Scheduling & Dispatch

Proposed Changes for Battery Storage Units

Modifications Committee

5th December 2023

This presentation provides background, content, and an explanation for the proposed changes to the Trading & Settlement Code for the Scheduling & Dispatch Programme initiative SDP_002: ESPS (Battery) Integration.

Achievable – Valuable – "Simple"

EirGrid semo Single Electricity Market Operator SONI

History of the Mod

- This mod was introduced to the mods committee on 19th October.
- Based on feedback from committee members it was decided that further sessions were required to work through the detail of the mod before going to a vote.
- Further sessions were held by the Scheduling and Dispatch team on the 8th and 15th of November. All members of the mods committee were invited to join these calls and a wider invitation was issued at our November Scheduling and Dispatch Programme workshop.
- Within these sessions the Scheduling and Dispatch Programme team provided further clarifying details on the mod proposal and related operational policies, and discussed queries and suggestions submitted by participants.
- Updates have been made to the mod based on these sessions and the mod has been resubmitted for a vote in this December committee meeting.

Updates to Mod Proposal since October Mods Committee Meeting

- Based on discussions with industry, updates have been made to the mod proposal:
    - Proposal to treat Battery Storage Units the similarly to interconnectors when applying loss adjustment factors has been removed, loss factors will be applied as they are for other generators.
    - A new requirement has been added to use Complex Commercial Offer Data in the settlement of Battery Storage Units. This is to allow these units to be compensated appropriately for dispatch away from Physical Notifications which have become infeasible due to TSO actions.

- Based on ongoing discussions with vendors:
    - Proposal to use Outturn Minimum Output as a floor in the calculation of Accepted Bid Offer Quantities (QBOAs) for incs has been postponed.

System Improvements

We are working with our vendors to remove limitations on market systems which currently restrict batteries' participation in the market.

The primary changes which will allow the control centre and market participants to gain greater value from these units in the balancing market are:

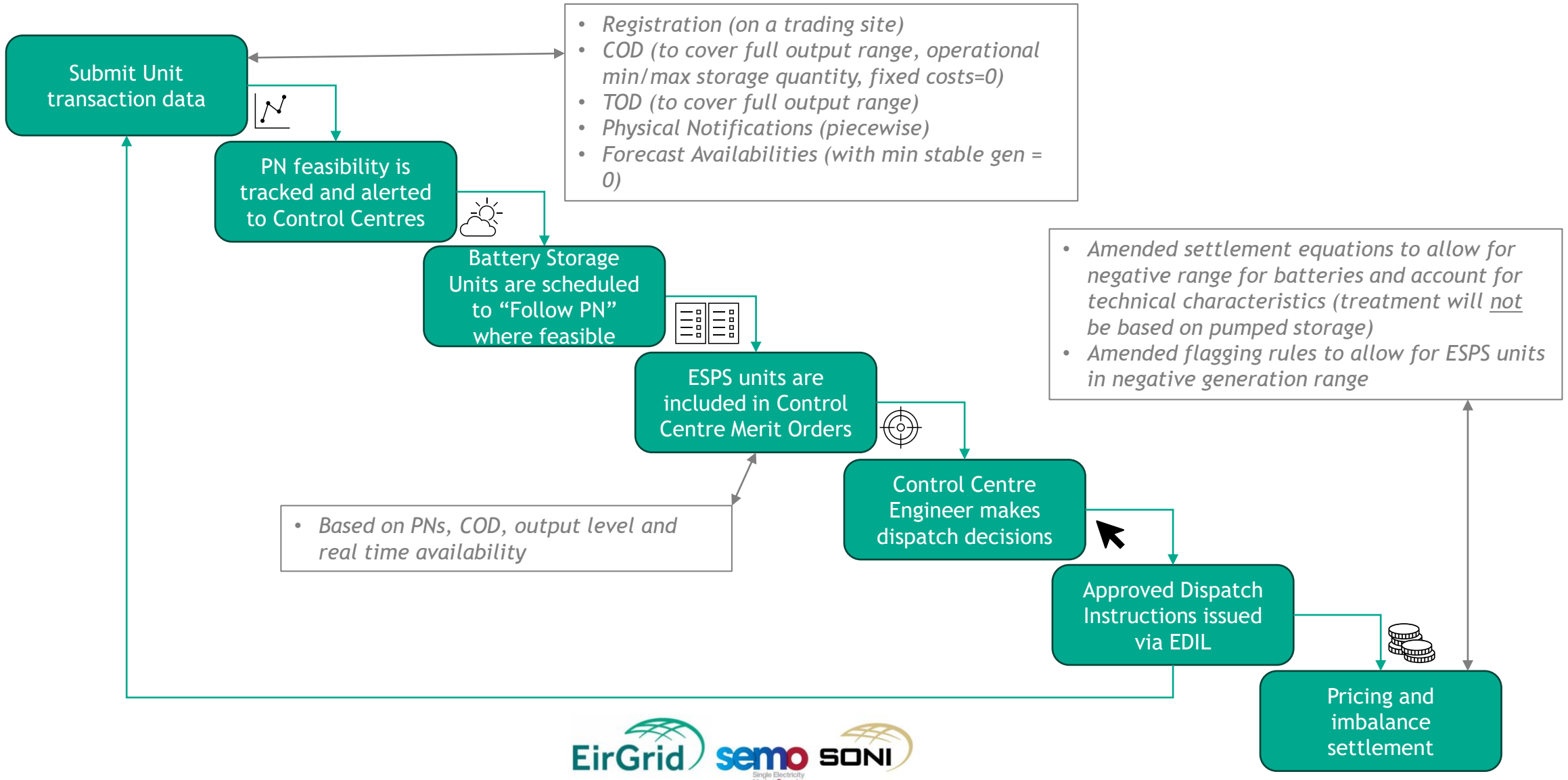
- The ability to register and identify these units correctly as Battery Storage Units.
- The ability for participants to submit negative Physical Notifications, representing an intention to import.
- The ability to schedule these units to follow Physical Notifications.
- The ability for these units to receive negative Dispatch Instructions.

As a result of these changes, updates to the rules for Battery Storage Units in the Trading and Settlement Code are required.

System Improvements

- Due to system limitations, the scheduling of Battery Storage Units cannot be optimised by market systems.
- In response to this and feedback from participants the approach detailed here has been developed as an **interim solution**.
- An **enduring solution** will follow as part of an upcoming programme of work within the TSOs and SEMO.
- Industry engagement will begin on that programme of work in early 2024.

Day in the Life - Battery Storage Units



Dispatch of Battery Storage Units

Proposed Operational Policy:

- If a battery unit has non-zero PNs, the control centre engineer will dispatch the unit to those 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.

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 previous TSO actions will be settled at better of COD price and the imbalance price.
- 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 previous 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.

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.

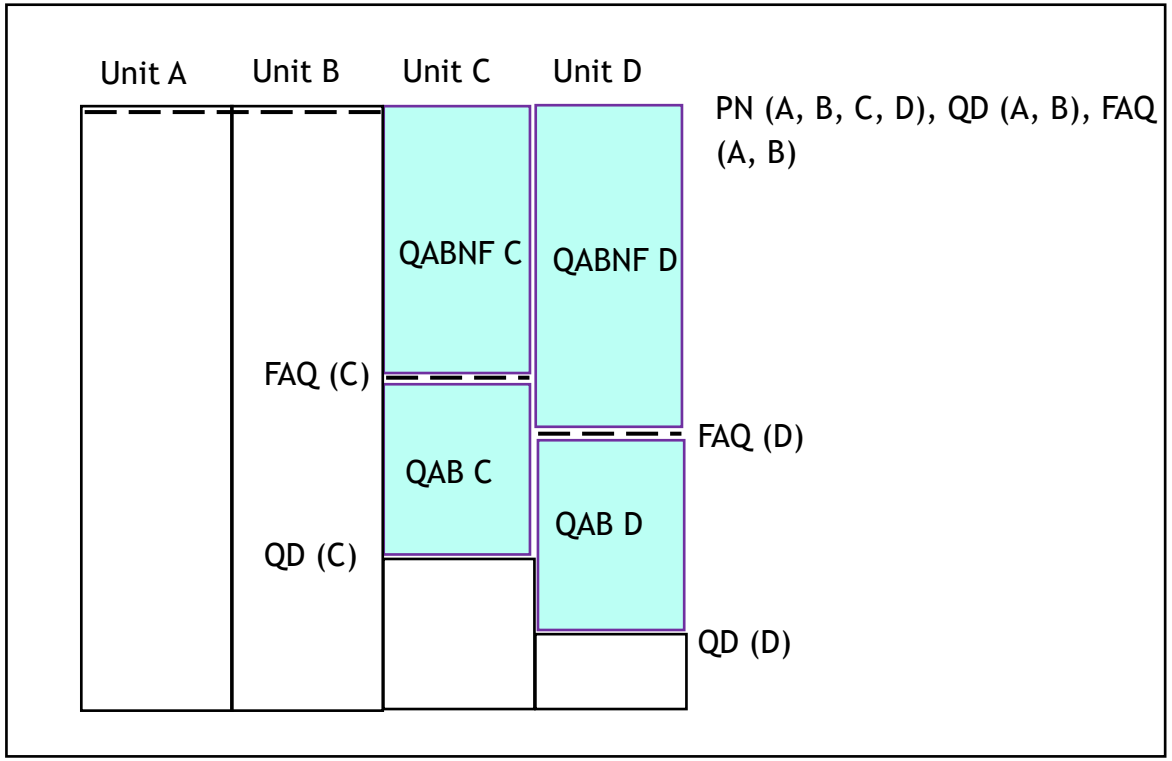
- Non-firm quantities are calculated on a Trading Site basis, so without being part of a Trading Site non-firm quantities will not be applied to Battery Storage Units.

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

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

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

$$Else$$

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

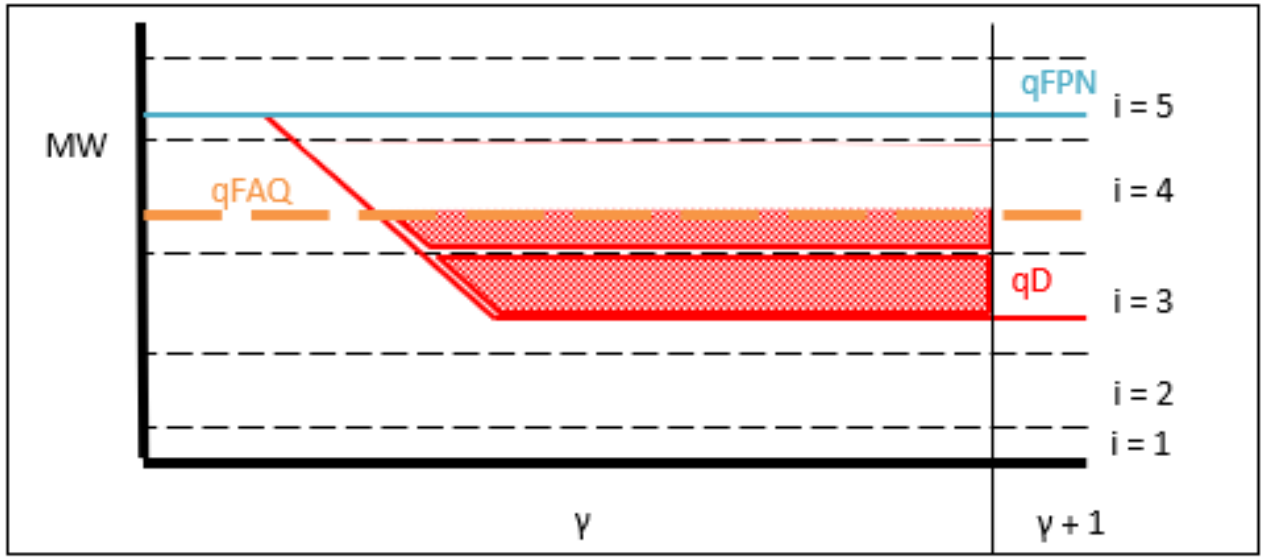
- When no dec actions are taken, Unit Firm Access Quantity qFAQ always = FPN
- When dec actions (QAB<0) are taken on the single unit Trading Site:

  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.

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

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.

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

- **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.

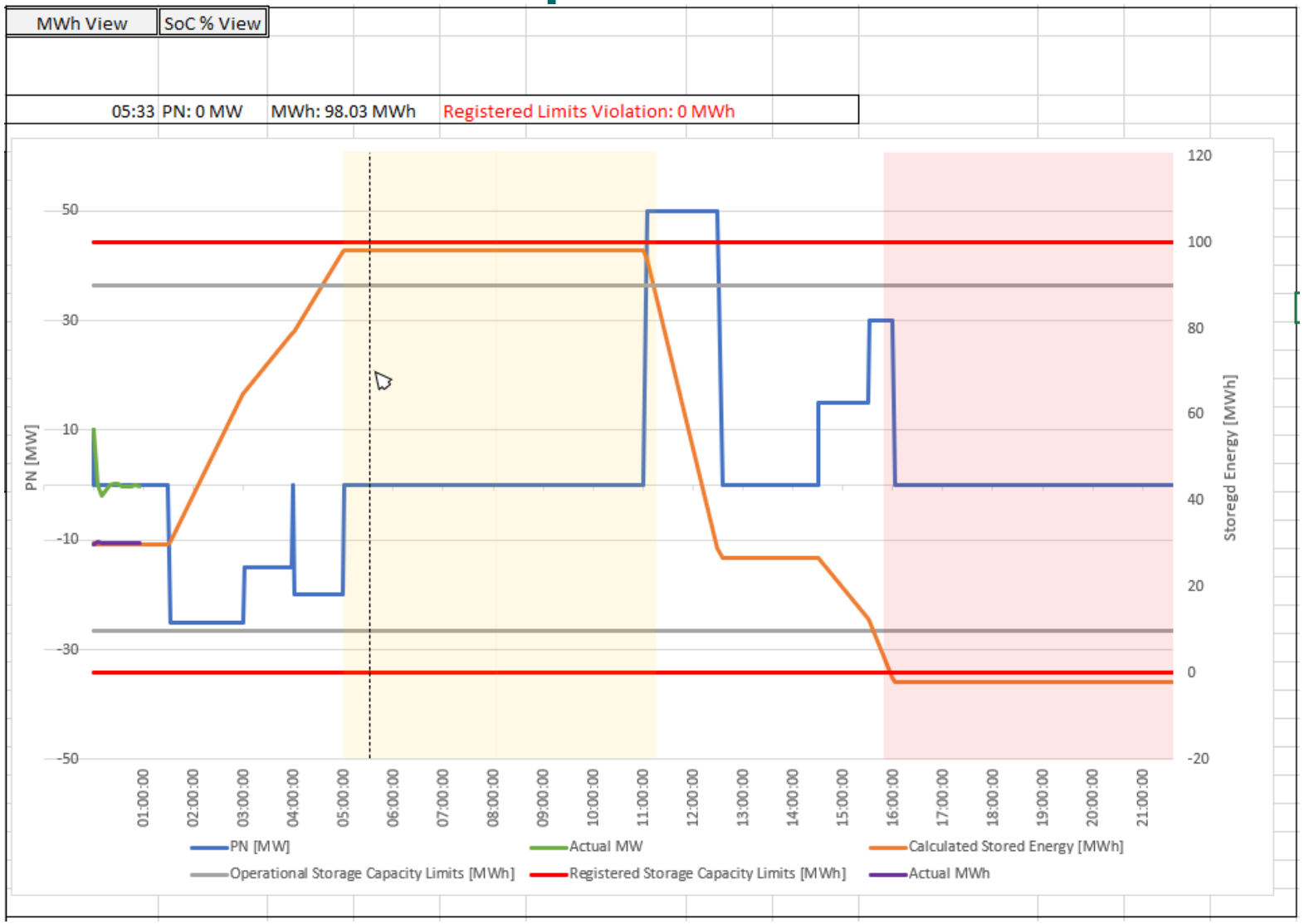
Questions from Participants

- **Can you explain the difference between 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



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)

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.

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.
- The existing tolerances within the Uninstructed Imbalance calculation (minimum of 1MW) may be used by Battery Storage Units to trickle charge.

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

- 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 is seen as an imbalance rather than an Accepted Bid, we had proposed that Outturn Minimum Output be included in the algebra for calculating Accepted Bid Offer Quantities (QBOAs) for incs.
  - F.6.2.3

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

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

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

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

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

- For consistency, this proposal also applied to the calculation of Trade Opposite TSO Accepted Bid Offer Quantities for Incs (not currently switched on in the market) and Accepted Offers Below Physical Notification and Accepted Bids Above Physical Notification Quantities.
- **Based on conversation with vendors this proposal has not been included in this mod so as not to hold up delivery of other necessary changes.**
- Therefore, under this mod QBOAs will be calculated as they are for other generators today, without the Outturn Minimum Output acting as a floor value.
- This proposal may be re-introduced in a later mod.

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 Factors

- We **had proposed** applying loss adjustment factors to Battery Storage Units in a similar manner to Interconnector Units.
- 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 have removed this change from the mod proposal. Loss factors will be applied to Battery Storage Units using the formula below.**

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

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