Review of January 24th, including Flagging & Tagging

27th February 2019

Review of January 24th

Agenda

1. *Introduction*
2. *Ex-Ante Market Results*
3. *System Operations*
4. *Flagging & Tagging*
5. *Application of the rules on January 24th*
6. *Next Steps…*

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Review of January 24th

- Following high Imbalance Settlement Price on Jan 24th, we undertook to provide a detailed report on the operation of the pricing software and how actions were flagging & tagged;
- Report published on Feb 21st;
- Report follows from ex-ante markets through to imbalance price calculation;
- Purpose of the report is provide information;
- To help participants understand how flagging & tagging and Imbalance Pricing;
- Presentations will follow the data in the report;
- Questions are welcome;
- Open to further engagement with industry and SEM RAs;

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Ex Ante Market – 23rd versus 24th DAM

- Both days, the DAM market cleared similarly – 23rd

Ex Ante Market – 23rd versus 24th DAM

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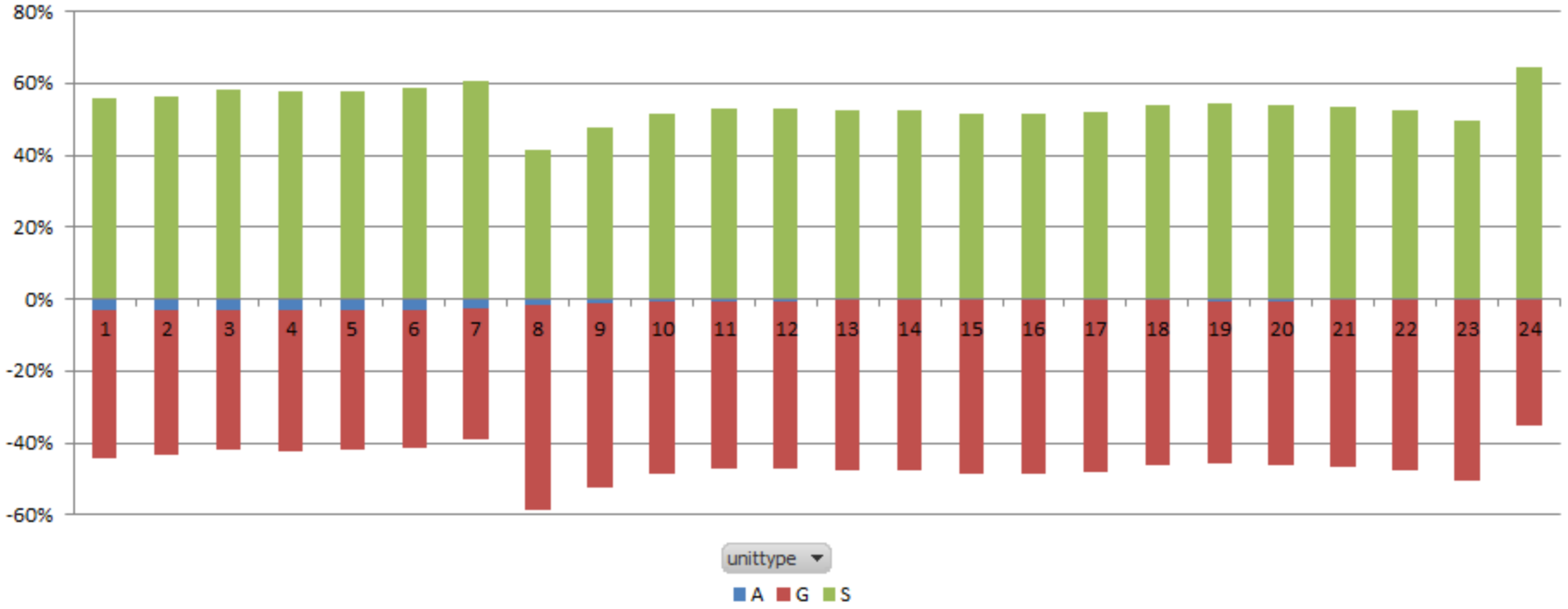
Ex Ante Market – 23rd versus 24th DAM

- However the Structure of **N.I.** units clearing was very different – **23rd**…



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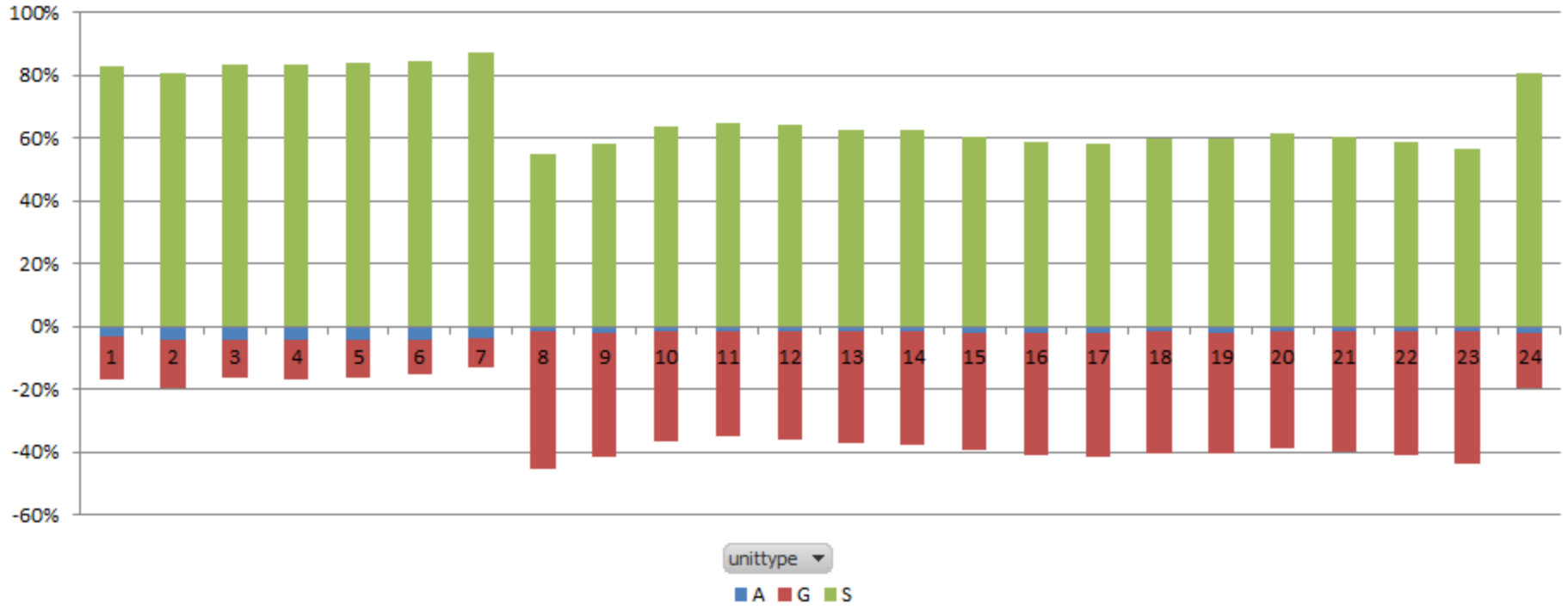


Ex Ante Market – 23rd versus 24th DAM

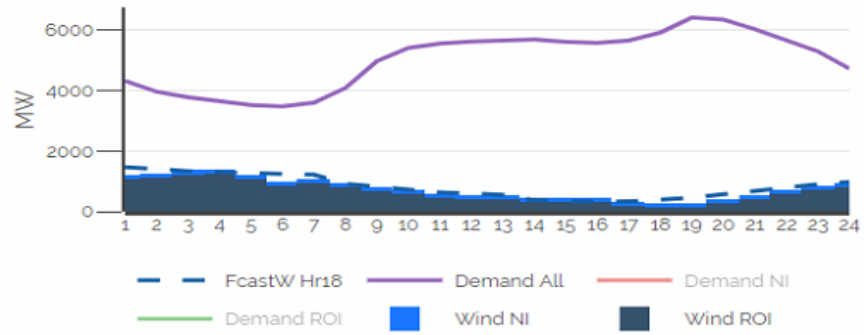
- However the Structure of **N.I.** units clearing was very different on the **24th** …

- NI Supplier units purchased at ratios up to 4:1 versus Generation on 24th

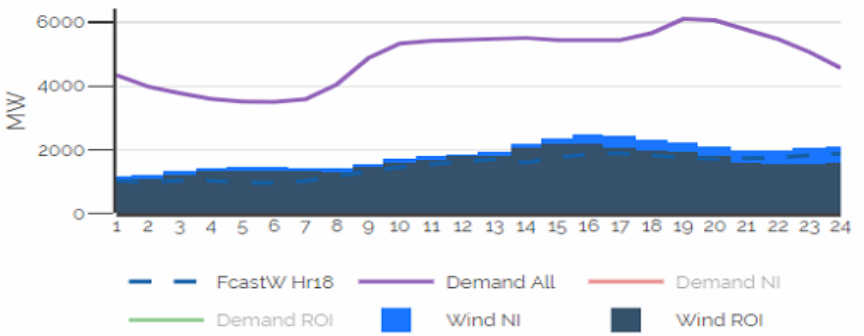
Ex Ante Market – 23rd versus 24th Wind

- Wind was stronger on **24th** …

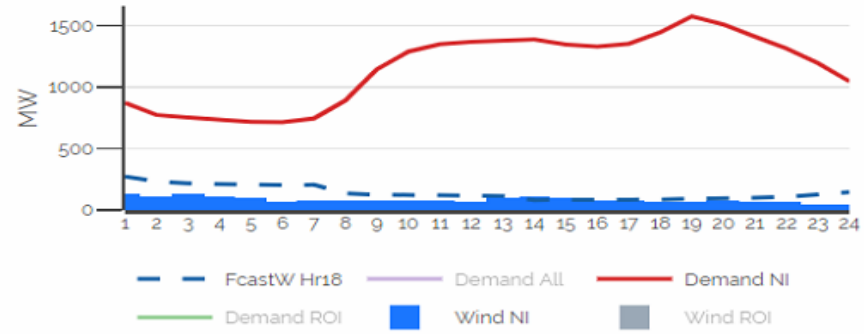
Forecast, Actual Wind v Demand - All Island



Forecast, Actual Wind v Demand - All Island



Forecast, Actual Wind v Demand - N.I.



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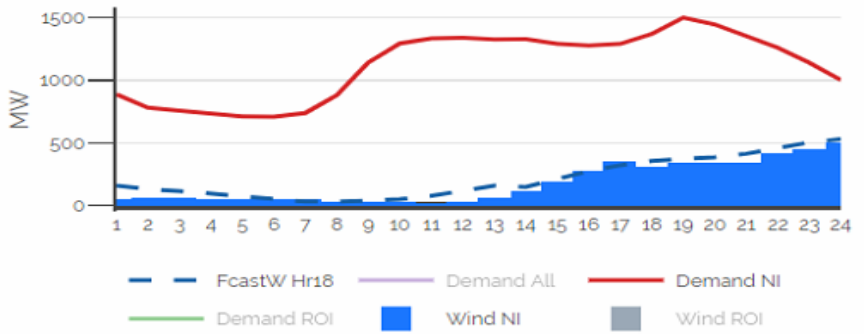

Ex Ante Market – 23rd versus 24th Wind

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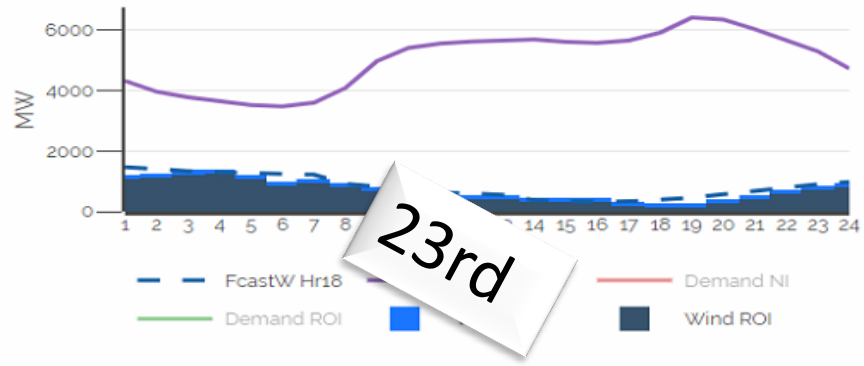

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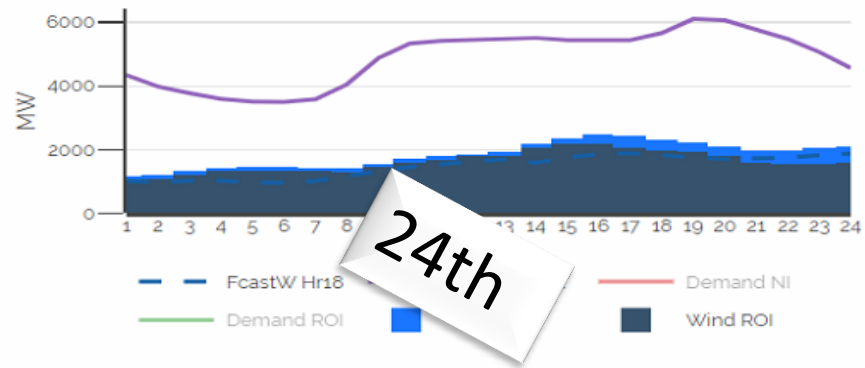

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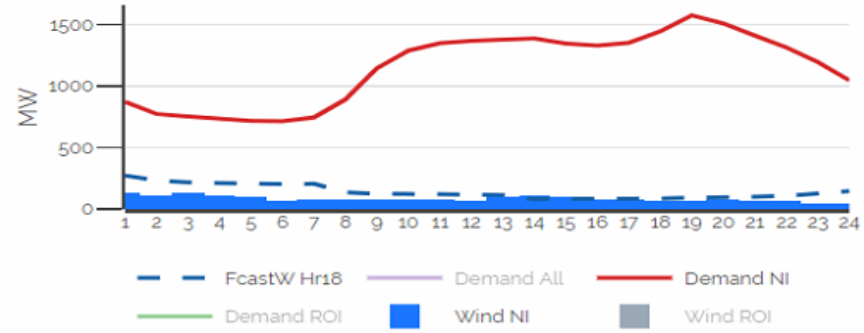

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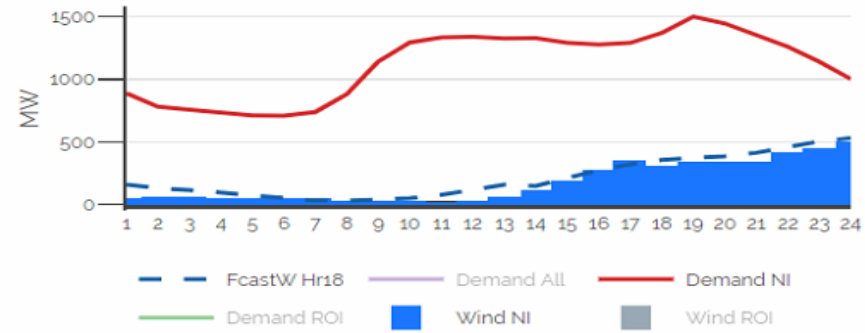

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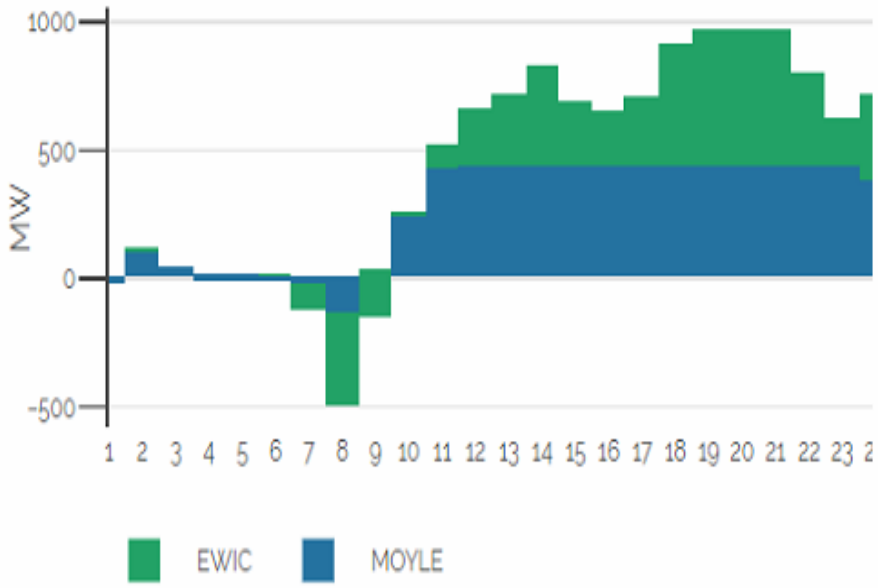
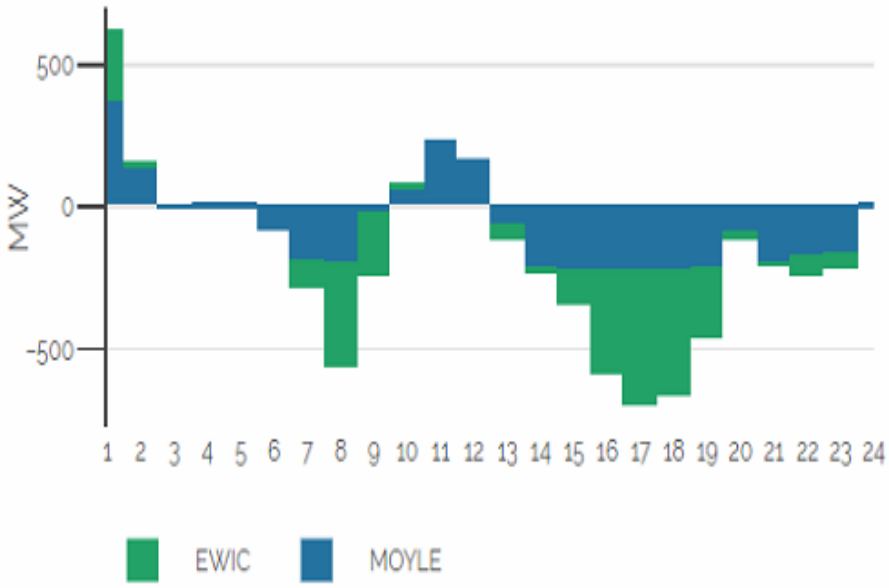
Ex Ante Market – 23rd versus 24th Interconnectors

- On **23rd** Interconnectors were Importing versus exporting (mostly) on **24th** …

Interconnector Flows



Interconnector Flows



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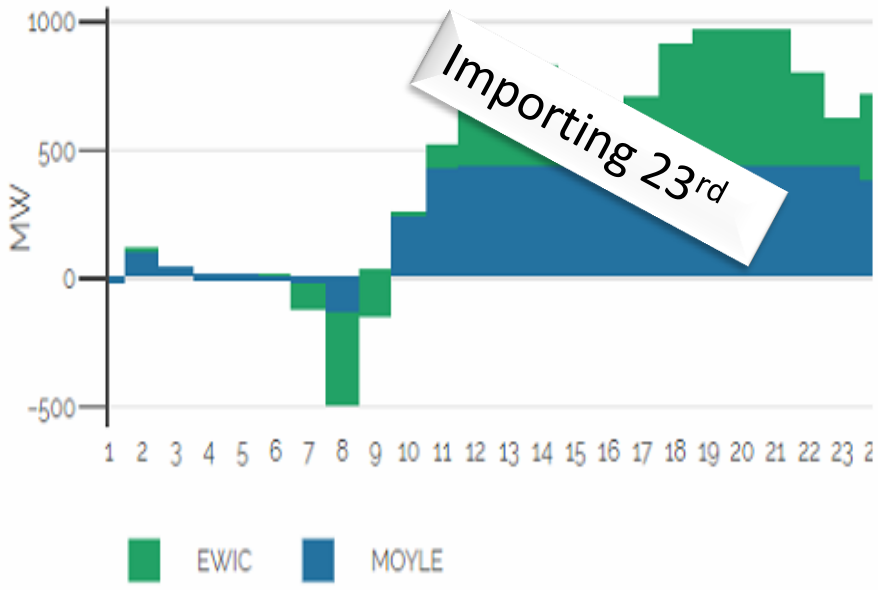
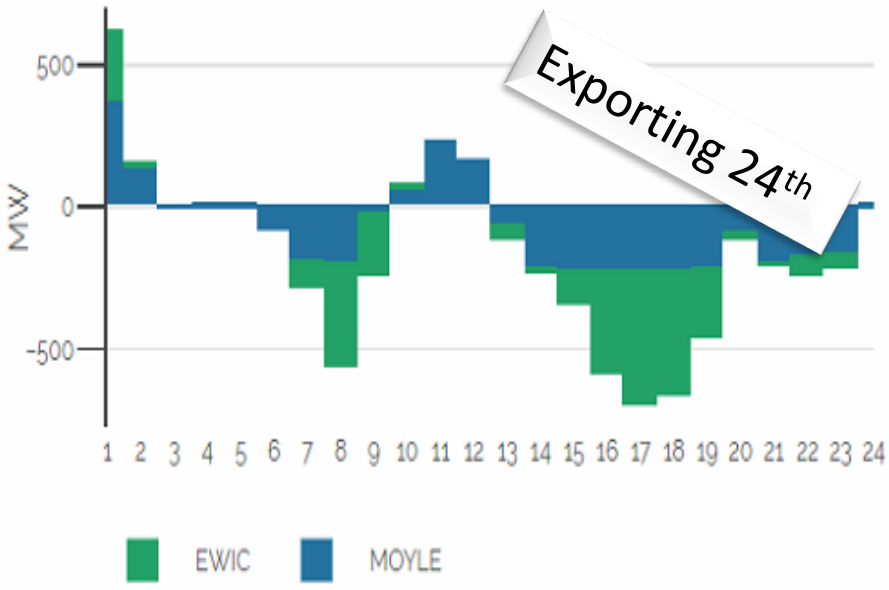
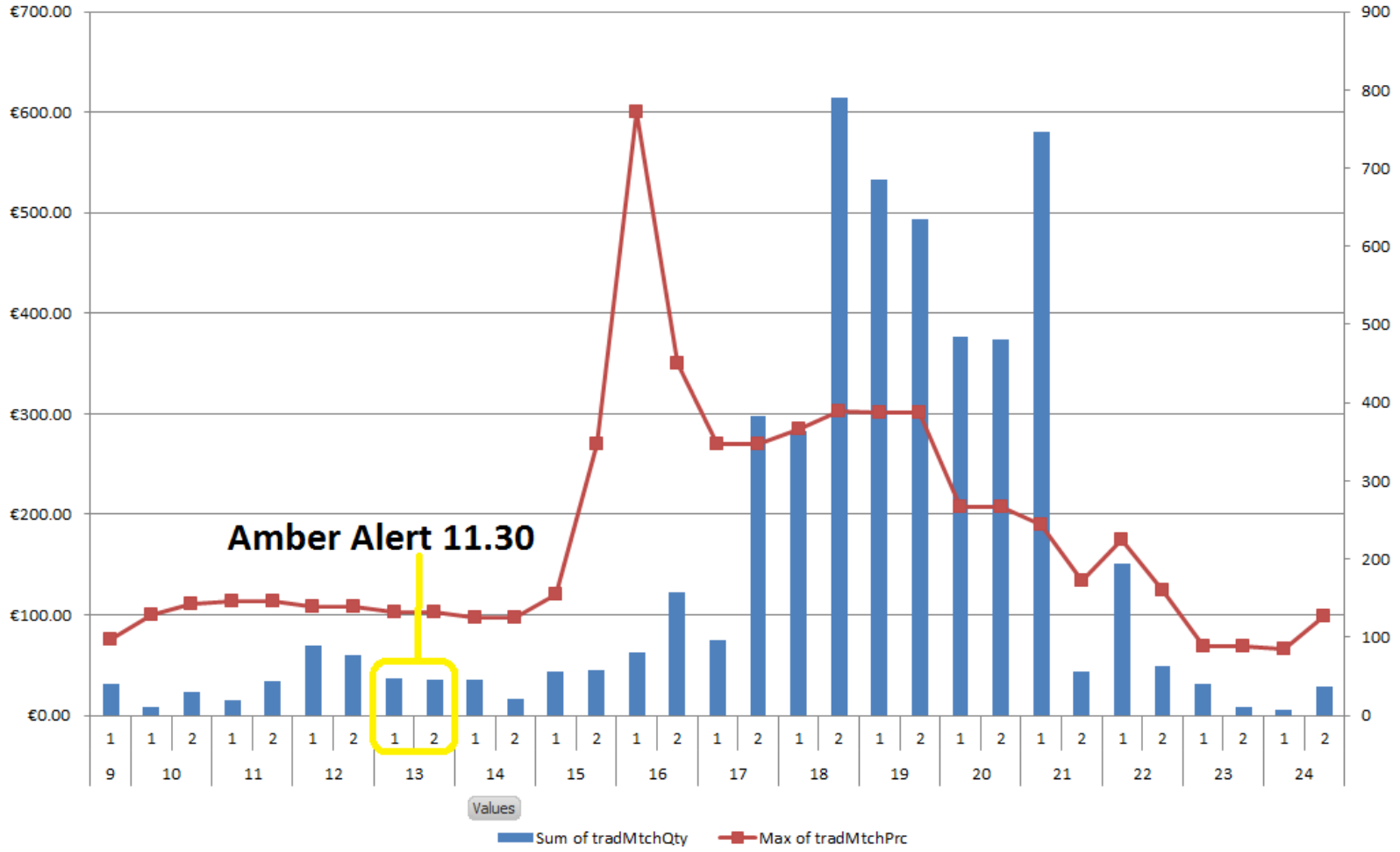


Interconnector Flows



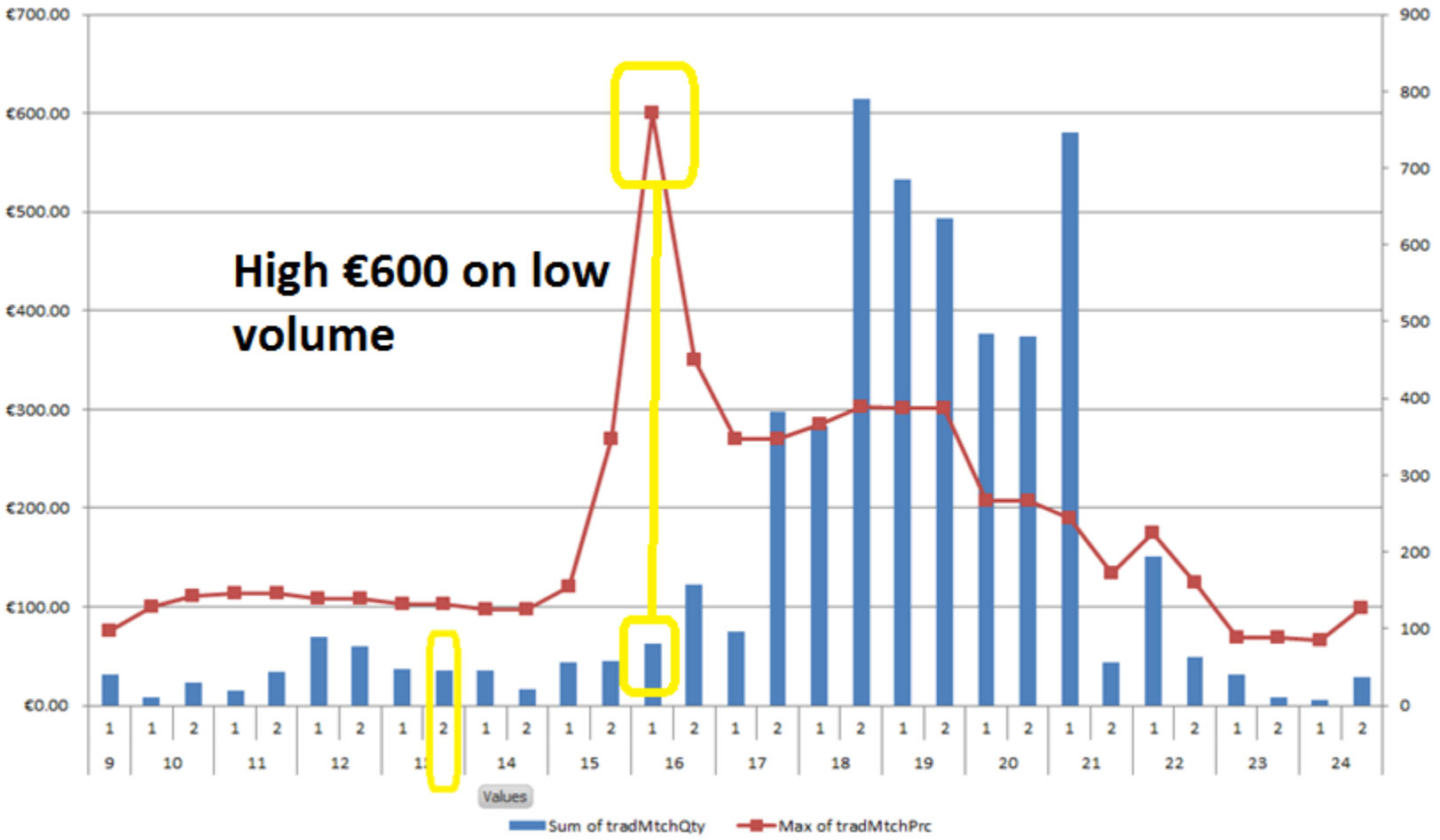
Ex Ante Market – 24th IDC Trading ….

- Amber Alert announced 11.30 …



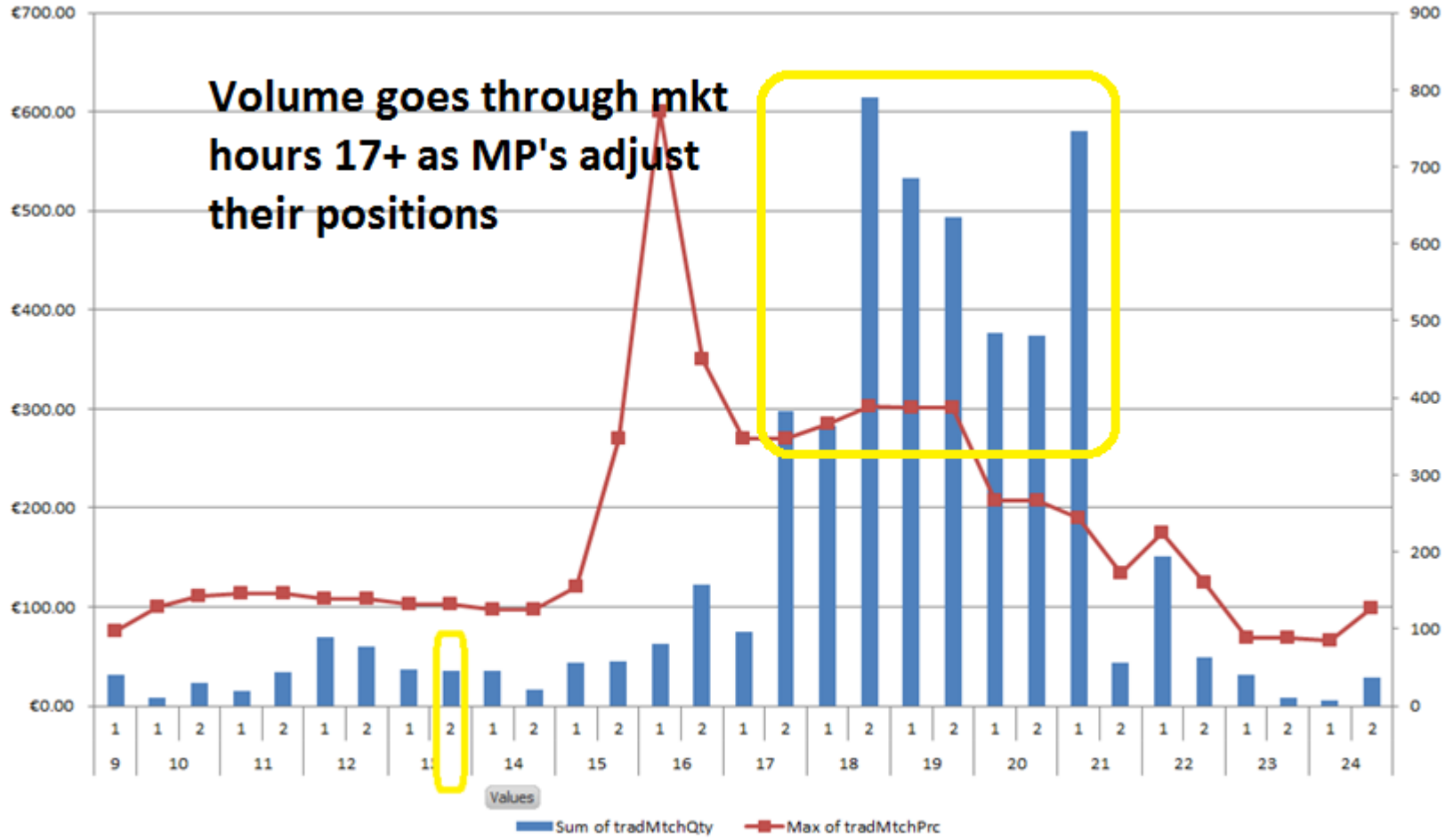
Ex Ante Market – 24th IDC Trading ….

- IDC Market (price) reacted …



Ex Ante Market – 24th IDC Trading ….

- Participants react (volume increases)



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Conditions on the day before the alert(23rd January)

- 23rd January Large NI unit became unavailable and would remain so for 3 days
- All remaining available large conventional NI units scheduled
- Medium wind output and import flows scheduled on Moyle
- Early indications for the 24th January showed very low wind and export flows on Moyle

24th January

- Wind in Ireland
  - Forecast just above 1500MW
  - Reality is that it arrives early and higher than both vendors indicated.

24th January

- Wind in N. Ireland
  - Forecast to start increasing mid morning
  - Reality is that it is significantly delayed while Moyle swings to export.

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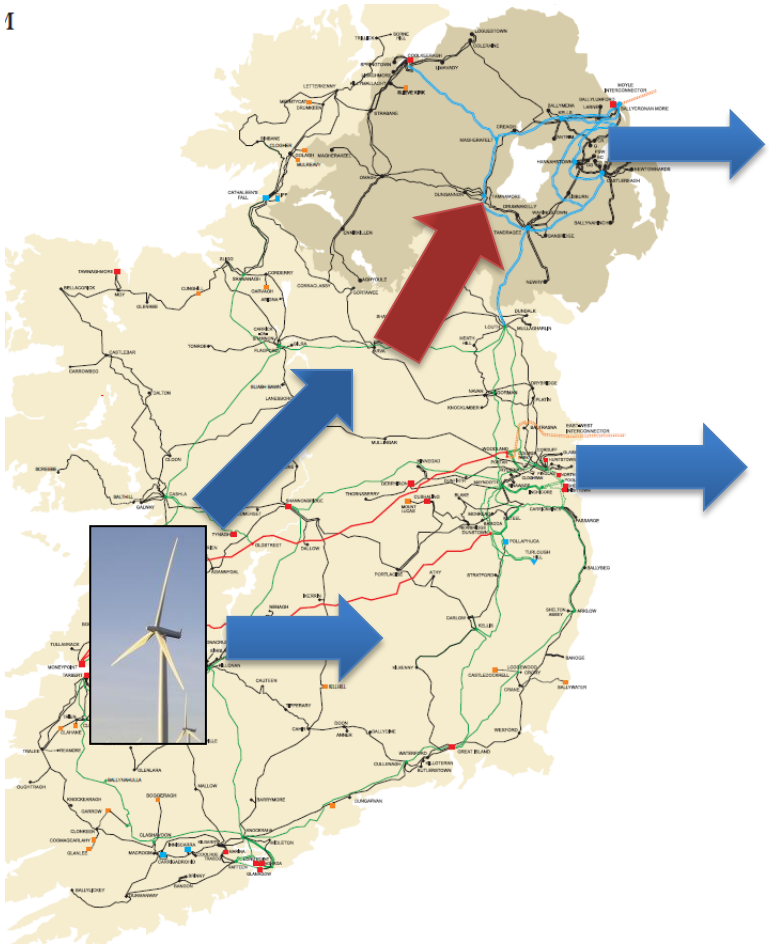
24th January

N. Ireland

- Very Low wind
- C30 Outage.
- Moyle exporting
- **Tie Line constraint**
- **Amber alert due to above**
- High price units in NI run

Ireland

- Reasonable wind >1500MW
- No Margin issues



All island

Enough capacity all island. Local NI issue.

Market correctly exports to GB.
(GB price higher than IE)

GB – record gas day. Low renewables.

NGESO do not agree to trade back energy on Moyle (as is their right). Emergency Assistance still available.

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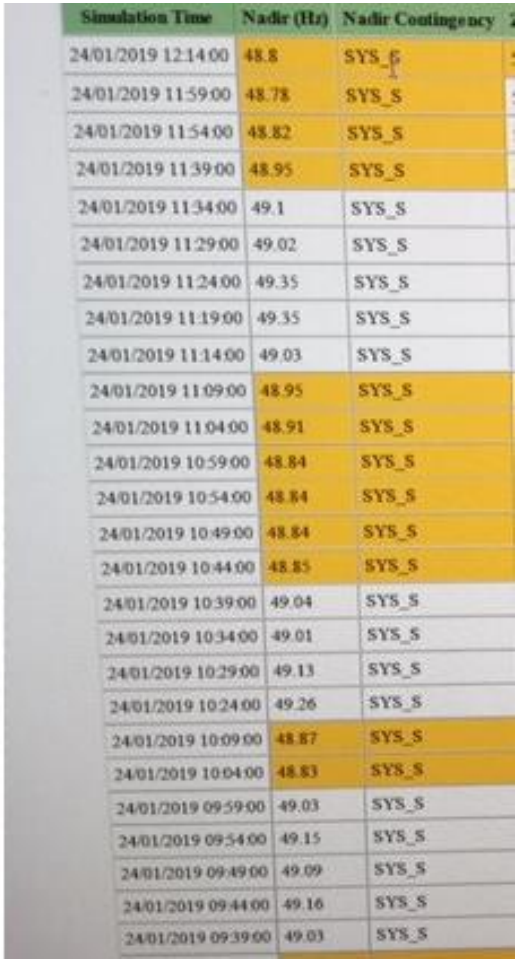
24th January

- System security
  - Tie Line hitting security limits as TSO maximises flow from Ireland to N. Ireland
  - Transient stability limit (managing nadir to avoid demand control for Tie line event)



Simulation Time	Nadir (Hz)	Nadir Contingency
24/01/2019 12:14:00	48.8	SYS_S
24/01/2019 11:59:00	48.78	SYS_S
24/01/2019 11:54:00	48.82	SYS_S
24/01/2019 11:39:00	48.95	SYS_S
24/01/2019 11:34:00	49.1	SYS_S
24/01/2019 11:29:00	49.02	SYS_S
24/01/2019 11:24:00	49.35	SYS_S
24/01/2019 11:19:00	49.35	SYS_S
24/01/2019 11:14:00	49.03	SYS_S
24/01/2019 11:09:00	48.95	SYS_S
24/01/2019 11:04:00	48.91	SYS_S
24/01/2019 10:59:00	48.84	SYS_S
24/01/2019 10:54:00	48.84	SYS_S
24/01/2019 10:49:00	48.84	SYS_S
24/01/2019 10:44:00	48.85	SYS_S
24/01/2019 10:39:00	49.04	SYS_S
24/01/2019 10:34:00	49.01	SYS_S
24/01/2019 10:29:00	49.13	SYS_S
24/01/2019 10:24:00	49.26	SYS_S
24/01/2019 10:09:00	48.87	SYS_S
24/01/2019 10:04:00	48.83	SYS_S
24/01/2019 09:59:00	49.03	SYS_S
24/01/2019 09:54:00	49.15	SYS_S
24/01/2019 09:49:00	49.09	SYS_S
24/01/2019 09:44:00	49.16	SYS_S
24/01/2019 09:39:00	49.03	SYS_S

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24th January

- Wind distribution exposes Tie Line constraint
  - Market exports on both interconnectors
  - Tie Line constraints until second Tie line
  - Only 1 generation outage in N. Ireland but high demand and exports to GB

- Amber 1 - it does not mean “an emergency”
  - Enough high price units to meet demand in full and maintain security standards
  - It is a warning that next event may lead to demand control.

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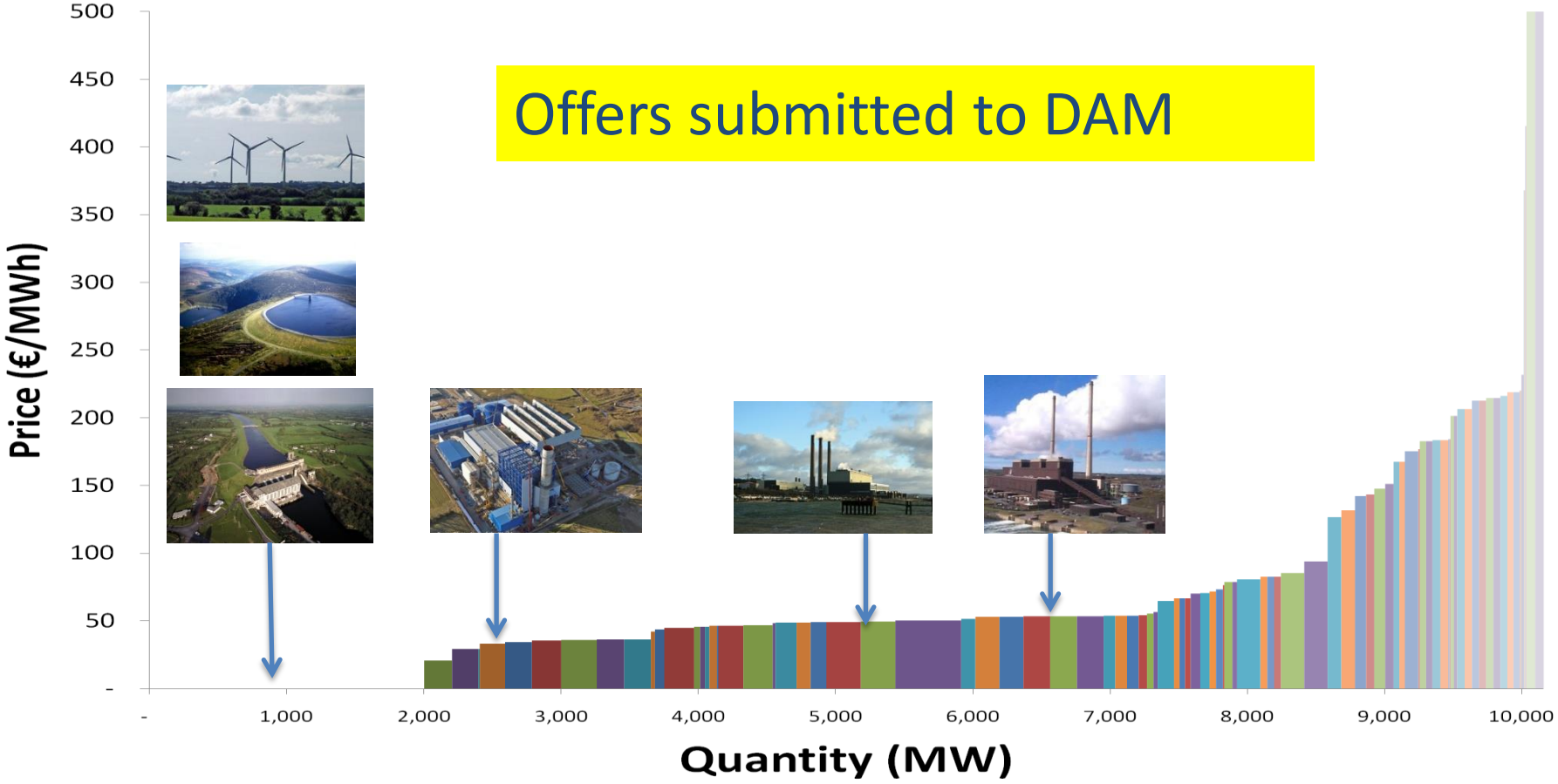
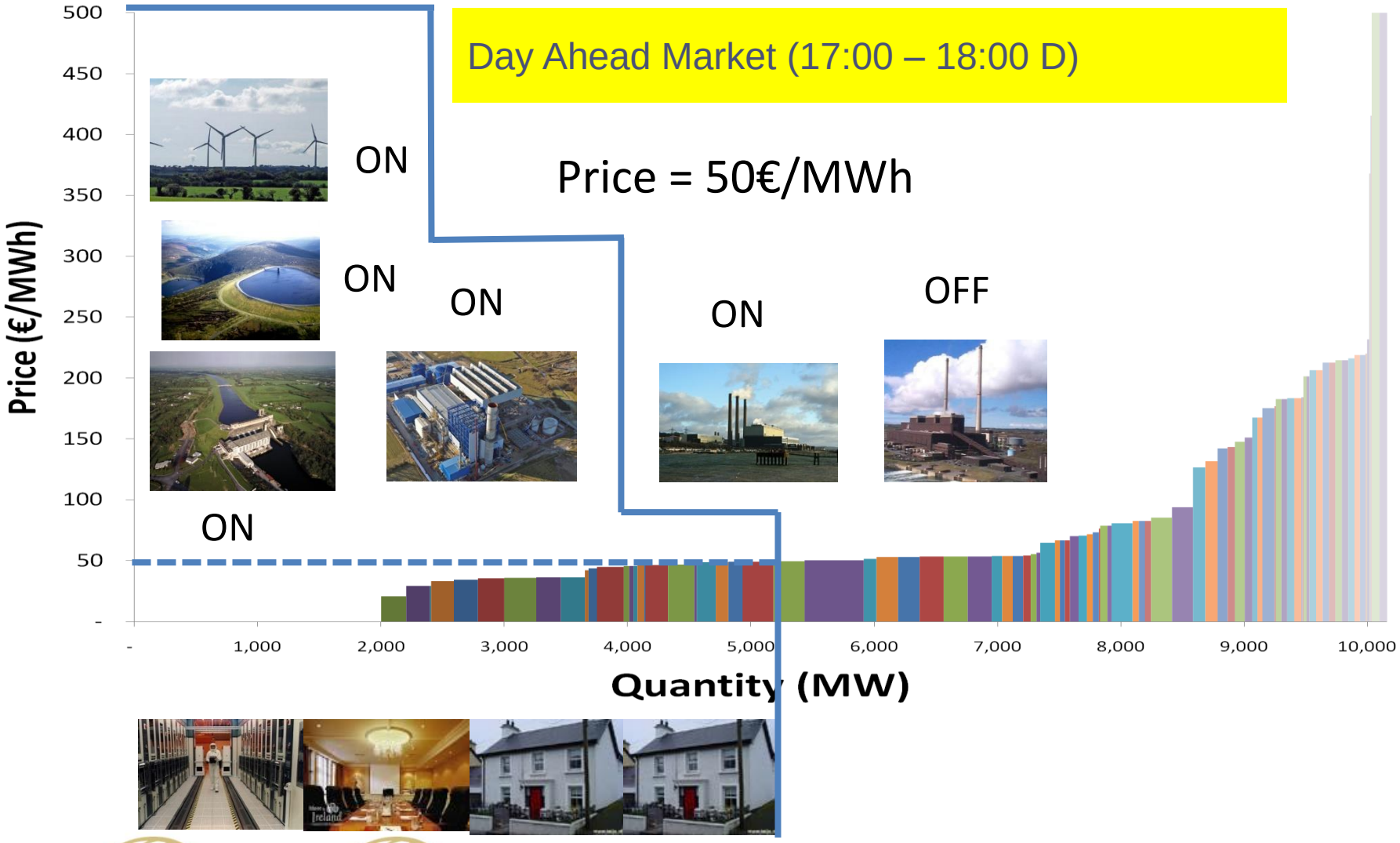
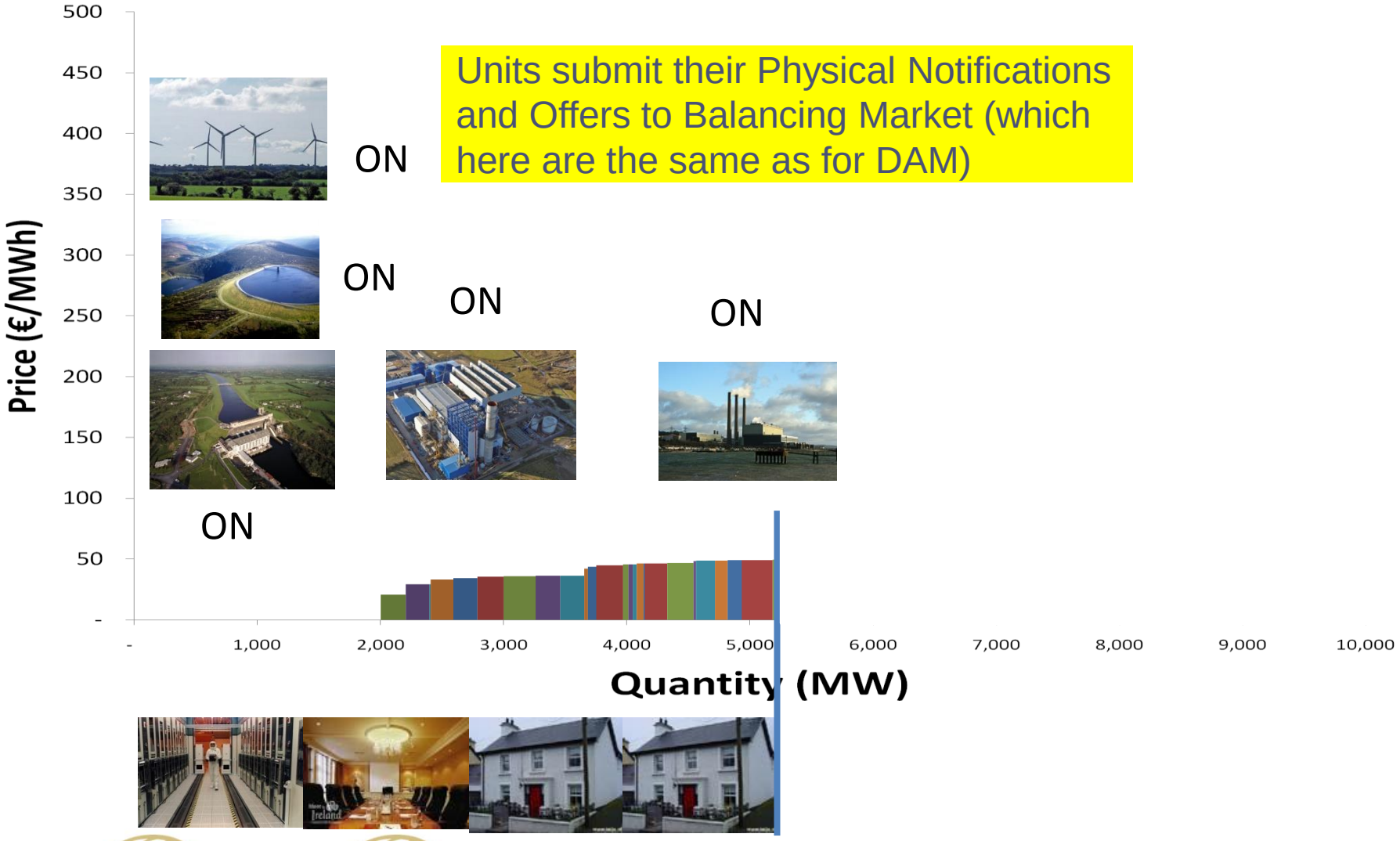
Day in the Life 1a: D-1 10:00



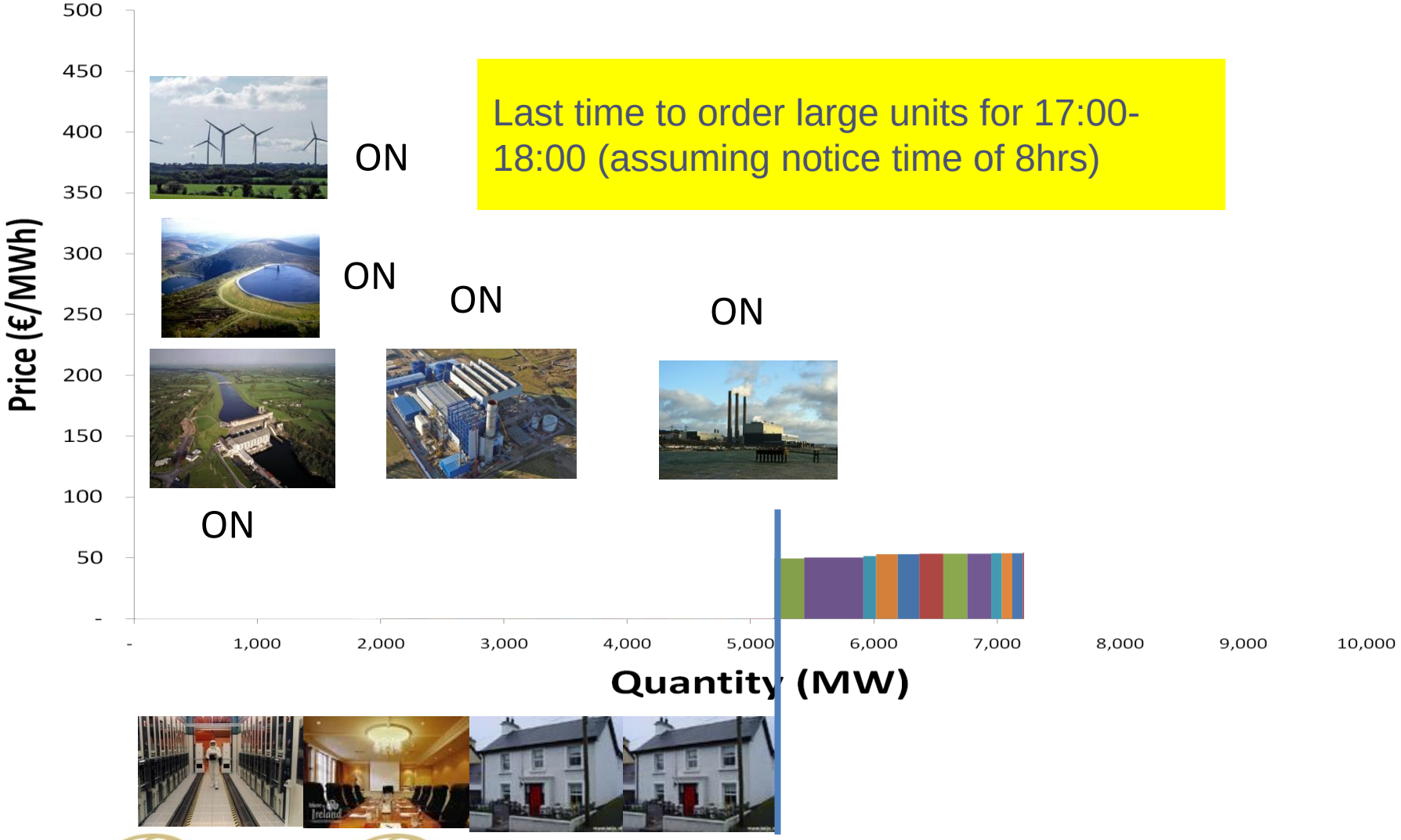
Day in the Life 1a: D-1 11:00



Day in the Life 1a: D-1 13:30

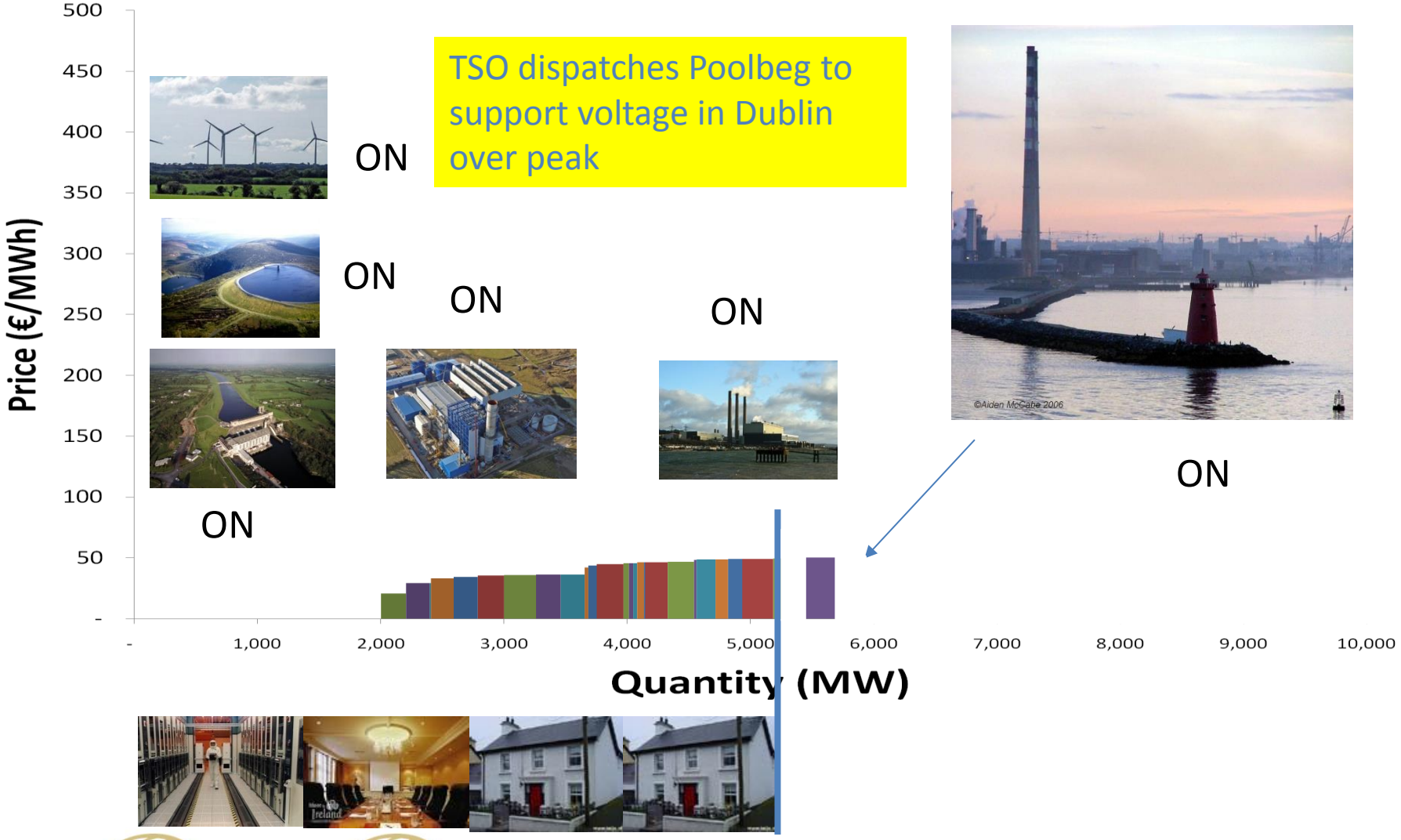


Day in the Life 1a: 09:00

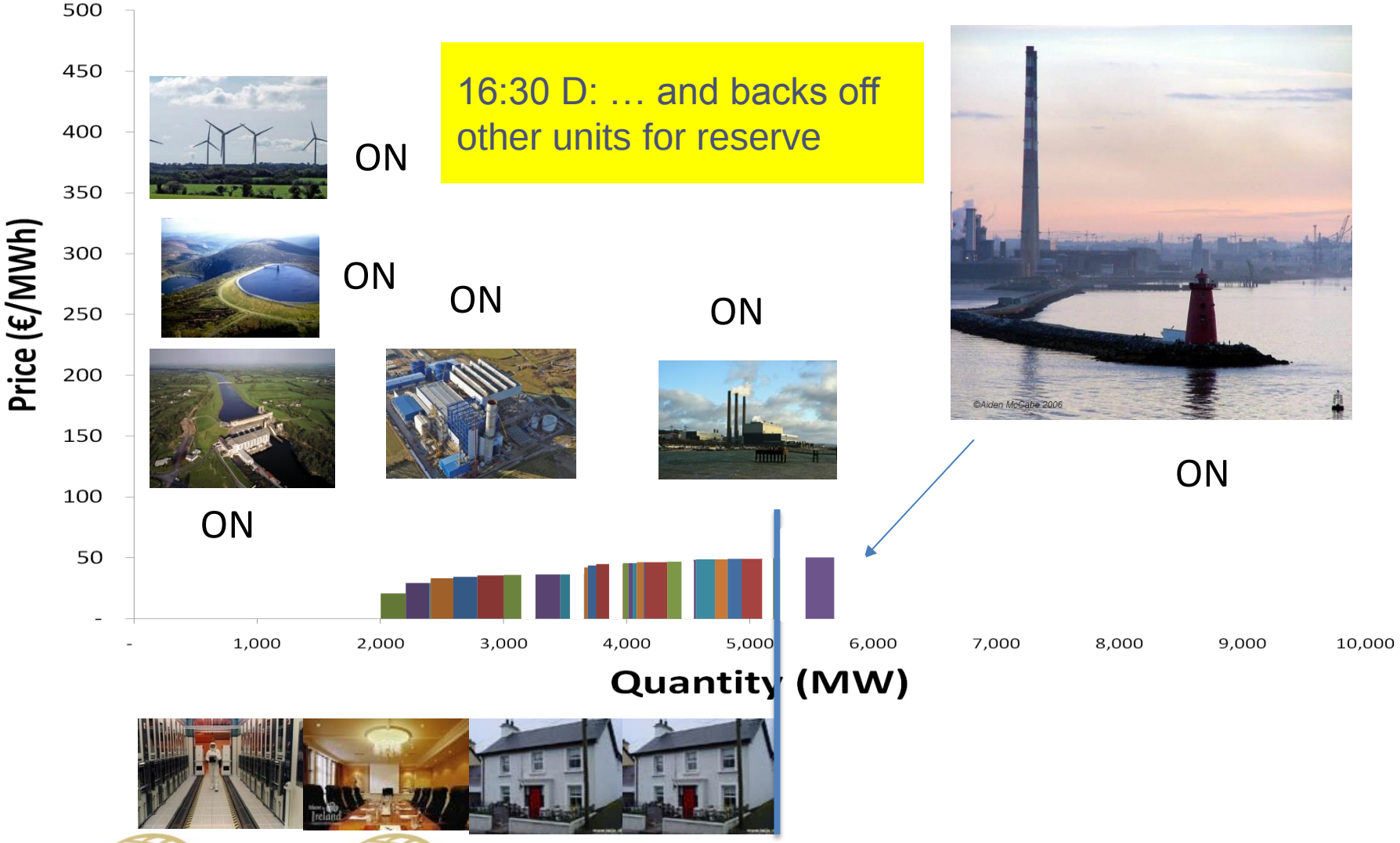


Last time to order large units for 17:00-18:00 (assuming notice time of 8hrs)

Day in the Life 1a: 09:00



Day in the Life 1a: 16:30



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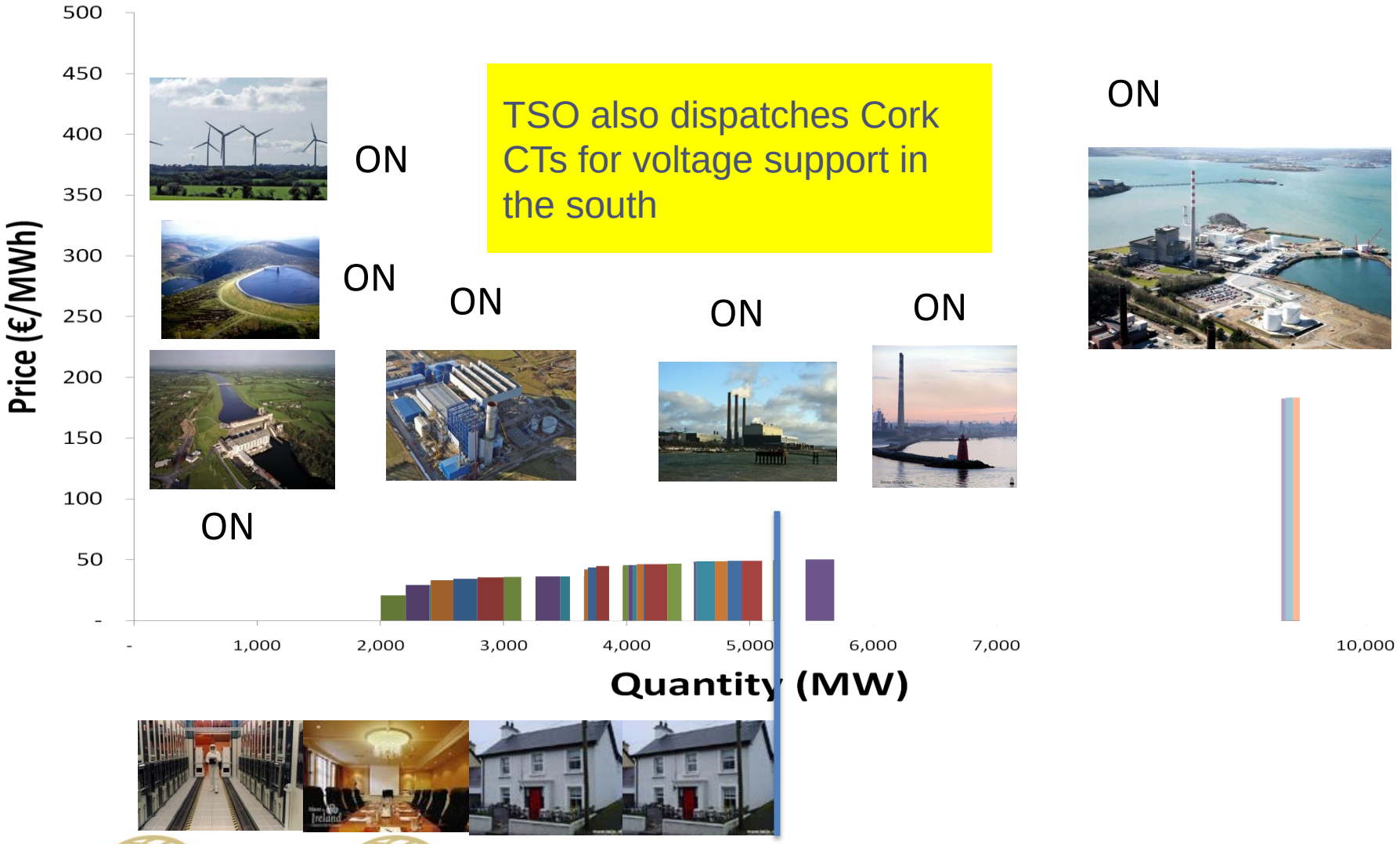
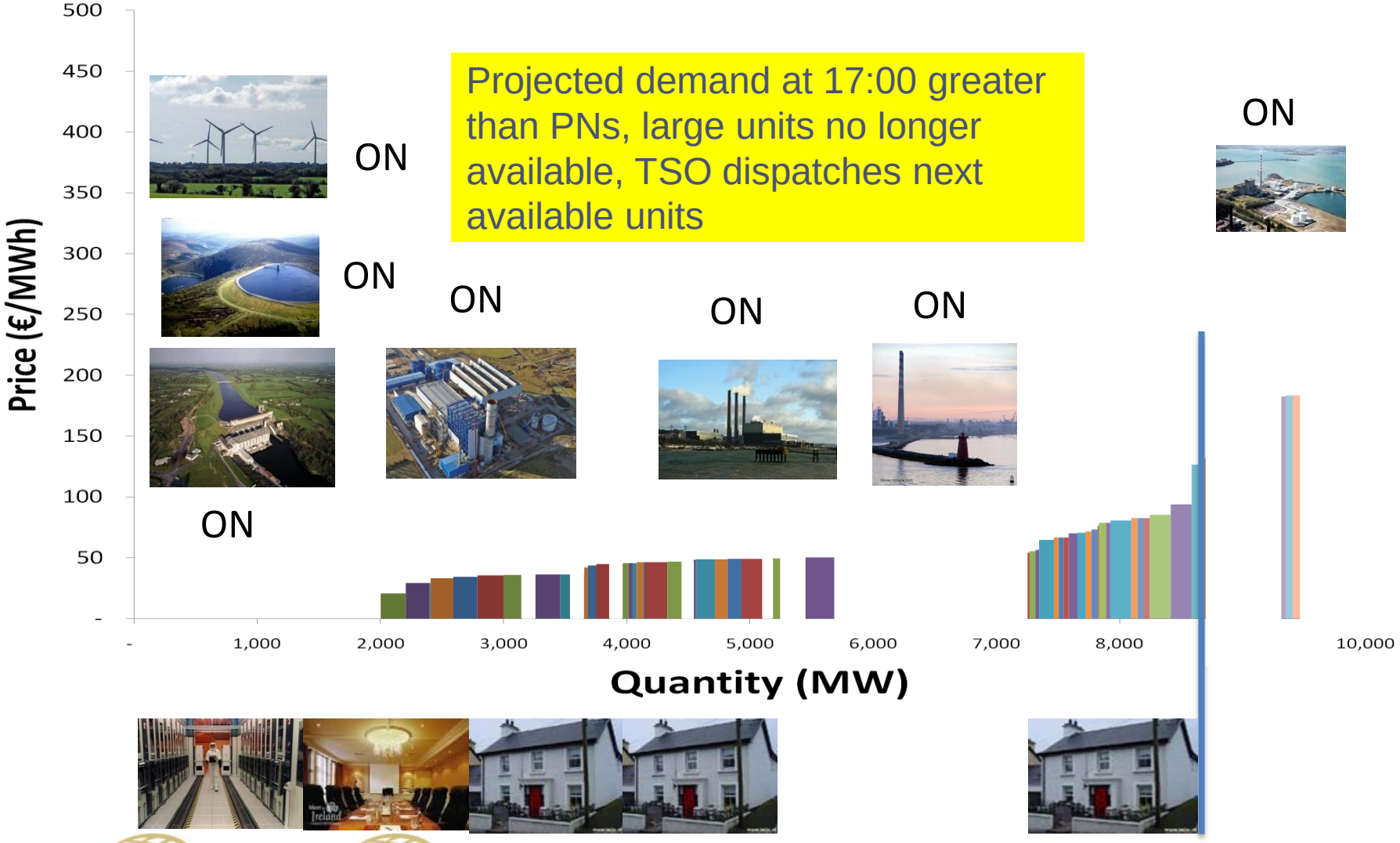
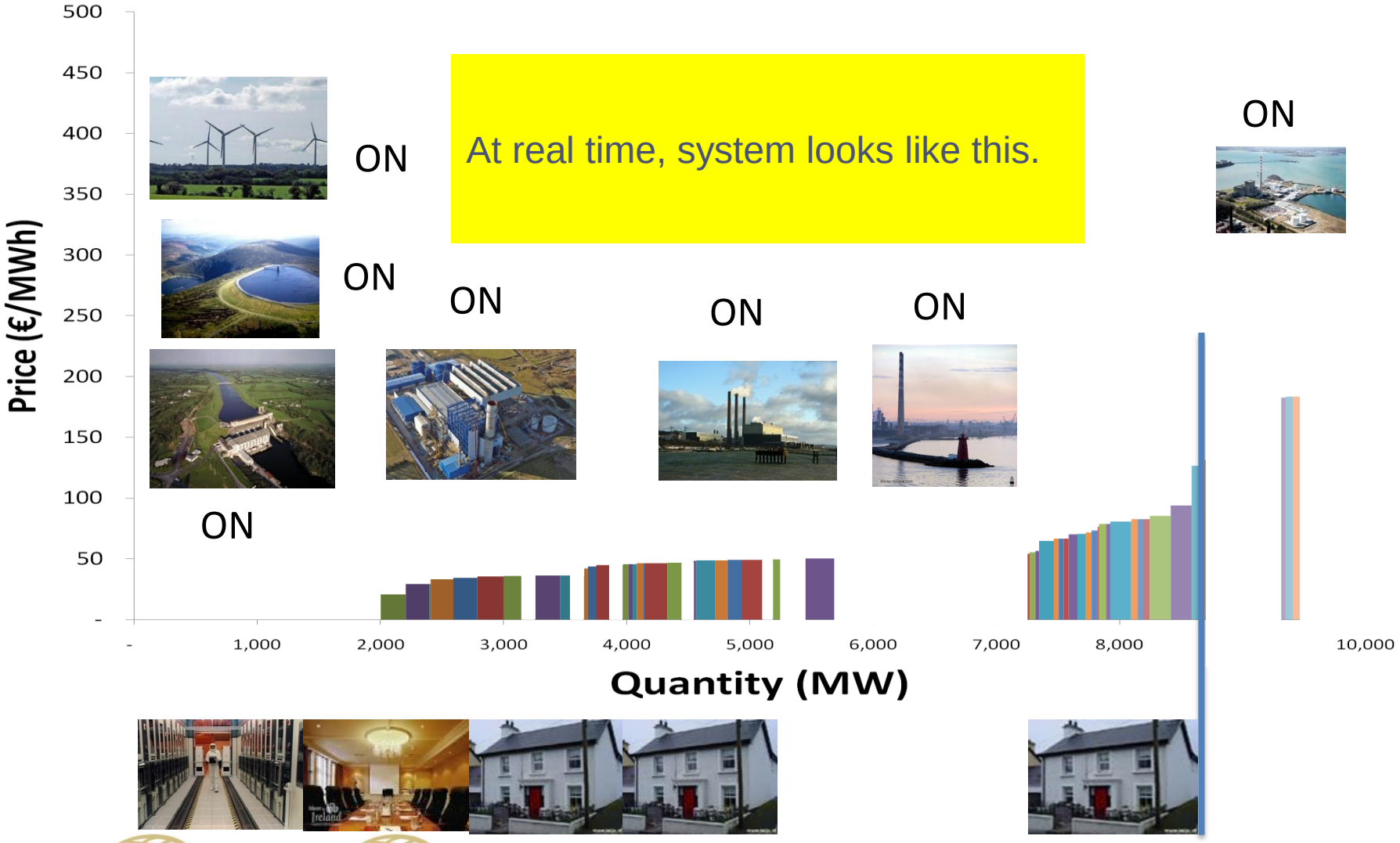


Day in the Life 1a: 16:45



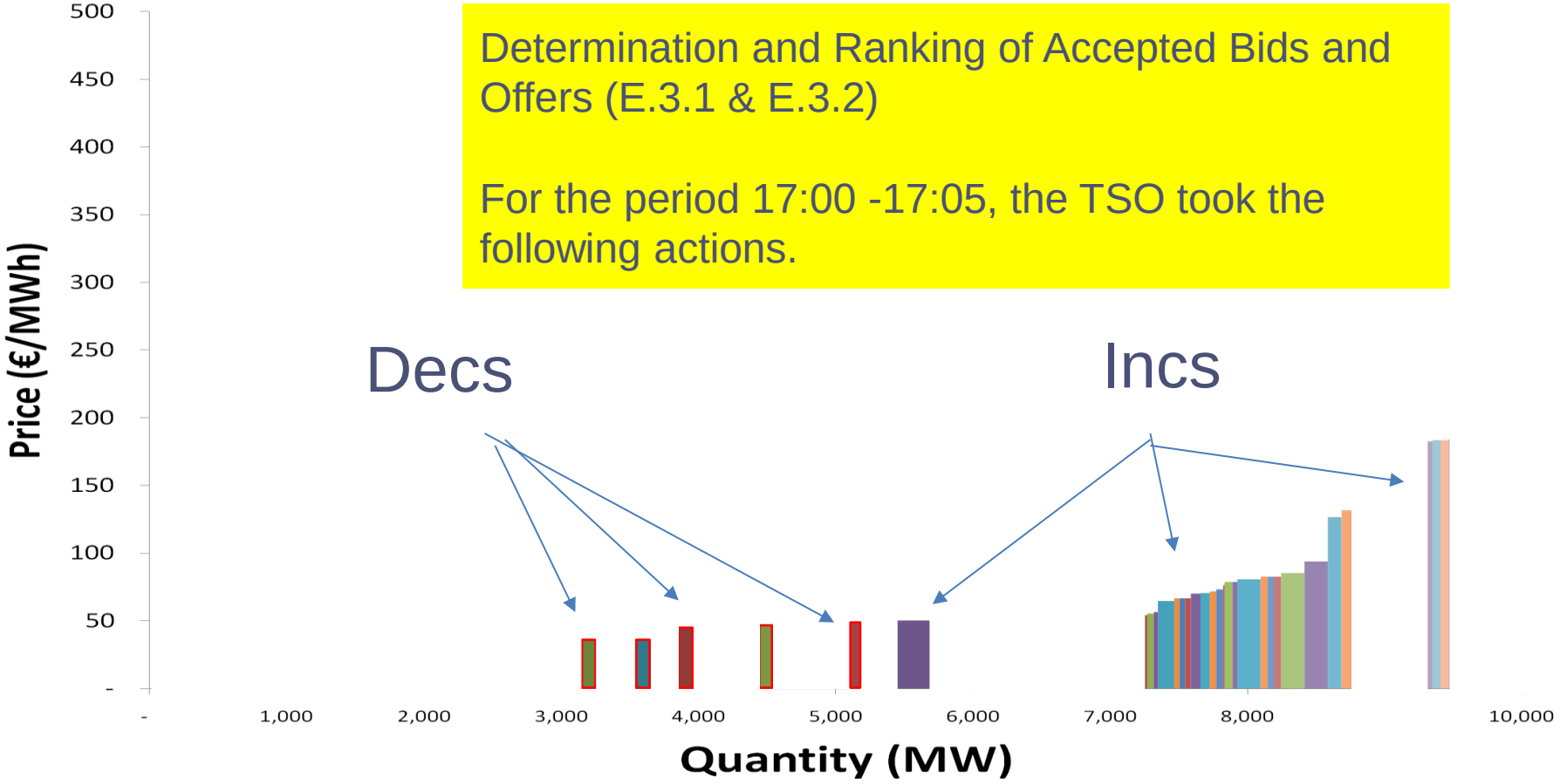
Day in the Life 1a: 17:00 (Real time)



Day in the Life 1a: 17:25 (Imbalance Pricing)

Determination and Ranking of Accepted Bids and Offers (E.3.1 & E.3.2)

For the period 17:00 -17:05, the TSO took the following actions.



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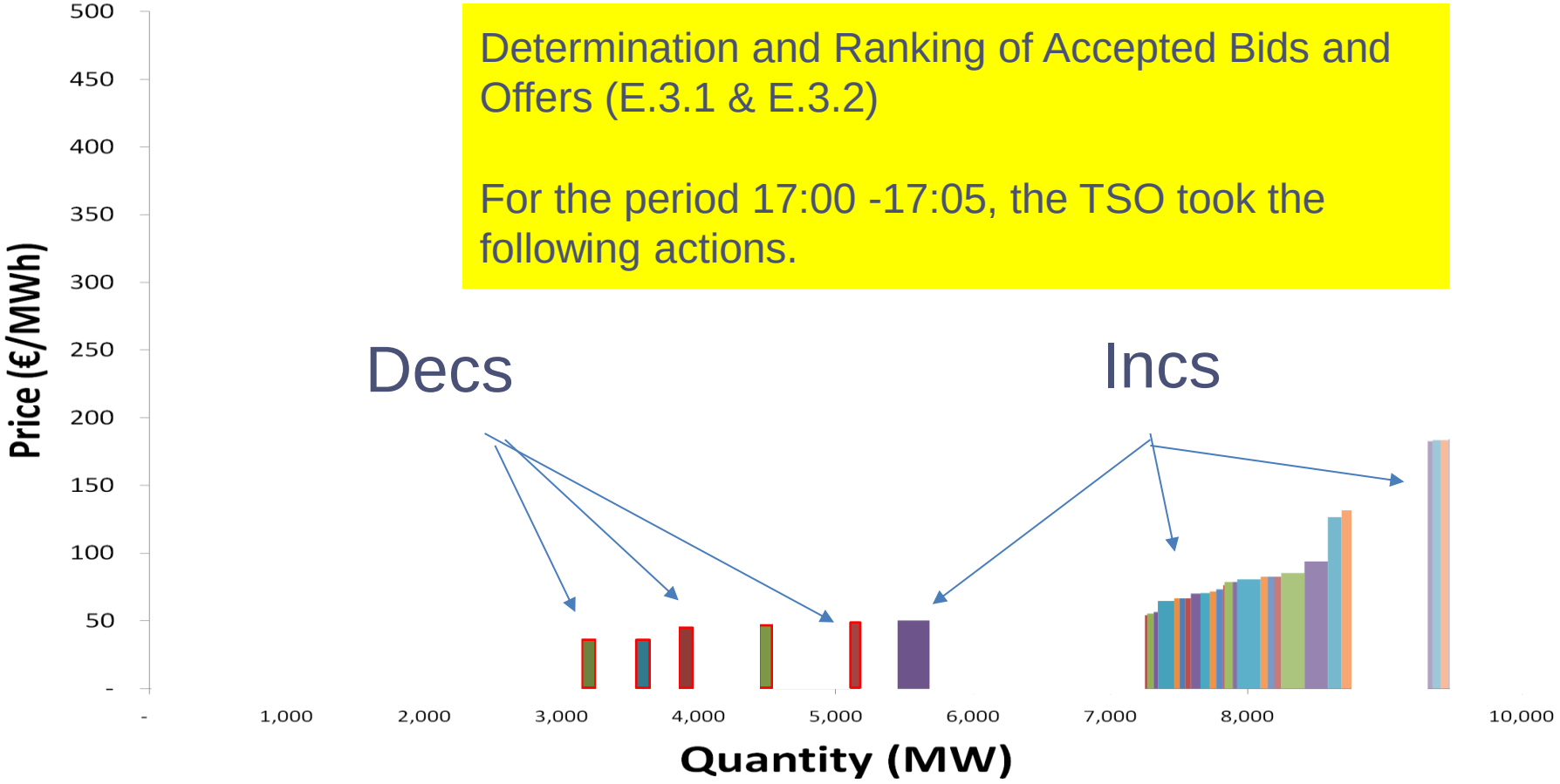
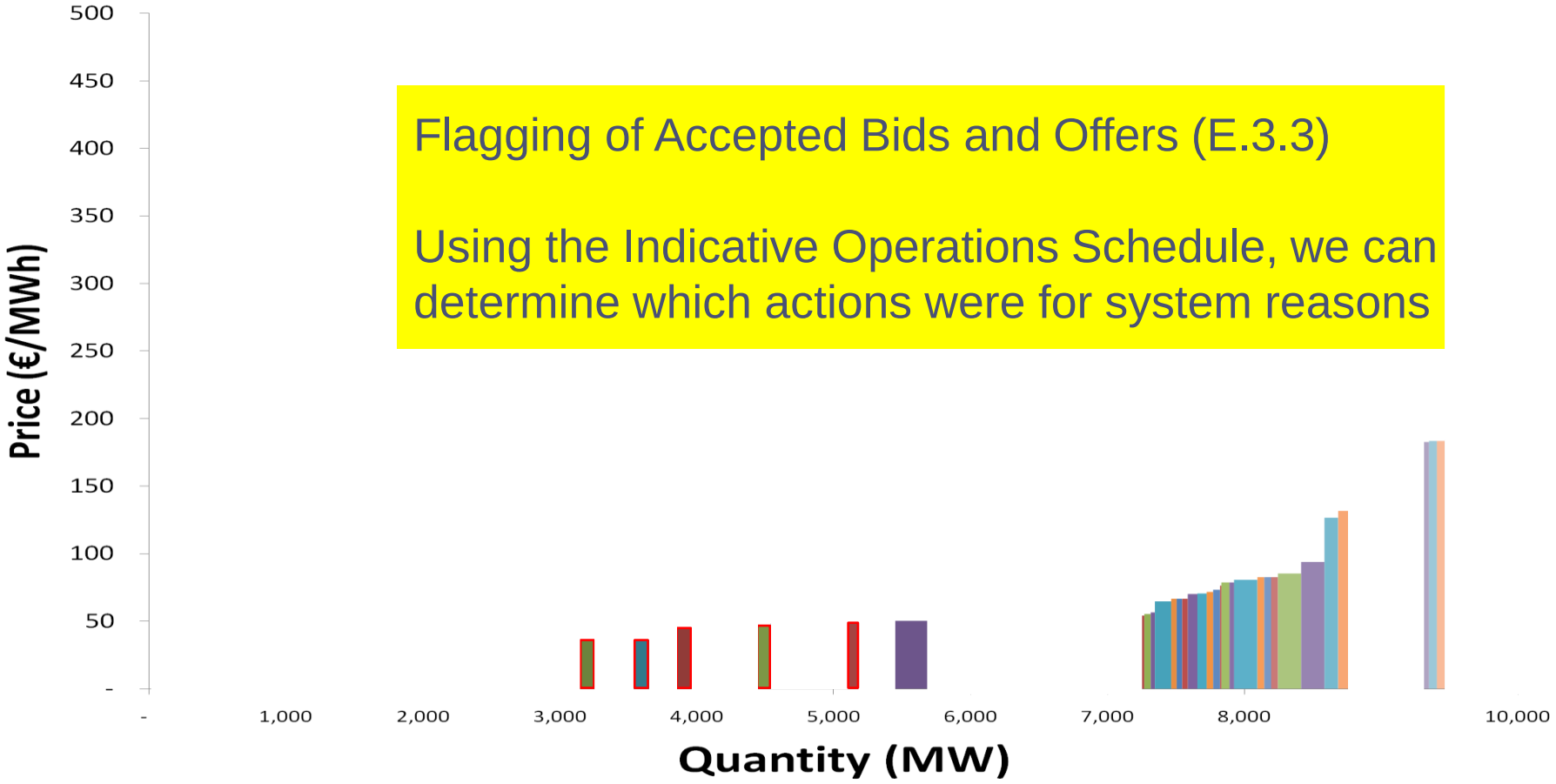


Rank k 1 2 3 4 5 6 7 to 27 28-31

Day in the Life 1a: 17:25 (Imbalance Pricing)

Flagging of Accepted Bids and Offers (E.3.3)

Using the Indicative Operations Schedule, we can determine which actions were for system reasons



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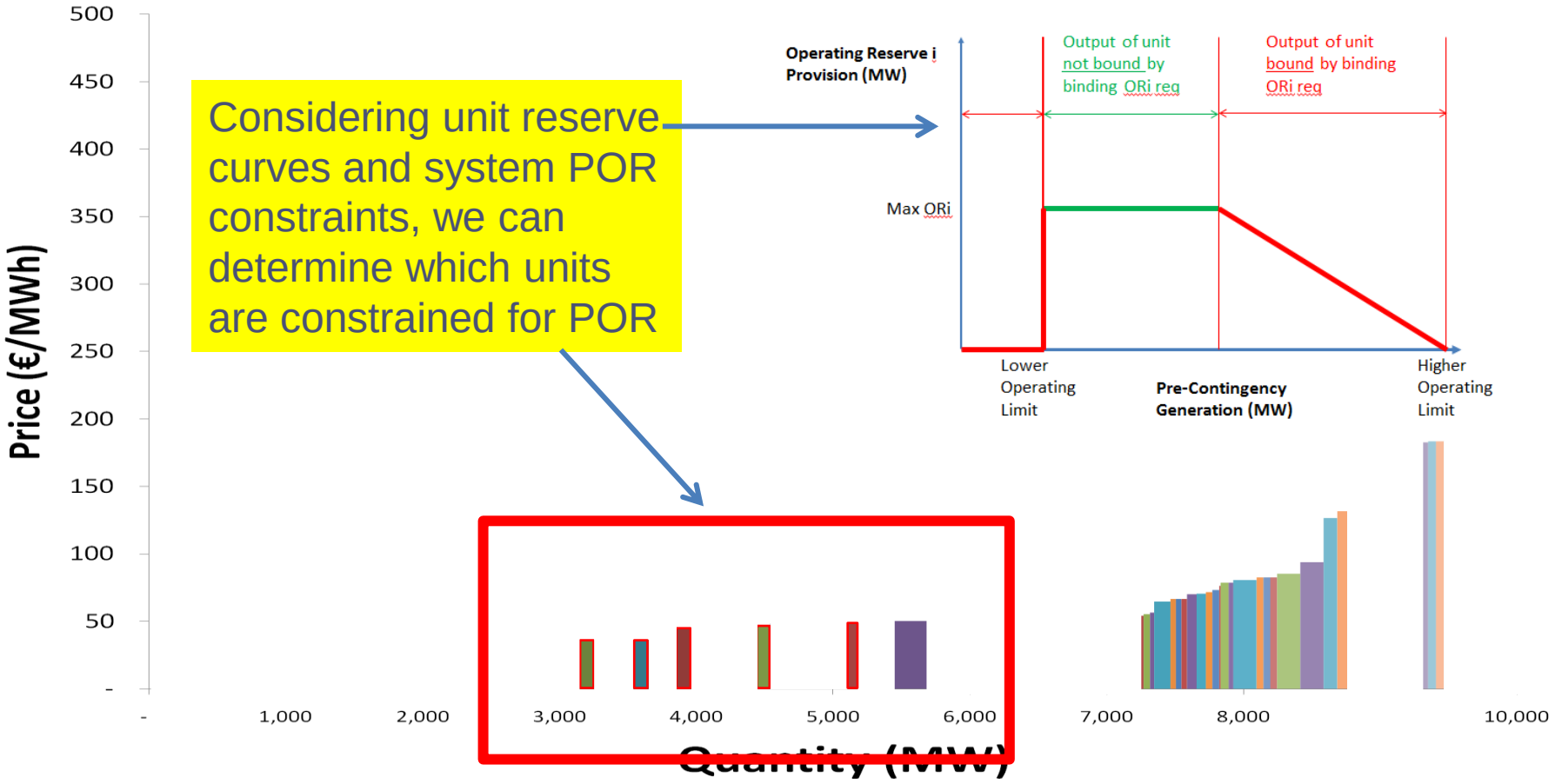
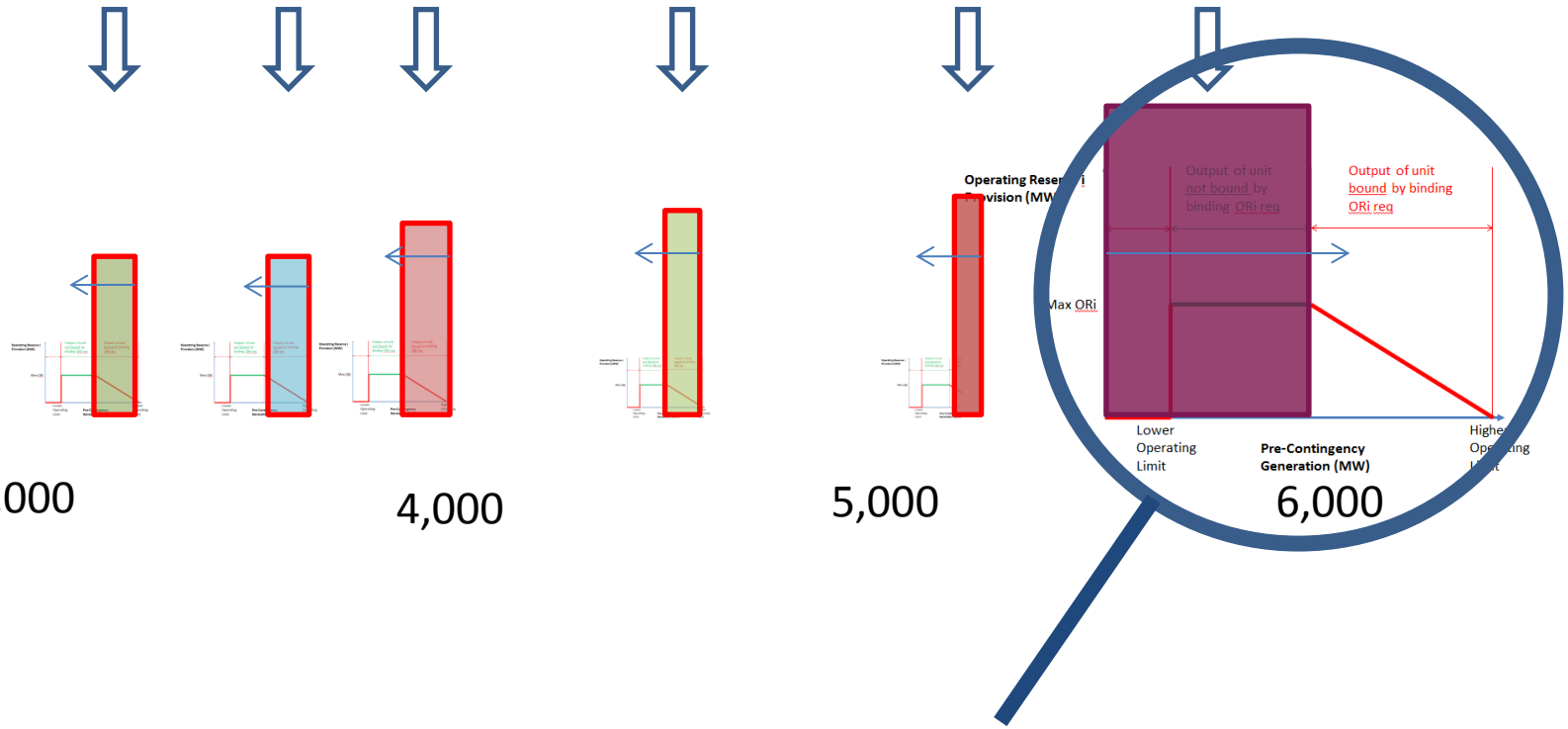


Day in the Life 1a: 17:25 (Imbalance Pricing)

Units constrained for POR
System Operator Flagged



3,000

4,000

5,000

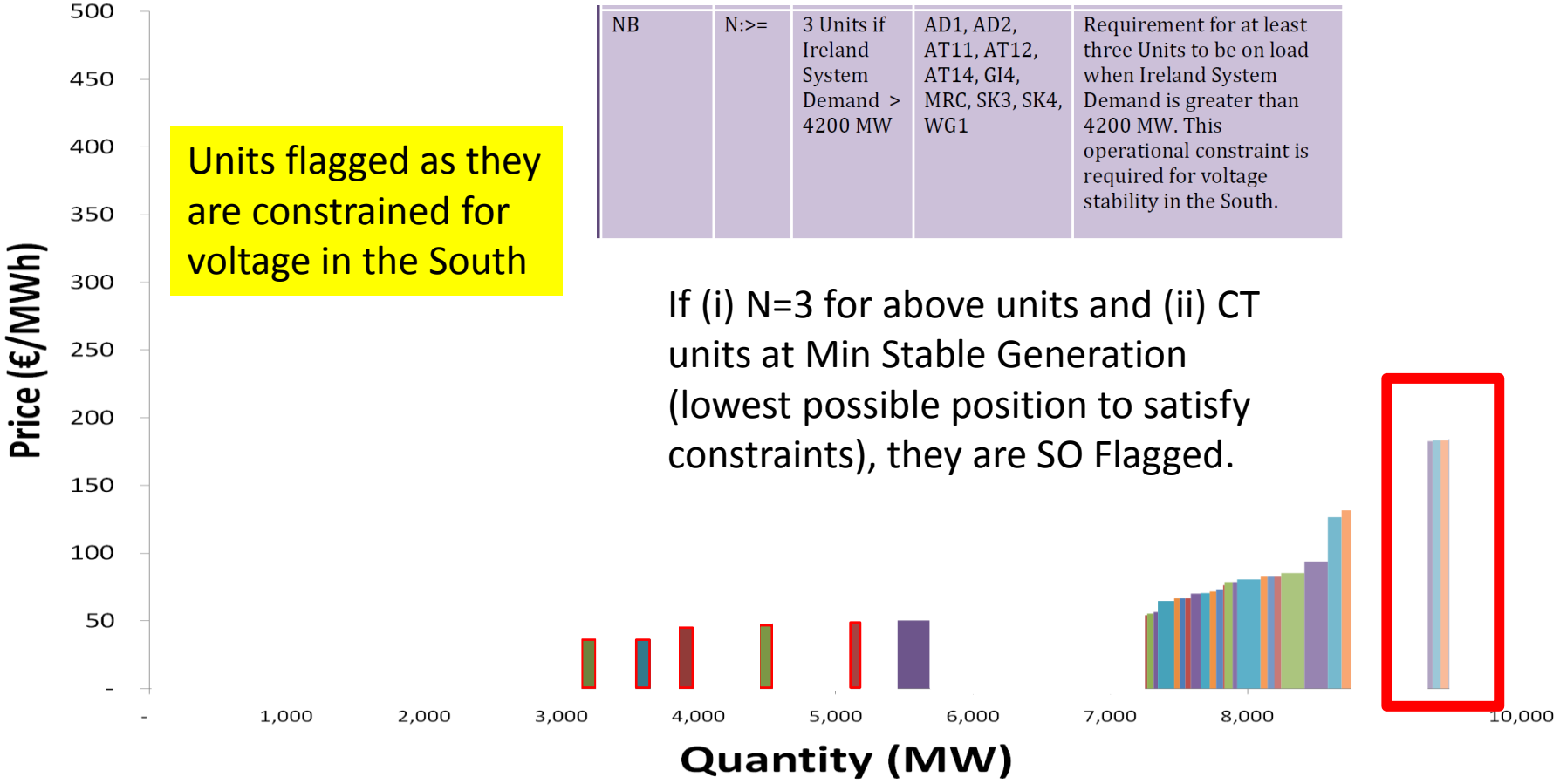
6,000

Day in the Life 1a: 17:25 (Imbalance Pricing)

Units flagged as they are constrained for voltage in the South

NB	N:>=	3 Units if Ireland System Demand > 4200 MW	AD1, AD2, AT11, AT12, AT14, GI4, MRC, SK3, SK4, WG1	Requirement for at least three Units to be on load when Ireland System Demand is greater than 4200 MW. This operational constraint is required for voltage stability in the South.

If (i) N=3 for above units and (ii) CT units at Min Stable Generation (lowest possible position to satisfy constraints), they are SO Flagged.



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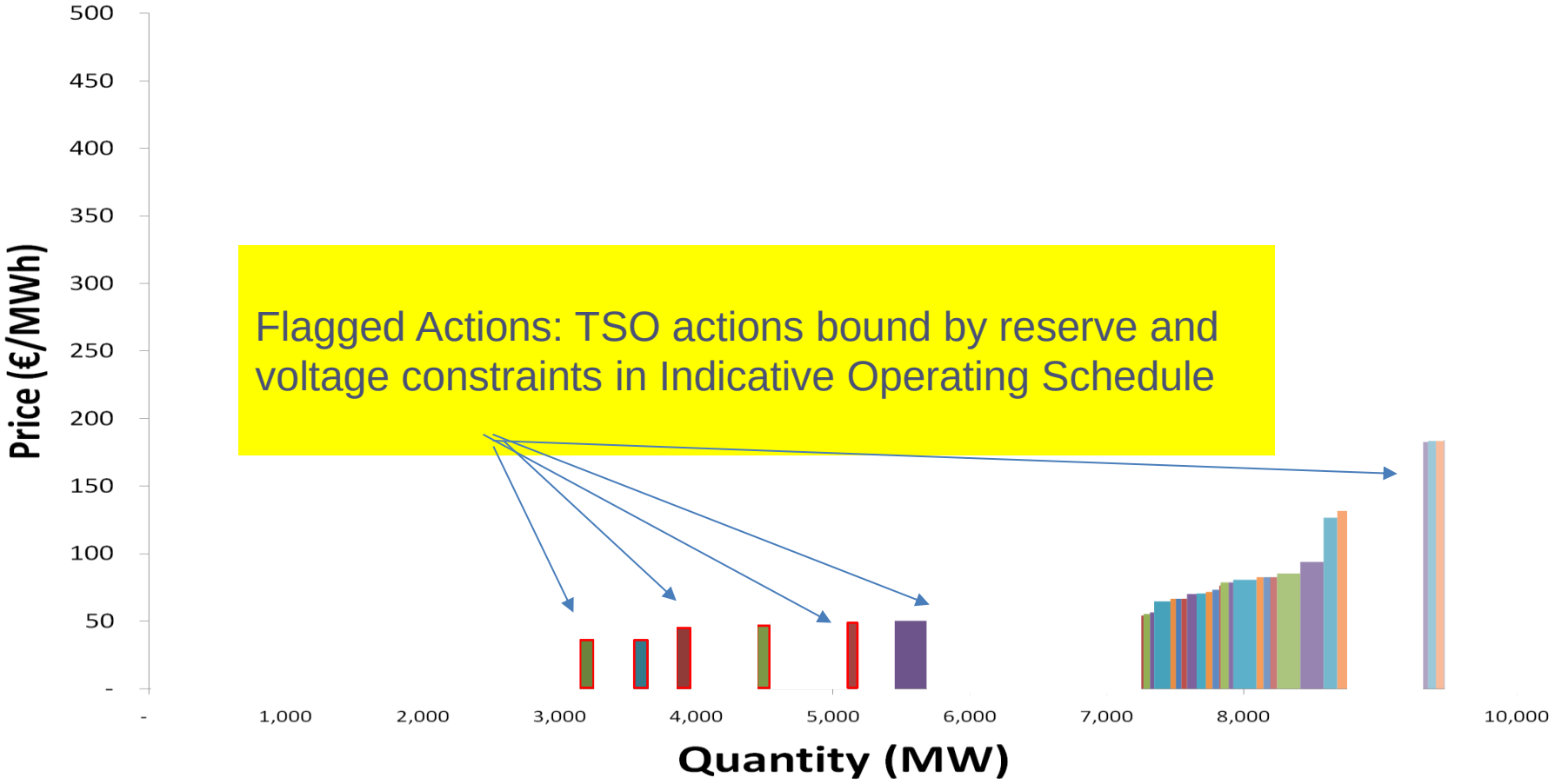

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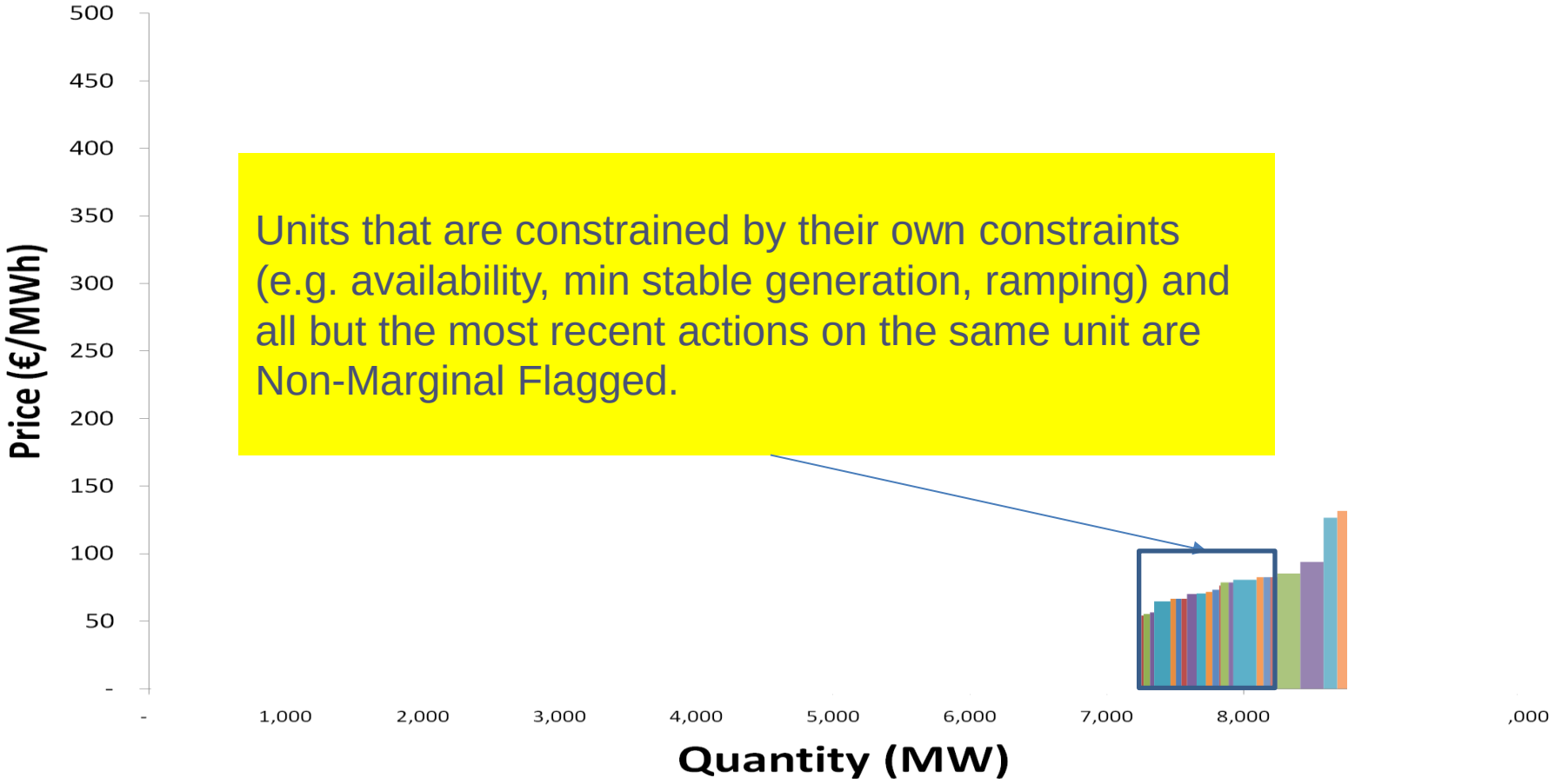

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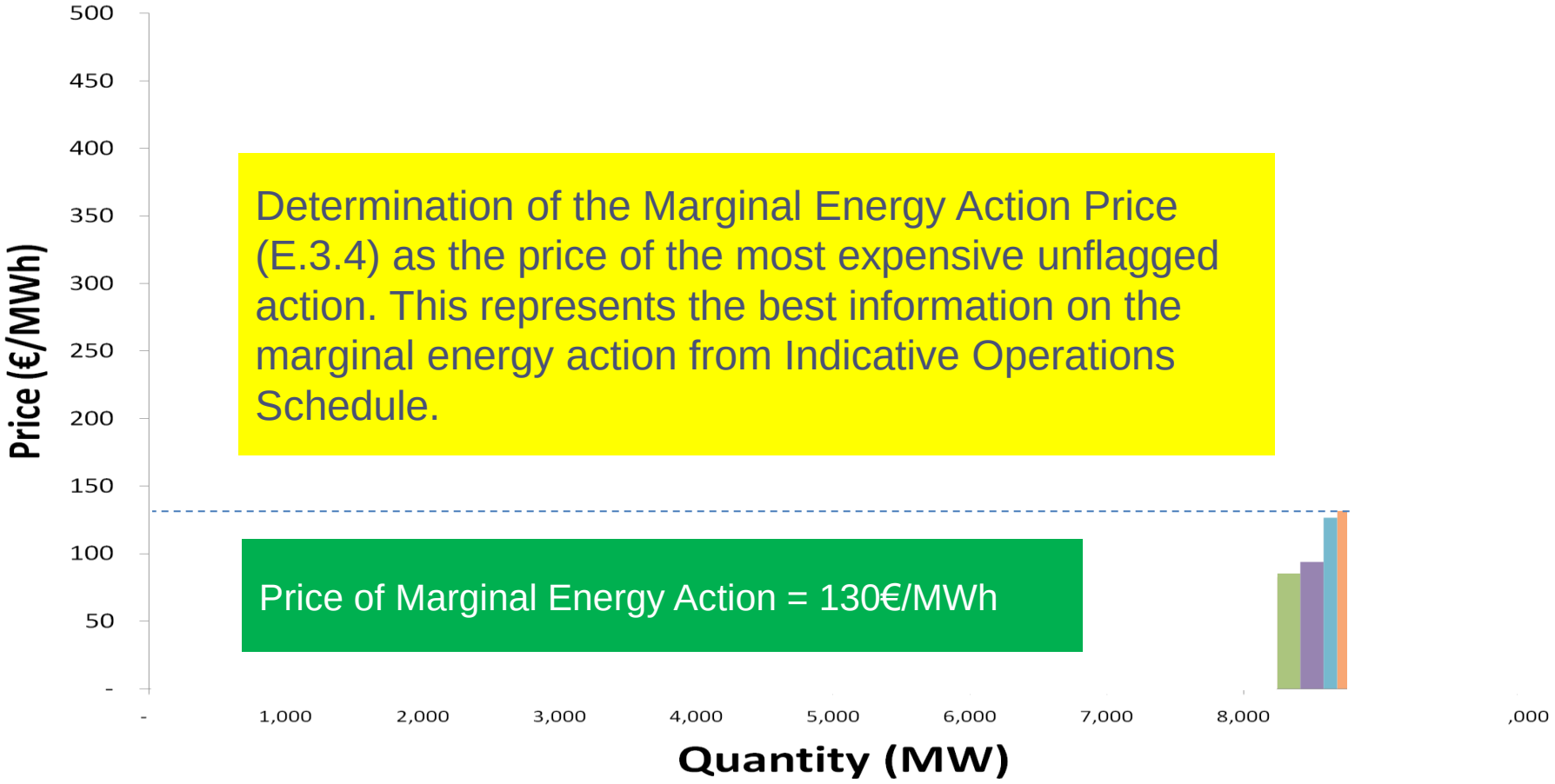
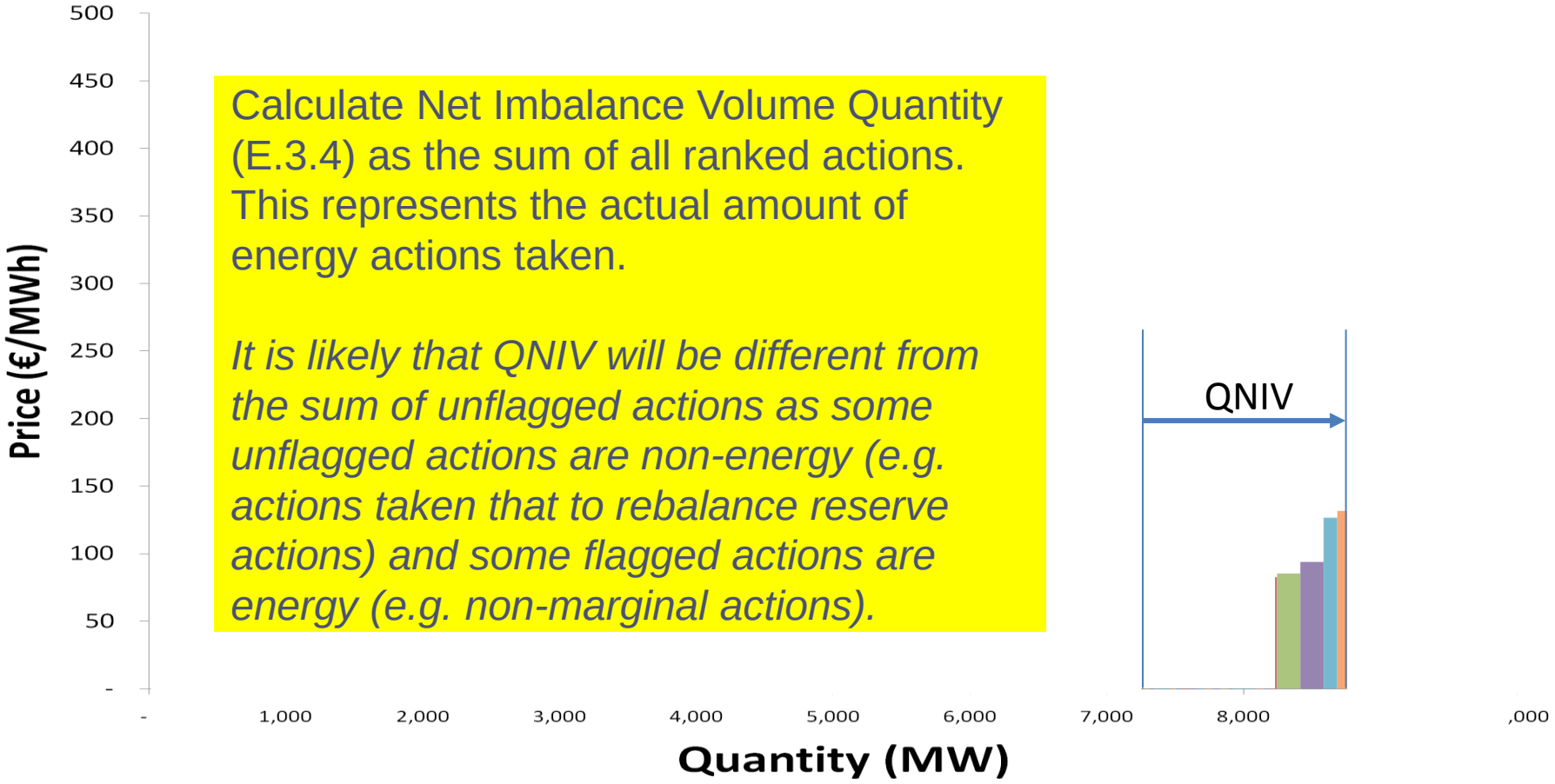


Day in the Life 1a: 17:25 (Imbalance Pricing)

Calculate Net Imbalance Volume Quantity (E.3.4) as the sum of all ranked actions. This represents the actual amount of energy actions taken.

It is likely that QNIV will be different from the sum of unflagged actions as some unflagged actions are non-energy (e.g. actions taken that to rebalance reserve actions) and some flagged actions are energy (e.g. non-marginal actions).

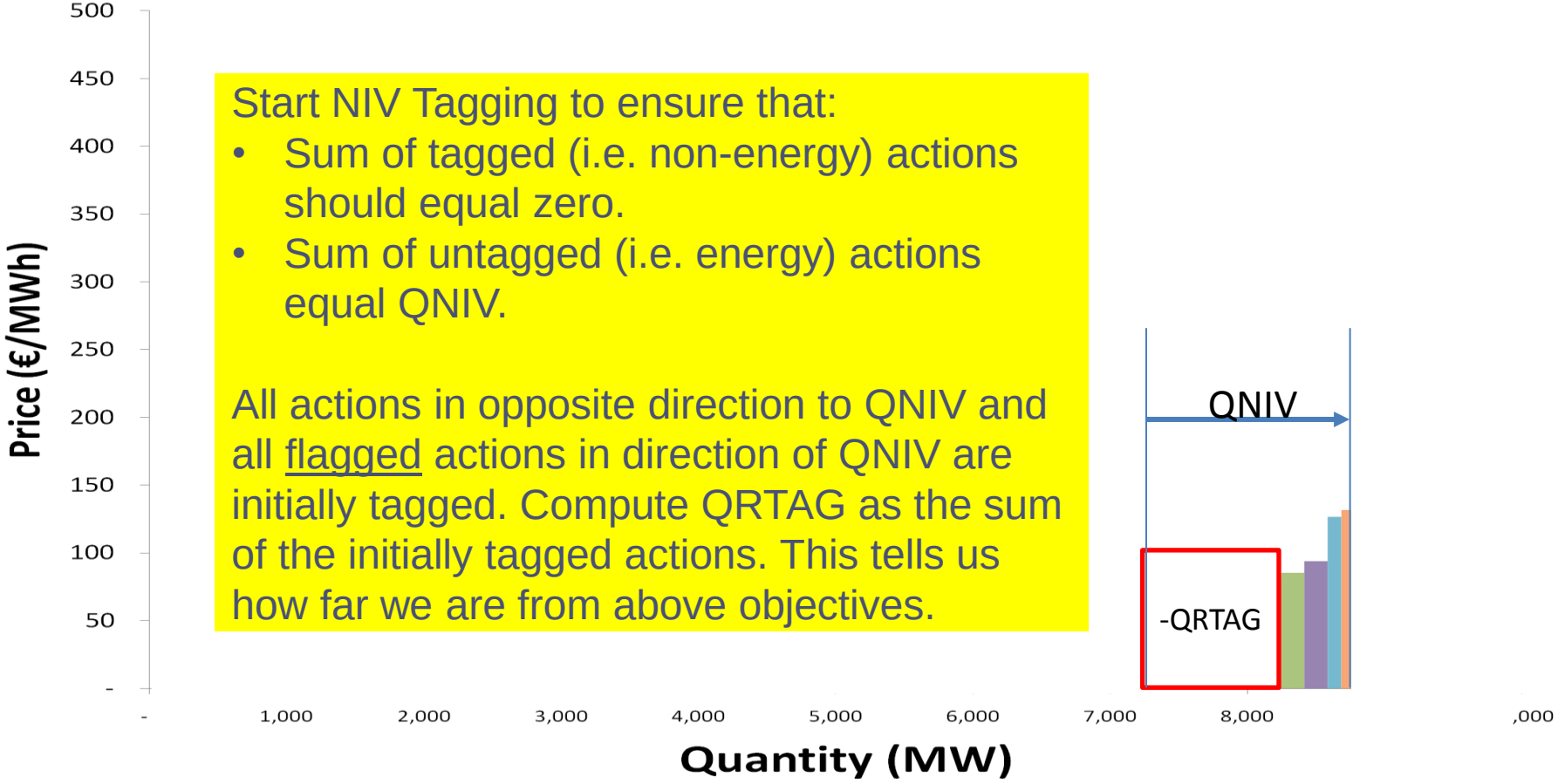


Day in the Life 1a: 17:25 (Imbalance Pricing)

Start NIV Tagging to ensure that:

- Sum of tagged (i.e. non-energy) actions should equal zero.
- Sum of untagged (i.e. energy) actions equal QNIV.

All actions in opposite direction to QNIV and all flagged actions in direction of QNIV are initially tagged. Compute QRTAG as the sum of the initially tagged actions. This tells us how far we are from above objectives.



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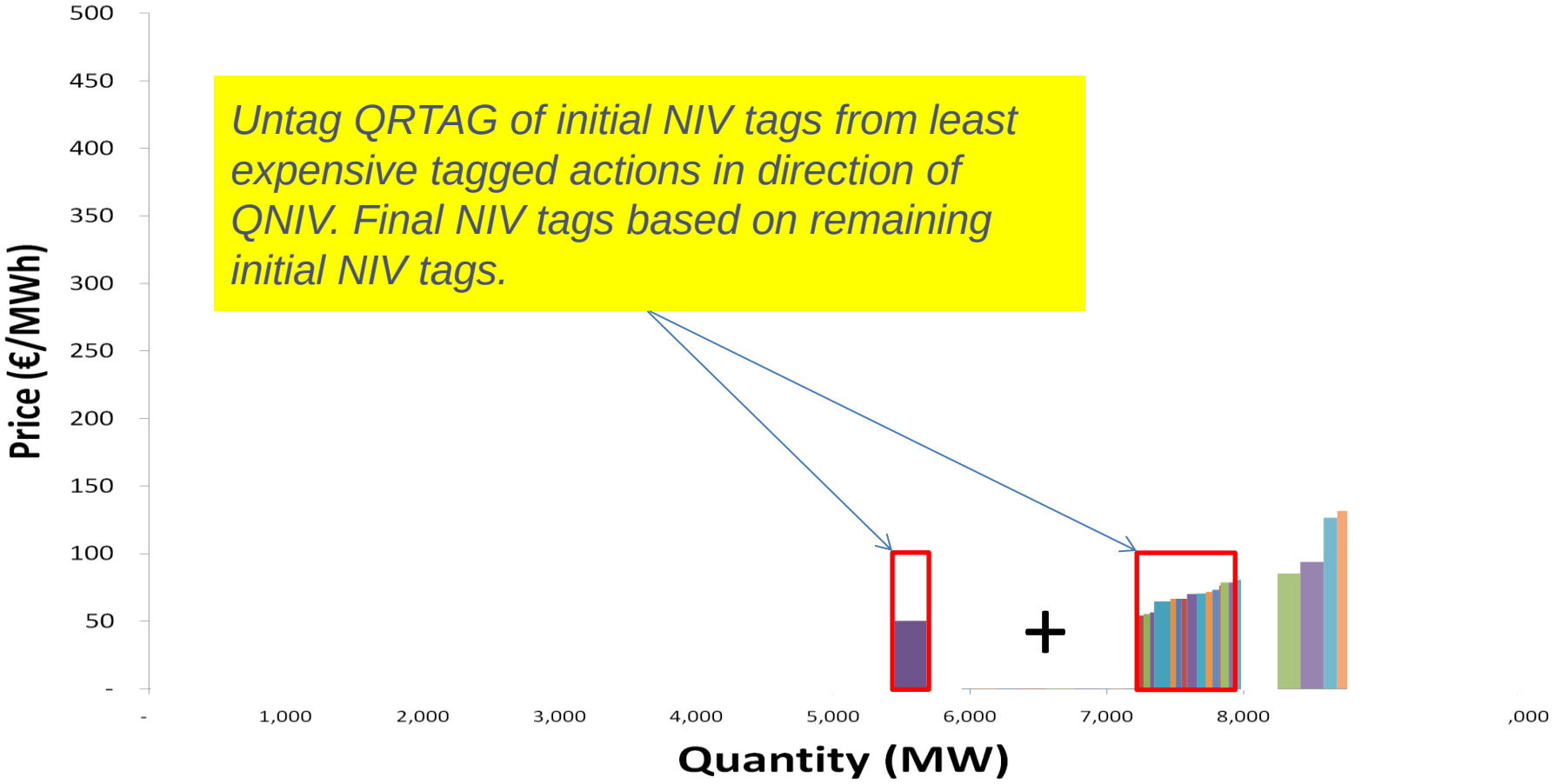
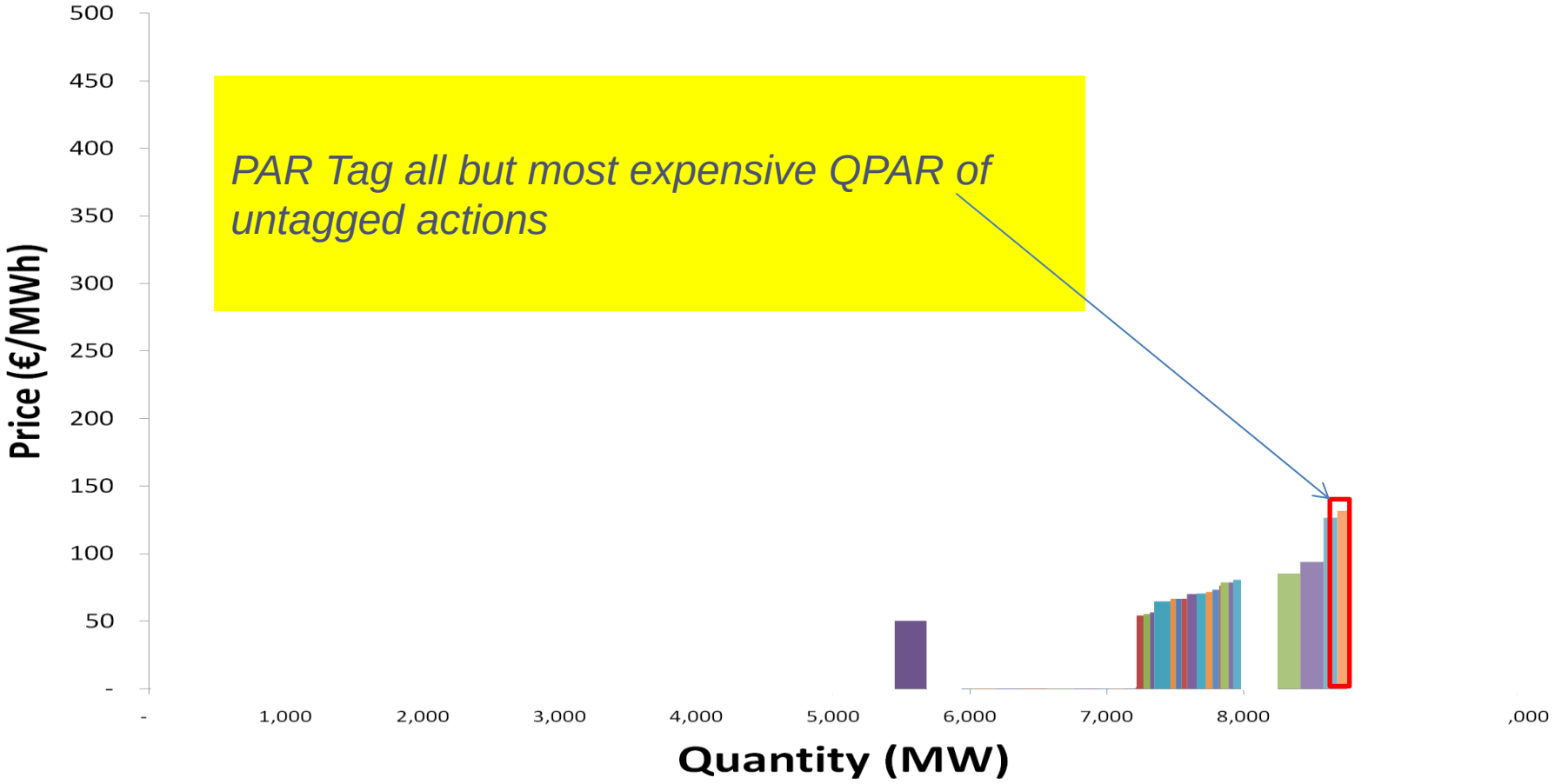
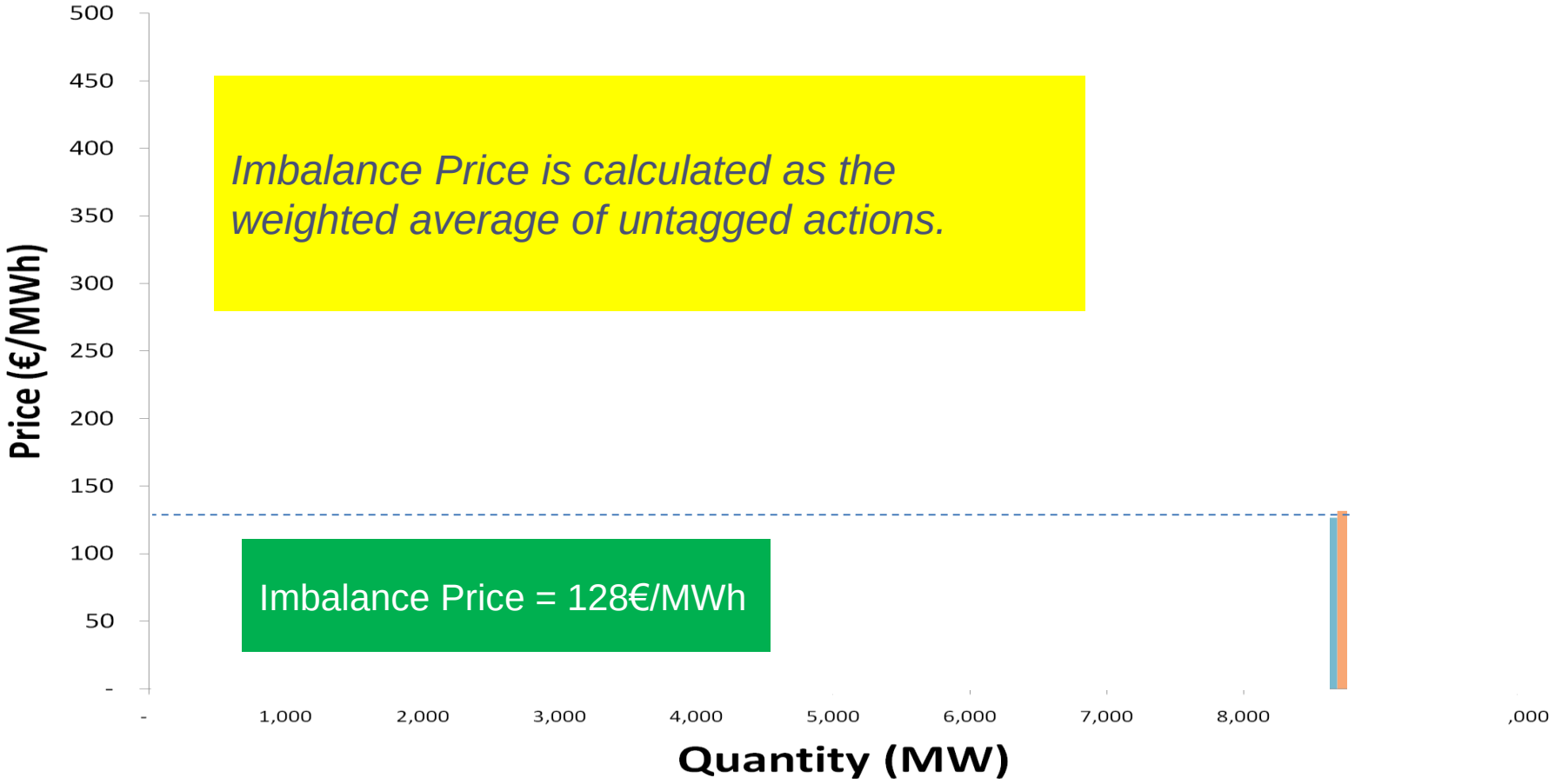


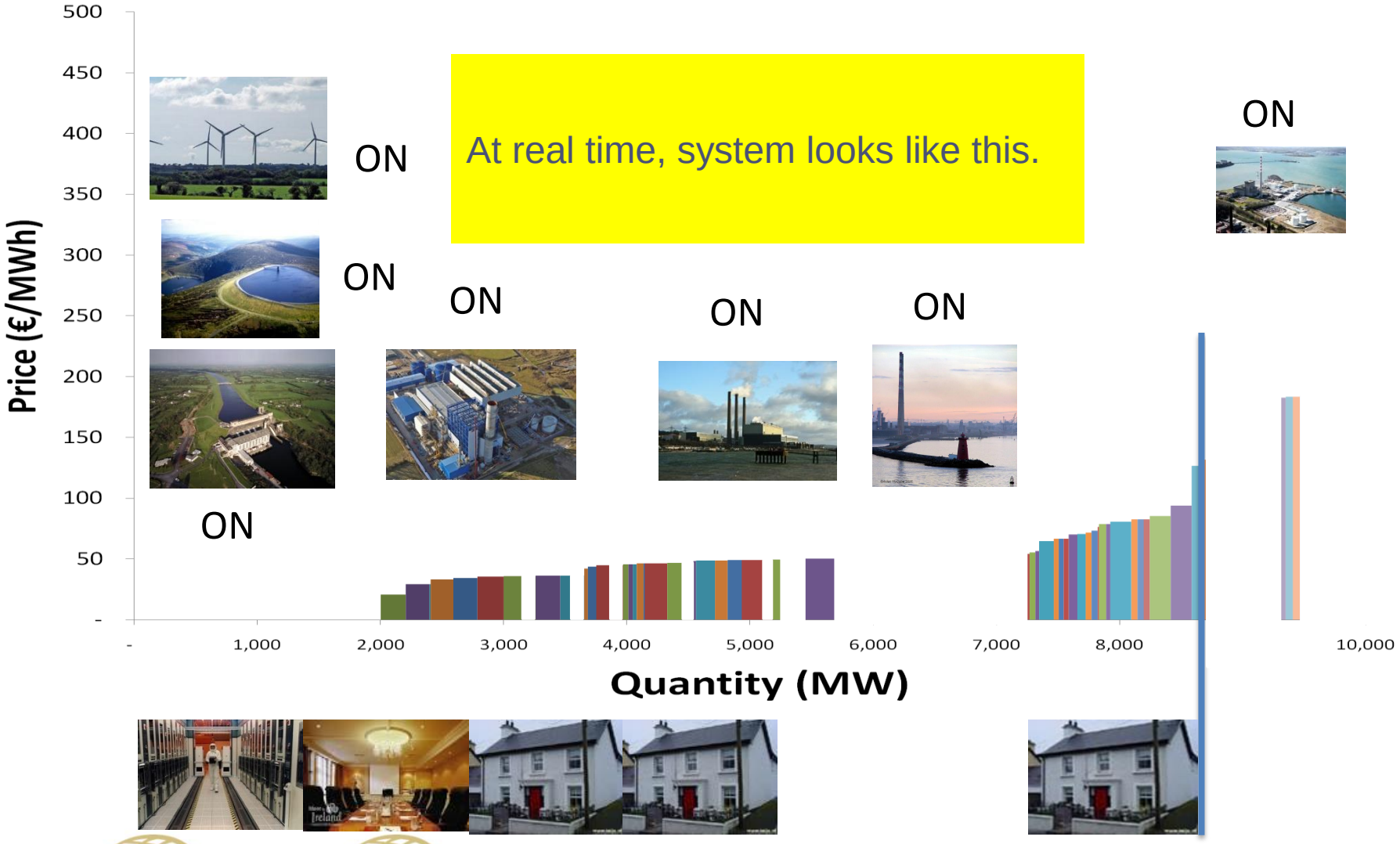
Day in the Life 1a: 17:25 (Imbalance Pricing)



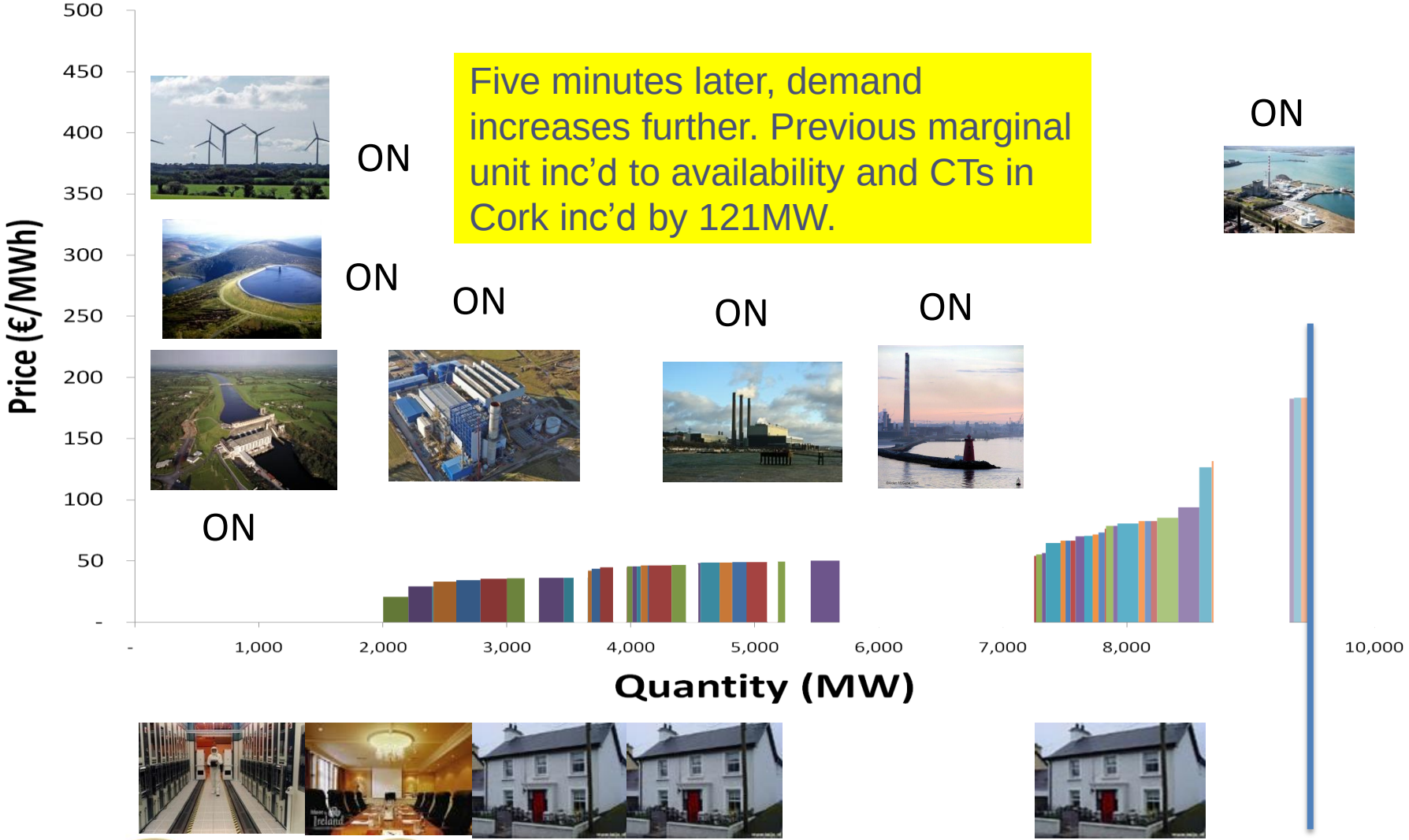
Day in the Life 1a: 17:25 (Imbalance Pricing)



Day in the Life 1b: 17:00 (Real time)



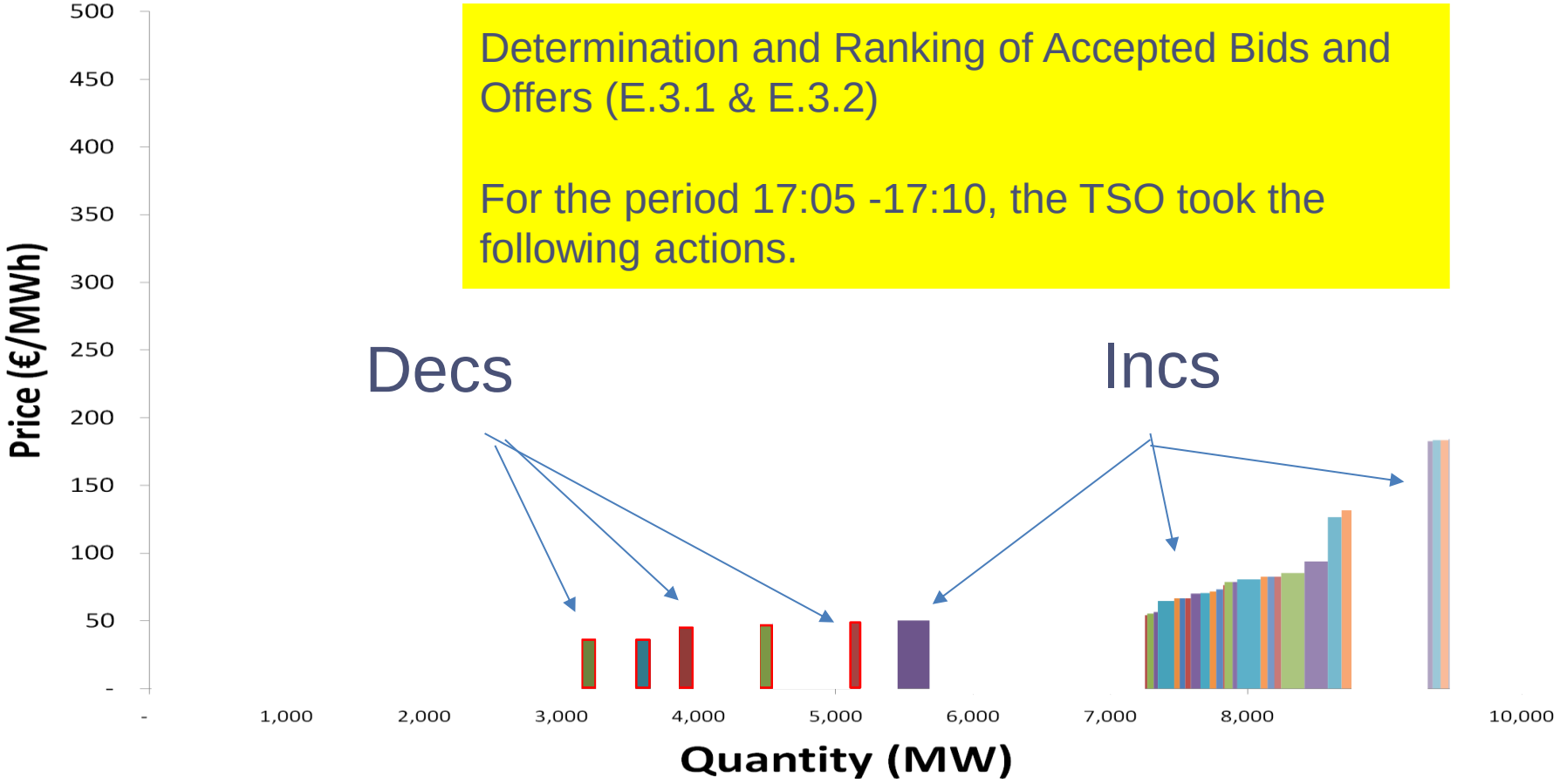
Day in the Life 1b: 17:05 (Real time)



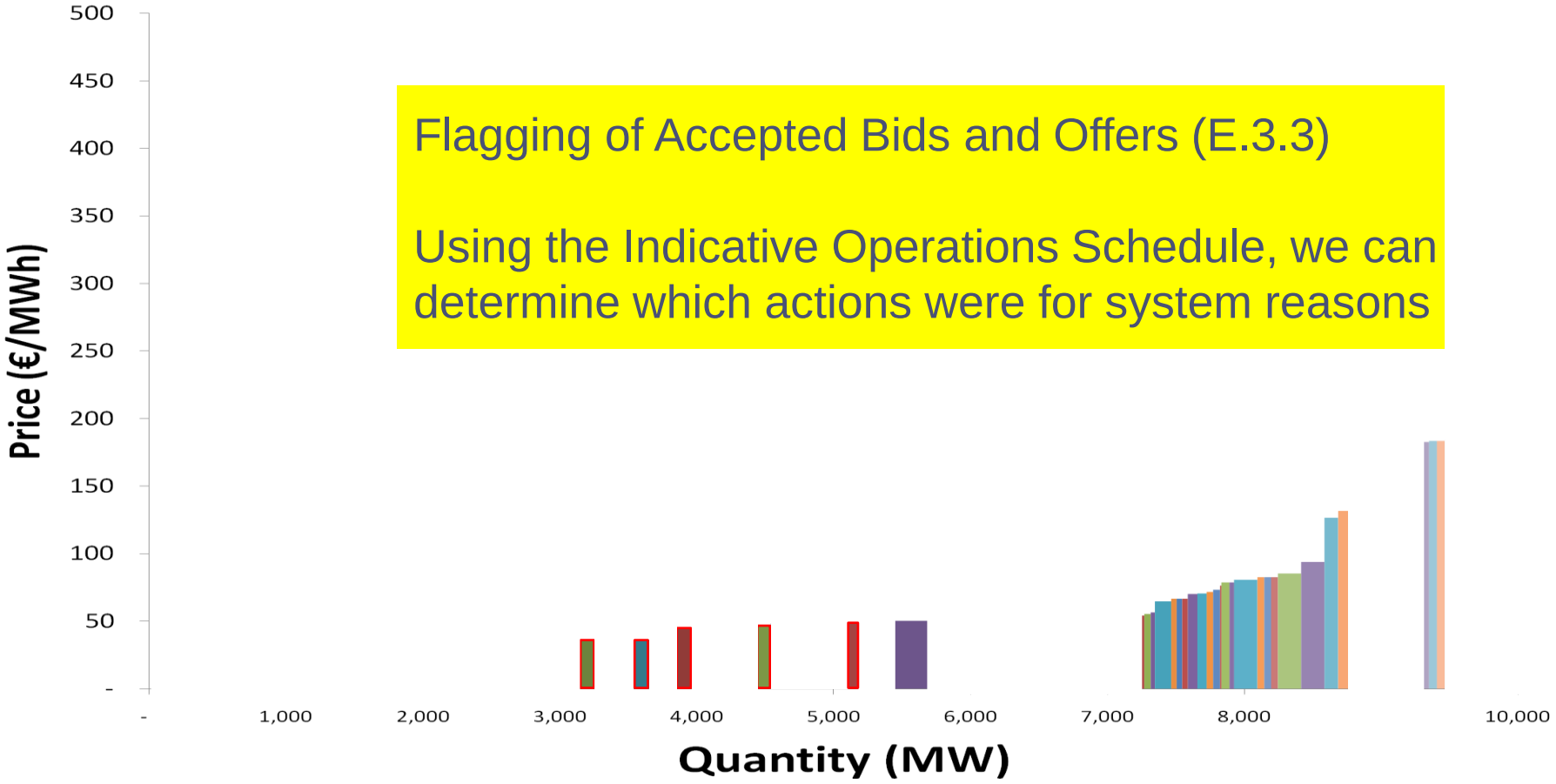
Day in the Life 1b: 17:30 (Imbalance Pricing)

Determination and Ranking of Accepted Bids and Offers (E.3.1 & E.3.2)

For the period 17:05 -17:10, the TSO took the following actions.



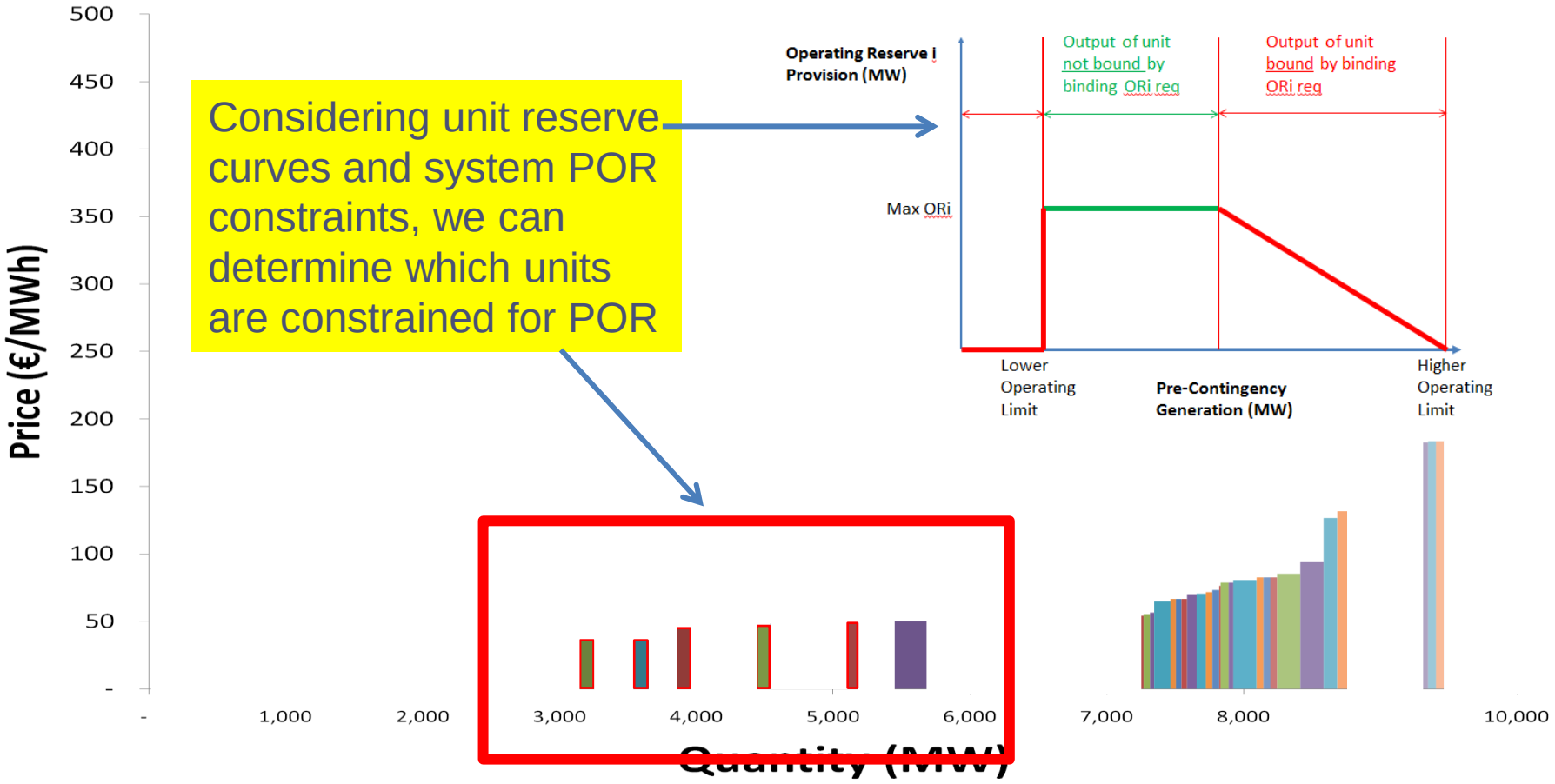
Day in the Life 1b: 17:30 (Imbalance Pricing)



Flagging of Accepted Bids and Offers (E.3.3)

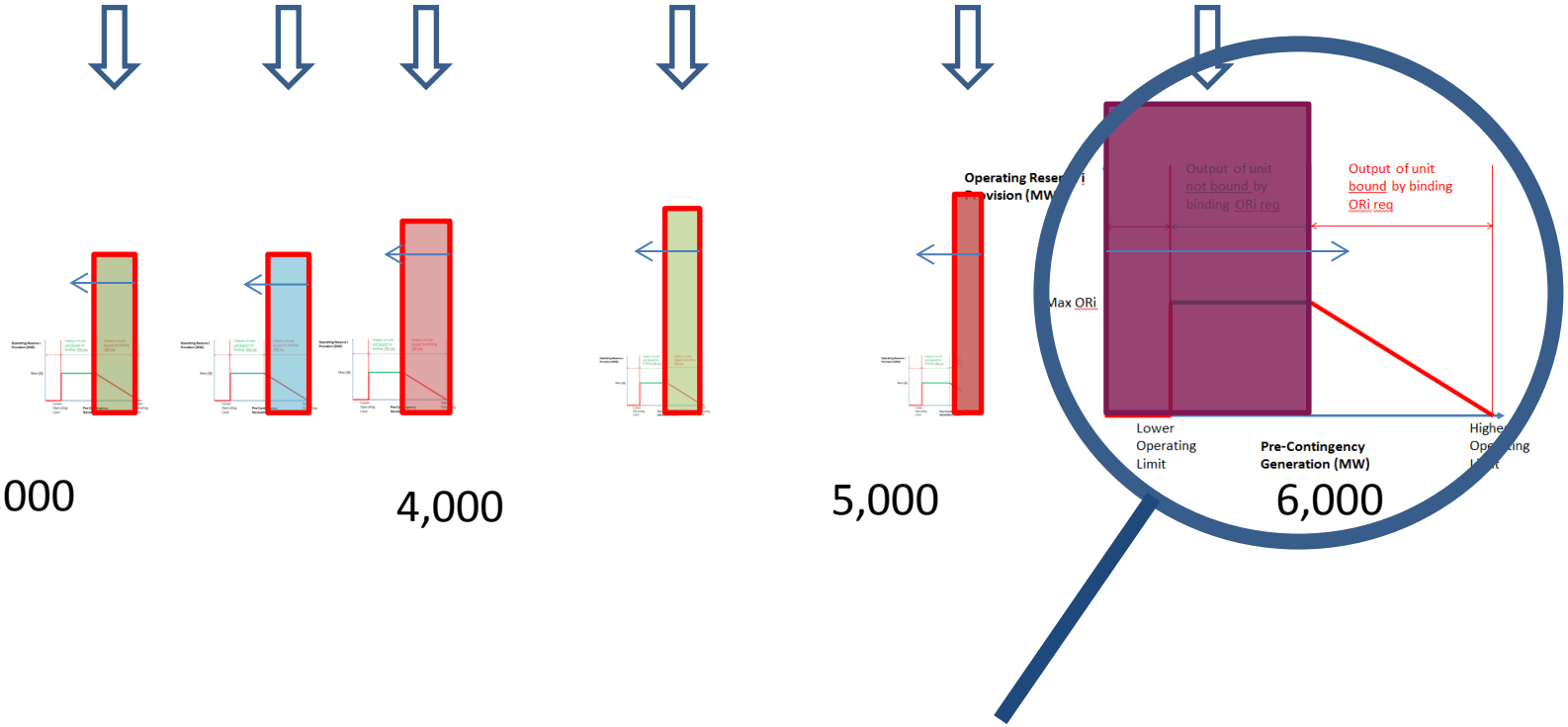
Using the Indicative Operations Schedule, we can determine which actions were for system reasons

Day in the Life 1b: 17:30 (Imbalance Pricing)



Day in the Life 1b: 17:30 (Imbalance Pricing)

Units constrained for POR
System Operator Flagged



3,000

4,000

5,000

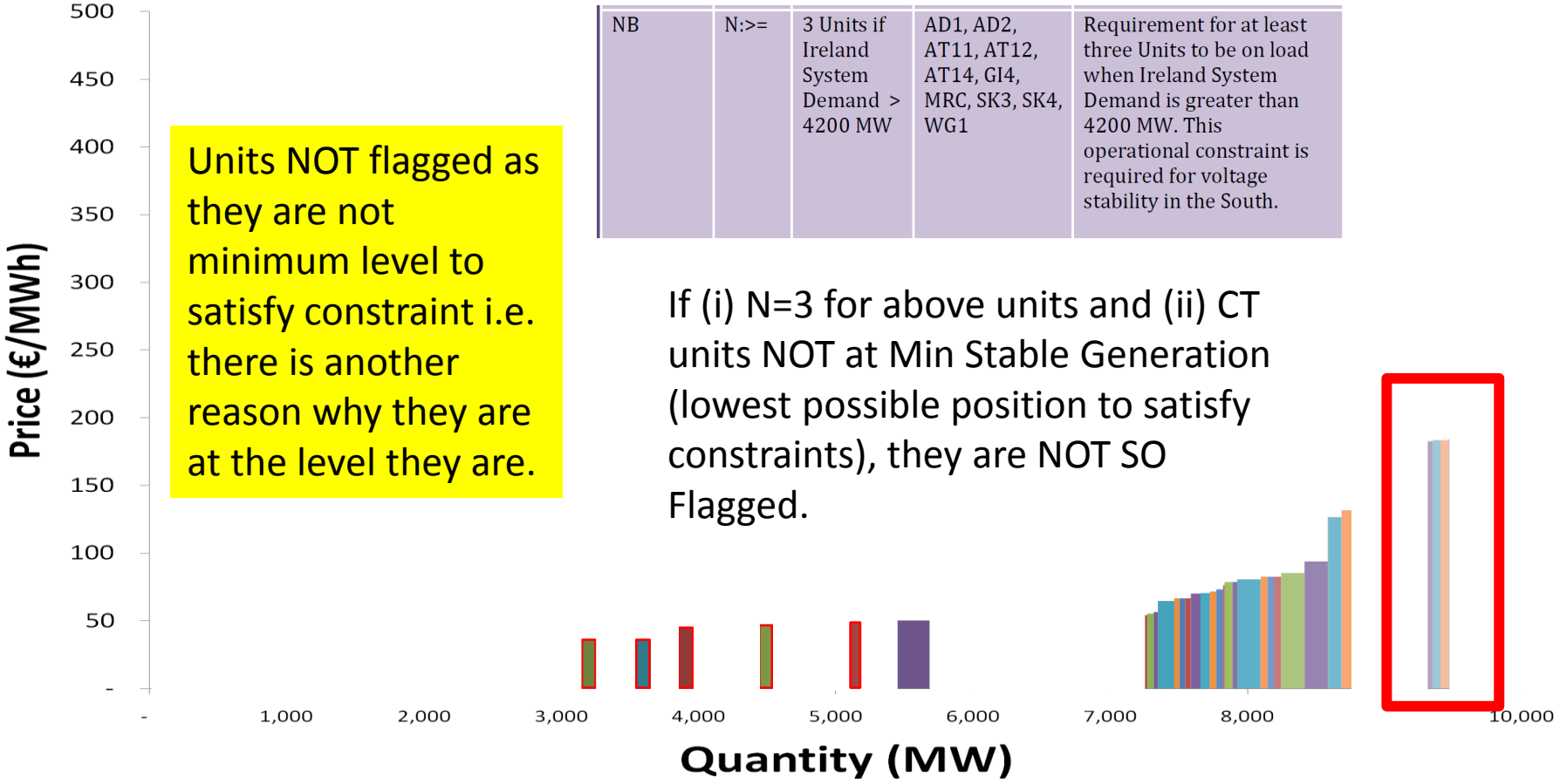
6,000

Day in the Life 1b: 17:30 (Imbalance Pricing)

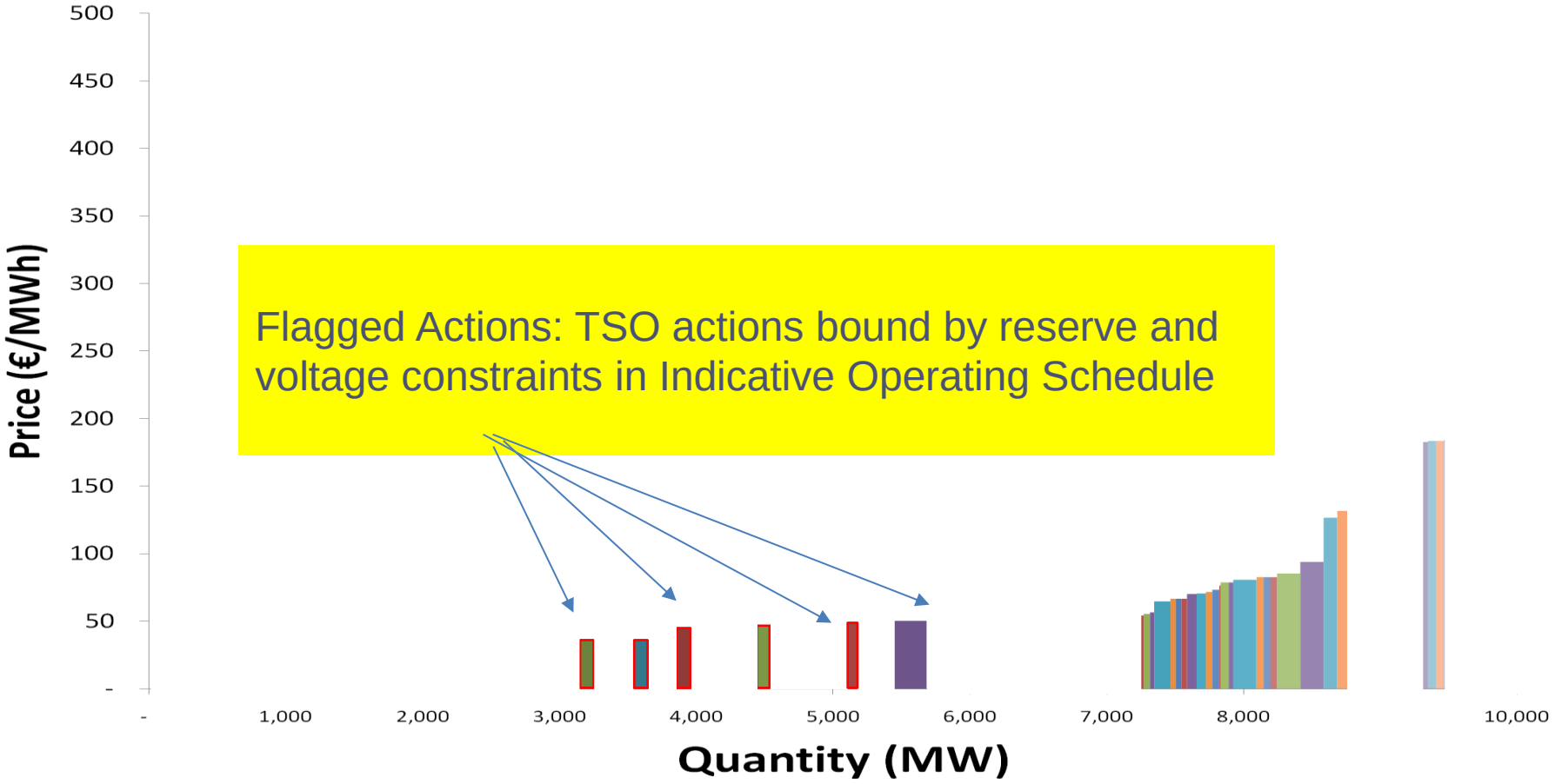
NB	N:>=	3 Units if Ireland System Demand > 4200 MW	AD1, AD2, AT11, AT12, AT14, GI4, MRC, SK3, SK4, WG1	Requirement for at least three Units to be on load when Ireland System Demand is greater than 4200 MW. This operational constraint is required for voltage stability in the South.

Units NOT flagged as they are not minimum level to satisfy constraint i.e. there is another reason why they are at the level they are.

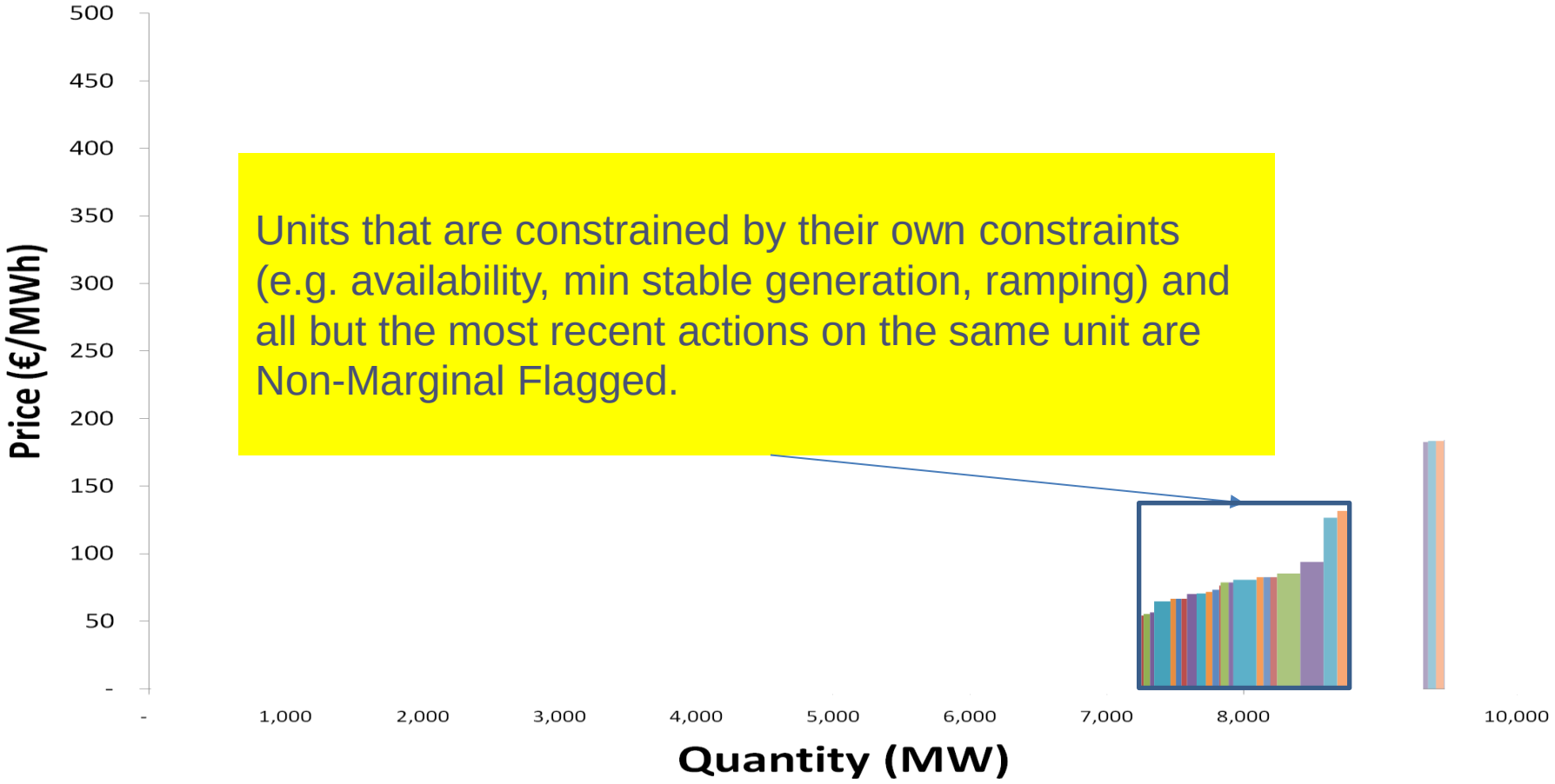
If (i) N=3 for above units and (ii) CT units NOT at Min Stable Generation (lowest possible position to satisfy constraints), they are NOT SO Flagged.



Day in the Life 1b: 17:30 (Imbalance Pricing)

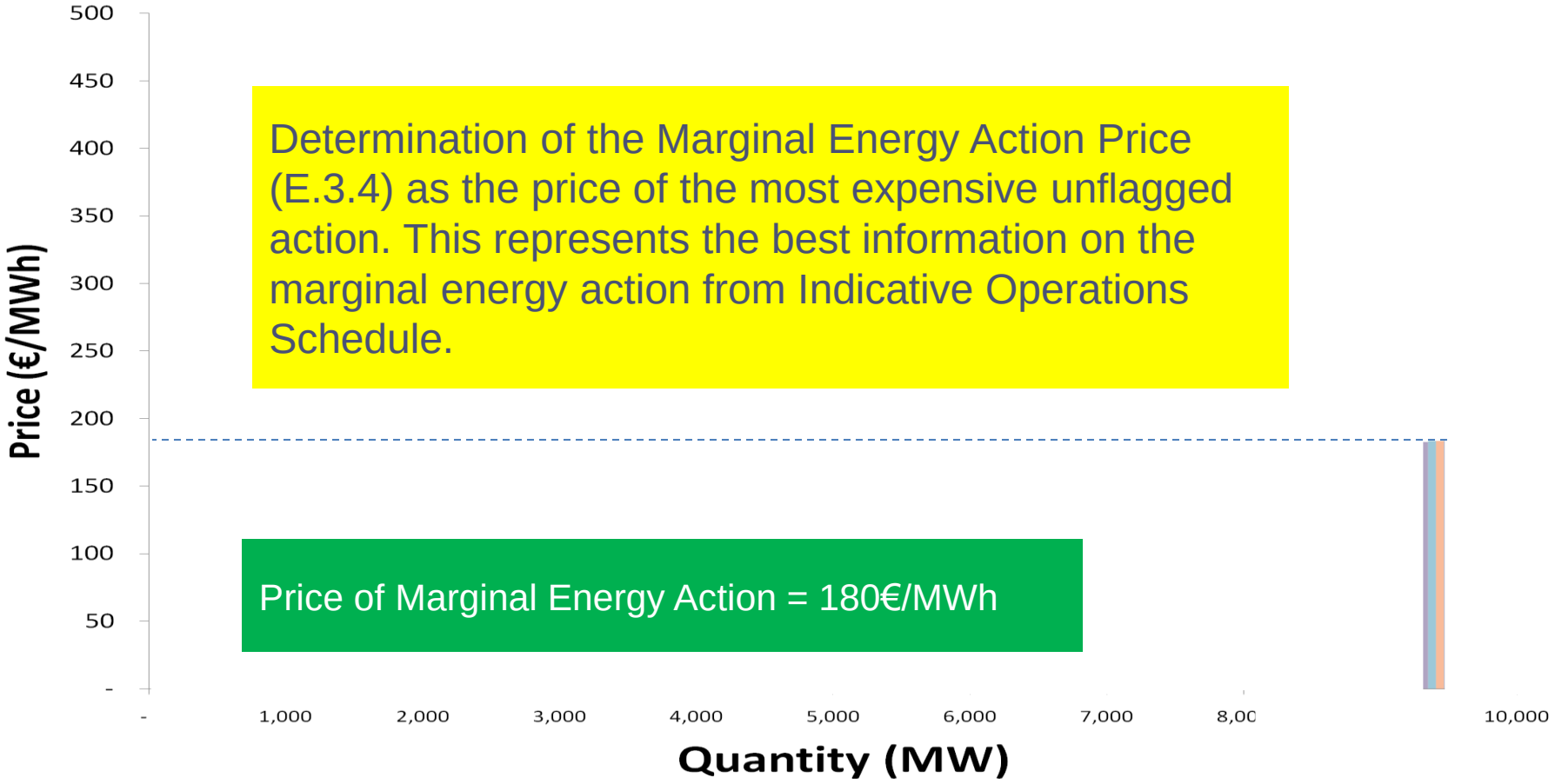


Day in the Life 1b: 17:30 (Imbalance Pricing)



Units that are constrained by their own constraints (e.g. availability, min stable generation, ramping) and all but the most recent actions on the same unit are Non-Marginal Flagged.

Day in the Life 1b: 17:30 (Imbalance Pricing)



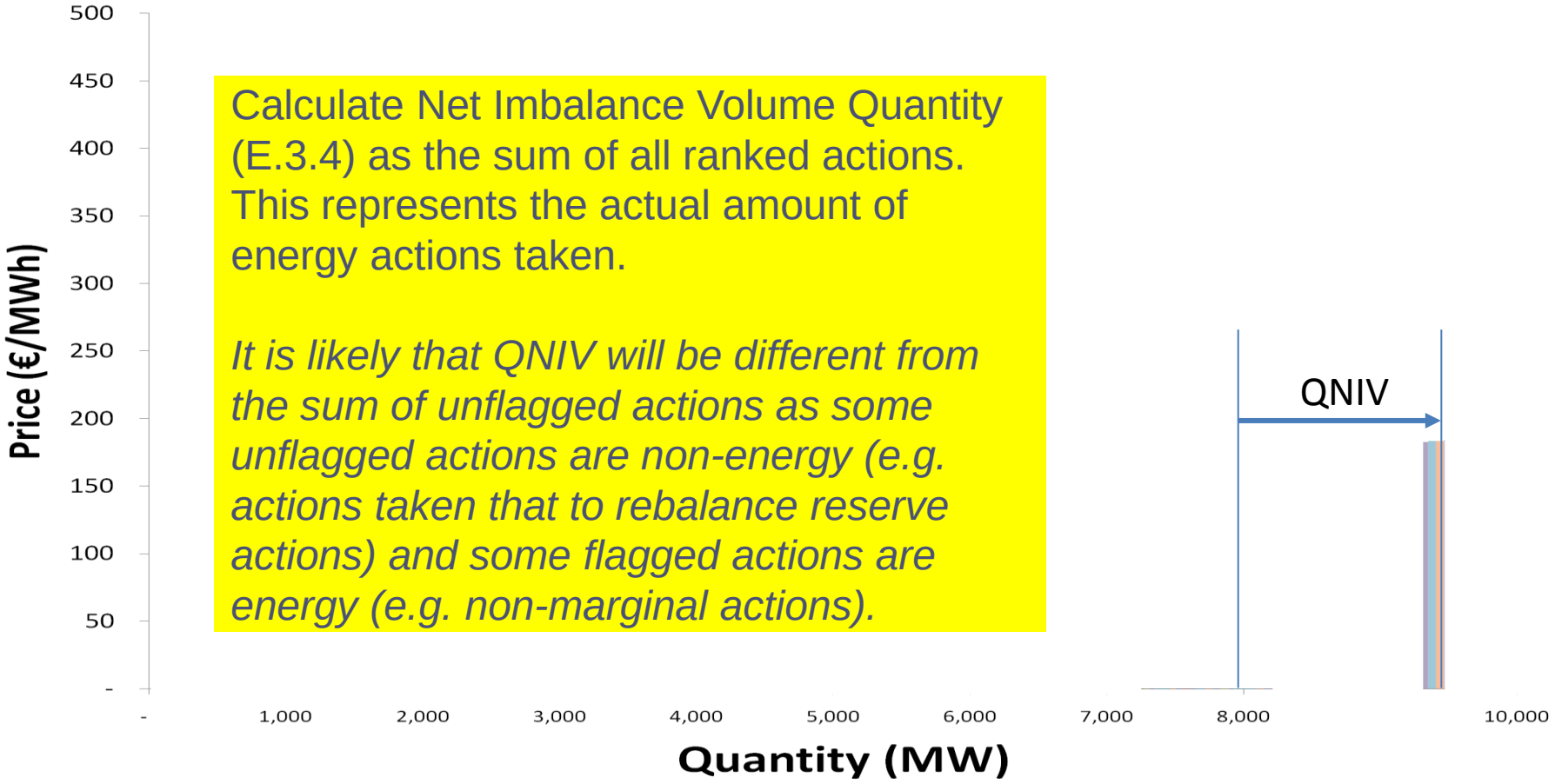
Determination of the Marginal Energy Action Price (E.3.4) as the price of the most expensive unflagged action. This represents the best information on the marginal energy action from Indicative Operations Schedule.

Price of Marginal Energy Action = 180€/MWh

Day in the Life 1b: 17:30 (Imbalance Pricing)

Calculate Net Imbalance Volume Quantity (E.3.4) as the sum of all ranked actions. This represents the actual amount of energy actions taken.

It is likely that QNIV will be different from the sum of unflagged actions as some unflagged actions are non-energy (e.g. actions taken that to rebalance reserve actions) and some flagged actions are energy (e.g. non-marginal actions).

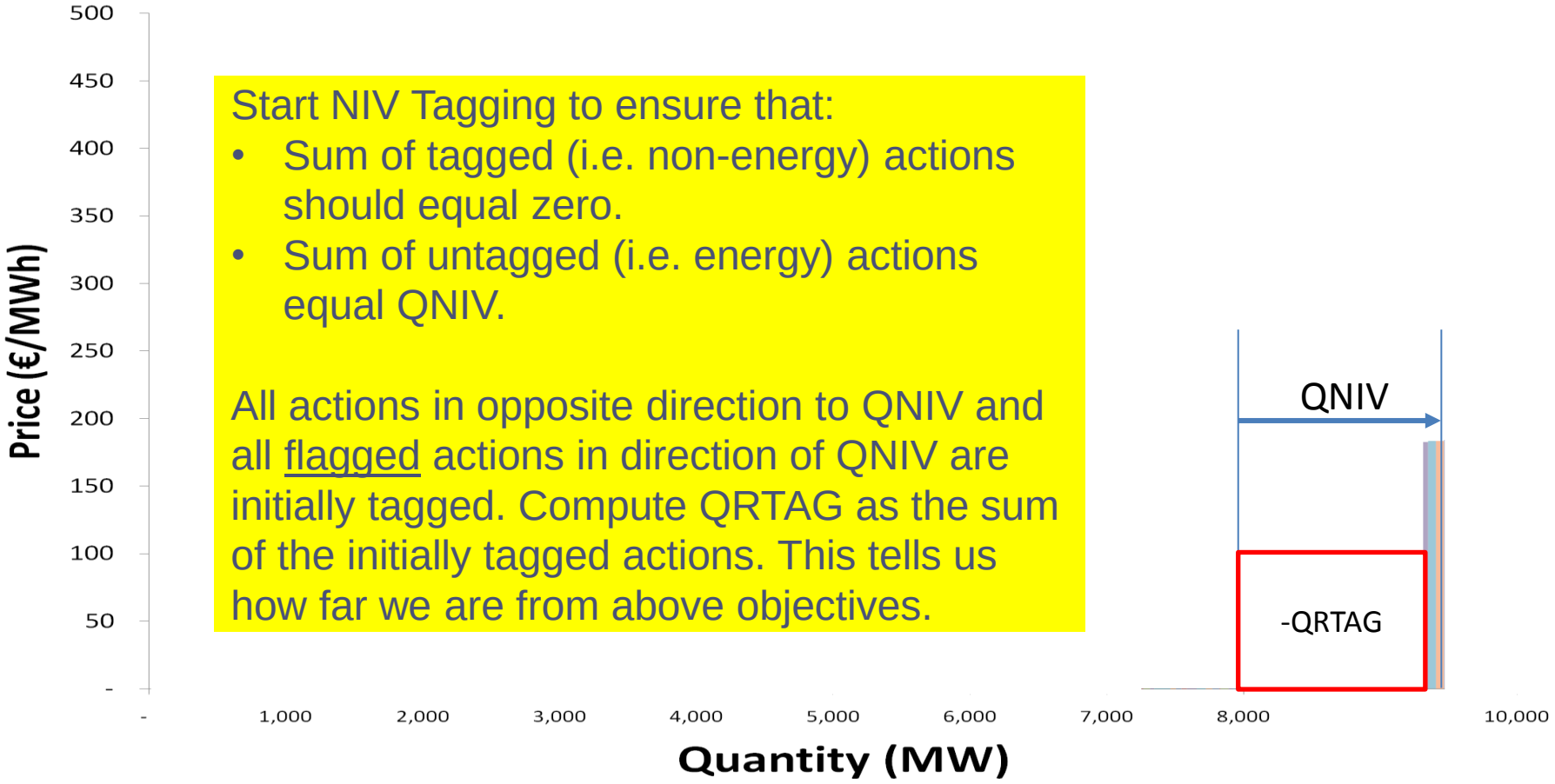


Day in the Life 1b: 17:30 (Imbalance Pricing)

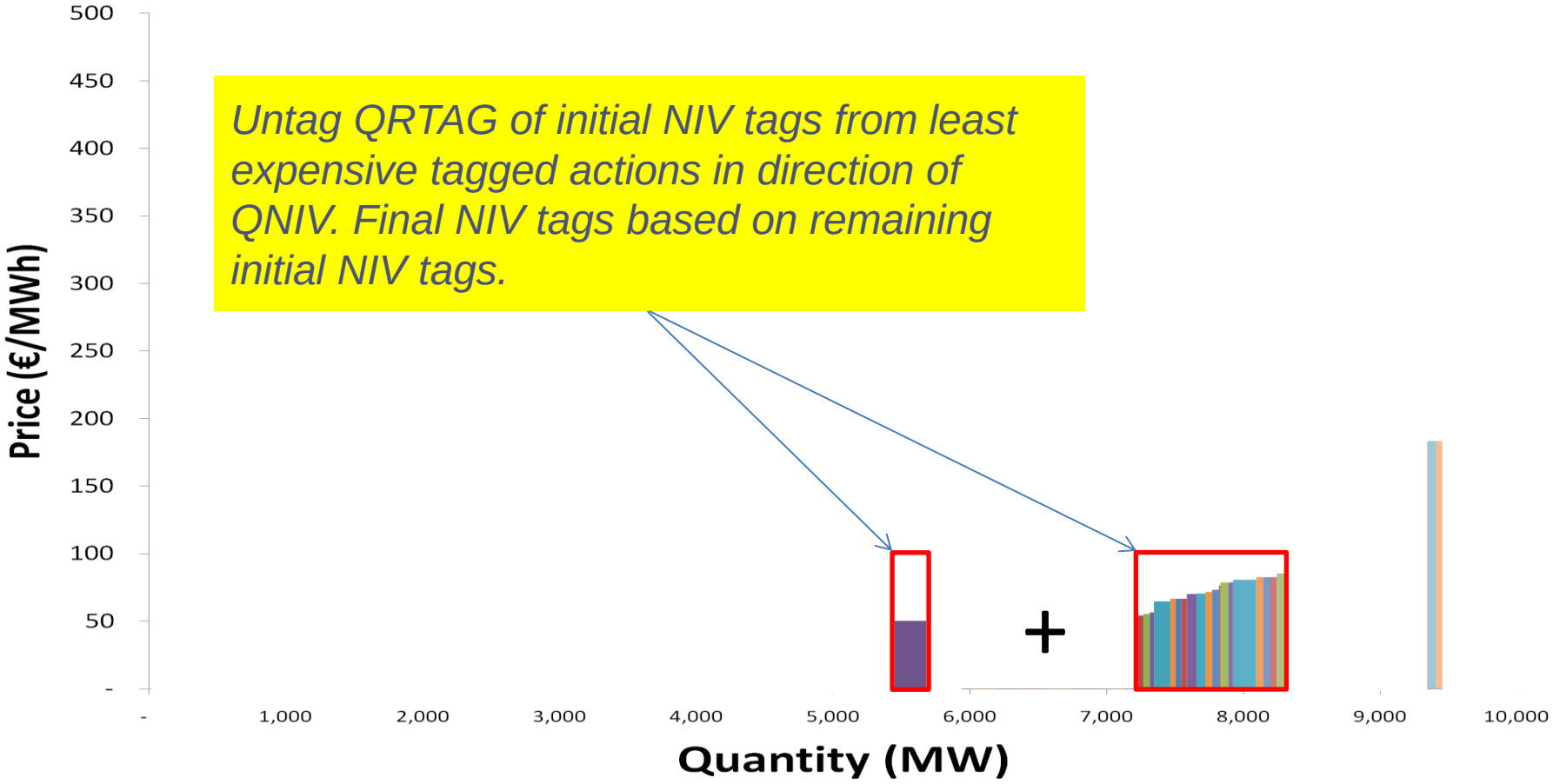
Start NIV Tagging to ensure that:

- Sum of tagged (i.e. non-energy) actions should equal zero.
- Sum of untagged (i.e. energy) actions equal QNIV.

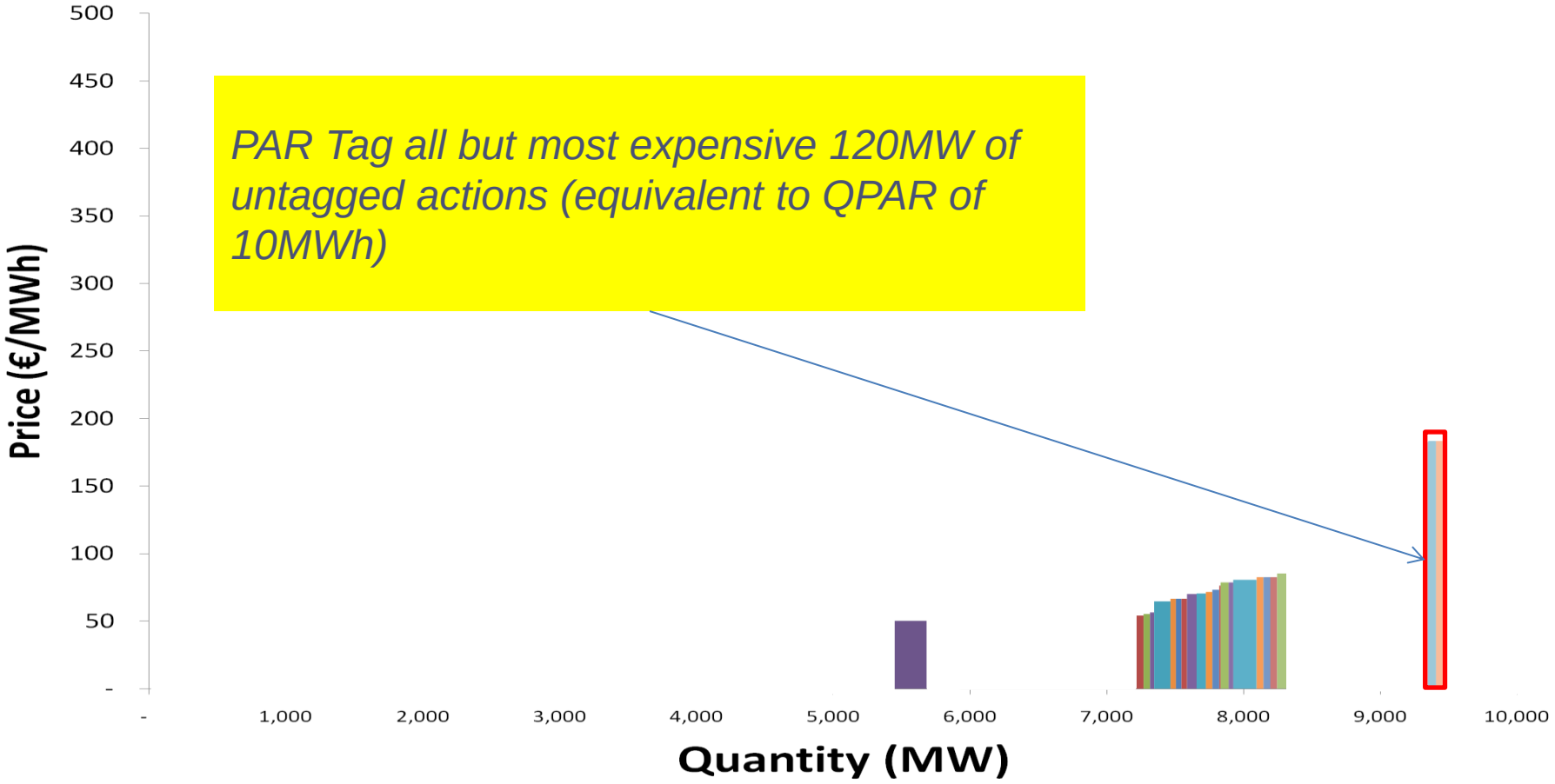
All actions in opposite direction to QNIV and all flagged actions in direction of QNIV are initially tagged. Compute QRTAG as the sum of the initially tagged actions. This tells us how far we are from above objectives.



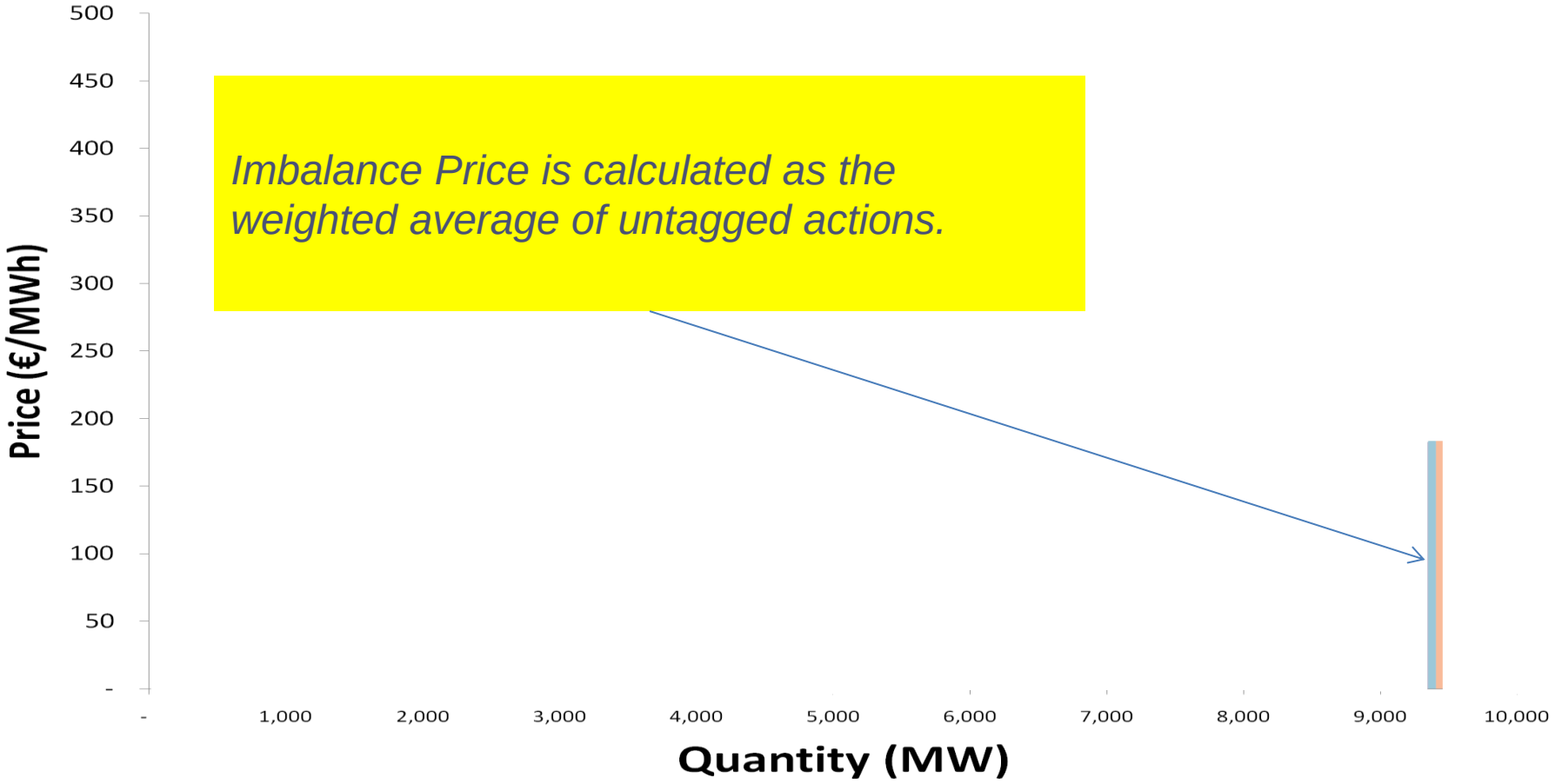
Day in the Life 1b: 17:30 (Imbalance Pricing)



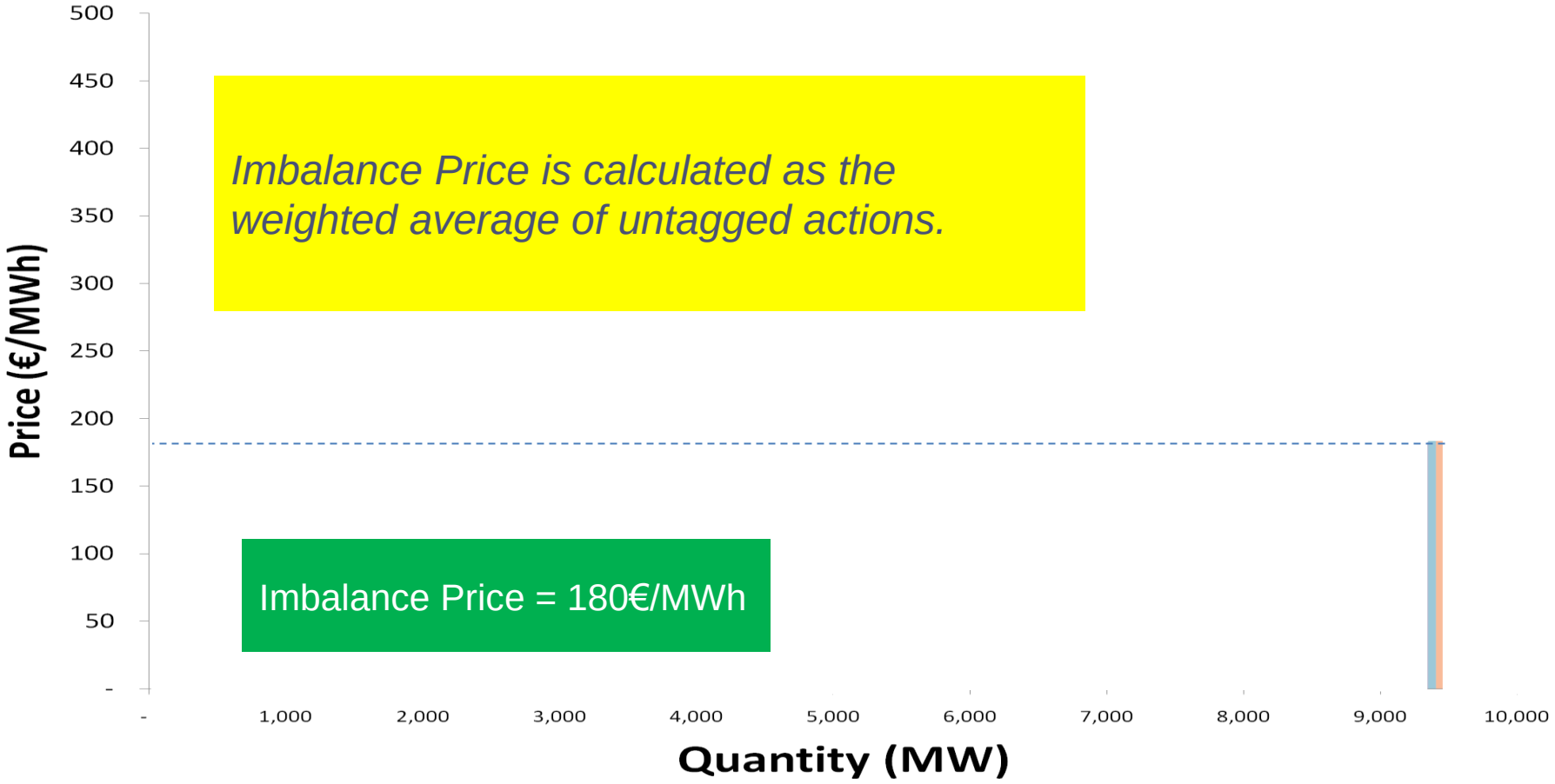
Day in the Life 1b: 17:30 (Imbalance Pricing)



Day in the Life 1b: 17:30 (Imbalance Pricing)



Day in the Life 1b: 17:30 (Imbalance Pricing)



Review of January 24th

Agenda

1. *Introduction*
2. *Ex-Ante Market Results*
3. *System Operations*
4. *Flagging & Tagging*
5. *Application of the rules on January 24th*
6. *Next Steps…*

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Imbalance Pricing

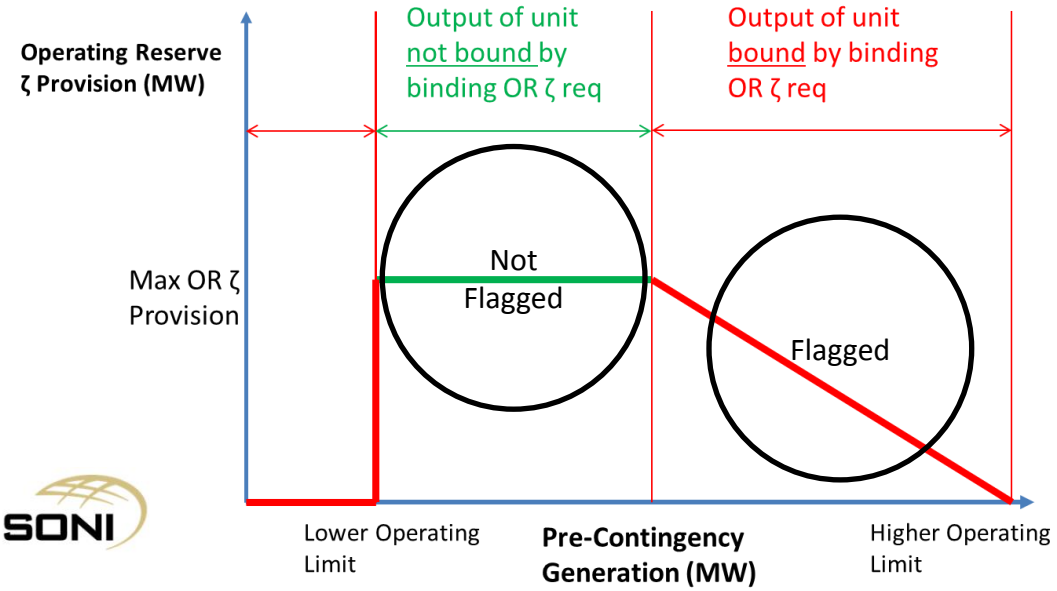
- Main types of constraints to be flagged:
  - Max MW;
  - Min MW;
  - Max Number of Units;
  - Min Number of Units;
  - Dynamic Reserves;
  - Negative Reserves;
  - System Inertia;
  - SNSP;
  - Rate of Change of Frequency;
  - MWR.

Imbalance Pricing

- All flagging is based on Scheduled Output results in the RTD scheduling tool;
- If a unit is not contributing to a constraint, it should not be flagged by it;
- This is obvious for some constraints where the unit is just not associated with the constraint, e.g. a Northern Ireland unit wouldn't contribute to an Ireland jurisdictional reserve;
- There are other less obvious examples, including:
  - Where a unit is not available (e.g. following a trip);
  - Where the amount of a particular service provided by a unit is zero. For example:
    - A unit scheduled to its maximum output and therefore reserve provision = 0, by changing their output they could only improve the amount of the service they provide;
    - A unit which cannot provide reserves when desynchronised, therefore reserve provision is zero, by changing their output to synchronise and start providing reserves they could only improve the amount of the service they provide.

Imbalance Pricing

- Rough rule of thumb is that there are always two tests:
  - One which tests if the constraint itself is binding;
  - One which tests if the unit itself is bound by the constraint.
- Therefore the constraint can be binding but not all units that contribute to that constraint will be bound.
- For example, for reserve constraints:
  - First test if Reserve Provision = Reserve Requirement;
  - If yes, then check each generator unit that contribute to that reserve constraint (also the Largest Single Infeed is also flagged):



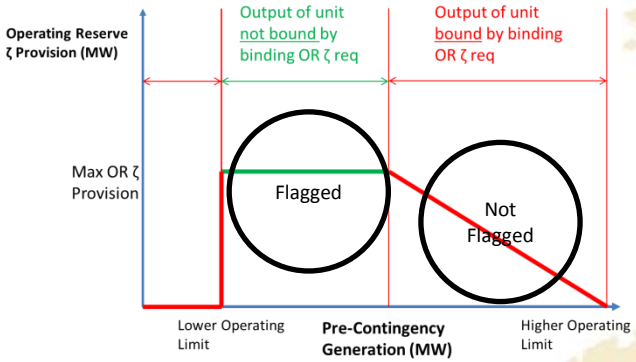
Imbalance Pricing

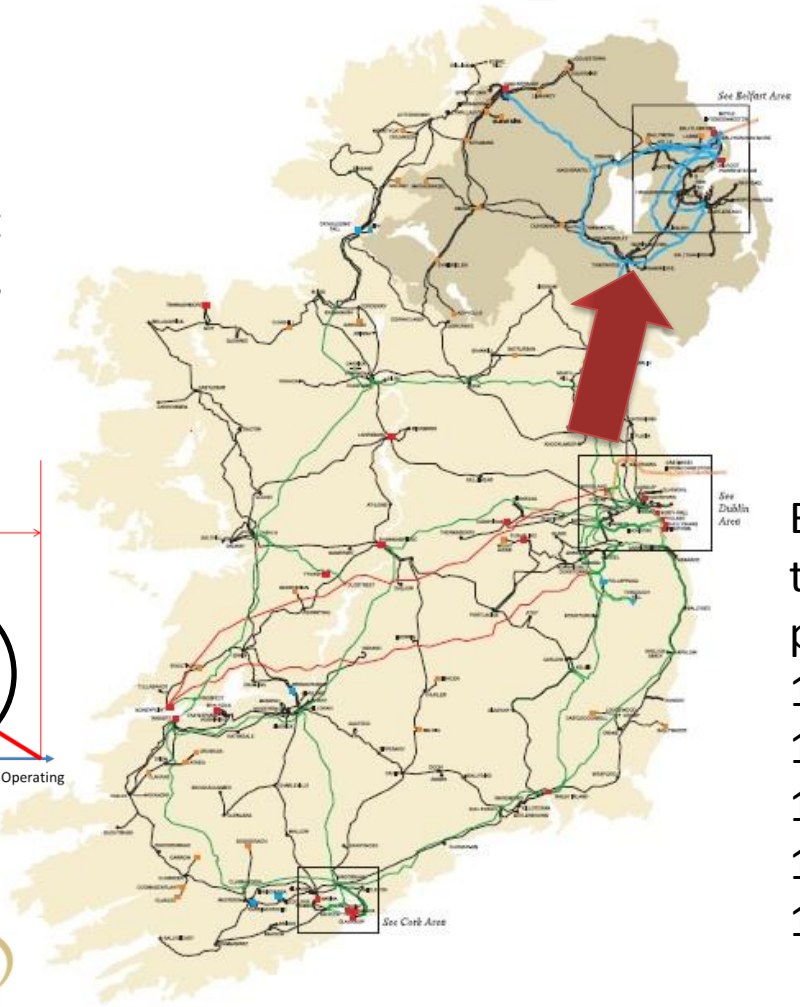
- Max MW:
  - If MW provided by relevant units = Maximum amount allowed;
  - If Scheduled Output of a relevant unit is less than HOL, then the unit is flagged.
- Min MW:
  - If MW provided by relevant units = Minimum amount allowed;
  - If Scheduled Output of a relevant unit is greater than zero, then the unit is flagged.
- Max Number of Units:
  - If number of relevant units committed on in a group = Maximum amount allowed;
  - If relevant unit is committed off, or is committed on with output less than Minimum Stable Generation, then the unit is flagged.
- Min Number of Units:
  - If number of relevant units committed on in a group = Minimum amount allowed;
  - If relevant unit is committed on with output equal to Minimum Stable Generation, then the unit is flagged.

Imbalance Pricing

- $T_{S-N} + Min(POR_{IE}, LSI_{NI} - 25\%\ POR_{NI}) \leq S\_MWR\_ROI - 20\ MW\ Margin\ of\ Safety$

If this form is binding:
- If unit is in Ireland, and change in Scheduled Output could change POR provision, then unit is flagged.





If this form is binding:
- No Northern Ireland unit is flagged

Between 11:00 and 14:30 this form was binding in periods:
11:00 – 11:10
11:55 – 12:30
12:40 – 12:45
13:00
13:45

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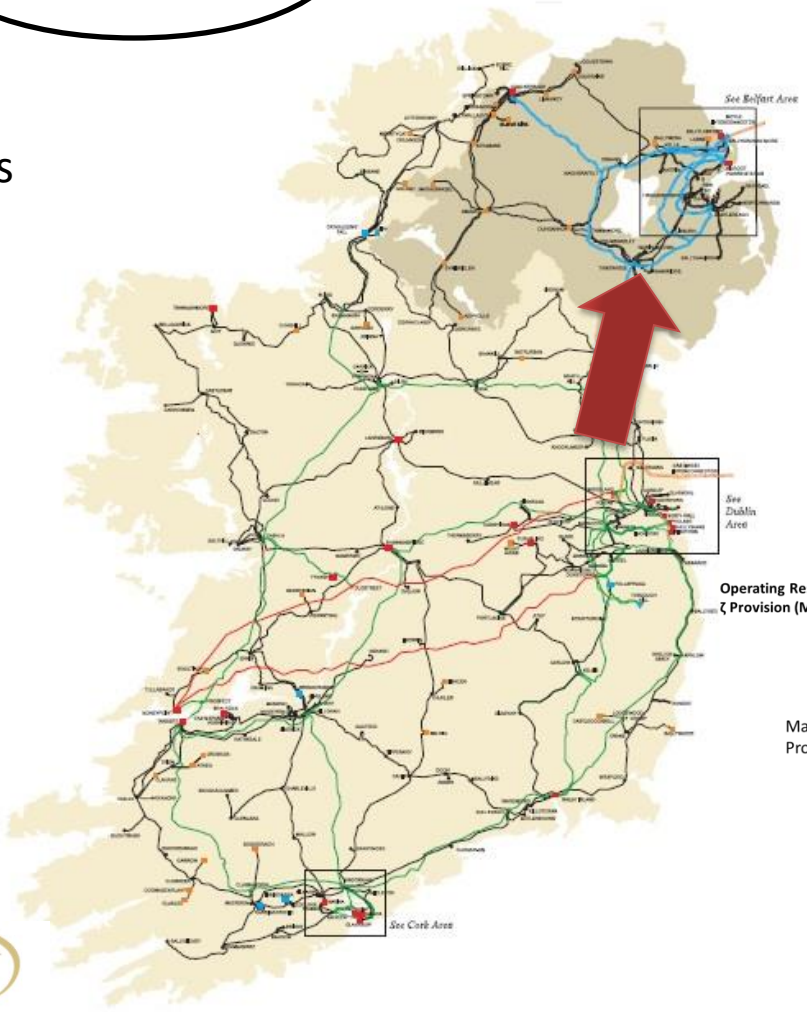
Imbalance Pricing

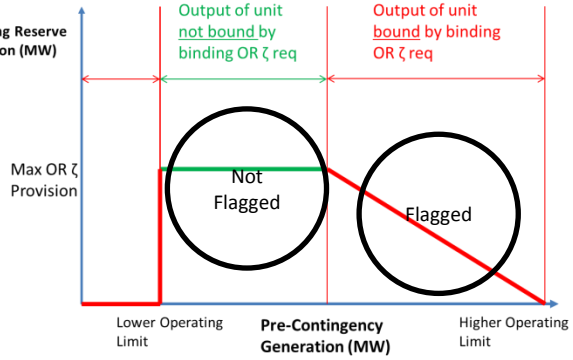
- $T_{S-N} + Min(POR_{IE}, LSI_{NI} - 25\%\ POR_{NI}) \leq S\_MWR\_ROI - 20\ MW\ Margin\ of\ Safety$

If this form is binding:
- If unit is in Ireland then it is flagged.

Between 11:00 and 14:30 this form was binding in periods:
11:15 – 11:50
12:35
12:50 – 12:55
13:05 – 13:40
13:50 – 14:25



If this form is binding:
- If unit is in Northern Ireland and is the LSI or change in Scheduled Output could change POR provision, then unit is flagged.



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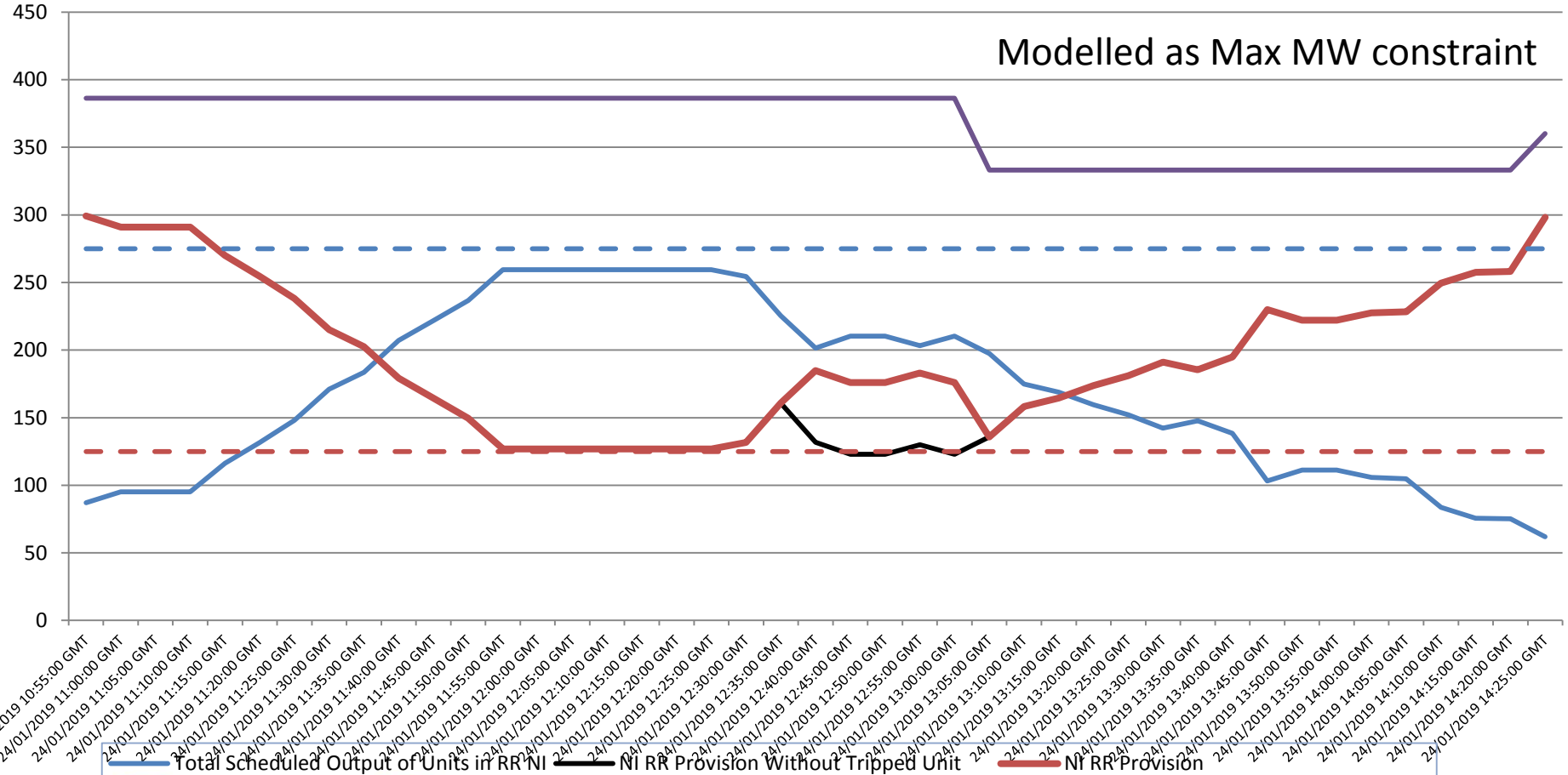
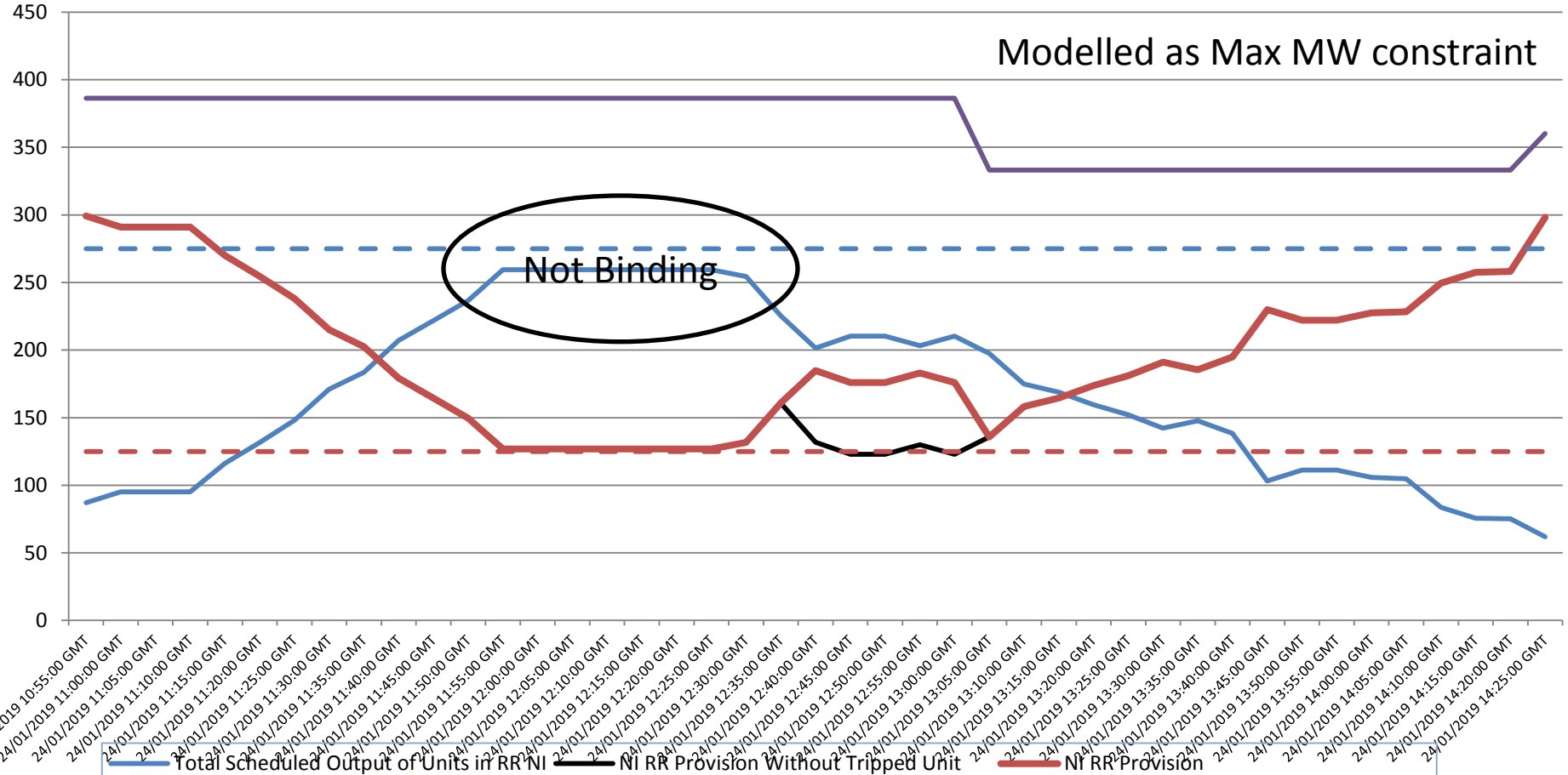
Imbalance Pricing

NI RR Constraint 11:00 - 14:00



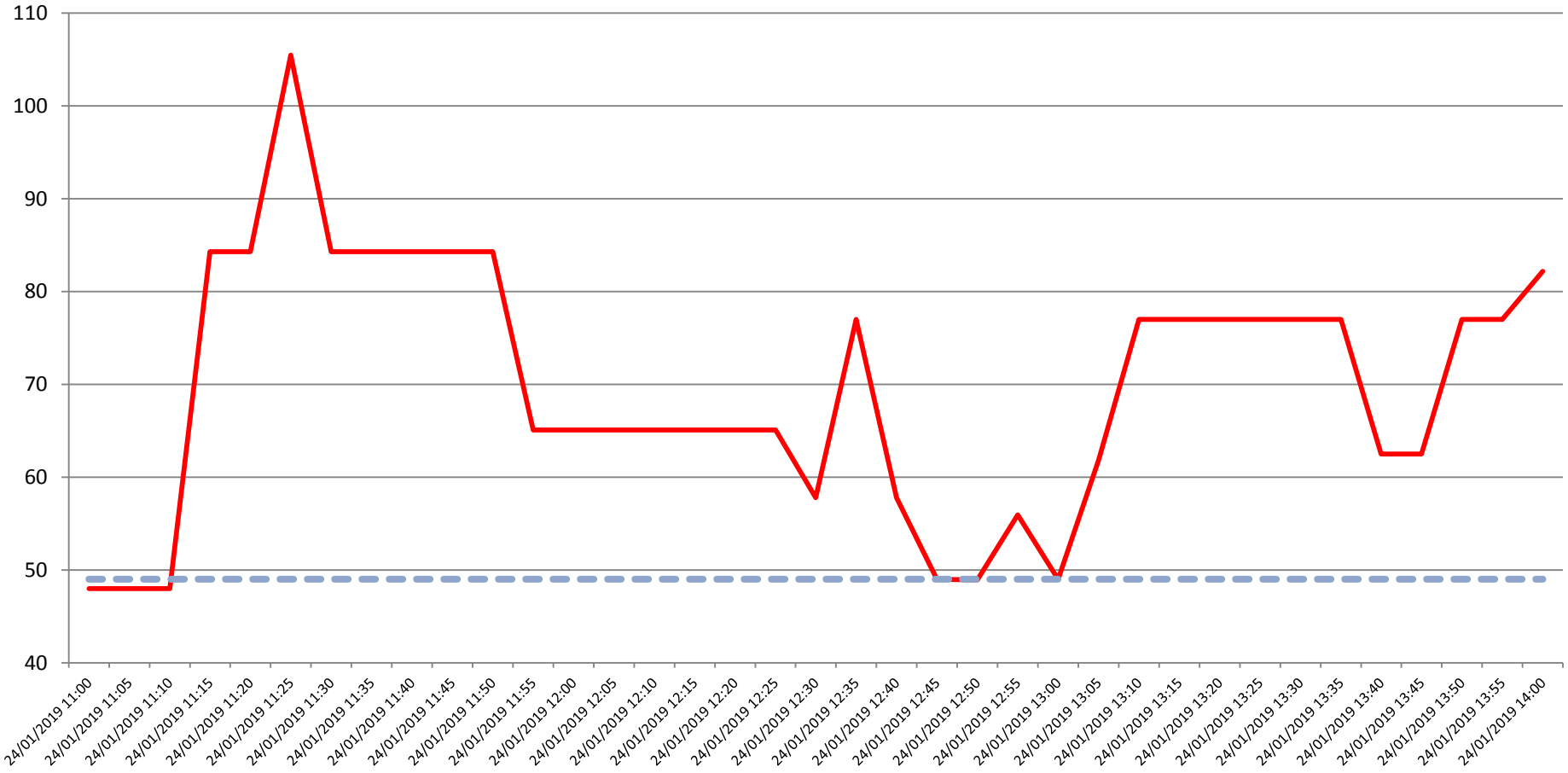
Imbalance Pricing

NI RR Constraint 11:00 - 14:00



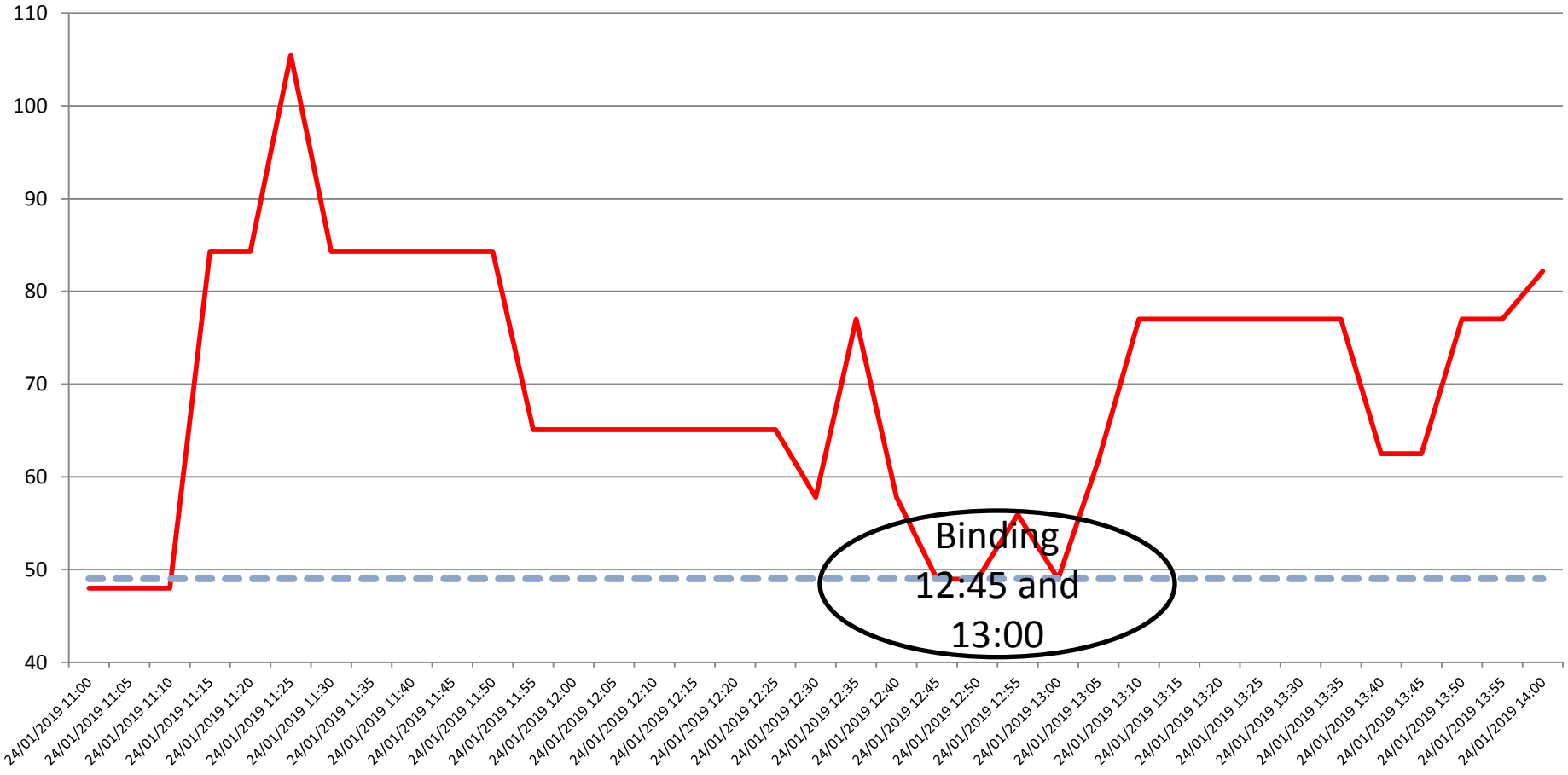
Imbalance Pricing

NI Dynamic POR Constraint 11:00 - 14:00



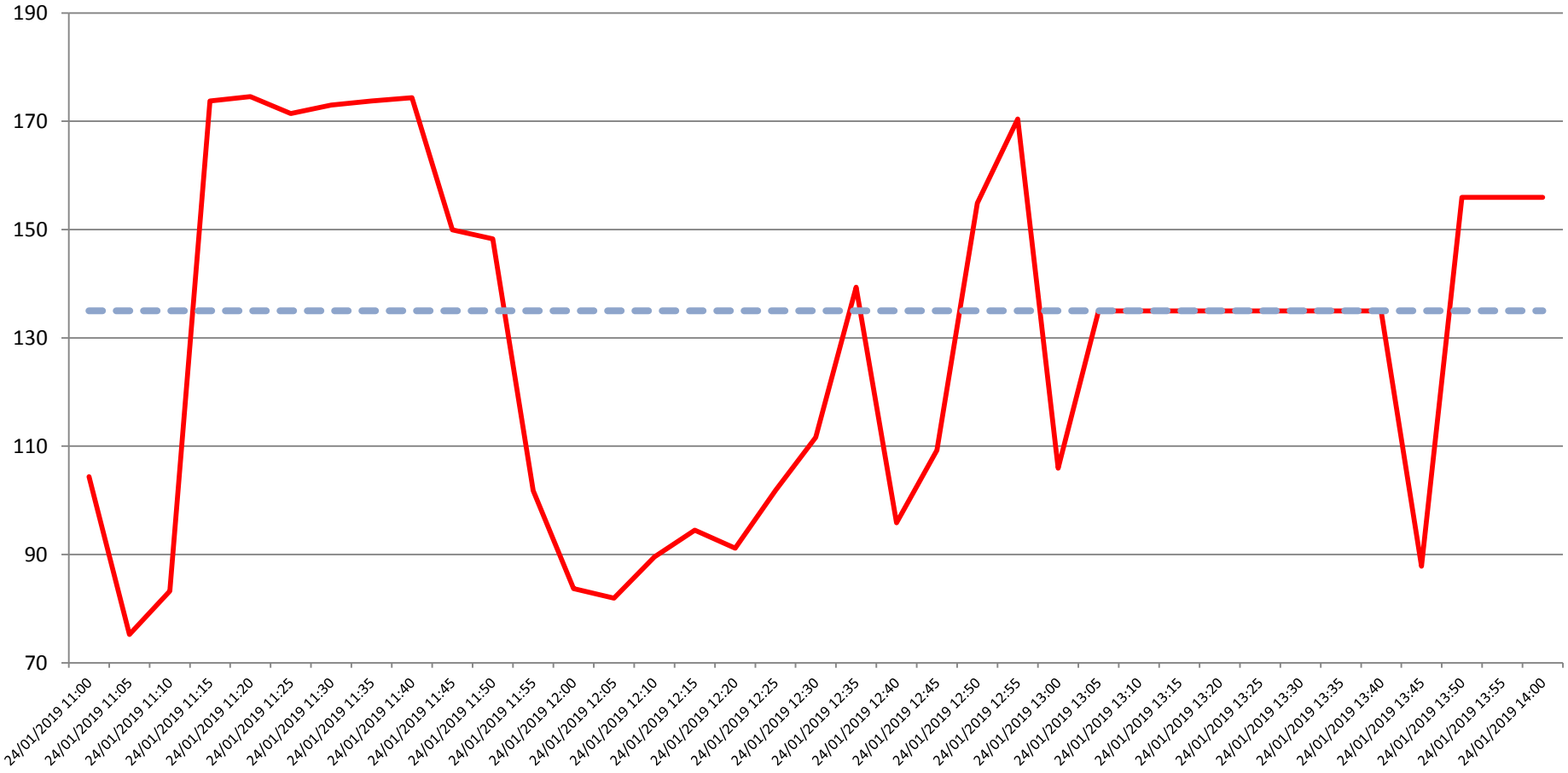
Imbalance Pricing

NI Dynamic POR Constraint 11:00 - 14:00



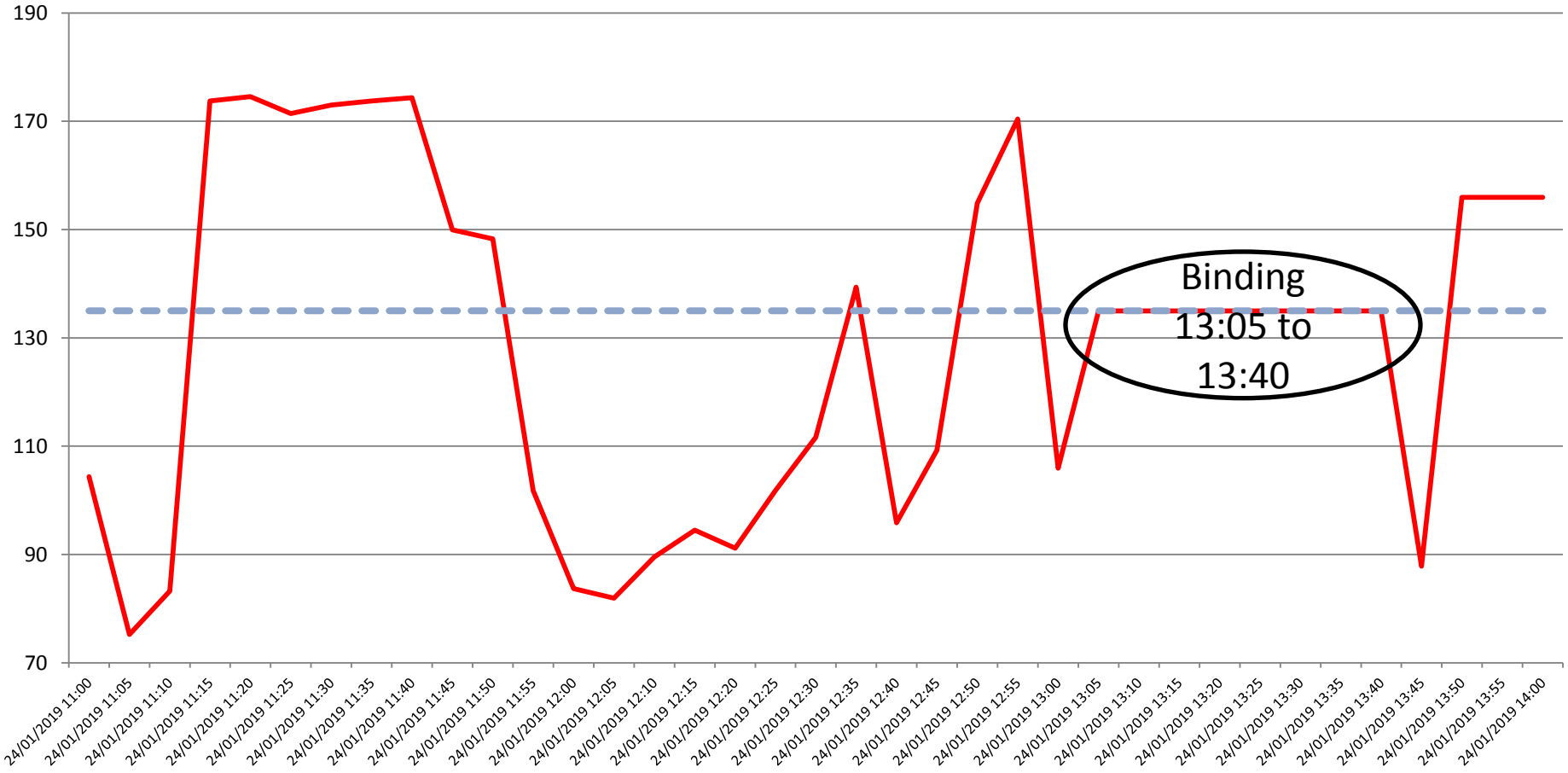
Imbalance Pricing

ROI Dynamic POR Constraint 11:00 - 14:00



Imbalance Pricing

ROI Dynamic POR Constraint 11:00 - 14:00



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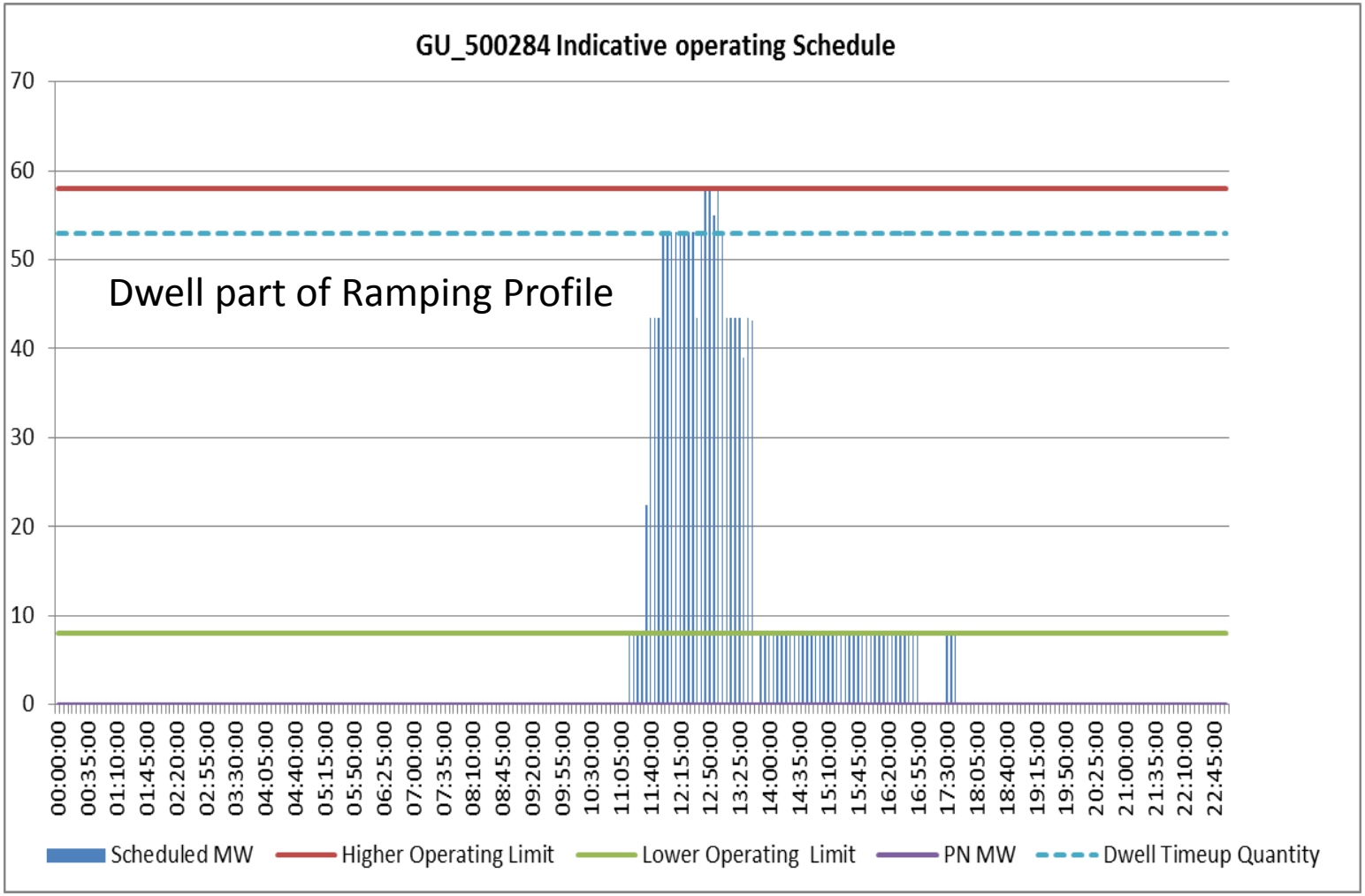

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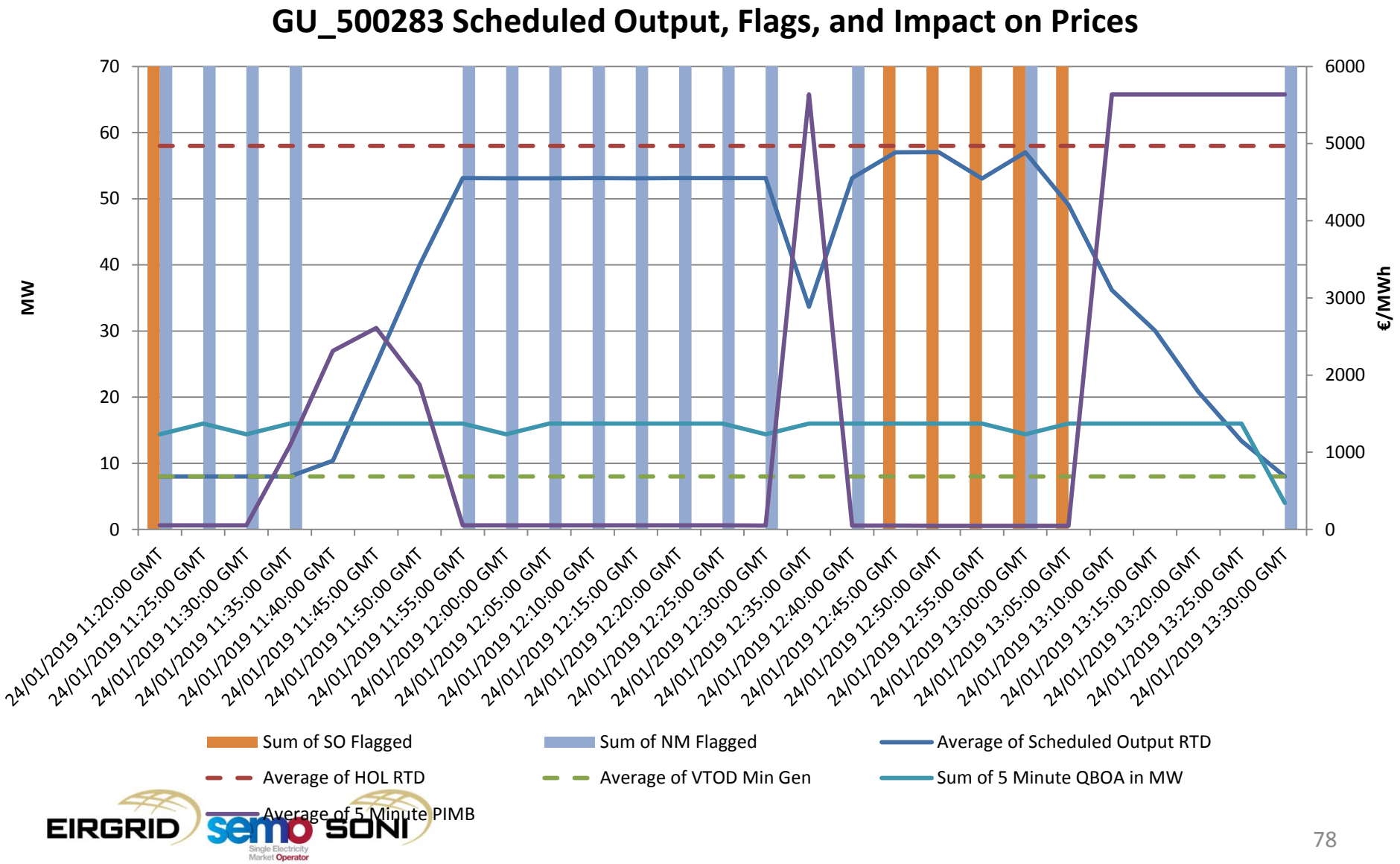

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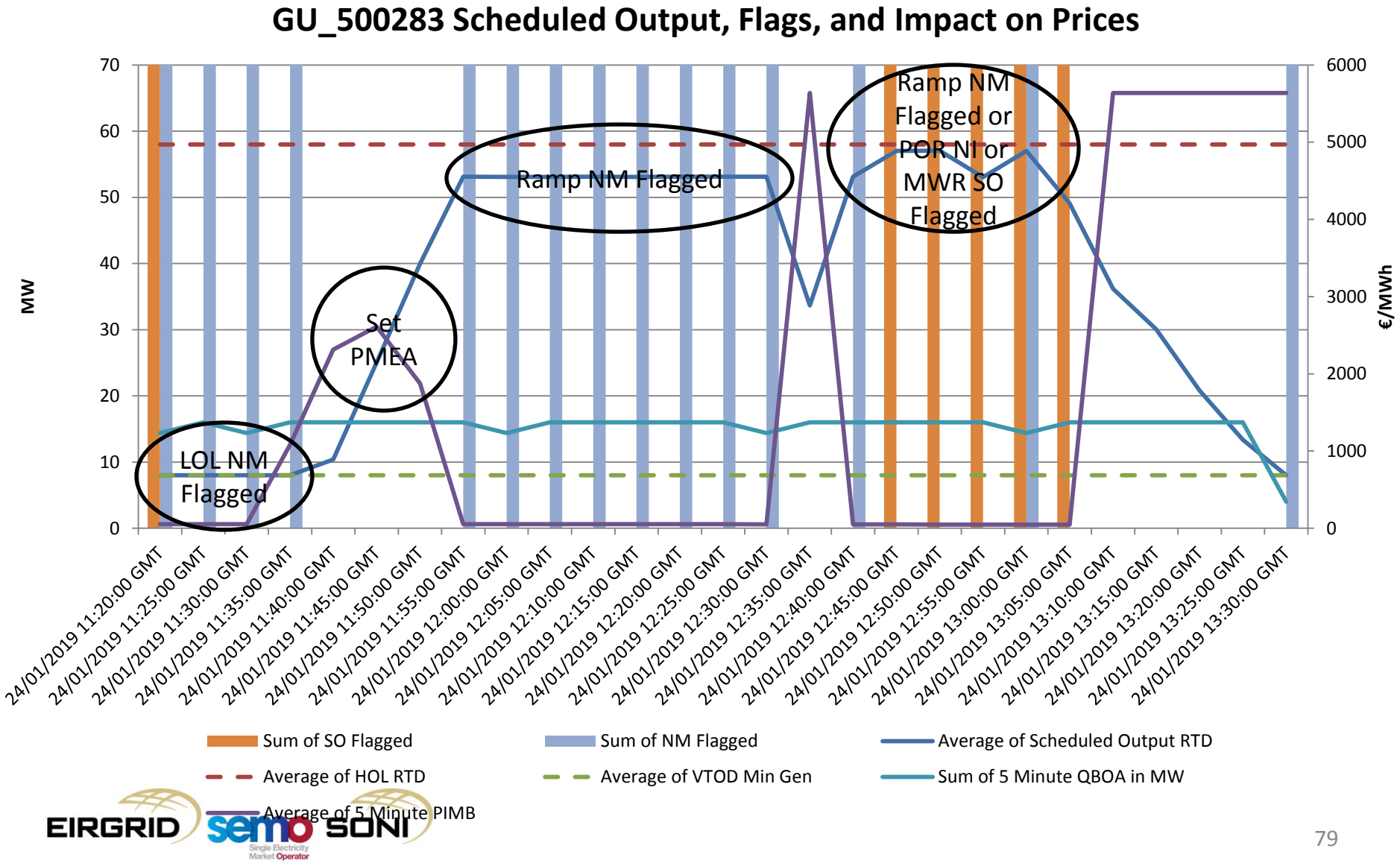

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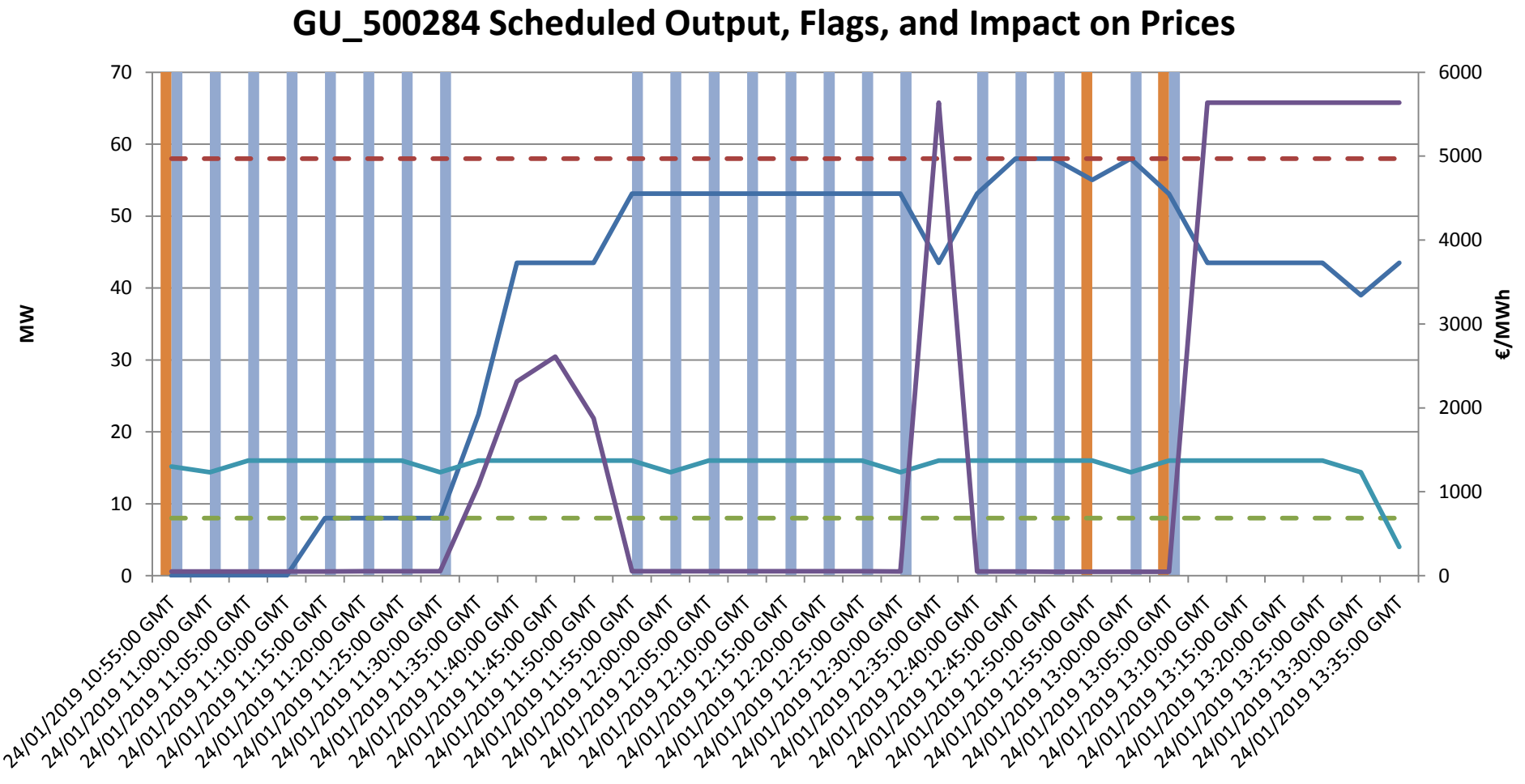

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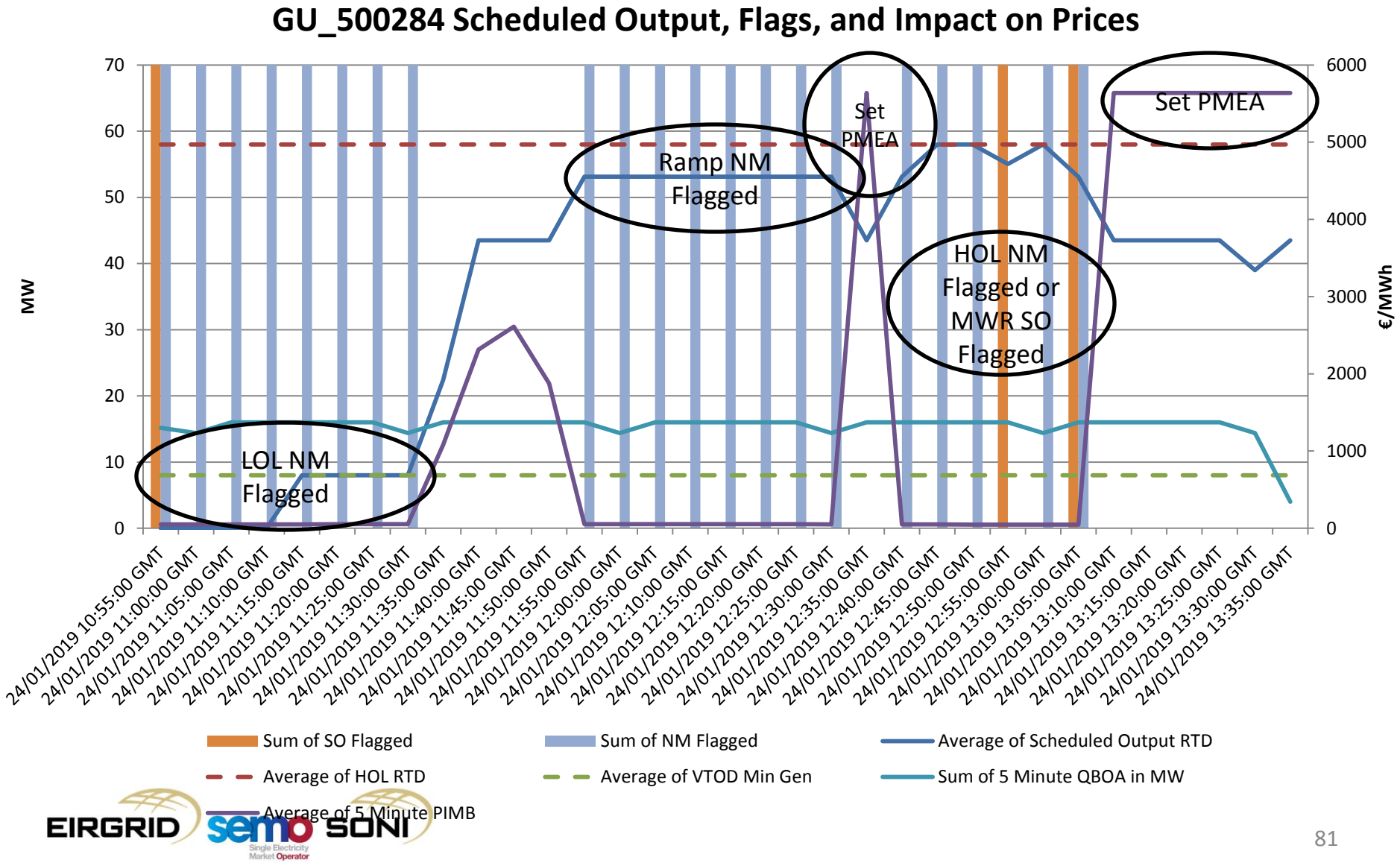

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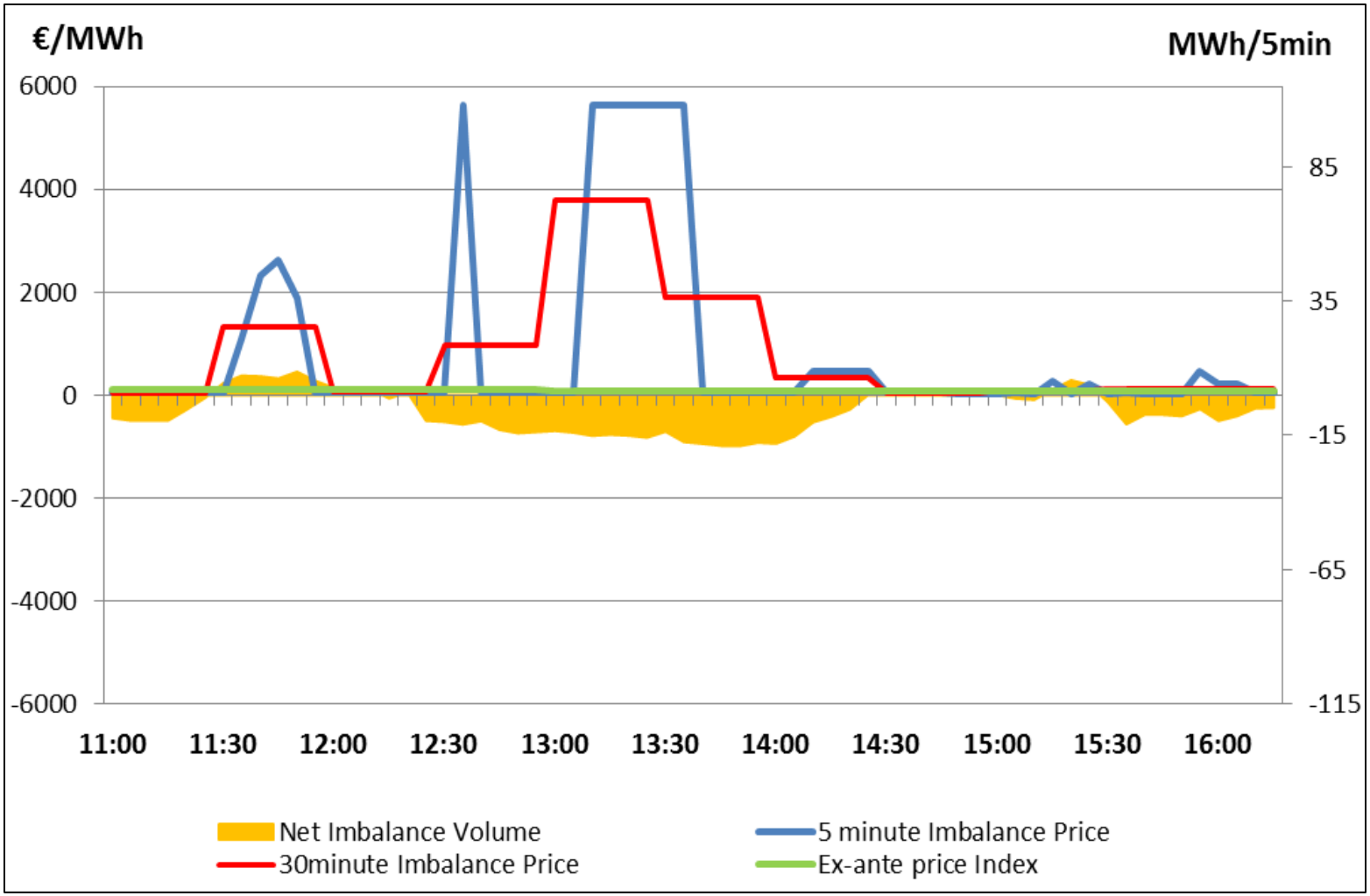

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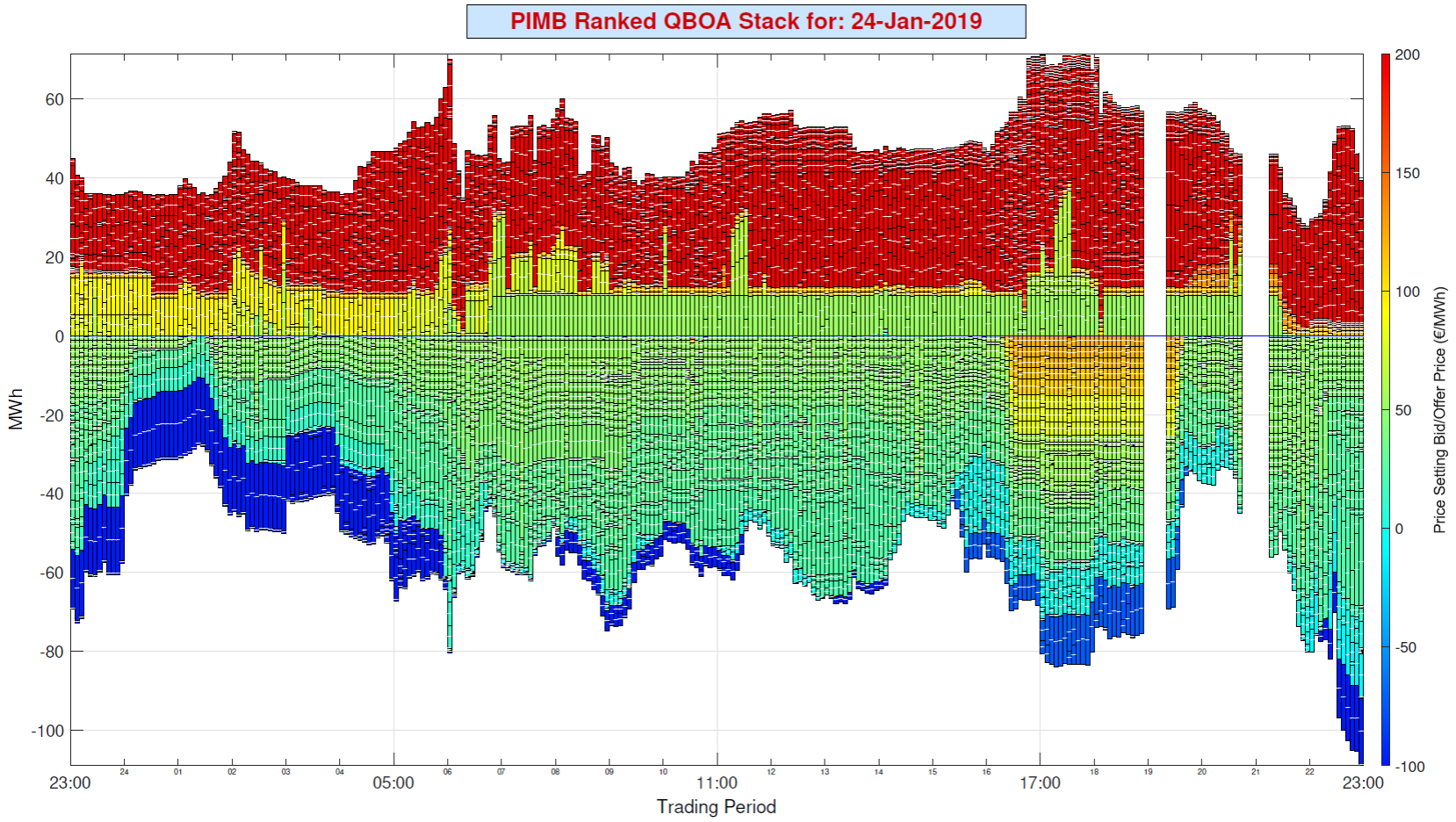

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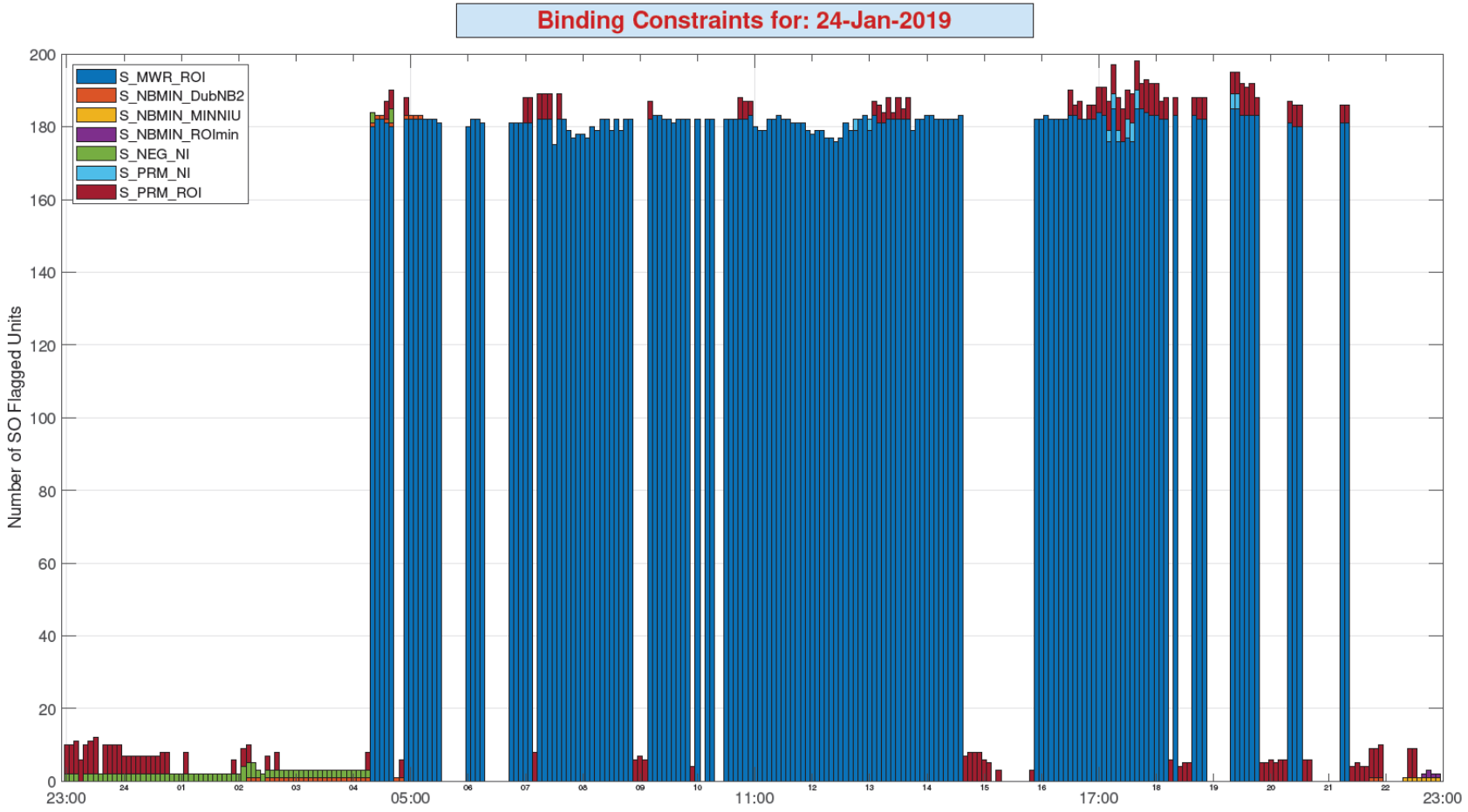

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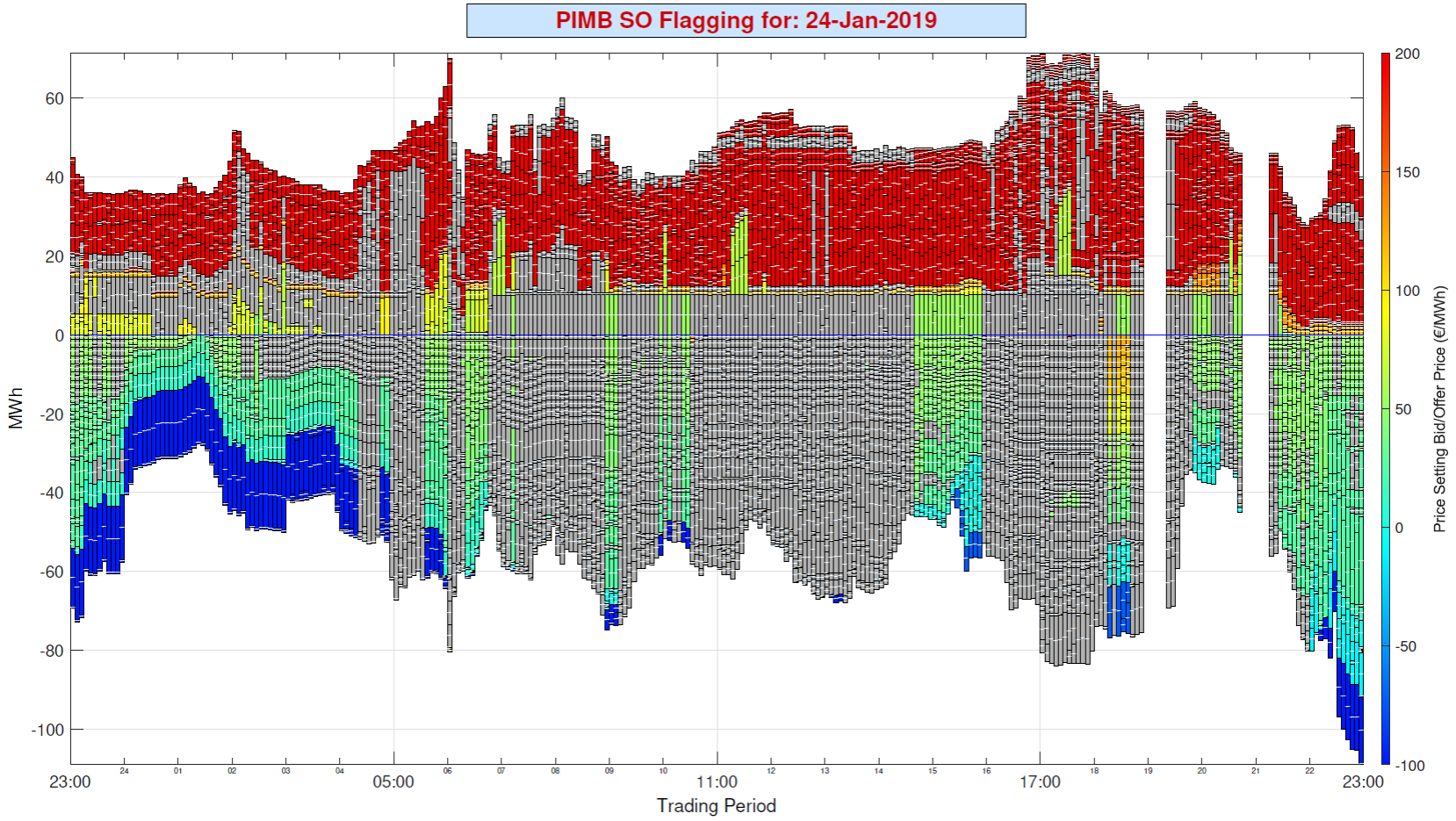

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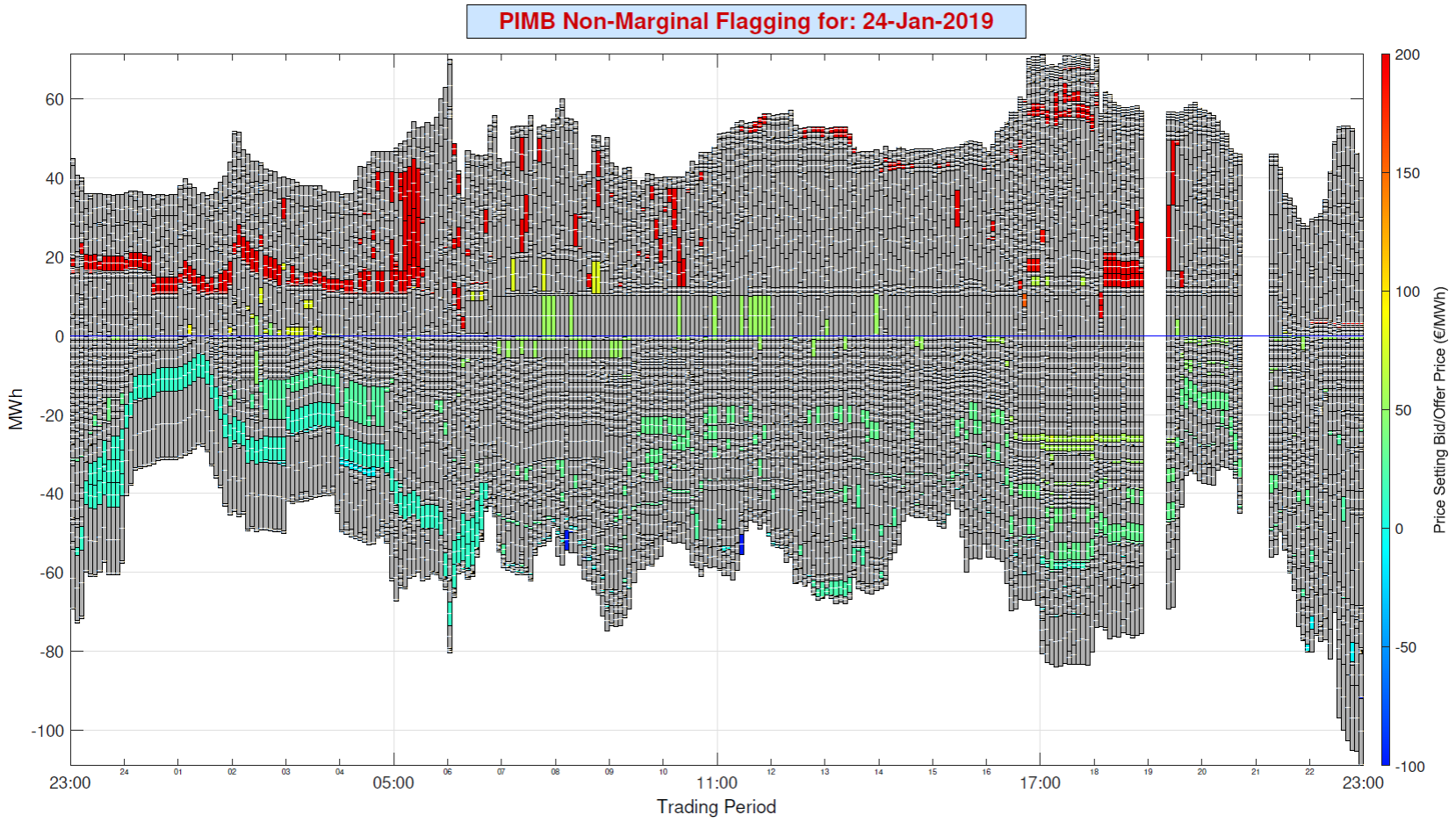

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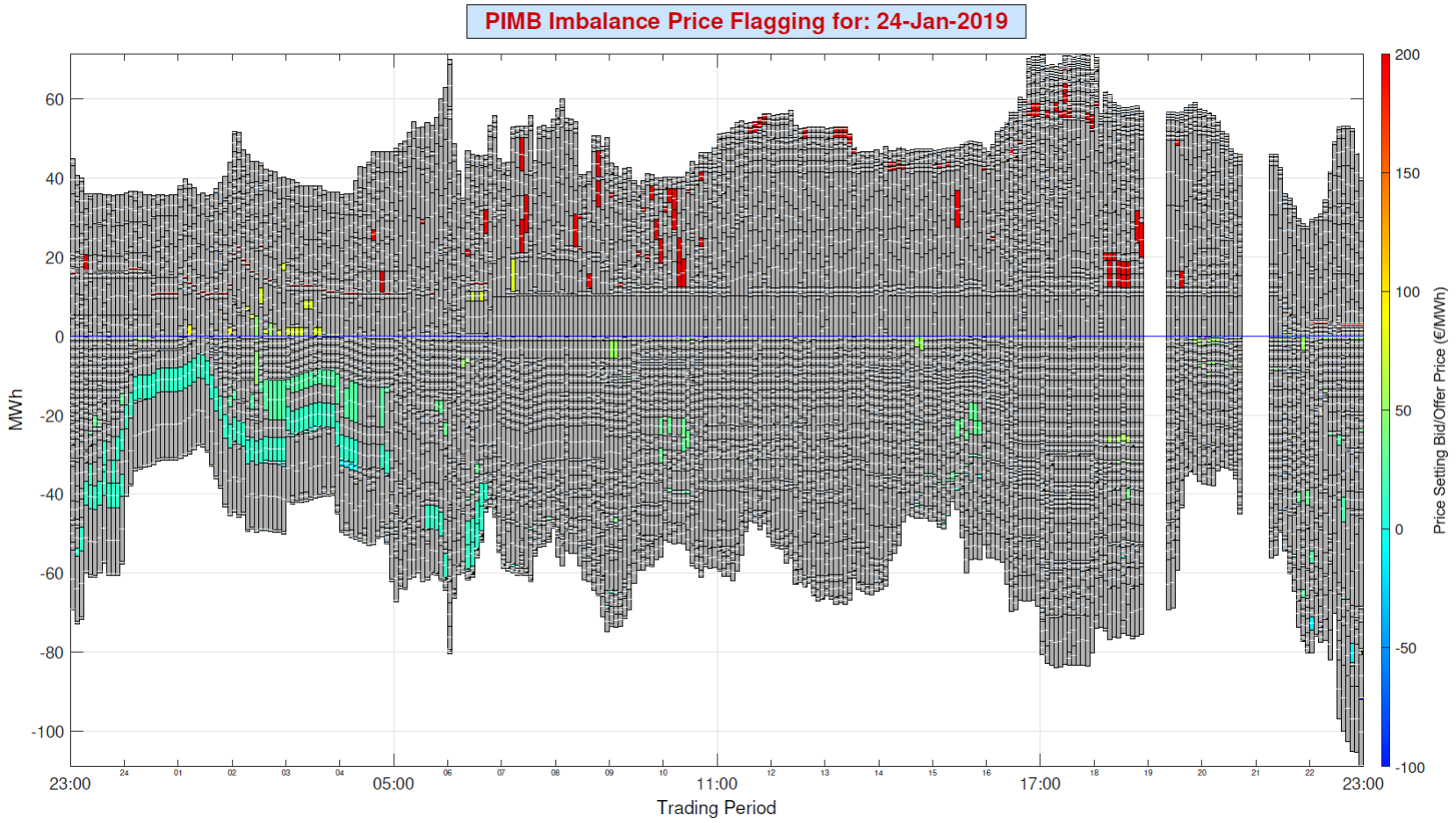

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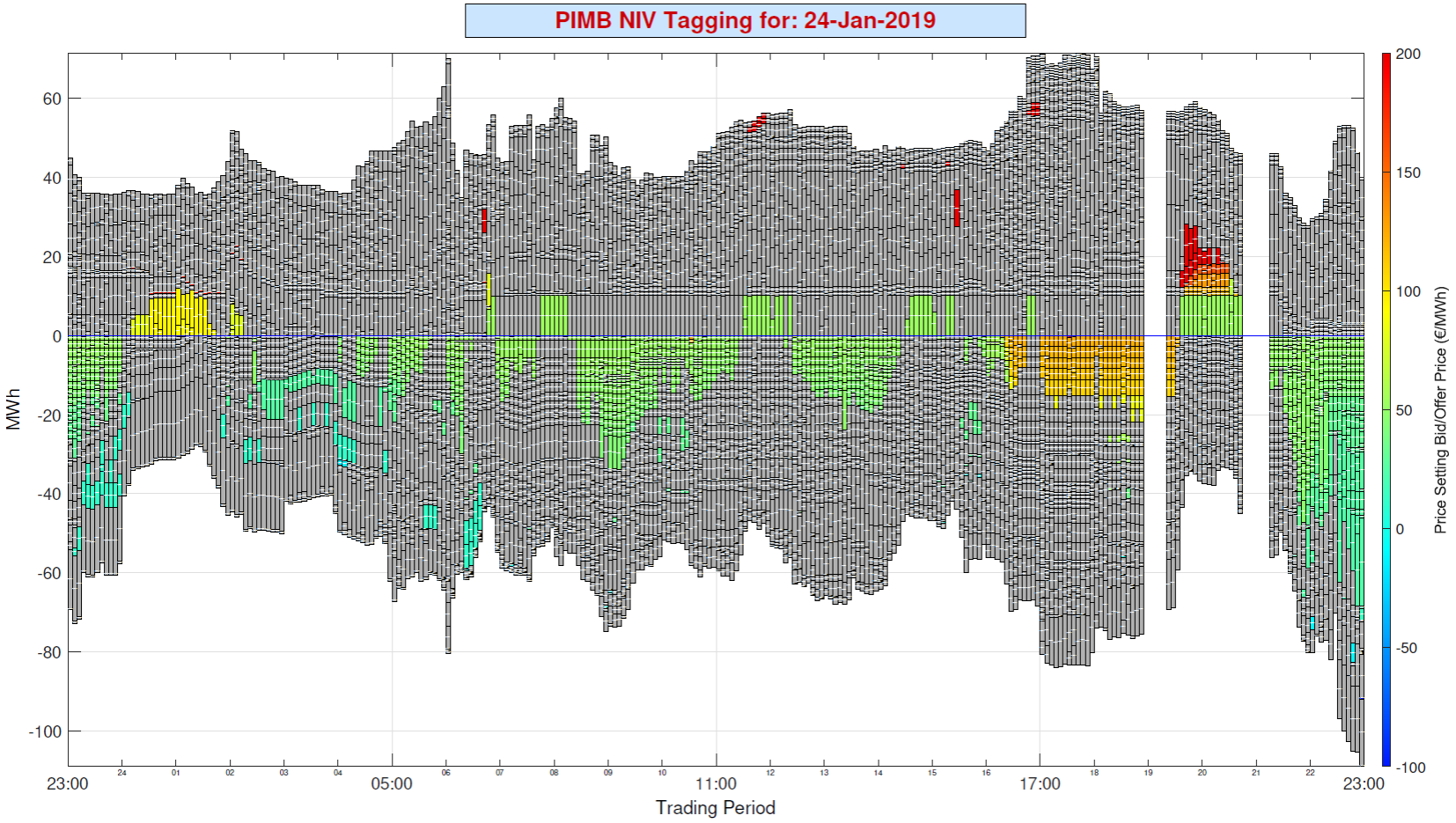

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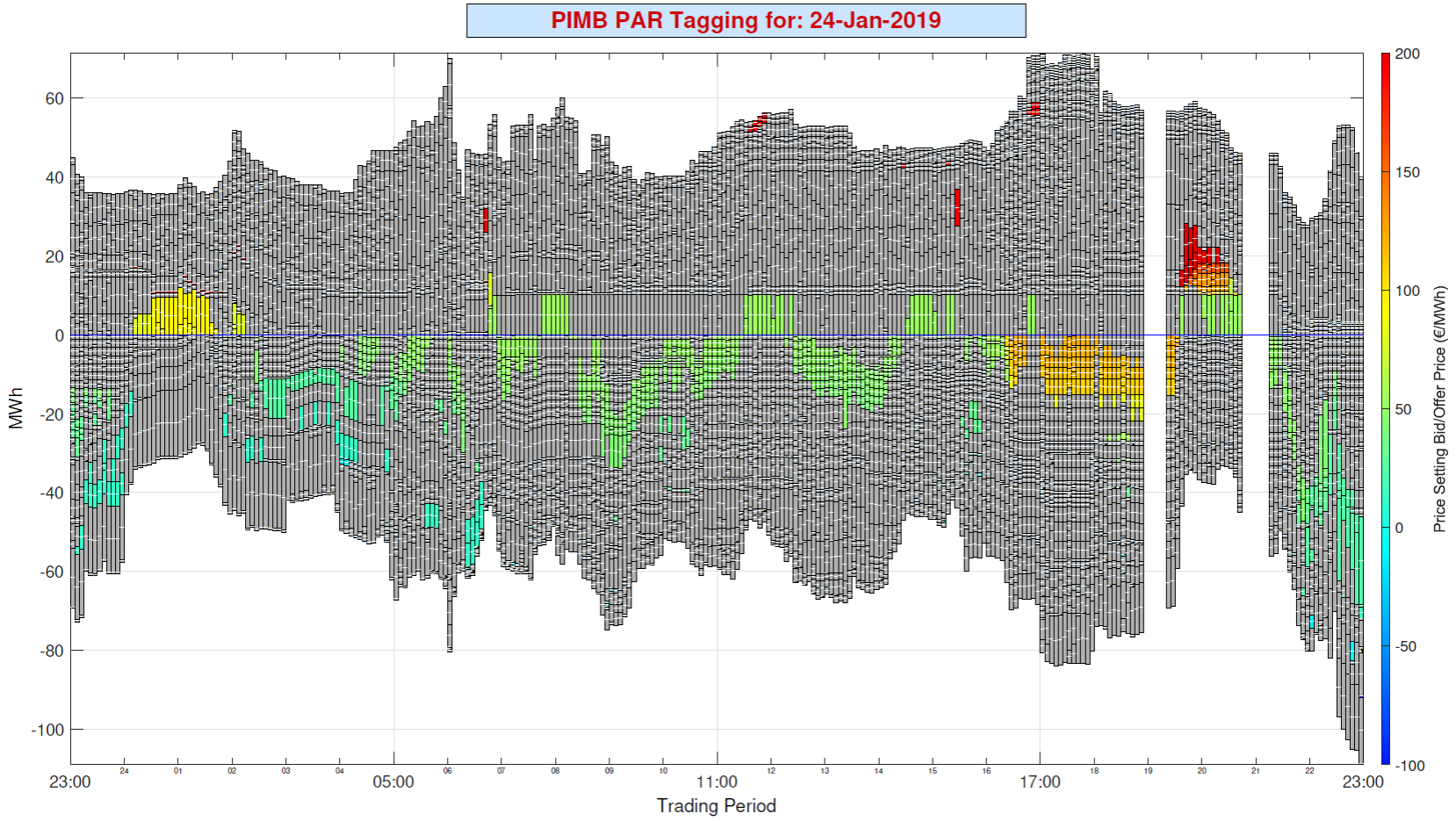

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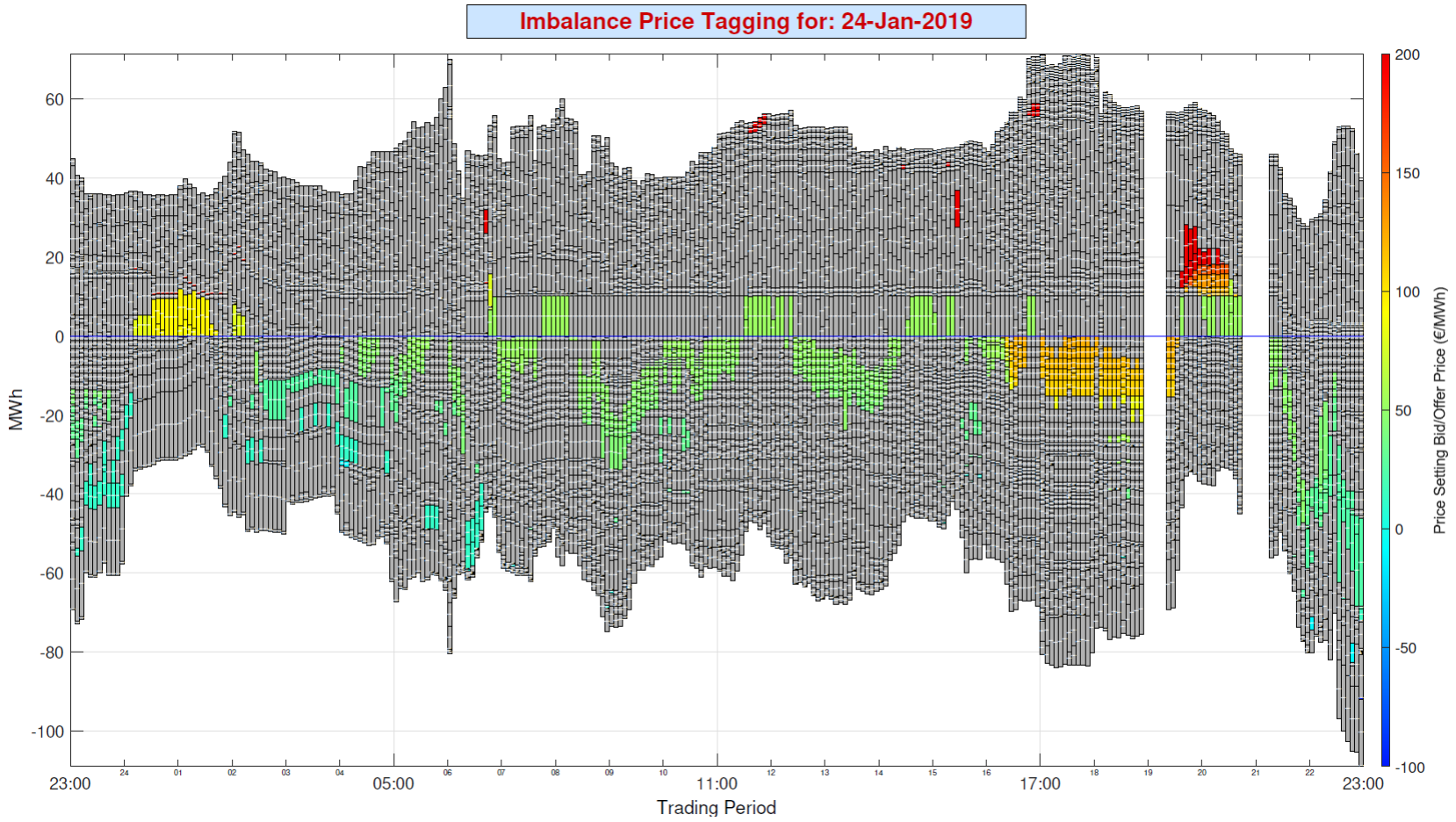

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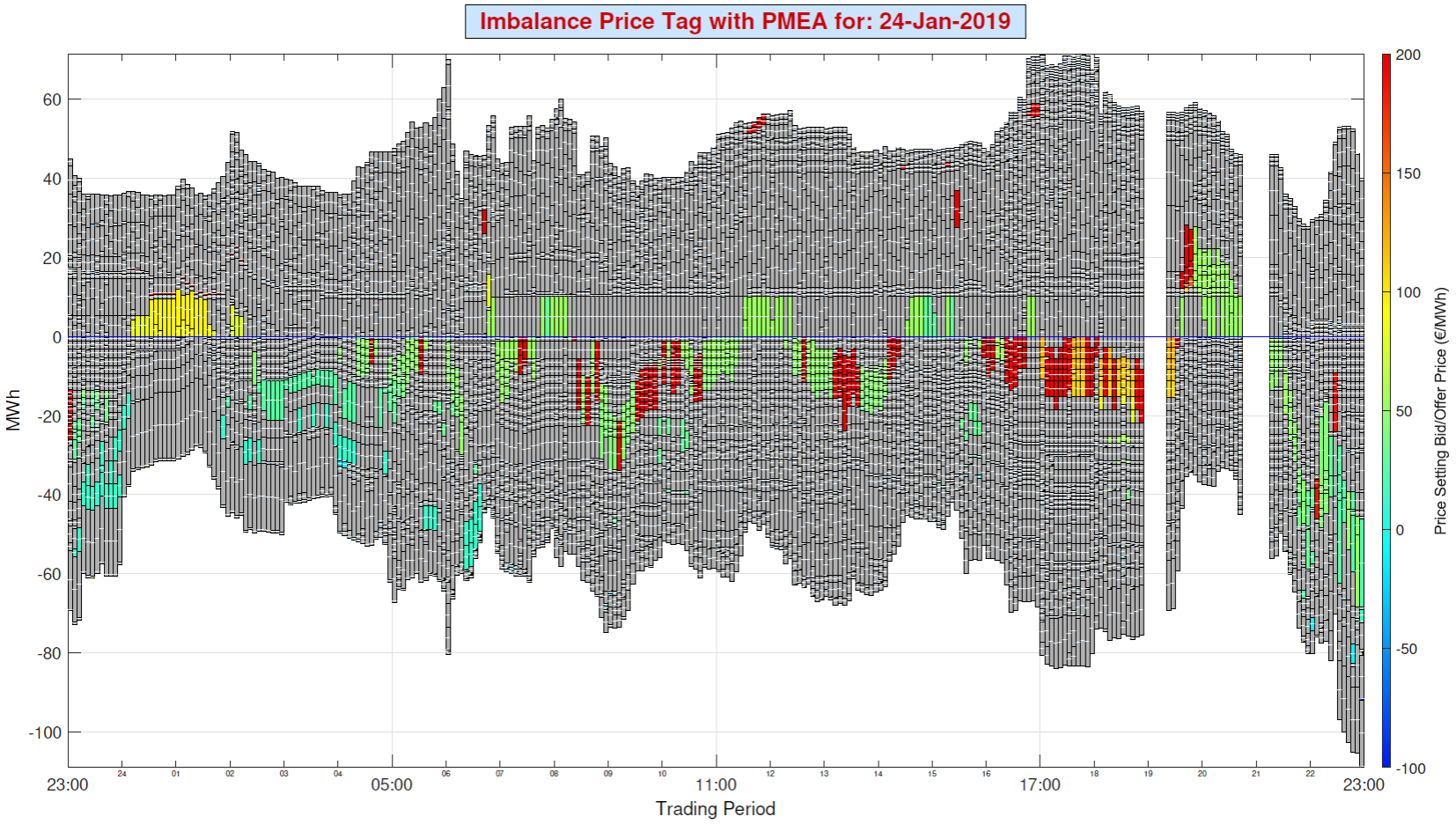
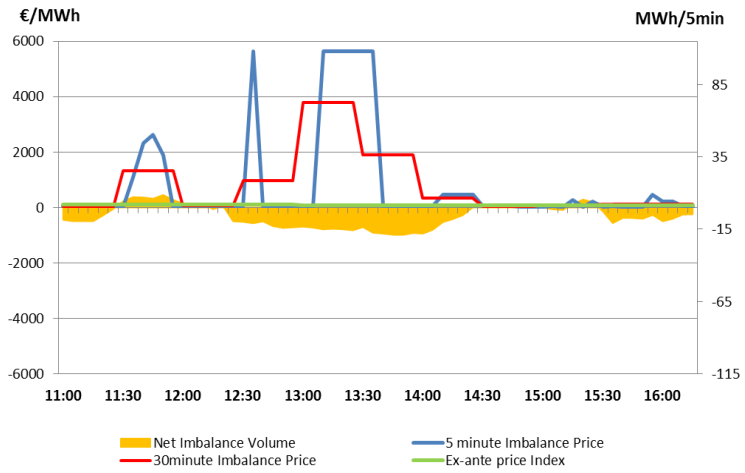


Imbalance Pricing Summary

- GU_500284 initially set the price when the market was short. The Imbalance price was lower than the units Bid Price due to Price Average Reference Tagging.
- GU_500824 was Non-Marginal due to ramp constraint following the initial high price, before becoming marginal for one period, setting MIN PMEA and the entire price at €5,636.
- The unit was again flagged for being Non- marginal in the indicative operating schedule for the next three periods before being moved to a level allowing it set the price for 6 imbalance price periods. The unit set the MIN PMEA and the entire price at €5,636.
- Overall Four Imbalance Settlement prices above strike price observed with max price of €3,773 .



Review of January 24th

Agenda

1. *Introduction*
2. *Ex-Ante Market Results*
3. *System Operations*
4. *Flagging & Tagging*
5. *Application of the rules on January 24th*
6. *Next Steps…*

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Review of January 24th

- Are there points of additional clarity required in the report on Jan 24th?
- Is there value in a similar report on Oct 9th?
- Modifications already in train in relation to high price events
- What additional information do participants feel they need to assist in their understanding and analysis of flagging & tagging and imbalance pricing?

Questions

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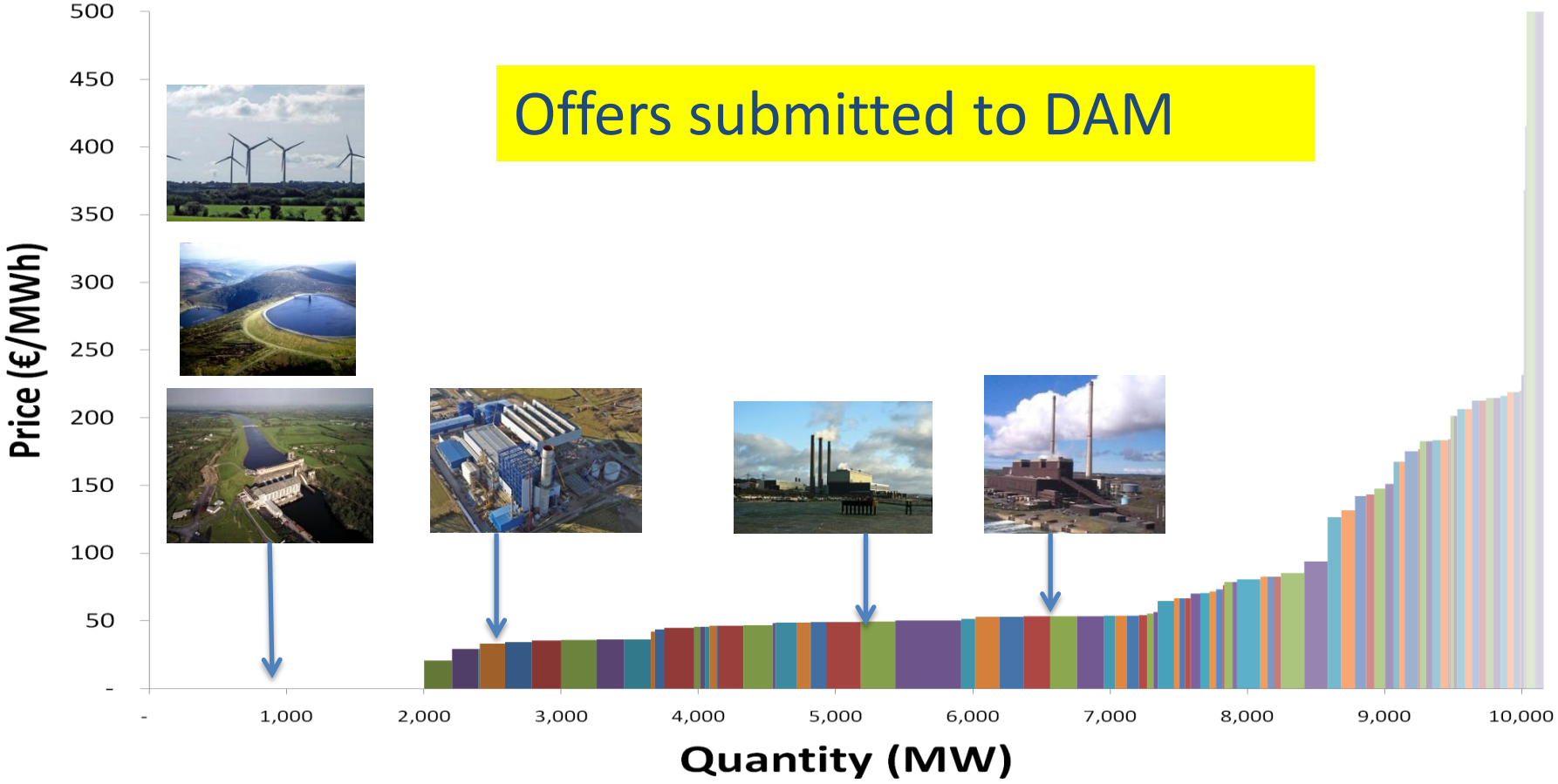
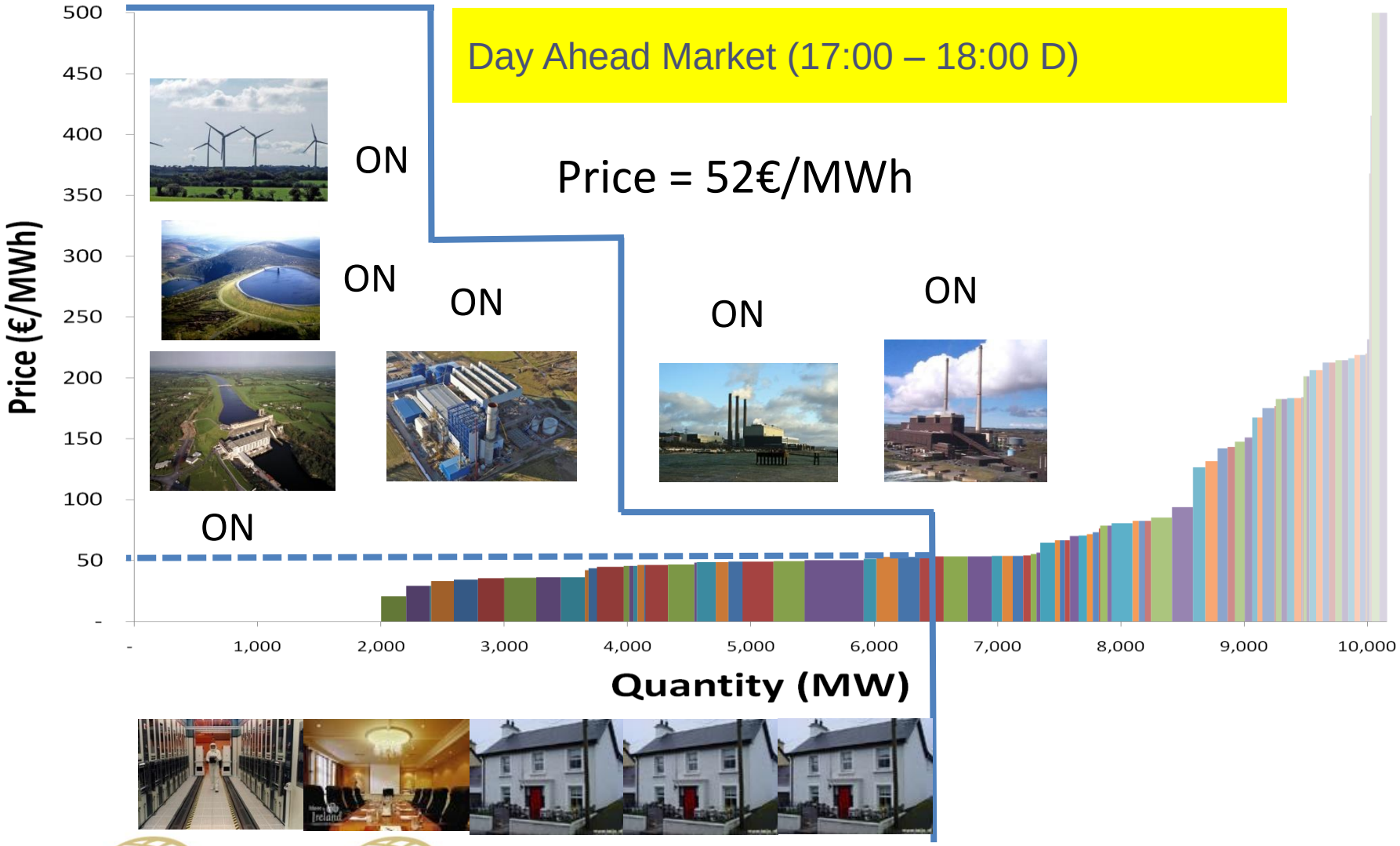
Appendix

A Day in the life 2a/b example

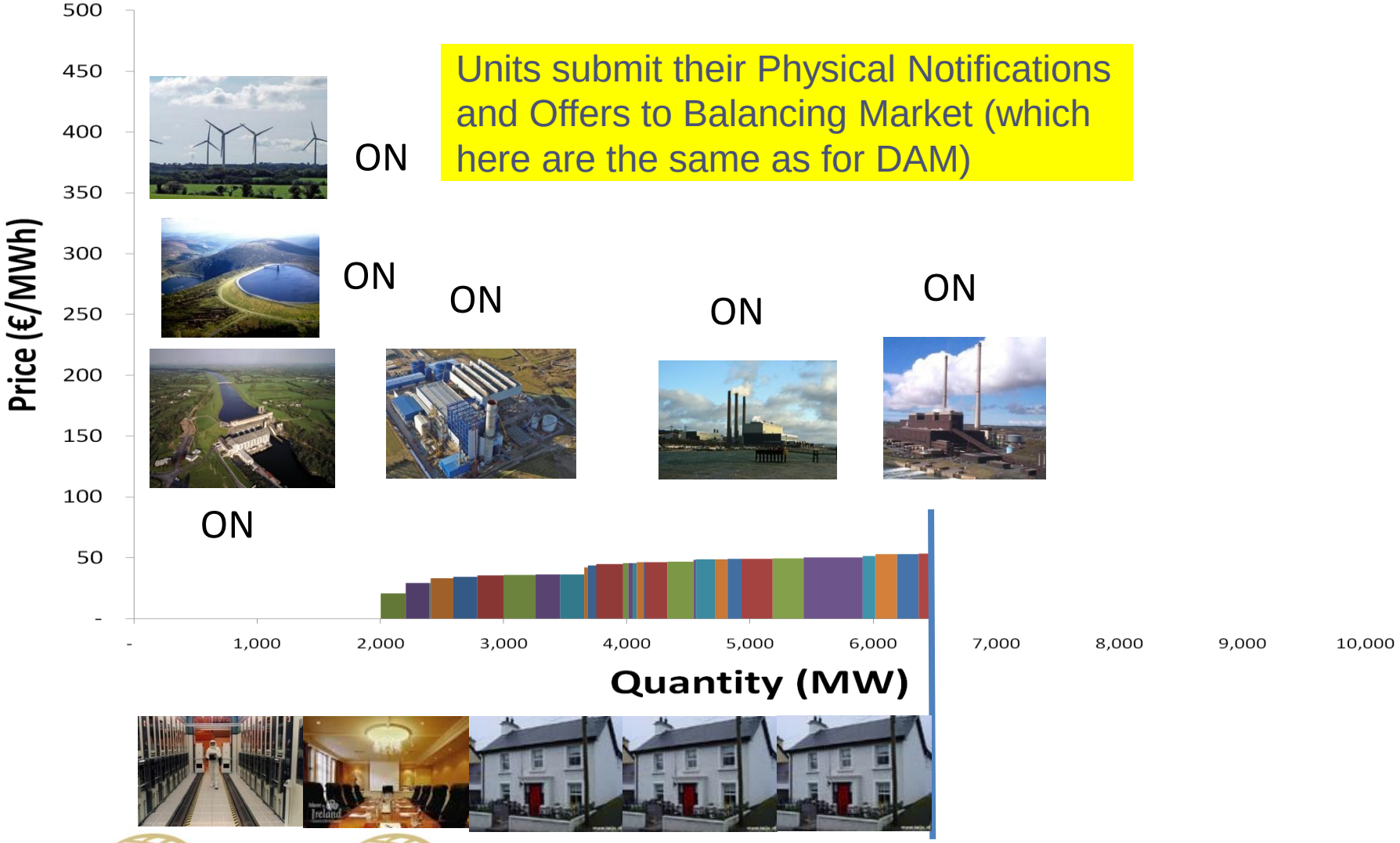
Day in the Life 2a: D-1 10:00



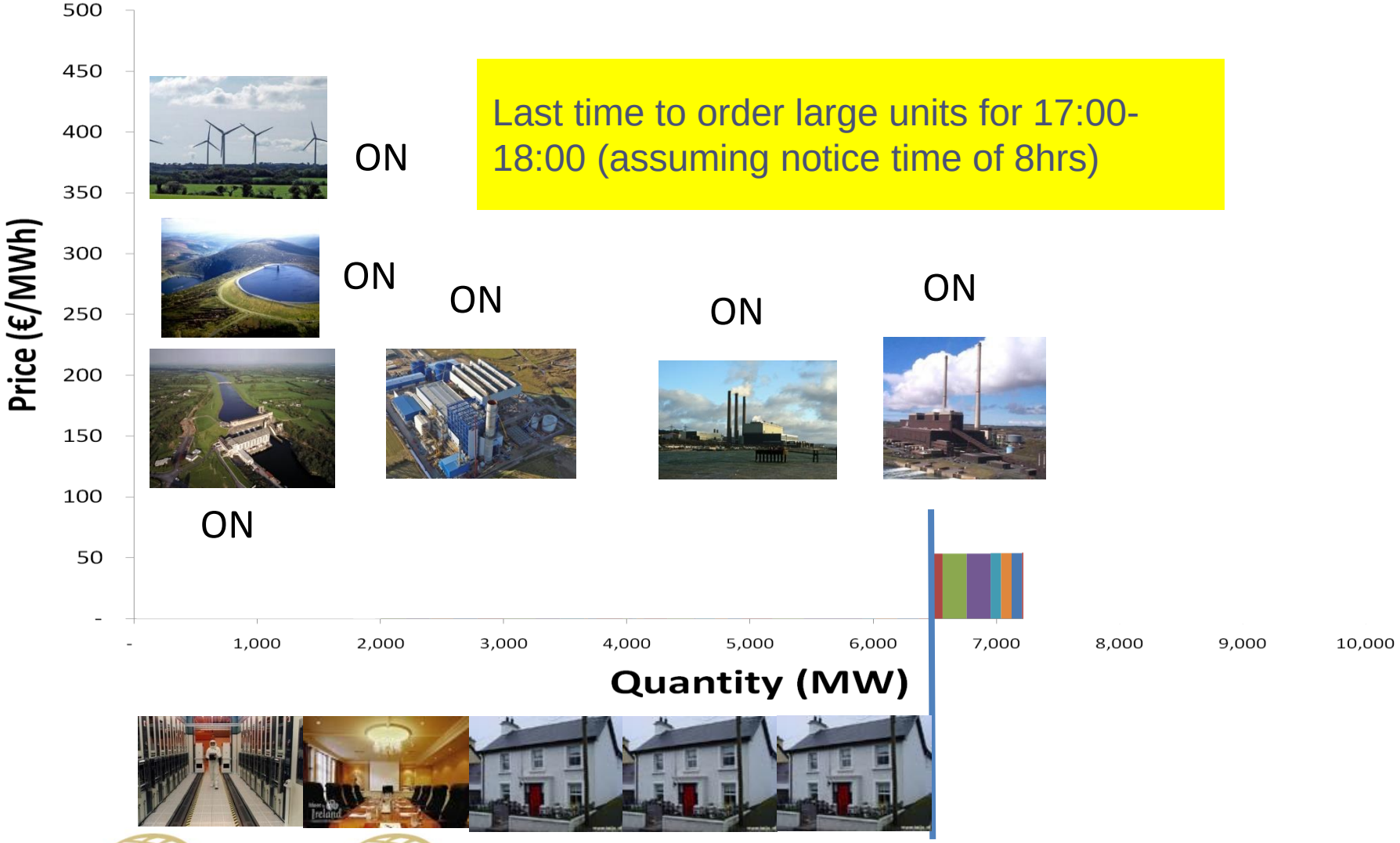
Day in the Life 2a: D-1 11:00



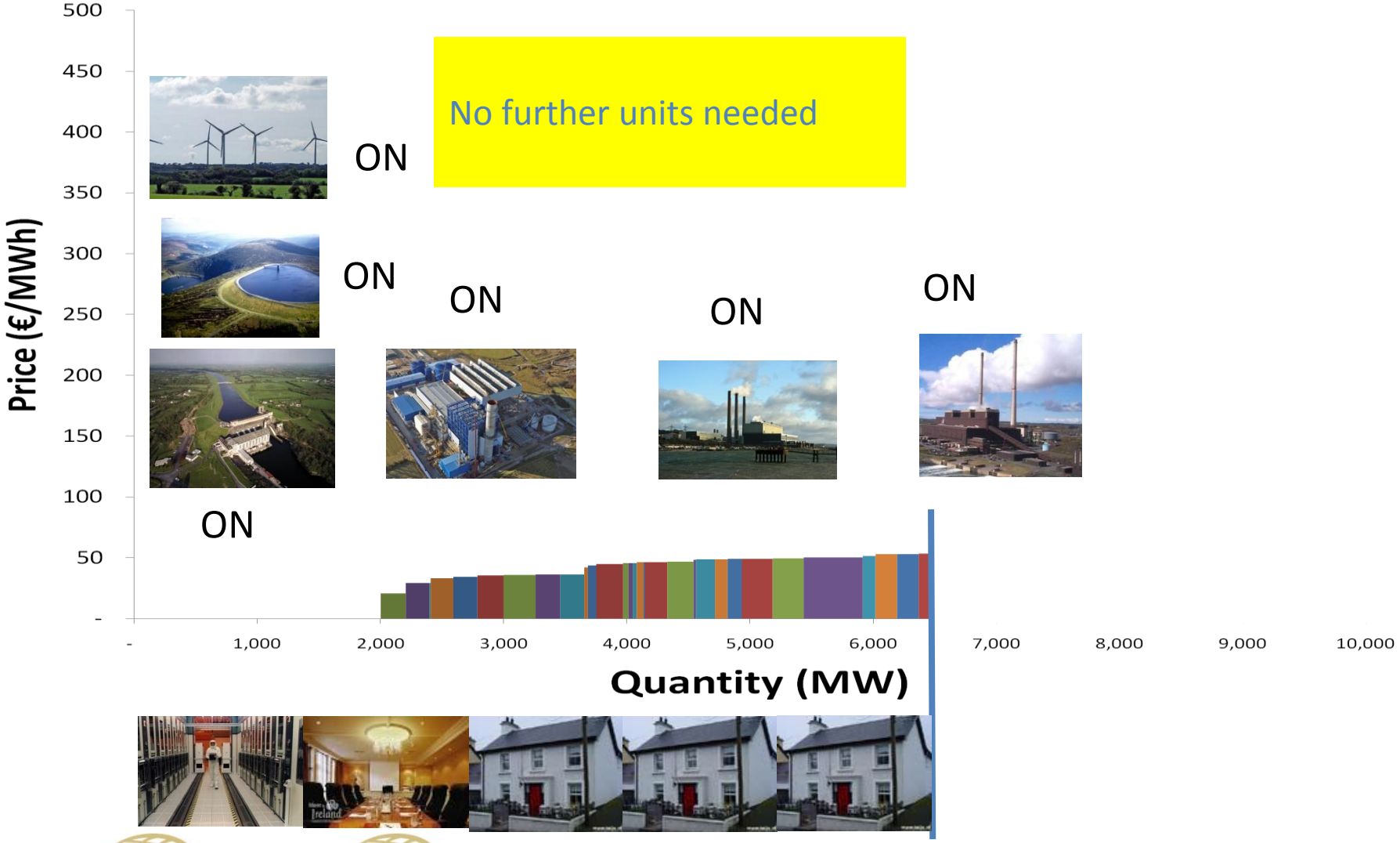
Day in the Life 2a: D-1 13:30



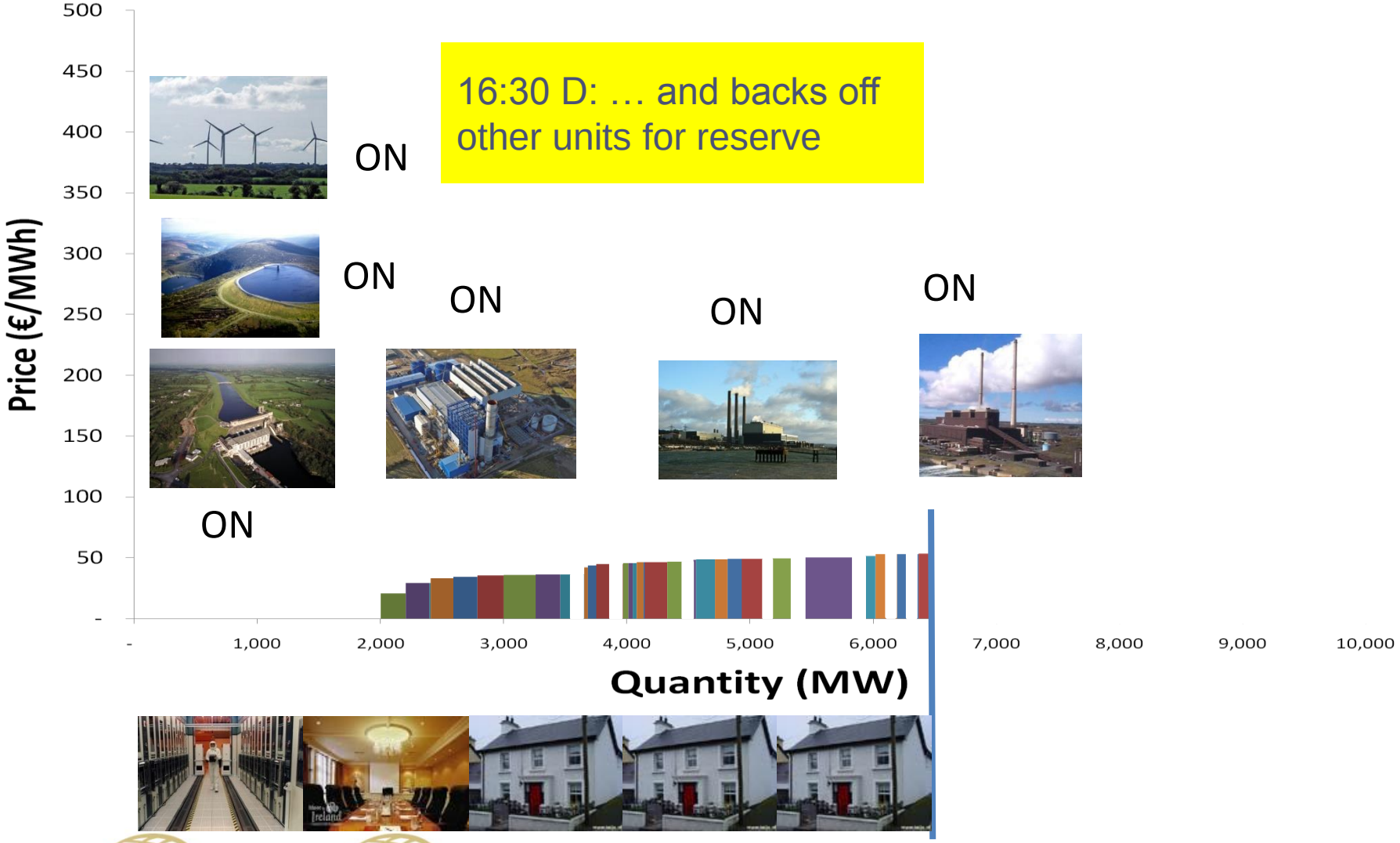
Day in the Life 2a: 09:00



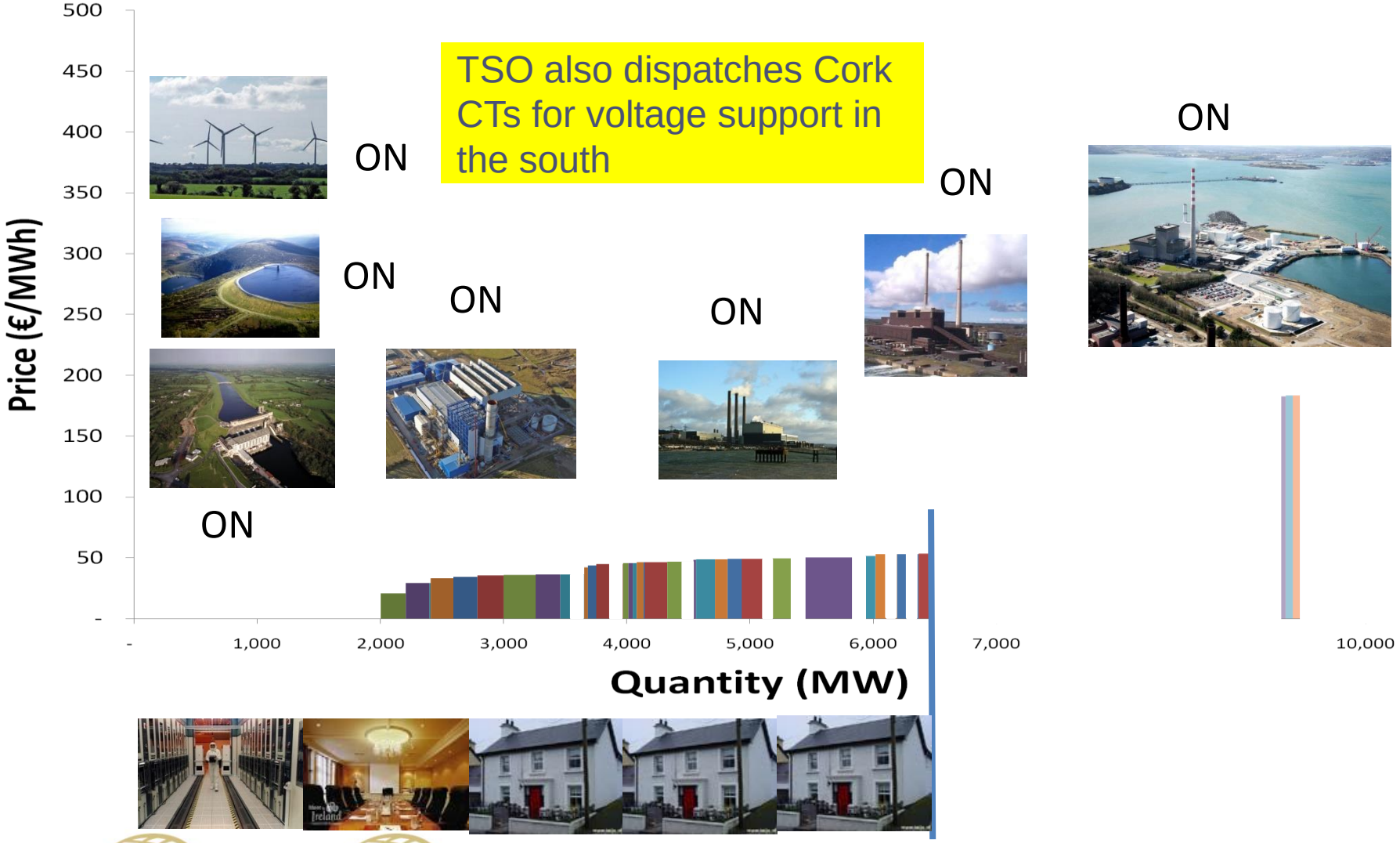
Day in the Life 2a: 09:00



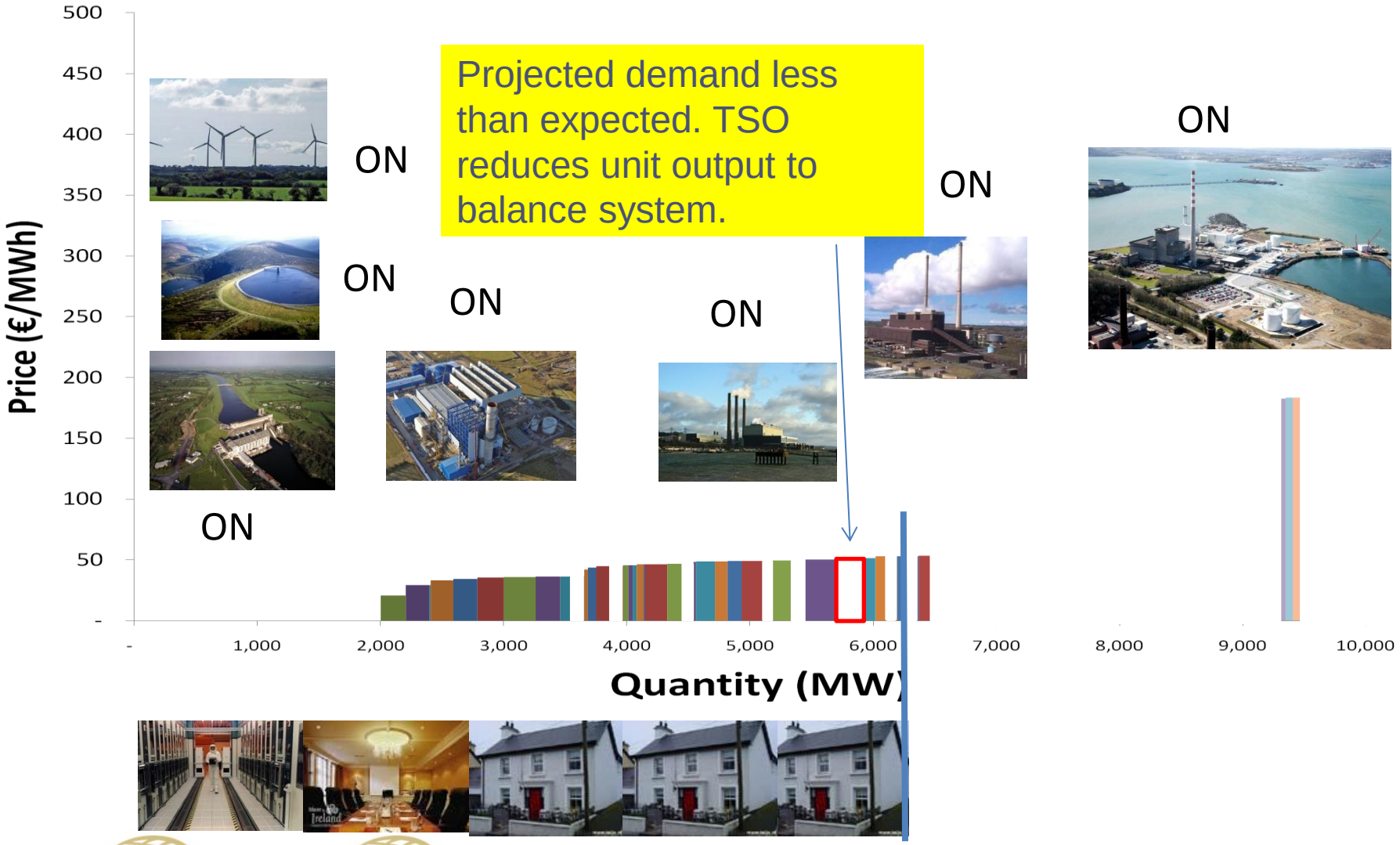
Day in the Life 2a: 16:30



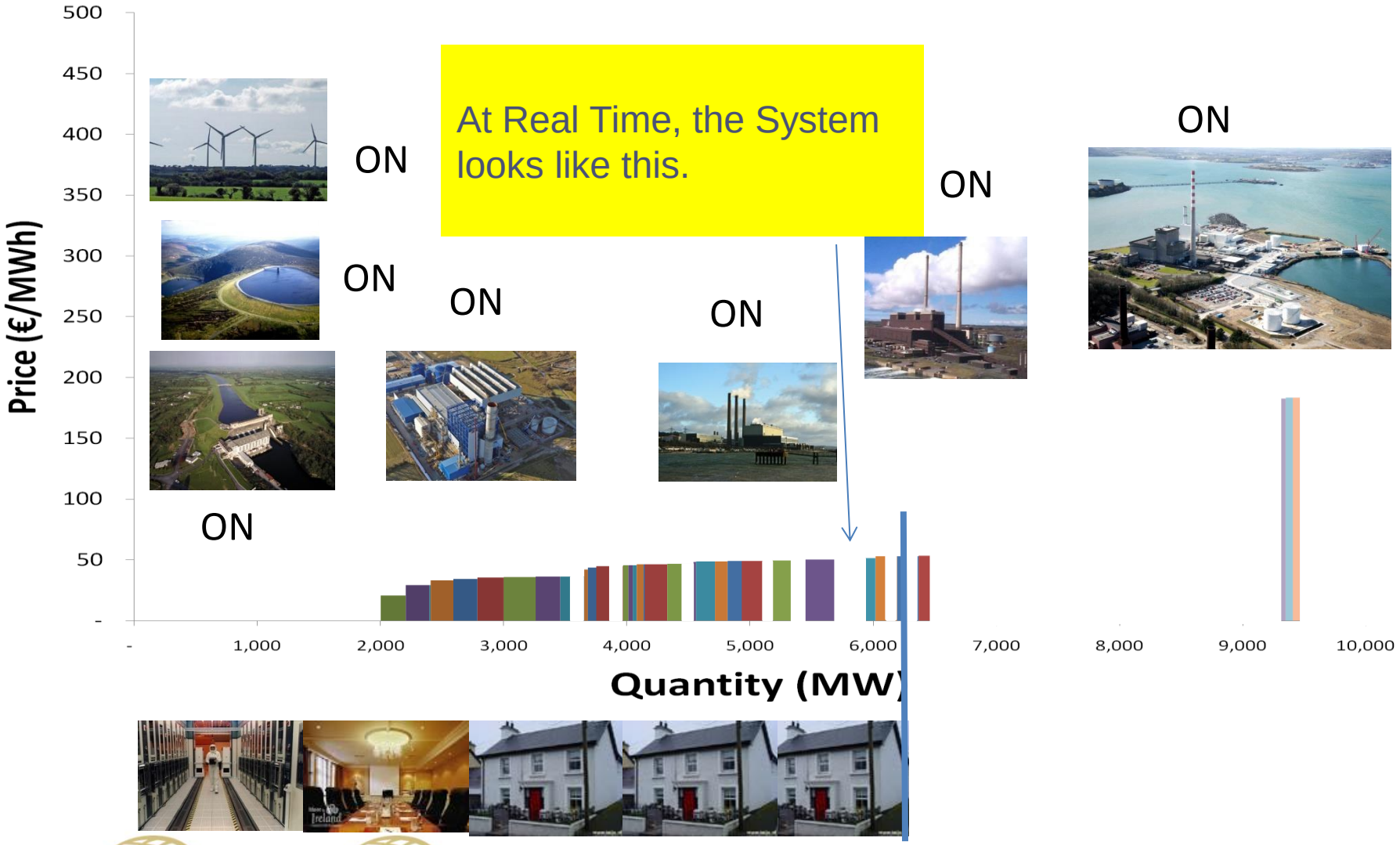
Day in the Life 2a: 16:30



Day in the Life 2a: 16:50



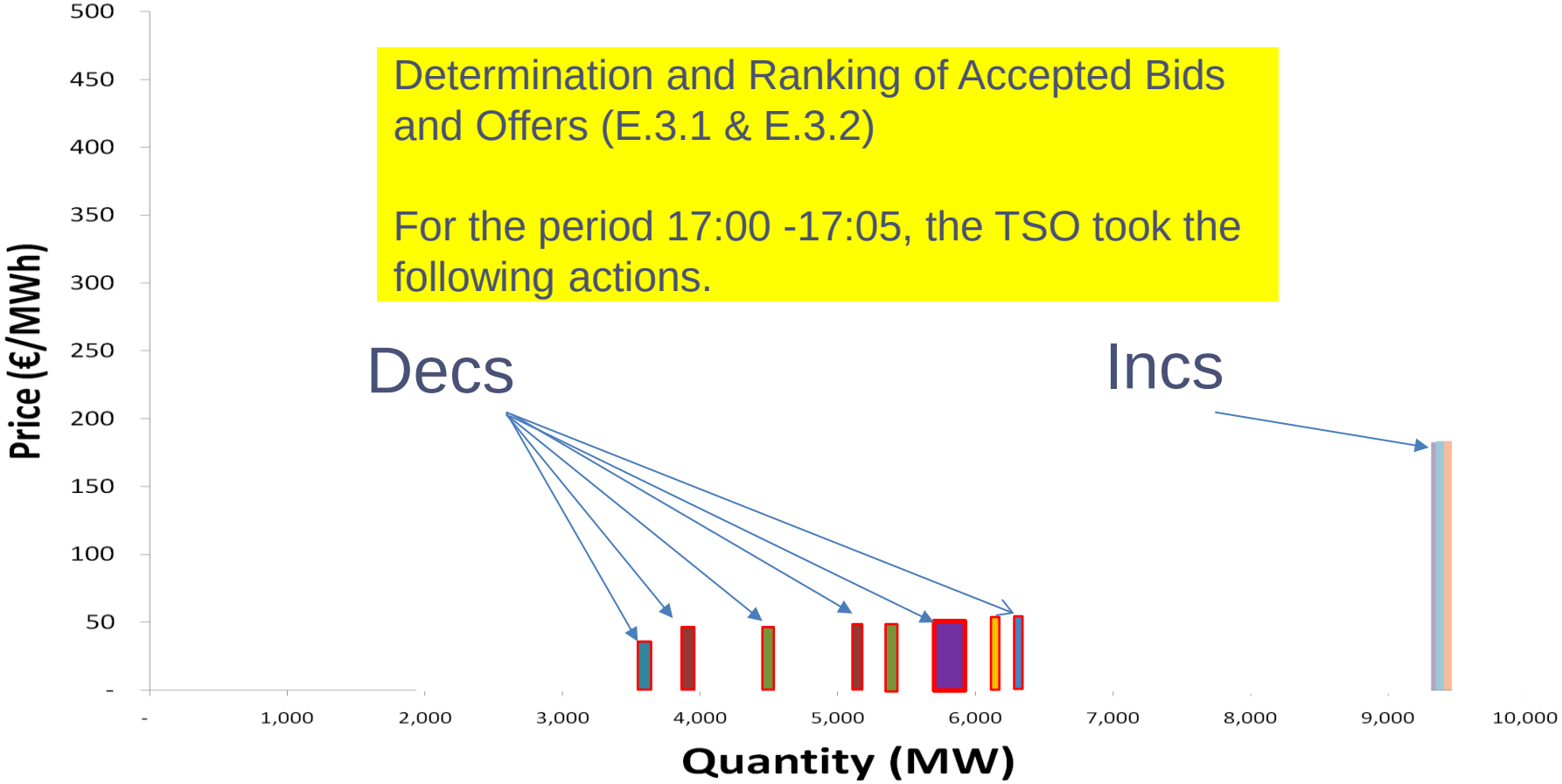
Day in the Life 2a: 17:00



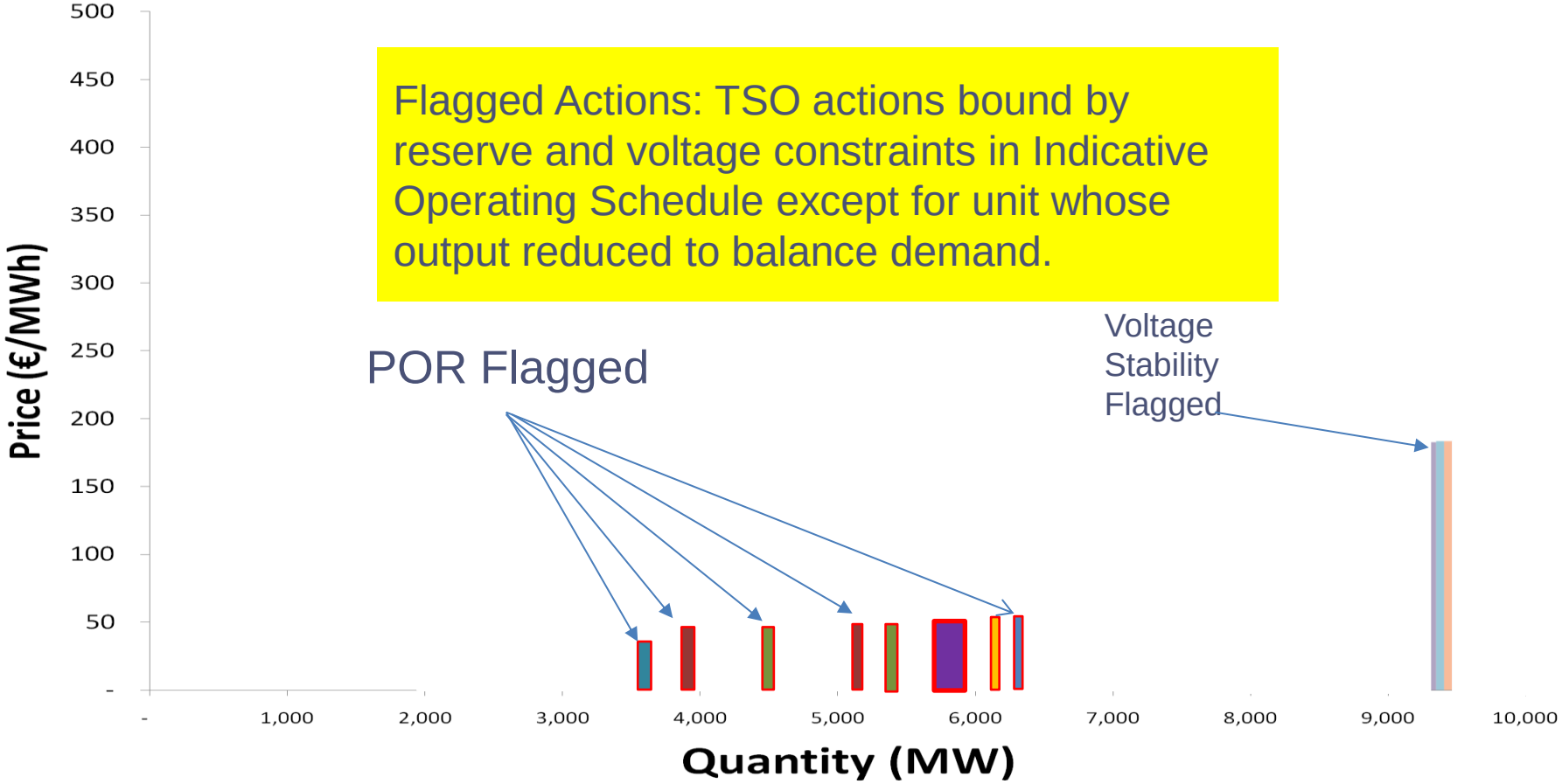
Day in the Life 2a: 17:25

Determination and Ranking of Accepted Bids and Offers (E.3.1 & E.3.2)

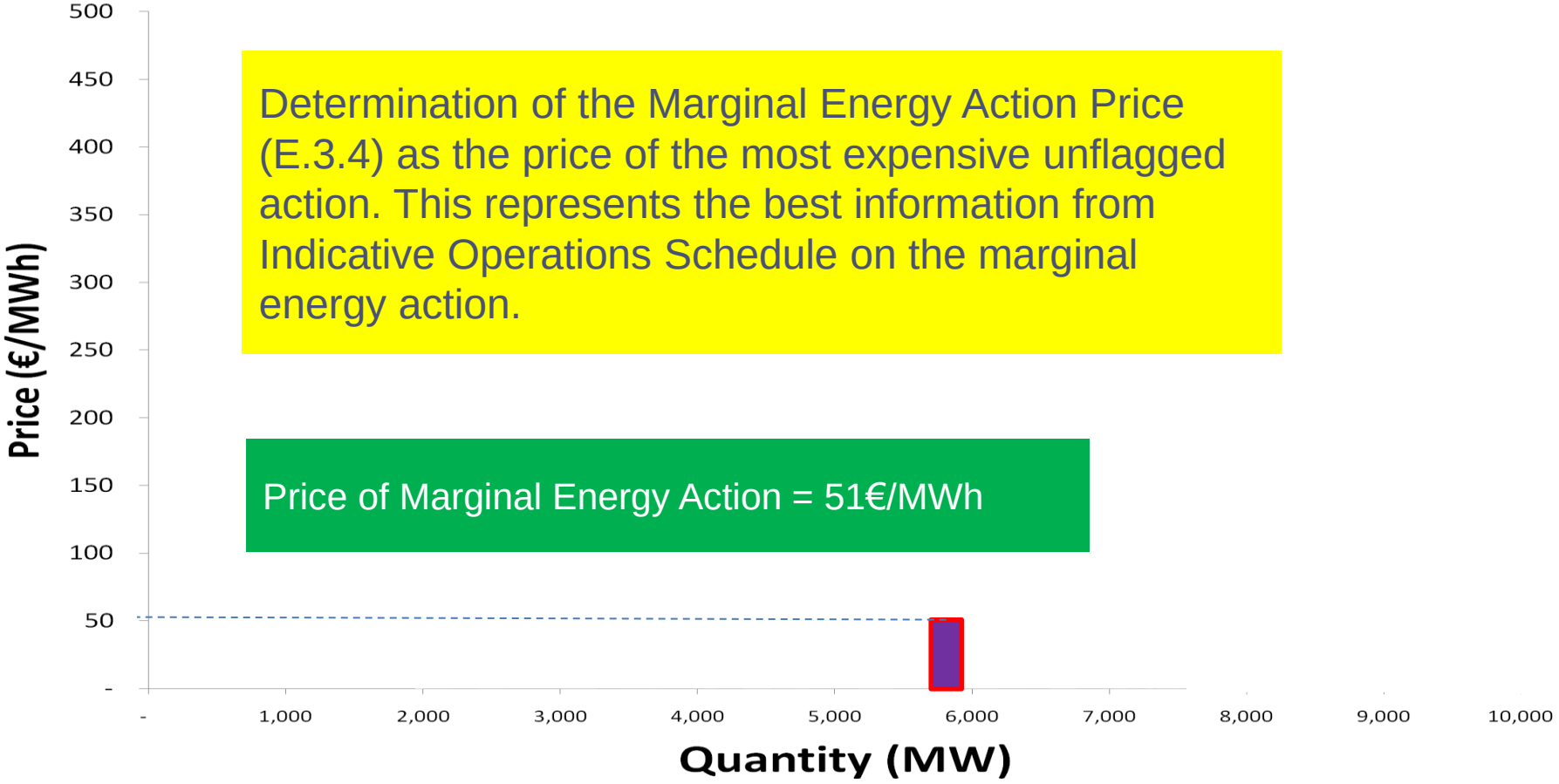
For the period 17:00 -17:05, the TSO took the following actions.



Day in the Life 2a: 17:25



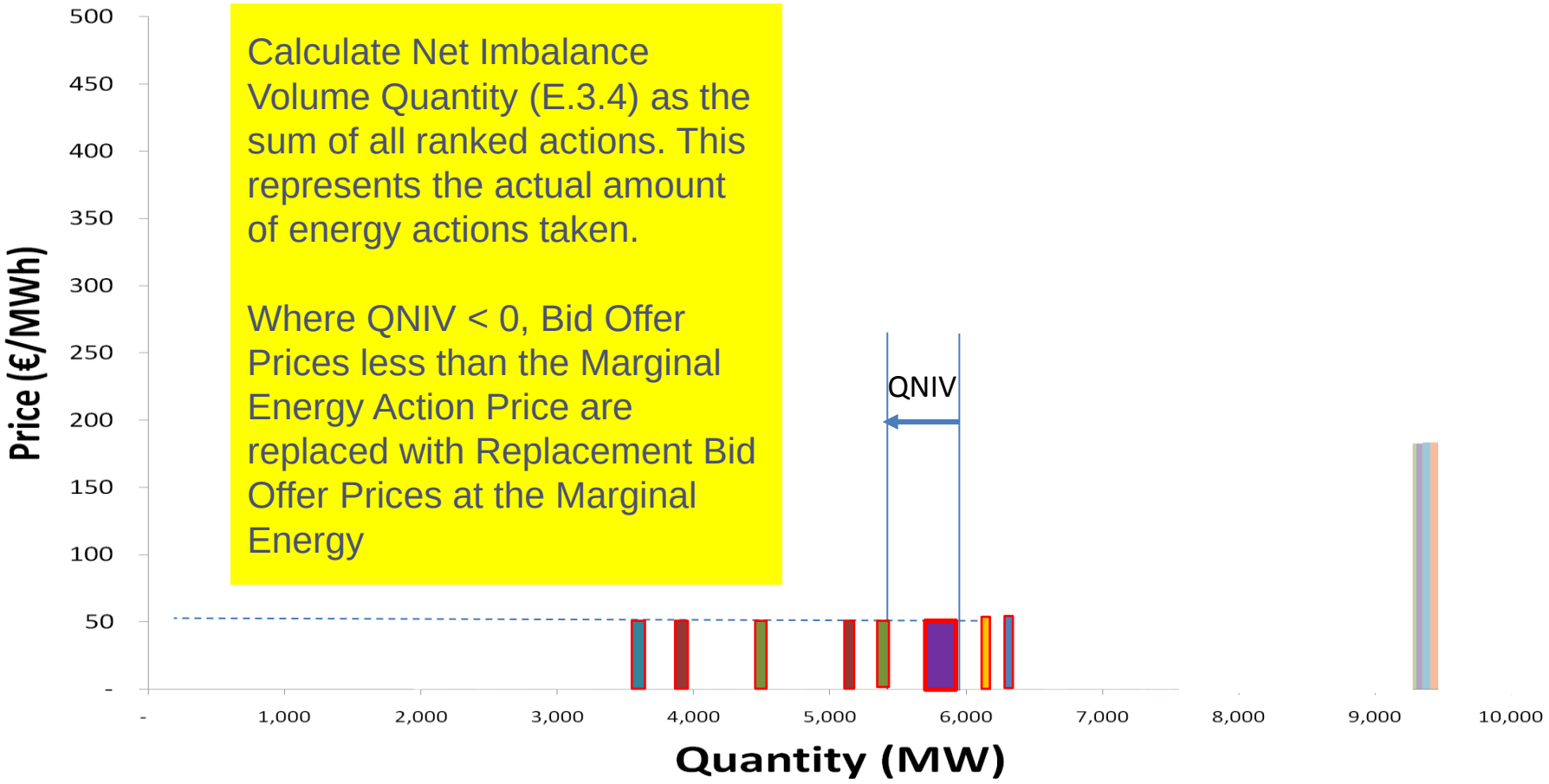
Day in the Life 2a: 17:25



Determination of the Marginal Energy Action Price (E.3.4) as the price of the most expensive unflagged action. This represents the best information from Indicative Operations Schedule on the marginal energy action.

Price of Marginal Energy Action = 51€/MWh

Day in the Life 2a: 17:25

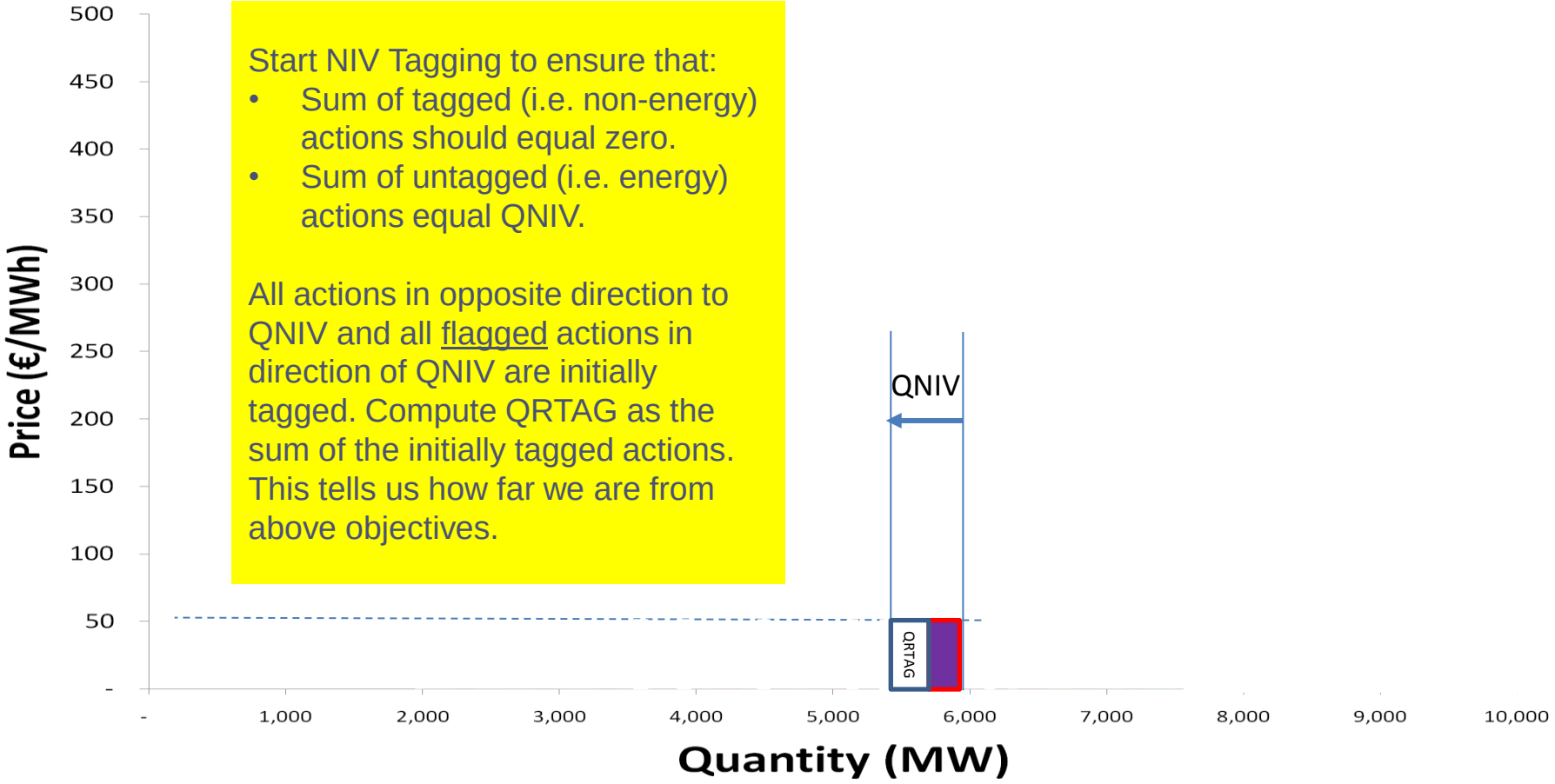


Day in the Life 2a: 17:25

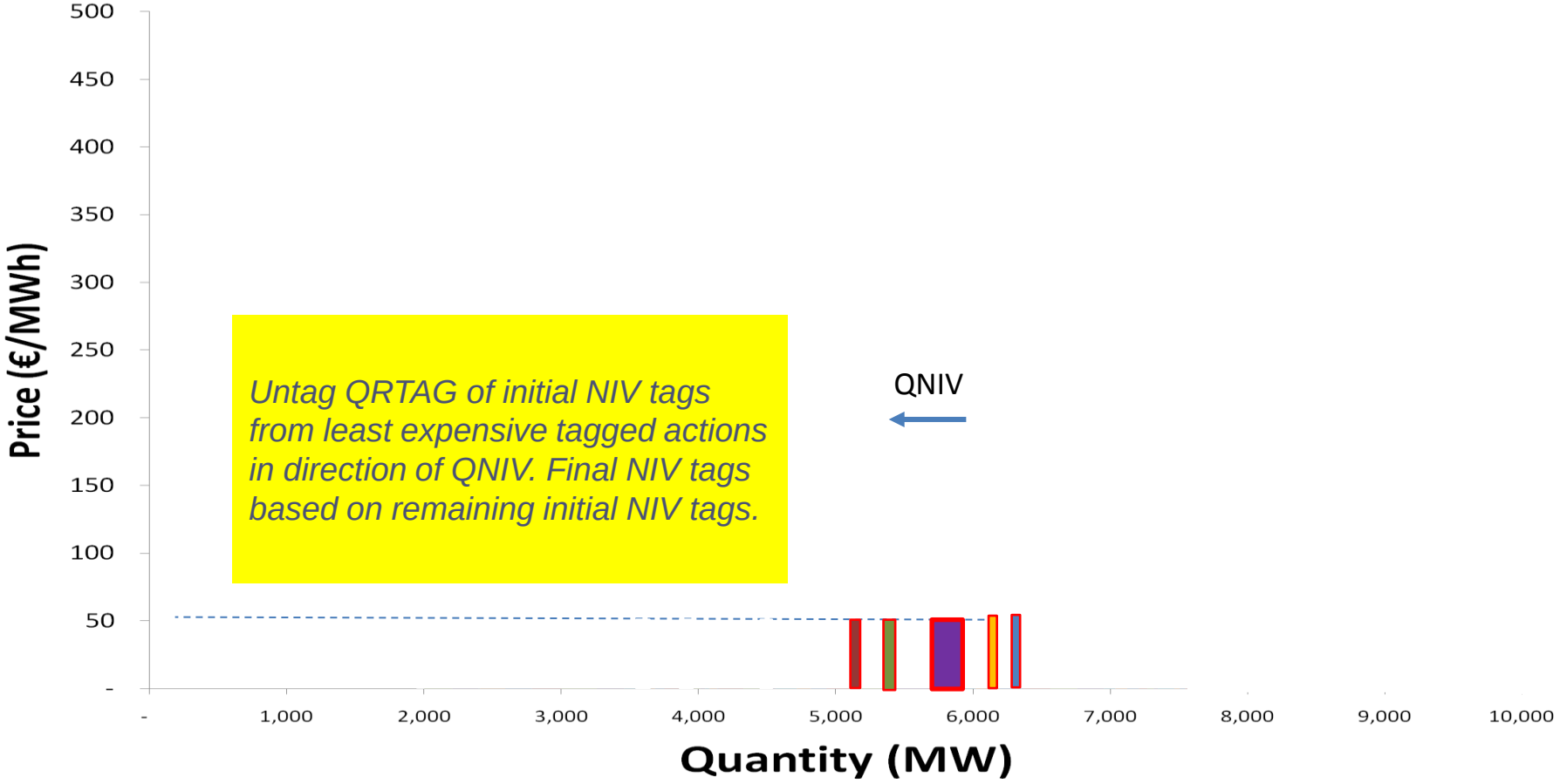
Start NIV Tagging to ensure that:

- Sum of tagged (i.e. non-energy) actions should equal zero.
- Sum of untagged (i.e. energy) actions equal QNIV.

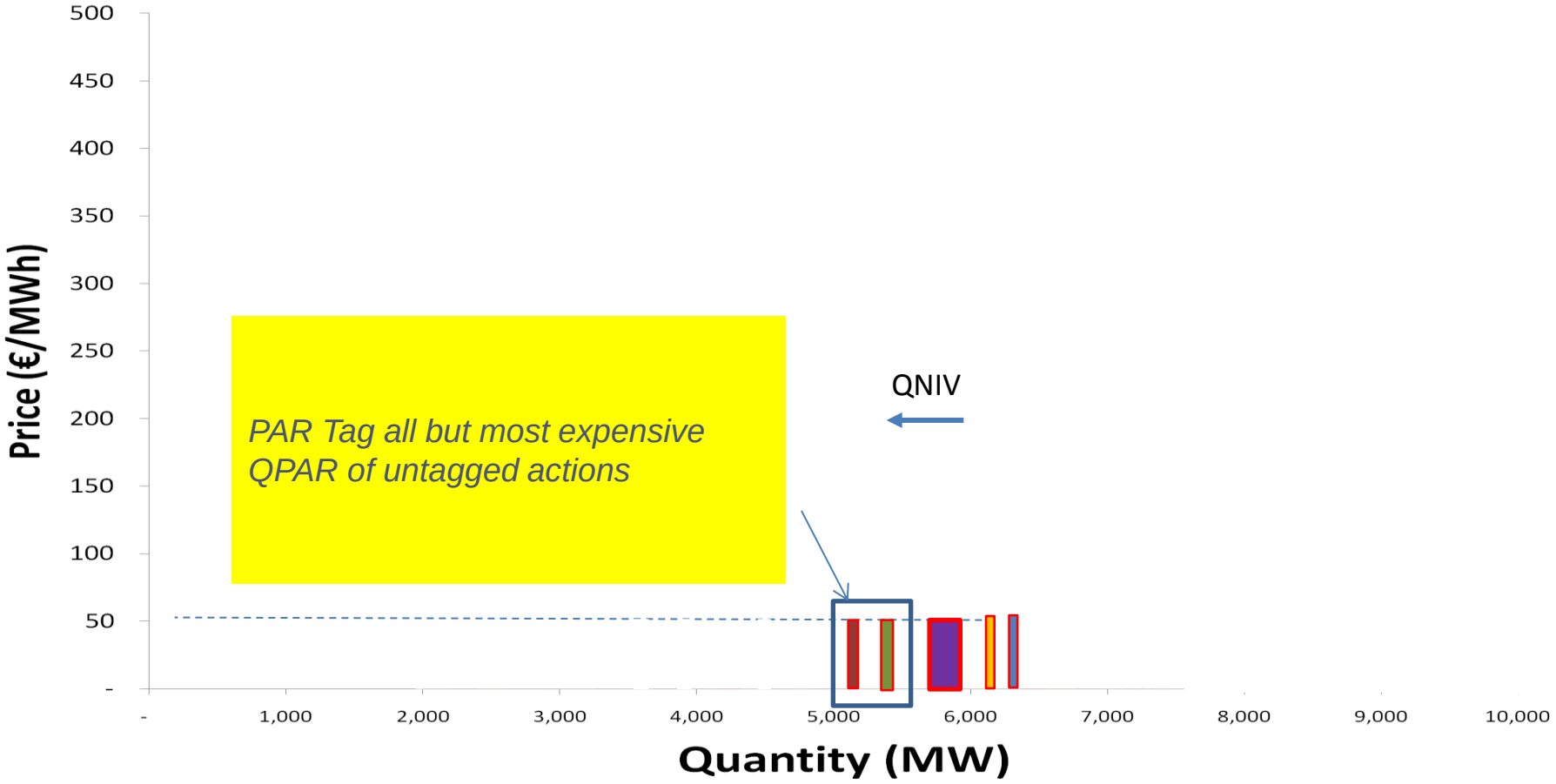
All actions in opposite direction to QNIV and all flagged actions in direction of QNIV are initially tagged. Compute QRTAG as the sum of the initially tagged actions. This tells us how far we are from above objectives.



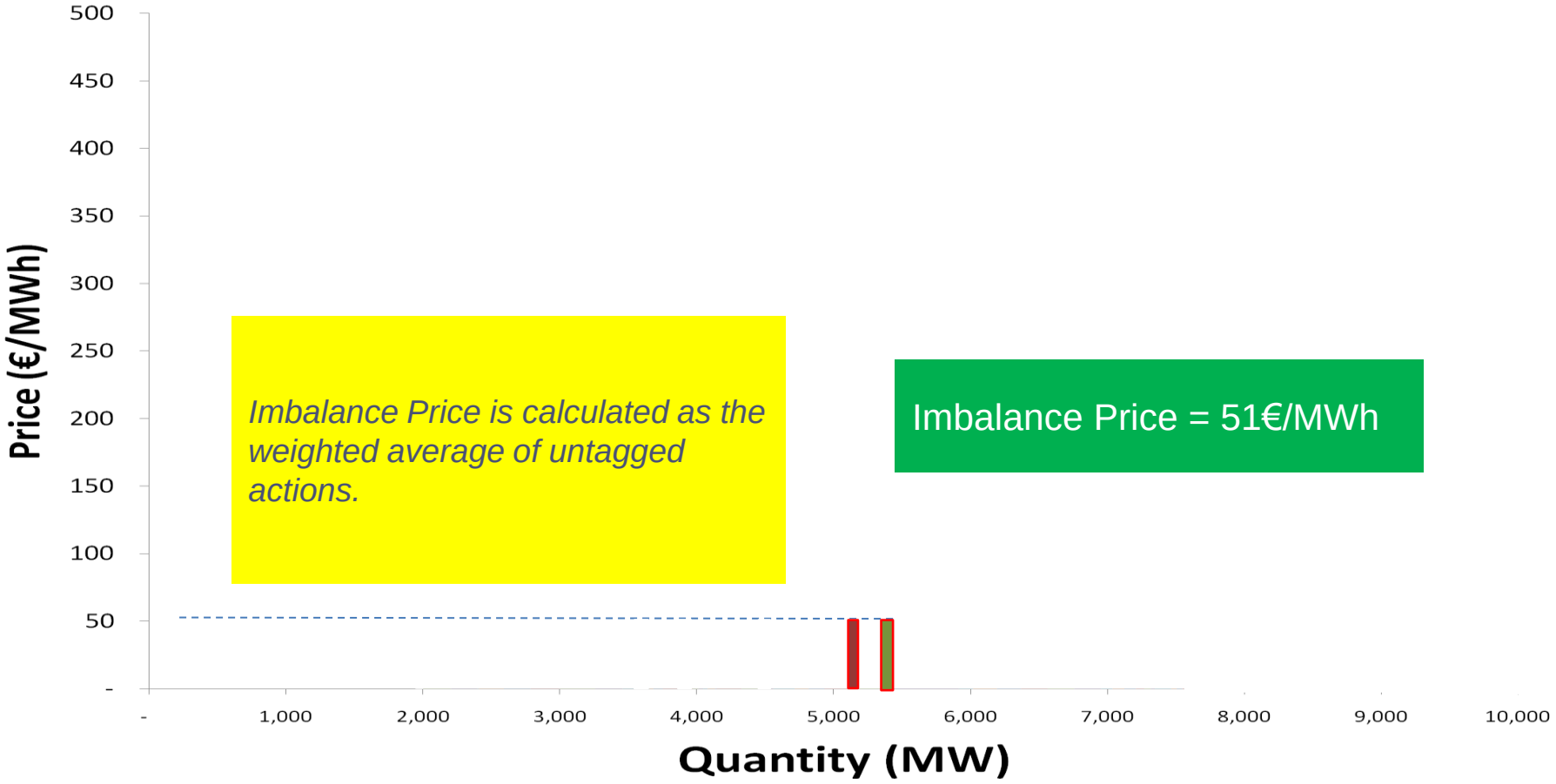
Day in the Life 2a: 17:25



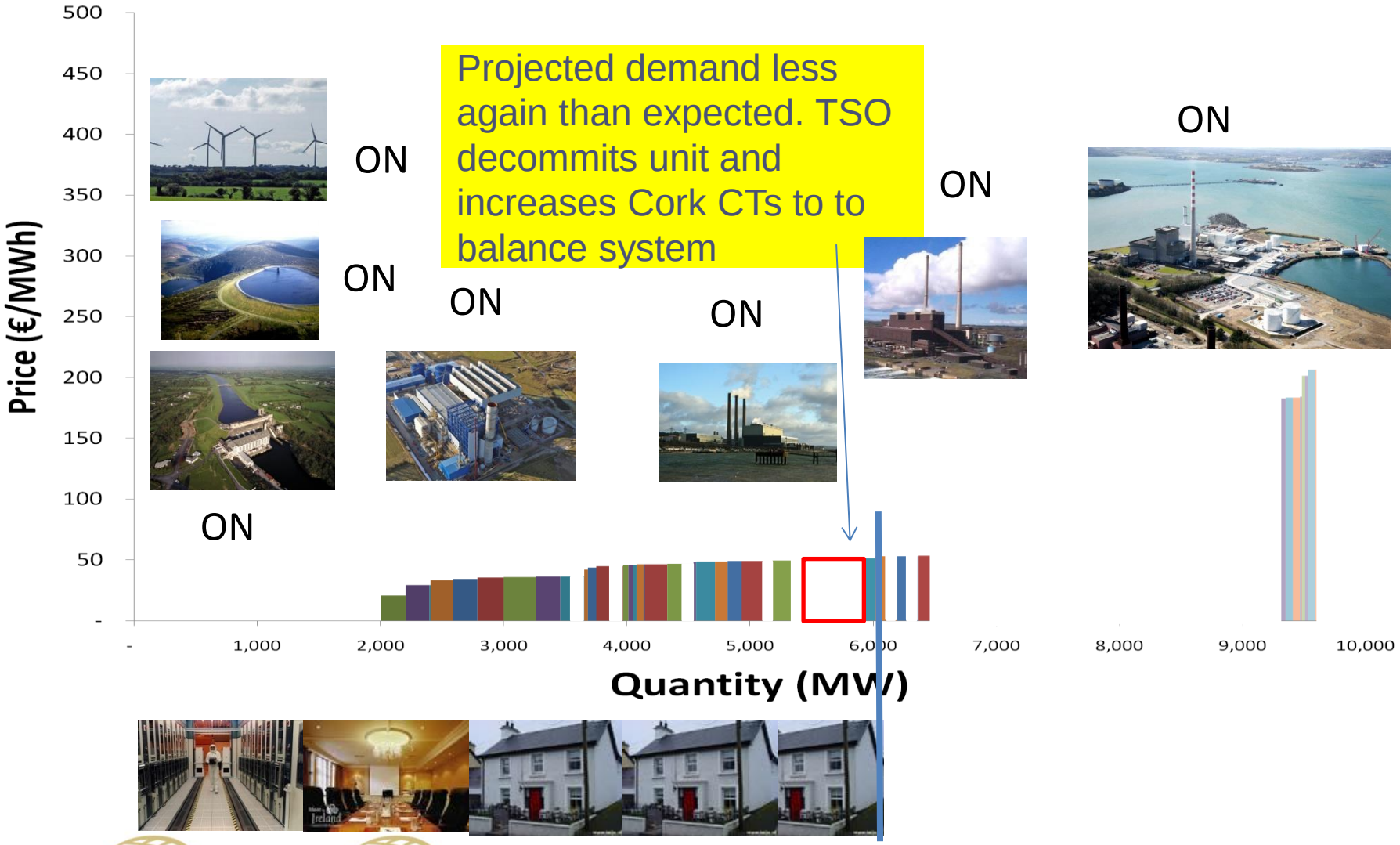
Day in the Life 2a: 17:25



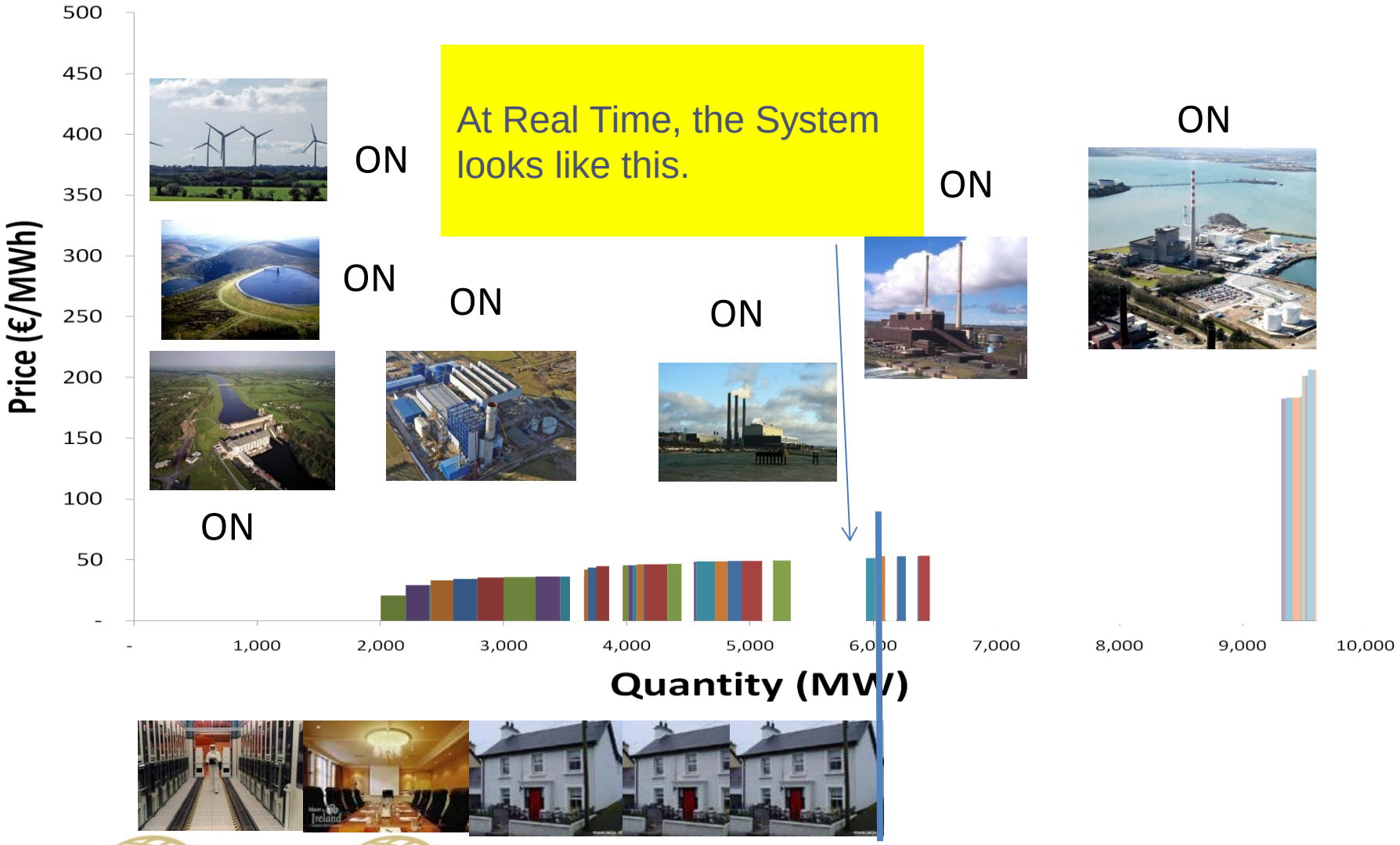
Day in the Life 2a: 17:25



Day in the Life 2a: 16:55



Day in the Life 2a: 17:05



Day in the Life 2a: 17:25

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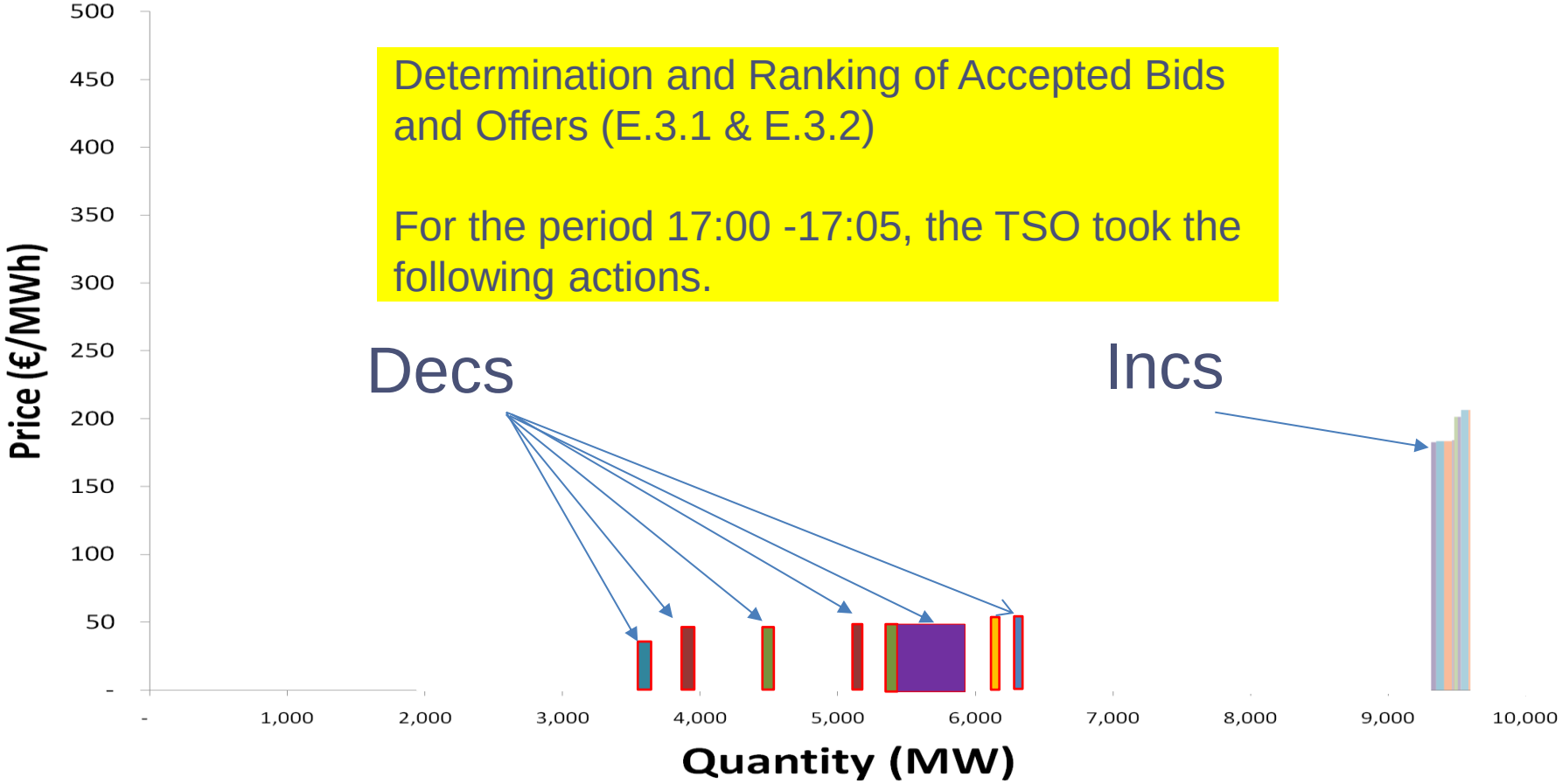
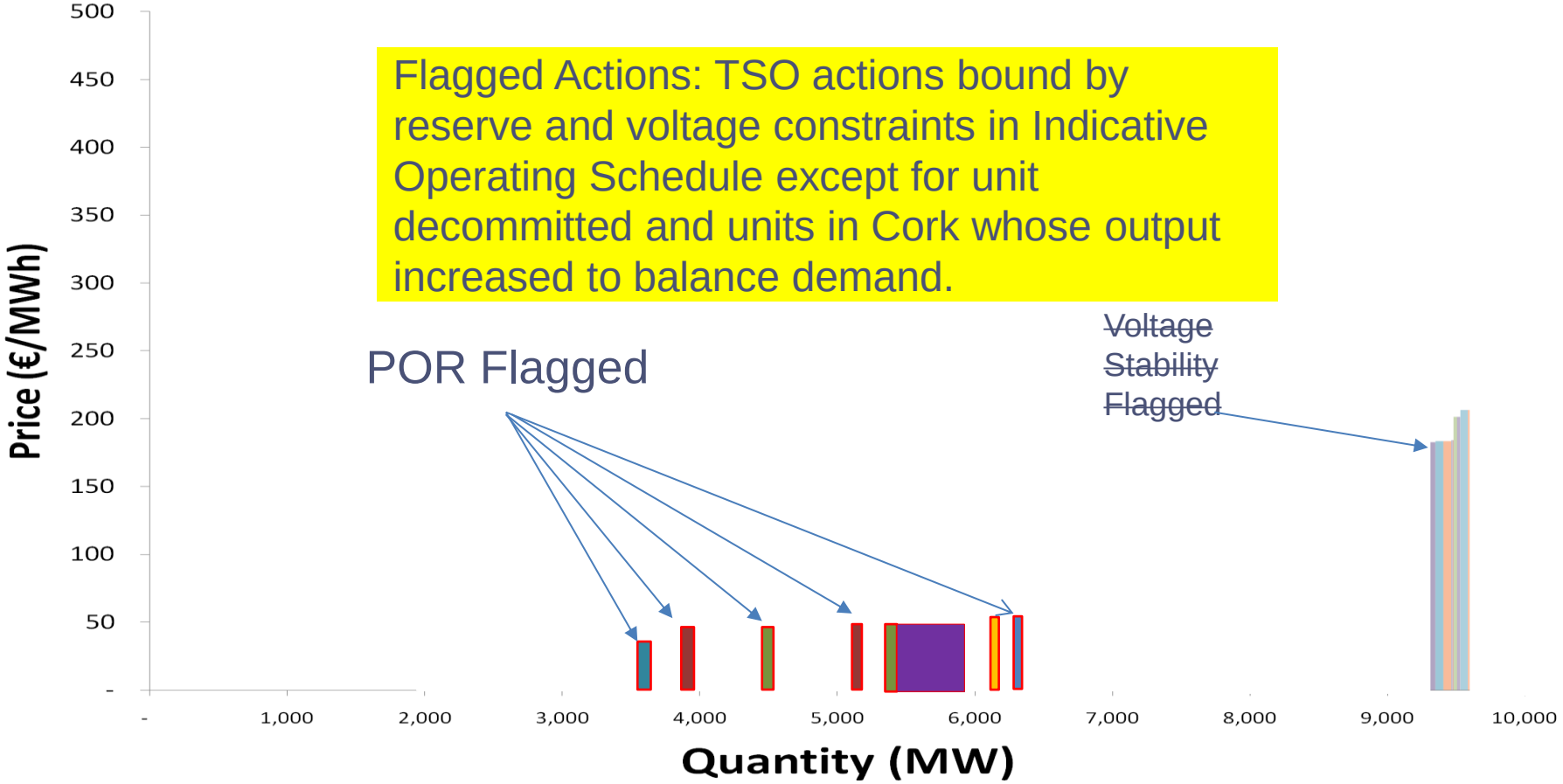
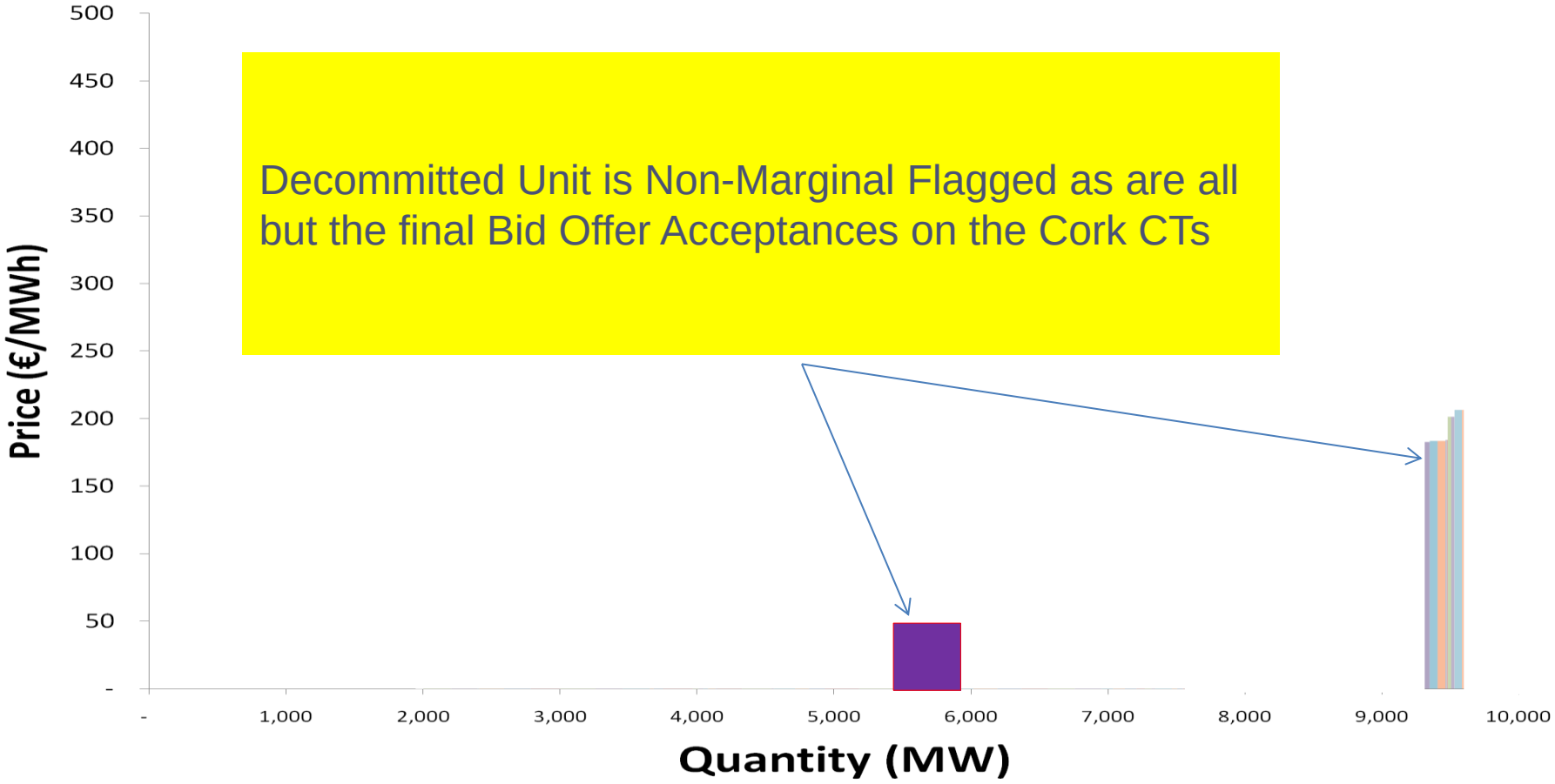


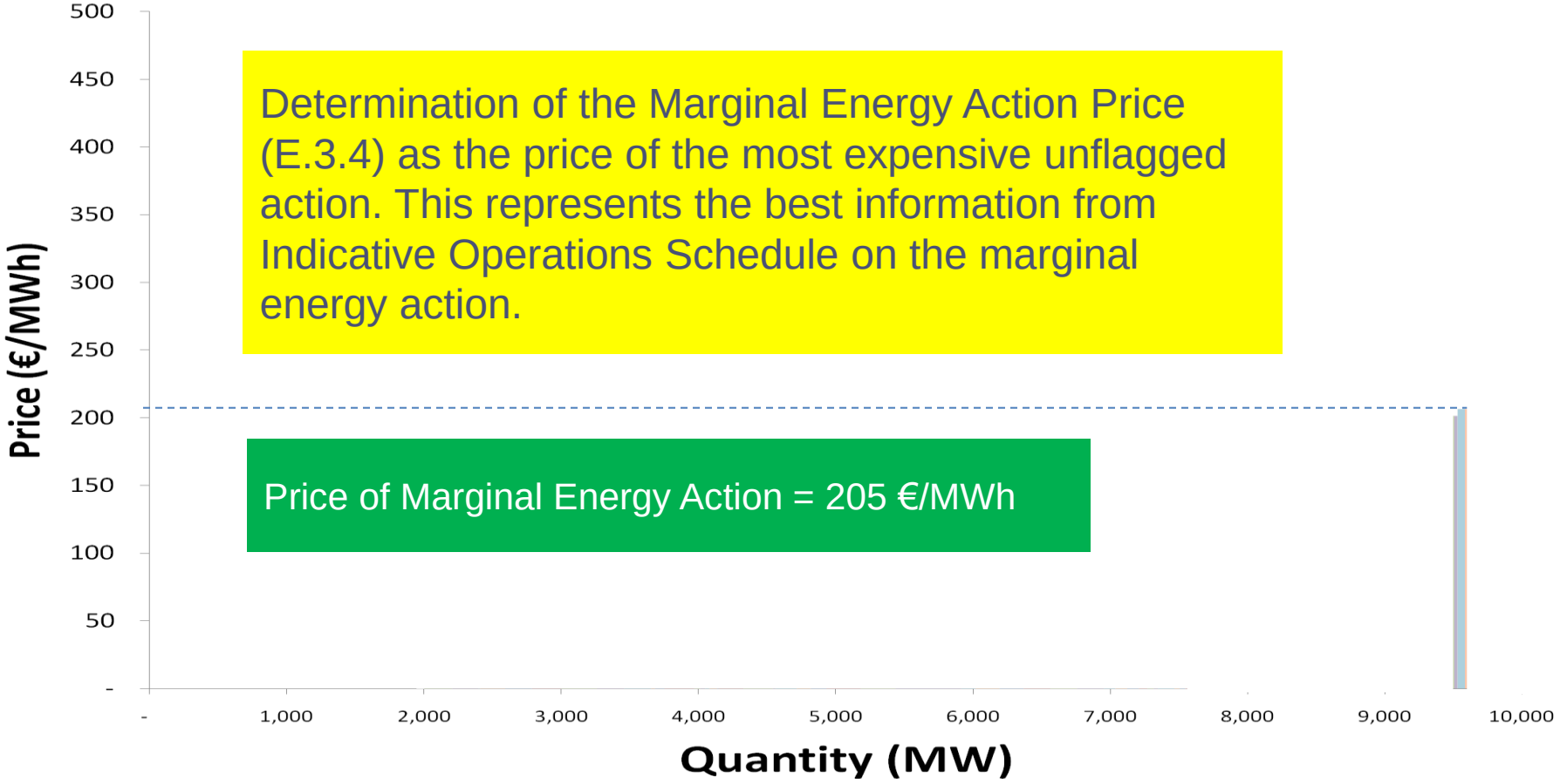
Day in the Life 2a: 17:25



Day in the Life 2a: 17:25



Day in the Life 2a: 17:25



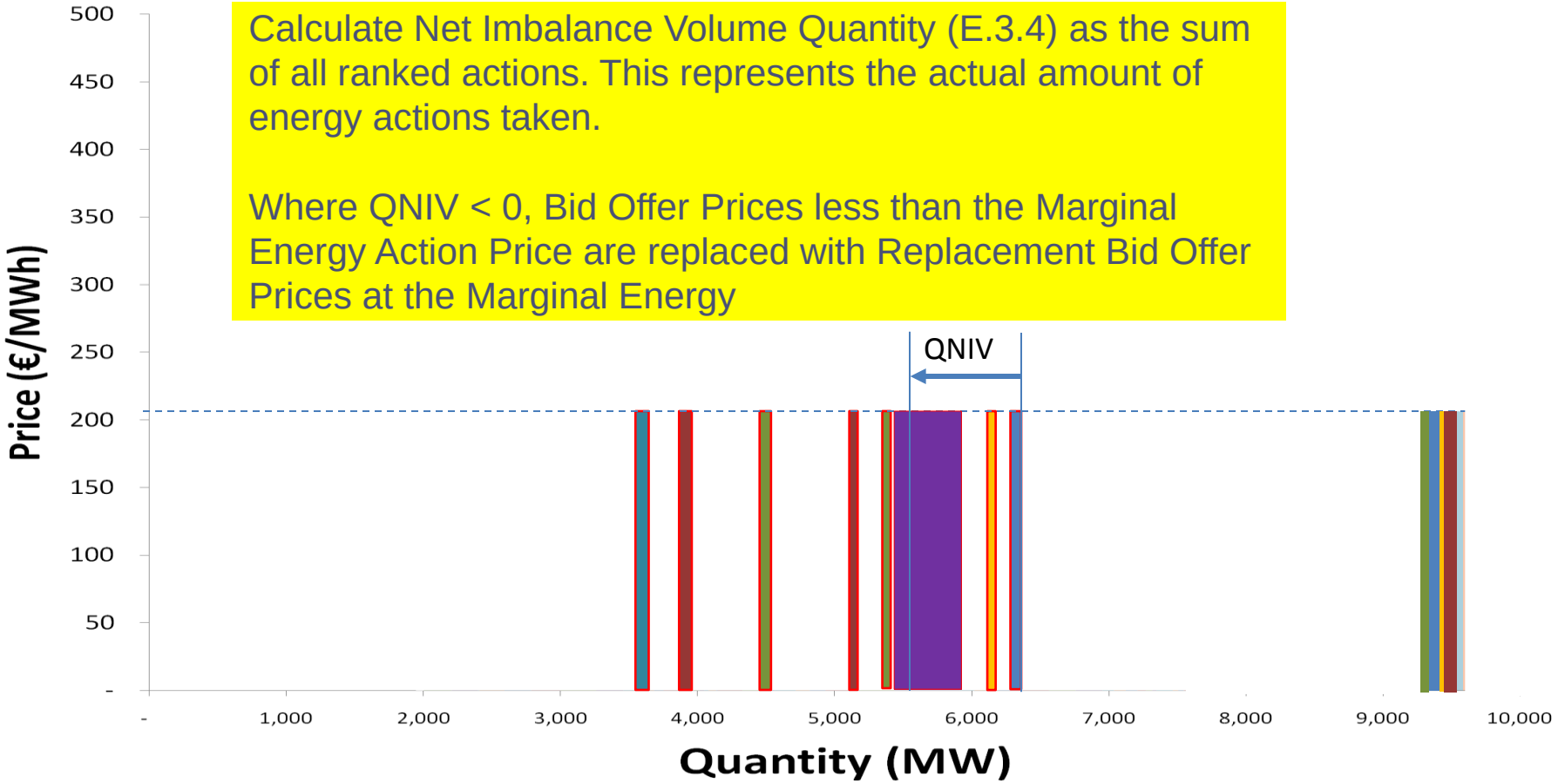
Determination of the Marginal Energy Action Price (E.3.4) as the price of the most expensive unflagged action. This represents the best information from Indicative Operations Schedule on the marginal energy action.

Price of Marginal Energy Action = 205 €/MWh

Day in the Life 2a: 17:25

Calculate Net Imbalance Volume Quantity (E.3.4) as the sum of all ranked actions. This represents the actual amount of energy actions taken.

Where QNIV < 0, Bid Offer Prices less than the Marginal Energy Action Price are replaced with Replacement Bid Offer Prices at the Marginal Energy



Day in the Life 2a: 17:25

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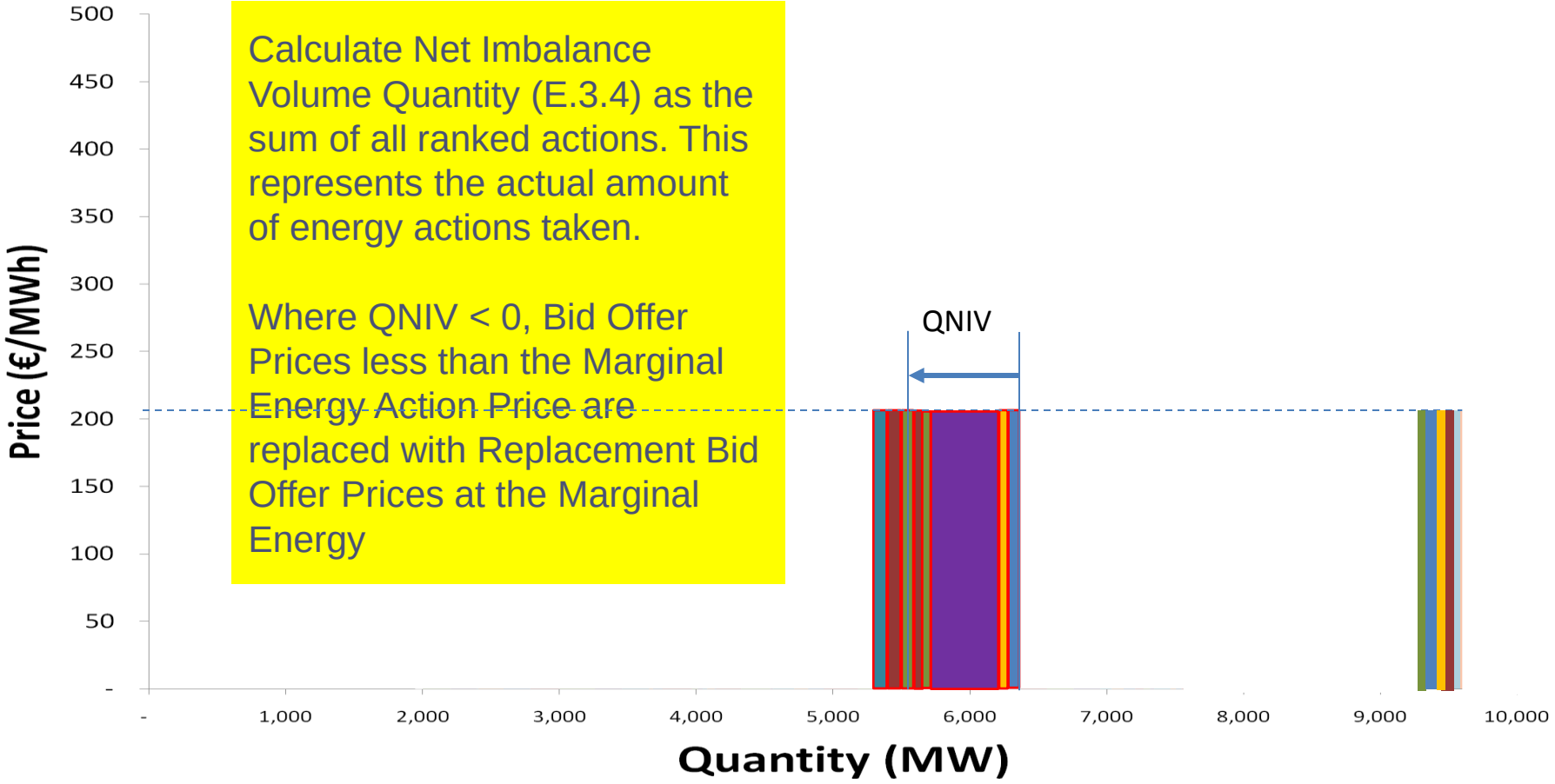

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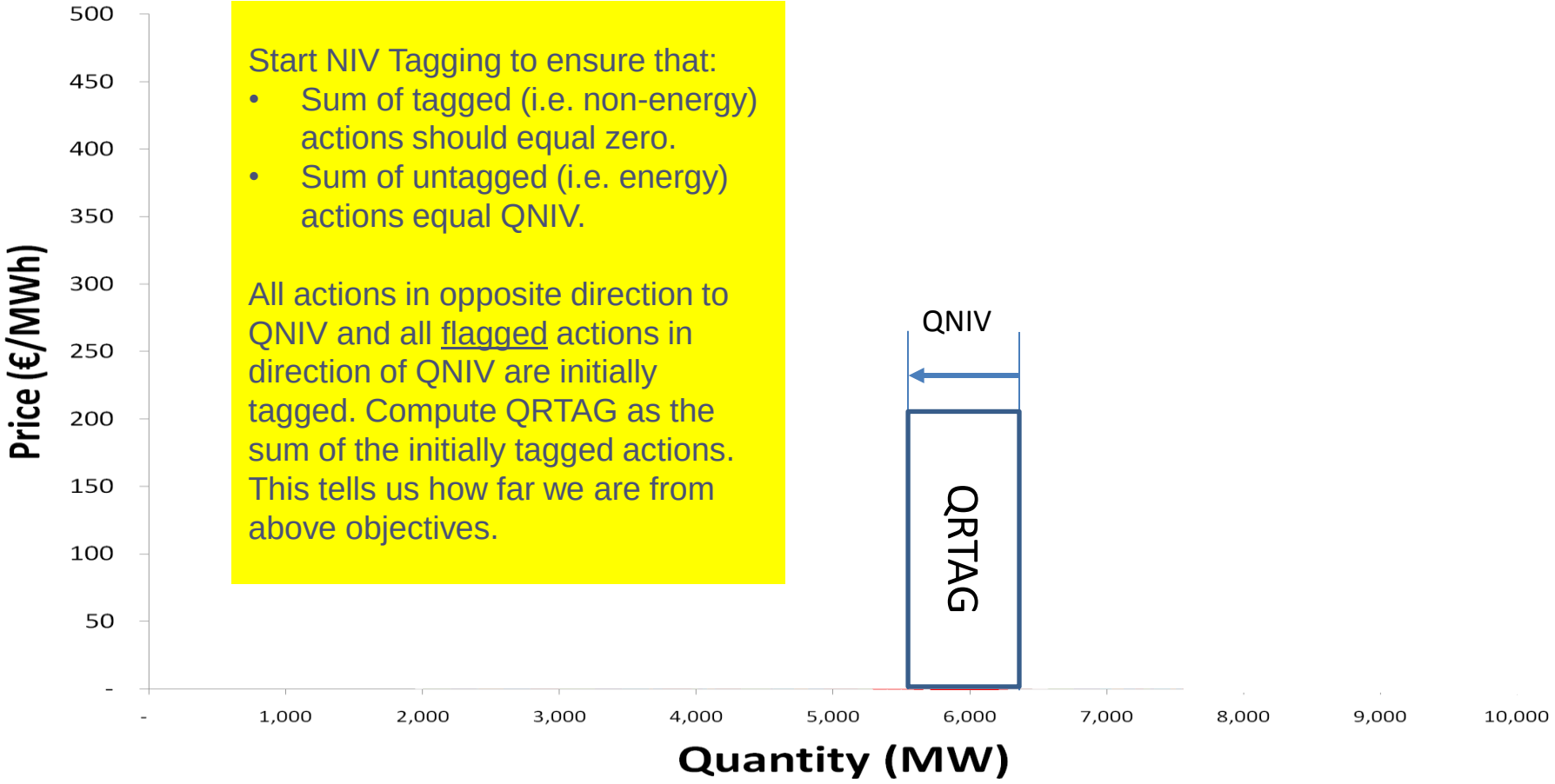
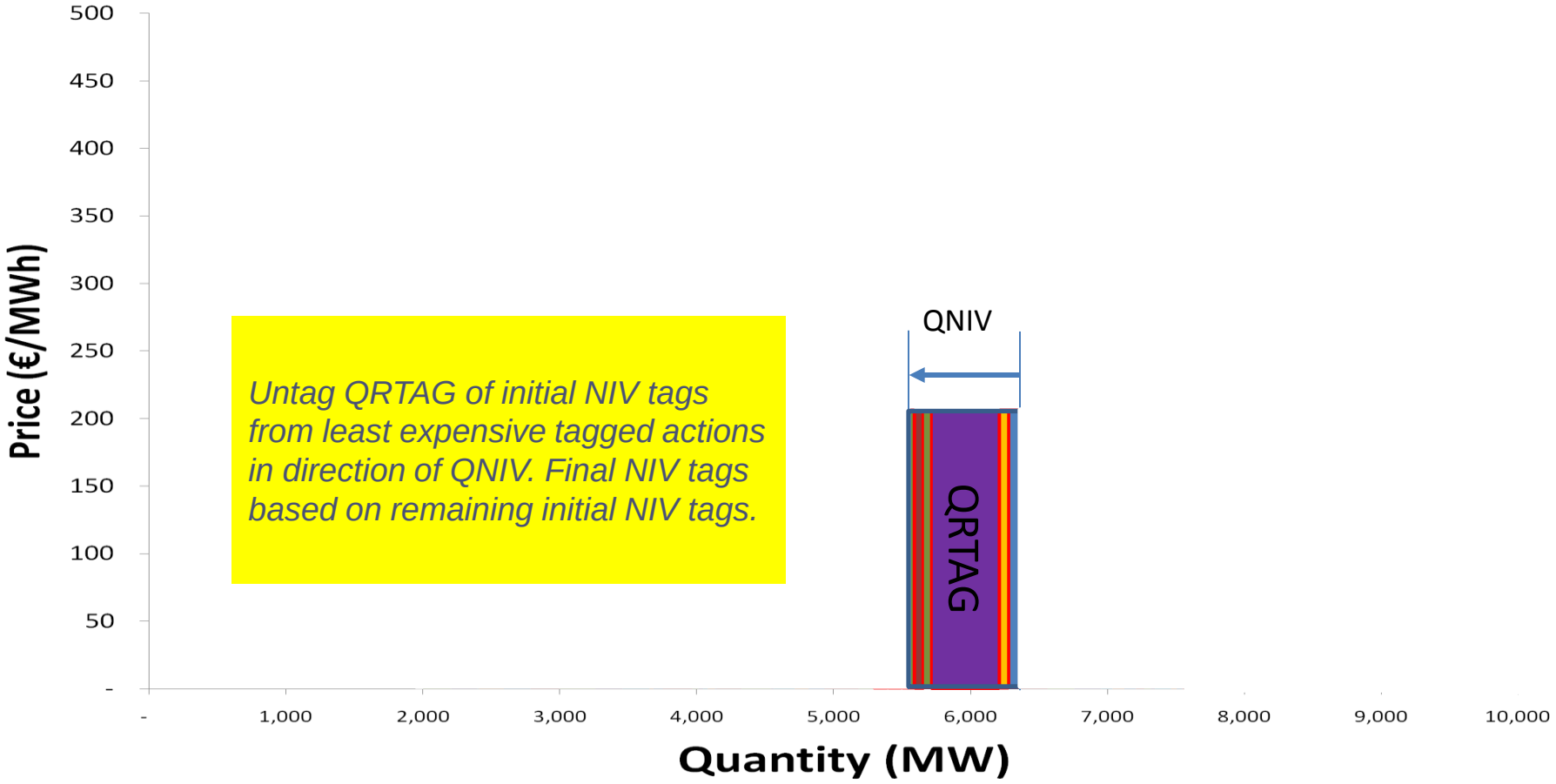
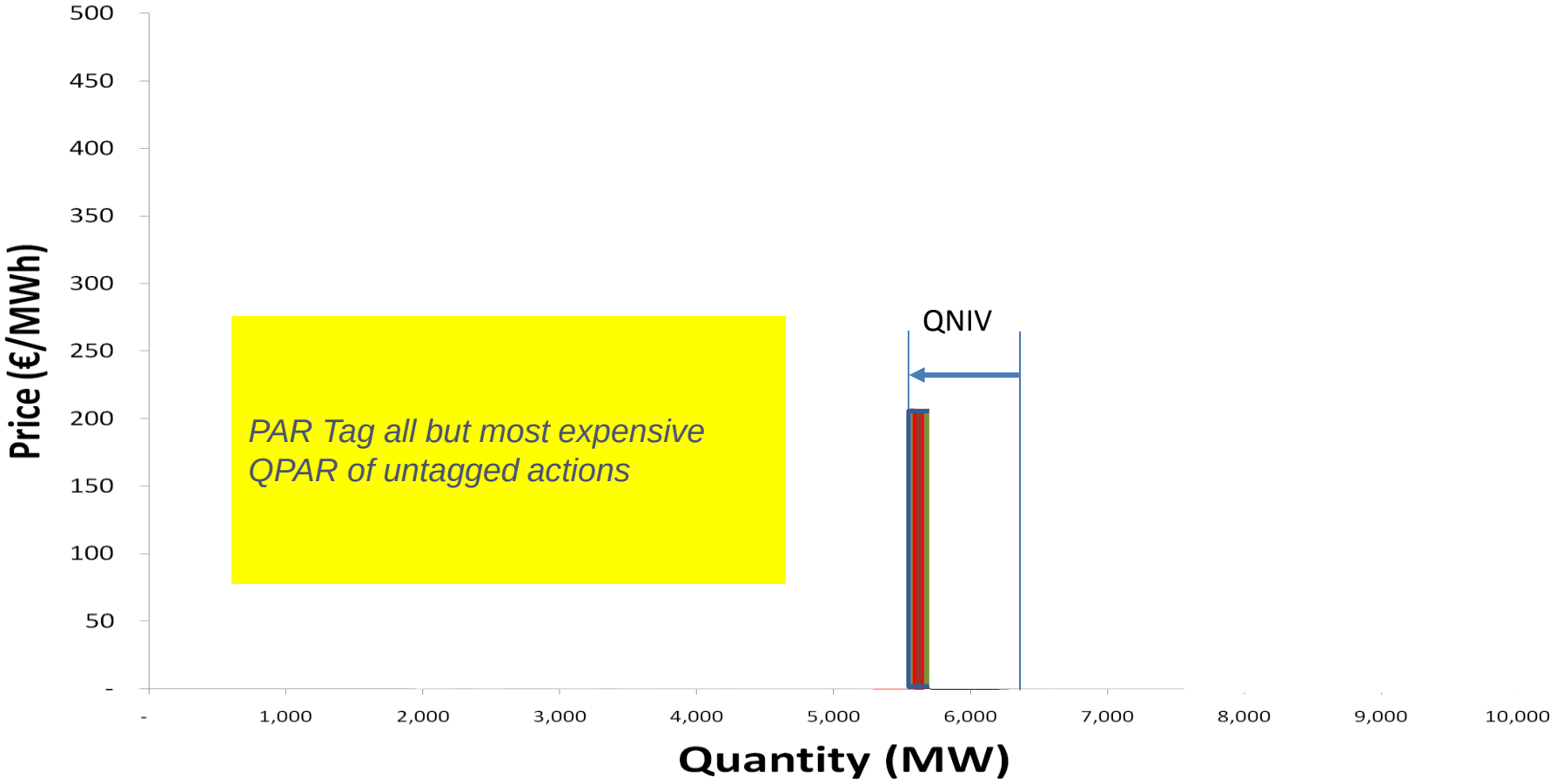


Day in the Life 2a: 17:25



Day in the Life 2a: 17:25



Day in the Life 2a: 17:25