IBERDROLA's experience in market participation of wind parks

Wind Power and Market Design
University Paris XI

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Paris, 6th of June 2008

IBERDROLA RENOVABLES

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Introduction

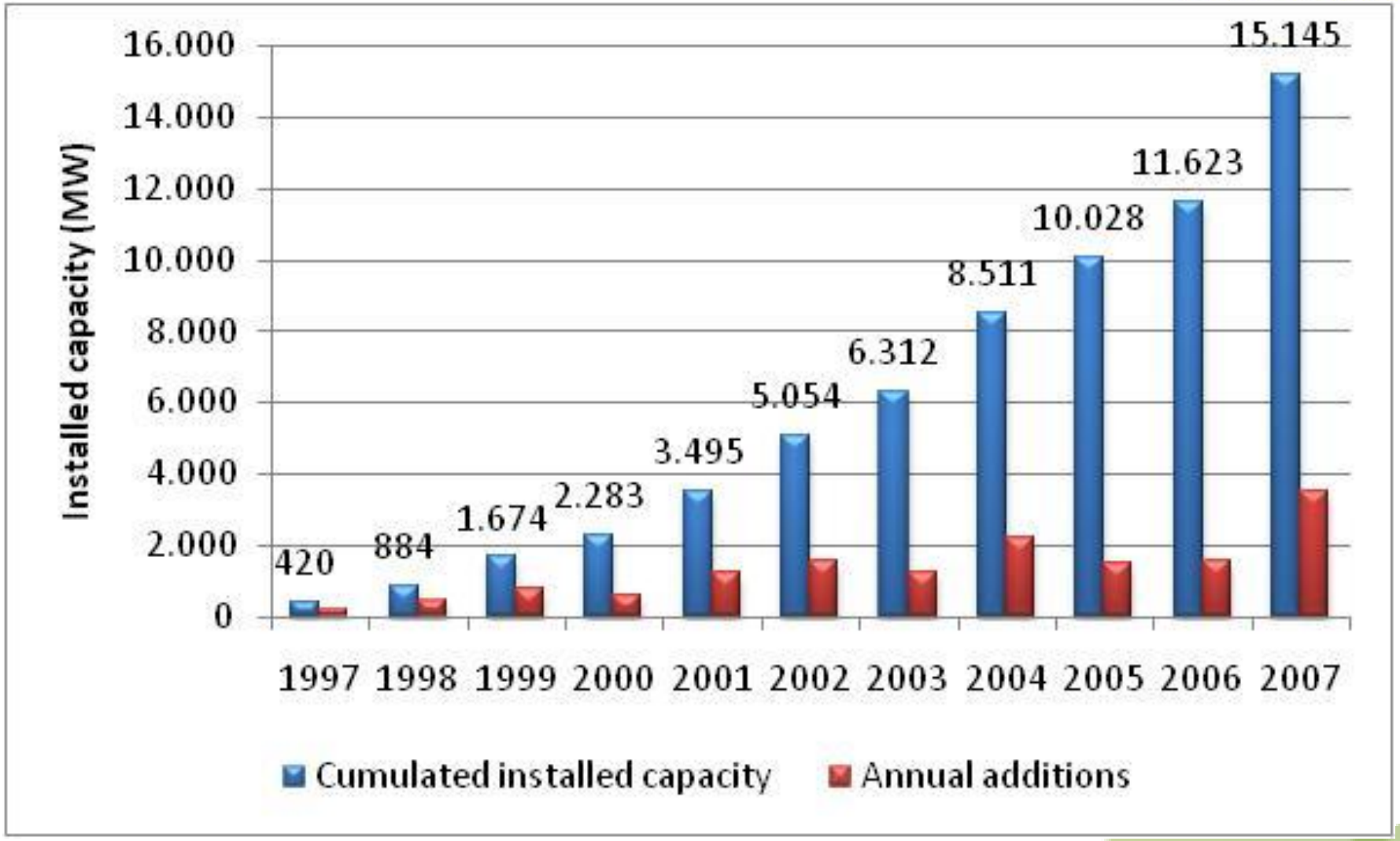
- Spain liberalized its electrical system back in 1998
- Spanish wholesale market design
  - 24 hour day ahead market
  - Succession of shorter term markets and ancillary services
  - Transparent: rules are published and followed
- Renewable Energy Sources (RES)
  - Feed-in-Tariff (FiT)
  - Wind has been the most successful technology
    - 15 GW now (3.5 GW during 2007)
    - 20 GW by 2010 and 40 GW by 2020 ?
- Achieving such penetration wouldn't have possible without a good integration in the system
  - 2004: integration of wind parks into the electricity wholesale market

Spanish wind story

Some data

- Spanish peak demand: **44.88 GW**
- Energy production 2007: **260.84 TWh**
- Wind energy production 2007: **26.67 TWh** (10%)
- Interconnection capacity: **~2.5 GW** (~6% of peak demand)
- Historic instantaneous peak wind production: **10,880 MW** (18th April 2008 at 16.50 – 33,500 MW of demand – 32% of instantaneous penetration)

Spanish wind story



Regulatory framework

- **Royal Decree 2818/1998**
  - **Feed-in-Tariff**
    - **Technology specific**
  - **Specific technical conditions**

- **Royal Decree 436/2004**
  - **Market option: market price + premium**
    - **Forecasting obligation**
    - **First measure to better integrate wind in the market**

- **Royal Decree 661/2007**
  - **Current regulation**
  - **Market + premium with a cap and a floor**

Regulatory framework

- **First main change: Royal Decree 436/2004**
  - **Technical requirements**
    - **Mandatory forecast of output (> 10MW)**
      - 1 hour ahead of each intraday gate closure
      - Imbalance
        - 20% dead band & 10% average estimated system total cost (€/kWh) per deviated kWh.
    - **Modulated reactive power generation**
      - Modulation from inductive 0.95 power factor to capacitive 0.95 based on 3 scenarios (low, medium and peak load) with economic incentives between -4% to +8%.
    - **Dip ride through capability**
      - No mandatory obligation
      - Economically incentivized

Regulatory framework

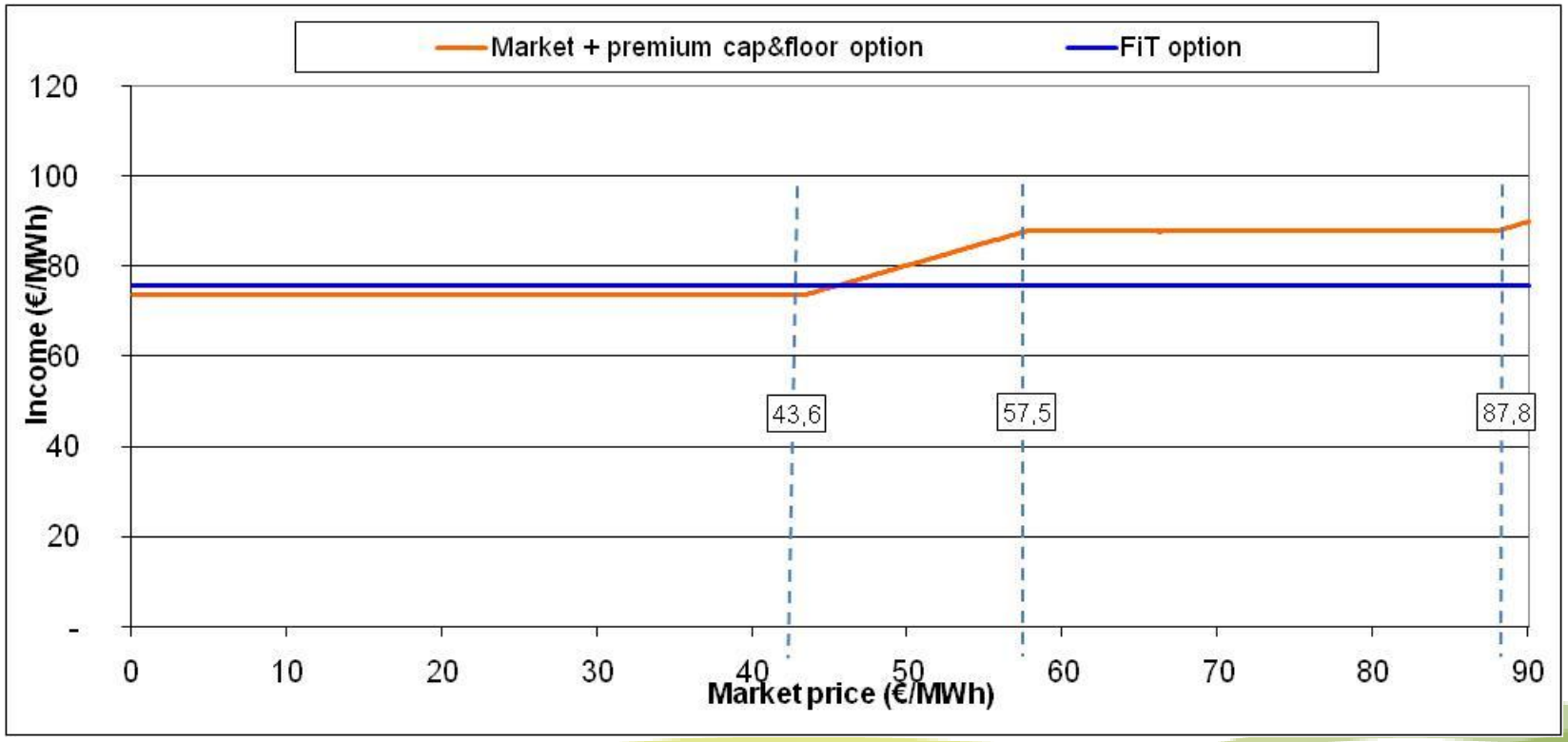
- **Royal Decree 436/2004 (ii)**
  - **Economic novelties: alternative to pure FiT**
    - **Integration into the wholesale market**
      - Market income
        - Participation in all markets and servicess
        - Exposure to all the economic signals, including full imbalance costs
        - 2 exceptions:
          - No payment for secondary reserve band
          - No voltage regulation, power factor regulation
        - Possibility of imbalance aggregation
      - **Additional premium for each kWh produced**
- **90% of wind parks switched to the market option**

Regulatory framework

- Second change: Royal Decree 661/2007
  - Technical novelties
    - Mandatory connection to delegate dispatch centres (DDC)
      - Each DDC is connected to the SO Renewable Control Centre CECRE
      - Sends real time information about production
      - Receives real time orders from SO
        - Curtailments
        - Reactive set points
    - Capacity for the SO to set specific reactive power set point
    - Non-controllable generators are forbidden from participating in ancillary services
    - Mandatory dip ride through capability for all wind parks (old & new)
    - No more dead band for imbalances for fixed tariff option

Regulatory framework

- **Royal Decree 661/2007 (ii)**
  - **Economic novelties**
    - **Cap & floor to overall income of wind generators**



System integration

- **10 years ago**
  - Several GW of wind was “unrealistic”
- **Now**
  - 15 GW without too much problems
- **Future**
  - 40GW by 2020 doesn’t seem unrealistic anymore

- **Strong commitment in integrating both technically and economically RES into the system from**
  - Regulator
  - SO
  - RES operators

System integration

System control

- High wind penetration levels
  - Lots of dispersed & uncontrollable generating units
- Iberdrola's vision
  - Iberdrola has been the first big utility to bet on wind
  - Same philosophy than for the rest of generation
  - Development of **Control Centre for Renewable Energy Sources: CORE**
    - Monitoring in real time > 5,000 wind turbines
    - > 300 variables per turbine
    - Capable of operating wind turbines
      - Both active and reactive power

System integration

System control

- This centre is at the origin of the Spanish SO RES control centre (CECRE)
  - It is now mandatory to any RES to be connected to the CECRE through a Delegate Dispatch Centre

- SO is now in control of RES facilities
  - Real time knowledge of production
  - Capacity to curtail what is needed in a practical way (talking about thousands of small generators)

- Crucial for reaching current wind penetration
  - **Gives confidence to SO of being in control**

System integration

Voltage control

- Power factor = 1
- Power factor table (0.95 ind. to 0.95 cap.)
- Capacity of the SO to set specific points
- Future: voltage set points ?

Dip-ride-through capability

- Mandatory tripping at 85%
- Economic incentive to dip-ride-trough capability
- Mandatory dip-ride-through capability

- **This has been the reason for wind curtailments**

System integration

Intermittency

- System has to adapt to variability of the output
  - Dispatch problems & higher costs
- If future production is not known: technical problem
- If production variability is known: economical problem

  - **Forecasting is the solution**

- Market integration and use of existing market mechanisms to solve imbalances
  - “Reasonable” rules are needed.

System integration

Next steps

- Today wind is still considered non-controllable generation
- Forbiden from providing ancillary services

- This is an economical problem, not a technical one
  - Wind can provide such services
  - There is a lack of economic incentives to do so

- In the future, with real high penetration level
  - Wind will have to provide all system ancillary services
  - Regulation has to change to assume and economically incentivize such participation

Reasons for success story

- **Political will**, with wide social support
  - 85% dependency on energy imports
  - Scenario with low energy prices
- Regional and local authorities involvement in wind deployment
  - **Minimizes NIMBY effect**
- Wind industry development at the same time
- **Big utilities involvement**
  - Highly concentrated wind sector, with high professionalization of wind producers

Reasons for success story

- **Stable and almost risk free support mechanism**
  - FiT has been a good choice
- **Transparency of the electricity market**
  - Independent bodies for SO and MO
  - Cost public and audited
- **Innovative solutions for technical and economical integration**
  - Market integration is a key factor to transmit and receive all the economic signals to optimize the power systems operation