Battery Mod Session 2

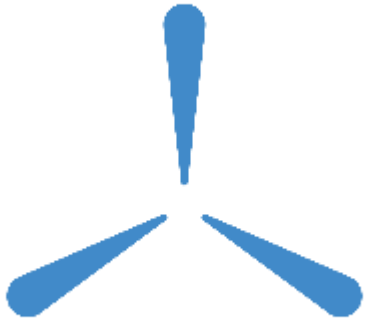
15/11/2023

EirGrid SONI semo Single Electricity Market Operator

Questions from Participants

Does this proposal apply only to batteries with firm access, or does it also apply to batteries with non-firm access?

- The same approach will be applied to firm and non-firm units.
- Non-firm quantities will be excluded from CDISCOUNT payments as they are for other generators today, and therefore settled at the imbalance price only.



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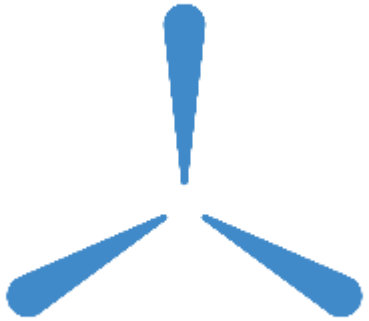
Questions from Participants

Further explanation of flagging and tagging, pricing and settlement for battery units under this proposal.

- The intention is for Battery Storage Units to be included in flagging, tagging and pricing processes similarly to other generators.
- In settlement, only Complex prices will be used, not Simple prices.



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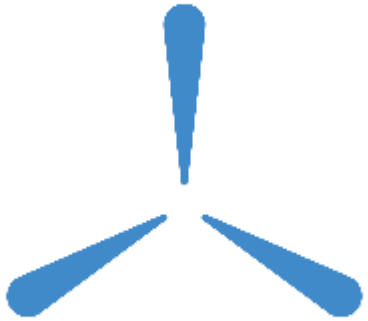
Questions from Participants

Can you provide more certainty about whether a unit will actually run to PNs?

- Units will be dispatched to PNs so far as is reasonably practicable while respecting system security.
- On rare occasions, e.g. frequency events or system alerts the control centre may need to dispatch these units away from PNs.



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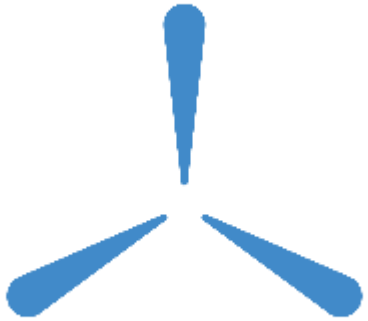
Questions from Participants

The policy statement suggests units could only be dispatched in the BM after the last PN of the day has passed - What's the rationale for this? Why can units not be considered for economic merit-order dispatch for any periods where there is a zero FPN, i.e. even between scheduled FPNs?

- This approach is to allow participants to indicate which treatment they would prefer while accounting for the energy limited nature of the technology.
- The running of battery units cannot be optimised by market systems.
- In response to this and feedback from participants the "follow PN" approach has been developed to allow participants to manage their state of charge.
- If these units are frequently run away from PNs their subsequent PNs may become infeasible creating an imbalance, an issue raised by participants.
- If PNs are zero for the remainder of the day then there are no subsequent PNs to reach, meaning that there is no risk of an imbalance, allowing the control centre to dispatch them economically.



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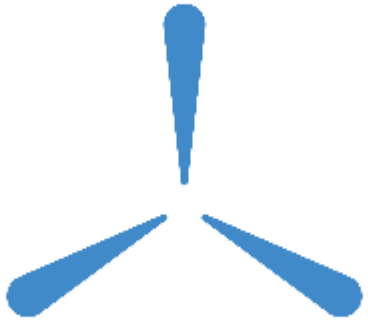
Questions from Participants

In terms of Dispatch away from PNs, does the future infeasible PN need to already be in the market systems for it to be considered infeasible and subject to a DEC/INC action?

- The control centre will use real time EMS data and latest submitted and accepted PNs to make dispatch decisions.
- Settlement will be based on FPNs, last submitted PNs before gate closure.



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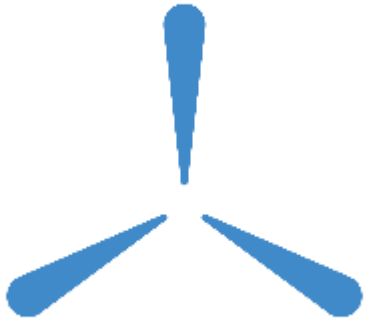
Questions from Participants

How will PNs that have become infeasible due to TSO actions be distinguished from just a 'wrong' PN that has been entered by the Participant that is infeasible (or would this also be subject to a DEC/INC action)?

- Participants are required to submit feasible PNs.
- T&SC D.7.1.3:

  Physical Notification Data shall be equal to the Output intended by the Participant for each of its Generator Units, excluding Accepted Offers and Accepted Bids during each Imbalance Settlement Period, γ.
- T&SC D.7.1.4:

  Participants shall ensure that all Physical Notification Data submitted in respect of a Generator Unit are consistent with the Technical Offer Data for that Generator Unit.
- Technical Offer Data includes registered minimum and maximum storage quantity.



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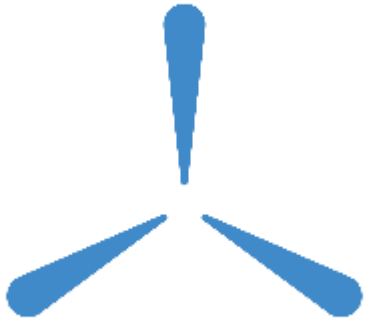
Questions from Participants

Availability declared via EDIL is not currently adjusted for changes in storage capacity/SoC in any case today. i.e. it is currently used to reflect instantaneous MW availability for export, so is already independent of MWh storage level, and therefore only changed in response to trips/MW outages. Is there a proposed change to how availability is expected to be adjusted in any other (non-TSO) situations relating to changes in MWh energy?

- No proposed change.



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Questions from Participants

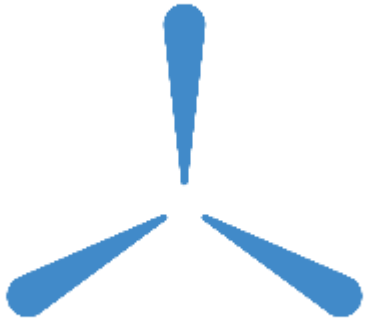
Assuming EDIL declared AAP is used for 'Outturn Availability', where will 'Minimum Output Quantity' be derived from, and will this need to be declared via EDIL also?

- Minimum Output declarations already exists in EDIL as the 'MNMW' signal.
- It will be possible to enter negative values for this field following SDP implementation.

Questions from Participants

The chart on slide 12 suggests the TSO will be estimating future SoC and using this as the basis of whether to follow PN - What if this view differs from the participants own view of what is feasible, will there be a process to challenge this? E.g. efficiency assumptions etc.

- Participant submitted efficiency values will be built into the model.
- The model will use real time data for current output and state of charge.
- The model will use the latest accepted participant submitted values for PNs and operational and registration limits.



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Registration as Part of a Trading Site

- Battery Storage Units will be required to register as part of a Trading Site like other generator units.

- Previously Battery Storage Units were required not to register as part of a Trading Site to match the treatment of Pumped Storage Units.

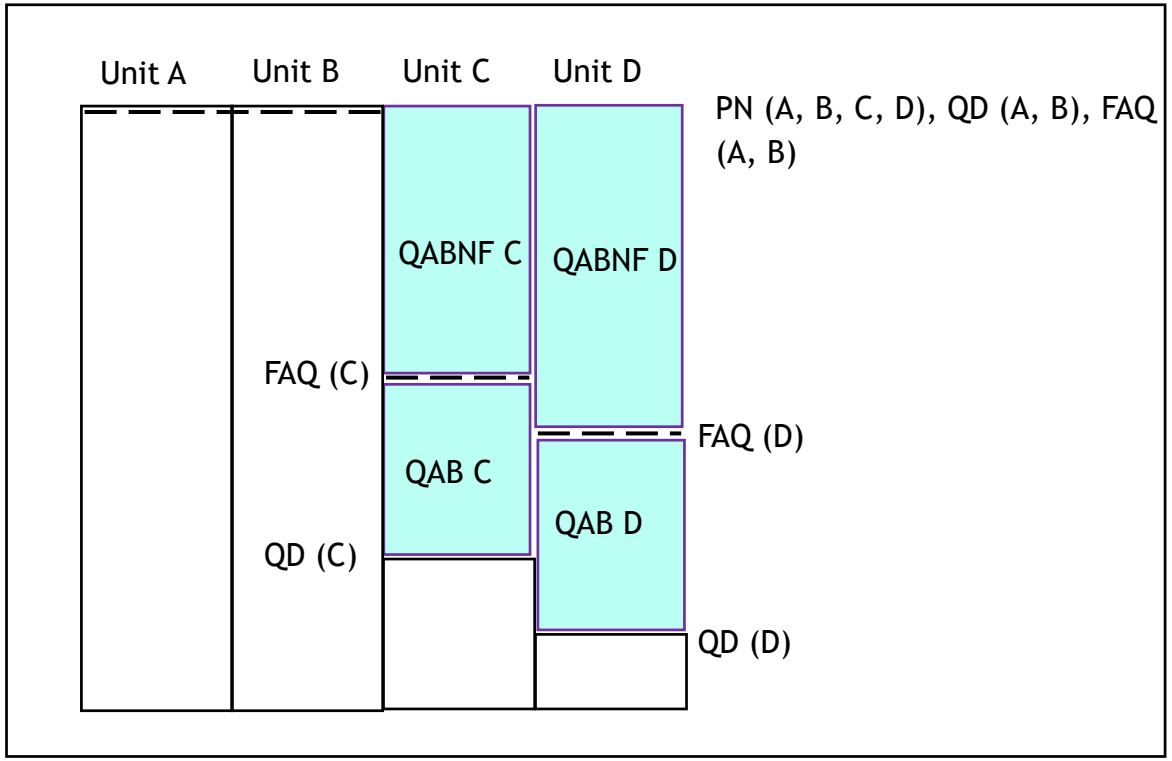
- Non-firm quantities are calculated on a Trading Site basis, so without being part of a Trading Site non-firm quantities will not be applied to Battery Storage Units.

Non-Firm Quantities

- Firm Access is a Trading Site concept, therefore there needs to be functionality to assign the Firm Access Quantity to the units under the Trading Site to allow for unit-level non-firm quantities to be calculated:

FAQ is divided in a way which is inversely proportional to the Accepted Bid Quantity on each unit:

- If unit dispatched to PN, fully firm;
- If unit dispatched below PN, non-firm;
- The greater the dec volume, the lower the firmness.



Example for a Battery Storage Unit registered as the only unit on a Trading Site with an Associated Supplier Unit

F.6.5.2 QFPNNF (Non-Firm Final Physical Notification Quantity for Trading Site)

$$QFPNNF_{s\gamma} = Max\left(\sum_{u \in s} QFPN_{u\gamma} + \sum_{v \in s} QM_{v\gamma} - \left(qFAQ_{s\gamma} \times DISP\right), 0\right)$$

>= 0 or < 0

= 0 as there is no Trading Site Supplier Unit (ASU instead)

Trading Site FAQ will be >= 0 as per Connection Agreement

- **If FPN >= 0:**
  Trading Site Non-Firm FPN Quantity QFPNNF = Max(positive - positive, 0) = between 0 and FPN
  (non-firm FPN quantity can be any value between zero and positive FPN quantity)

- **If FPN < 0:**
  Trading Site Non-Firm FPN Quantity QFPNNF = Max(negative - positive, 0) = 0
  (no portion of FPN quantity is non-firm)

Example for a Battery Storage Unit registered as the only unit on a Trading Site with an Associated Supplier Unit

F.6.5.2

$$If \sum_{u \in s} \sum_{o} \sum_{i} QAB_{uoiy} < 0, then$$

$$qFAQ_{uy}(t) = \frac{Max\left(QFPN_{uy} - QFPNNF_{sy}\left(\frac{\sum_o \sum_i QAB_{uoiy}}{\sum_{u \in s} \sum_o \sum_i QAB_{uoiy}}\right), 0\right)}{DISP}$$

$$Else$$

$$qFAQ_{uy}(t) = \frac{QFPN_{uy}}{DISP}$$

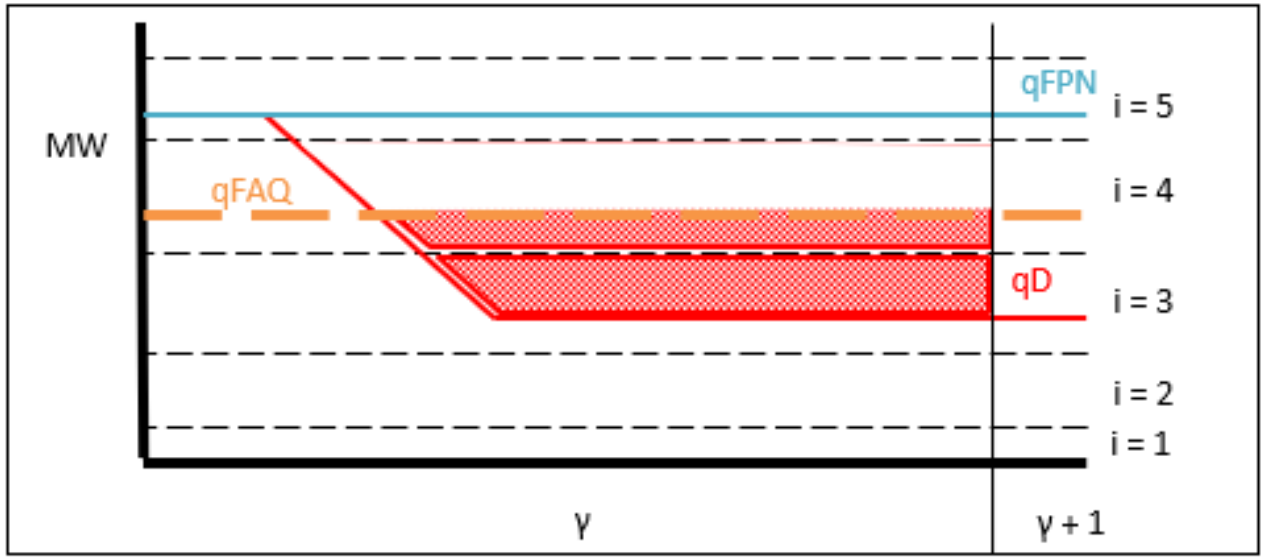
- When no dec actions are taken, Unit Firm Access Quantity qFAQ always = FPN
- When dec actions (QAB<0) are taken on the single unit Trading Site:

If FPN >= 0:
Unit Firm Access Quantity qFAQ = FPN - non-firm portion of FPN = Trading Site FAQ

If FPN < 0:
Unit Firm Access Quantity qFAQ = Max(negative - positive, 0) = 0

Example for a Battery Storage Unit registered as the only unit on a Trading Site with an Associated Supplier Unit

The Non-Firm Accepted Bid Quantity QABNF for a unit used in the calculation of CDISCOUNT payments represents the reduction in electricity output that has been accepted for levels of output above the Firm Access Quantity of the unit.



As shown above for a Battery Storage Unit on a single unit Trading Site with an Associated Supplier Unit subject to decremental actions:

- If FPN >= 0 then qFAQ = Trading Site FAQ which will be >= 0 as per Connection Agreement
- If FPN < 0 then qFAQ = 0

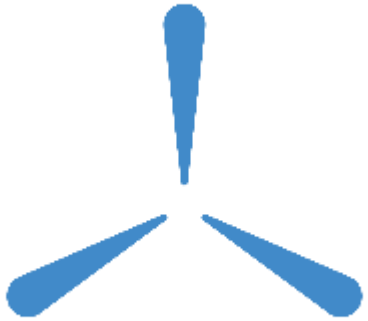
Therefore, quantities below zero will not be settled as non-firm.

Commercial Offer Data

- *Additional fields for battery storage units:*
  - Operational Minimum Storage Quantity (MWh)
  - Operational Maximum Storage Quantity (MWh)

These fields will allow a warning to be provided to the control centre if Physical Notifications submitted by a participant for a battery unit cause the unit's storage level to fall outside of these operational limits.

- *Forecast Minimum Stable Generation:*
  - To be mandated to be submitted as zero for all imbalance settlement periods.
  - This will allow unit to be synchronised to import or export.



Technical Offer Data

- *Updated field names:*
  - Storage Cycle Efficiency (for both Pumped Storage and Battery Storage)
  - Minimum Storage Quantity (for both Pumped Storage and Battery Storage)
  - Maximum Storage Quantity (for both Pumped Storage and Battery Storage)

- *Field to be removed:*
  - Battery Storage Capacity (exists to allow units to be profiled to storage capacity when a GOOP PUMP instruction is received, these units will not receive these instructions and so will not need this field, will instead be profiled to Target Instruction Level)

Charging Mode

- Definition of Battery Storage Unit in charging mode is proposed to be removed:

F.2.1.4 The Market Operator shall determine whether a Battery Storage Generator Unit, u, is in Charging Mode for the purposes of the calculations in this Code as follows:

(a) If the value of a Battery Storage Unit's Dispatch Quantity ($qD_{uo\gamma}(t)$) at all times within an Imbalance Settlement Period, γ, is positive (i.e. in the generating range of the Unit's output), then the Unit is deemed to be in Generating Mode for the entirety of that Imbalance Settlement Period; and

(b) If the value of a Battery Storage Unit's Dispatch Quantity ($qD_{uo\gamma}(t)$) at any time within an Imbalance Settlement Period, γ, is negative (i.e. in the charging range of the Unit's output), then the Unit is deemed to be in Charging Mode for the entirety of that Imbalance Settlement Period.

- The current text is based on legacy arrangements which recognised that Pumped Storage Units cannot control the exact level to which they consume power when dispatched to pump.
- Battery Storage Units are currently aligned with pumped storage units in the Trading and Settlement Code.
- However, unlike Pumped Storage Units, Battery Storage Units can control the level to which they consume power and can run to specific negative MW Target Instruction Levels when dispatched to charge, and so do not need different treatment while importing and exporting.

Imbalance Charge

- We propose that Battery Storage Units be removed from the clause below so that the Imbalance Charge is applied the same while charging as discharging.

F.5.3.3 The Market Operator shall calculate the Imbalance Component Payment or Charge ($CIMB_{u\gamma}$) for each Pumped Storage Unit or Battery Storage Unit, u, in each Imbalance Settlement Period, γ, for which it is in Pumping Mode (as determined in paragraph F.2.1.3) or in Charging Mode (as determined in paragraph F.2.1.4), as the case may be, as follows:

$$CIMB_{u\gamma} = PIMB_{\gamma} \times \left(\sum_{o} \sum_{i} \left(QAOLF_{uoi\gamma} - Max\left(QAOBIAS_{uoi\gamma}, QAOUNDEL_{uoi\gamma} \right) \right) + \sum_{o} \sum_{i} \left(QABLF_{uoi\gamma} - Min\left(QABBIAS_{uoi\gamma}, QABUNDEL_{uoi\gamma} \right) \right) \right)$$

- As described above this exception was put in place to account for the technical limitations of Pumped Storage Units, which do not apply to Battery Storage Units.
- This change is required in order to comply with regulatory requirements for Balance Responsible Parties under the EU's Clean Energy Package (CEP), Energy Balancing Guidelines (EBGL), and Imbalance Settlement Harmonisation Proposal methodology (ISHP).
- The need for this change was identified in SEM-21-017: EirGrid and SONI Analysis of SEM Compliance with Commission Regulation (EU) 2017/2195 of 23 November 2017 Establishing a Guideline on Electricity Balancing.

Uninstructed Imbalance

F.9.4.2 When a Pumped Storage Unit or Battery Storage, u, is in Pumping Mode or Charging Mode, as the case may be, for an Imbalance Settlement Period, γ, or any part thereof, the Market Operator shall calculate the Uninstructed Imbalance Charge ($CUNIMB_{u\gamma}$) for that Pumped Storage Unit or Battery Storage Unit, u, in that Imbalance Settlement Period, γ, as having a value of zero.

- We propose that Battery Storage Units be removed from the clause above so that the Uninstructed Imbalance Charge is applied while charging as it is while discharging.
- Unlike Pumped Storage Units, Battery Storage Units can control the level to which they consume power when dispatched to charge, and so do not need different treatment while importing and exporting.

Pre-Agreed Charging ("Trickle Charge")

- Due to the inability to send negative Dispatch Instructions within EDIL, it has not been possible for Control Centre Engineer to charge a battery unit to date. As a result, a "Pre-Agreed Charging" approach was agreed by the TSOs to allow battery operators to charge themselves without the need for a dispatch instruction from the TSOs.
- The Scheduling and Dispatch Programme will allow negative Dispatch Instructions to be sent via EDIL, and so pre-agreed charging is no longer required.
- Participants will also have the ability to obtain a position to charge in ex-ante markets, or price themselves to do so in the balancing market.
- Under the SEM's central dispatch arrangements, the TSOs schedule and dispatch all units (SEM-12-105b).
- With an increasing volume of Battery Storage Units connecting to the grid, allowing these units to self-dispatch to charge could cause risks to system security.
- EirGrid's recently approved Grid Code modification MPID304: Incorporation of Battery ESPS Grid Code Implementation Note included the following:

  "Pre-Agreed Charging was not deemed appropriate for inclusion in this modification. Pre-Agreed Charging is a temporary operational measure that was included in V3 to give guidance to industry, not necessarily to advise on Grid Code alterations."

Minimum Output in the Calculation of Accepted Bid Offer Quantities for Incs

- At present Outturn Availability is included in the algebra for calculating Accepted Bid Offer Quantities for decs to ensure that any decrease in output from PNs due to reduced availability is seen as an imbalance, rather than an Accepted Bid:

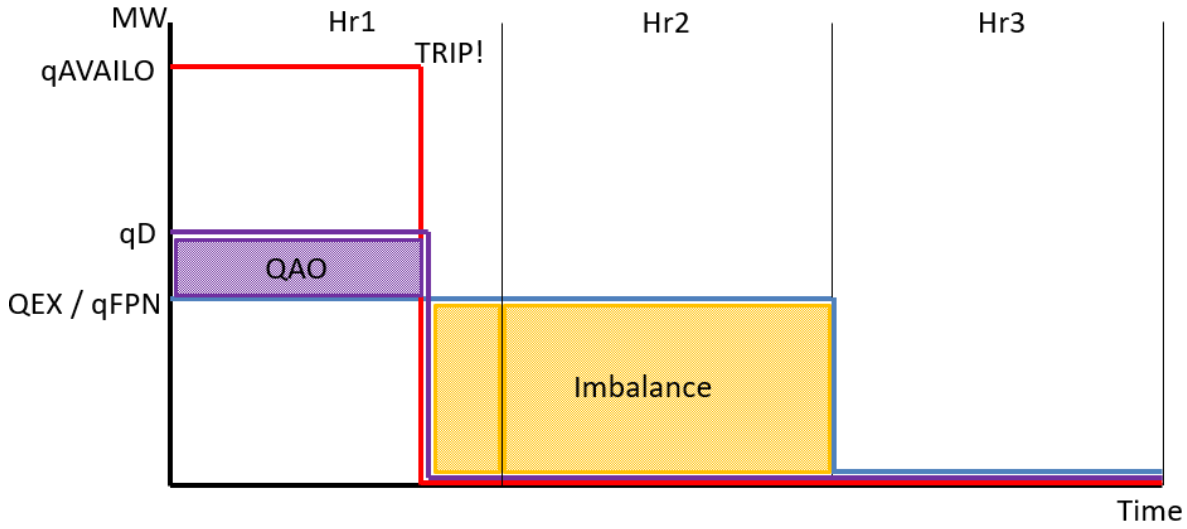
F.6.2.4

$$qDA_{uoh}(t) = Min\left(qD_{uoh}(t), qDA_{u(o-1)h}(t)\right)$$

$$qDA_{u(o-1)h}(t) = Min\left(qD_{u(o-1)h}(t), qAVAILO_{uh}(t)\right)$$

$$qD_{u(o=0)h}(t) = qFPN_{uh}(t)$$

$$qBOUR_{u(i=0)h}(t) = 0$$
$$qBOLR_{u(i=0)h}(t) = 0$$



Minimum Output in the Calculation of Accepted Bid Offer Quantities for Incs

- Minimum Output under the Trading and Settlement Code is the minimum level of output at which a Generator Unit may operate.
  - For units other than Pumped Storage and Battery Storage Units Minimum Output is always zero.
  - For Pumped Storage and Battery Storage Units Minimum Output is their availability to import.

To mirror the inclusion of Outturn Availability in the algebra for calculating Accepted Bid Offer Quantities for decs, and to ensure that any increase in output from PNs due to reduced minimum output (i.e. incs from PNs that the unit did not have sufficient storage capacity to reach) is seen as an imbalance rather than an Accepted Bid, we propose that Outturn Minimum Output is included in the algebra for calculating Accepted Bid Offer Quantities for incs as shown below:

- F.6.2.3

$$qDA_{uoh}(t) = Max\left(qD_{uoh}(t), qDA_{u(o-1)h}(t)\right)$$

$$qDA_{u(o-1)h}(t) = Max(qD_{u(o-1)h}(t), qMINOUT_{uh}(t))$$

$$qD_{u(o=0)h}(t) = qFPN_{uh}(t)$$

$$qBOUR_{u(i=0)h}(t) = 0$$

$$qBOLR_{u(i=0)h}(t) = 0$$

Minimum Output in the Calculation of Accepted Bid Offer Quantities for Incs

Trade Opposite TSO Accepted Bid Offer Quantities for Incs (F.6.4)

- Trade Opposite TSO is where a unit can increase the volume of a Bid or Offer accepted by the SOs after the time it has been accepted.
- For completeness the Outturn Minimum Output is proposed to be included in the same way in the calculation of Trade in the Opposite Direction to the TSO Quantities.
- Where Outturn Availability is included in the algebra for Without Trade Opposite TSO Accepted Bid Offer Quantity for Decs resulting from Bid Offer Acceptance (F.6.4.8), Outturn Minimum Output will be included in the algebra for Without Trade Opposite TSO Accepted Bid Offer Quantity for Incs resulting from Bid Offer Acceptance (F.6.4.7).
- This functionality is not currently switched on for any unit in the market.

Accepted Offers Below Physical Notification and Accepted Bids Above Physical Notification Quantities (F.7)

- Similarly, Outturn Minimum Output is proposed to be included in the same way in the calculation of Accepted Offers Below Physical Notification and Accepted Bids Above Physical Notification Quantities.
- Where Outturn Availability is included in the algebra for Price Only Accepted Bid Offer Quantity for Decs resulting from Bid Offer Acceptance (F.7.1.4), Outturn Minimum Output will be included in the algebra for Price Only Accepted Bid Offer Quantity for Incs resulting from Bid Offer Acceptance (F.7.1.3).

Testing Charge

Testing Charge for Generator Units other than Interconnector Error Units (F.13.2.1):

$$CTEST_{u\gamma} = -Max\left(QMLF_{u\gamma}, 0\right) \times PTESTTARIFF_{u\gamma}$$

Testing Charge for Interconnector Error Units (F.13.2.2):

$$If\ QMLF_{u\gamma} > 0\ then$$

$$CTEST_{u\gamma} = -Max\left(QMLF_{u\gamma}, 0\right) \times PTESTTARIFF_{u\gamma}$$

$$else$$

$$CTEST_{u\gamma} = QMLF_{u\gamma} \times PTESTTARIFF_{u\gamma}$$

We propose that Battery Storage Units also be included under F.13.2.2 so that negative meter quantities can be handled appropriately, and the Testing Charge can be incurred for testing while importing and exporting.

Application of Loss Adjustment Factors

Application of Loss Adjustment Factors for most Generator Units (F.4.3.2):

$$XXXLF_{\gamma} = XXX_{\gamma} \times FCLAF_{\gamma}$$

Application of Loss Adjustment Factors for Interconnectors, Interconnector Error Units, Interconnector Residual Capacity Units, Capacity Market Unit related to an Interconnector (F.4.3.3):

$$If\ XXX \geq 0\ then$$

$$XXXLF_{u\gamma} = XXX_{u\gamma} \times FCLAF_{l\gamma}$$

$$else$$

$$XXXLF_{u\gamma} = \frac{XXX_{u\gamma}}{FCLAF_{l\gamma}}$$

Application of Loss Adjustment Factors

Application of Loss Adjustment Factors to QABLF and QAOLF for Interconnectors, Interconnector Error Units, Interconnector Residual Capacity Units, Capacity Market Unit related to an Interconnector (F.4.3.4):

$$If\ QD_{u\gamma}\ \geq 0\ then$$

$$QAOLF_{u\gamma} = QAO_{u\gamma}\ \times FCLAF_{l\gamma}$$

$$QABLF_{u\gamma} = QAB_{u\gamma}\ \times FCLAF_{l\gamma}$$

$$else$$

$$QAOLF_{u\gamma} = \frac{QAO_{u\gamma}}{FCLAF_{l\gamma}}$$

$$QABLF_{u\gamma} = \frac{QAB_{u\gamma}}{FCLAF_{l\gamma}}$$

Application of Loss Adjustment Factors to qCLF for Capacity Market Unit related to an Interconnector (F.4.3.5):

$$\mathrm{qCLF}_{u\gamma} = \mathrm{qC}_{u\gamma}\ \times FCLAF_{l\gamma}$$

Application of Loss Adjustment Factors

We propose:

- excluding Battery Storage Units from F.4.3.2

and including Battery Storage Units in

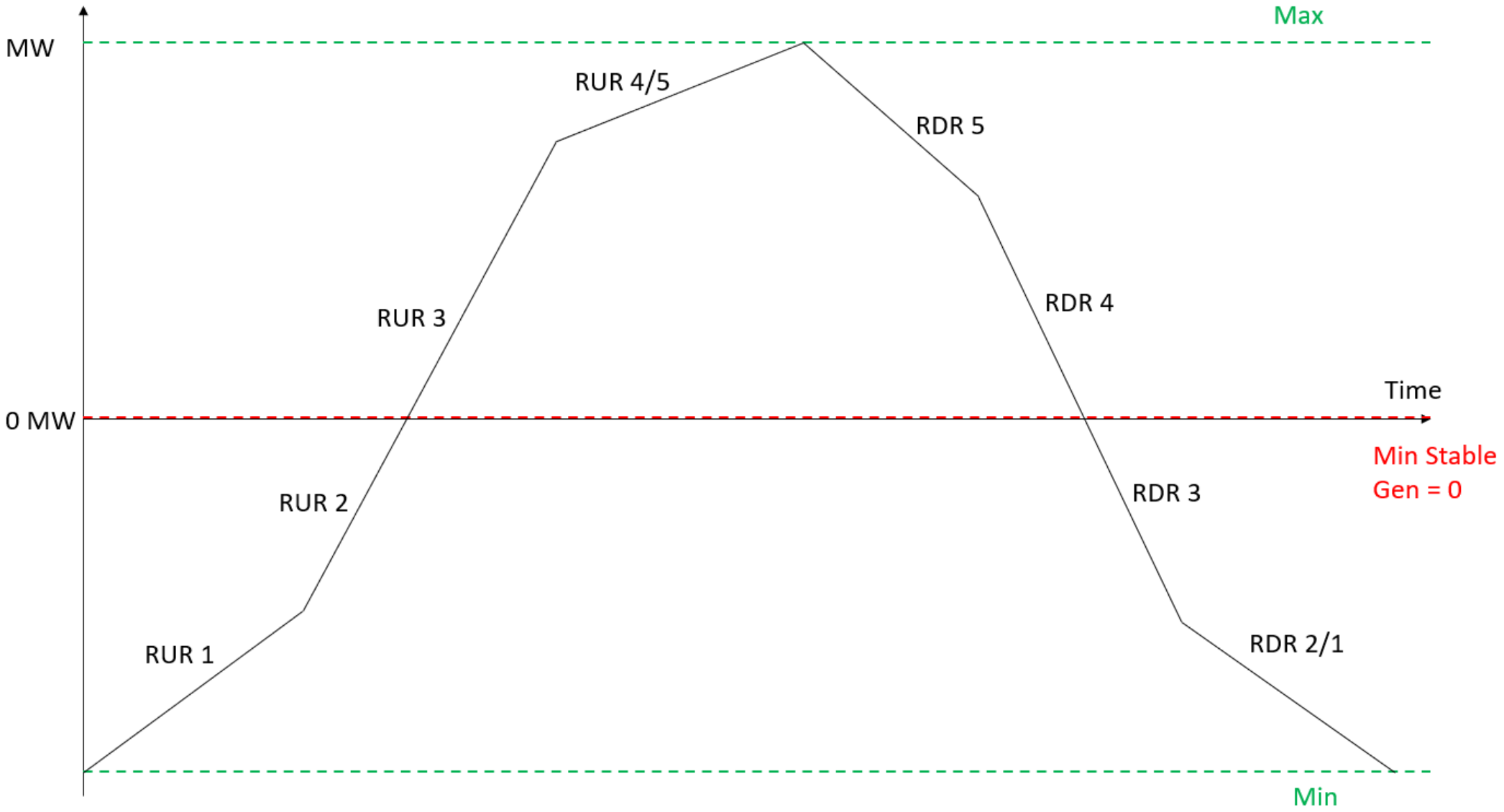
- F.4.3.3,
- F.4.3.4 and
- F.4.3.5

so that loss adjustment factors are applied similarly to Battery Storage Units as they are for Interconnector Units, taking into consideration import as well as export.

Instruction Profiling

- Battery Storage Units will be dispatched using MWOF Dispatch Instructions rather than GOOP instructions as GOOP instructions are more aligned to the technical characteristics of Pumped Storage Units and are not well suited to Battery Storage Units.
- Minimum Stable Generation to be submitted as zero.
- SYNC instructions may be issued to charge or discharge.
- Ramp Rates will be used between Registered Minimum Output and zero as well as between Minimum Stable Generation and Maximum Generation.

Sample Technical Offer Data Profile



Dispatch (Follow PNs vs. Economic Dispatch)

Proposed Operational Policy:

- If a battery unit has non-zero PNs at any point in the remainder of the trading day, the control centre engineer will make reasonable endeavours to run the unit to those PNs (exceptions for frequency events, system alert, maximising priority dispatch).
- If a battery unit has PNs of zero for the remainder of the trading day the control centre engineer may dispatch the unit economically as per the merit order.

Trickle Charge:

- Will be available up to the 1MW tolerance included in the Uninstructed Imbalance Charge.

Settlement of Dispatch Away from PNs

- The TSO will **not** require these units to declare unavailable in EDIL when discharged or charged by the TSO away from PNs, i.e. EDIL availability will not be affected by state of charge.
- Settlement will be based on **EDIL availability**, meaning that dispatch to zero from PNs that have become infeasible due to TSO actions will be settled at the lower of COD price and imbalance price for decs and the higher of COD price and imbalance price for incs.
- Settlement for **all actions** on these units will be based on **Complex prices** so that when the TSO must dispatch a unit to zero from PNs that have become infeasible due to TSO actions, they are not forced to accept Simple prices.
- **Simple prices** can be submitted, will be used to form the merit order lists, and can set the imbalance price.
    - Participants can use these Simple prices as a signal to the market.
    - If the unit's simple price is the price of the marginal energy action, it will be included in price formation as per the current rules.

Application of Loss Factors

- We have reviewed the proposed changes based on comments from participants.
- We now agree that loss factors should be applied to battery units as they are for other generator units rather than interconnectors.
- We will remove this change from the mod proposal before resubmission for December Mods Committee.

Dispatchable Demand

- Scheduling and Dispatch Programme scope specifically concerns battery storage units.
- We will not be expanding the scope of this project to include dispatchable demand.
- Dispatchable demand is being considered for inclusion in future programmes of work within the TSOs.
- It may be possible for dispatchable demand to register as battery storage units as a workaround.
- We are progressing conversations internally to see whether this is possible.
- We will also reach out to participants to discuss this further.

Questions from Participants

- How is firm access applied on the dec action when unit is already in the charging mode and FAQ is zero? (application to F.6.5.2). Full mathematical example for i<0

i	Q	P
-5	-100	20
-4	-80	30
-3	-60	40
-2	-40	50
-1	-20	60
0	0	
1	100	70

FPN	-10
QD	-50
qAA	100
FAQ	0

Questions from Participants

- How is firm access applied on the dec action when unit is already in the charging mode and FAQ is zero? (application to F.6.5.2). Full mathematical example for i<0

$$qD_{u(o=0)\gamma}(t) = qFPN_{u\gamma}(t)$$

$qD_{u(o=0)\gamma}(t) = -50$

$$qDA_{u(o-1)\gamma}(t) = Min\left(qD_{u(o-1)\gamma}(t), qAVAILO_{u\gamma}(t)\right)$$

$qDA_{u(o=0)\gamma}(t) = Min(-50,100)$

$qDA_{u(o=0)\gamma}(t) = -50$

$$qDANF_{uo\gamma}(t) = Min\left(Max\left(qD_{uo\gamma}(t), qFAQ_{u\gamma}(t)\right), qDA_{u(o-1)\gamma}(t)\right)$$

$qDANF_{u(o=1)\gamma}(t) = Min(Max(-50,0),-50)$

$qDANF_{u(o=1)\gamma}(t) = -50$

$$qDA_{uo\gamma}(t) = qDANF_{uo\gamma}(t)$$

$qDA_{u(o=1)\gamma}(t) = -50$

Questions from Participants

- How is firm access applied on the dec action when unit is already in the charging mode and FAQ is zero? (application to F.6.5.2). Full mathematical example for i<0

$$qBOANF_{uoi\gamma}(t) = Min\{Max\{qDA_{uo\gamma}(t), qBOLR_{ui\gamma}(t)\}, qBOLR_{u(i+1)\gamma}(t)\} - Min\{Max\{qDA_{u(o-1)\gamma}(t), qBOLR_{ui\gamma}(t)\}, qBOLR_{u(i+1)\gamma}(t)\}$$

$$qBOUR_{u(i=0)\gamma}(t) = 0$$

$$qBOLR_{u(i=0)\gamma}(t) = 0$$

i=-1 $qBOANF_{u(o=1)(i=-1)\gamma}(t)$ = Min(Max(-50,-20),0) – Min(Max(-50,-20),0) = 0

i=-2 $qBOANF_{u(o=1)(i=-2)\gamma}(t)$ = Min(Max(-50,-40),-20) – Min(Max(-50,-40),-20) = 0

i=-3 $qBOANF_{u(o=1)(i=-3)\gamma}(t)$ = Min(Max(-50,-60),-40) – Min(Max(-50,-60),-40) = 0

Questions from Participants

- **What is the difference between Operational Maximum Storage Quantity required for COD and Maximum Storage Quantity (QMAXL) required for TOD?**
  - Maximum Storage Quantity (MWh) is a registration TOD field representing “the maximum quantity of Generation that can be produced by the Battery Storage Unit”, or the installed storage capacity of the unit.
  - Operational Maximum Storage Quantity (MWh) is included as a COD field so that it can be updated daily.
  - This field will give participants the opportunity to let the control centre know if the unit’s storage capacity is reduced for any reason on a given day.
  - It will be an optional field and will default to Maximum Storage Quantity if not submitted.

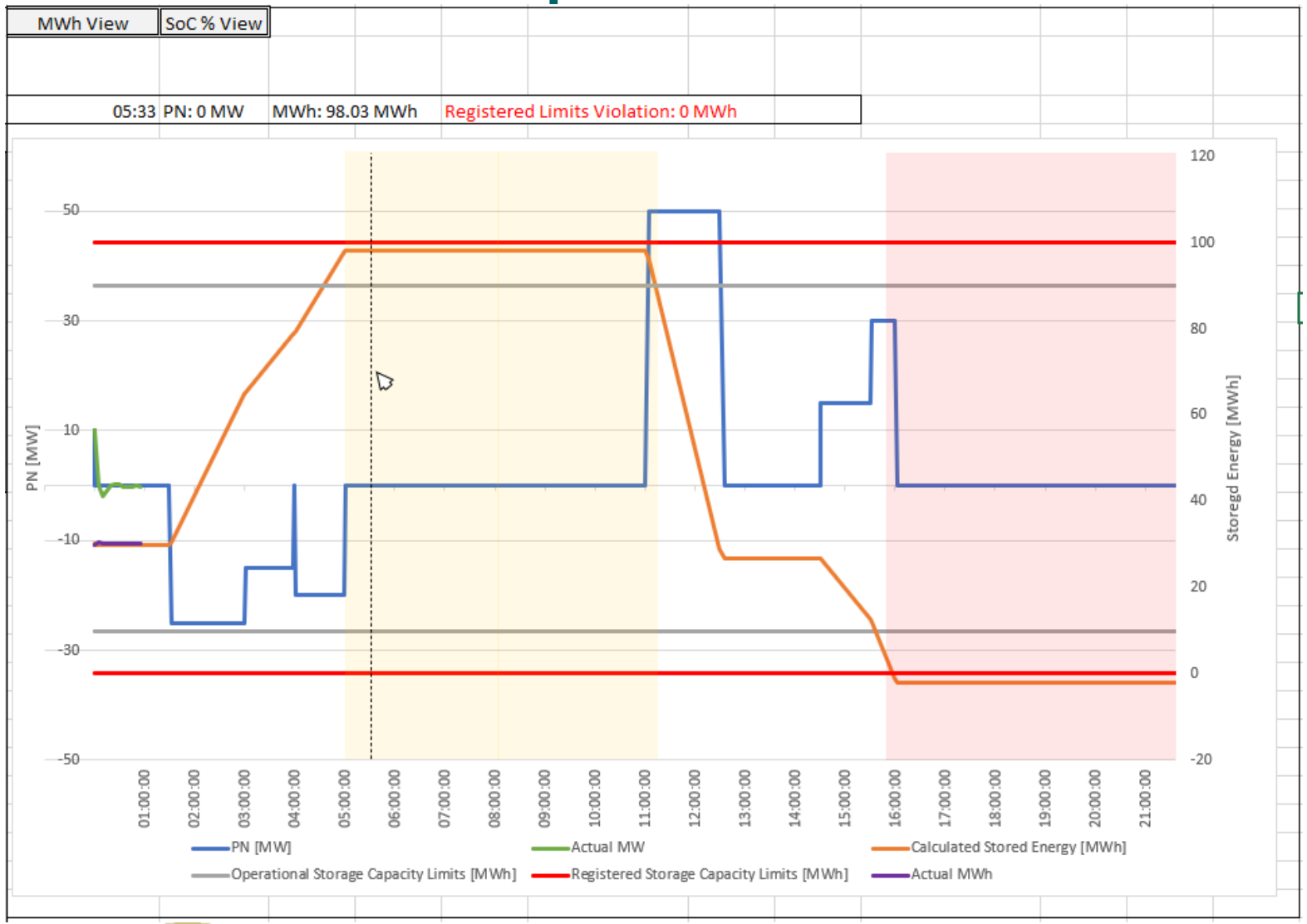
Questions from Participants

- **Same as for D.4.2.6 (e) above - can you explain the difference between the two terms (Minimum Storage Quantity and Operational Minimum Storage Quantity).**
  - Minimum Storage Quantity (MWh) is a registration TOD field representing means the minimum quantity of Generation that can be produced by the Battery Storage Unit.
  - Operational Minimum Storage Quantity (MWh) is included as a COD field so that it can be updated daily.
  - This field will give participants the opportunity to let the control centre know if the unit's minimum level of charge is increased for any reason on a given day.
  - It will be an optional field and will default to the Registered Minimum Storage Quantity if not submitted.

Questions from Participants

- **What is this parameter (Operational Min/Max Storage Quantity) used for? Can you provide a full example.**
- These parameters will be used for a new ‘PN Feasibility Display’ within the control centre.
- The purpose of the proposed PN Feasibility Display is to allow control centre engineers to be informed of and visualise the feasibility of PN profiles submitted by Battery Storage Units according to the current remaining Export Energy [MWh] stored in the unit.
- Once the control centre engineer is happy that the PNs submitted are feasible they can set that unit to “Follow PN” in scheduling.
- An example of the display to be shown to control centre engineers is given on the next slide.

Questions from Participants



Questions from Participants

- **Where is Forecast Minimum Stable Generation value used? Only for scheduling or in settlement as well?**
  - Forecast Minimum Stable Generation is only used for scheduling.
  - Registered Minimum Stable Generation is used for instruction profiling.

Questions from Participants

- **Can you please explain the difference between values that are requested for Forecast Minimum Stable Generation and Registered Minimum Stable Generation? The first one is mandated as zero however the second one doesn't seem to be but the value is used for profiling.**
    - It is intended that Registered Minimum Stable Generation will also be mandated to be zero through validation.
    - When a unit is sync'd it is assumed that it will load up to its Minimum Stable Generation before ramping up to its target level.
    - If a unit is sync'd to a value below its Minimum Stable Generation, it defaults to its Minimum Stable Generation.
    - With a Minimum Stable Generation of zero these units will be assumed to reach this immediately when sync'd and then can ramp to a positive or negative value.
    - If a unit had a Minimum Stable Generation >0 and was sync'd to charge it would be assumed to load up to the Minimum Stable Generation before ramping down to the target level.

Questions from Participants

- **While there is currently a rule prohibiting storage assets to submit non-zero values for No-Load and Start Up Costs the system should be able to allow non-zero value in the future if the situation changes. Can you confirm this value will not be hard-coded in the market systems?**
- For system performance reasons:
  - the interface is specified to ensure zero SUC and NLC
  - scheduling will not include SUC/NLC
  - settlement equations for fixed costs will not be performed for these units
- If in future there is a need to change this it will need to be done through the usual mod/release process.

Questions from Participants

- **The definition of "Charging Mode" should not be deleted yet as we are still in the interim solution space. Until the full enduring battery solution is implemented the distinction between generation and charging mode should remain in place (eg. used for firm access quantity determinations)**
    - We are of the view that leaving this term in the code when it is not used for anything could cause confusion.
    - If this definition or something similar is required as part of a future enduring solution it can be re-introduced then.

Questions from Participants

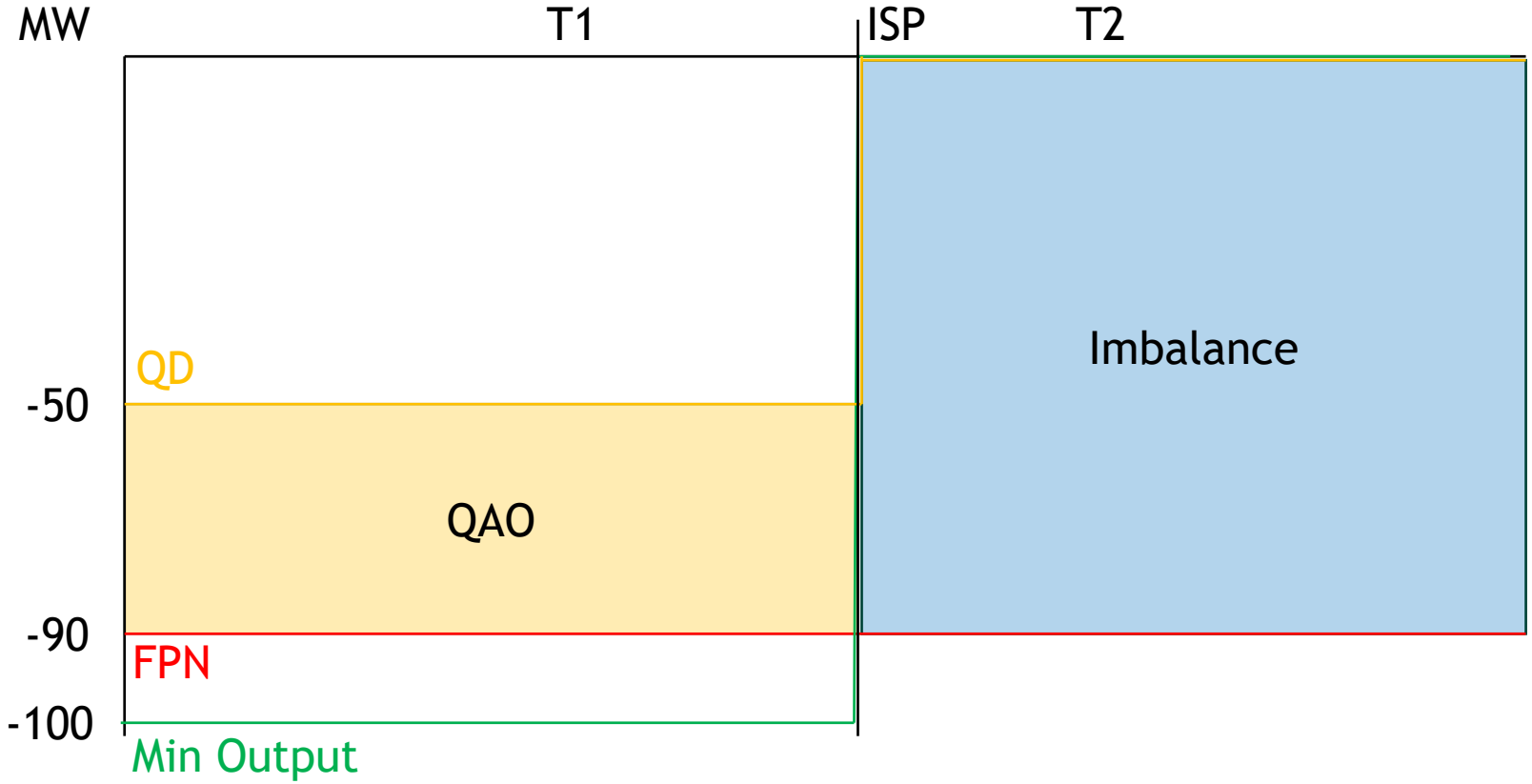
- **Can you explain why was Battery Storage Capacity was deleted? Is this covered by Registered Minimum Output?**
    - Yes this field is covered by Registered Minimum Output.
    - It had been included as a separate field to mirror Pumped Storage.
    - The Pumped Storage field is used in Instruction Profiling. When a PS unit receives a PUMP instruction it is automatically profiled to its full storage capacity.
    - This will not be needed for Battery Storage Units as they will be instructed and profiled to specific MW target levels using MWOF instructions.

Questions from Participants

- **Outturn Minimum Output Quantity term is not included in the Glossary - can you provide a definition?**
- Glossary: Minimum Output Quantity is determined in accordance with paragraph D.6.3.3. (D.6.3.3. specifically refers to *Outturn* Minimum Output Quantity)
- Glossary: Minimum Output Quantity variable $qMINOUT_{u\gamma}(t)$ - The Minimum Output Quantity for a Generator Unit, u, in an Imbalance Pricing Period, φ, or an Imbalance Settlement Period, γ, as a function of time.
- We will update the variable above to explicitly mention Outturn Minimum Output Quantity (similarly to Outturn Availability Quantity).

Questions from Participants

- Can you provide a further mathematical examples of how qMINOUT affects BOA calculations?



Questions from Participants

- Can you provide a further mathematical examples of how qMINOUT affects BOA calculations?

i	Q	P
-5	-100	20
-4	-80	30
-3	-60	40
-2	-40	50
-1	-20	60
0	0	
1	100	70

	T1	T2
FPN	-90	-90
QD	-50	0
qMINOUT	-100	0

Questions from Participants

- Can you provide a further mathematical examples of how qMINOUT affects BOA calculations?

T=1

$$qD_{u(o=0)h}(t) = qFPN_{uh}(t)$$

$qD_{u(o=0)h}(t) = -90$

$$qDA_{u(o-1)h}(t) = Max(qD_{u(o-1)h}(t), qMINOUT_{uh}(t))$$

$qDA_{u(o=0)h}(t) = Max(-90,-100)$

$qDA_{u(o=0)h}(t) = -90$

$$qDA_{uoh}(t) = Max\left(qD_{uoh}(t), qDA_{u(o-1)h}(t)\right)$$

$qDA_{u(o=1)h}(t) = Max(-50,-90)$

$qDA_{u(o=1)h}(t) = -50$

Questions from Participants

- Can you provide a further mathematical examples of how qMINOUT affects BOA calculations?

T=1

$$qBOA_{uoih}(t) = Min\{Max\{qDA_{uoh}(t), qBOLR_{uih}(t)\}, qBOLR_{u(i+1)h}(t)\} - Min\{Max\{qDA_{u(o-1)h}(t), qBOLR_{uih}(t)\}, qBOLR_{u(i+1)h}(t)\}$$

$$qBOUR_{u(i=0)\gamma}(t) = 0$$

$$qBOLR_{u(i=0)\gamma}(t) = 0$$

i=-1 $qBOA_{u(o=1)(i=-1)\gamma}(t)$ = Min(Max(-50,-20),0) – Min(Max(-90,-20),0) = 0

i=-2 $qBOA_{u(o=1)(i=-2)\gamma}(t)$ = Min(Max(-50,-40),-20) – Min(Max(-90,-40),-20) = 0

i=-3 $qBOA_{u(o=1)(i=-3)\gamma}(t)$ = Min(Max(-50,-60),-40) – Min(Max(-90,-60),-40) = 10

i=-4 $qBOA_{u(o=1)(i=-4)\gamma}(t)$ = Min(Max(-50,-80),-60) – Min(Max(-90,-80),-60) = 20

i=-5 $qBOA_{u(o=1)(i=-5)\gamma}(t)$ = Min(Max(-50,-100),-80) – Min(Max(-90,-100),-80) = 10

Questions from Participants

- Can you provide a further mathematical examples of how qMINOUT affects BOA calculations?

T=2

$$qD_{u(o=0)h}(t) = qFPN_{uh}(t)$$

$qD_{u(o=0)h}(t) = -90$

$$qDA_{u(o-1)h}(t) = Max(qD_{u(o-1)h}(t), qMINOUT_{uh}(t))$$

$qDA_{u(o=0)h}(t) = Max(-90,0)$

$qDA_{u(o=0)h}(t) = 0$

$$qDA_{uoh}(t) = Max\left(qD_{uoh}(t), qDA_{u(o-1)h}(t)\right)$$

$qDA_{u(o=1)h}(t) = Max(0,0)$

$qDA_{u(o=1)h}(t) = 0$

Questions from Participants

- **Can you provide a further mathematical examples of how qMINOUT affects BOA calculations?**

T=1

$$qBOA_{uoih}(t) = Min\{Max\{qDA_{uoh}(t), qBOLR_{uih}(t)\}, qBOLR_{u(i+1)h}(t)\} - Min\{Max\{qDA_{u(o-1)h}(t), qBOLR_{uih}(t)\}, qBOLR_{u(i+1)h}(t)\}$$

$$qBOUR_{u(i=0)\gamma}(t) = 0$$

$$qBOLR_{u(i=0)\gamma}(t) = 0$$

i=-1 $qBOA_{u(o=1)(i=-1)\gamma}(t)$ = Min(Max(0,-20),0) – Min(Max(0,-20),0) = 0

i=-2 $qBOA_{u(o=1)(i=-2)\gamma}(t)$ = Min(Max(0,-40),-20) – Min(Max(0,-40),-20) = 0

i=-3 $qBOA_{u(o=1)(i=-3)\gamma}(t)$ = Min(Max(0,-60),-40) – Min(Max(0,-60),-40) = 0

i=-4 $qBOA_{u(o=1)(i=-4)\gamma}(t)$ = Min(Max(0,-80),-60) – Min(Max(0,-80),-60) = 0

i=-5 $qBOA_{u(o=1)(i=-5)\gamma}(t)$ = Min(Max(0,-100),-80) – Min(Max(0,-100),-80) = 0