Bidirectional unit stakeholder workshop

Integrating Energy Storage Systems

Monday 24 July 2023

We acknowledge the Traditional Owners of country throughout Australia and recognise their continuing connection to land, waters and culture.

We pay respect to their Elders past, present and emerging.

AGENDA

#	TOPIC	PRESENTER
1	**Welcome and introduction**	Ulrika Lindholm
2	**Context**	Luke Barlow
3	**Industry transition to IRP/BDU**	Emily Brodie
4	**Final IESS model**	Luke Barlow
	4.1 Bid structure, validation and interface	Basilisa Choi
	4.2 SCADA requirements and dispatch instructions	Basilisa Choi
5	**Q&A and meeting close**	Ulrika Lindholm

APPENDICES	
A	IESS Glossary
B	Competition law meeting protocol
C	Technical information: C1: Energy storage limits C2: Ramp rates C3: Price ties
D	Project commitment criteria

1. Introduction

Introduction

SESSION PURPOSE

- Provide market participants with an overview of final Bidirectional Unit (BDU) design in relation to the Integrating Energy Storage Systems (IESS) rule implementation.
- Discuss industry transition arrangements aiming to lessen the impacts of the IESS settlements changes.
- Provide sufficient information to assist participants in planning and developing their BDU implementation, ahead of release of detailed technical specifications and data model.

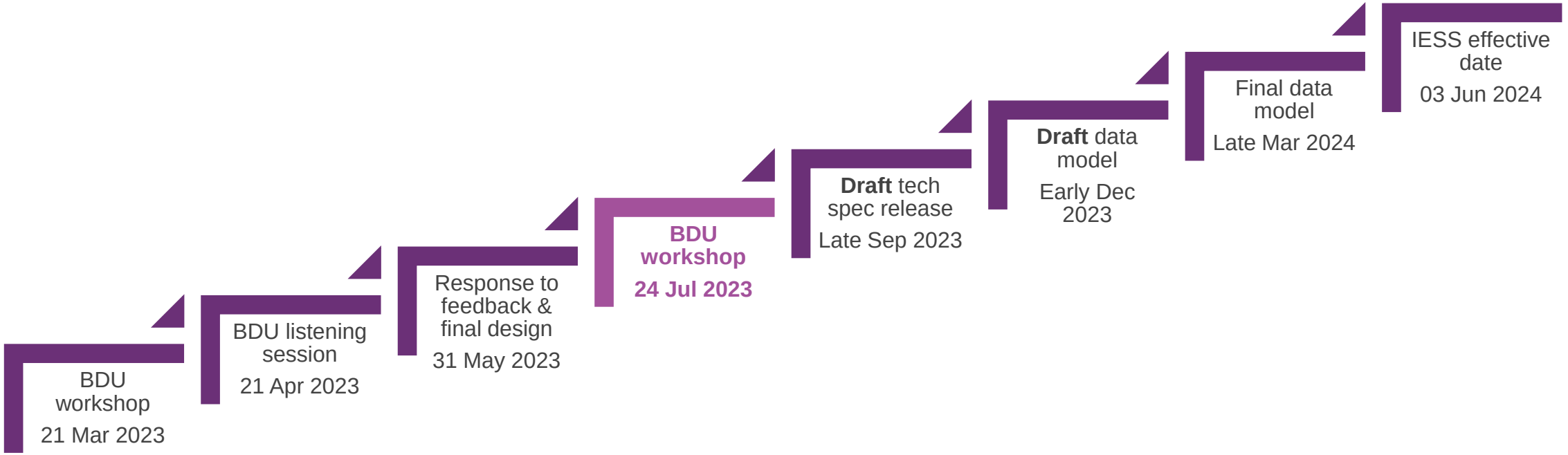
STAKEHOLDER ENGAGEMENT ON BDU IMPLEMENTATION

- To prepare for the IESS rule commencement, AEMO's IESS project has engaged with affected industry participants on the BDU implementation design.
- Participants have been engaged through:
  - Information session on 21 Mar 2023. Session outlined bidding and dispatch changes for BDUs and sought industry feedback on implementation arrangements.
  - Call for industry feedback on implementation arrangements in writing by 04 Apr 2023.
  - Listening session on 20 Apr 2023. Session allowed stakeholder to provide verbal feedback on BDU implementation design and industry transition.
  - Bilateral discussions with existing energy storage participants in April-May 2023.
  - Information session on 31 May 2023. Session provided an overview of feedback received and resulting response including adjustments to the BDU model design.
  - This workshop (24 July 20230 and bilateral discussions with existing and prospective energy storage participants in June/July.
- AEMO thanks stakeholders for their continued participation and feedback received.

Engagement on BDU design

AEMO thanks stakeholders for their participation and feedback received.

*Refer to IESS Glossary in Appendix B for full list of acronyms

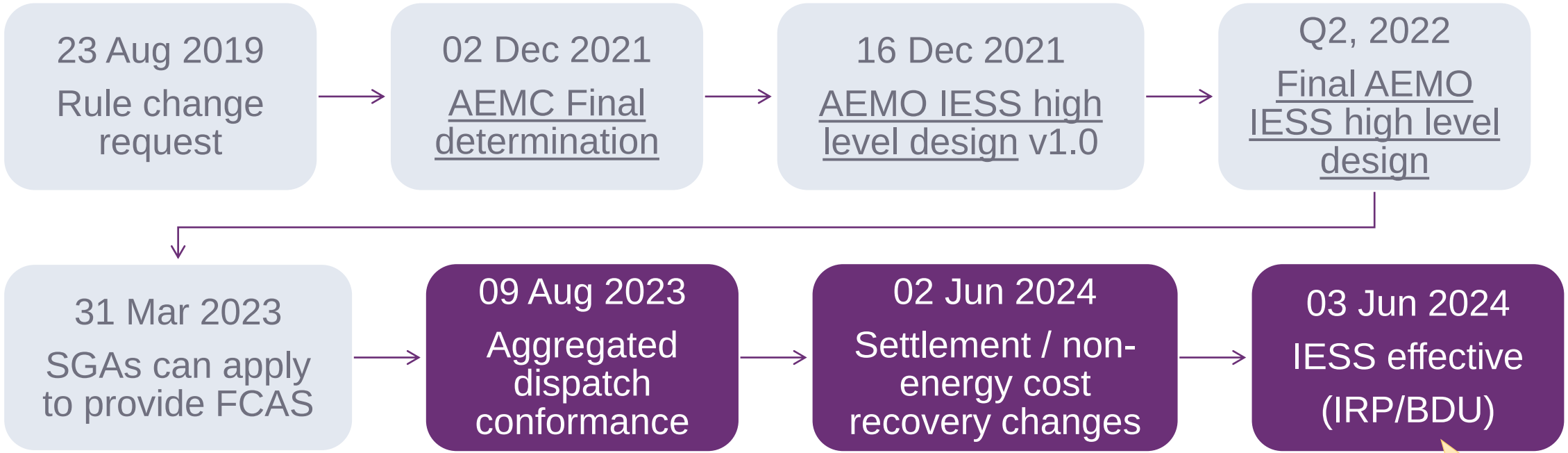


- Ongoing industry readiness engagement via the NEM Reform Implementation Forum and 1to1 conversations
- SO_OP 3705 Dispatch procedure engagement: Q3 2023 - minor/administrative terminology changes only

2. Context

Luke Barlow

BACKGROUND: IESS high-level Timeline



This document relates to BDU implementation

SGA	Small generation aggregator
FCAS	Frequency control ancillary service/s
IRP	Integrated resource provider
BDU	Bidirectional unit

REFERENCES

- **AEMC** IESS rule change
- **AEMC** Implementing IESS rule change
- **AEMO** IESS High Level Design and Implementation Strawperson
- **AEMO** IESS Participant Toolbox

Background

- Australia's first grid-scale battery (Hornsdale Power Reserve) was commissioned and registered in 2017.
- To quickly register and integrate HPR into NEM systems with as little disruption as possible, the BESS was represented as two units:
  - Registered twice – generation and load sides
  - Operates in the energy and FCAS markets as separate generation and load DUIDs
  - Contingency FCAS limited to one DUID only to prevent over-scheduling.

IESS rule & final determination

- To address these challenges, the IESS Rule introduces a single bid form and single DUID model for BDUs.
- The AEMC determined that this approach increases efficient investment and operation for AEMO and participants, particularly in the context of major increases in BESS connections needed to support the energy transition.
- Relevant excerpts from the IESS final determination (section A.3.2, pp. 33-34) that illustrate the AEMC's decision are set out below.

Central dispatch

The Commission's final decision is to retain the draft decision in how storage and hybrid systems participate in central dispatch, with clarification added to the final rule as to how aggregate dispatch conformance will apply. The key features are:

- Scheduled storage assets (5 MW and above):
  - that can transition between generation and consumption linearly (with no dead band around zero) will participate in central dispatch with a single bidding form and single DUID, and will be labelled as a scheduled bidirectional unit
  - that have a dead band around their zero point of generation/consumption, typically hydro units, will maintain dual bidding forms and DUIDs, one for each of its classifications as a scheduled generating unit and scheduled load.

Bidding form for storage units

The Commission's final decision is to maintain the draft decision, which is to introduce a new unit classification, the scheduled bidirectional unit, which would participate in central dispatch as a single unit across generation and consumption. The number of price bid bands is maintained at 20 (that is, 10 for the load side and 10 for the generation side of the bidirectional unit).

Some stakeholders questioned if the benefits of this change outweighed the costs. The Commission tested these views with AEMO, and AEMO noted it expects it could implement this approach largely by applying existing functionality, which would minimise the complexity and cost.

The Commission considers the rule is likely to provide a number of benefits which align with the assessment criteria for the rule change, including:

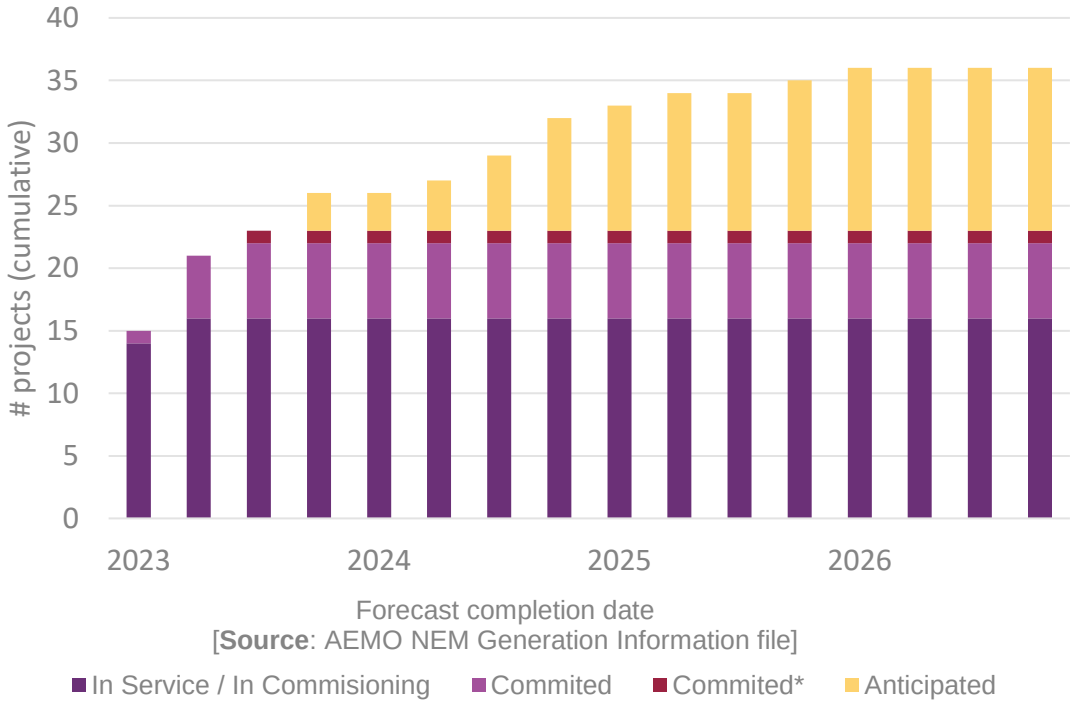
- Minimises administrative and regulatory burden — Reducing administrative cost on AEMO dealing with two separate units. This includes initially in the registration and classification stage but also ongoing in various IT and system processes such as forecasting and constraint formulation.
- Promotes competition — Reduces the set-up costs and ongoing operational complexity of participating in central dispatch for participants.
- Promotes transparency — Transparency of information in the market will increase as storage will be more visible compared to if it was two relatively unrelated DUIDs.

The Commission considers the final rule on bidding provides a simple and clear framework for participants, in alignment with a single registration and classification process. The Commission agrees with AEMO that the current arrangements, in the context of the introduction of the IRP in this final determination, makes participation unnecessarily complex and expensive for AEMO and scheduled storage units. This could create barriers to entry and impact on efficient investment and operation. Consequently, the Commission considers the final rule is in the long-term interests of consumers.

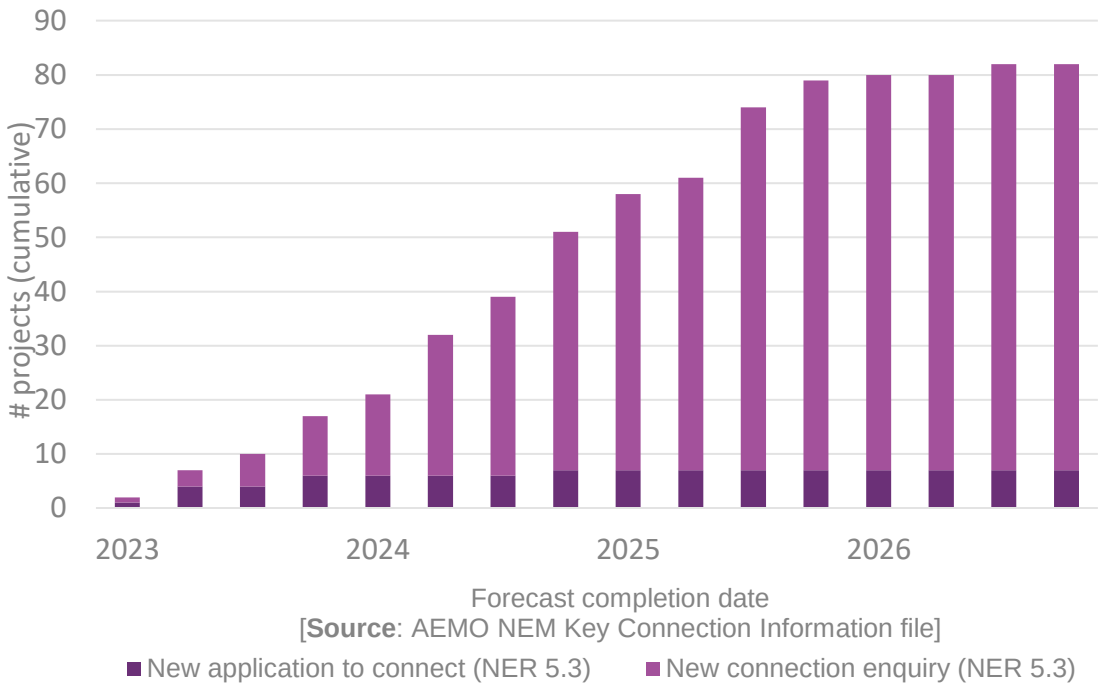
BESS pipeline projections @ June 2023

MORE CERTAIN | LESS CERTAIN

BESS pipeline based on commitment level**



BESS pipeline based on enquiries & applications



See Appendix for commitment level definitions

BDU model options summary

ID	Model	# DUID	Conditional Regulation FCAS bids	Contingency FCAS across full range	Energy Limit model	Reduced operational complexity
A	Gen and Load DUIDs (current status)	2	Y	N	N	N
B	Gen and Load DUIDs linked	2	Y	N	Y	N
C	Initial BDU model	1	N	Y	Y	Y
D	BDU with conditional Regulation FCAS bids	1	Y	Y	Y	Y
E	Gen and Load DUIDs in the market but one BDU in Operational Displays	2	Y	N	Y	Y

Questions on BDU model presented in May 2023

- Could option E be changed to include contingency FCAS across full range?
  - Not in the current structures of the dispatch process as the determination of contingency FCAS is within the optimisation process and would need to link “within” two DUIDs.
- Could the single BDU model be changed to reduce industry costs to implement?
  - Yes the design has been changed to align the bidding structures as closely as possible with the existing 10 band structures of scheduled load and generators.
  - The transition is backwards compatible such that existing loads and generators do not need to change bidding systems and BESS Operators need only to make one change over the transition period.

BDU implementation: Confirming single DUID approach

- Single DUID approach for BDUs aligns the DUID and the control point (asset) reducing complexity in the scheduling process
  - DUIDs are the pricing and control point for scheduled assets
  - NEM is evolving from a smaller number of large generators to greater numbers of smaller assets.
  - Will likely get more small bidirectional assets as a result of the “Scheduled Lite” rule change request.
- Single DUID approach for BDUs will be implemented through a combination of adjusted BDU model and improved transition.

3. Industry BDU transition

Emily Brodie

Industry BDU transition: Overview

TRANSITION

AEMO is introducing a longer and more flexible transition period so that:

- At IESS commencement (03 Jun 2024):
  - BESS do not have to cutover to 1DUID on “day one”
  - AEMO’s BDU operations start.
- More BESS can have a longer period to cutover to 1DUID (to 03 Mar 2025)
  - Provides more time for industry to develop and implement quality solutions.
- Still allows participants to cutover on or near 03 Jun 2024 if they are ready.
- BESS cutovers to 1DUID can be better scheduled and coordinated
  - Particularly for companies with multiple BESS or who have a common bidding system vendor.

PARTICIPANT SUPPORT

- Earlier release of tech specs and data model.
- Provision of participant support environment so that participants can test:
  - Bid interface updates
  - Data Model changes related to bids.

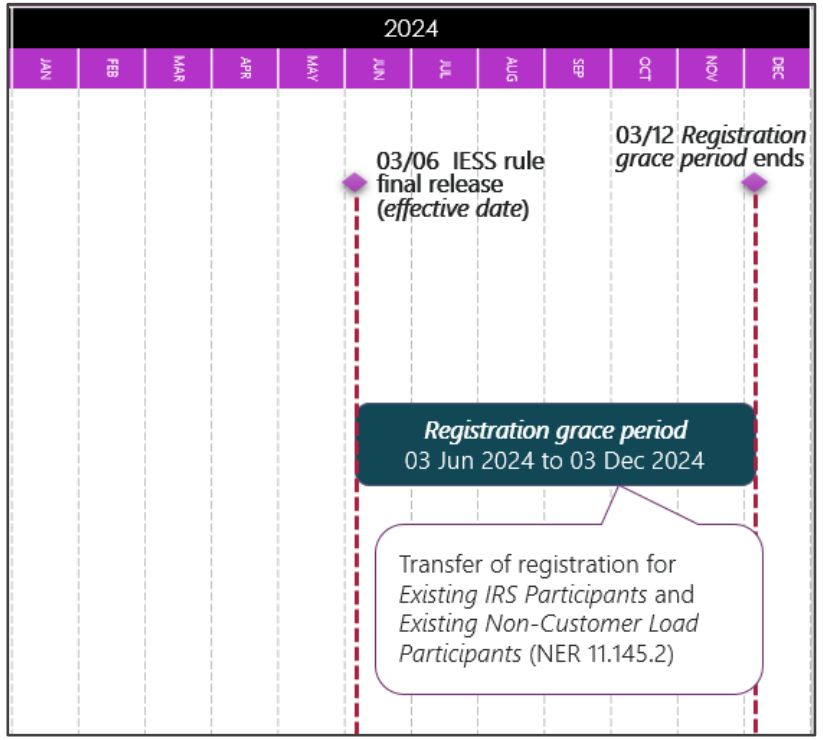
IESS rule transitional arrangements

IESS rule transition does not consider participants' range of circumstances or operational risks of cutting over multiple BESS to 1DUID operation on single day.

PARTICIPANT TYPE	IESS RULE TRANSITION
*New IRS participant** • BESS operational since Dec 2021	• Registered between 02 Dec 2021 & 02 Jun 2024 • Move to 1-DUID on 03 Jun 2024
*Existing IRS participant** • BESS operational prior to Dec 2021	• Registered prior to 02 Dec 2021 • Need to have applied to register as an IRP by 03 Sep 2024 • Need to have completed registration by 03 Dec 2024
Participants with both 'new' and 'existing' BDUs	• Not considered
Participants with common bidding system vendor	• Not considered

*Defined terms in IESS Rule (NER 11.145.1)
AEMC | IESS determination and rule

REGISTRATION GRACE PERIOD



Stakeholder feedback: Transition

- In Q3/4 2022, the IESS project team held some one-to-one discussions with incumbent battery operators and bidding software vendors, along with discussions in the IESS working group.
- Wider industry discussions have been held across Q1/2 2023 via one-to-one meetings and participant forums.

Stakeholder feedback to date	In response, AEMO is:
For some participants that have both an 'existing' and a 'new' bidirectional resource, there is a preference to move all bidirectional resources to the 1-DUID model at the same time i.e. use the grace period for their new BDU/s.	Introducing flexibility for these participants to move all of their bidirectional resources to the 1-DUID model at the same time (within the grace period).
Some vendors have a preference to move clients on same bidding system to single DUID at similar time, irrespective of whether those clients operate 'existing' or 'new' BESS.	Introducing flexibility for participants to move their bidirectional resources to the 1-DUID model at the same time as other participants with a common bidding system vendor (within the grace period).
Preference for: (a) a longer grace period, or (b) grandfathering of the 2-DUID model.	(a) Introducing flexibility for existing bi-directional units to have a longer (but not indefinite) grace period. (b) For reasons set out above, all BESS to move to single-DUID.
Need for technical specifications to be released in time for bidding software vendors to design, build and test IESS changes and allow time for their customers' to participant in market trial.	See following slides for tech spec and data model information.

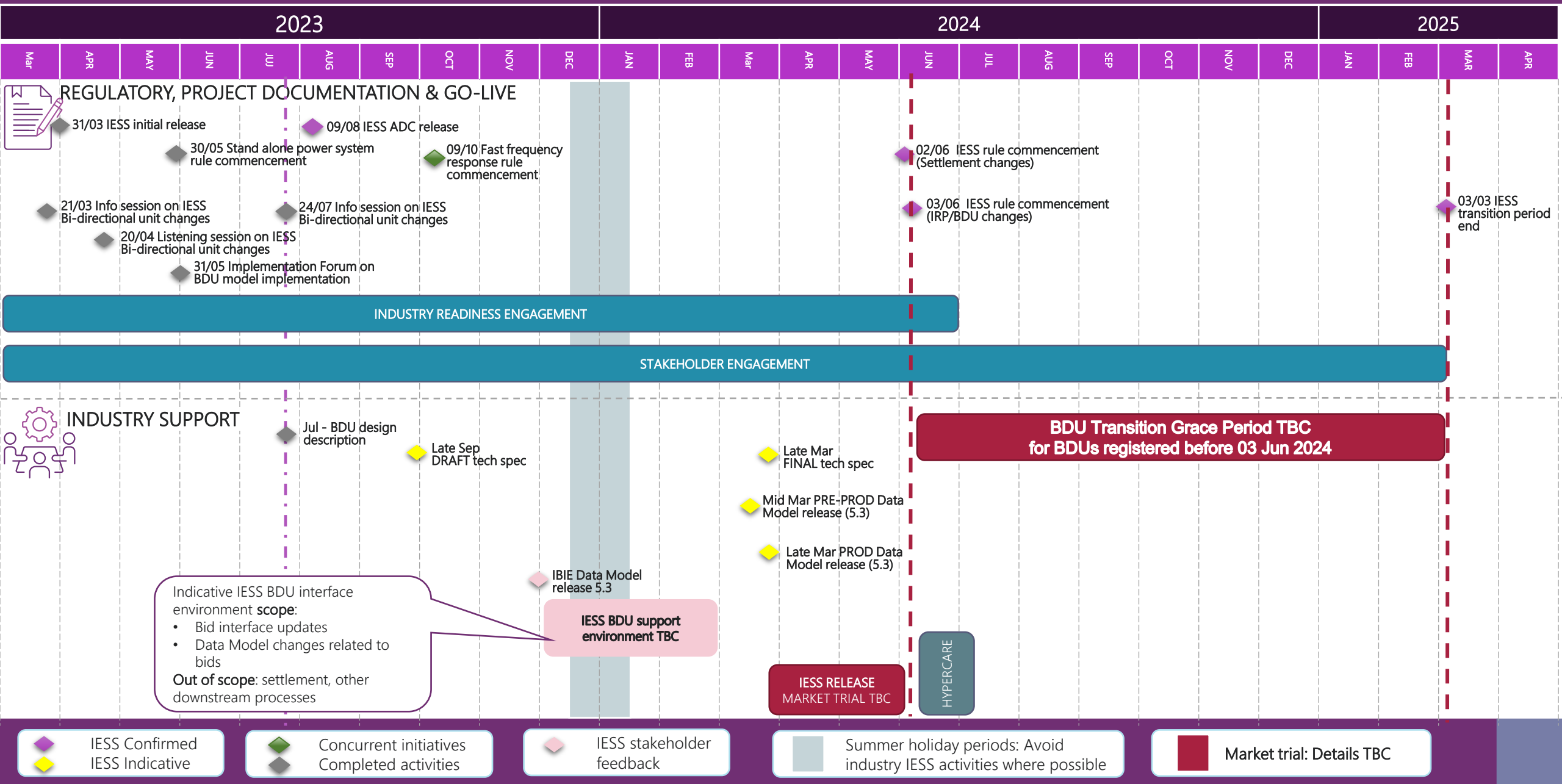
Proposed transitional arrangements

AEMO is proposing a more flexible transition in response to feedback.
NOTE: The proposed transition has been modified further in response to feedback raised at the information session

PARTICIPANT TYPE	IESS RULE TRANSITION	PROPOSED TRANSITION
*New IRS participant** • BESS operational since Dec 2021	• Registered between 02 Dec 2021 & 02 Jun 2024 • Move to 1-DUID on and from 03 Jun 2024	**BESS that have completed registration on and from 03 Jun 2024** are expected to commission and operate each BESS as a single DUID. • Where there are extenuating circumstances, IRS participants can approach AEMO to discuss the possibility of commissioning the BESS as 2 DUIDs with a plan to cutover to 1-DUID by 03 Mar 2025. (All BDUs must be operating as 1-DUID by this time.)
*Existing IRS participant** • BESS operational prior to Dec 2021	• Registered prior to 02 Dec 2021 • Need to have applied to register as an IRP by 03 Sep 2024 • Need to have completed registration by 03 Dec 2024	**IRS participants with one or more BESS that completed registration prior to 03 Jun 2024**: AEMO is offering an extended transition period up to **03 March 2025**. All BDUs must be operating as 1-DUID by this time.
Participants with both 'new' and 'existing' BDUs	• Not considered	**APPROACH** • AEMO is ready for 03 Jun 2024 IESS commencement • IESS market trial (~8 weeks duration) available prior to commencement • AEMO's pre-prod environment available for industry testing on ongoing basis from market trial start • *Existing IRS participants* need to have applied to register as an IRP by 03 Sep 2024. AEMO will facilitate this process. • *New IRS participants* who are operational prior to 03 Jun 2024 will be "taken to be registered as an *Integrated Resource Provider* in relation to the *integrated resource system*" [NER 11.145.3(c)] • AEMO to notify AER of transition approach.
Participants with common bidding system vendor	• Not considered	**RATIONALE** • Mitigates risks of cutting over multiple BESS to 1-DUID operation during live system/market operation • Still allows participants to cutover on or near rule commencement date (03 Jun 2024) if they are ready • Allows AEMO and operators with both new and existing BDUs and/or with common bidding system vendors to efficiently coordinate cutover to 1-DUID across portfolios. • Enables AEMO to provide more comprehensive participant readiness support rather than minimum viable support • Provides more time for industry to develop and implement quality solutions

*Defined terms in IESS Rule (NER 11.145.1)
AEMC | IESS determination and rule

IESS – Indicative BDU transition



BDU implementation: Next steps

NOTE: The IESS project team is finalising the advice to industry on release dates and content for technical specifications, data model and test environments. We expect to communicate this information through the Program Consultative Forum (PCF) on Wed 09 Aug and further in the Implementation Forum on Tue 29 Aug.

Mon 24 Jul	BDU stakeholder workshop, including BDU final design and transition info pack: • Allows participants to plan and scope their BDU implementation • Supports early conversations with vendors • Does not have sufficient technical detail for development certainty.
Late Sep 2023	Publish draft EMMS tech spec (milestone date TBC)
Late Nov 2023	Draft EMMS data model released (milestone date TBC)
TBC	BDU support environment. Indicative scope: • Bid interface updates • Data Model changes related to bids • Out of scope: settlement, other downstream processes
Industry readiness planning	Industry readiness preparations via the NEM Reform Implementation Forum (see next slide)

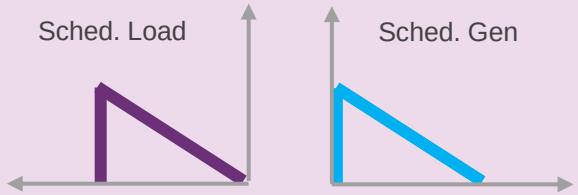
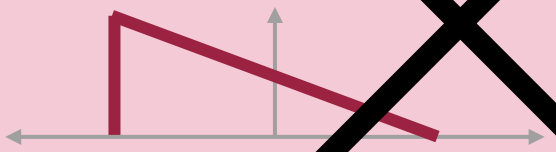
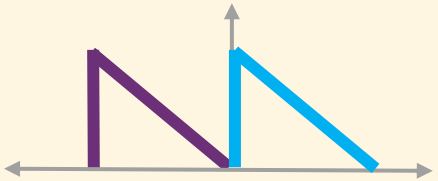
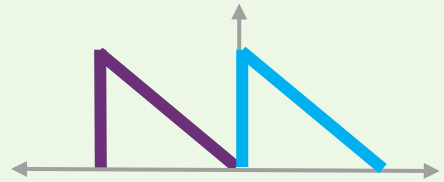
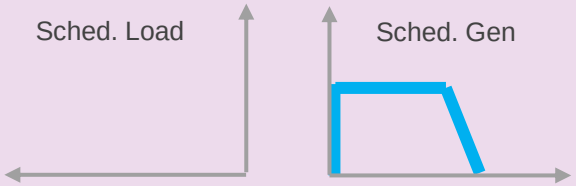
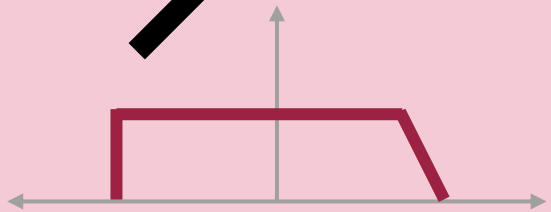
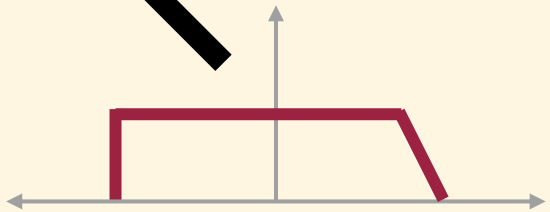
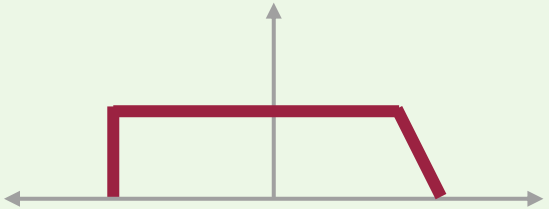
IESS readiness approach: Indicative timing

ELEMENT	DOCUMENT	IF / ITWG ENGAGEMENT	FINAL	STATUS
STRATEGY	Readiness approach	28 Mar 2023	26 Apr 2023	Complete
	★ Participant impact assessment	26 Apr 2023	TBC	On track
READINESS CRITERIA	★ Go-live criteria and monitoring	Oct 2023	Q4 2023	Not started
TEST / TRIAL	★ Market trial & industry test **strategy**	Jul 2023 (Implementation Forum)	Oct 2023 ITWG	On track
	★ Detailed market trial/industry test **plan**	Dec 2023 ITWG	Jan/Feb 2024 ITWG	Not started
TRANSITION	★ **Reclassifications**: • SGAs become IRPs • Existing BDUs become IRPs • Relevant loads & generators ASUs	n/a	15 Dec 2023	Not started
	NMI classification codes where a new code needs to apply (links to NCC go-live plan)	Nov 2023	Dec 2023	Not started
	★ **Bi-directional units**: • **Existing** BDUs to single DUID participation, including consolidating NMIs & moving to single bid forms. • **"New"** BDUs start single DUID participation 03 Jun 2024	Aug/Sep 2023	Dec 2023	Not started
GO-LIVE	New NMI classification codes (links to NCC transition plan)	Oct 2023	Dec 2023	Not started
	★ Go-live plans for data model releases (wholesale and retail)(TBC)	Dec 2023	Feb 2024	Not started

Final IESS model

IESS NEMDE models: Context

NOTE: All trapeziums are for a typical raise service

CURRENT (PRE-IESS): 2 DUID	INITIAL IESS MODEL: 1 DUID (to May 2023)	REVISED IESS MODEL: 1 DUID (May 2023)	FINAL IESS MODEL: 1 DUID (July 2023)
ENERGY			
Independent capacity, bids, etc.	• 20 bids bands for energy • 10 per FCAS	• 20 bids bands for energy • 10 per FCAS	• 10 bids bands each direction for Energy and Regulation FCAS • 10 bids bands across full range for Contingency FCAS
REGULATION FCAS			
One trapezium per DUID, but resolved back to a single unit for AGC 	One trapezium. Does not support conditional bidding. 	Two trapeziums per DUID. Supports conditional bidding. 	Two trapeziums per DUID. Supports conditional bidding. 
CONTINGENCY FCAS			
Limited to single DUID (raise on gen-side, lower on load-side) 	Offered across full range. Better manages droop limits. 	Offered across full range. Better manages droop limits. 	Offered across full range. Better manages droop limits. 

FCAS Trapeziums in BDU Model

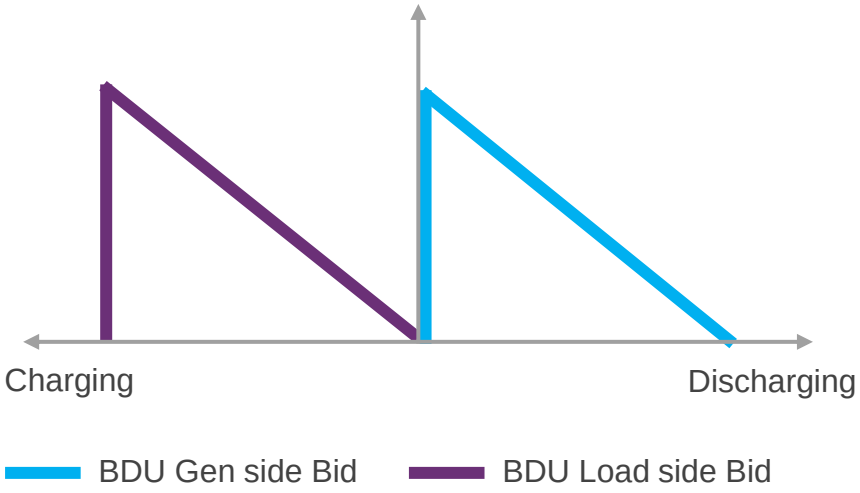
Regulation FCAS trapeziums

- Separate trapezium on the load and generation sides.
- Allows for conditional FCAS offers, with regulation FCAS across 10 bid bands per side (20 bands in total) for each raise and lower service
- Bid structure aligns with existing structures to reduce implementation costs

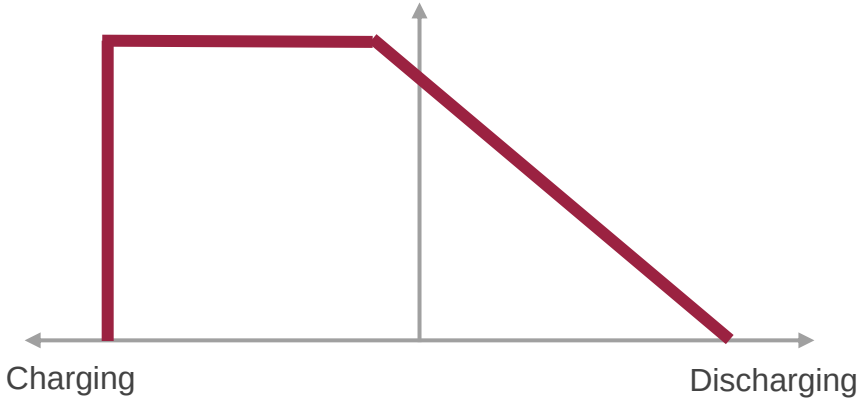
Contingency FCAS trapezium

- Single trapezium per service covers both load and generation sides.
- Allows enablement to cross the zero point.
- 10 bid bands across whole range, per service.

Regulation FCAS trapeziums (raise)



Contingency FCAS trapezium (raise)



4.1. Bid structure, validation and interfaces

Bid structure: Energy

	Load	Generation
Price Bands	1 to 10	1 to 10
Band Availabilities	Negative • Load Band MW ≥ Registered Minimum Capacity • ∑ Load Bands MW ≤ Registered Minimum Capacity	Positive • Gen Band MW ≤ Registered Maximum Capacity • ∑ Gen Bands MW ≥ Registered Maximum Capacity
Ramp Rate Up/Down	Positive/Positive	Positive/Positive
Max Availability*	Negative	Positive
PASA Availability	Negative	Positive
Energy Limit (optional)	Positive (Max Energy Limit)	Positive (Min Energy Limit)

*Note: To reduce implementation costs the “MaxAvail” field in the bid structures will be utilised for the load side to represent the minimum value with a negative sign convention.

Bid structure: Design details

- Bid “DailyEnergyConstraint” for the existing two-DUID model (defined for a trading day) will change to an interval-based bid Min Energy/Max Energy limit for the single DUID BDU model.
- NOTE: The option for semi-scheduled generating units and bidirectional units to submit fast start inflexibility profiles has been removed from the NER.

TI	DUID	Direction	BidType	Max Avail	Ramp Up Rate	Ramp Down Rate	Fixed Load	Energy Limit	PASA Avail
1	DUID_BDU1	Generation	ENERGY	250	8	8		0	250
1	DUID_BDU1	Load	ENERGY	-200	6	6	-10	100	-220
2	DUID_BDU1	Generation	ENERGY	250	8	8		0	250
2	DUID_BDU1	Load	ENERGY	-200	6	6		100	-220

Bid structure: Bands

Price Bands

Settlement Date	DUID	Direction	BidType	PriceBand1	PriceBand2	...	PriceBand9	PriceBand10
31/12/2024	DUID_BDU1	GENERATION	ENERGY	$0.00	$10.00	...	$302.98	$13,398.40
31/12/2024	DUID_BDU1	LOAD	ENERGY	-$1,000.00	-$171.65	...	$60.21	$299.50

Band Quantities

Settlement Date	TI	DUID	Direction	BidType	MaxAvail	BandAvail1	BandAvail2	...	BandAvail9	BandAvail10
31/12/2024	1	DUID_BDU1	GENERATION	ENERGY	250.00	100	50	...	20	0
31/12/2024	1	DUID_BDU1	LOAD	ENERGY	-200.00	-150	-20	...	0	0
31/12/2024	2	DUID_BDU1	GENERATION	ENERGY	250.00	100	50	...	20	0
31/12/2024	2	DUID_BDU1	LOAD	ENERGY	-200.00	-150	-20	...	0	0

Band Cumulation

Settlement Date	TI	DUID	Direction	BidType	MaxAvail	BandAvail1	BandAvail2	...	BandAvail9	BandAvail10
31/12/2024	1	DUID_BDU1	GENERATION	ENERGY	250.00	100	150	...	250	250
31/12/2024	1	DUID_BDU1	LOAD	ENERGY	-200.00	-150	-170	...	-180	-180
31/12/2024	2	DUID_BDU1	GENERATION	ENERGY	250.00	100	150	...	250	250
31/12/2024	2	DUID_BDU1	LOAD	ENERGY	-200.00	-150	-170	...	-180	-180

Bid validation

BAND PRICES

- Load
  - PriceBand1 < PriceBand2 < … < PriceBand9 < PriceBand10
  - Minimum Band1 price = MFP * Load Loss Factor
  - Maximum Band10 price = MPC * Load Loss Factor
- Generation
  - PriceBand1 < PriceBand2 < … < PriceBand9 < PriceBand10
  - Minimum Band1 price = MFP * Gen Loss Factor
  - Maximum Band10 price = MPC * Gen Loss Factor

BAND AVAILABILITIES

- Load
  - Band availability for each BandAvail1 to BandAvail10 ≥ Registered Load Capacity
  - Sum of availabilities BandAvail1 to BandAvail10 ≤ Registered Load Capacity
- Generation
  - Band availability for each BandAvail1 to BandAvail10 ≤ Registered Generation Capacity
  - Sum of availabilities BandAvail1 to BandAvail10 ≥ Registered Generation Capacity

Bid convexity validation

Bid convexity validation for each trading interval:

- An NER Rule requirement to validate **band prices monotonically increase**
- Prevents the concurrent dispatch of Load and Generation bands
- Load Bands with non-zero availability are validated against Generation Bands with non-zero availability (effective bands)
- "Effective band" refers to non-zero band MW capacity limited by bid MaxAvail
    - Bidding MaxAvail = 0 on Load-side allows the participant to shift band MW capacity into MFP-priced Gen Band 1 without violating the bid convexity rule
      This allows the BDU to compete with other BDU's and Gens at the MFP (and vice versa applies)
- **MLF-adjusted band prices for these effective bands must monotonically increase from Band 1 to Band 10 for both Load and Generator side**
- Load Bands should only have availability in bands priced lower than any of the Generation Bands with availability.

Load	Band1	Band2	Band3	...	Band8	Band9	Band10
Price Band (MLF adj)	-$1,000.00	-$500.00	-$300.00		**$0.00**	$30.00	$300.00
Band Availability (MW)	-20	-20	-20		**-20**	-20	-20

Generation	Band1	Band2	Band3	...	Band8	Band9	Band10
Price Band (MLF adj)	-$962.00	**-$23.99**	$0.01		$300.01	$7,500.01	$15,500.00
Band Availability (MW)	0	**50**	100		0	0	100

$ Load < $ Generation	Band1	Band2	Band3	...	Band8	Band9	Band10
Band1							
Band2	TRUE	TRUE	TRUE		**FALSE**	**FALSE**	**FALSE**
Band3	TRUE	TRUE	TRUE		TRUE	**FALSE**	**FALSE**
...							
Band8							
Band9							
Band10	TRUE	TRUE	TRUE		TRUE	TRUE	TRUE

Regulation FCAS trapezium parameters

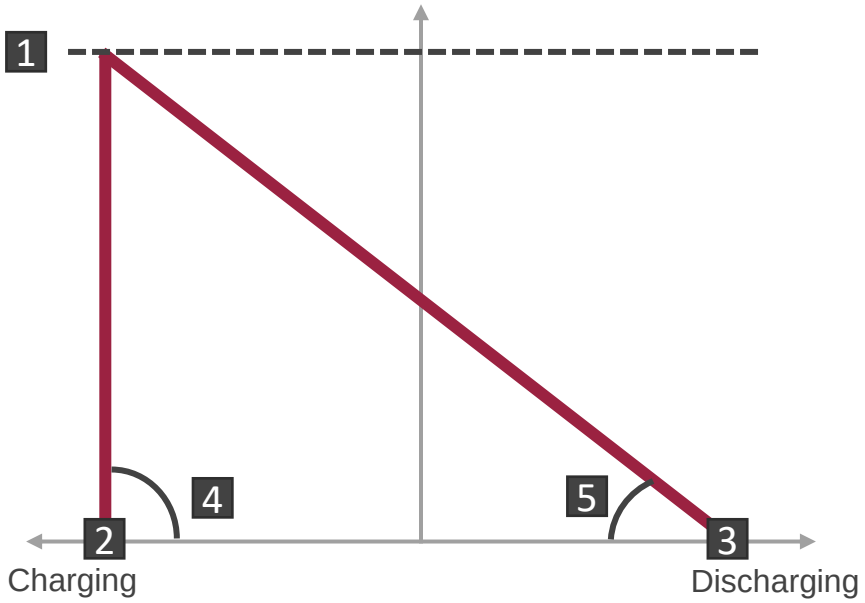
Registration data (Sch 3.1 Bid Validation Data)

- Maximum Capacity (1)
- Minimum Enablement Level (2)
- Maximum Enablement Level (3)
- Maximum Lower Angle (4)
- Maximum Upper Angle (5)

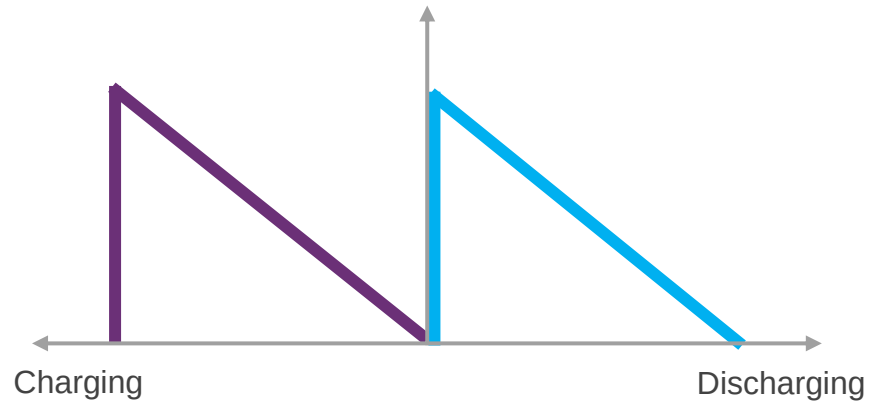
Separate bids for load + gen sides, but bids for both sides must be submitted simultaneously for validation

Load side	Generation side
$MaxAvail_{Load}$	$MaxAvail_{Gen}$
$EnablementMin_{Load}$	$EnablementMin_{Gen}$
$EnablementMax_{Load}$	$EnablementMax_{Gen}$
$LowBreakpoint_{Load}$	$LowBreakpoint_{Gen}$
$HighBreakpoint_{Load}$	$HighBreakpoint_{Gen}$

Conceptual registration trapezium



Regulation FCAS trapeziums in NEMDE (raise)

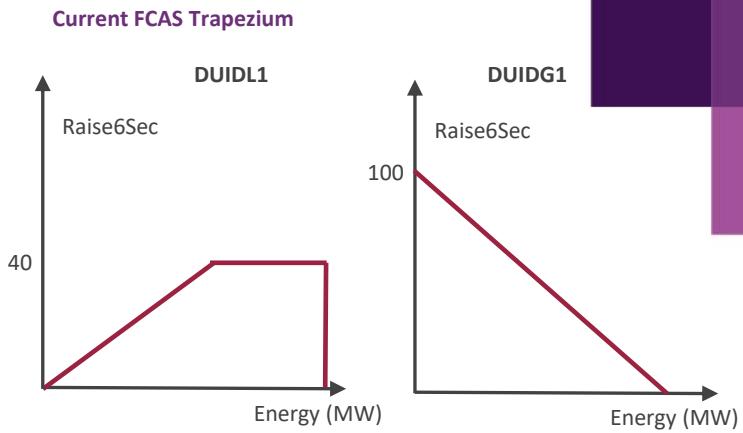


Bid structure: FCAS

Current Model

DUID	BIDTYPE	PriceBand1	PriceBand2	…	PriceBand9	PriceBand10
DUIDG1	RAISEREG	$0.00	$1.00	…	$128.00	$256.00
DUIDL1	RAISEREG	$0.00	$1.00	…	$128.00	$256.00
DUIDG1	RAISE6SEC	$0.00	$1.00	…	$128.00	$256.00

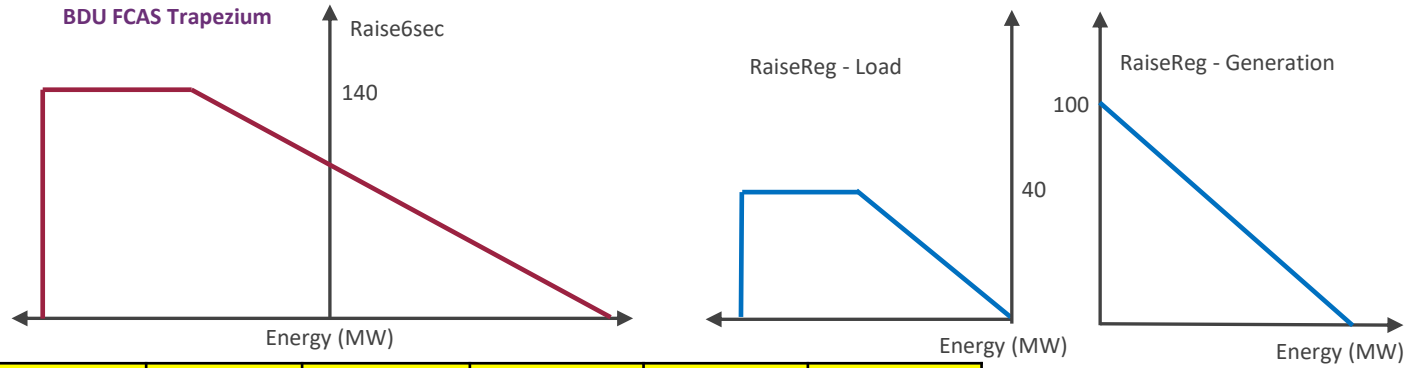
Simple example – further capping could apply when droop setting is considered



DUID	BIDTYPE	TI	BandAvail1	BandAvail2	…	BandAvail9	BandAvail10	Max Avail	Enablement Min	Low BreakPoint	High BreakPoint	Enablement Max
DUIDG1	RAISEREG	1	0	0	…	15	50	100	0	0	0	100
DUIDL1	RAISEREG	1	0	10	..	10	50	40	0	40	100	100
DUIDG1	RAISE6SEC	1	0	0	…	15	50	100	0	0	0	100

BDU Model

DUID	Direction	BIDTYPE	PriceBand1	PriceBand2	…	PriceBand9	PriceBand10
DUID_BDU1	Generation	RAISEREG	$0.00	$1.00		$128.00	$256.00
DUID_BDU1	Load	RAISEREG	$0.00	$1.00		$128.00	$256.00
DUID_BDU1	Bidirectional	RAISE6SEC	$0.00	$1.00		$128.00	$256.00



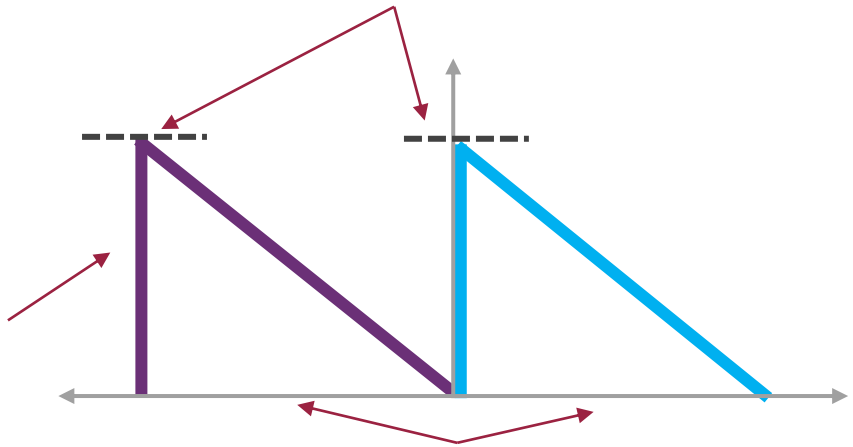
DUID	Direction	BIDTYPE	TI	BandAvail1	BandAvail2	…	BandAvail9	BandAvail10	Max Avail	Enablement Min	Low BreakPoint	High BreakPoint	Enablement Max
DUID_BDU1	Generation	RAISEREG	1	0	10	…	25	100	100	0	0	0	100
DUID_BDU1	Load	RAISEREG	1	0	10	…	25	100	40	-100	-100	-40	0
DUID_BDU1	Bidirectional	RAISE6SEC	1	0	10	…	25	100	40	-100	-100	-40	100

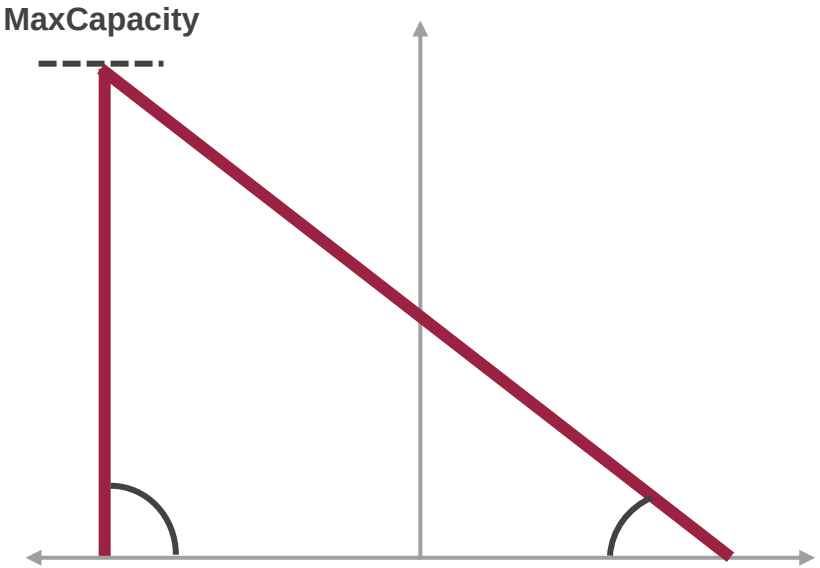
Validation of regulation FCAS trapeziums (1)

Ensures the trapeziums have a standard shape, and – when combined - are within the registered trapezium.

1. Combined load and generation regulation max availability must not exceed registered regulation max capacity: $MaxAvail_{Load} + MaxAvail_{Gen} <= MaxCapacity.$
2. Gen trapezium is defined on the positive side, and load trapezium is defined on the negative side.
3. Trapezium has a 'standard' shape: *EnablementMin <= LowBreakpoint <= High Breakpoint <= EnablementMax*.

Parameters define a standard trapezium shape.

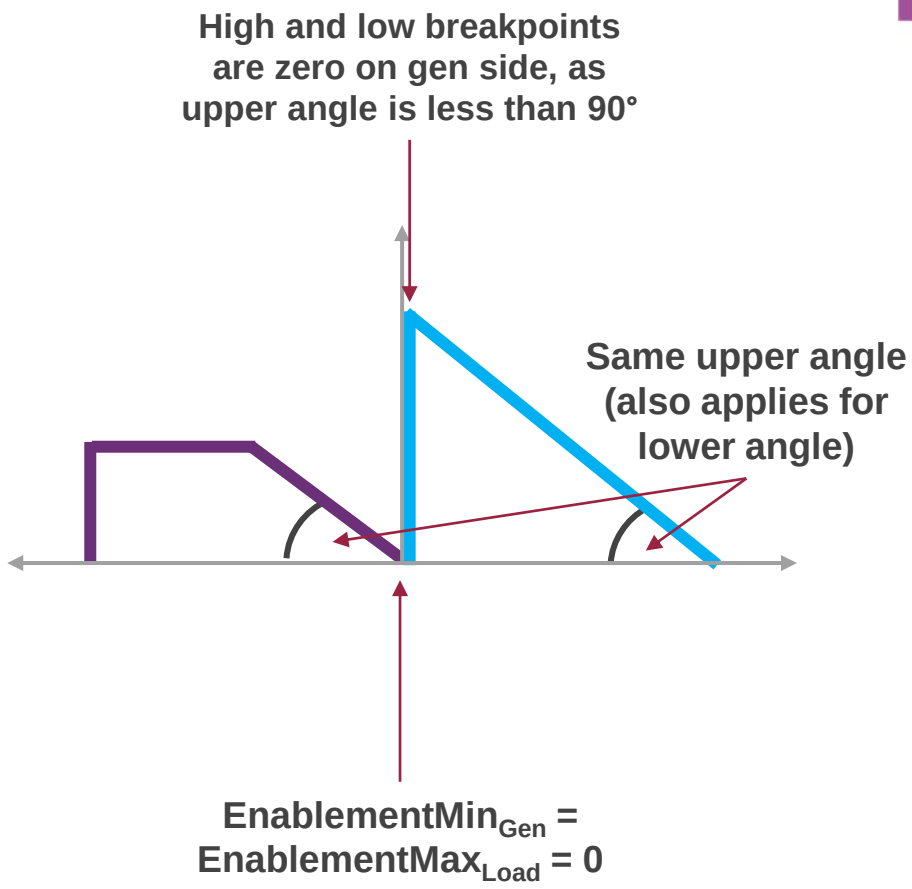




Validation of regulation FCAS trapeziums (2)

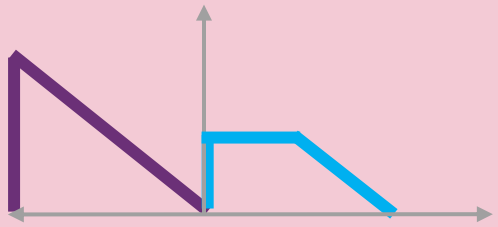
The following apply only if there is bid non-zero regulation max availability on <u>both</u> the load and gen sides:

1. Must be no ‘gaps’ between trapeziums:
   - $\text{EnablementMin}_{\text{Gen}} = 0$
   - $\text{EnablementMax}_{\text{Load}} = 0$
2. Both trapeziums must have the same upper angle.
3. Both trapeziums must have the same lower angle.
4. If the upper angle is less than 90°, high and low breakpoints <u>on the generation trapezium</u> must be set to zero.
5. Similarly, if the lower angle is less than 90°, high and low breakpoints <u>on the load trapezium</u> must be set to zero.

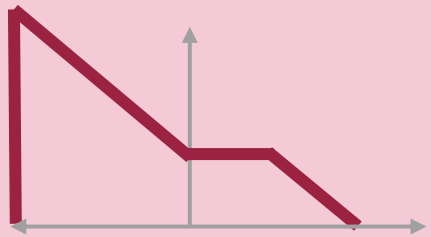


Examples of invalid regulation trapeziums (1)

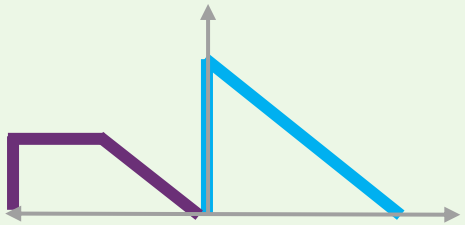
Invalid trapezium



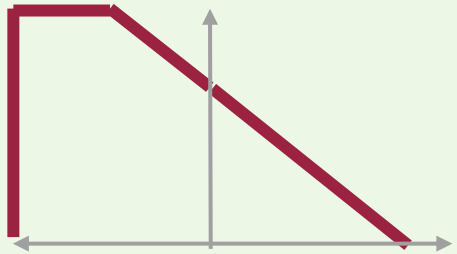
Combined



Valid alternative



Combined

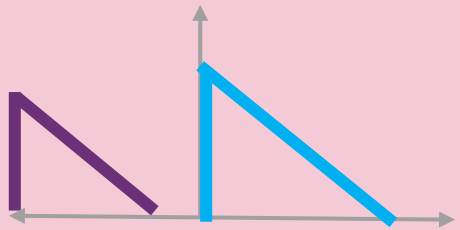


Explanation

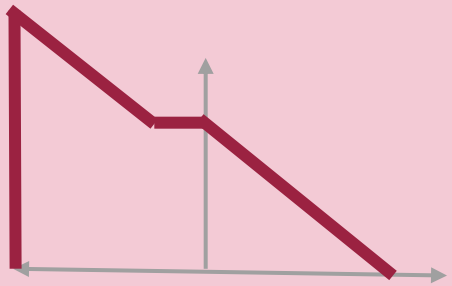
If the upper angle is less than 90°, both the low and high breakpoint on the generation side must be zero.

Examples of invalid regulation trapeziums (2)

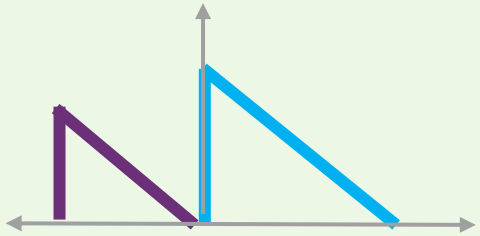
Invalid trapezium



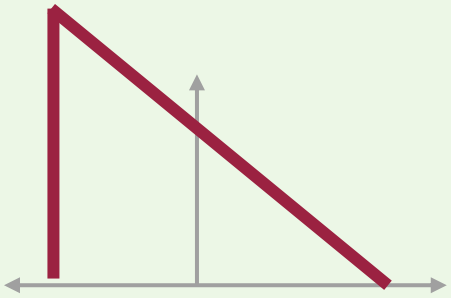
Combined



Valid alternative



Combined



Explanation

A gap between the trapeziums allows for non-convex solutions.

Resolved by setting $MaxEnablement_{Load} = 0$ (shown)
or $MaxAvail_{Gen} = 0$

Bidding interfaces

- System to System interfaces (via FTP and API) for bidding of Scheduled, Semi Scheduled Generators and Scheduled Loads will remain backwards compatible
  - Existing participant bidding systems will not require immediate changes on the rule effective date. This allows BESS operators to align any bidding changes with their transition date.
- System to System interfaces (via FTP and API) will be enhanced to allow BDU bid submissions within the existing portfolio bid structures
  - Participants will continue to be able to submit a bid with all elements of their scheduled portfolio.
- The web portal bidding user interface will be upgraded to support functions for a BDU
  - Review submitted bids
  - Enter Bids
  - Upload Bids.
- No changes to bid structures for other types of units.

4.2. SCADA requirements & dispatch instructions

SCADA requirements

No Changes

- Active Power (+/-, MW)
- Ramp Rates (+, MW/min)
  - Ramp Up (Import to Export direction)
  - Ramp Down (Export to Import direction)
- State of Charge (+, MWh)
  - Current (Initial SOC)
- AEMO's AGC calculation:
  - AGC Status (ON/OFF)
  - AGC Ramp Up Rate (+)
  - AGC Ramp Down Rate (+)
  - AGC Upper Limit (+/-)
  - AGC Lower Limit (+/-)

Dispatch instructions

DISPATCH INSTRUCTIONS

- Dispatch Target (MW) via market systems/AGC
  - Negative for load (consumption)
  - Positive for generation (production)
- Conformance Mode (only applicable if participating in Aggregated Dispatch Conformance)
- FCAS Enabled (MW)
  - Positive (no change)

ENERGY STORAGE (MWh)

- Apply to NEMDE Pre-dispatch/PD7DAY
- Future PASA only (post-July 2025)

Dispatch Target Example

Charging

Current Model

DUID	TOTALCLEARED	RAISE1SEC	RAISE6SEC	RAISE60SEC	RAISE5MIN	RAISEREG	LOWER1SEC	LOWER6SEC	LOWER60SEC	LOWERMIN	LOWERREG
DUIDG1	0	5	6	19	10	60	0	0	0	0	0
DUIDL1	40	0	0	0	0	10	5	6	19	10	60

BDU Model

DUID	TOTALCLEARED	RAISE1SEC	RAISE6SEC	RAISE60SEC	RAISE5MIN	RAISEREG	LOWER1SEC	LOWER6SEC	LOWER60SEC	LOWERMIN	LOWERREG
DUID_BDU1	-40	5	6	19	10	70	5	6	19	10	60

Discharging

Current Model

DUID	TOTALCLEARED	RAISE1SEC	RAISE6SEC	RAISE60SEC	RAISE5MIN	RAISEREG	LOWER1SEC	LOWER6SEC	LOWER60SEC	LOWERMIN	LOWERREG
DUIDG1	30	5	6	19	10	50	0	0	0	0	30
DUIDL1	0	0	0	0	0	0	5	6	19	10	50

BDU Model

DUID	TOTALCLEARED	RAISE1SEC	RAISE6SEC	RAISE60SEC	RAISE5MIN	RAISEREG	LOWER1SEC	LOWER6SEC	LOWER60SEC	LOWERMIN	LOWERREG
DUID_BDU1	30	5	6	19	10	50	5	6	19	10	80

Q&A and meeting close

For more information visit

aemo.com.au

Appendix A: IESS Glossary

IESS Glossary

Term	Definition
5MPD	5-minute pre-dispatch
AGC	Automatic generation control
ASL	Ancillary service load
ASU	Ancillary service unit
B2B	Business-to-business
B2M	Business-to-market
BDU	Bidirectional unit
BESS	Battery energy storage system
CR	Change request
CRMP	Cost recovery market participant
DRSP	Demand response service provider
DUID	Dispatchable unit identifier
FRMP	Financially responsible market participant
IESS	Integrating Energy Storage Systems rule
IRP	Integrated resource provider

Term	Definition
IRS	Integrated resource system
MSATS	Market settlements and transfer solutions
MSGA	Market small generation aggregator
MT PASA	Medium-term PASA
NCC	NMI classification code
NECR	Non-energy cost recovery
NEMDE	National electricity market dispatch engine
NMI	National metering identifier
PAE	Profiling and allocation engine
PASA	Projected assessment of system adequacy
PD	Pre-dispatch
PMS	Portfolio management system
SCADA	Supervisory control & data acquisition
SoC	State of charge
UFE	Unaccounted for energy
WDRU	Wholesale demand response unit

Appendix B:
Competition law meeting protocol

AEMO Competition Law - Meeting Protocol

AEMO is committed to complying with all applicable laws, including the Competition and Consumer Act 2010 (CCA). In any dealings with AEMO regarding proposed reforms or other initiatives, all participants agree to adhere to the CCA at all times and to comply with this Protocol. Participants must arrange for their representatives to be briefed on competition law risks and obligations.

Participants in AEMO discussions **must**:

- Ensure that discussions are limited to the matters contemplated by the agenda for the discussion
- Make independent and unilateral decisions about their commercial positions and approach in relation to the matters under discussion with AEMO
- Immediately and clearly raise an objection with AEMO or the Chair of the meeting if a matter is discussed that the participant is concerned may give rise to competition law risks or a breach of this Protocol

Participants in AEMO meetings **must not** discuss or agree on the following topics:

- Which customers they will supply or market to
- The price or other terms at which Participants will supply
- Bids or tenders, including the nature of a bid that a Participant intends to make or whether the Participant will participate in the bid
- Which suppliers Participants will acquire from (or the price or other terms on which they acquire goods or services)
- Refusing to supply a person or company access to any products, services or inputs they require

Under no circumstances must Participants share Competitively Sensitive Information. Competitively Sensitive Information means confidential information relating to a Participant which if disclosed to a competitor could affect its current or future commercial strategies, such as pricing information, customer terms and conditions, supply terms and conditions, sales, marketing or procurement strategies, product development, margins, costs, capacity or production planning.

Please visit: https://aemo.com.au/en/consultations/industry-forums-and-working-groups

Appendix C:
BDU model technical information

- A1: Energy storage limits
- A2: Ramp rates
- A3: Price ties

A1: Energy storage limits (State of charge)

Issues with current Energy Storage model

Current bid daily energy limit model is problematic for BDU, and is not recommended:

- Energy limit is defined for a trading day and not profiled over the trading day
- Energy limit applies once over the whole trading day, rather than potentially multiple times within and across trading days
- Model only applies to PASA and NEMDE Pre-dispatch, not NEMDE Dispatch and 5MPD
- Model does not initialise to the current SCADA stored energy, but to the bid daily energy limit *minus* energy used since 0400 (based on dispatch targets)
- Model does not recognise energy storage headroom limits
- Because of these limitations, many existing BESS do not use the current model

BDU Energy Storage model: Information requirements

REGISTERED STANDING DATA

- **Minimum Energy** (typically zero) and **Maximum Energy** (MWh)
- **Import and Export Storage Efficiency Factors** (between 0..1)
  - Export Efficiency Factors = (Exported Energy / Change in Stored Energy)
  - Import Efficiency Factors = (Change in Stored Energy/ Imported Energy)

AEMO STANDING DATA

FCAS Raise Regulation Usage Factor and **FCAS Lower Regulation Usage Factor** (between 0..1)

- Regulation Used / Regulation Enabled
- Use in energy storage calculation, to adjust the energy utilised in providing regulation.
- Determined by AEMO based on historical analysis

BID DATA

- **Energy Limit** (MWh) Min on Generation side and Max on the Load Side
  - Either null (no energy limit) or defined for trading intervals of trading day bid
  - Must be ≤ Registered values

SCADA DATA

- **Current Energy** (MWh, aka State of Charge for BESS or Initial SOC)

BDU Energy Storage model: Application of Energy Storage Limits

Constraints on Target MW due to Energy Storage Limits in Predispatch (PD/7DayPD only)

Only applied if the participants opt-in.

Upper bound (constrain-off generation to avoid going below minimum energy storage)…

Target MW ≤ Max **{** 0, **[{** (Initial SOC – bid Min Energy Limit) / (Time Period/2) **}** - Initial MW **]** **}**

Lower bound (constrain-off load to avoid going above maximum energy storage)…

Target MW ≥ Min **{** 0, **[{** (Initial SOC – bid Max Energy Limit)) / (Time Period/2) **}** - Initial MW **]** **}**

Note: Will not constrain a BESS to within bid energy limits if the initial SoC is outside bid limits

where;

Initial SoC: Telemetered (via SCADA) State of Charge (+) at the start of the interval

Min Energy Limit = Minimum energy storage; positive (bid Energy Limit from the Generation side)

Max Energy Limit = Maximum energy storage; positive (bid Energy Limit from the Load side)

BDU Energy Storage model: Tracking Energy Storage

For each interval the remaining energy is calculated based on the cleared energy and regulation targets from the NEMDE solution for that interval .

Remaining Energy Storage = Max [0 , Initial Energy Storage – Efficiency Adjusted Energy Used]

Efficiency Adjusted Energy Used = Adjusted efficiency Factor *
{
(Initial MW + Target MW) / 2
+ (Raise Reg Enabled MW * Raise Reg Usage Factor)
- (Lower Reg Enabled MW * Lower Reg Usage Factor)
}
*** Time Period**

Where:

Adjusted efficiency Factor : If importing then ‘import efficiency factor’ else 1/’export efficiency factor’.

Initial MW = current SCADA active power (first interval) , or previous trading interval’s Target MW; positive or negative

Initial Energy Storage = current SCADA SOC (first interval), or previous trading interval’s Remaining Energy Storage; always positive

Target MW = NEMDE dispatch target ; positive or negative

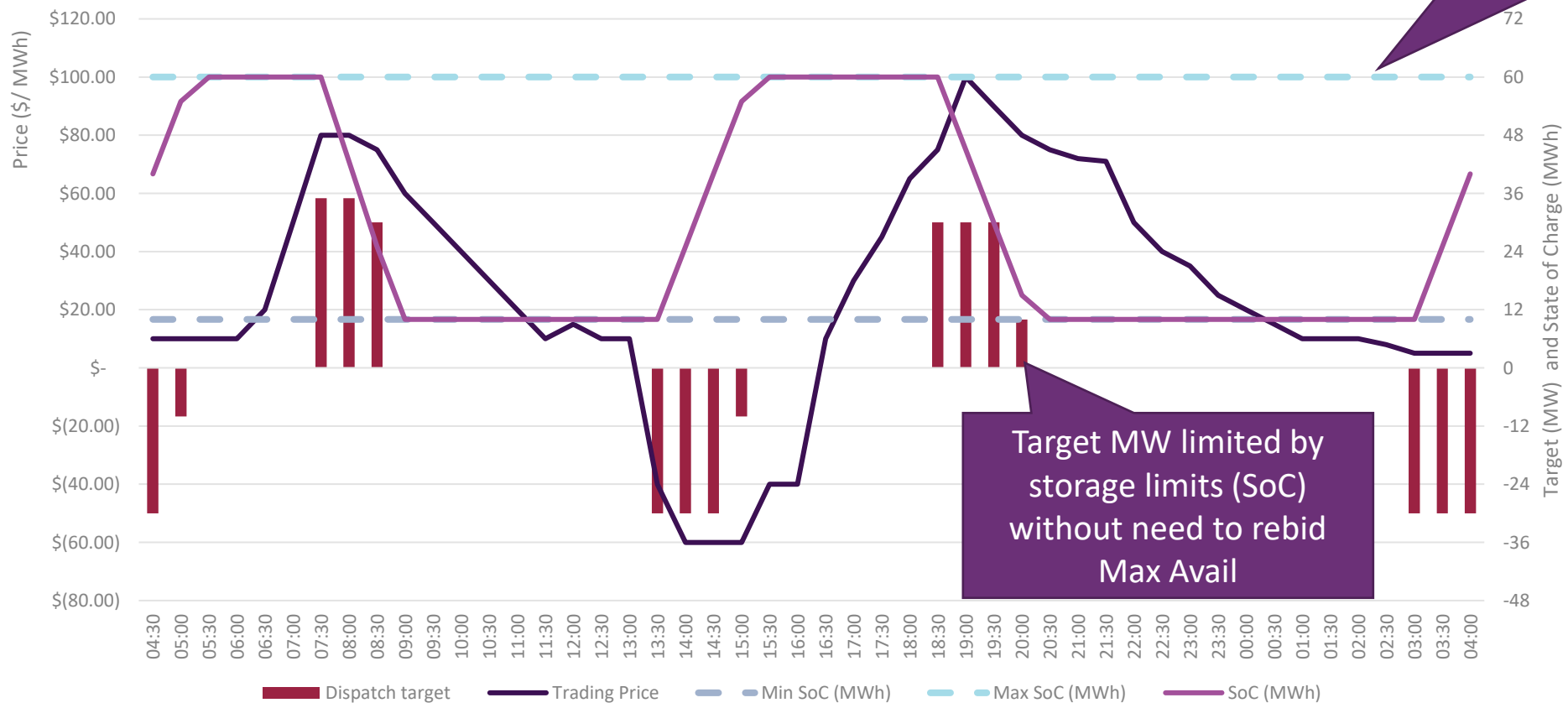
Raise Reg Enabled MW , Lower Reg Enabled MW; positive

Raise Reg Usage Factor, Lower Reg Usage Factor; positive between 0..1 .

Time Period = Interval Length (hours)

Application of Energy Storage Limits

Example dispatch profile of a 30 MW / 60 MWh battery



A2: Ramp rates

Ramp rates

- A separate set of Ramp Rates (all positive) are defined for each direction and for each of Generation and Load sides
  - Registration (Maximums)
  - Bid
- NEMDE calculates composite bid Ramp Up and Ramp Down constraints:
  - When ramping from load to generation:
    - Use the bid Load Ramp Down Rate to reduce load to 0, then
    - Use the bid Gen Ramp Up Rate to increase generation from 0
  - When ramping from generation to load:
    - Use the bid Gen Ramp Down Rate to reduce generation to 0, then
    - Use the bid Load Ramp Up Rate to increase load from 0
- SCADA Ramp Up and Ramp Down Rates (directional only, not defined for each side)
- NEMDE uses the minimum (SCADA, Composite bid Ramp Rate) for first TI

Composite ramp rate constraint

- Composite ramp up rate constraint
  - Target MW ≤

    min {Initial MW + [SCADA Ramp Up Rate * TimePeriodConstant*60]

    ,

    If Initial MW ≥ 0

    then Initial MW + [Gen Bid Ramp Up Rate * TimePeriodConstant*60]

    else

    min {0, Initial MW + [Load Bid Ramp Down Rate * TimePeriodConstant*60]} +

    [Gen Bid Ramp Up Rate * max {0,(TimePeriodConstant*60 – [ABS(Initial MW)/Load Bid Ramp Down Rate])}]

    }

- Composite ramp down rate constraint
  - *Target MW ≥*

    max {Initial MW - [SCADA Ramp Down Rate * TimePeriodConstant*60]

    ,

    If Initial MW ≤ 0

    then Initial MW - [Load Bid Ramp Up Rate * TimePeriodConstant*60]

    else

    max {0, Initial MW - [Gen Bid Ramp Down Rate * TimePeriodConstant*60]} -

    [Load Bid Ramp Up Rate * max {0,(TimePeriodConstant*60 – [ABS(Initial MW)/Gen Bid Ramp Down Rate])}]

    }

Composite Ramp Rates - Example (1)

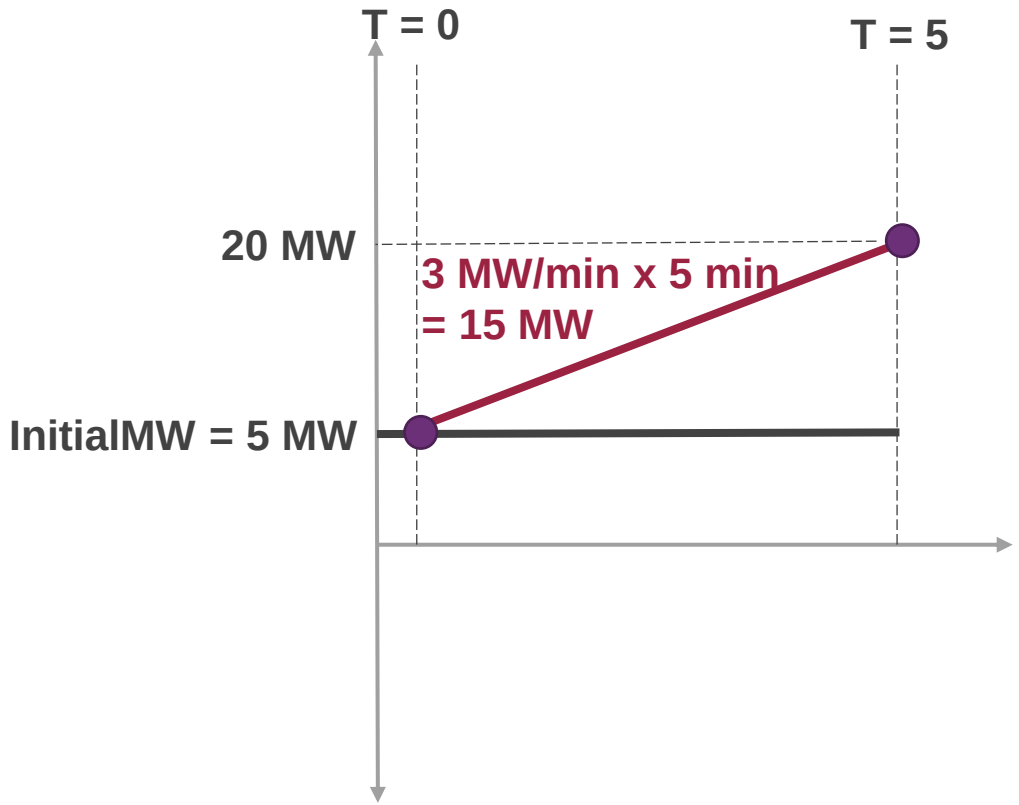
Stakeholder feedback requested an example of how composite ramp rates work in NEMDE.

For BDUs, separate load/gen-side ramp rates may be specified. Consider ramping in the direction of decreasing load/increasing generation, with ramp-rate limits of:

- **Load side:** 5 MW/min
- **Generation side:** 3 MW/min

If the InitialMW is in the generation side (5 MW), increases to the TargetMW will be limited by the gen-side rate only.

TargetMW <= 5 MW + 3 MW/min × 5 min = 20 MW



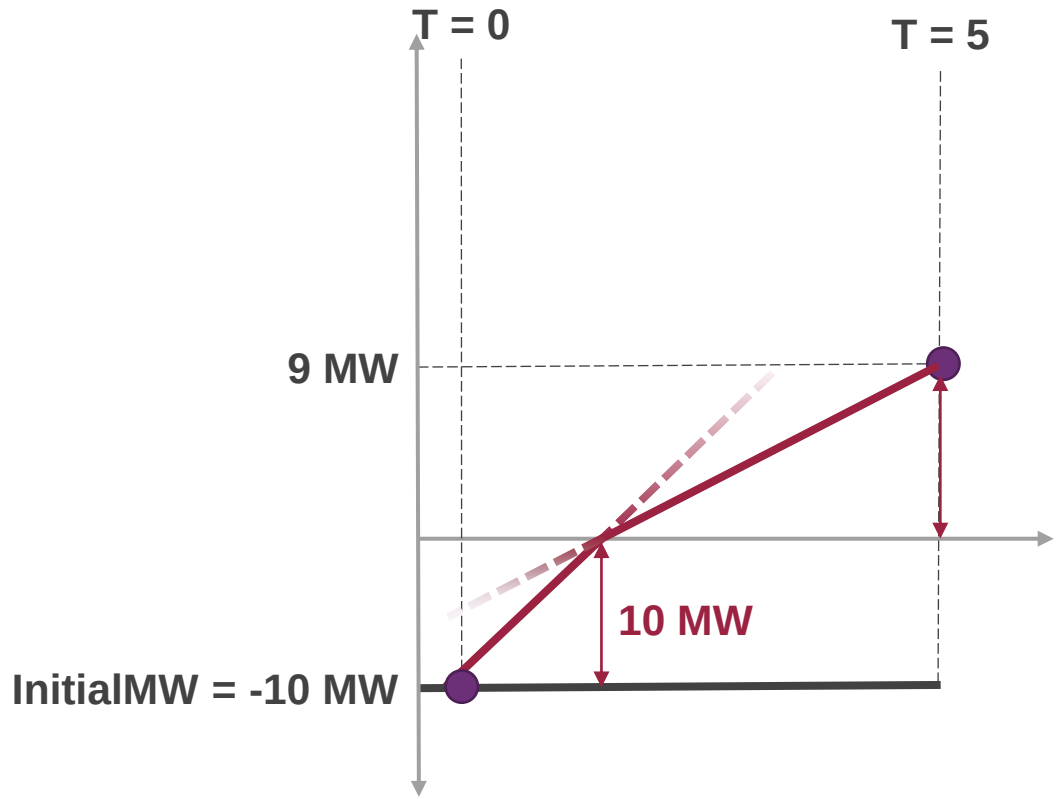
Composite Ramp Rates - Example (2)

Instead consider that the InitialMW is in the load side (-10 MW).

TargetMW will be limited by the load-side rate… but may also be limited by the gen-side rate.

TargetMW <= MIN(0, 5MW/min × 5min)
+ 3MW/min × MAX(0, 5min - ABS(-10 MW) / 5MW/min)
= 9 MW

Ramp rates will also be limited by the SCADA ramp rate limit.



A3: Price ties

Price ties and energy dispatch

No change proposed to the current principles for resolving price-tied energy bands based on their relative Band MW:

- BDU Load Bands are pro-rata dispatched against other price-tied BDU Load Bands and Scheduled Loads within the same region
  - Includes scheduled loads for legacy 2-DUID BDUs
- BDU Gen Bands are pro-rata dispatched against other price-tied BDU Gen Bands and Scheduled/Semi-Scheduled Gens within the same region
  - Includes scheduled generating units for legacy 2-DUID BDUs

Appendix D:
Project commitment criteria

Proposed generation in the NEM (1/3)

In addition to capacity forecasts, generation plant owners advise AEMO about the status of generation projects currently under development in each region.

Generation projects can be at different stages of development (i.e. Project Commitment Status), which are assessed using AEMO's five (5) commitment criteria, covering site acquisition, contracts for major components, planning and other approvals, financing, and construction (see table below for a description of the criteria).

Criteria Name	Description
Land	The project proponent has purchased / settled / acquired (or commenced legal proceedings to purchase / settle / acquire) land for the construction of the project.
Contracts	Contracts for the supply and construction of major plant or equipment components (such as generating units, turbines, boilers, transmission towers, conductors, and terminal station equipment) have been finalised and executed, including any provisions for cancellation payments.
Planning	The proponent has obtained all required planning consents, construction approvals, connection contracts (including approval of proposed negotiated Generator Performance Standards from AEMO under clause 5.3.4A of the National Electricity Rules), and licences, including completion and acceptance of any necessary environmental impact statements.
Finance	The financing arrangements for the proposal, including any debt plans, must have been concluded and contracts executed.
Construction	Construction of the proposal must either have commenced or a firm commencement date must have been set. Commercial use date for full operation must have been set.

Proposed generation in the NEM (2/3)

Traffic light categories

Traffic Light Colour	Symbol
Red	
Amber	
Green	

NOTE:

1) A commitment criterion is deemed to be “satisfied” if all associated questions have been answered in the positive, making the category "green".
2) A commitment criterion is deemed to have “progressed” if the category is “amber” or "green".

Application of Traffic light categorisation to Project Commitment Criteria to classify Commitment Status

Project Commitment criteria must have been satisfied to at least the minimum level of traffic light categorisation that is required for each Commitment Status classification, as shown in the table

		← Increasing certainty (Commitment Status)				
	Criteria	Committed	Committed*		Anticipated	Publicly Announced
← Increasing project maturity	Land					
	Contracts					
	Planning					
	Finance					
	Construction					

Proposed generation in the NEM (3/3)

FURTHER DESCRIPTION OF COMMITMENT STATUS

New production and transmission projects fall into one of six classes of certainty (Commitment Status).

The Commitment Status is determined by assessing the progress of a Generation Project against the Project Commitment Criteria, as outlined above.

Commitment Status	Summary Status	Description
Committed	Committed	Projects that will proceed, with known timing, satisfying all five of the commitment criteria. That is, all categories are green.
Committed*	Committed	Projects that are highly likely to proceed, satisfying Land, Finance and Construction criteria plus either Planning or Components criteria. Progress towards meeting the final criteria is also evidenced and construction or installation has also commenced. Typically, Committed* projects are included in sensitivity analysis for MLF calculations and in the base case for reliability assessments.
Anticipated	Proposed	Scheduled and semi-scheduled generation projects that are sufficiently progressed towards meeting at least three of the five commitment criteria are assigned a commitment status classification of anticipated for ISP purposes. If a generation information survey has not been submitted by the project proponent in the previous six months the project will no longer be classified as anticipated.Typically, anticipated projects are included in integrated system planning, but not in reliability assessments.
Publicly announced	Proposed	These projects have been announced publicly and are not yet sufficiently progressed to be regarded as Anticipated, Committed* or Committed.

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