

# Economical Analysis Of Energy Storage For Renewable Energy Farms

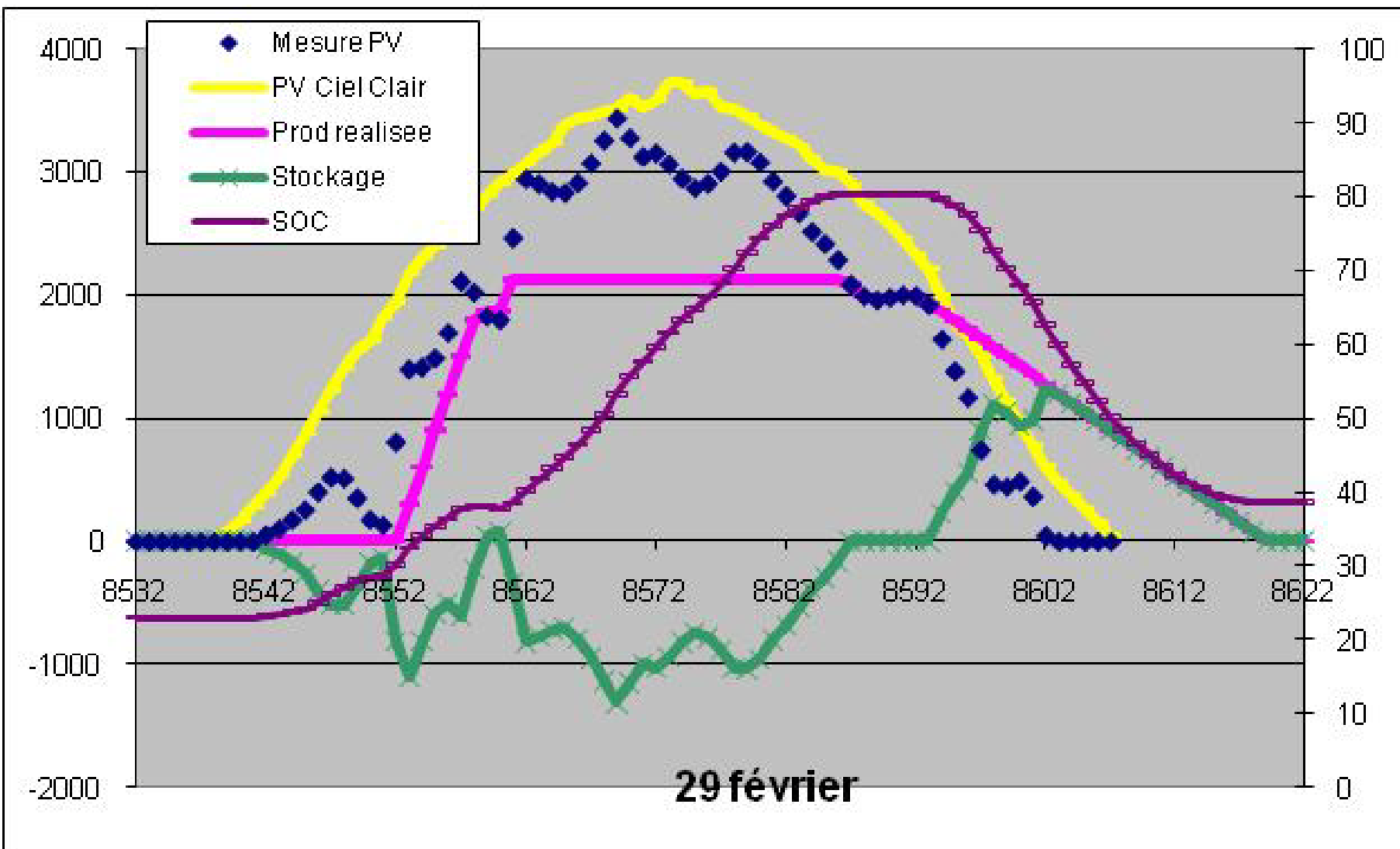


Experience of EDF EN on the basis of 3  
call for tender issued by the French  
Government in 01/2010; 11/2010;  
09/2011

- Main object : 5MW PV farms associated to storage in Corsica, Martinique, Guadeloupe, Guyana, La Réunion
- Main Requirement : Storage is at minimum 30% of PV farm power; functions required are essentially limitation of power excursions and fluctuations , frequency control,
- No bidder were selected – lessons learned :
  - Insufficient requirements gave rise to very high energy prices,
  - Bidder were not really ready to manage the high degree of sophistication required by an optimal design of storage in the context of a PV farm

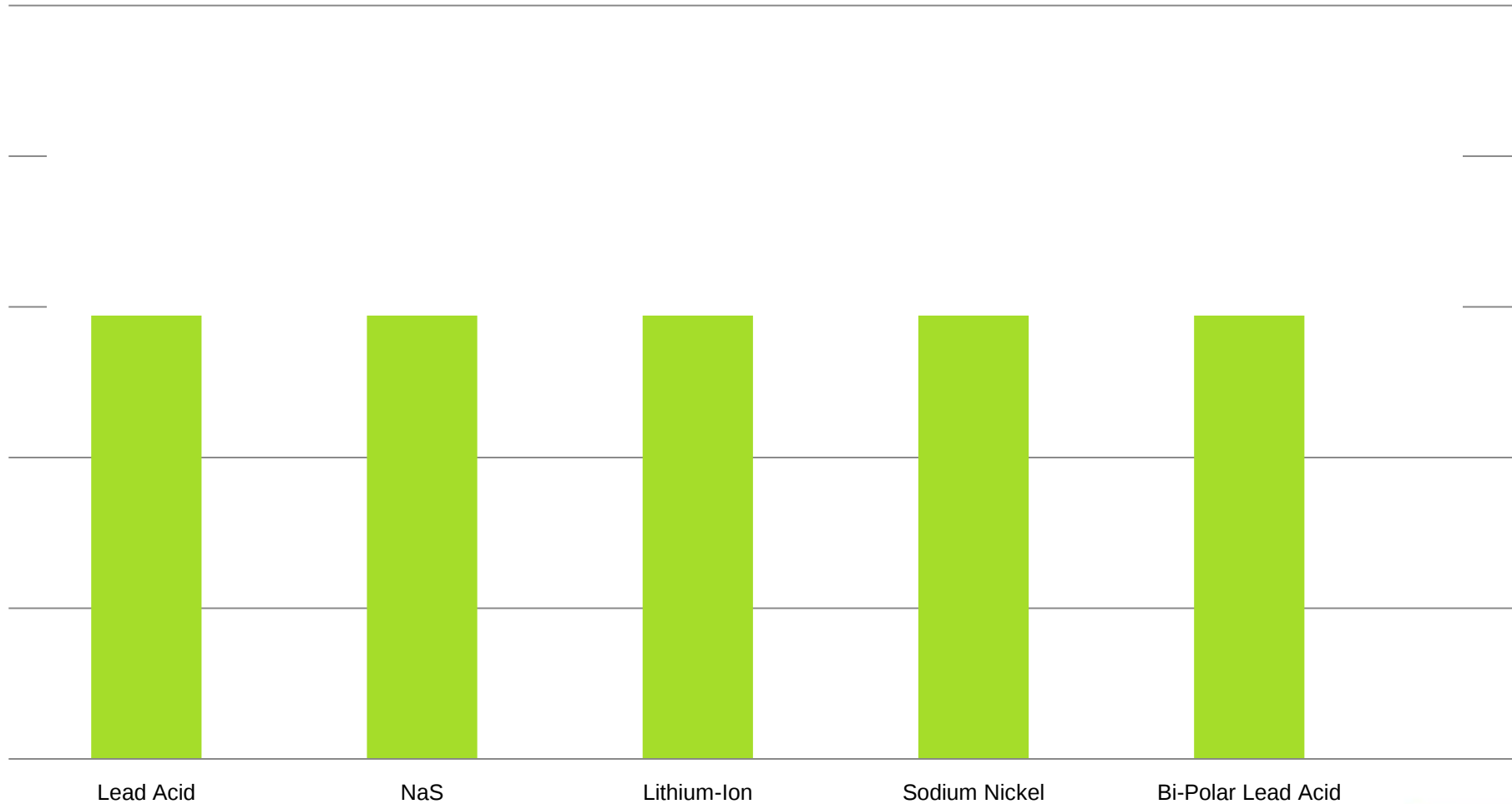
# 09/2011 Call for tender for 5 MW PV farms + Storage

- Requirements were much more sophisticated, demanding in energy capacity, and probably representative of a typical utility requirement :
  - Demand for a guaranteed Power, corresponding to 40% of Maximum PV farm output
  - One single constant Power step during one day,
  - Announcement of Power prediction, starting and end of the Power output one day before (i.e. requirement for a Solar irradiation prediction)
  - Error has to be less than 2,5%, with strong penalties,
  - Strong Reactive Power Requirement : up to 2 times Active Power
  - Frequency regulation : 10% of guaranteed Power
- Maximum Price of Energy : 500 €/MWh



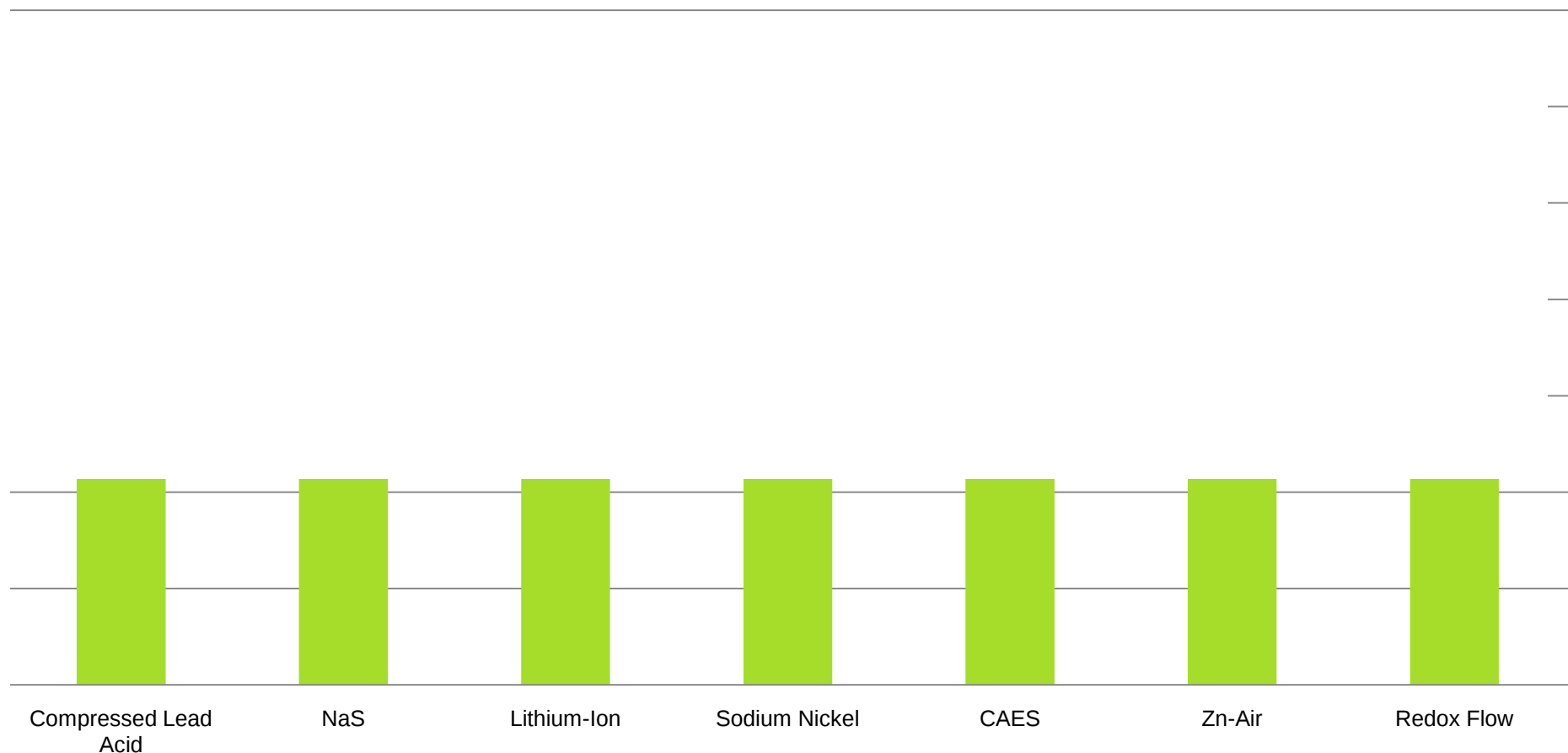
# Additional Price Of Energy For different Technologies **available today**

**Additional COE (€/MWh) : Total COE – PV Farm alone COE**



# Additional Price Of Energy For Technologies **Available Tomorrow**

**Additional COE (€/MWh)**

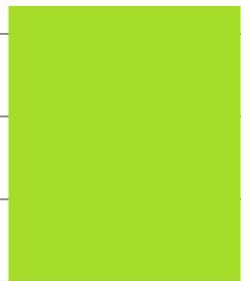


# 11/2010 call for tender for wind farms + storage

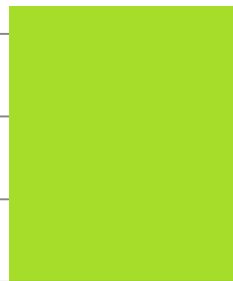
- Requirements are much lighter than for PV : essentially limitation of fluctuations + frequency regulation
  - D-1 announcement of Power output Shape, with 30 minutes stable periods; error for prediction can be +/- 15%
  - Primary reserve for 10% of wind farm during 15 minutes

# Additional Price Of Energy For different Technologies **available today**

**Additionnal COE (€/MWh)**



Sodium Nickel



NaS



Lithium Ion

- There is a complex learning process on optimal requirement – optimal sizing of batteries.
- The differences in Cost Of Energy provided by different storage technologies are not so huge,
- Energy Storage Function suitable for optimal utility requirements may double the price of PV Cost Of Energy
- For Frequency regulation only, cost penalty is much less, but market is probably narrow,
- Cost roadmap for storage has to be more aggressive if we want storage solutions to be implemented on a wide basis, not a niche market : Prices should be divided by at least 2 compared to the available 2020 roadmaps provided by manufacturers
- This is probably possible by volume effects + technologies