



Costs of wind power integration into electricity grids Spain

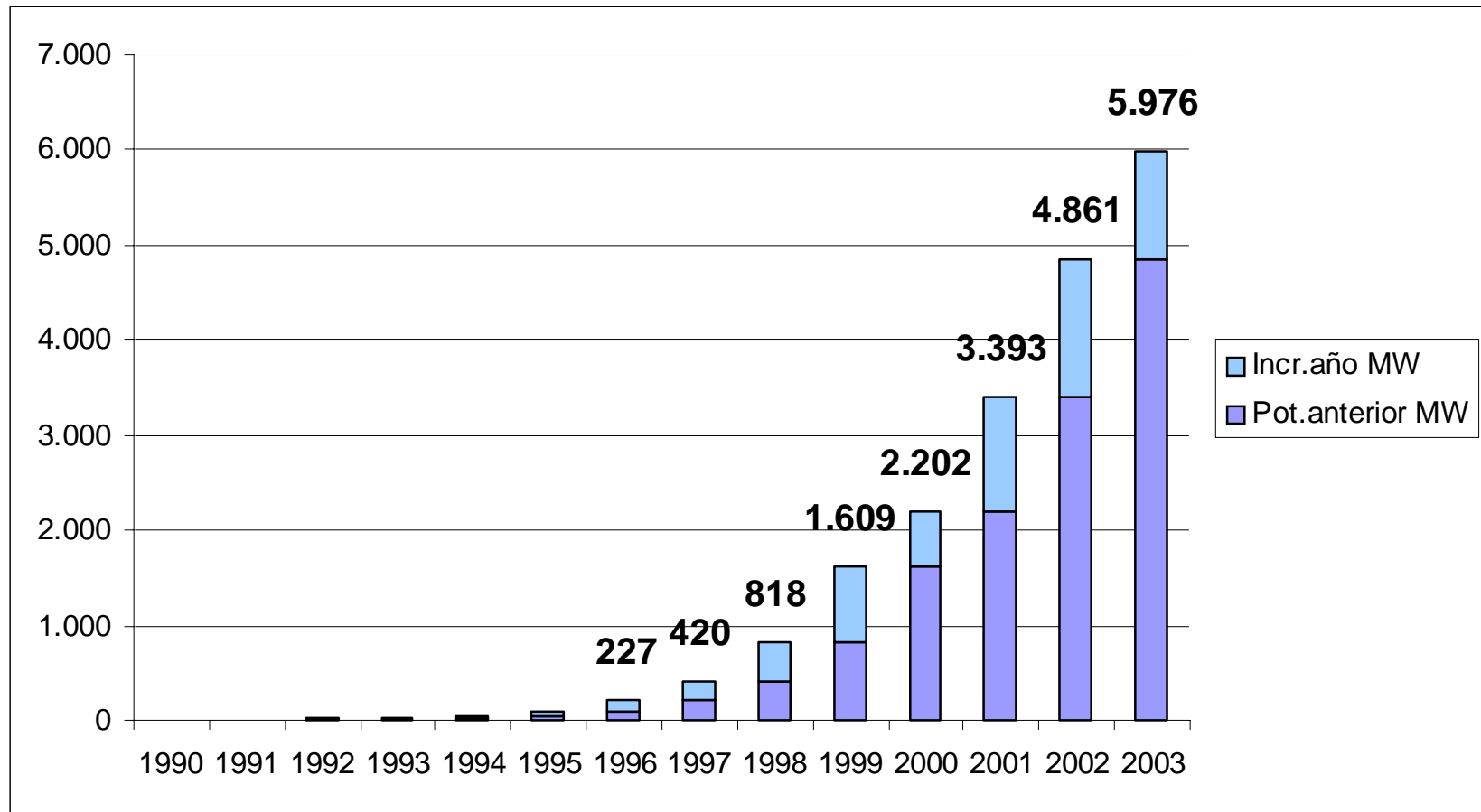
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Main figures of the Spanish power system

- Capacity installed in 2003: Total:60 GW; Wind 6 GW -> 10%
- Capacity installed in 2011: Total:80 GW; Wind 13 GW -> 16%
- Peak load in 2003: 38 GW; Wind 1 GW -> 3%
- Peak load in 2011: 49 GW; Wind 10 GW -> 20%
- Energy in 2003: Total: 215 TWh; Wind 12 TWh -> 6%
- Energy in 2011: Total: 270 TWh; Wind 29 TWh -> 11%

Main figures of wind energy in Spain



Basic regulation

- **Spanish Electric Power Act**
 - ▶ *Special system of electricity generation*
Priority dispatch for RES and CHP. They receive economic incentives + market price.
 - ▶ *Indicative planning, with the target for RES to reach 12% of Spain's total energy demand by the year 2010 (to internalize the social benefits in the tariff)*

- **Infrastructures Planning 2002-2011**
 - ▶ *Targets by 2011:*
 - ⇒ Wind energy: capacity 13,000 MW
 - Based on dynamic stability studies (fault situations):
max. 10,000 MW on peak hours withstanding 0.5 s., and max. 5,000 MW in valley hours.

Basic regulation: New Royal Decree 436/2004

- In order to reach the targets set in the indicative planning
- Two optional mechanisms for the agents: a) feed-in and b) economic incentives to participate in the power market.
- Characteristics:
 - ▶ ***Security and predictability of the economic supports*** in the long term (they are insured during the life of the installation, and they are indexed on the yearly power tariff)
 - ▶ ***Increase the quality of this kind of energy:***
 - ⇒ If the installations participate in the market
 - ⇒ If they do not participate, they must make a production schedule and fulfill it, and they can provide some ancillary services (like tension control or withstanding in fault situations).

Basic regulation: Future regulatory developments

- **New connecting and operating rules**
 - ▶ *Connecting and reinforcement costs are paid by wind farms*
 - ▶ *Update connecting requirements, protection equipment, remote metering and control, resolution of constraints, wind farm clustering, etc.*
- **System to guarantee the origin of the energy from RES and CHP**
- **Transposition of the CHP Directive**
- **Review planning (every 4 years), to enlarge transmission network**

Cost of wind energy

- Investment: 855 €/kW
- Operating cost: 1,23 c€/kWh
- Enlargement of the transmission network (Planning)
- Reinforcement of the grid
- Energy losses in the network
- Balancing costs (capacity reserve)
- Voltage control (reactive control)
- Fault situations (dynamic stability)

Cost of wind energy: Questions

Wind energy poses some difficulties for system operation: 1 Balance, 2 Voltage control, and 3 Dynamic stability

There are other problems: costs of enlargement, reinforcement and energy losses of the transmission network. But, RES also introduces environmental and energy benefits. Planning could incorporate targets for capacity and enlargement.

From the view point of TSOs, What can we do to reduce these difficulties?

1. Do you expect that the production schedule and remote control for wind energy will improve the balancing costs enough?
2. Do you expect that supplementary payments could help to improve the voltage control?
3. What do you prefer: mandatory requirements or economic incentives or both in order to improve the dynamic stability in fault situations?