RED ELÉCTRICA DE ESPAÑA

Wind energy development in Spain

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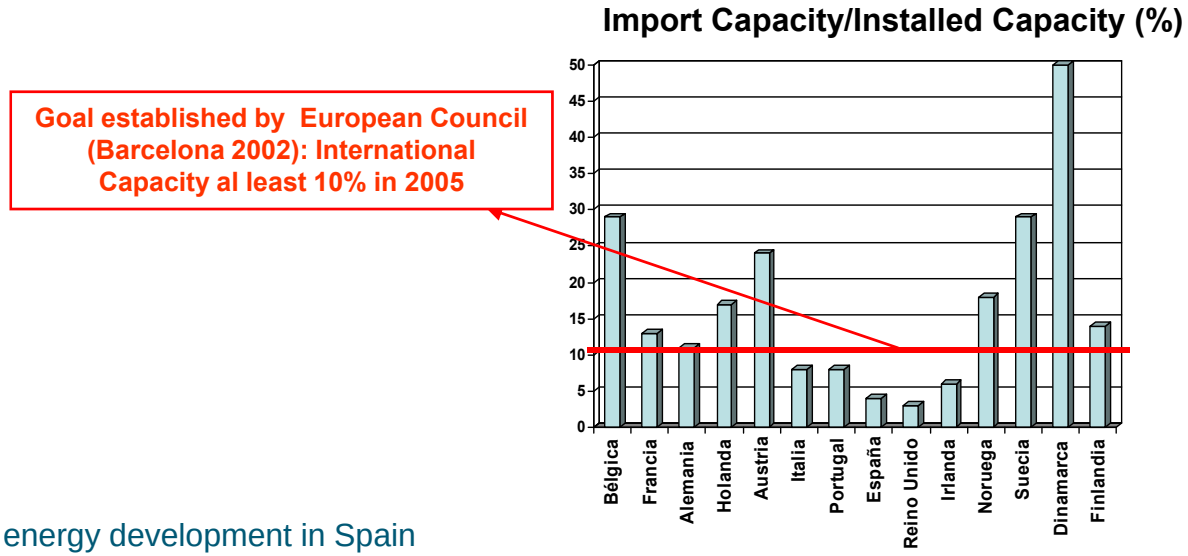
Present Spanish energy outline

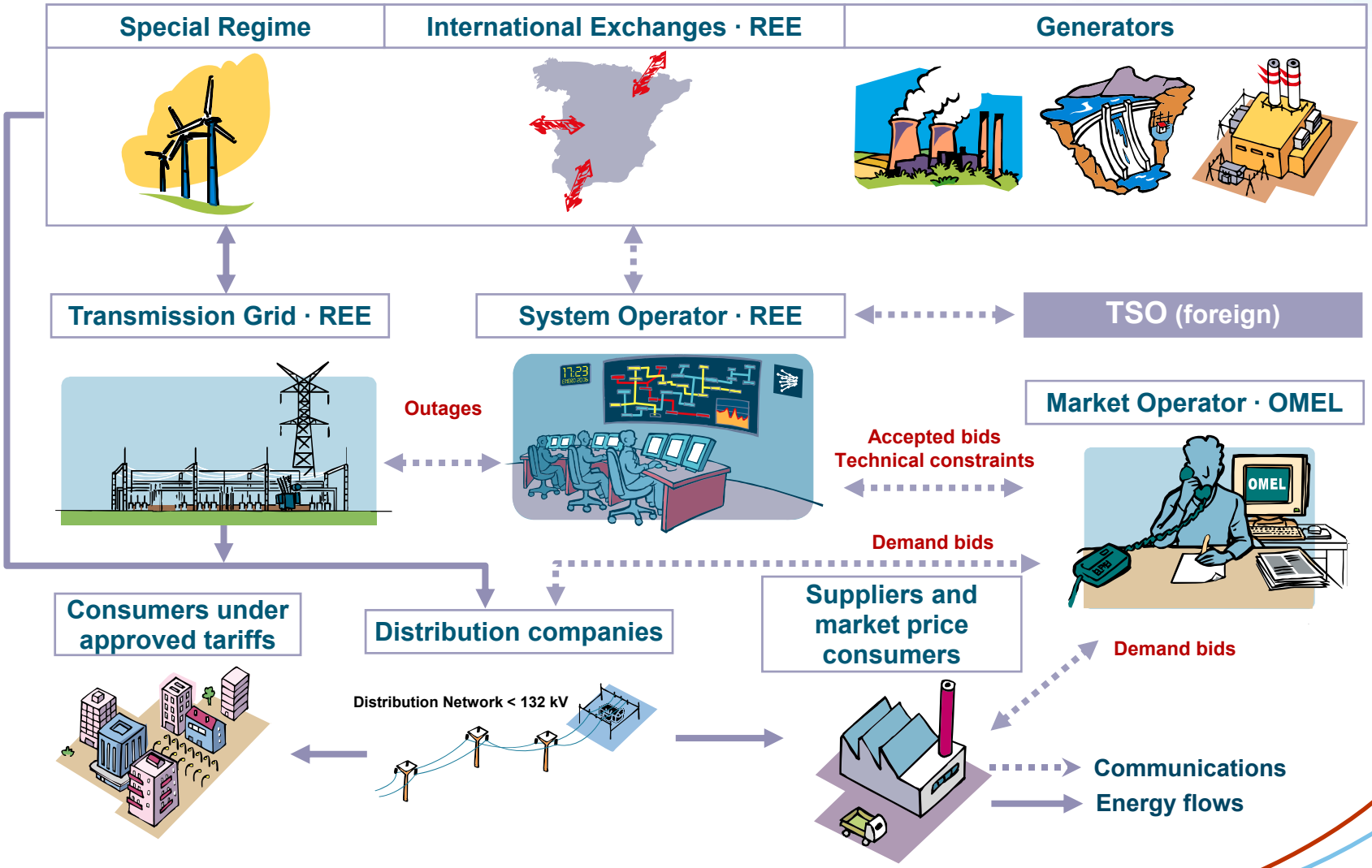
- High external energy dependency (84% in 2008).
- High electricity consumption growth rates, 70.6% between 1996 and 2008:
  - Significant growth of the economic activity (57.8% between 1996 and 2008).
  - Limited improvements in energy efficiency.
- Increase in CO_2 emissions (52,6% between 1990 and 2007).
- Spain is also a peninsula electrically speaking, with weak electrical interconnections with the European Union.



The Spanish electricity sector (I)

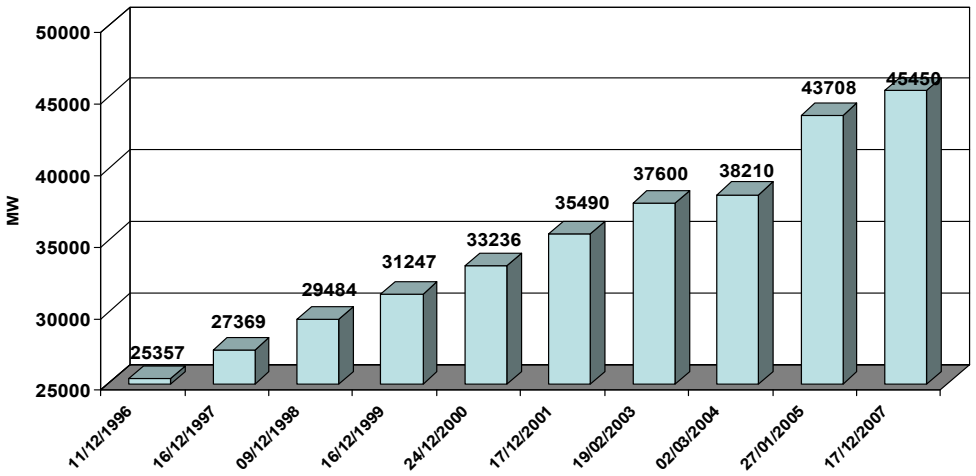
- **REE: TSO (System Operator and Transmission Network Owner)**
  - **Principles of behavior:**
    - **Independence**
    - **Transparency**
    - **Neutrality**
  - **Listed company (80% floating)**
  - **1st TSO in the world. Founded in 1985**
    - **Ownership unbundling of the transmission system.**
    - **Operates coordinately the generation and transmission systems.**
    - **Key figure in making the development of wind energy feasible.**

The Spanish electricity sector (II)

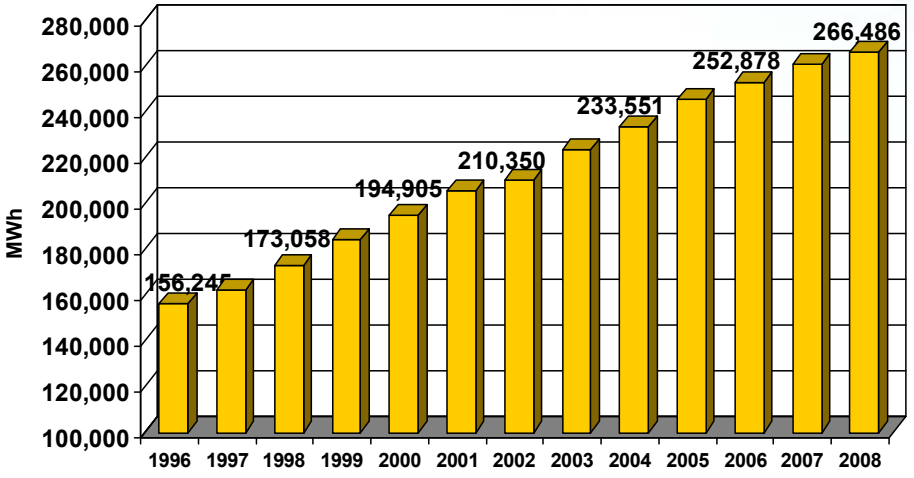


The Spanish electricity sector (III): Load and installed capacity

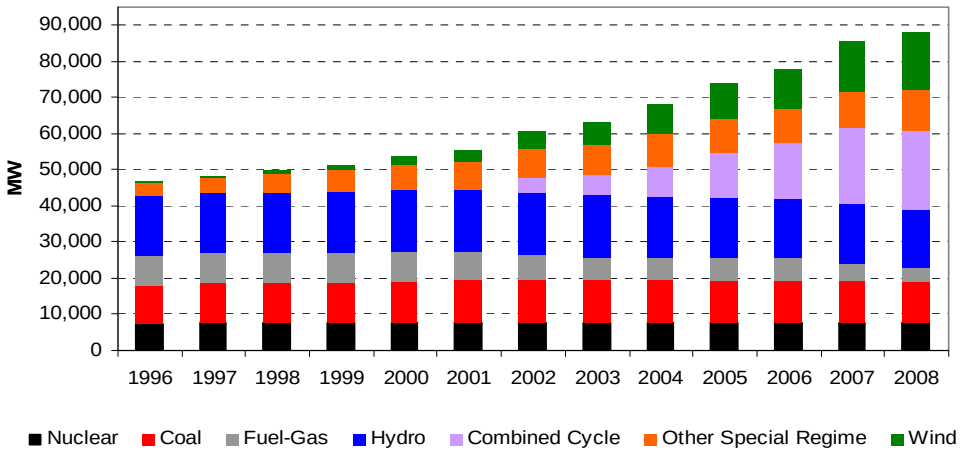
Peak demands in MW 1996-2008.



Annual Consumption in MWh 1996-2008.

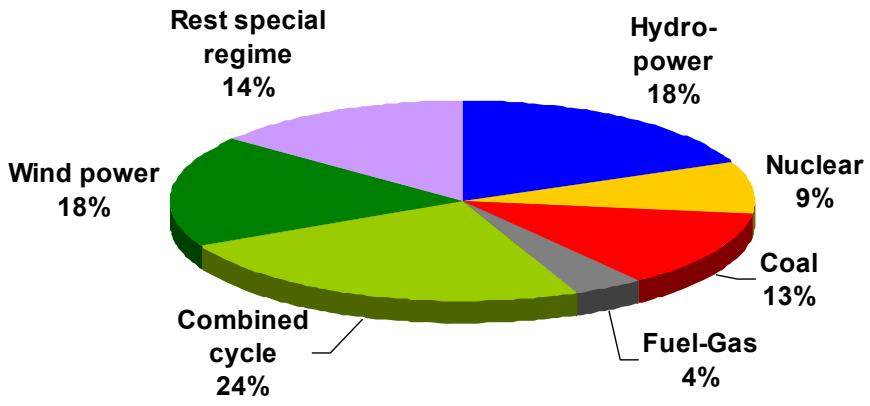


Installed Power in MW 1996-2008.

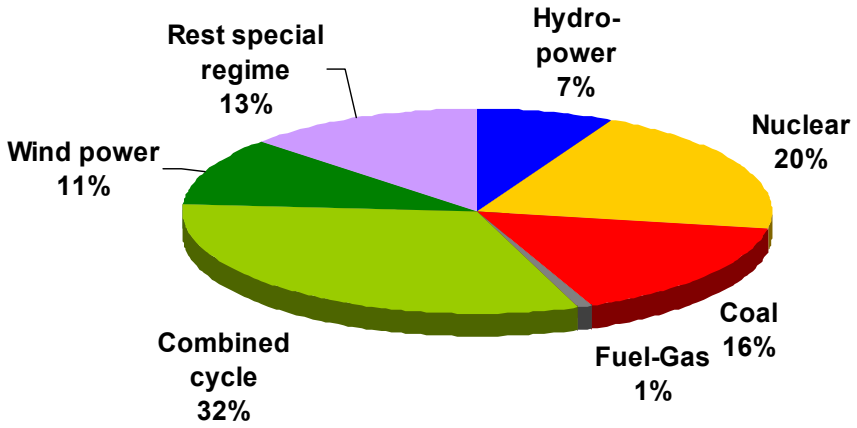


The Spanish electricity sector (IV): Installed capacity[1] and production 2008

Installed capacity



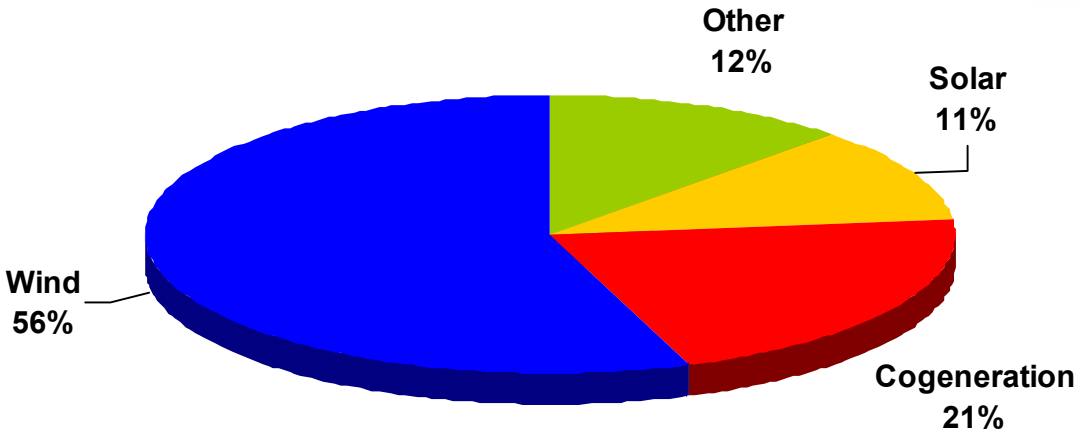
Electricity production mix in 2008.



Technology	MW	%
Hydro-power	16.657	18,5
Nuclear	7.716	8,6
Coal	11.357	12,6
Fuel-Gas	3.585	4,0
Combined cycles	21.570	23,9
Total (ordinary regime)	60.885	67,6
Wind power generation	16.189	18,0
Rest of special regime	12.998	14,4
Total (special regime)	29.187	32,4
Total	90.072	

[1] Wind power installed capacity updated in march 2009

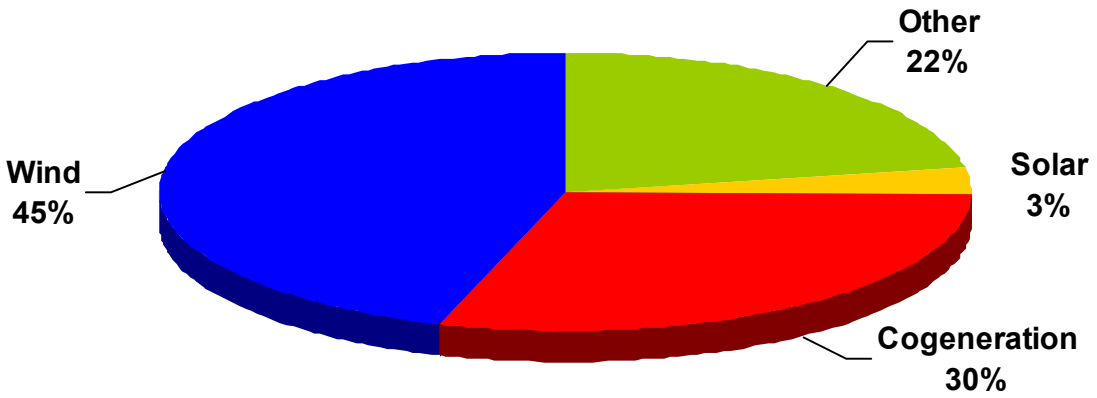
Installed Power Special Regime



Tecnology	MW	%
Solar	3.278	11,2
Cogeneration	6.167	21,1
Wind[1]	16.189	55,5
Other	3.553	12,2
Total Special Regime	29.187	

[1] Wind power installed capacity updated in March 2009

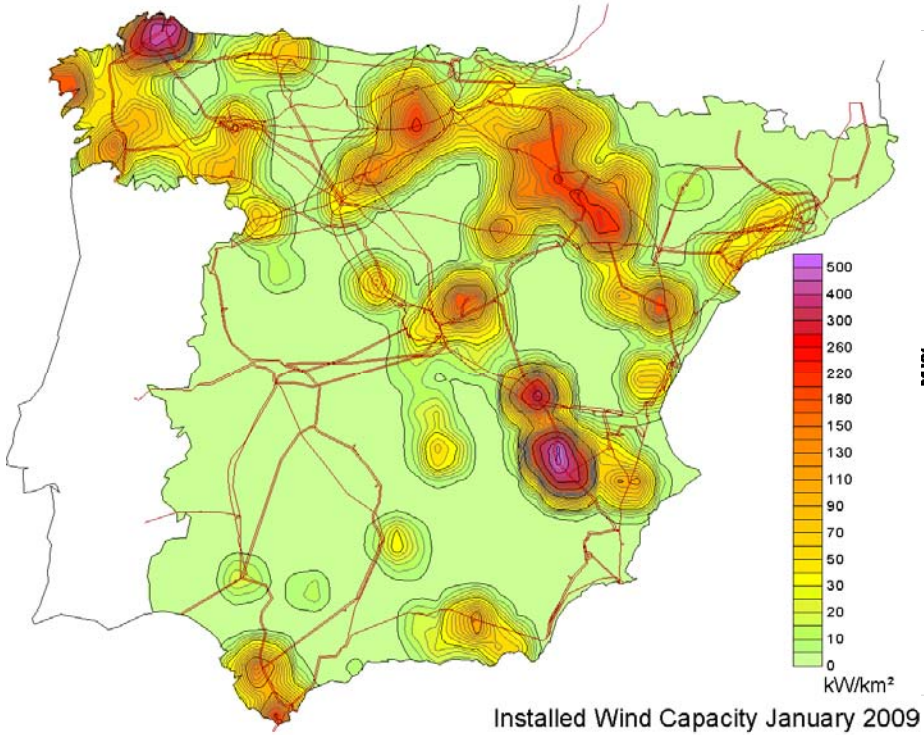
Energy produced in 2008



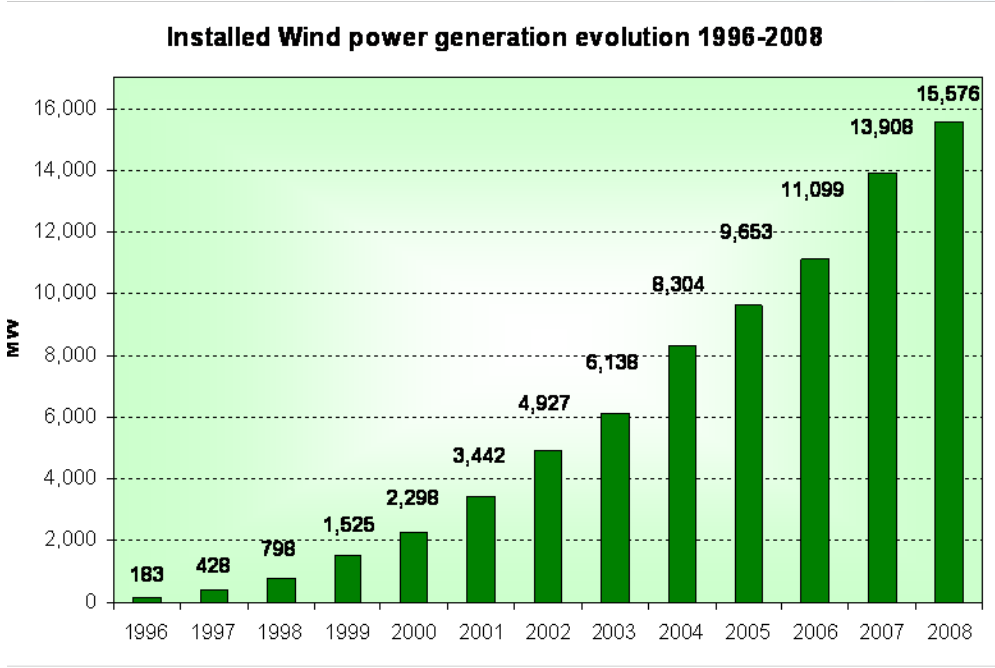
Tecnology	GWh	%
Solar	2.249	3,3
Cogeneration	20.590	29,7
Wind	31.112	44,9
Other	15.304	22,1
Total Special Regime	69.255	

Source CNE. Data Feb. 2009.

Wind Power in Spain today: installed capacity



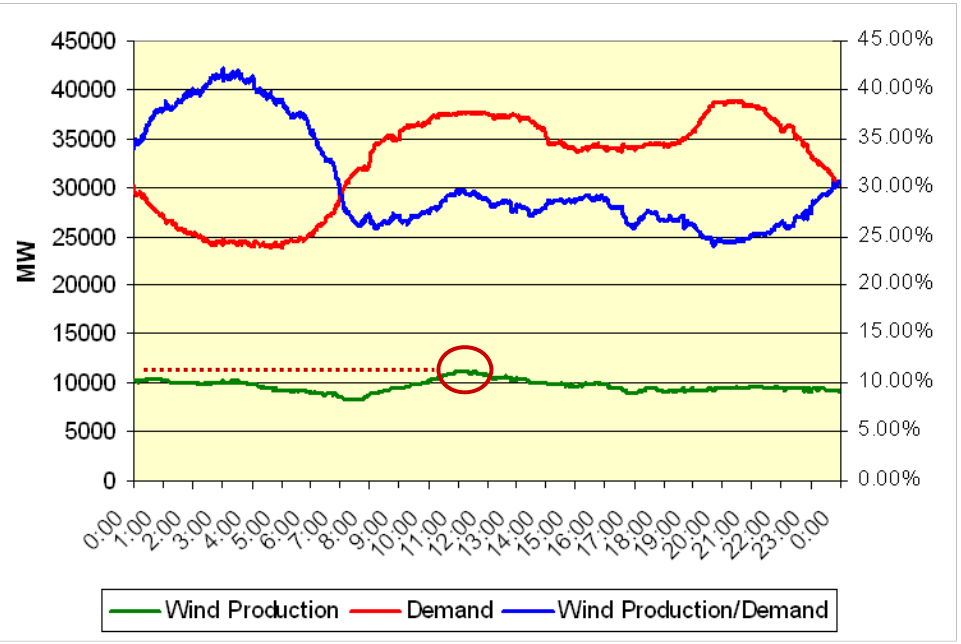
Installed Wind Capacity January 2009



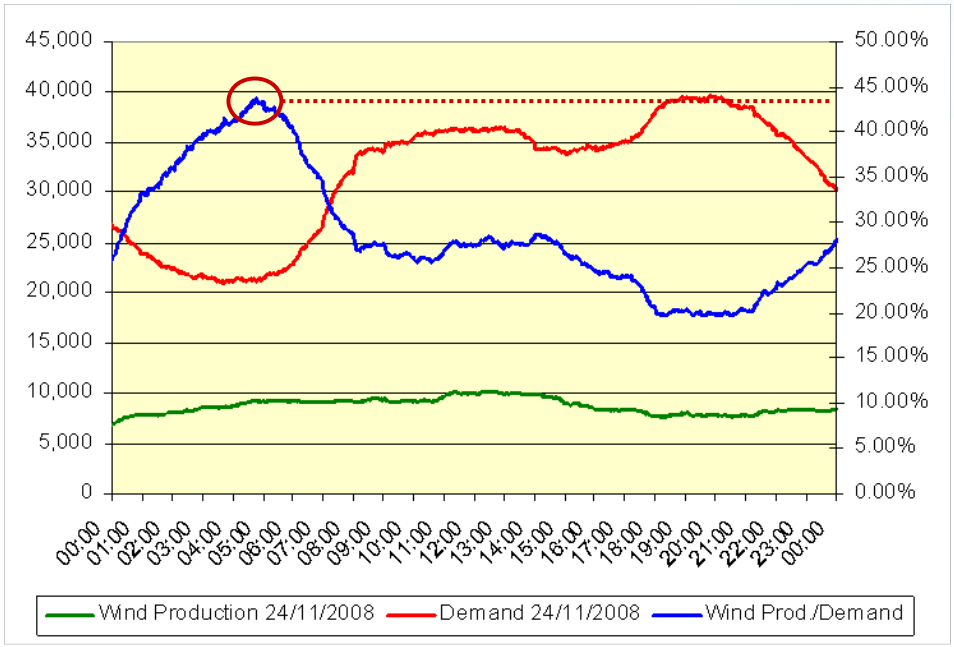
- **Renewable Energy Plan for Spain (August 2005): ~20,000 MW by the year 2010.**
- **Official Network Planning for 2016 contemplates ~29,000 MW.**
- **Further increase expected for 2020 for compliance with proposed EC initiatives (20% of primary energy must come from renewables, which for the electricity sector represents an objetive of 40% from renewables).**

Wind power in Spain today: production records

MAXIMUM PRODUCTION



DEMAND vs. WIND PRODUCTION



Maximum and minimum production

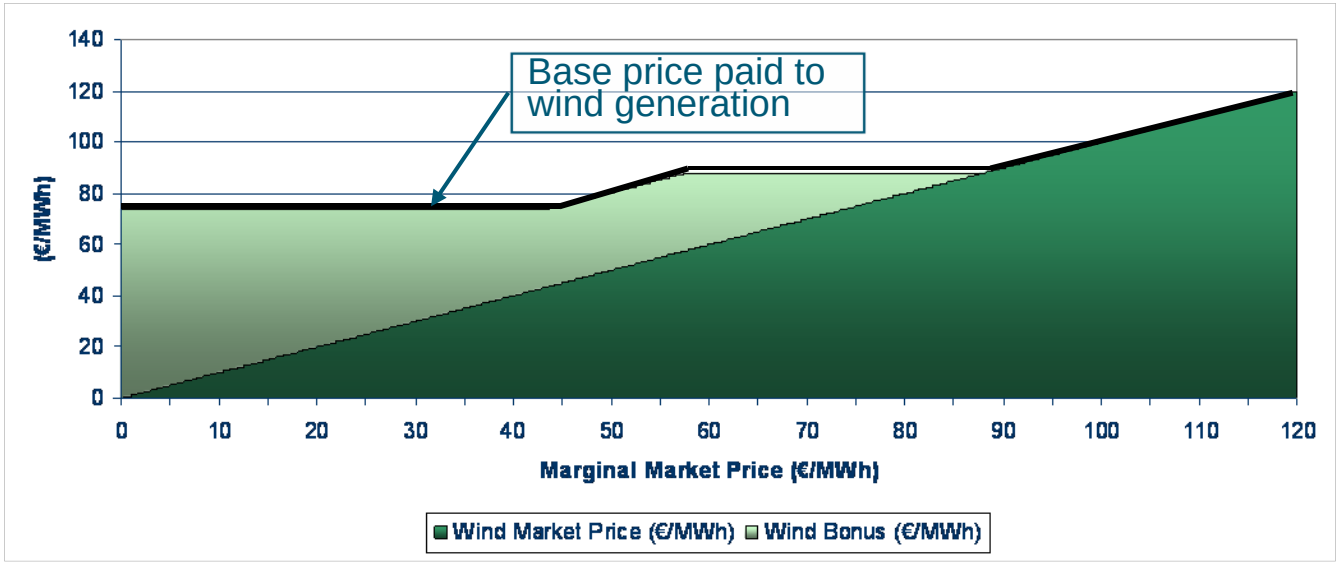
- Maximum: 11.203 MW (05/03/2009)
- Minimum last year: 204 MW (30/05/2008)

Maximum and minimum demand coverage by wind energy

- Maximum: 43% of demand (24/11/2008)
  - Wind production peak : 10.273 MW
  - Demand peak: 39.656 MW
- Minimum < 1% of demand

Cornerstones of the Spanish leadership in wind energy (I)

- **1. Regulation**
  - **Existence of incentives (bonus) that vary according to day-ahead market marginal prices constituting a floored payment system (black line). If market prices are high the wind power does not receive incentives.**

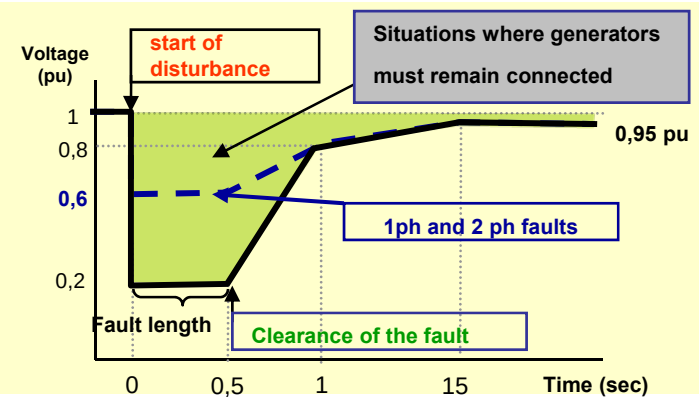


  - **Access and dispatching priority.**
  - **Impulse of the Regional Administrations.**
  - **Existence of a Transmission Network Planning taking into account electricity production criteria, to be developed by Red Eléctrica.**

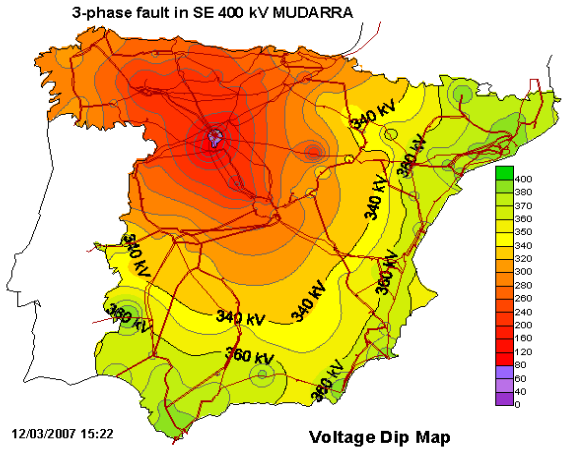
Cornerstones of the Spanish leadership in wind energy (II)

2. System Operation: Challenges

1. Weak international interconnection.
2. Production variability.
3. Forecast difficulty.
4. Geographical and proprietary dispersion.
5. No contribution to system's ancillary services.
6. Electrical System load-generation balance in off-peak periods with high wind production.
7. Technological vulnerability (voltage dips which lead to sudden disconnections).



New "grid code". Operational Procedure 12.3

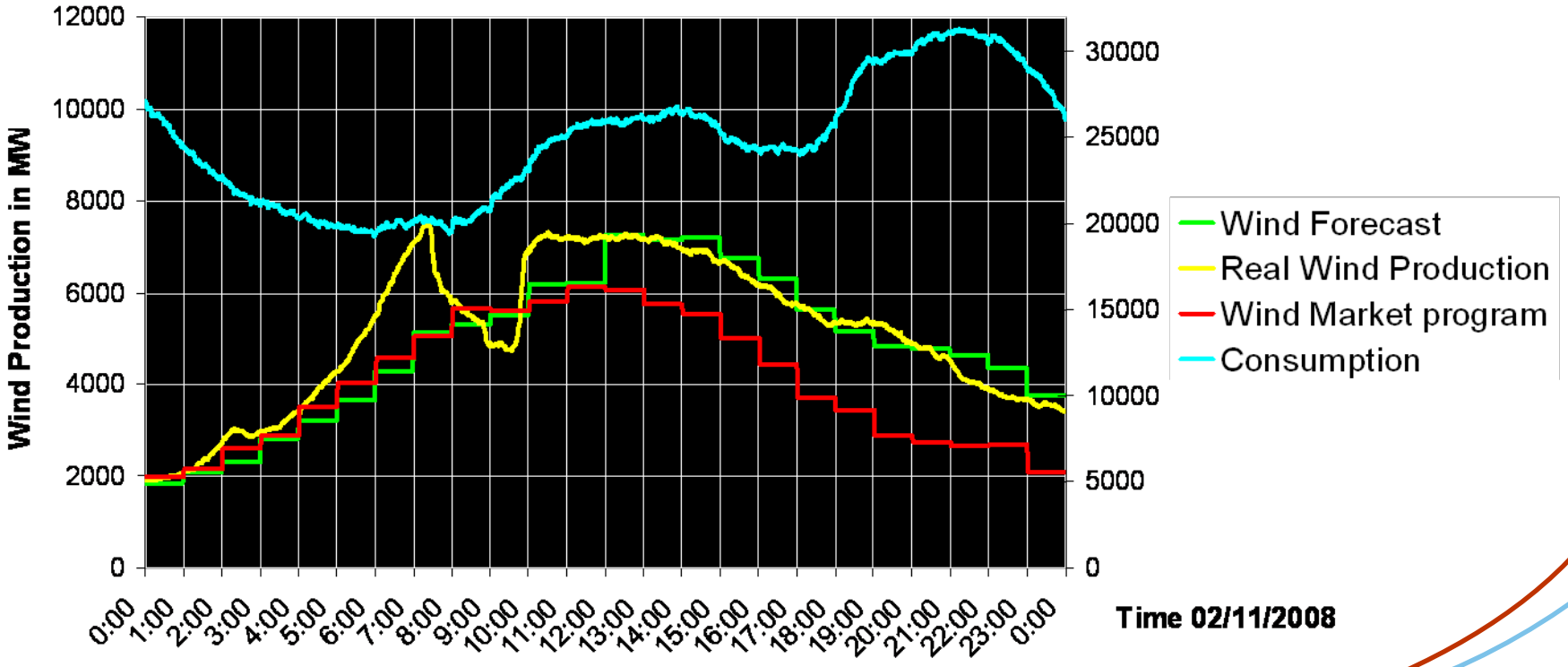


Real Time Risk Assesment

Cornerstones of the Spanish leadership in wind energy (III)

Off-peak load-generation balance with high wind production. An example:

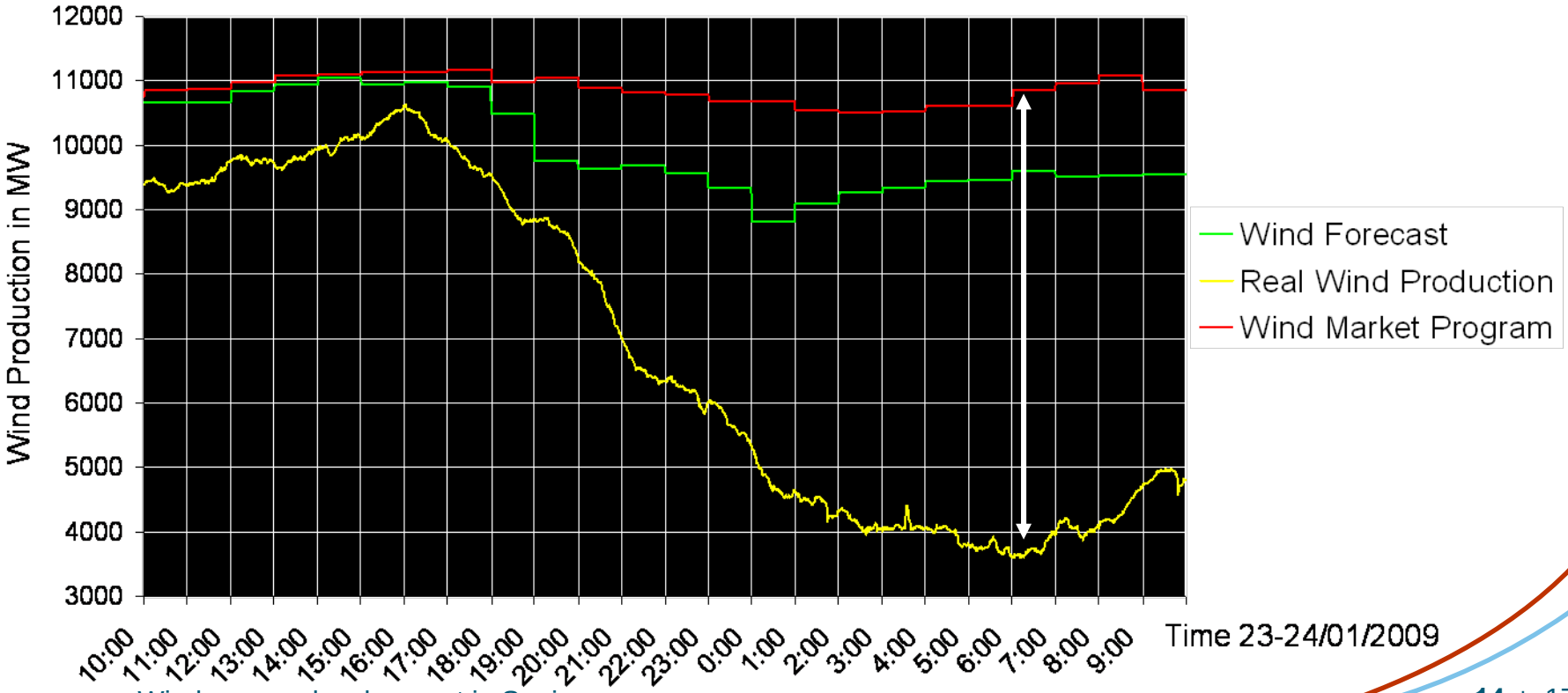
- Low demand (~20 000 MW) with wind prediction error around 3 200 MW.
- Spanish system ran out of downward reserves very rapidly. As a last resort, the only solution to balance the system was to reduce wind production from 7:22 to 9:30 h.



Cornerstones of the Spanish leadership in wind energy (IV)

Wind prediction errors may be very large. Storm Klaus.

- On January 23rd and 24th 2009 the storm Klaus hit the Iberian peninsula. Some wind parks recorded winds up to 220 km/h.
- Most turbines in the north of Spain shut down due to their over-speed protection.
- Difference between real and scheduled wind production was greater than 7 000 MW.



Cornerstones of the Spanish leadership in wind energy (V)

- **2. System Operation: Solutions**

1. **Proposals for changes in regulation by the TSO.**

   Adapting wind power generator technology to ease integration with the TSO leadership.

2. **Creation of the Control Center for Renewable Energy (CECRE) → Supervision and control of generators in real time.**
3. **Maximize hydro-pump storage units possibilities as a System Operation tool.**
4. **Improvement in wind energy forecast.**
5. **International interconnections and transmission grid reinforcements.**
6. **Increase of real time demand side management (consumers participation in demand management, electric car in the future and others).**
7. **Performing system operation enhancing integration of these technologies.**

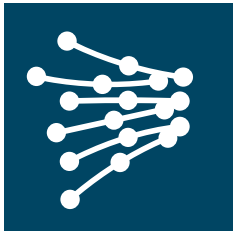
Cornerstones of the Spanish leadership in wind energy (VI)

- **3. Wind development driving forces**
  1. **Project financing.**
  2. **Spanish leadership during early stages of technology development.**
  3. **Strategic decision of Spanish companies.**
  4. **Positive influence of wind farm benefits in the local economies:**
     - **Creating local jobs**
     - **Economic returns to municipalities**
  5. **Positive social perception of wind energy as a renewable energy resource.**

Closing remarks

- Electricity is the key energy vector for integration of renewables.
- Wind energy leadership is possible due to:
  - Existence of REE as an independent TSO very much committed to the renewable technologies integration (CECRE).
  - REE transmission network investment Plan of more than 8.500 M€ 2008-2016.
  - Favorable regulation (sufficient and stable income)
- Integration of wind power in the electric system poses significant challenges and requires innovative solutions.
- Social support and energy dependency push forward renewables.
- We can be more ambitious for the future. We are preparing ourselves for operating the electric system with more than 40% of renewables in 2020.

Thanks for your attention!



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