RED ELÉCTRICA DE ESPAÑA

The wind in Spain: past, present and future challengers for a TSO.

DS3 AG Dublin 2nd Feb 2011
Juan Ma. Rodríguez

Contents:

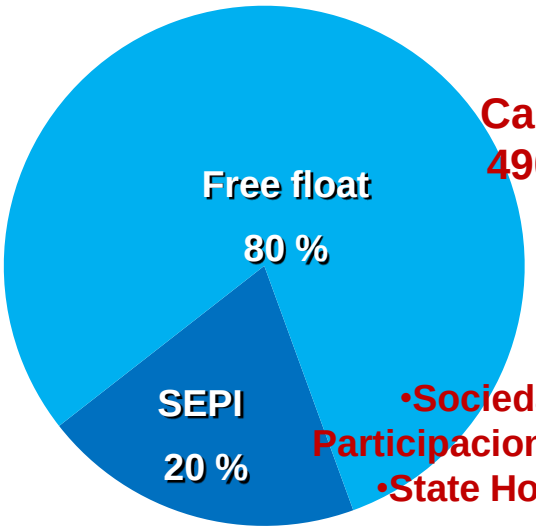
- Who is Red Electrica de España (REE)?
- Where are we?
- Present wind power capacity and evolution.
- REE solutions for safe integration of renewables.
- Current developments.
- Conclusions.

Tacumshane Windmil, Co. Wexford, Ireland.

Who is Red Electrica de España (REE)?

- REE is the Spanish Transmission System Operator (TSO)
- REE is operating the mainland and the island systems

- REE's Shareholders composition:



Market Capitalization: 4900 Million €

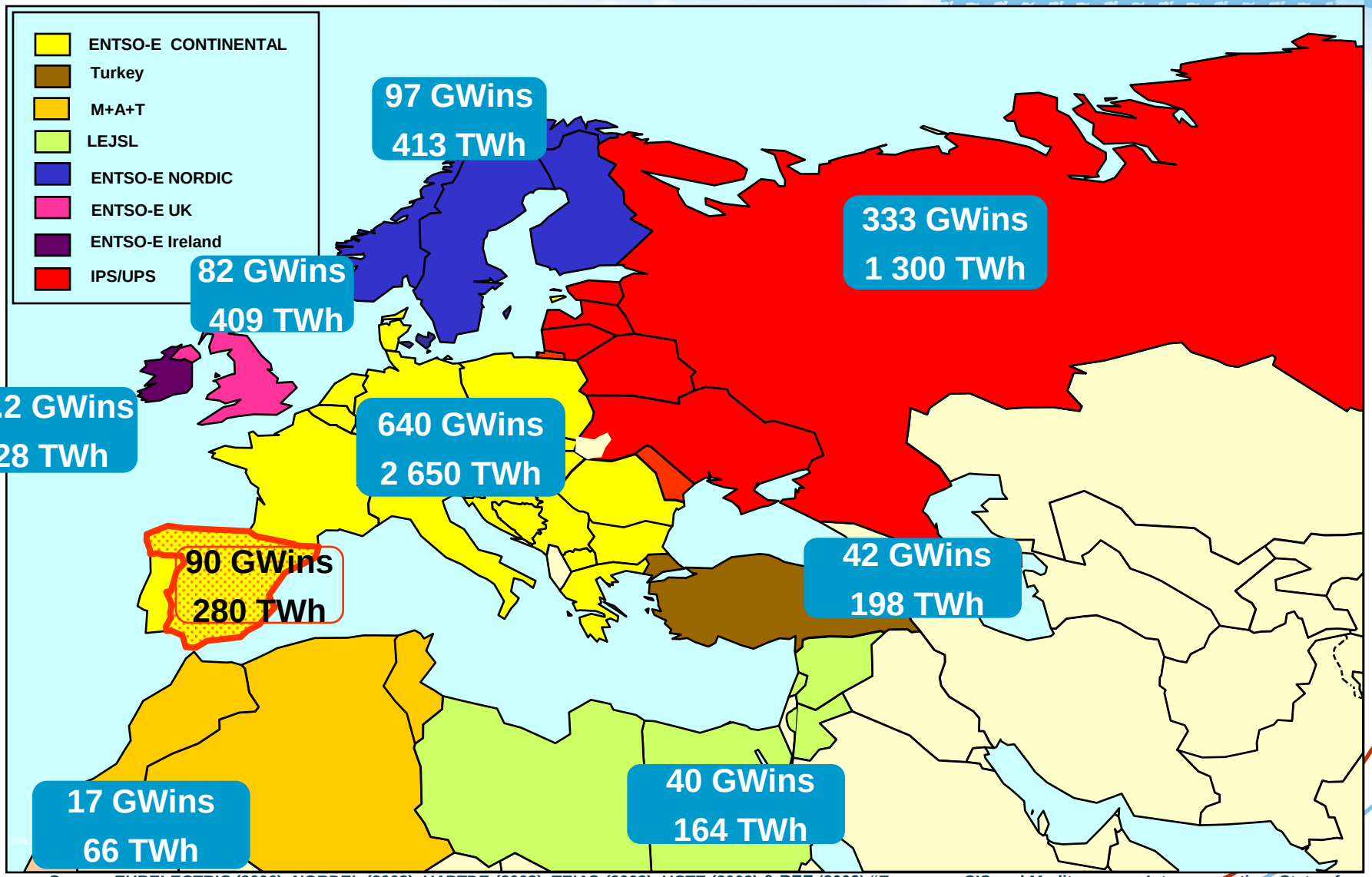
SEPI:
- **Sociedad Española de Participaciones Industriales**
- **State Holding Company**

First independent TSO company in the world, in 1985

Guarantees the adequate operation of the Spanish power system

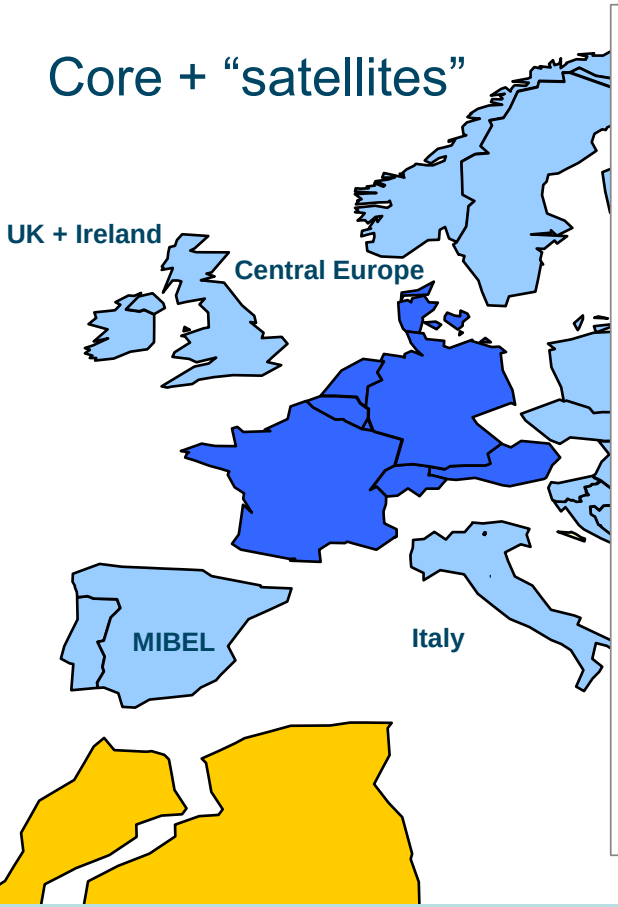
Transmission Network (SPeninsularPS)		End 2011
Lines	400 kV [km ct]	19 622
	≤ 220 kV [km ct]	17 699
SubSt.	≤ 220 & 400 kV	3 951
	Transformers 400/X kV [MVA]	71 047

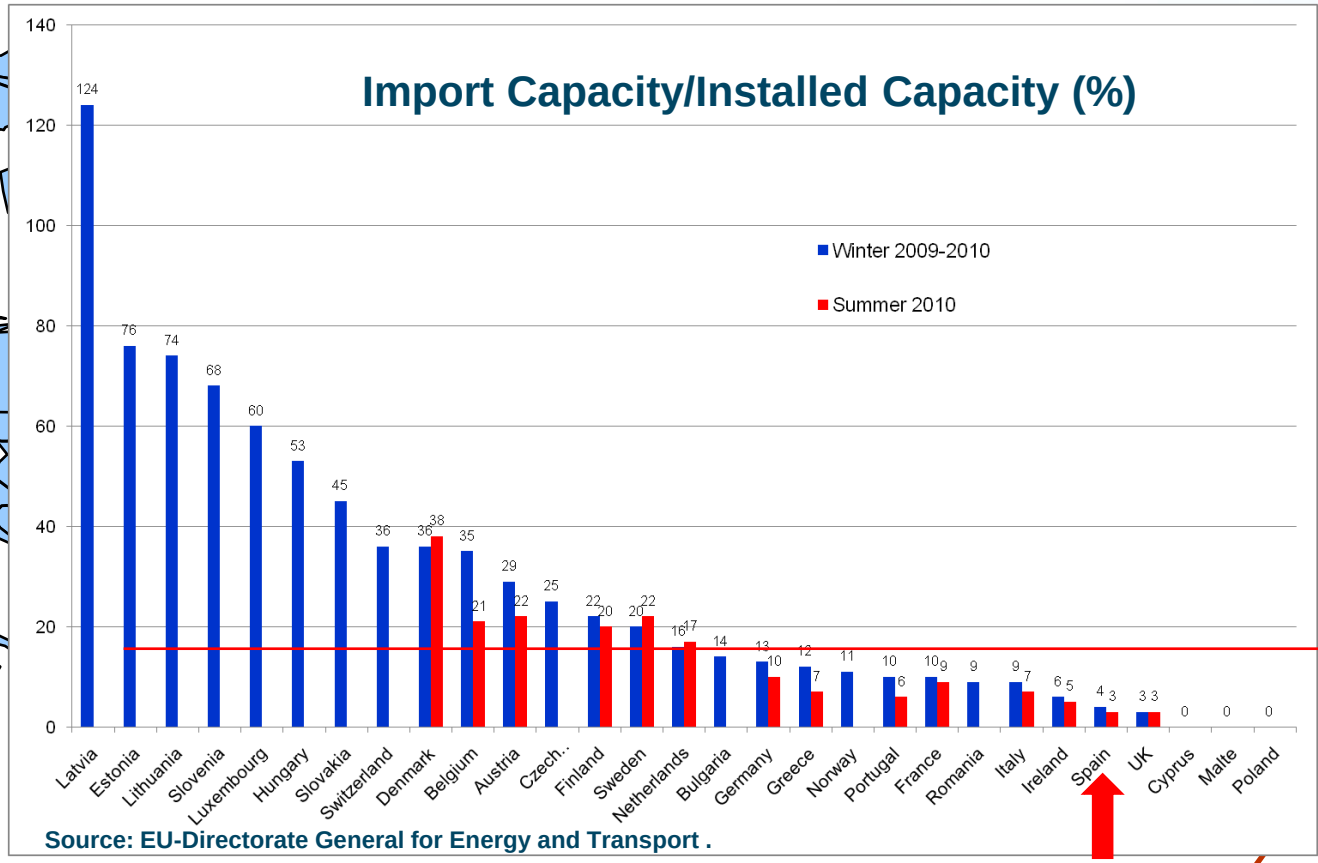
Where are we?



Source: EURELECTRIC (2006), NORDEL (2008), UAPTDE (2008), TEIAS (2008), UCTE (2008) & REE (2008) "European, CIS and Mediterranean Interconnection: State of Play 2006 Joint EURELECTRIC-UCTE

Where are we? international interconnections:





The “Electricity Iberian Island”

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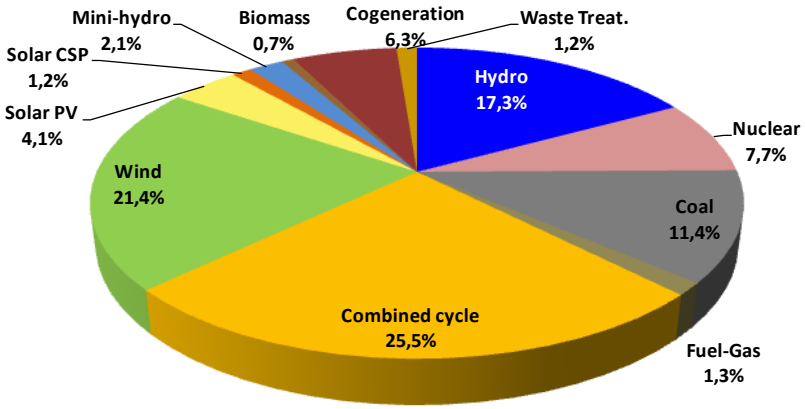
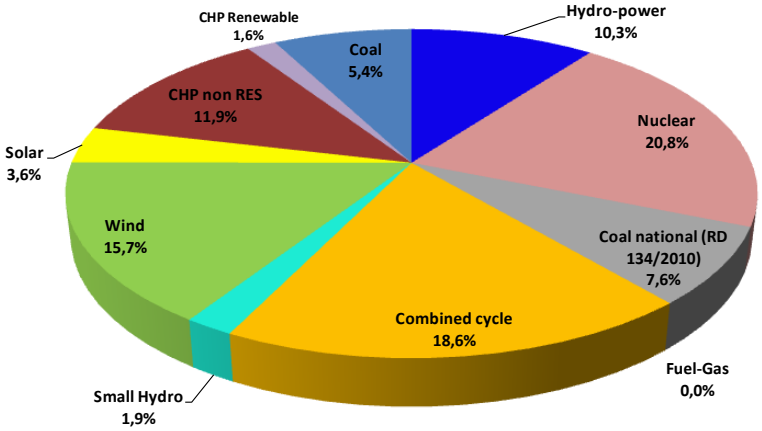
Installed capacity and demand supply 2011:

Installed capacity January 2012



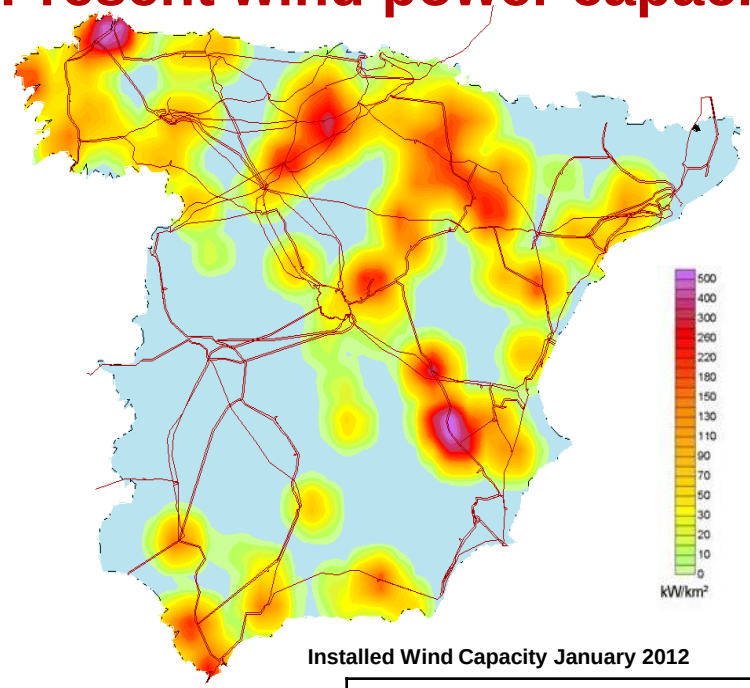
Demand supply 2011



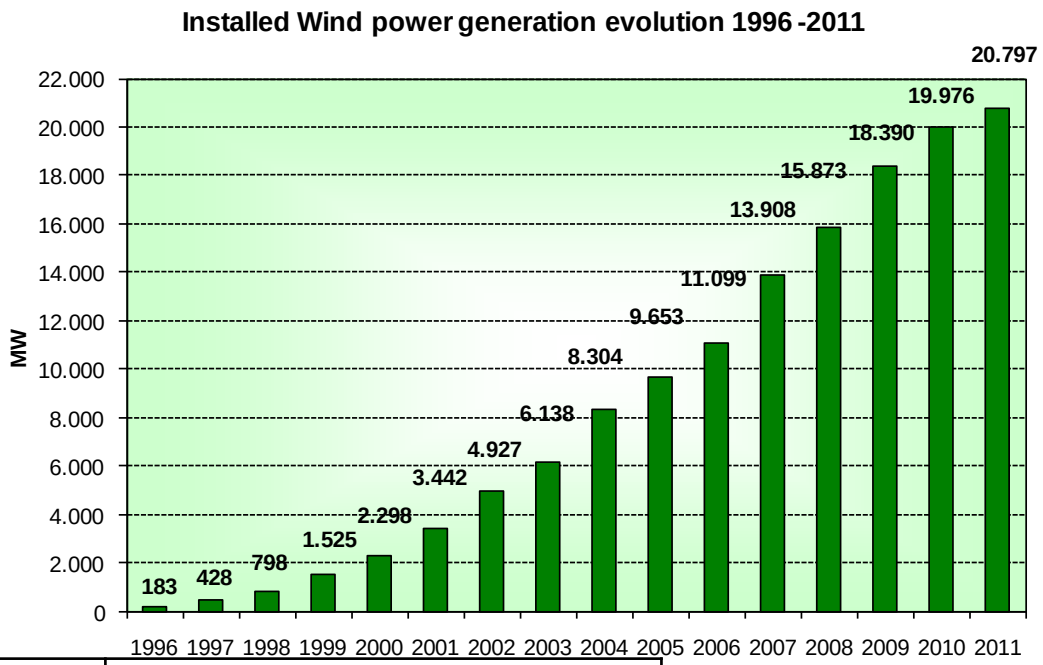
Technology	MW	%
Hydro	16 657	17.2
Nuclear	7 455	7.7
Coal	11 085	11.5
Fuel-Gas	1 252	1.3
Combined cycle	24 789	25.6
Total (ordinary regime)	61 238	63.0
Wind power generation	20 775	21.4
Solar PV	3 977	4.1
Solar CSP	1 150	1.2
Biomass	717	0.7
Micro-hydro	2 026	2.1
Cogeneration	6 098	6.3
Waste treatment	1 202	1.2
Total (special regime)	35 945	37.0
Total	97 183	

255 179 GWh = 172 177 Net Ordinary Regime
+ 92 353 Net Special Regime
- 3 245 Hydro-pump storage
- 6 105 International exchanges

Present wind power capacity and evolution

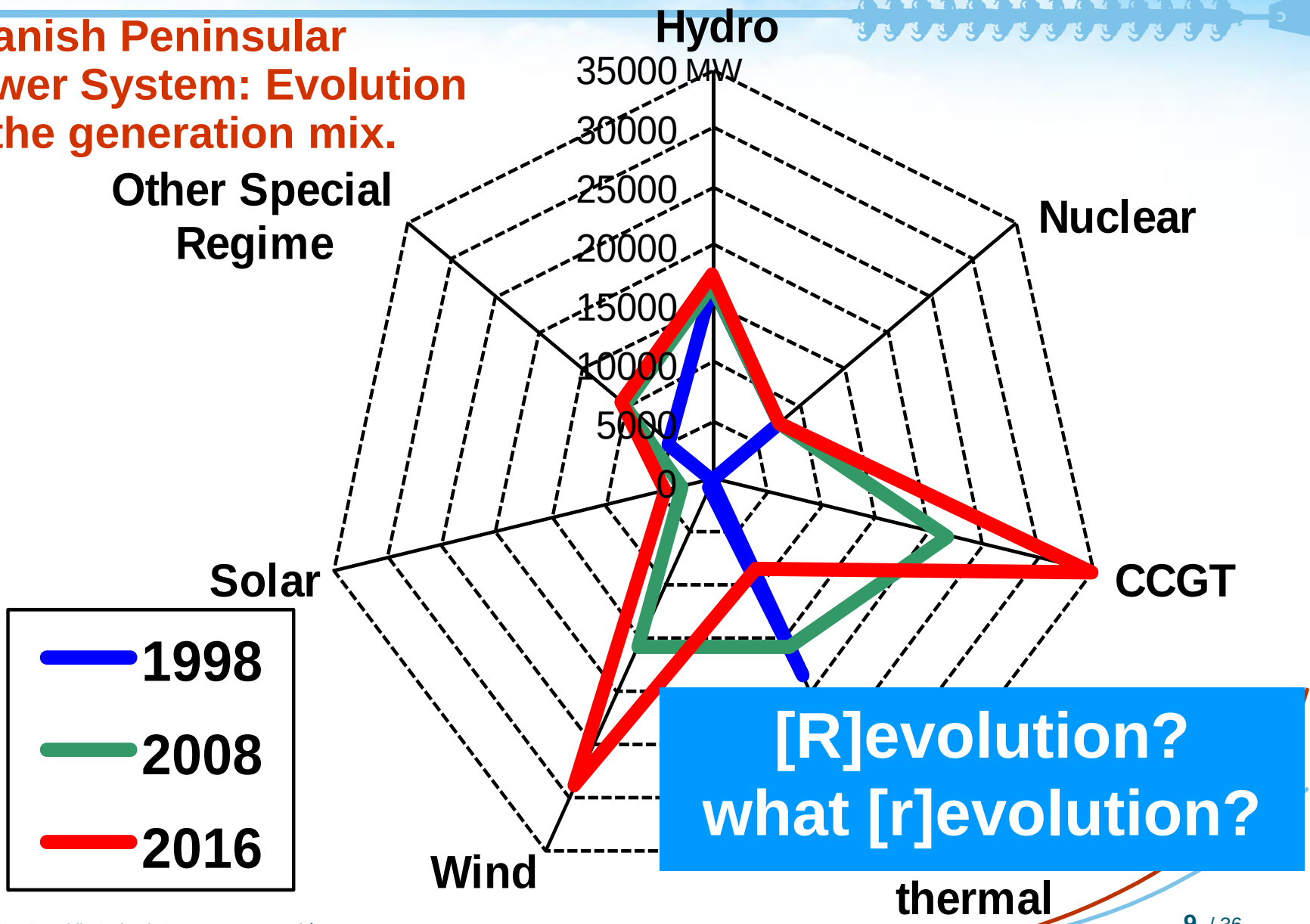


Installed Wind Capacity January 2012



Renewable Energy Plan (PER 2011-2020)	Planned installed capacity (MW)	
	2015	2020
Onshore wind power	27847	35000
Offshore wind power	22	750
PV	5416	7250
Solar Thermal	3001	4800

Spanish Peninsular Power System: Evolution of the generation mix.



[R]evolution? what [r]evolution?

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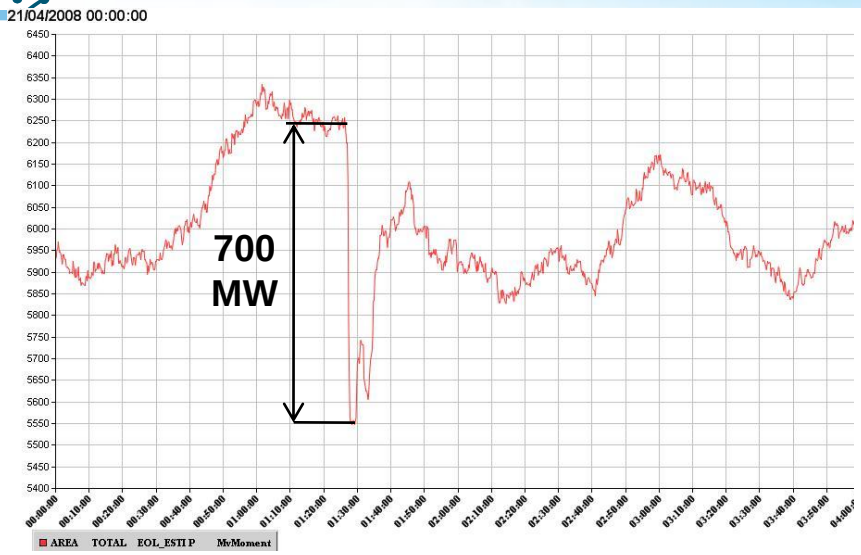
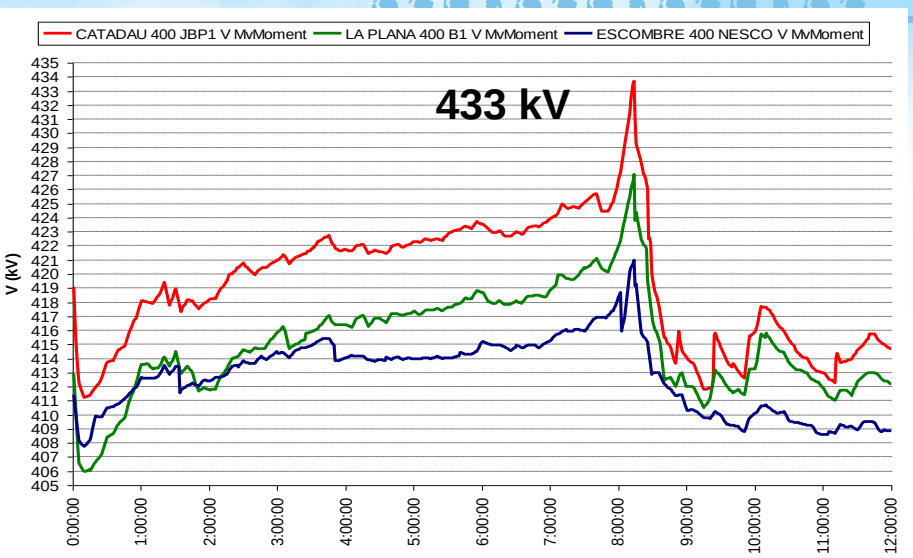
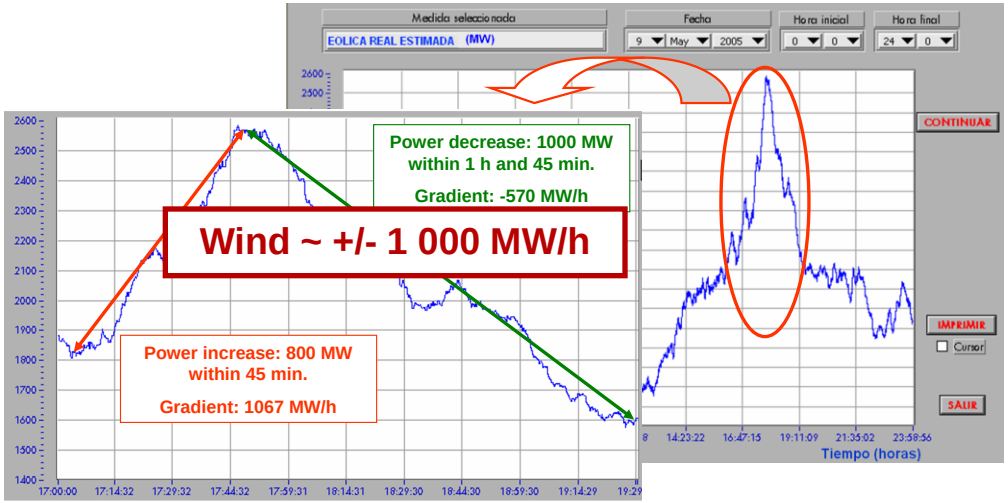
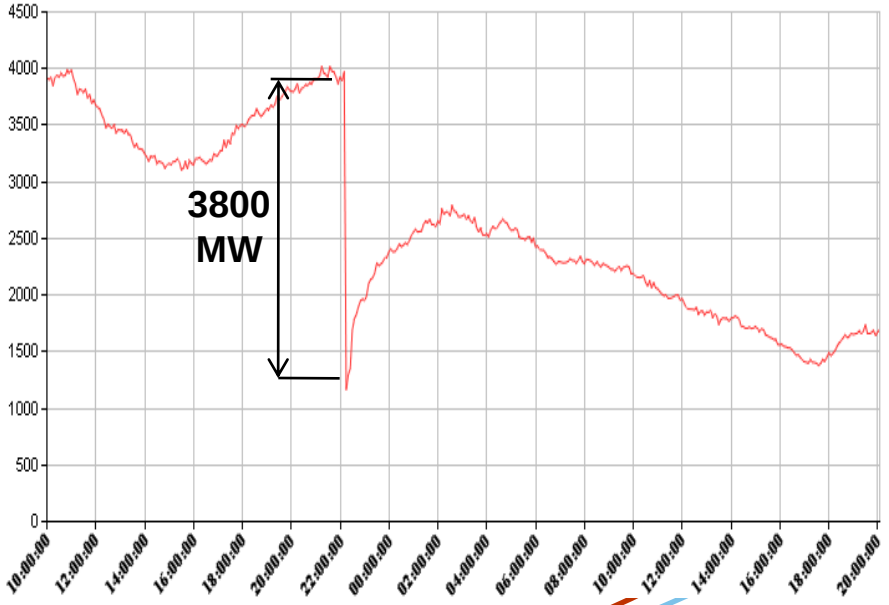
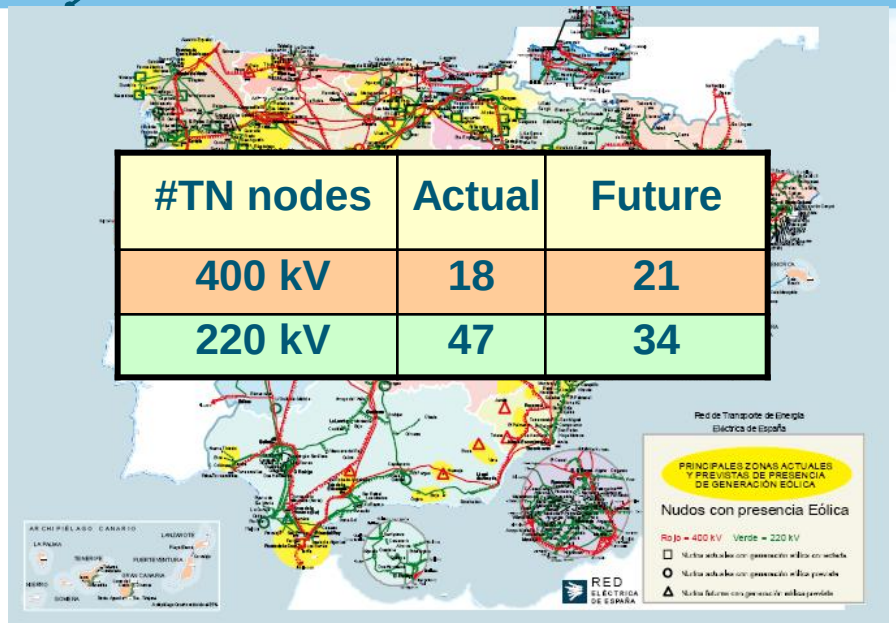

21/04/2008 00:00:00
700
MW
AREA TOTAL EOL_ESTIP MvMoment


CATADAU 400 JBP1 V MvMoment
LA PLANA 400 B1 V MvMoment
ESCOMBRE 400 NESCO V MvMoment
433 kV
V (kV)

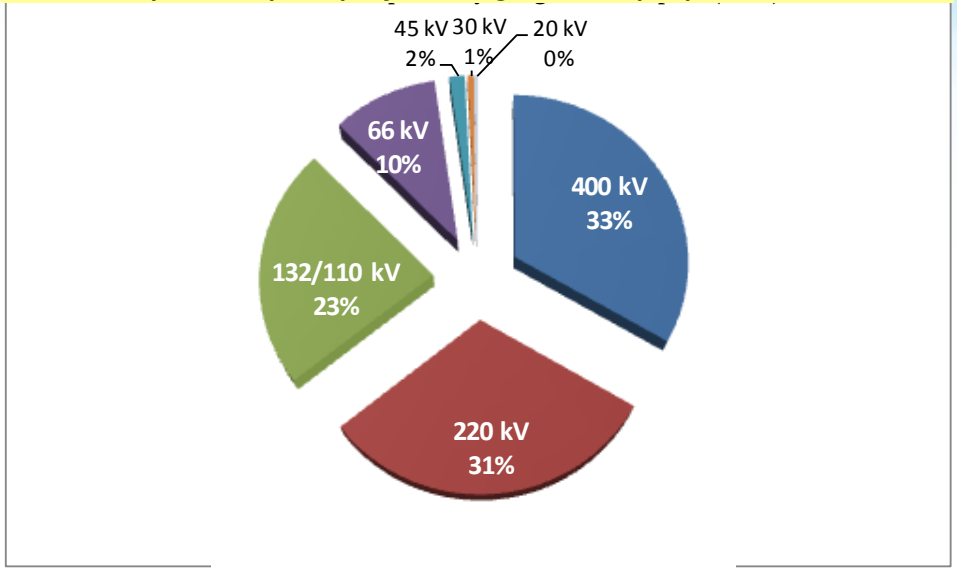

Medida seleccionada
EOLICA REAL ESTIMADA (MW)
Fecha
Hora inicial
Hora final
CONTINUAR
IMPRIMIR
Cursor
SALIR
Tiempo (horas)
Power decrease: 1000 MW within 1 h and 45 min.
Gradient: -570 MW/h
Wind ~ +/- 1 000 MW/h
Power increase: 800 MW within 45 min.
Gradient: 1067 MW/h

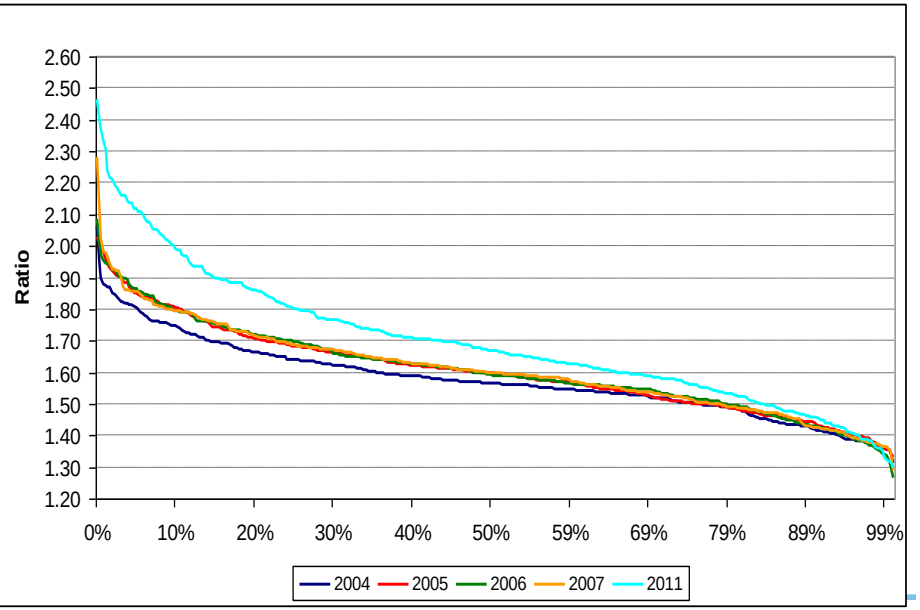

3800
MW

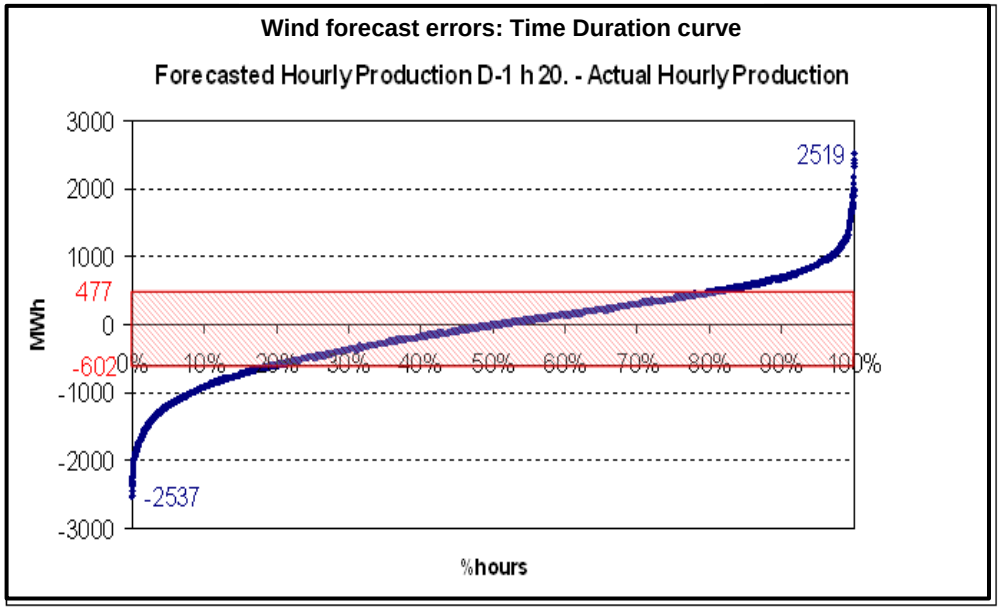


#TN nodes	Actual	Future
400 kV	18	21
220 kV	47	34

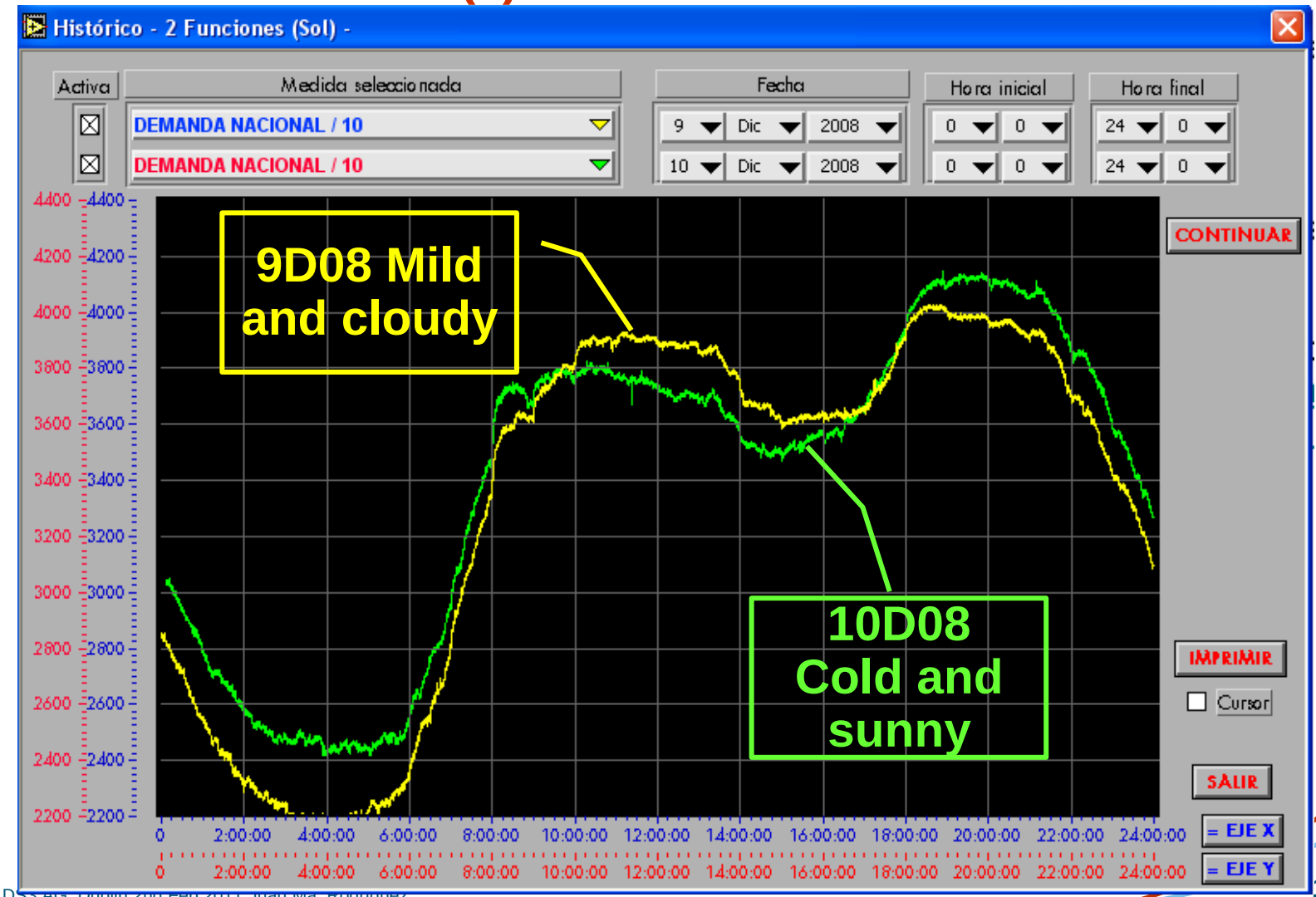
Installed power (MW) by voltage level (kV)

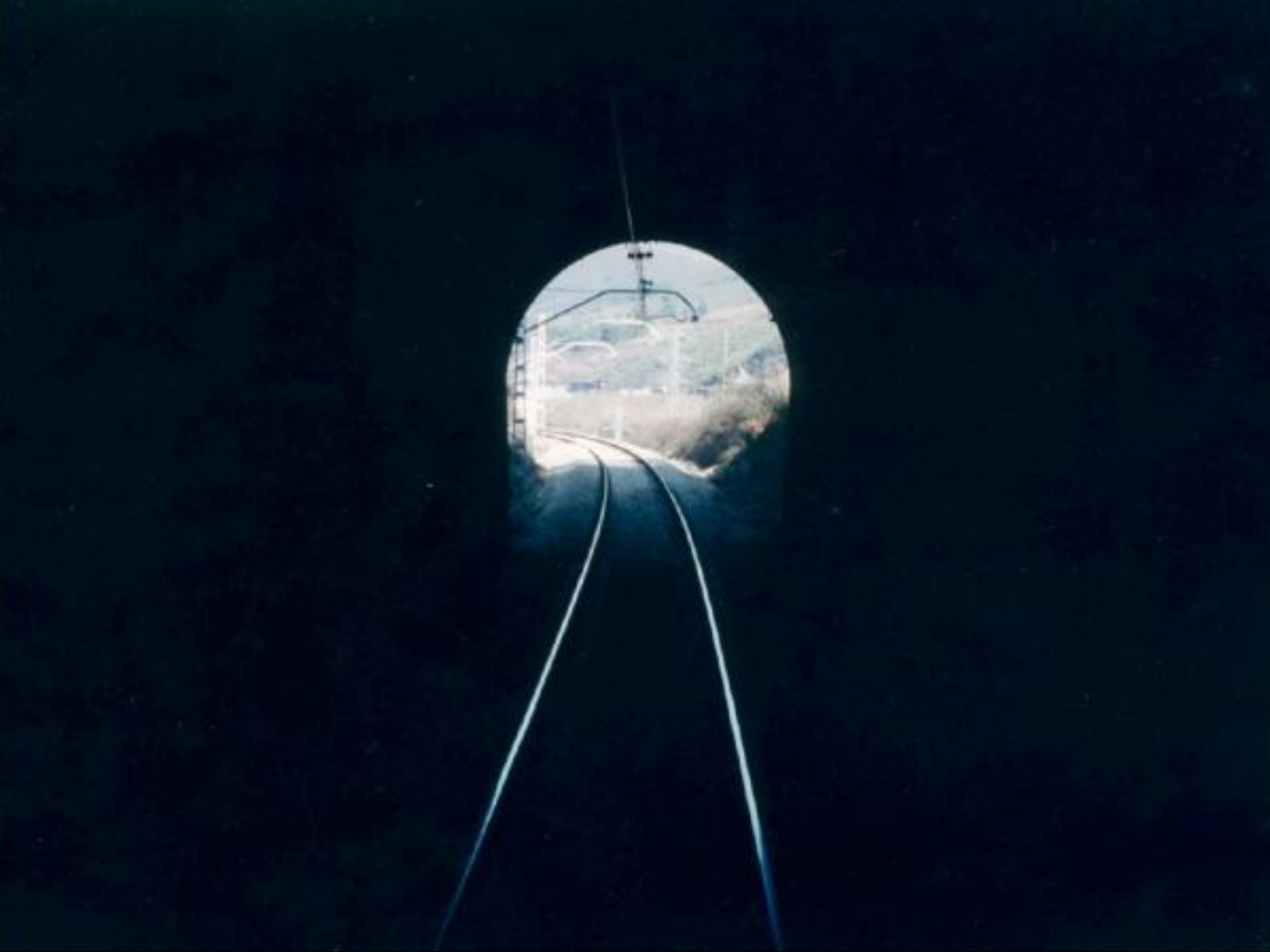






…and the sun-rise(s)!!!





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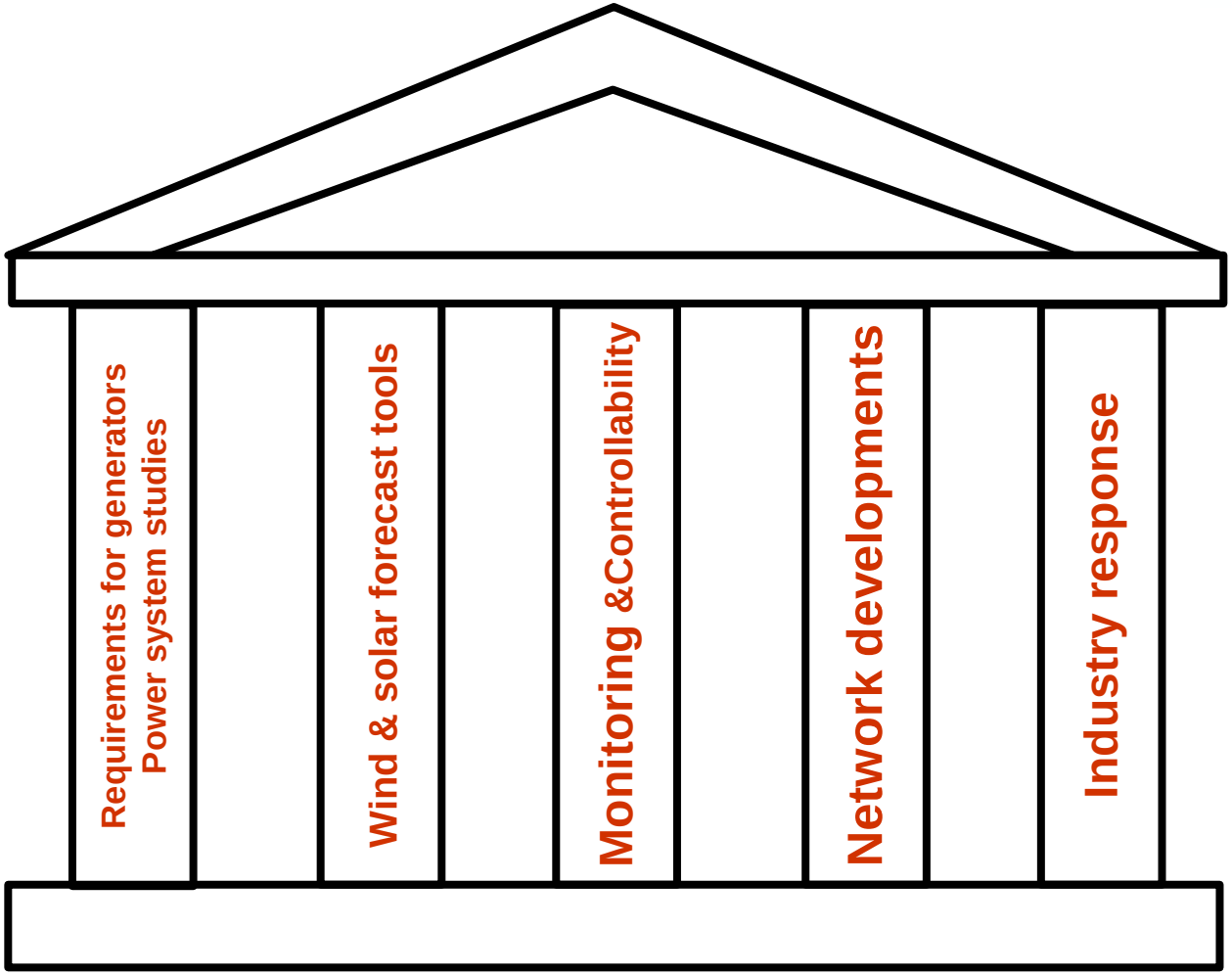
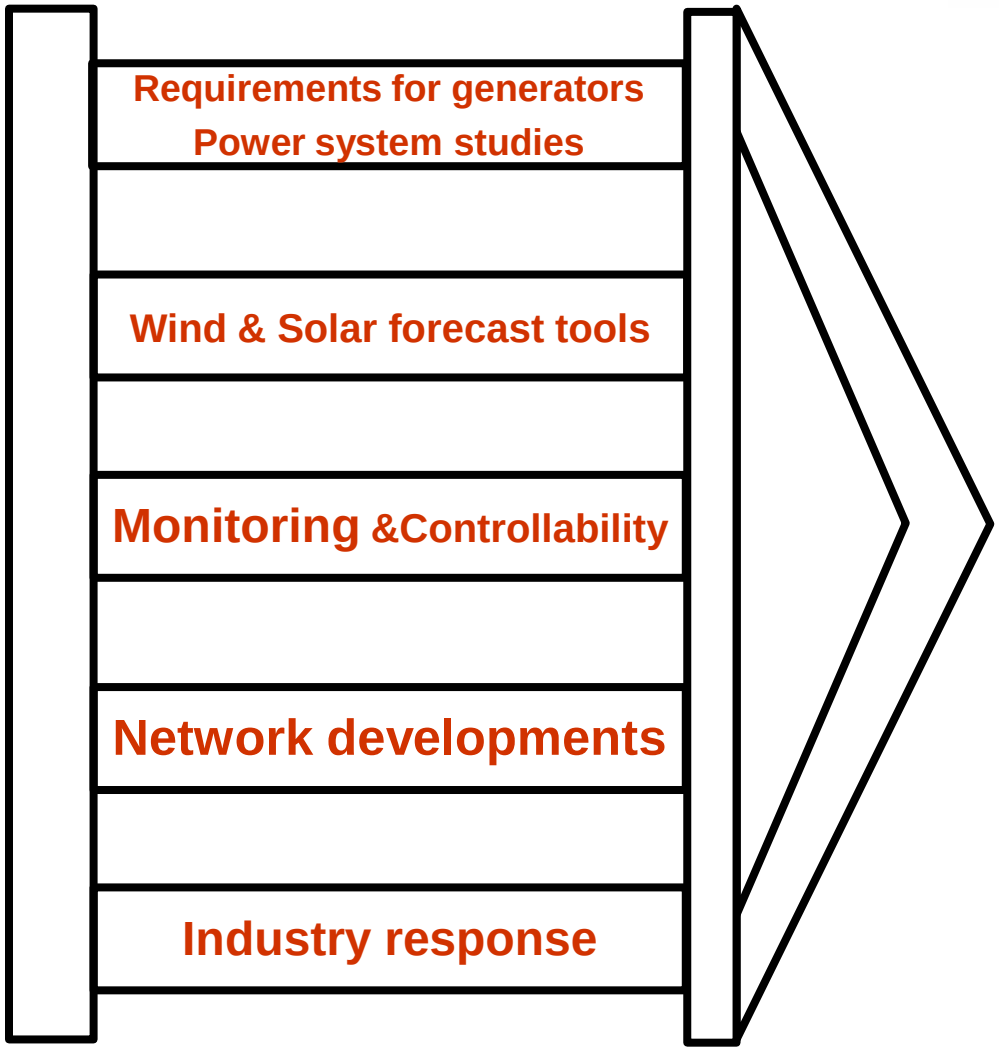
REE's solutions for safe integration of renewables:



REE's solutions for safe integration of renewables:



Wind farm requirements / Power system studies:

- **Ministry Plan H2011 (October 2002):**

Load	Permissible wind power production (frtc≥500 ms)
Peak	10 000 MW
Off-peak	3 000 ÷ 5 000 MW

13 000 MWinst

- **2005 review: Regulators, Wind Associations, REN & REE**

Load	% of wind power technically adapted respect to the present one (10GW)	Permissible wind power production (MW)
Peak	50%	< 10 000 MW
	75%	14 000 MW
	100%	>16 000 MW
off-peak	0%	5 000 MW
	75%	> 10 000 MW

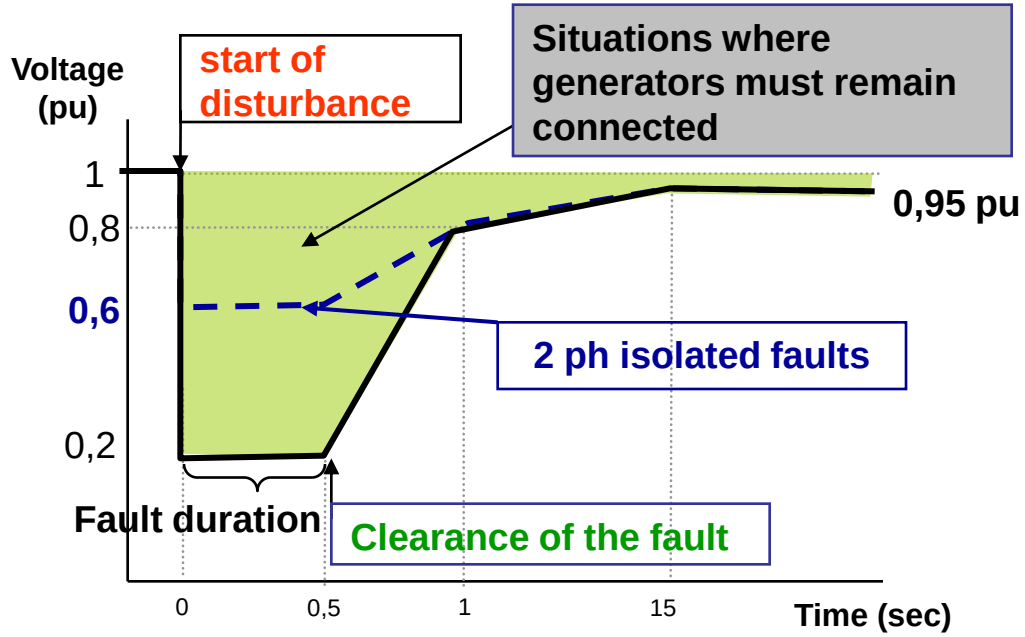
16-20 000 MWinst

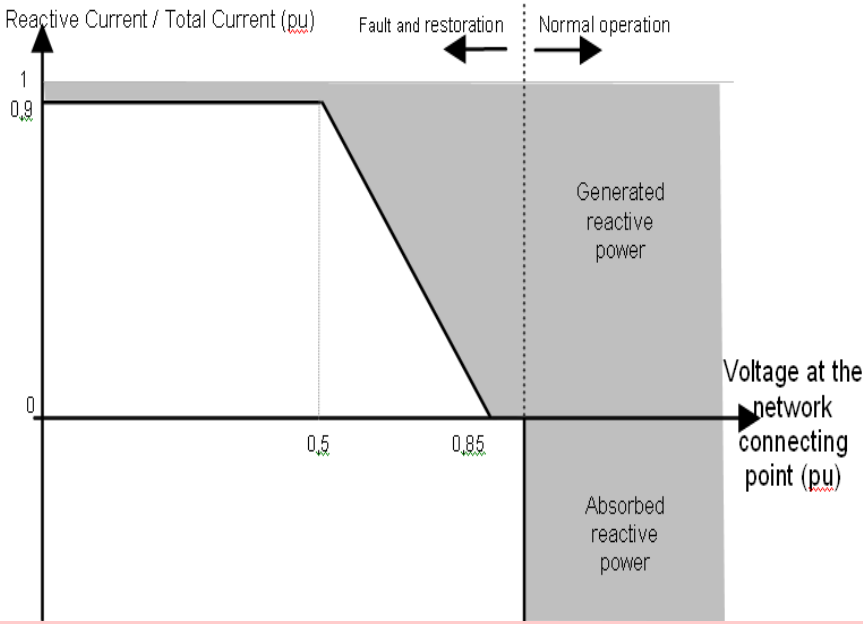
Wind farm requirements / Power system studies: Technical Requirements for Wind Power Plants.

- Remain connected to the system in case of faults in the network (3/2/1 phase shortcircuits), allowing the protection system to clear the default (*fault*

- Voltage–time at the connection point to be supported *(P.O.12.3)*

- Permissible active & reactive consumption values during voltage situations *(P.O.12.3)*

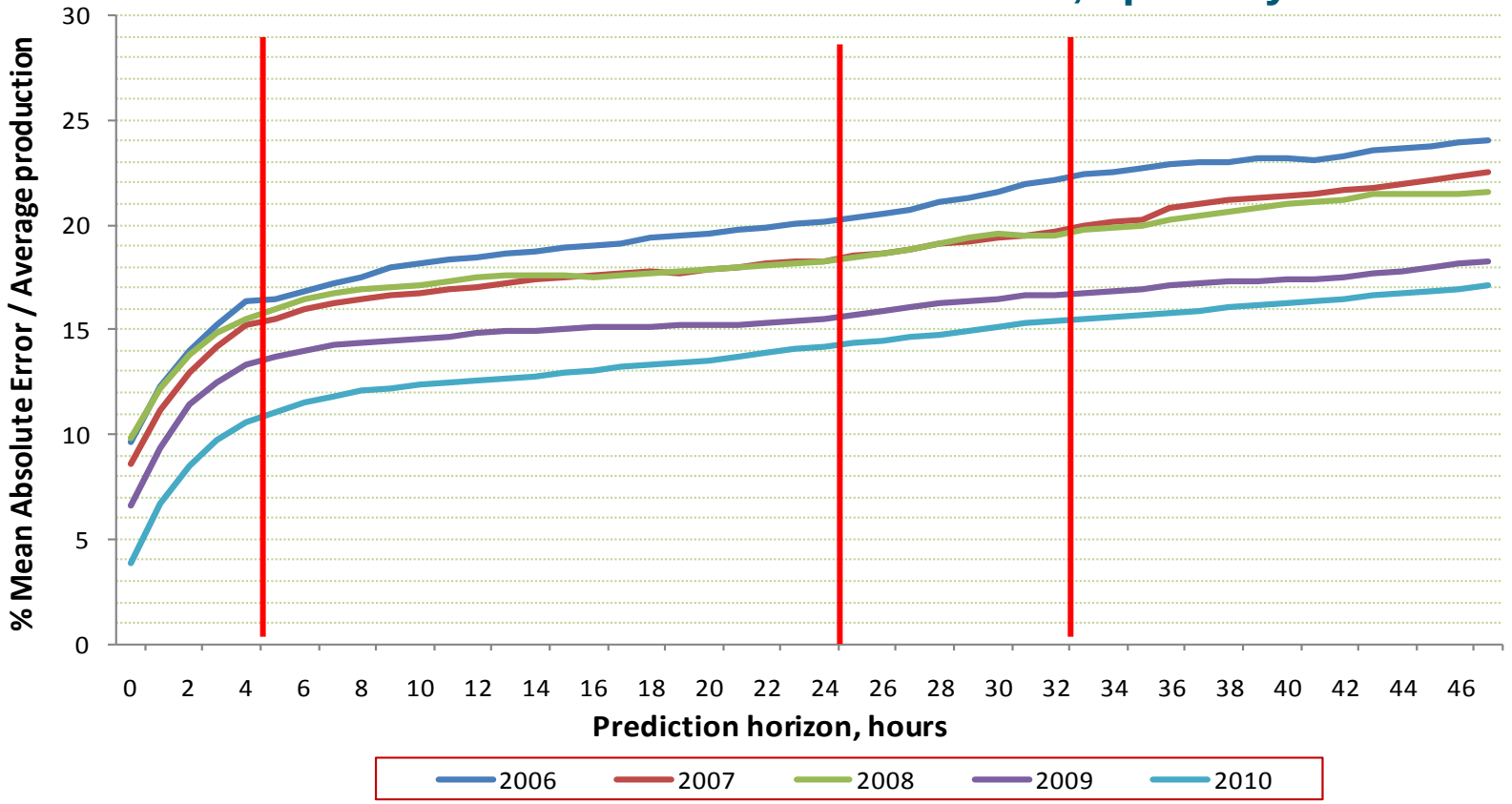




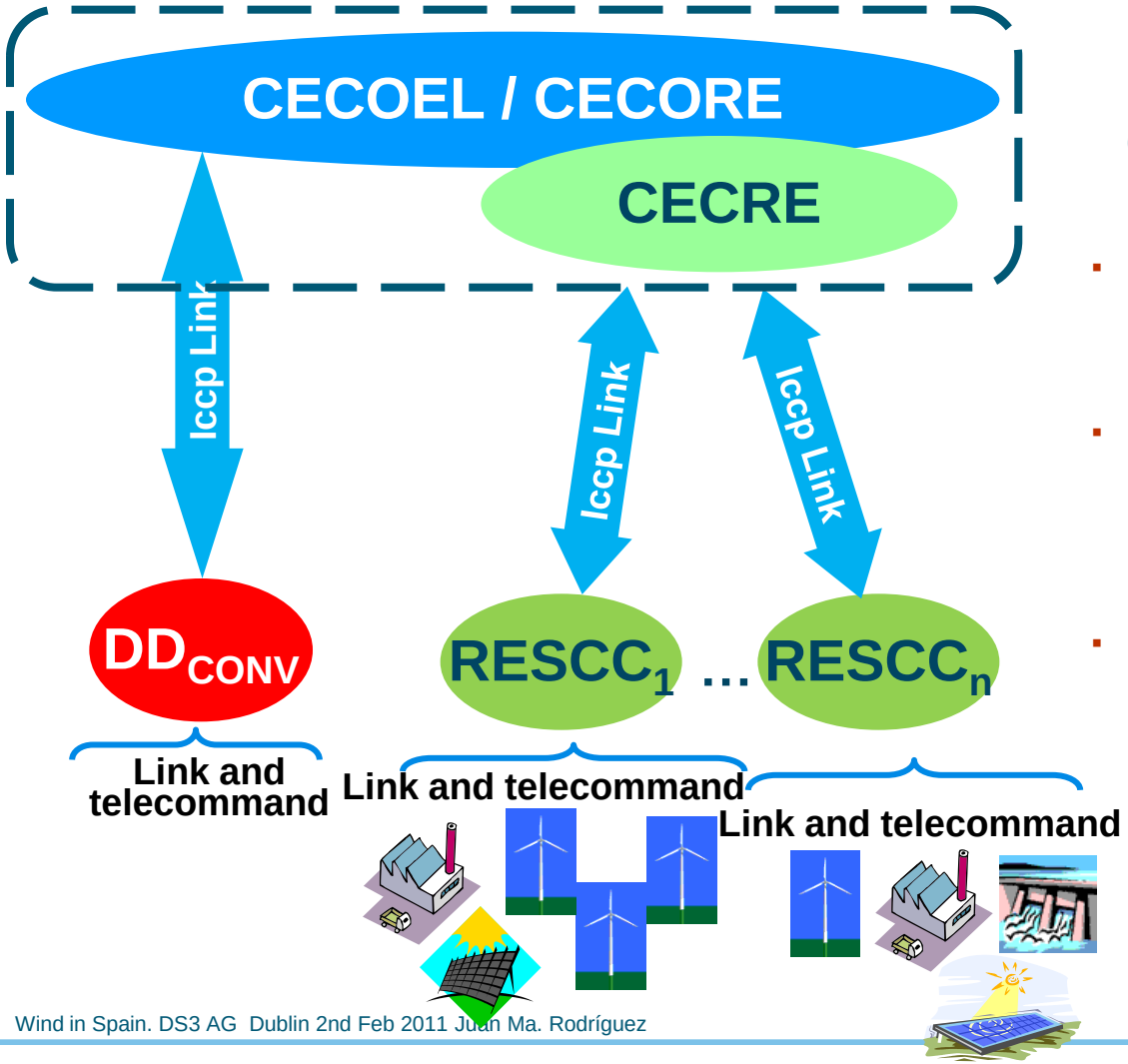
- Limits in power consumption (P,Q) during the fault and recovery: exception periods - ≈150 ms- and lower restriction for unbalanced faults

Wind forecast tools “SIPREOLICO”: mean absolute error.

- Critical time horizons are 24 or 32 hours ahead for D-1 reserve evaluation and 5 hours for real-time evaluation.
- Positive evolution in forecast error in the last years has resulted in need for fewer reserves to cover wind forecast errors, specially in D-1.



Monitoring &Controllability: CECRE
Special Regimen Control Centre



- CECRE is Integrated in REE's control structure
- Communication with generation Control Centres for supervision and control instructions.
- CECRE does not telecommand generation equipment; this function is done by generation Control Centres.
- CECRE issues generation limitations through the SCADA system to the Control Centres.

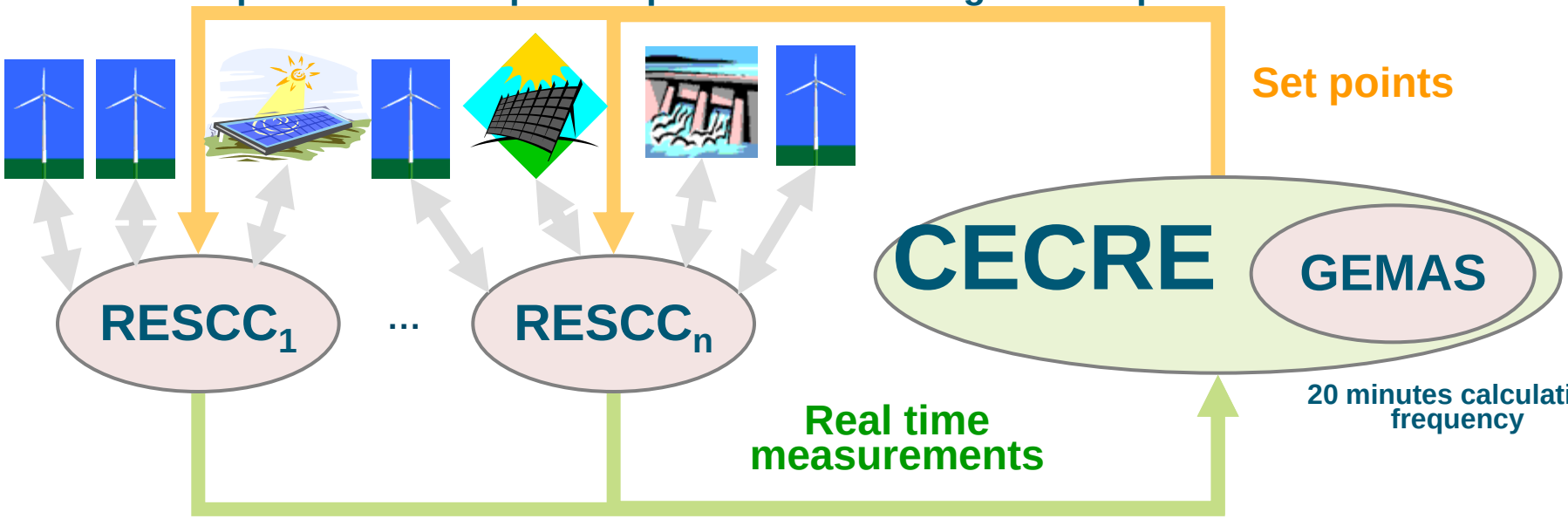
CECRE: Special Regime Control Centre

RESCC: Renewable Energy Source Control Centre

DD: Delegate Dispatch for conventional generation

Checking the security with the real-time wind scenario:

- CECRE analysis in real time the maximum wind generation supported by the system.
- If curtailments are needed, wind generation set-points are calculated and sent.
- Wind parks must adapt their production to the given set-point within 15 minutes.

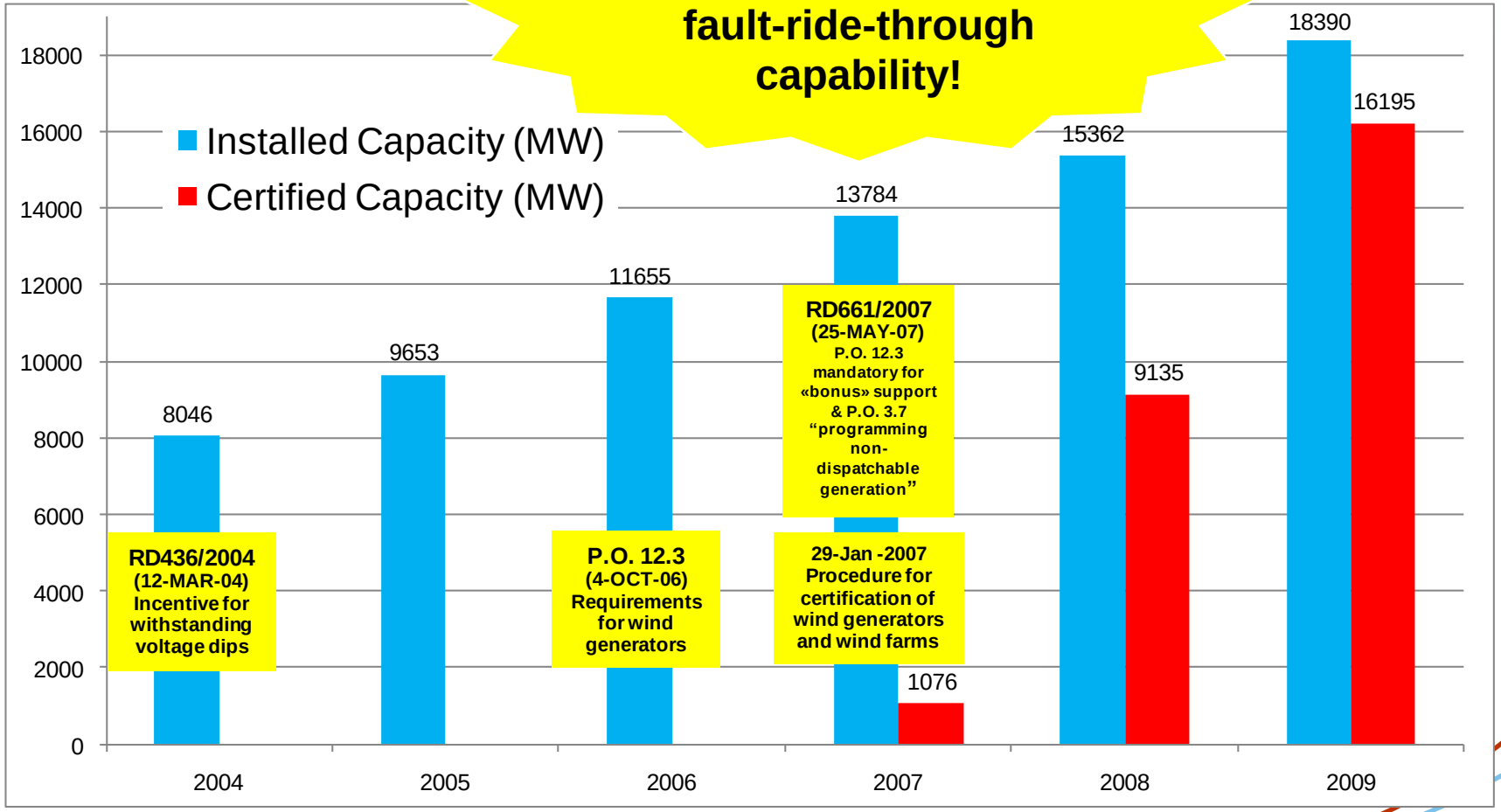


- Presently only done for wind generation, but a similar methodology can also be applied for all renewable energy sources.

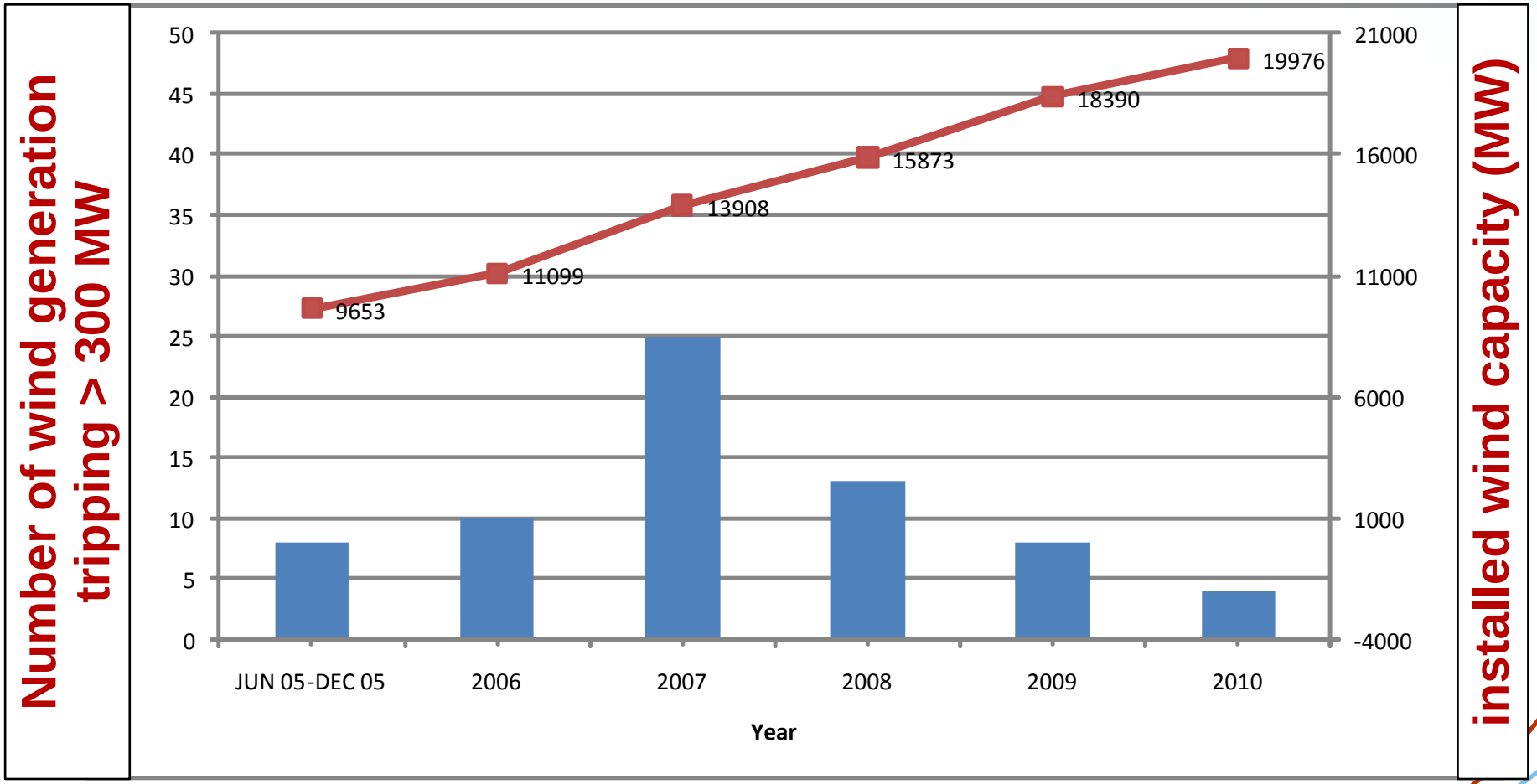
GEMAS: Analysis in real time the maximum wind generation supported by the system.

Industry response: Evolution of installed capacity vs. certified capacity

circa 500 MW do not currently manage the fault-ride-through capability!



Industry response: recorded wind generation trippings.



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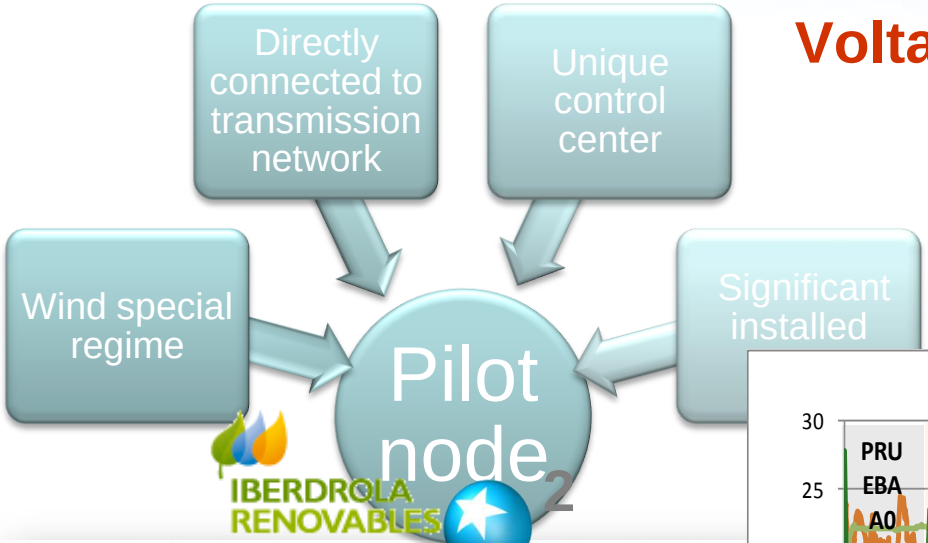
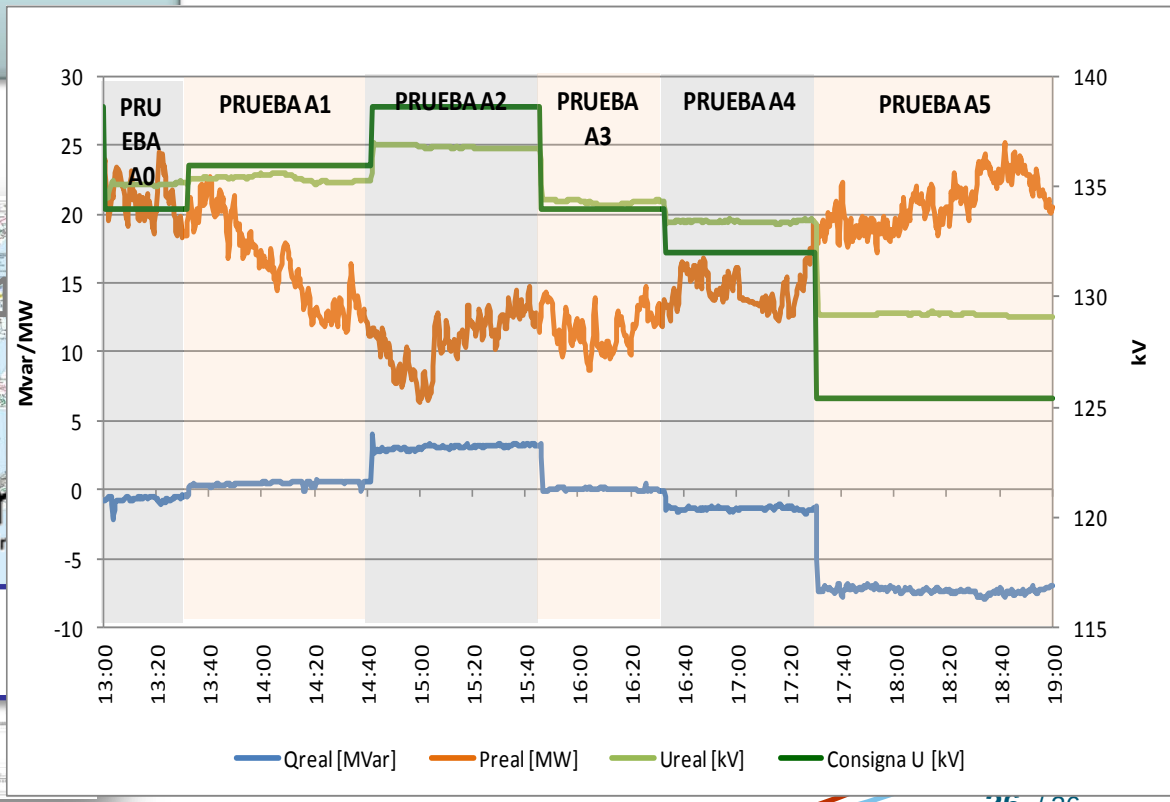
Voltage control test by wind farms:

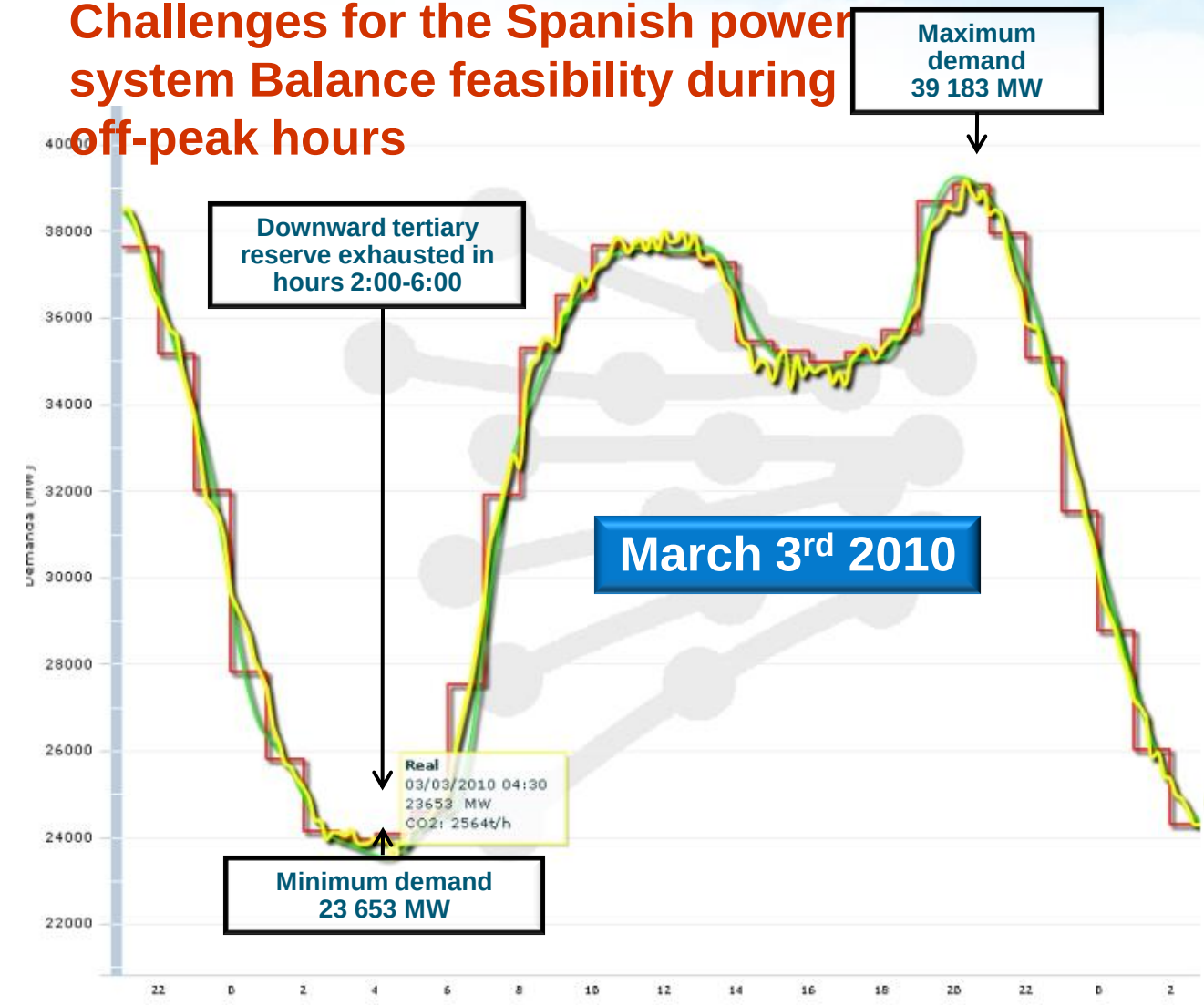


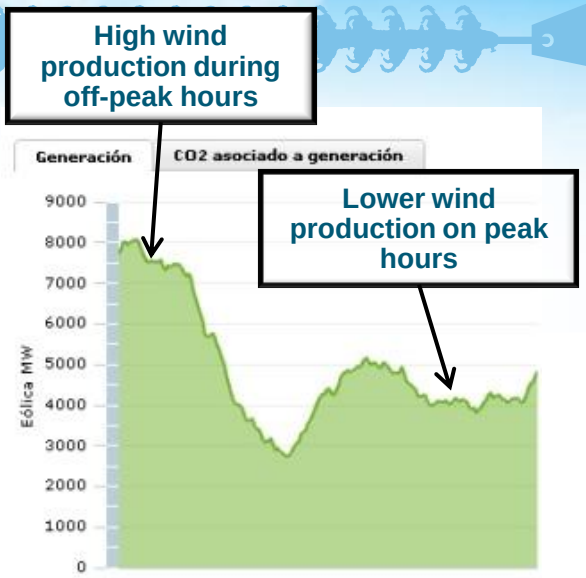


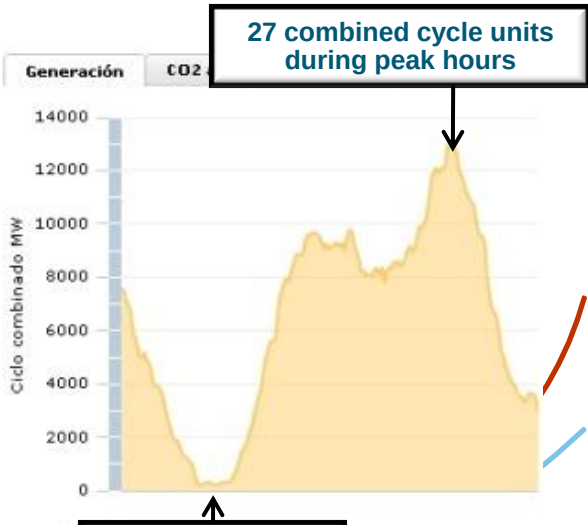
Influence of wind variations on reserves:

System Balancing Reserves	Definition	Influence of Wind Power on Reserve
Primary Regulation	Action of speed regulators from generator units responding to changes in system frequency (<30 s to 15 minutes)	Not influenced by wind power
Secondary Regulation	Automatic action of central algorithm and AGCs in the generation units that provide this service responding to changes in system frequency and power deviations with respect to France. (≤100 s to 15 minutes)	Only slightly affected by wind generation ramps when these ramps are opposite to system demand. Presently, no need to contract further reserve bands.
Tertiary Regulation	Manual power variation with respect to a previous program in less than 15 minutes. (<15 min to 2 hours)	Only slightly affected by wind generation ramps when these ramps are opposite to system demand.
Running Reserves or Hot Reserves	Dispatchable generation reserves that can be called upon within 15 minutes to approximately 2 hours. Include tertiary reserves and consist on the running reserves of connected thermal units and hydro and hydro pump storage reserves. (15 min-2 hours to 4 hours)	Significant influence of wind power. Reserve provision must be increased to take into account wind power forecast errors. Reserves are checked from day D-1 once market results are received until real time.

Challenges for the Spanish power system Balance feasibility during off-peak hours

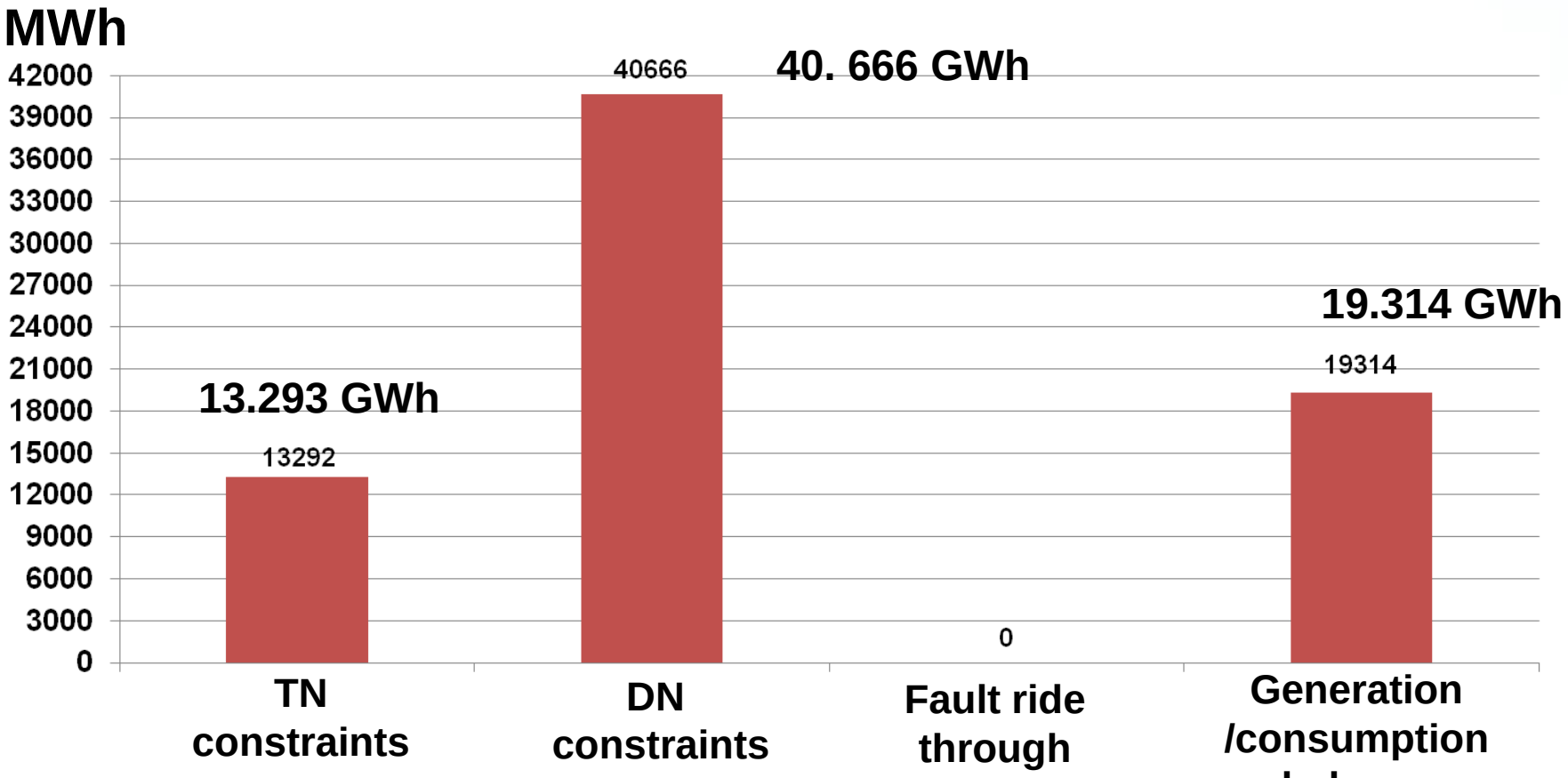






1 combined cycle unit during off-peak hours

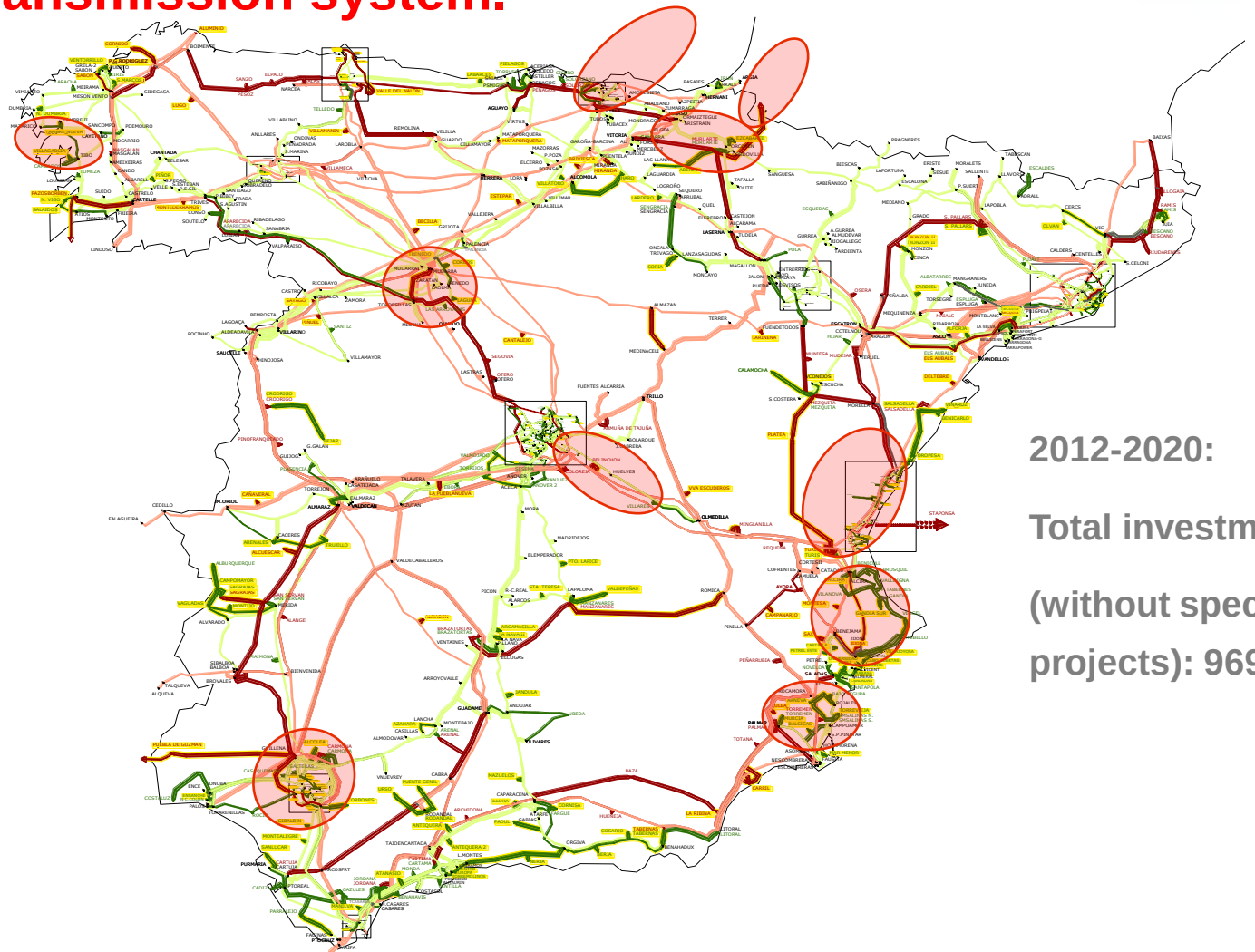
Wind power curtailments (Year 2011):



(2011) Total: 255 179 GWh

Wind: 40 063 GWh

Challenges for the Spanish power system: Transmission system.

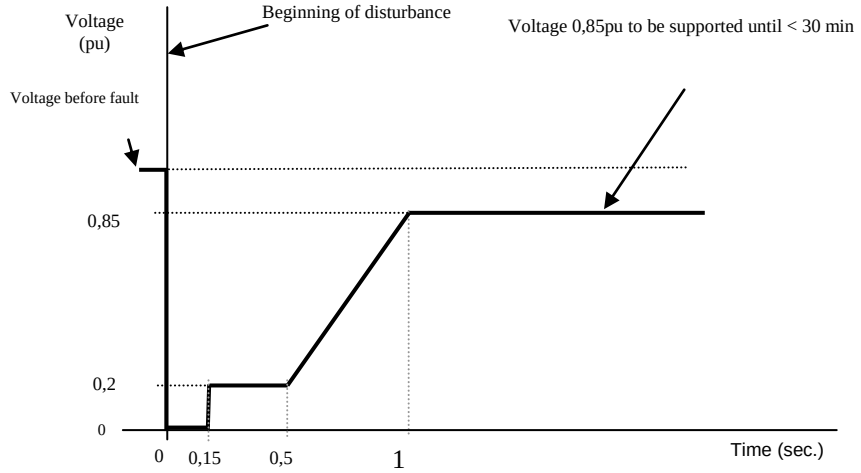


2012-2020:

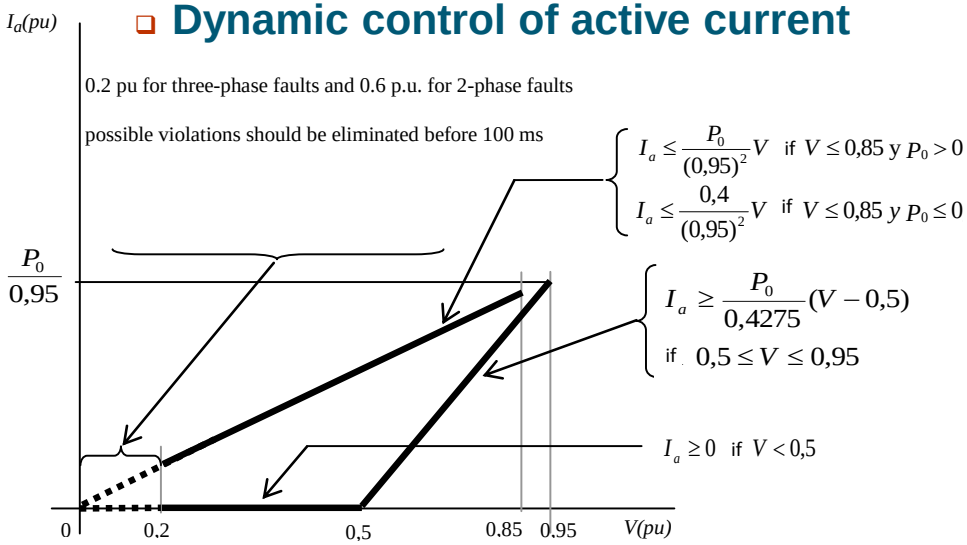
Total investment (without special projects): 9695 M€

More demanding requirements:

- **new fault ride-through (FRT) capability**

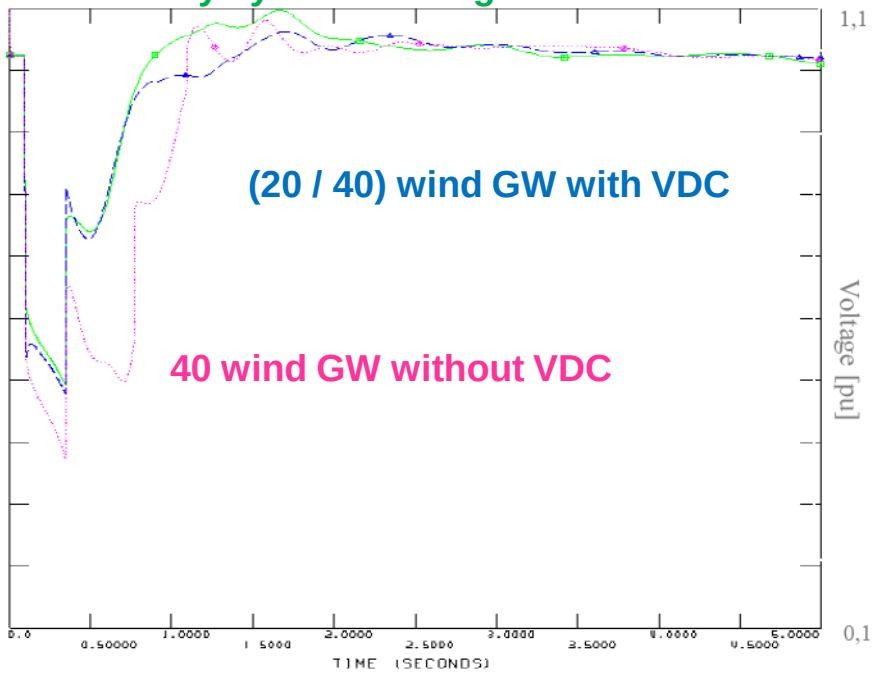


- **Dynamic control of active current**



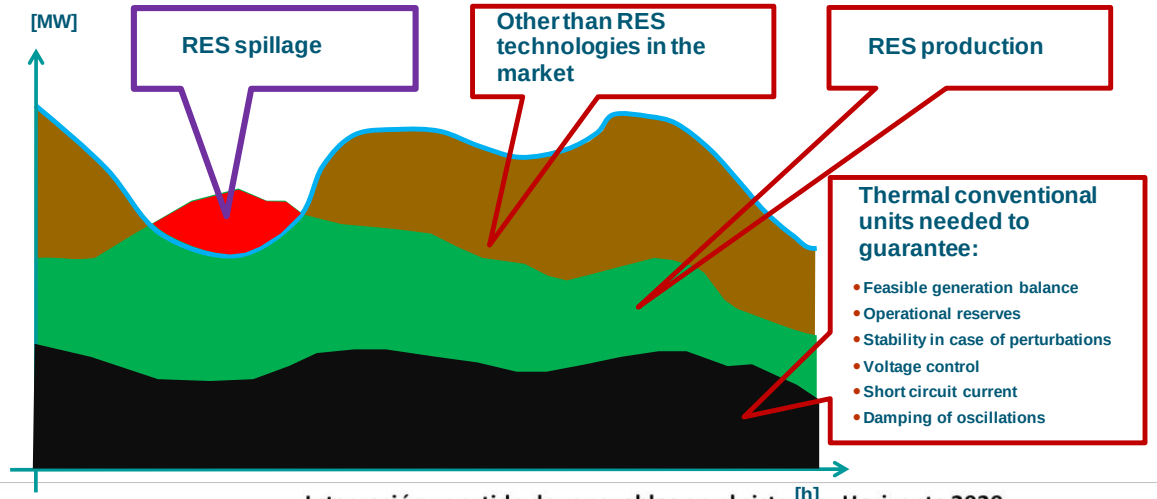
- **Voltage dynamic control:**

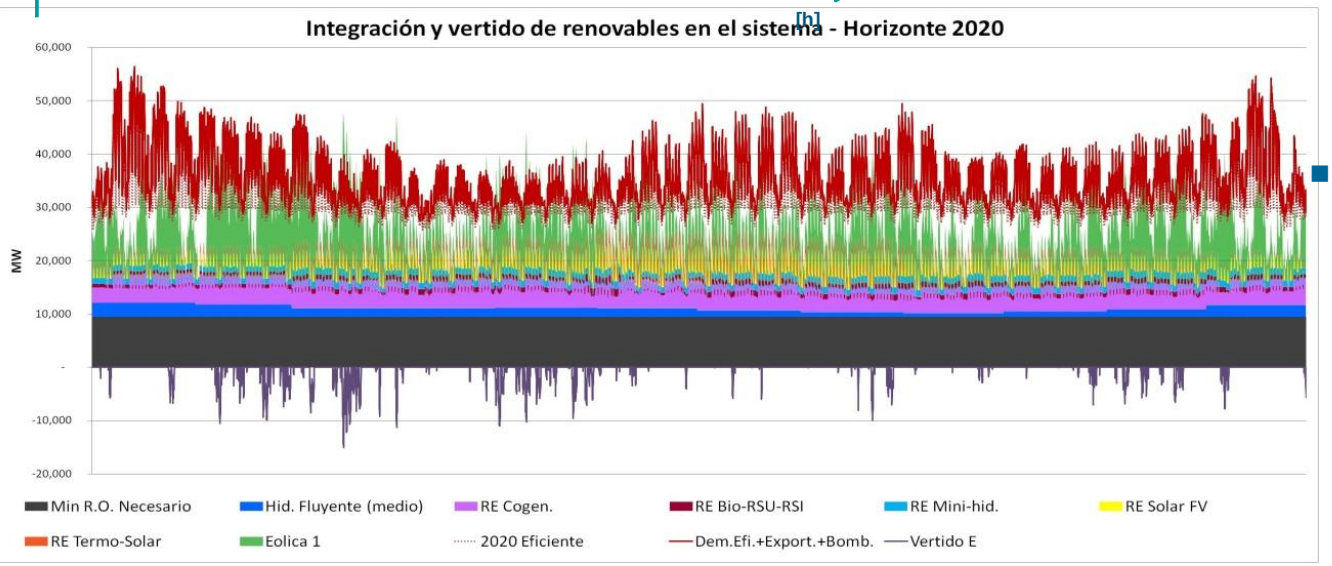
only synchronous generators



- **Shortcircuit current reduction**
- **f/P control..**
- **Virtual Inertia..**

Implications in dispatching: prognosis 2020.





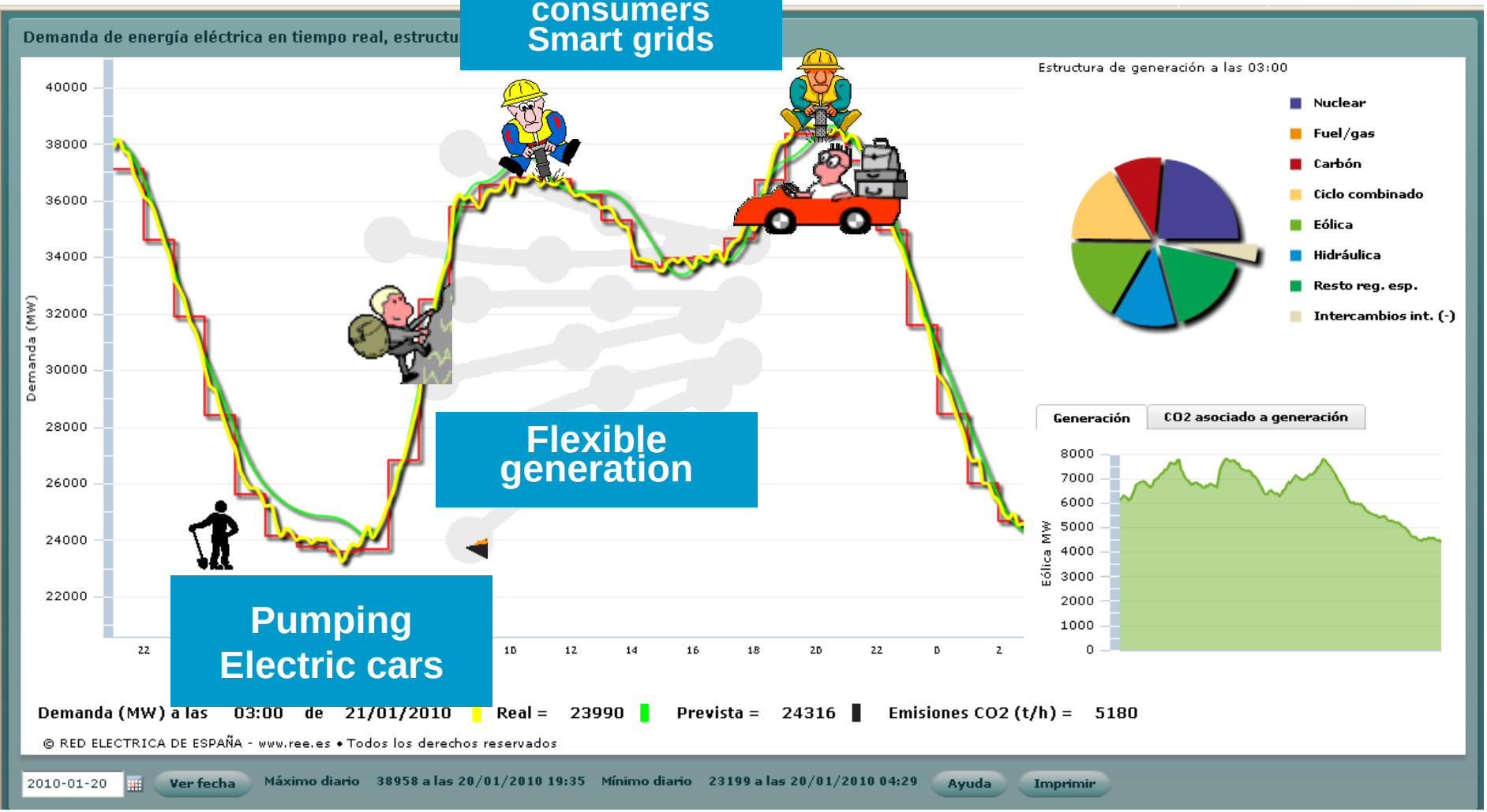
- Scenario:
  - 34.800 MW wind,
  - 3.800 MW TS +
  - 6250 MW PV
- Days with high renewable resource, it is not possible to integrate all RES.
- REE estimations on RES: “average spillage”: 2,3 TWh, equivalent to 3,1% of yearly wind production.

Conclusions:

- The Spanish Peninsular Power System has integrated successfully more than 20 GW of wind power.
- the CECRE and RESCC facilitate the integration of special regime generation and in particular RES in the System Operation.
- As safer the integrations is, more renewable energy is able to be integrated without reducing the system security:
  - special tools
  - more demanding requirements.
  - networks.

- **But not closing…**

But it is not enough!



Thanks for your attention!

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DE ESPAÑA

www.ree.es