



Electricity Market Structure, Wind Penetration and Information Aggregation

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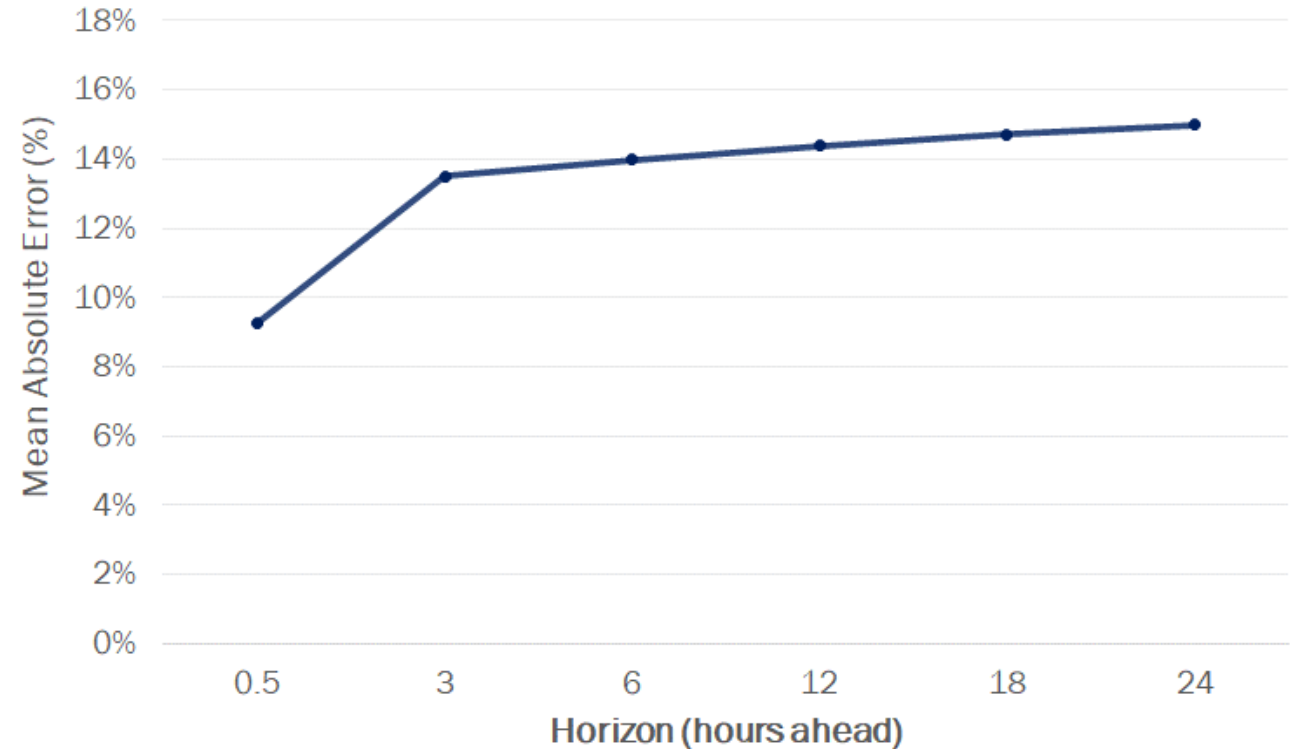
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- Energy is bought and sold in most U.S. ISOs through a **two-settlement system**
- Wind penetration brings challenges for this market structure because day-ahead (DA) wind output is uncertain, and **non-wind units take time to adjust**
- Forecast errors should be corrected as soon as possible to minimize the cost of rescheduling units

What happens after the DA market, if there is new information about wind?

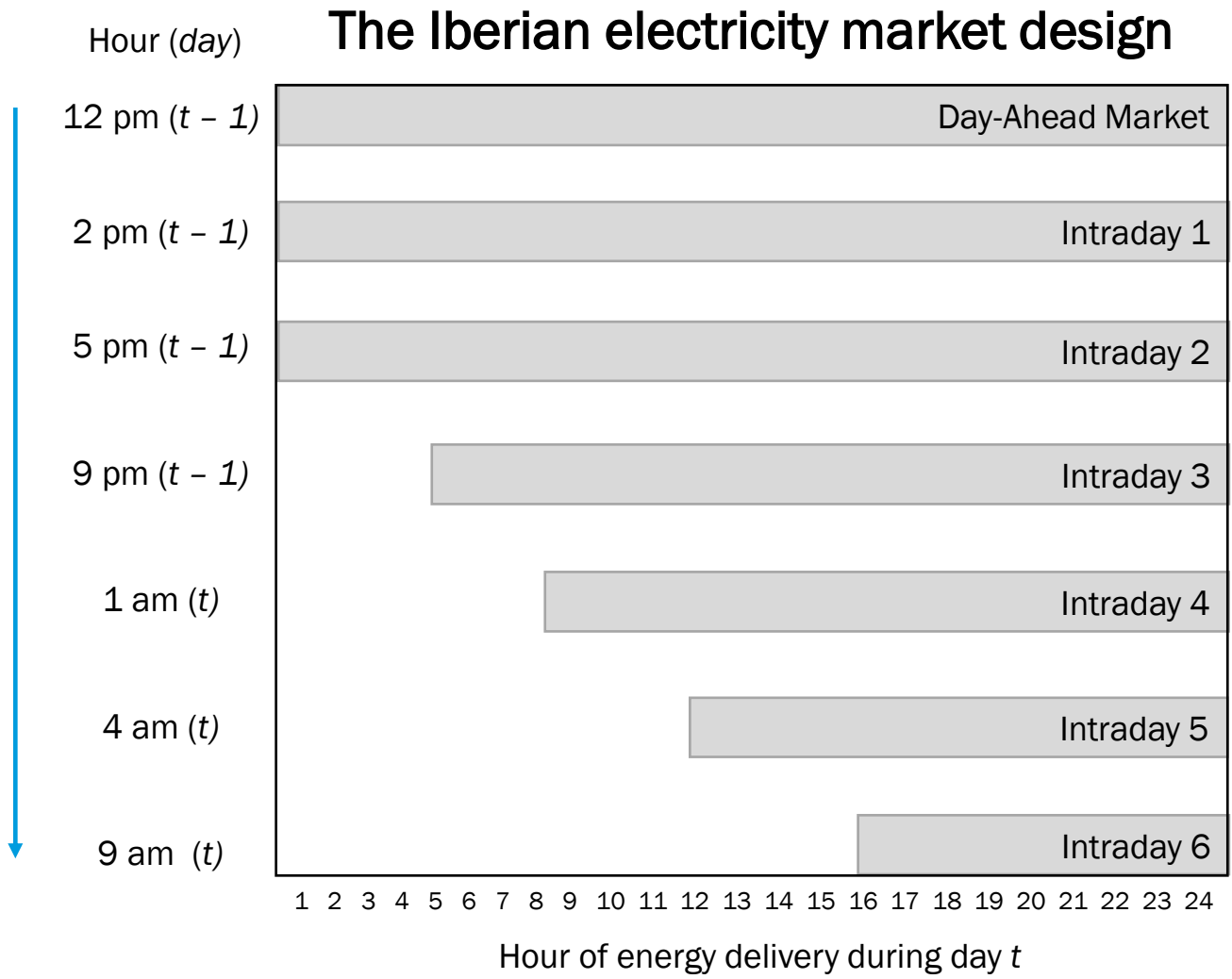
- Intraday commitment processes to facilitate rescheduling in advance of real time → **advisory prices**
- **Central forecasting service by ISOs**

Average wind output forecast accuracy



Source: Own elaboration based on data from ISO New England, 2017

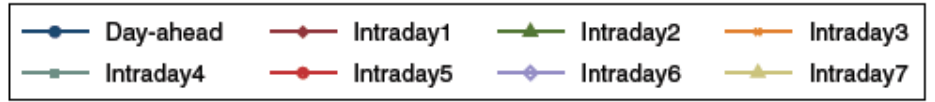
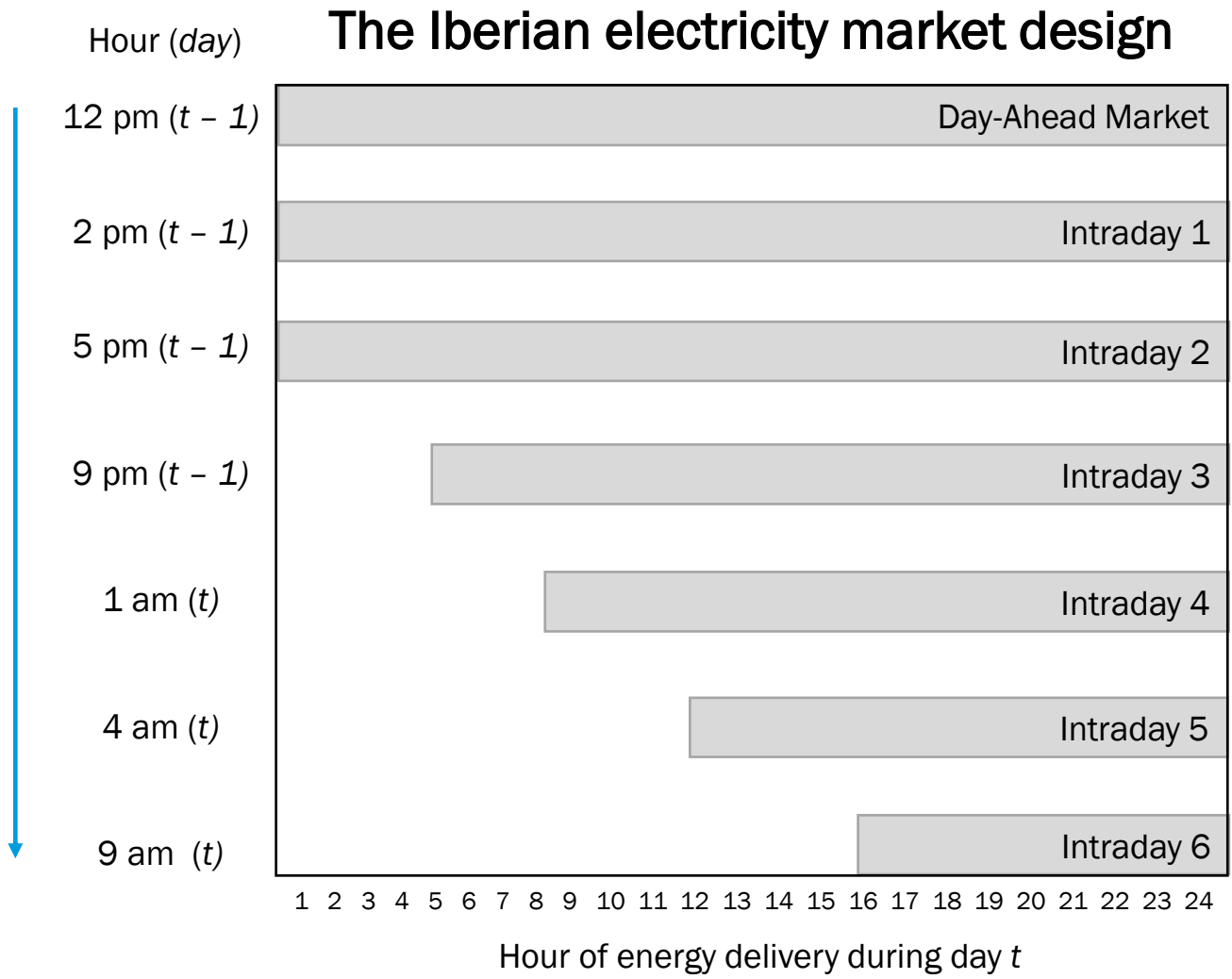
An alternate approach: sequential re-trading markets



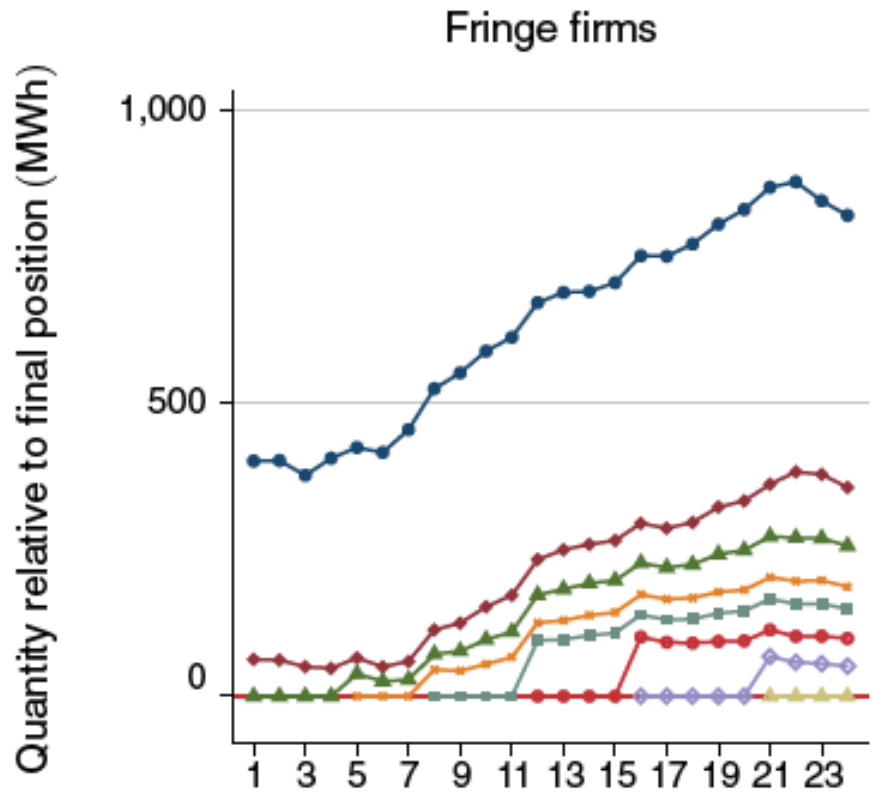
Do wind farms adjust their forward positions in the Iberian intraday markets



An alternate approach: sequential re-trading markets



Panel A. Wind farms



Source: Ito and Reguant (2016)

Which approach is more efficient?

- We use **optimization methods** and **experimental economics** to compare two designs:
 - ✓ A two-settlement system with central forecasting service (**2S**)
 - ✓ A multi-settlement system with sequential intraday markets (**MS**)

Focus here is on the optimization models

- **Unit commitment and dispatch decisions** made by the ISO, not bidding decisions
- Models are run for 24h on **representative wind days**, and **co-optimize** energy and reserves
- MS includes **4 intraday stages** and **physical constraints**
- Wind production forecasts for individual farms are from ISO New England

- MS is more likely to yield *higher* annual uplift than 2S*
 - ✓ MS better than 2S when DA forecasts > ID forecasts > RT output
 - ✓ Inaccurate ID forecasts (e.g., when DA forecasts > ID forecasts < RT output, and RT output > DA forecast) lead to inefficient commitment decisions
 - ✓ Co-optimization of energy and reserves → peaking units require uplift when cheaper baseload units substitute between energy and reserves, and set the energy price → more frequent outcome in MS as there are more stages
 - ✓ A unit may also require more uplift if settlement occurs at ID prices < RT prices that would be received in 2S

*Hohl, Lo Prete, Radhakrishnan and Webster. “Comparing two-settlement and multi-settlement market designs for wind integration into the NPCC electric power system”. *Working Paper*.



Thank You!

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Tony Kwasnica

Mort Webster

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