BALANCING MARKETS PERFORMANCE: EVIDENCE FOR THE ITALIAN MARKET

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Motivation and aim of the paper

- High RES penetration in electricity generation has influenced wholesale markets from day-ahead to real time.
- Optimal design of a sequence of sessions to accommodate RES production at the minimum cost for the system
- The correct evaluation of RES impact on the system may be calculated only contrasting lower wholesale prices coming from the so-called *merit order effect* with higher costs due to direct support and to balancing activity.
- We provide a **detailed evaluation** of balancing costs which are disentangled for **hours, market purpose** and most importantly by **technologies** We highlight how different players in the balancing sessions react to flexibility needs and how prices are affected.

Main results

We analyze data for the Italian North zone across two sample periods: 2006-08 and 2013-15 at specific hours (H 3, 9, 11, 13, 19, 21)

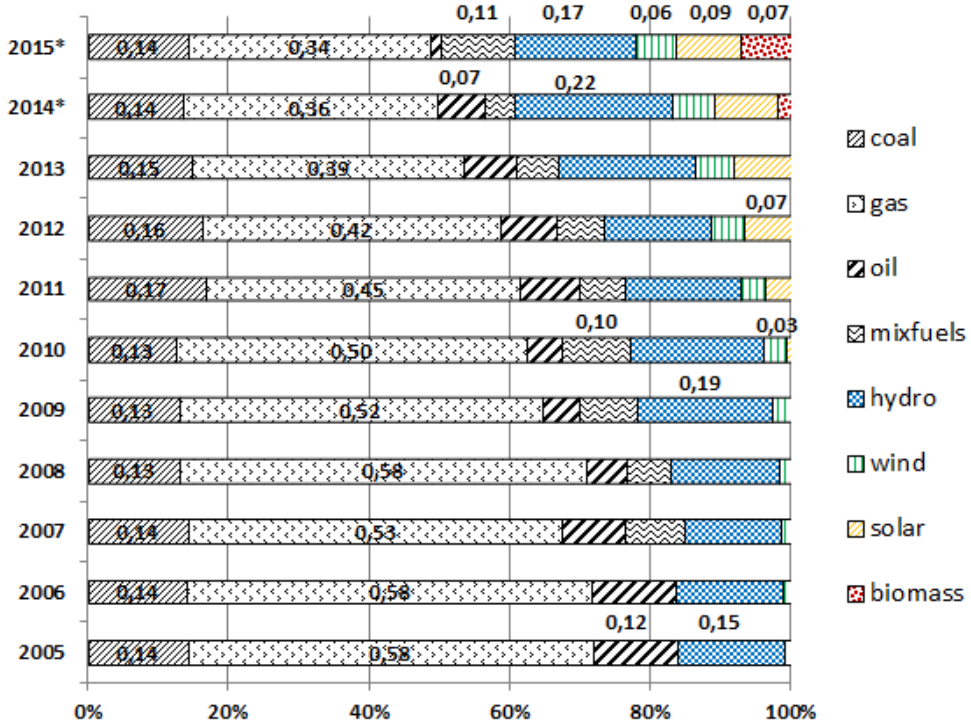
- Balancing quantities decreased from first to second sample. We believe this is motivated by the new intra-day market design introduced in between the two samples.
- Balancing costs increased especially for up-regulation
- Evidence of peaking prices for specific hours/technologies. This is the result of strategic behavior of bidders across market sessions

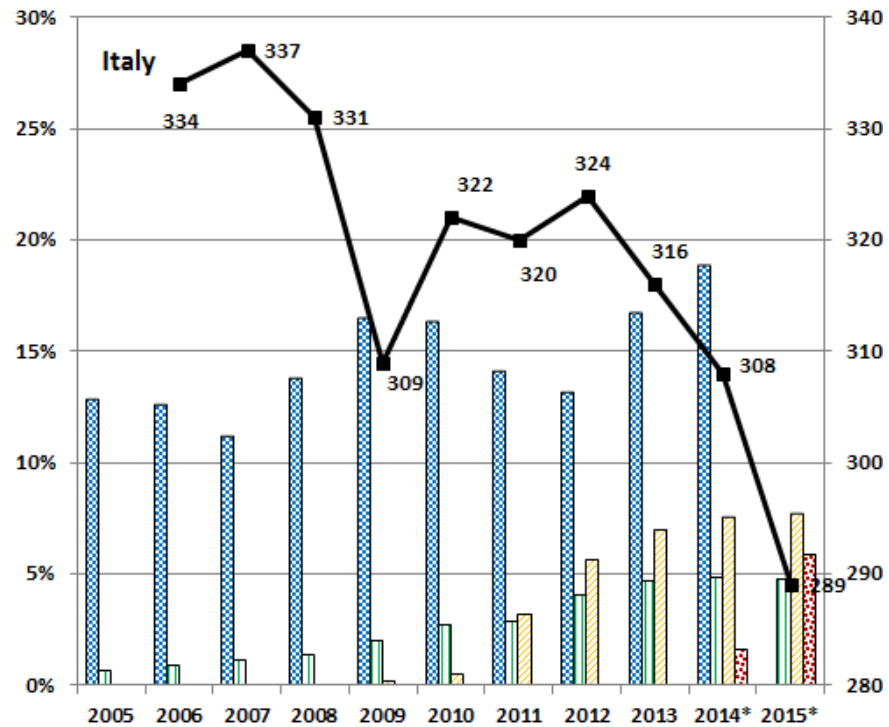
Relevant literature and received evidence 1

- Papers studying the relationship between RES-E and electricity prices (mainly limited to day-ahead)
- Hirth and Ziegenhagen (2015) describe the main issues related to balancing activities and to the requirements imposed by the increasing share of variable RES production. Using German market data they surprisingly notice that while wind capacity has tripled since 2008, balancing reserves have been reduced by 15% and balancing costs by 50%
- The so-called "German Paradox" has been explained by Ocker and Ehrhart (2017), who refer to two new flexible trading options in the market and to national and international Grid Control Cooperations which augmented system flexibility making costly reserves less necessary.

Evolution of the Italian generation mix

Identification of two scenarios: "low" (06-08) and "high" (13-15) RES



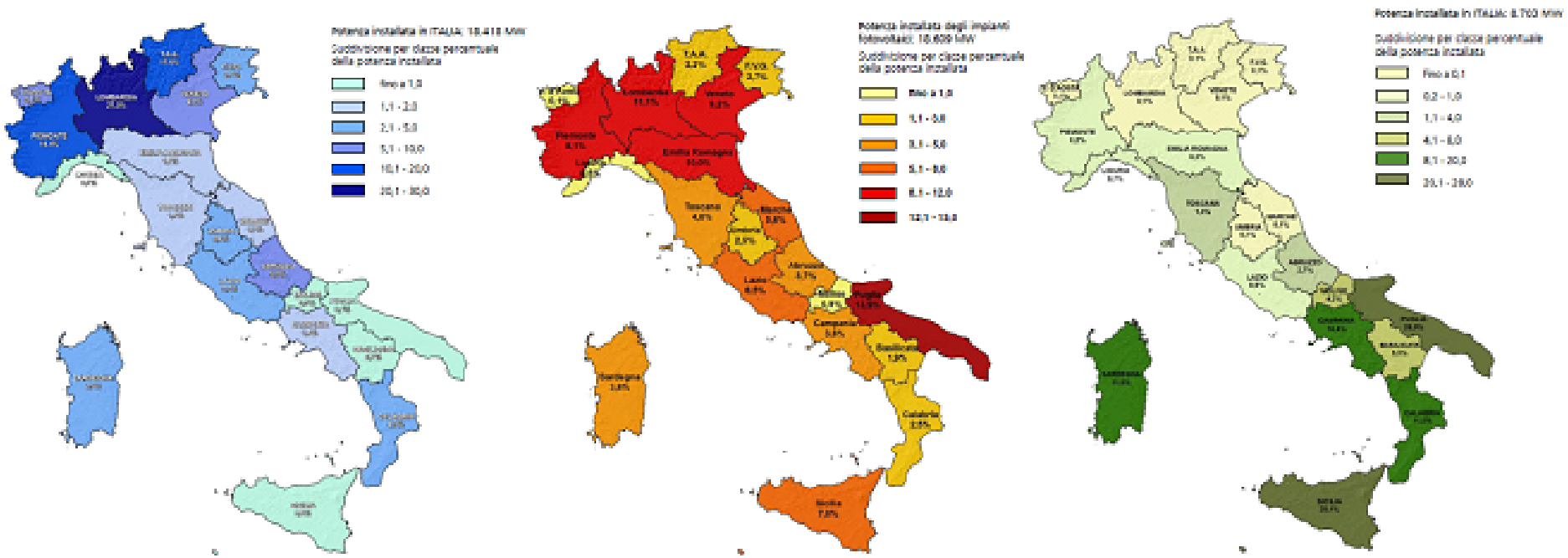


Italian shares by technology generation (on the left), and RES penetration together with Demand levels in TW (on the right). Source: ENTSO-E

RES generation in Italy

Selection of the Northern Zone

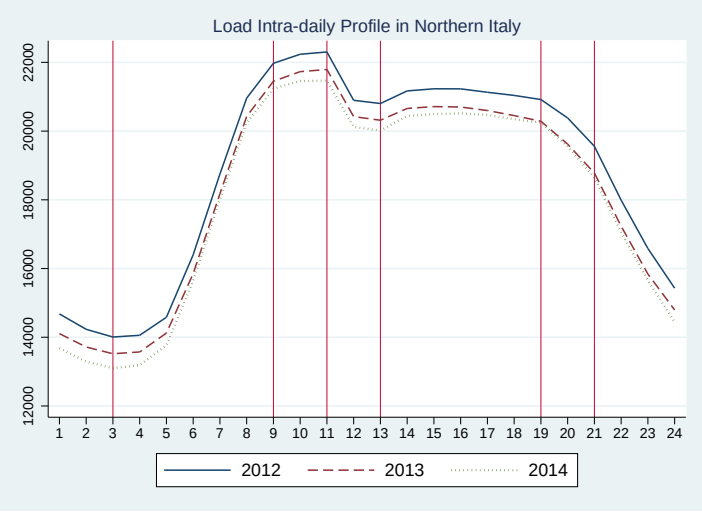
Hydro (left), solar PV (middle) and wind (right) generation

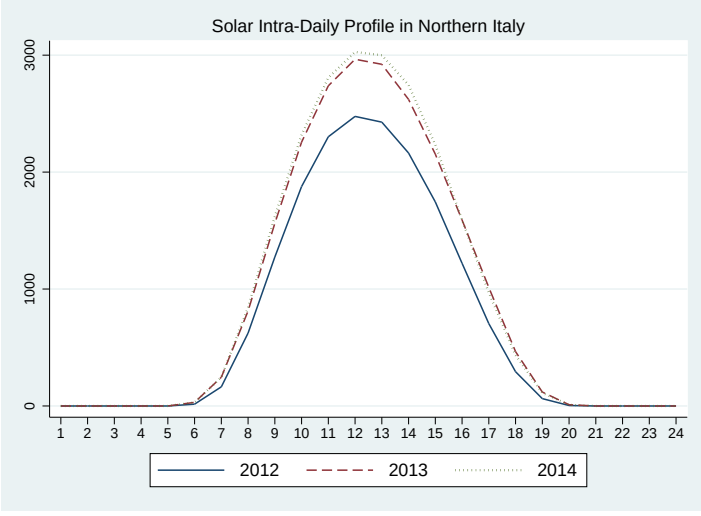


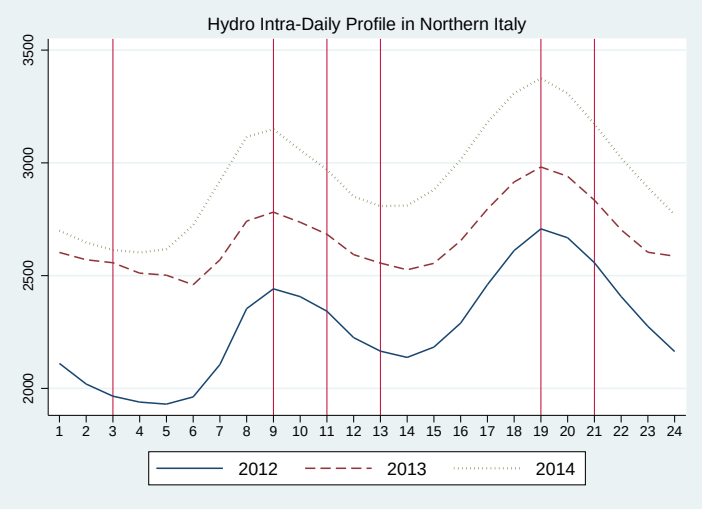
In Northern Italy, there is the majority of hydro and solar PV. Whereas, most wind power is generated in Southern Italy.

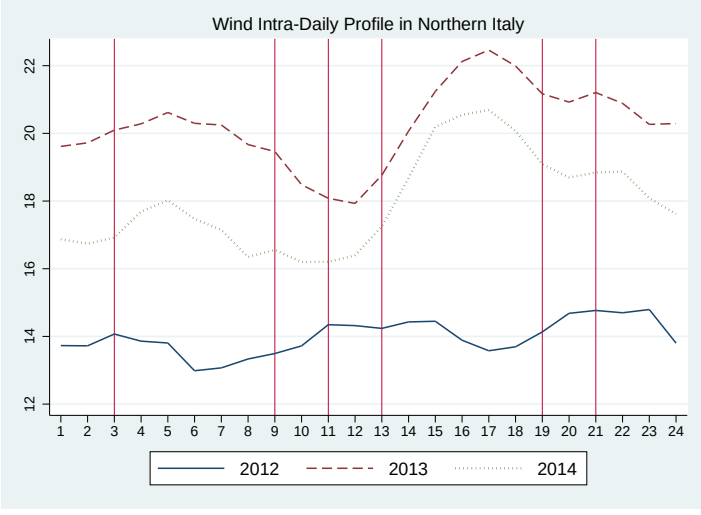
Inspection of Intra-daily Profiles

Selection of Hours: 3–9–11–13–19–21

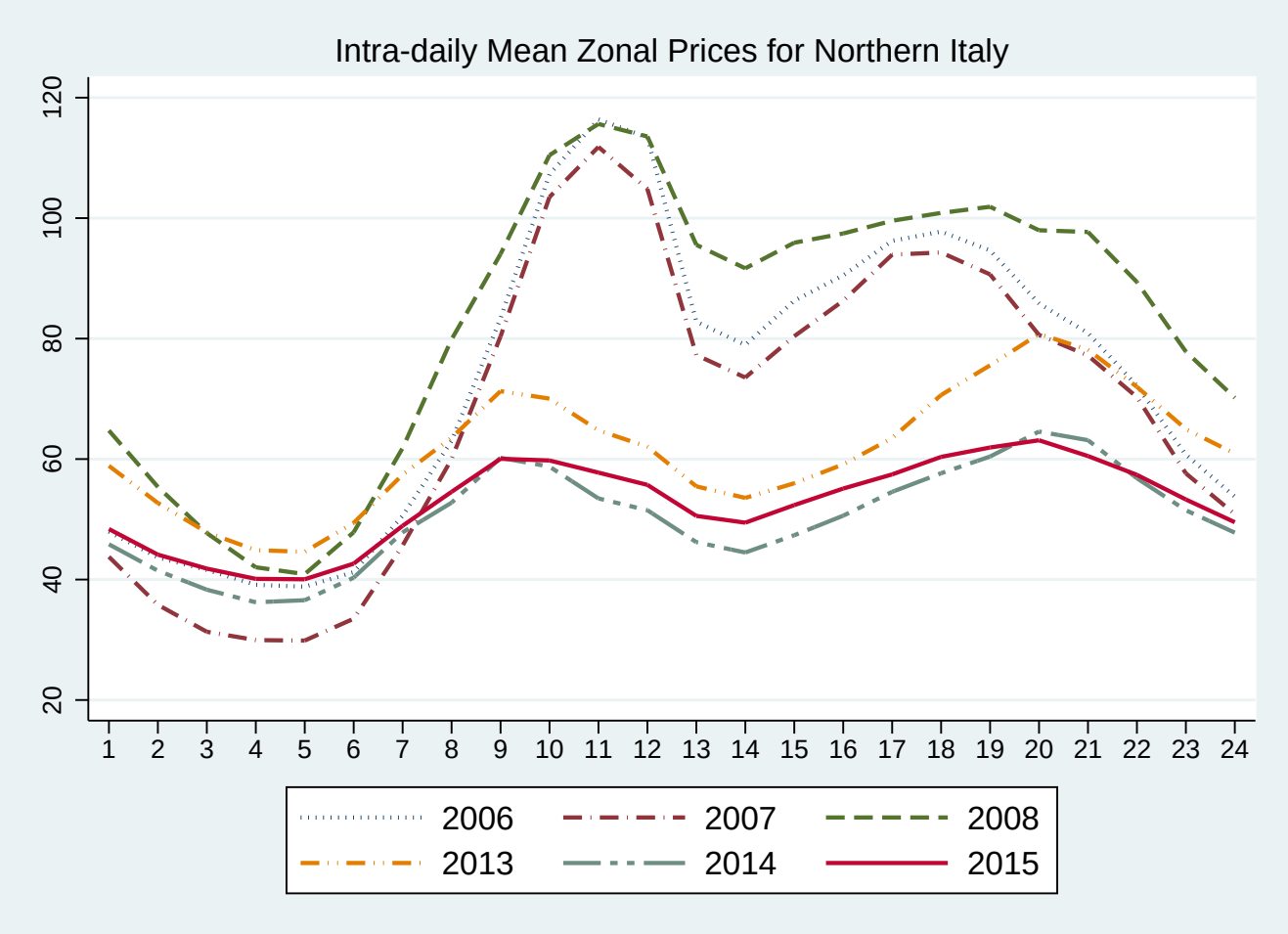








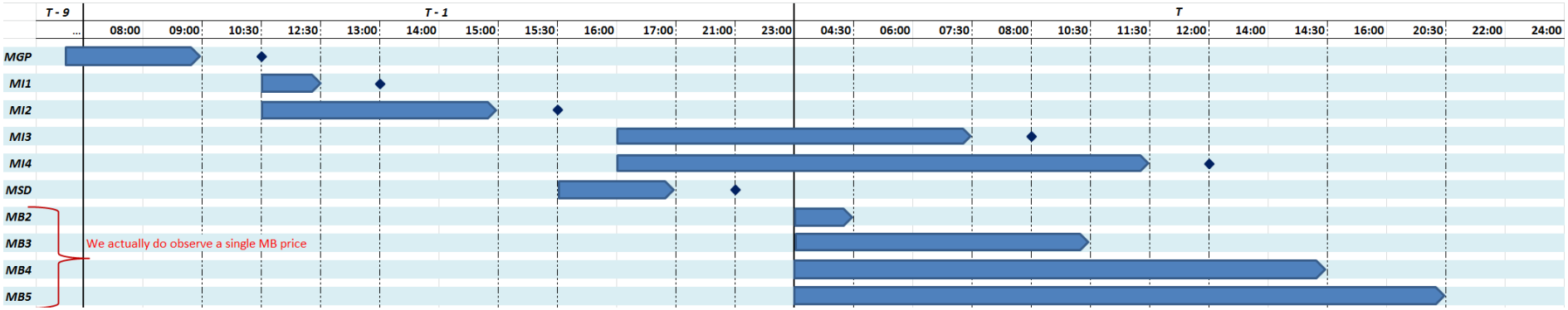
Inspection of Intra-daily Profiles



Spread between peak and off-peak: in 2008 peak price was three times the off-peak, whereas in 2015 peak price was only 50% higher.

Structure of the Italian Power Exchange

Two reforms between first and second sample: Intra-day market (MI) in 2009 and MSD market in 2011.



- MSD has a scheduling sub-stage (ex-ante MSD) and a balancing market (MB).
- Bids submitted in MB sessions can only contain **better economic conditions** with respect to MSD bids.
- During our sample 2013-15 volumes exchanged on MSD were approximately equal to 10% of those exchanged on MGP.

Real time markets: MSD and MB

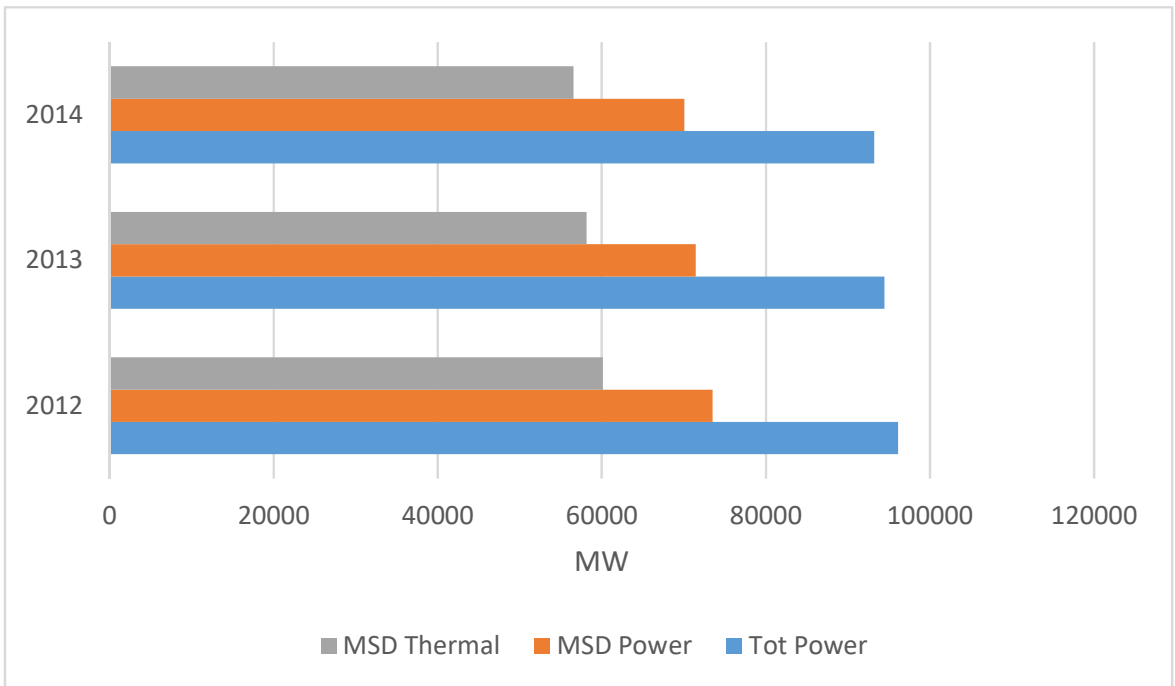
- In the ex-ante MSD, TERNA accepts bids and offers in order to relieve congestions and to create reserve margins. (Start-up, primary and tertiary control)
- During MB sessions, Terna accepts bids and offers in order to provide secondary control and to balance energy injections into and withdrawals from the grid in real time. (Secondary control)
- Market purpose: 'upward' reserve (for balancing capacity/energy procured to compensate a negative imbalance) and 'downward' reserve (for balancing capacity/energy procured to compensate a positive imbalance)
- The ex-ante MSD and MB are based on the pay-as-bid pricing mechanism (a reference price usually calculated as the weighted average of all accepted bids, both for purchases and for sales).

Participants to balancing sessions

Balancing sessions are more concentrated than DAM session.

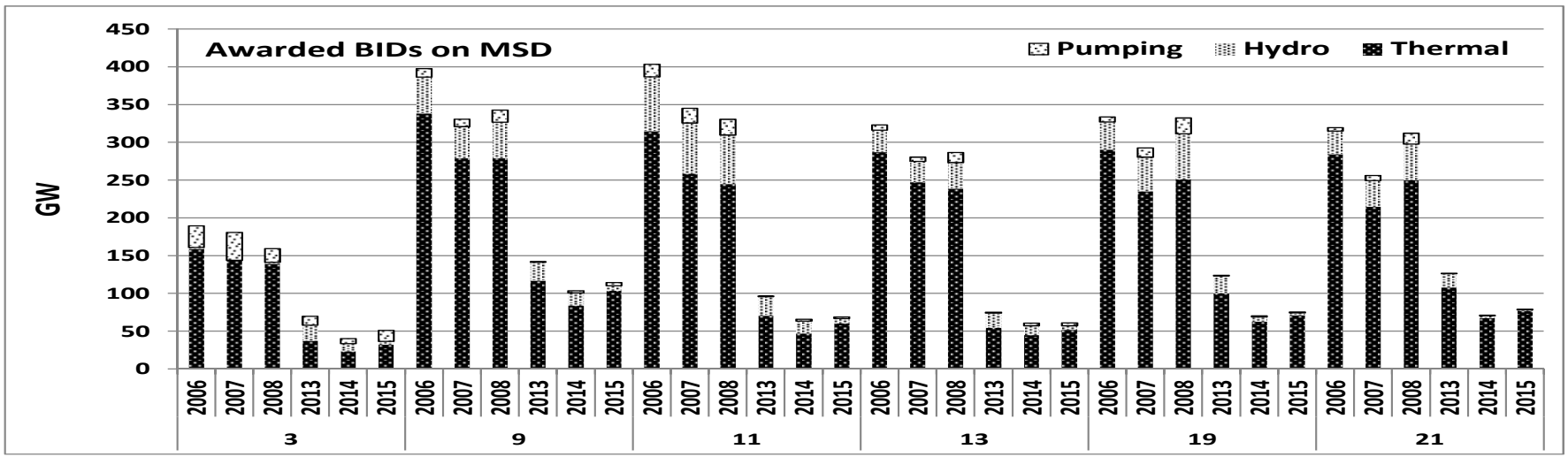
- Thermal (CCGT units with largest market share)
- Pumping units
- Hydro units

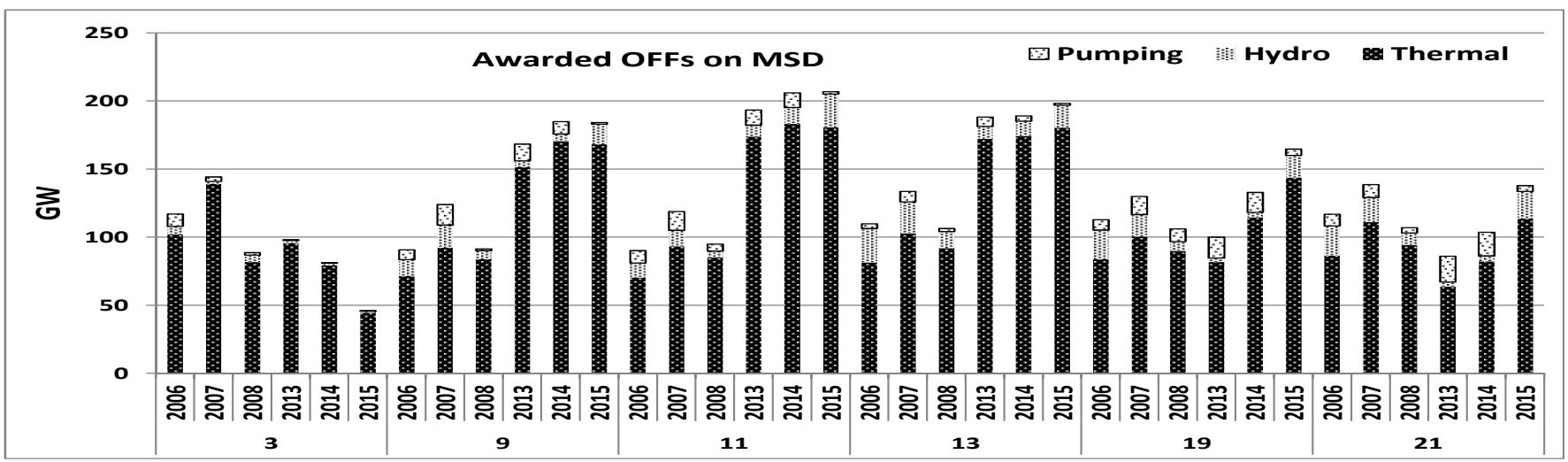
In recent years we notice a reduction of capacity entitled to bid into balancing session, expecially in the thermal segment (-5,7%).



Balancing Quantities in the ex-ante MSD

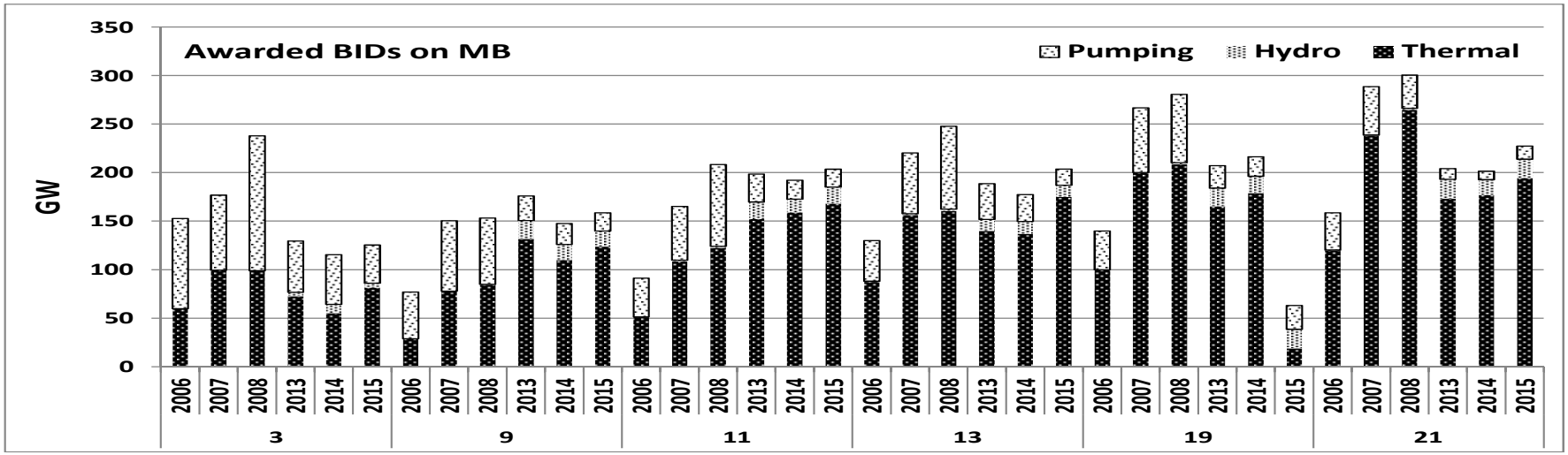
Total yearly quantities for down-regulation (first row) and for up-regulation (second row)

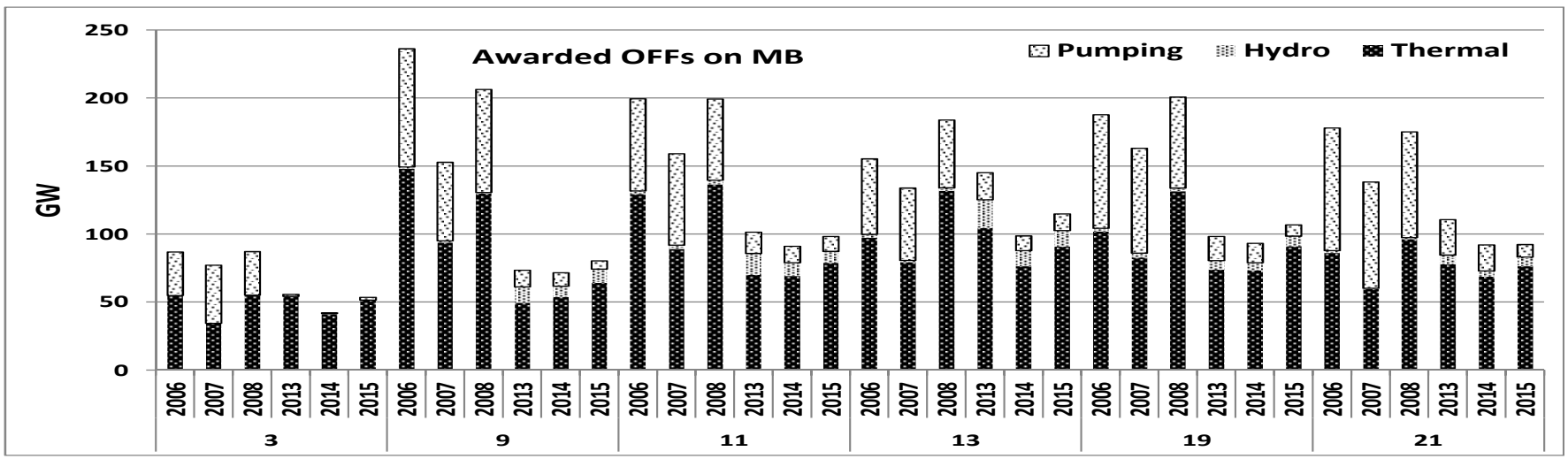




Balancing Quantities in MB

Total yearly quantities for down-regulation (first row) and for up-regulation (second row)





Main findings

- Reduced needs for down-regulation in MSD
- Increasing needs for up-regulation: H9, H11, H19 in MSD. This trend continues and become even more evident during 2016, when ex-ante MSD became the preferred platform to sell electricity by CCGT units.
- Reduced quantities awarded in MB, both for up and down-regulation
- Strong reduction of the share of water pumping (due to flat daily profile for the SMP)

Price differences for up-regulation across the two samples

	Hydro				Water Pumping				Thermal			
	Max		Mean		Max		Mean		Max		Mean	
Hour	MSD	MB	MSD	MB	MSD	MB	MSD	MB	MSD	MB	MSD	MB
3	↓ 20	↑ 111	↓ 3	↑ 8	↑ 19	↑ 67	↑ 36	↑ 63	↑ 148	↑ **884**	↓ 3	↑ 31
9	↓ 54	↑ 176	↓ 33	↓ 31	↑ 19	↑ 57	↑ 11	↑ 37	↑ 48	↑ 30	↓ 28	↑ 45
11	↓ 12	↑ **1422**	↓ 44	↓ 20	↑ 34	↑ 55	↑ 15	↑ 34	↑ 38	↑ 25	↓ 34	↑ 21
13	↓ 46	↑ 13	↓ 28	↓ 31	↑ 25	↑ 39	⟷	↑ 28	↑ 35	↑ **1717**	↓ 34	↑ 17
19	↑ 22	↑ **1689**	↓ 22	↓ 24	↑ 48	↑ 60	↑ 35	↑ 40	↓ 11	↑ **903**	↓ 33	↑ 18
21	↓ 41	↑ **1922**	↓ 28	↓ 23	↑ 43	↑ 55	↑ 36	↑ 42	↓ 50	↑ 379	↓ 34	↑ 18

↑, ↓ and ↔ represent an average increment, decrement or no changes across the two samples in €/MWh.

Prices are calculated as weighted averages of accepted bids.

- Hydro: decreasing mean prices. Evidence of peaking prices in MB at H11, 19, 21.
- Increasing prices for water pumping
- Thermo: decreasing mean prices on MSD, increasing mean prices on MB, evidence of peaking prices on MB at H3,13, 19.

Hydro and Thermal units on MB

	Hydro				Water Pumping				Thermal			
	Max		Mean		Max		Mean		Max		Mean	
Hour	MSD	MB	MSD	MB	MSD	MB	MSD	MB	MSD	MB	MSD	MB
3	↓ 20	↑ 111	↓ 3	↑ 8	↑ 19	↑ 67	↑ 36	↑ 63	↑ 148	↑ **884**	↓ 3	↑ 31
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More precisely

- Some units may exploit their dominant position.
- They do not bid in MGP (supply at the cap of €3,000) where prices are low due to the merit order effect of RES and then sell more valuable power in the real time (pay-as-bid rule)
- In one case a unit sold power in MGP, bought it back in intra-day sessions so that it was switch-off. It then offered power in real time at a very high price.
- During 2016 the strategy was so evident that the Italian Authority opened a trial on the point. At the end the dispute has been resolved with a formal commitment by the firm to accept a revenue cap.

A short detour: what drives balancing prices?

- In a related research paper we investigate the dynamics of balancing prices, showing that they are quite unrelated with fuel prices
- Taking advantage of the pay-as-bid rule that allows us to separate awarded prices for each unit dispatched, we conduct a dynamic analysis (IRF) on thermal units bidding in MSD/MB. The natural candidate are fuel prices as leading forces (oil, coal and gas)

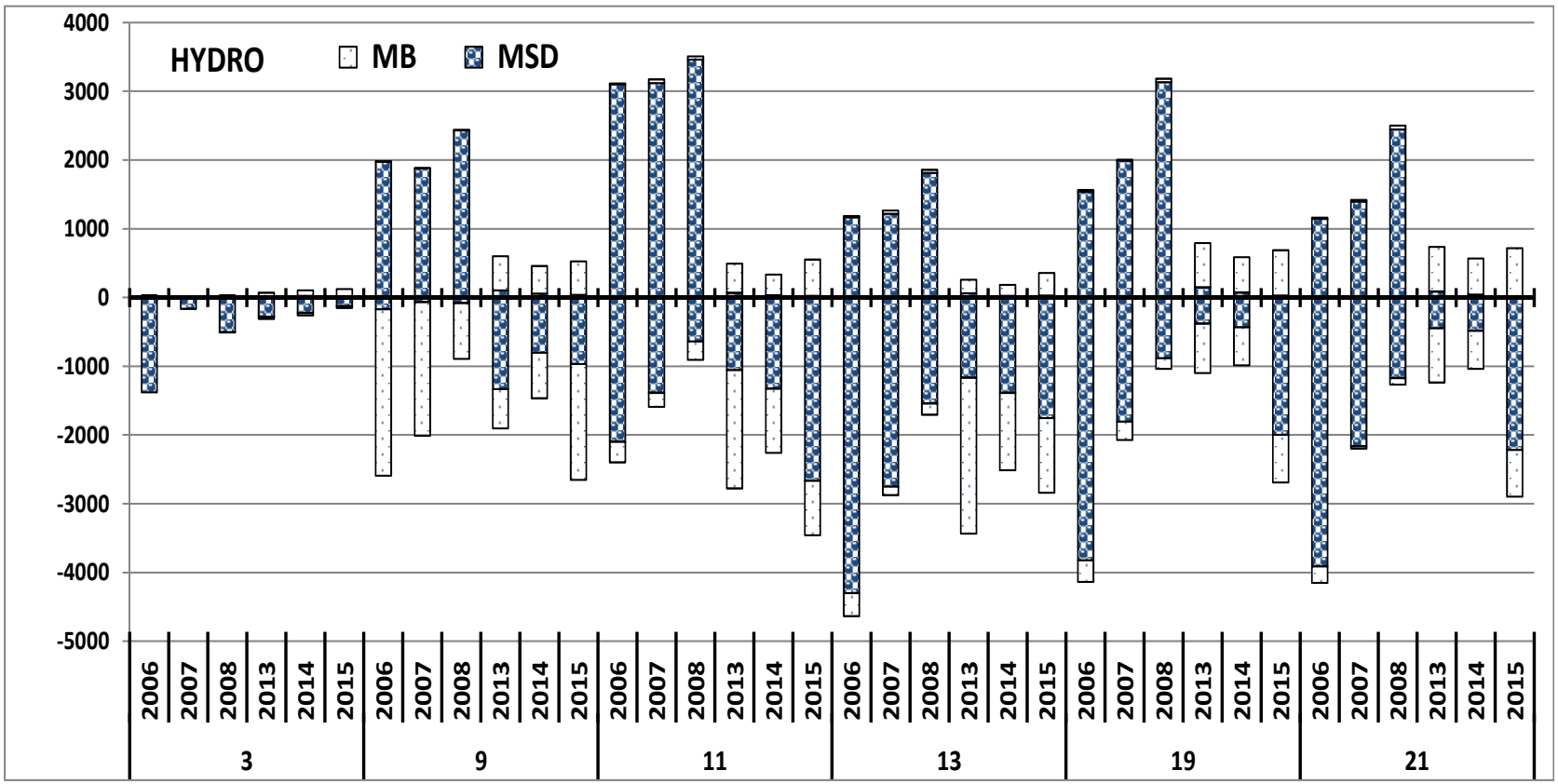
$\Rightarrow$ Balancing prices were more related to fuel prices in the first than in the second sample

$\Rightarrow$ Results indicate that shocks on fuel prices influence balancing prices **when that technology was marginal in day-ahead market**

Evolution of balancing costs across technologies

Hydro Costs (in thousands of €)

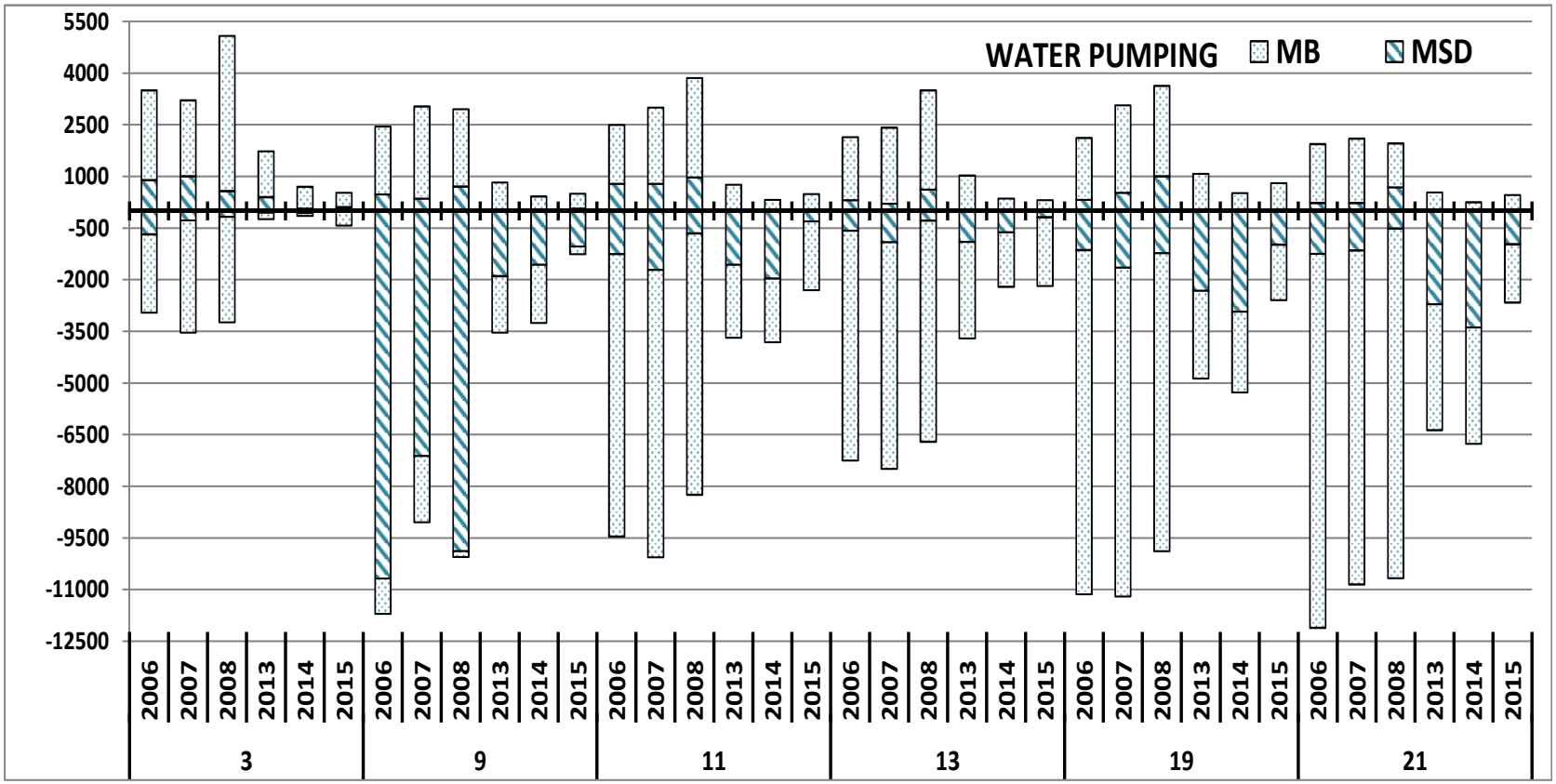
After an initial reduction, regulation services by hydro units become very costly.



Evolution of balancing costs across technologies

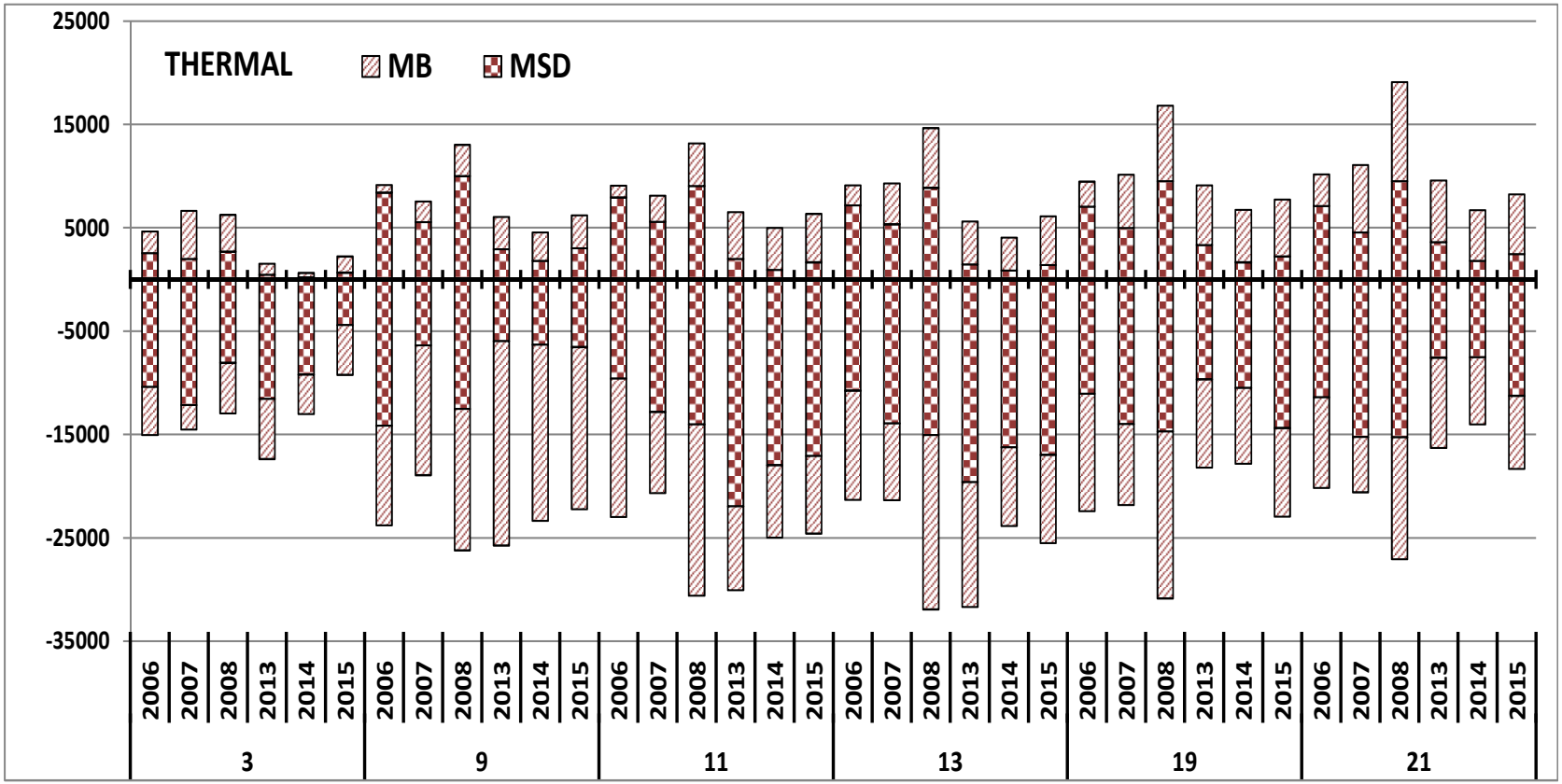
Water Pumping Costs (in thousands of €)

Quantity and cost reduction for water pumping



Evolution of balancing costs across technologies

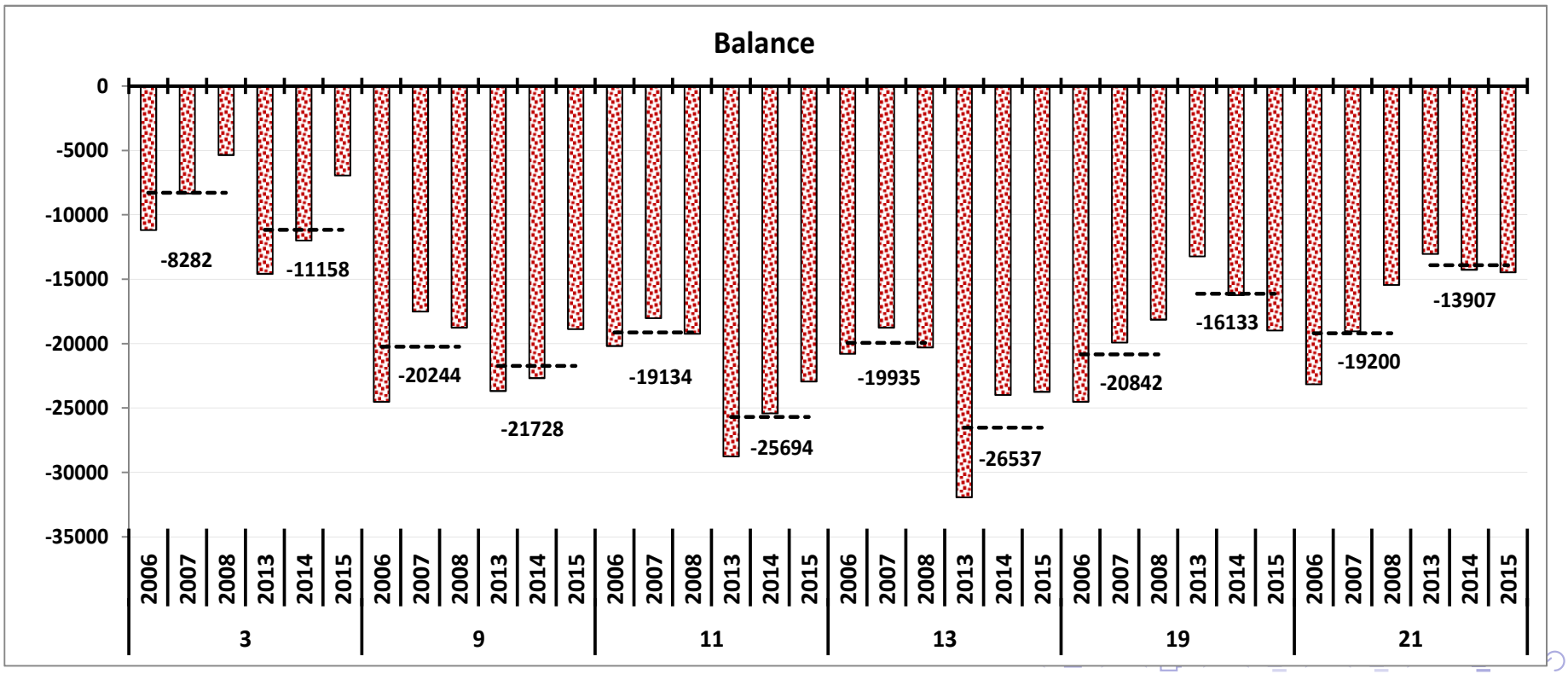
Thermal Costs (in thousands of €)



Overall Balance (in thousands of €)

as the difference between profits and costs, faced by the Italian TSO for the Northern zone

We quantify the overall profits/costs as sum across technologies on both market sessions within a year. Clearly the activities of planning resources and dispatching balancing power are highly costly, and increasing across samples for all hours but H19 & H21



Conclusions

- On the whole, balancing quantities reduced from the first to the second sample
- Balancing costs are generally higher in the second sample due to differential bidding strategies of units
- We have provided a detailed analysis across hours, market purpose and technologies and we showed that:
  - Costs from water pumping have strongly reduced
  - Hydro costs have initially decreased and then increased from 2014 to 2015 especially at sunset
  - The largest share of costs remunerate balancing power sold by thermal units. After market reform costs decreased but in the last two years the trend was reverted
  - We have found signals of strategic behavior of sellers
- The capacity market rules that will be implemented in the near future will in fact cap the balancing price avoiding extreme price observations.