWERS, PERMANENT MAGNETS, …

2011 Costs of main turbine components, onshore, 870 €/kW



Source: Tegen et al.: *2010 Cost of Wind Energy Review*. NREL, April 2012. Total 870 €/kW

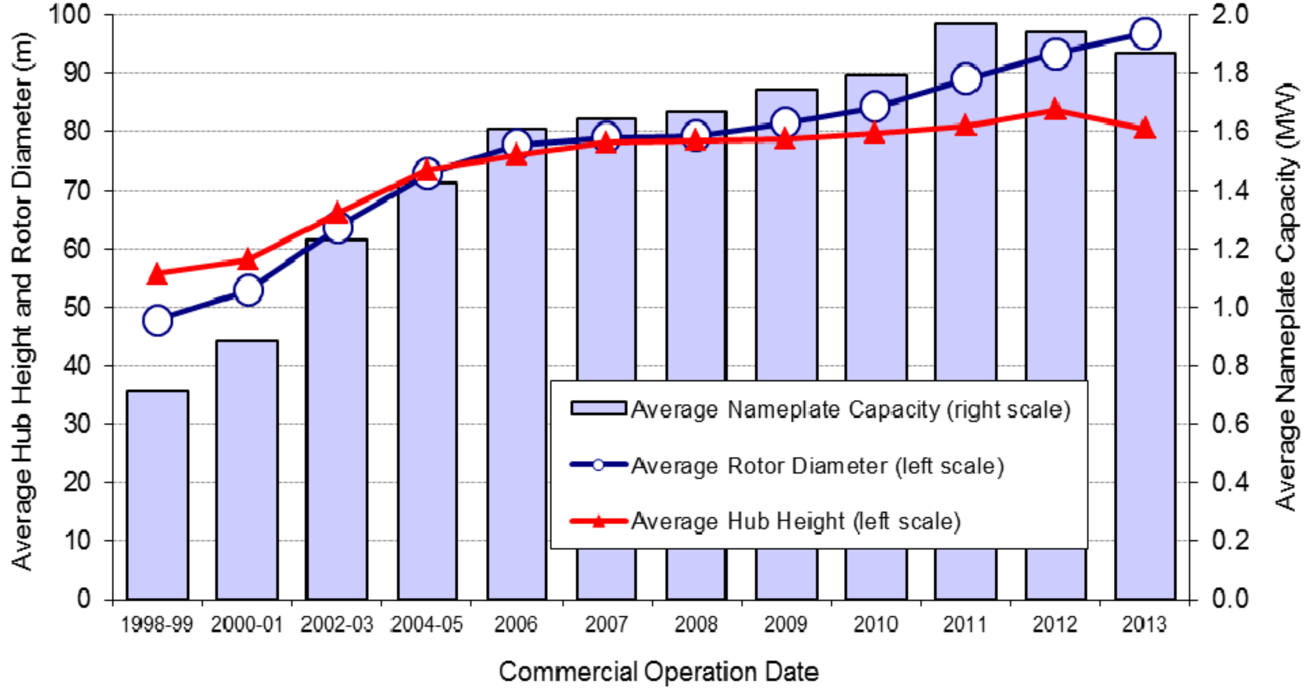
COMPETITION IS ENCOURANGING THE REDUCTION OF COSTS



- Recent turbine orders reportedly in the range of $900-1,300/kW, with more-favorable terms for buyers and improved technology 42

INCREASE OF THE ROTOR DIAMETER AND HIGHER CAPACITY FACTORS. INCREASING OF COST IS COMPENSATED BY MORE GENERATION

Turbine Nameplate Capacity, Hub Height, and Rotor Diameter Have All Increased Significantly Over the Long Term

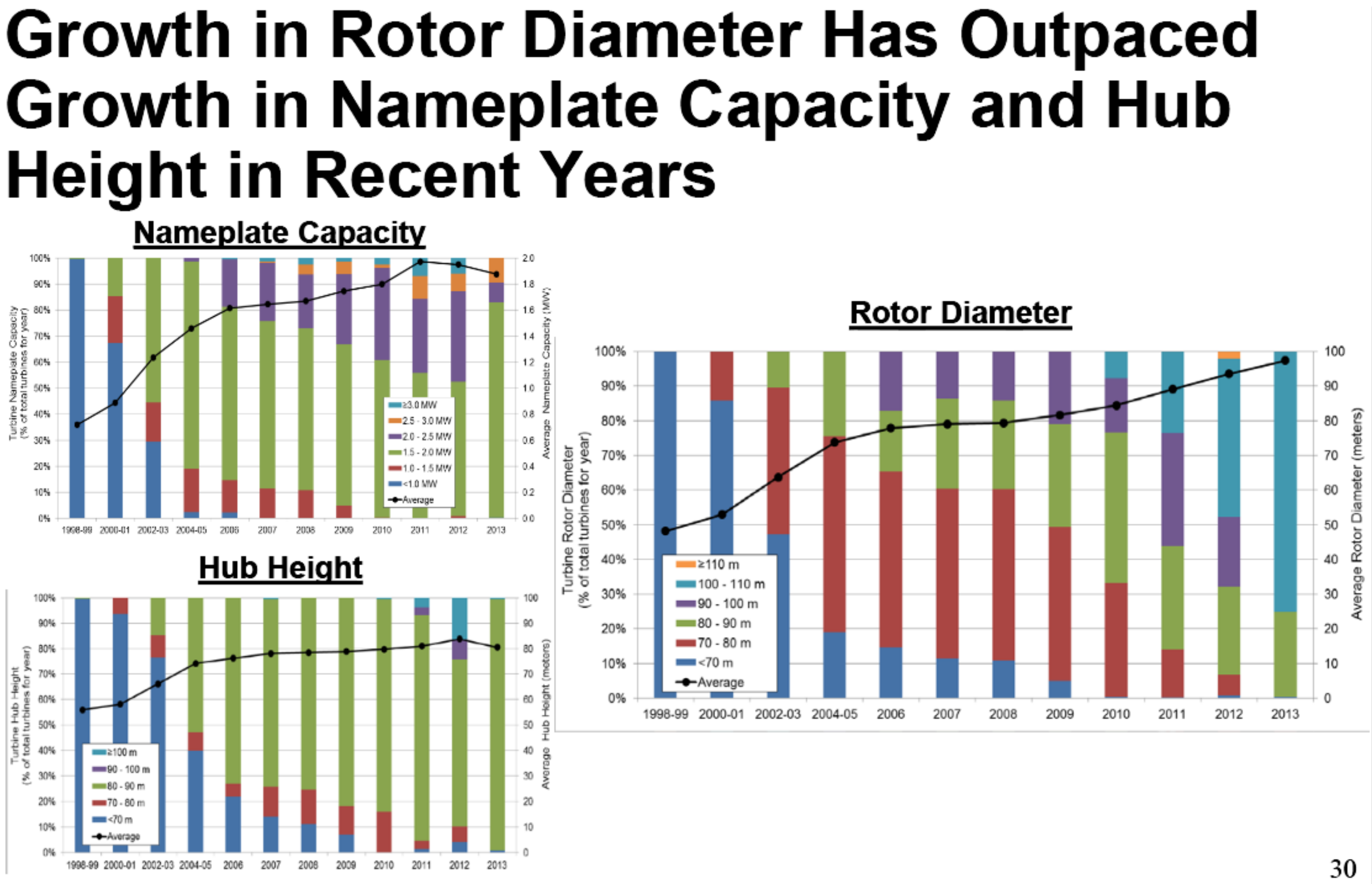


$$P_t = \frac{1}{2} \cdot \rho \cdot A \cdot v^3 \cdot Cp$$

A: área del rotor

29

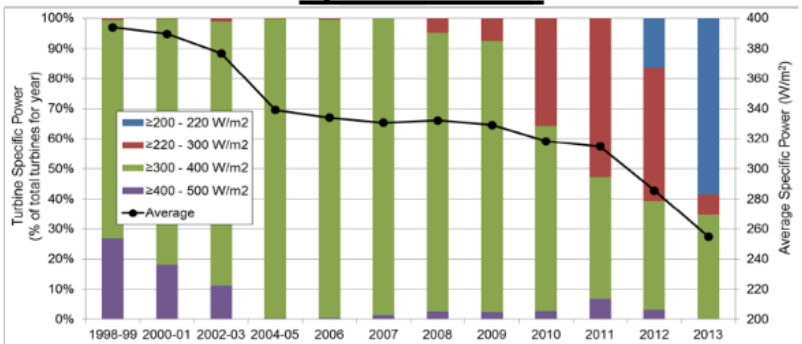
THE IEC 61400-1 IS STILL VALID?



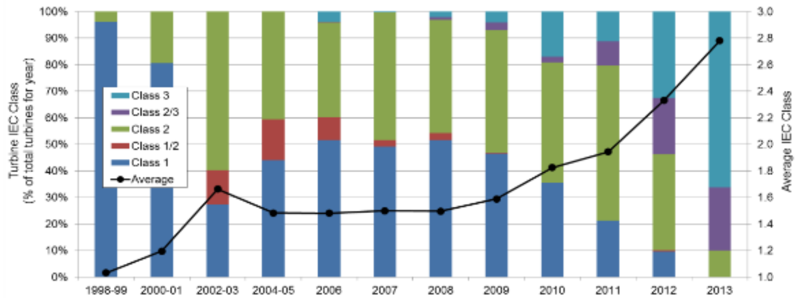
THE IEC 61400-1 IS STILL VALID?

Turbines Originally Designed for Lower Wind Speed Sites Have Rapidly Gained Market Share

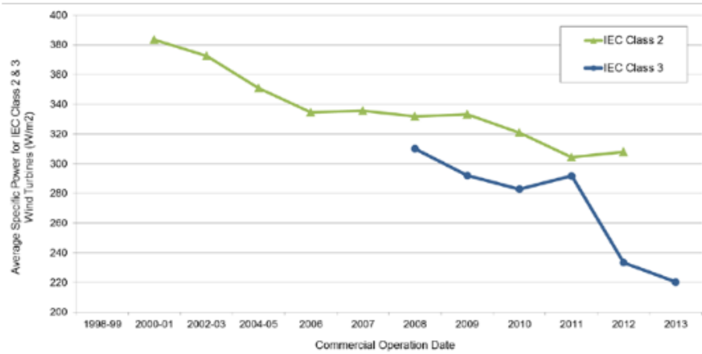
Specific Power



IEC Class



Specific Power by IEC Class 2 & 3



31

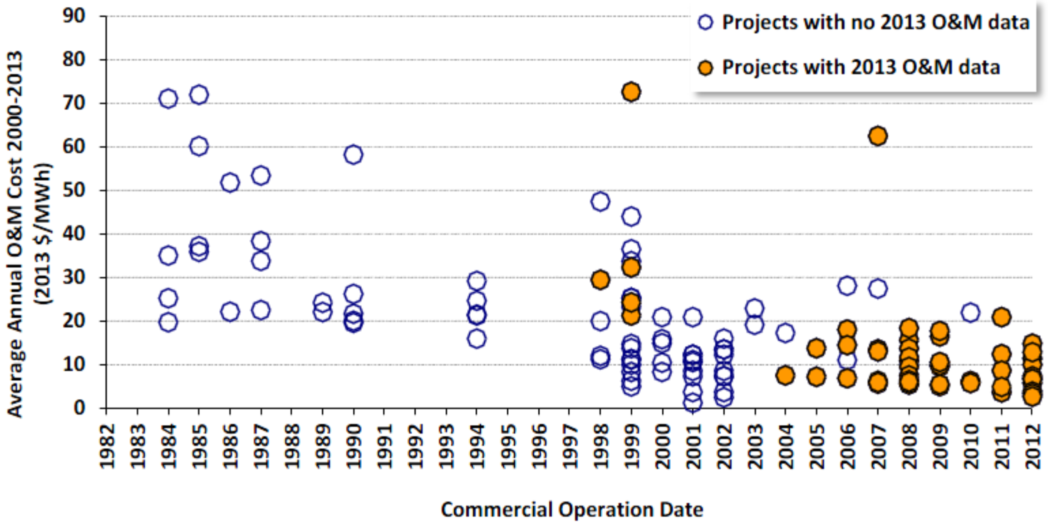
GROWING TREND TO PERMANENT MAGNET GENERATORS: LIGHTER AND INCREASE OF PRODUCTION, BUT POSSIBLE SUPPLY PROBLEMS

Turbine Model	Country	Drivetrain	IEC Class	Hub Height
Clipper C100 2.5	USA	GPMSG	IIa	80/100
Doosan WinDS3000-91	South Korea	GPMSG	Ia	80
EWT DW96 2.0	Netherlands	DDPMSG	IIIa	85
Fuhrlander FL 120 3.0	Germany	GPMSG	IIa	100/140
Gamesa G128 4.5	Spain	GPMSG	IIa	120
GE 2.5-100	USA	GPMSG	IIb (HH85), IIIa (HH98.3)	85/98.3
Goldwind GW 77 1.5	China	DDPMSG	IIa	61.5/85/100
Hyundai AW928 2.5-93	South Korea	DDPMSG	IIa	80
IMPSA V77 1.5	Argentina	DDPMSG		85-100
Leitwind LTW101-3000	Italy	DDPMSG	IIa	97
Mingyang MY2500-100	China	GPMSG	IIa	75/85/90/100
Northern 2.0-110	USA	DDPMSG	IIIa	80/98
Samsung 100 25xc	South Korea	GPMSG	IIIa	80/100
Siemens SWT 3.0-101	Germany	DDPMSG	Ia	79.5/99.5
STX 72 2.0	Netherlands	DDPMSG	IIb	65/85/100
STX 93 2.0	Netherlands	DDPMSG	IIIb	60/80/88
Sun 3.0-X100	China	DDPMSG	IIa	70/90
Swiss Electric YZ113-3.0	China	DDPMSG	II/III	100/110
Unison U88	South Korea	GPMSG	IIa	80
Vestas V100 2.0 GS	Denmark	GPMSG	IIa (HH80 & HH95), III (HH125)	80/95/125
XEMC Darwind XD115	China	DDPMSG		

Fuente: NREL

PROGRESSIVE AND GENERAL INTRODUCTION OF CMS AND GENERAL REDUCTION OF MAINTENANCE COSTS

Operations and Maintenance Costs Varied By Project Age and Commercial Operations Date

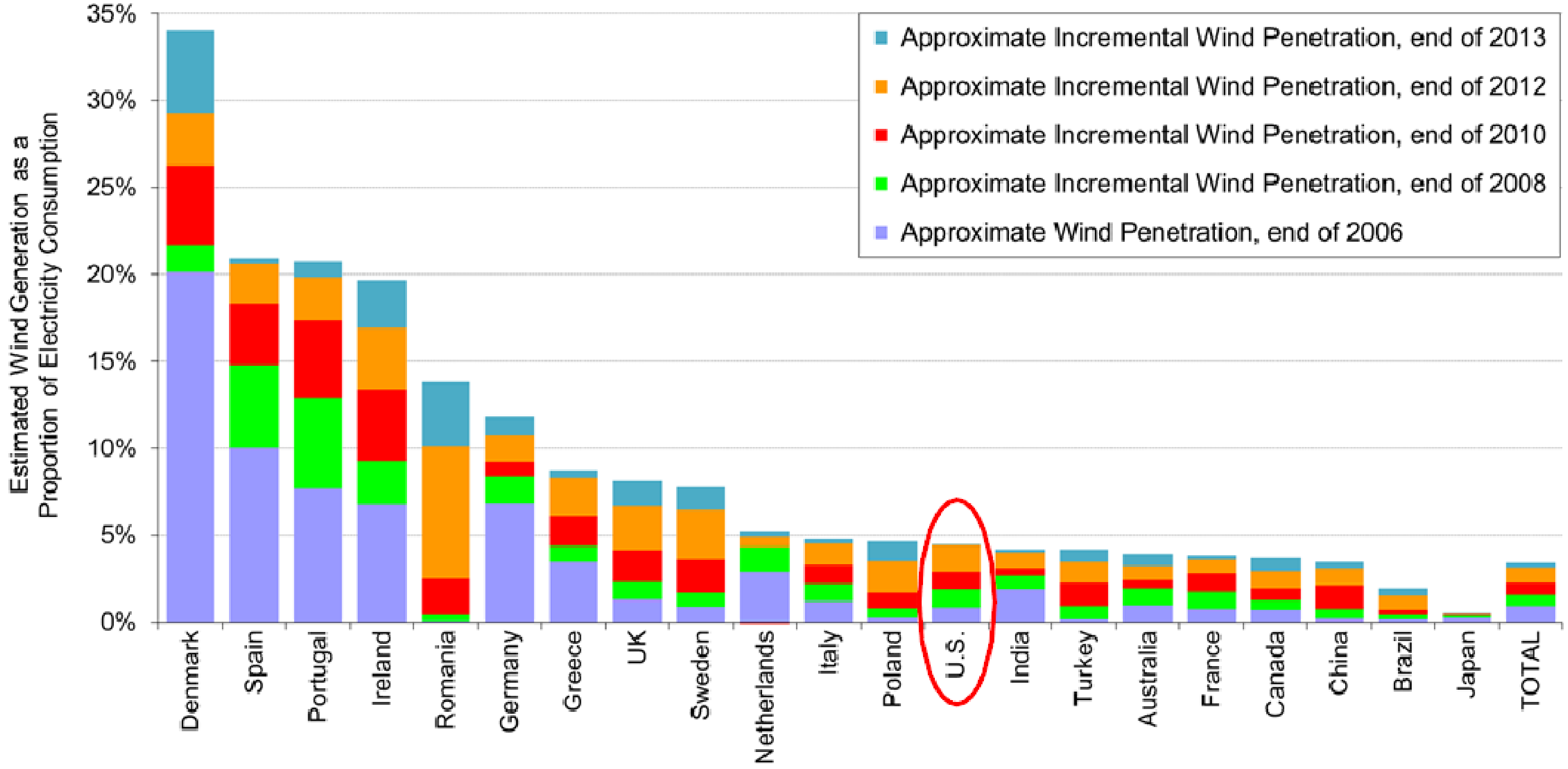


Capacity-weighted average 2000-13 O&M costs for projects built in the 1980s equal **$34/MWh**, dropping to **$23/MWh** for projects built in 1990s, to **$10/MWh** for projects built in the 2000s, and to **$9/MWh** for projects built since 2010

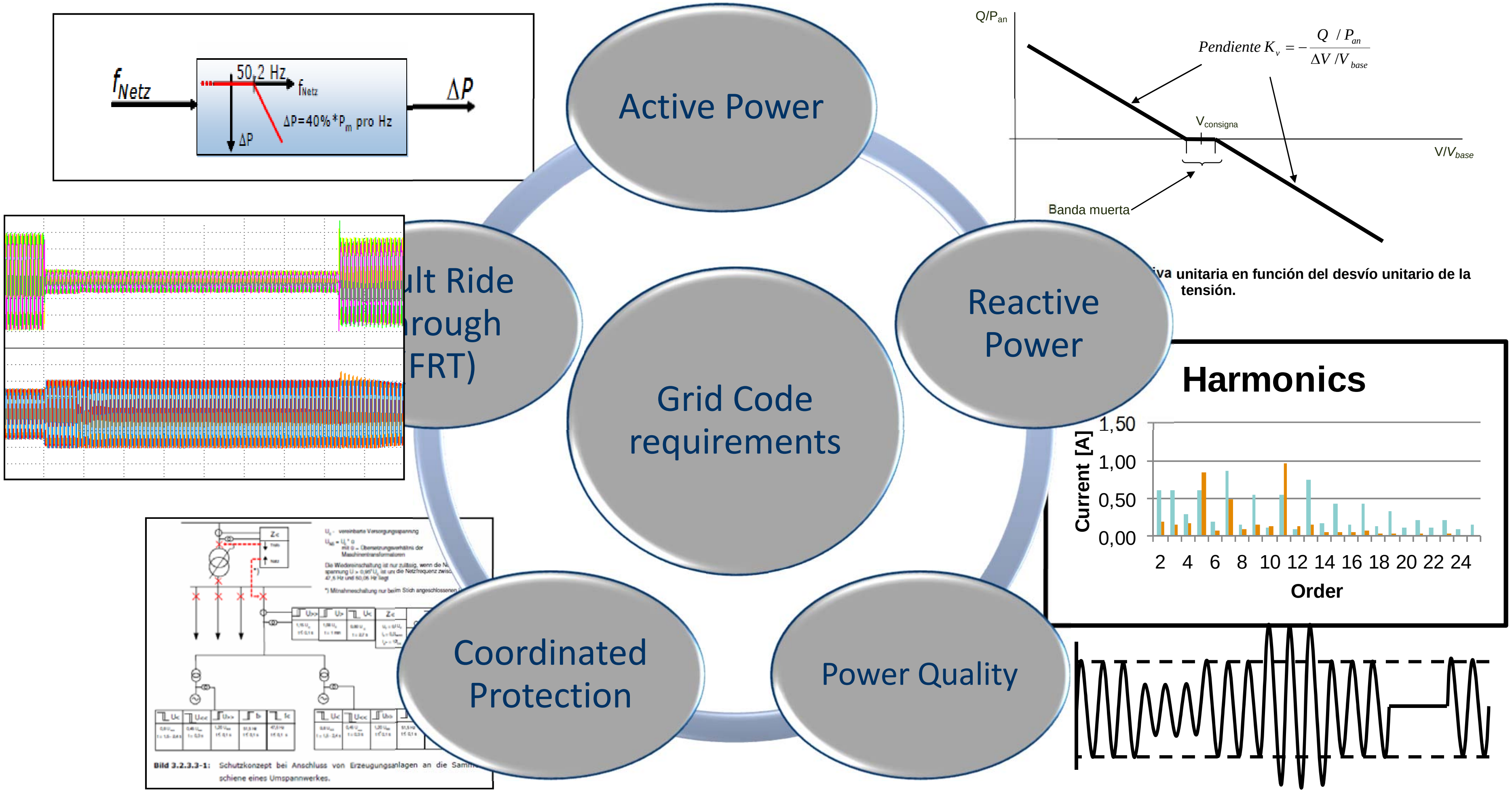
*Note: Sample is limited, and consists of 152 wind projects totaling 10,679 MW; few projects in sample have complete records of O&M costs from 2000-13; O&M costs reported here **DO NOT** include all operating costs* 46

INTEGRACION EN RED

THE CONTRIBUTION OF WIND POWER TO DEMAND IS VARIABLE. MAIN CHALLENGES FOR ISLANDS

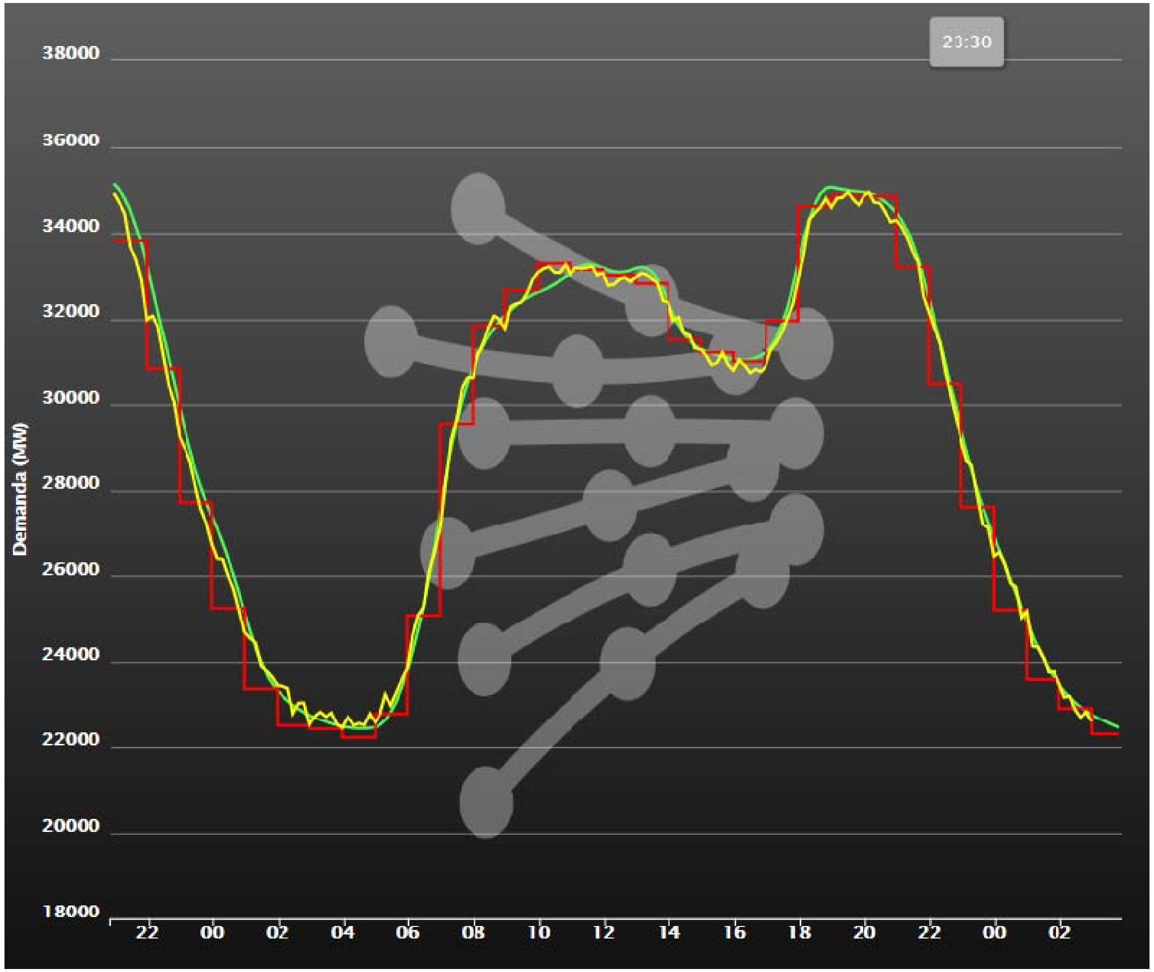


INERTIA AND ANCILLARY SERVICES ARE BECOMING MORE IMPORTANT

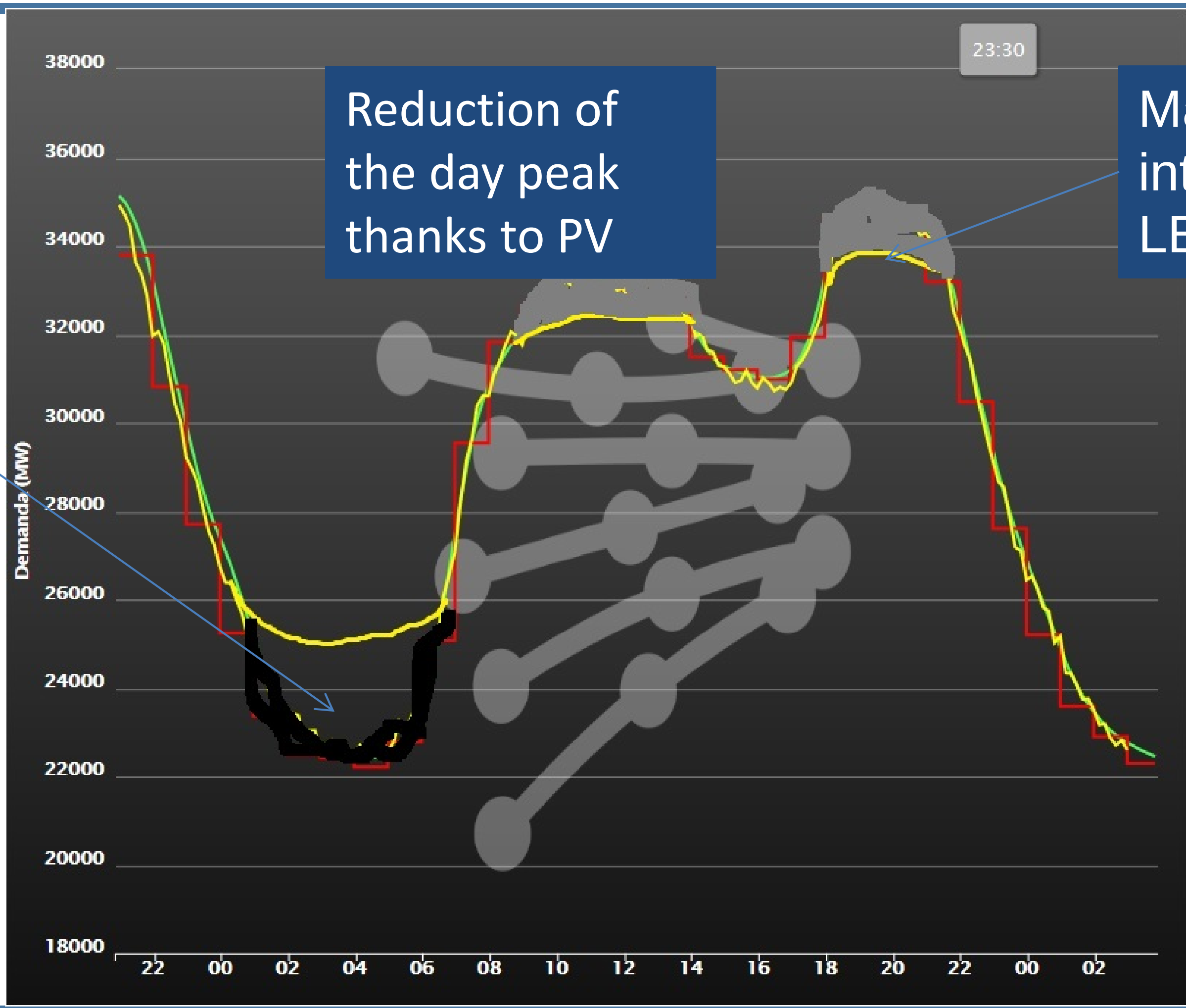


Source: Langstädtler | FGH – Certification

THE LOAD SHAPE IS GOING TO CHANGE IN THE NEXT TEN YEARS, NEW POWER USES AND MORE EXPORTS TO FRANCE



THE LOAD SHAPE IS GOING TO CHANGE IN THE NEXT TEN YEARS, NEW POWER USES AND MORE EXPORTS TO FRANCE

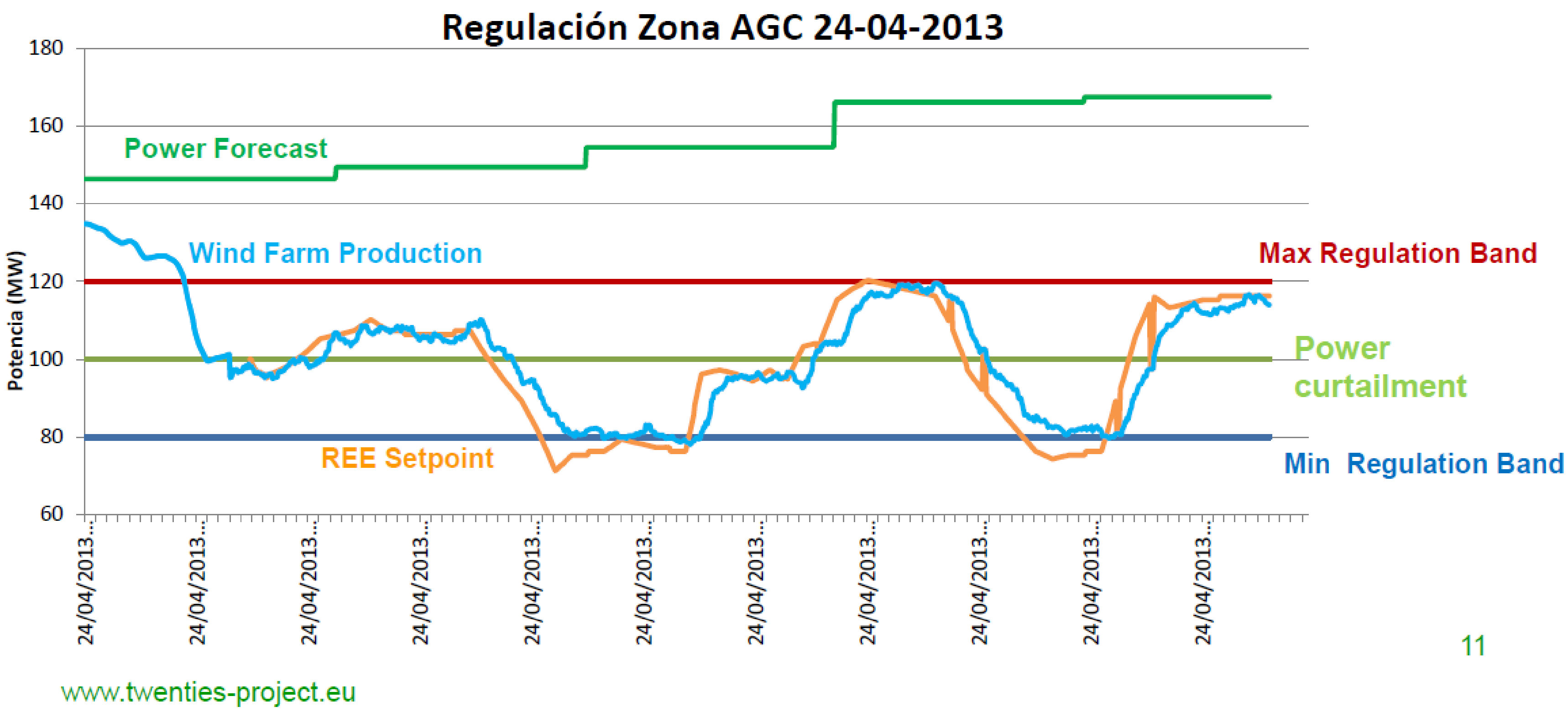


Increase of the valley demand due to the electric vehicles

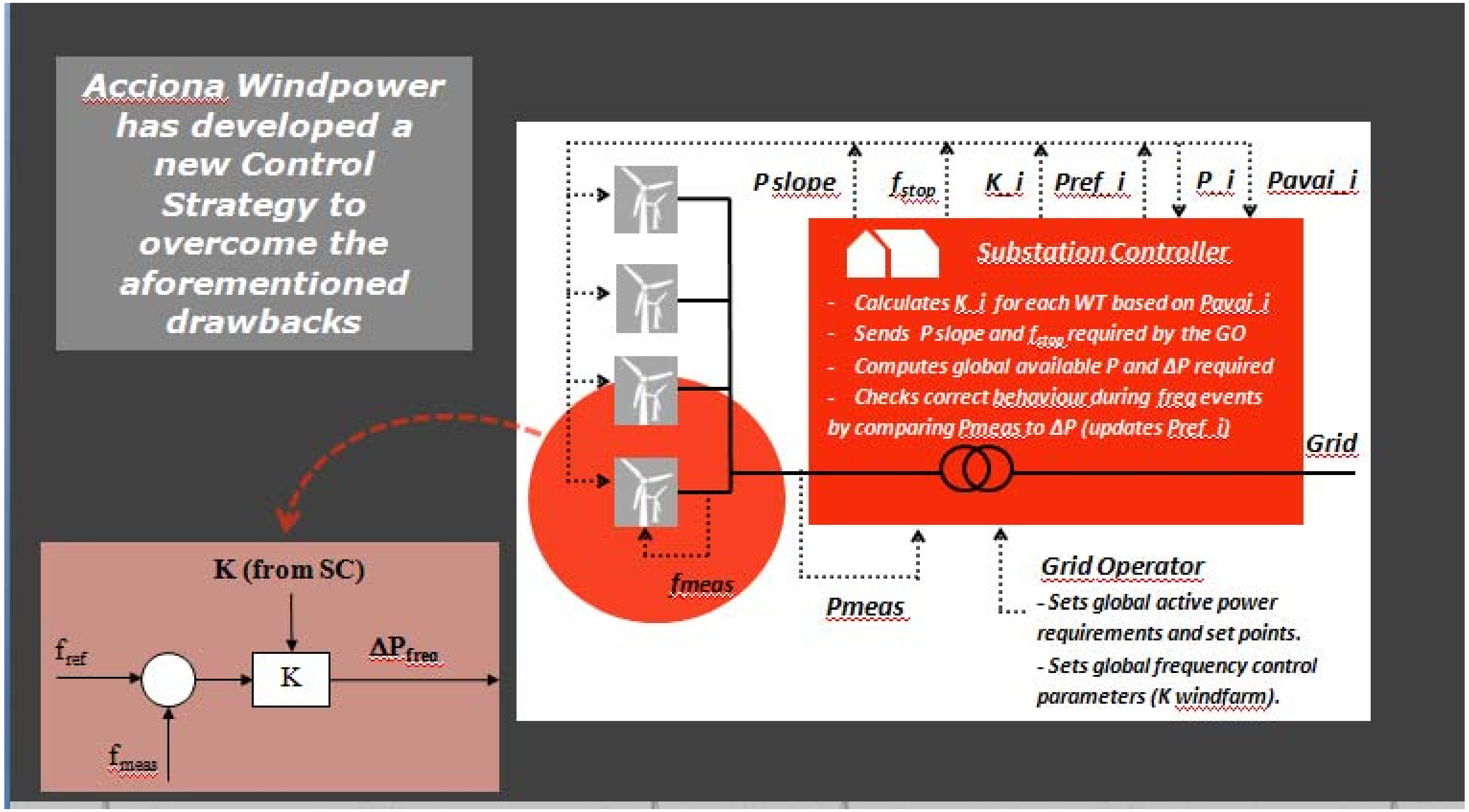
Reduction of the day peak thanks to PV

Massive introduction of LEDs

CONSEQUENCE: WIND POWER IS GOING TO PARTICIPATE IN THE ANCILLARY SERVICES



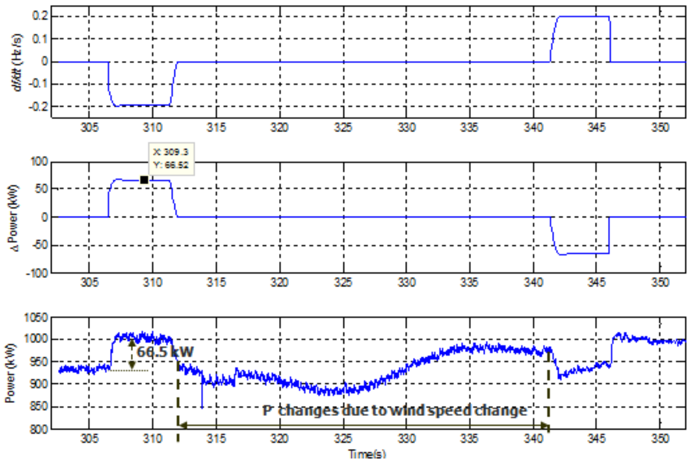
MODULARITY AND FLEXIBLE OPERATION IS A CLEAR ADVANTAGE



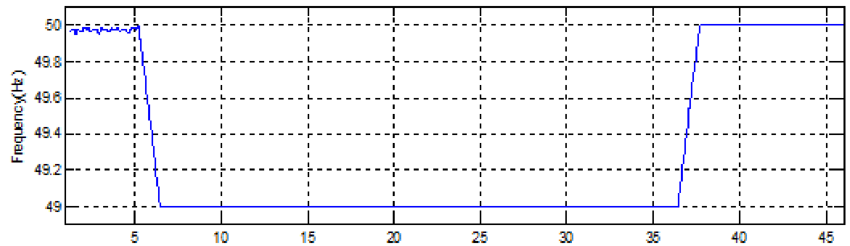
Source: ACCIONA WP

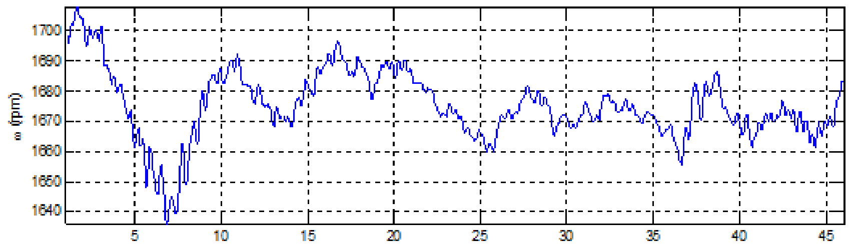
WIND TURBINES CAN ALSO CONTRIBUTE TO GRID INERTIA

- Potencia parcial:
  - Generación del $\Delta P_{inertia} = -2 \cdot H \cdot df/dt$



- Potencia nominal:
  - La velocidad de giro no cambia: suficiente potencia del viento





Source: GAMESA

CONSEQUENCE: WIND POWER IS GOING TO PLAY AN IMPORTANT ROLE IN THE ECONOMIC OPERATION OF THE EU INTERNAL MARKET

Towards Single European Market: Next Steps

Source: OMIE

CONCLUSIONES

CONCLUSIONES

1. Reduction of LCOE is critical for the future of the on shore wind energy: less costs and more production.

2. It is now critical to keep the manufacturing facilities in Europe, high risk of delocalization by request of local production and reduction of transport costs. Furthermore the trend for the extension of life will reduce new orders.

3. Once again, it is also important to maintain the european supply chain and to reinforce the cooperation with the research and technological centers.

4. A greater involvement in the technical operation of the system is going to be also a challenge for the future integration.