Bidirectional unit price band bid validation

Fact Sheet

This fact sheet provides background information and guidance on the bidirectional unit energy bid price band validation, which requires that prices increase monotonically for bid price bands with available capacity.

Context

The changes for integrating energy storage systems (IESS) to the National Electricity Rules (NER) introduces the scheduled bidirectional unit (BDU). The BDU classification will enable storage units to submit a single bid and to receive a single dispatch instruction (compared with the previous state where storage participated as two units – generation and load).

The IESS rule extends the same dispatch bid validations to bidirectional units that are currently applied to scheduled generators. Clause 3.8.6(h)(2) of the NER states:

> *prices specified for each price band specified in the dispatch bid must increase monotonically with an increase in available MWs;*

AEMO manages this rule requirement via bid price validations. These validations are more complex for BDUs than for individual generators or loads because different loss factors may apply to each direction.

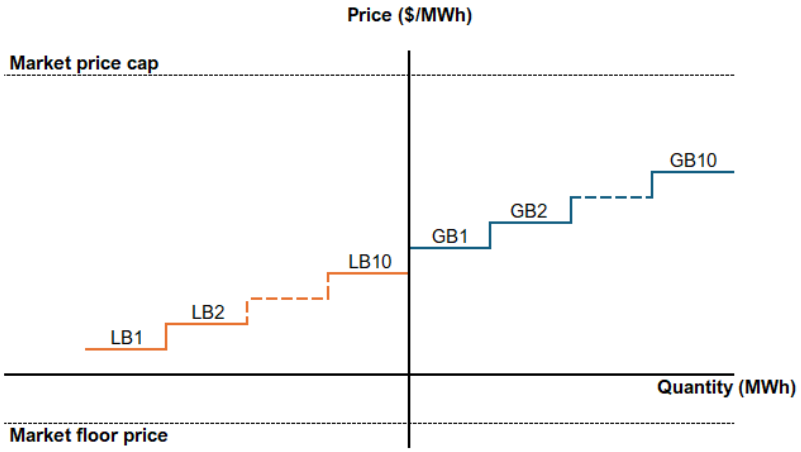
This fact sheet provides background information on the allowable BDU energy bids and examples of how these are validated.

BDU bidding for energy

Up to 20 bid bands are available for submission in respect of a scheduled BDU energy bid. These bid bands are restricted to a maximum of 10 bands for capacity on both the consumption side and 10 bands for capacity on the generation side.

Like bids for existing unit types, prices in BDU bid bands are required to monotonically increase in each direction. Figure 1 shows a theoretical example where all 20 price bands are bid with non-zero capacity.

Figure 1 Theoretical: 20 effective bid bands (10 Load and 10 Generation) for scheduled BDUs



Where:
LB = load bid band for consumption
GB = generation bid band for production

Note:
Consumption-side MLF is applied to prices in the consumption bid bands.
Generation-side MLF is applied to prices in the generation bid bands.

In operational circumstances, asset operators are likely to require access to a range of price bands from Market Floor Price to Market Price Cap, for both consumption and generation, to manage changing market conditions.

To enable this capability, AEMO will apply an additional bid validation (sometimes called 'bid convexity validation') only to the '**effective**' price bands to enforce the NER Cl 3.8.6(h)(2) requirement across the consumption and generation price bands.

'Effective' price bands are the non-zero capacity bands up to the relevant direction's bid MaxAvail, that is accumulated as:

- For the load side, from price band 10 to 1
- For the generation side, from price band 1 to 10

For example, in Table 1 below, only price bands 2, 3 and 5 are effective price bands for the consumption direction because the MaxAvail is 300MW, likewise price bands 3, 5, 6 and 10 are the effective price bands for the generation direction as the MaxAvail is 400MW. Note that only 100MW is effectively available in price band 10 for generation.

Table 1 Effective price bands

MaxAvail	Consumption Band Capacity (MW)									
	PB1	PB2	PB3	PB4	PB5	PB6	PB7	PB8	PB9	PB10
300	300	100	100	0	100	0	0	0	0	0

MaxAvail	Generation Band Capacity (MW)									
	PB1	PB2	PB3	PB4	PB5	PB6	PB7	PB8	PB9	PB10
400	0	0	100	0	100	100	0	0	0	300

Figure 2 reflects the data from Table 1 above where only some of the price bands are effective. The effective price bands are shown in solid lines, while non-effective price bands are shown in dotted lines. The prices shown here are the marginal loss factor (MLF) adjusted prices referenced at the relevant regional reference node (RRN), see MLF price adjustment information in the 'BDU price band validation' section on the next page.

Figure 2 Typical 20 price bands for scheduled BDUs – mix of effective and non-effective price bands

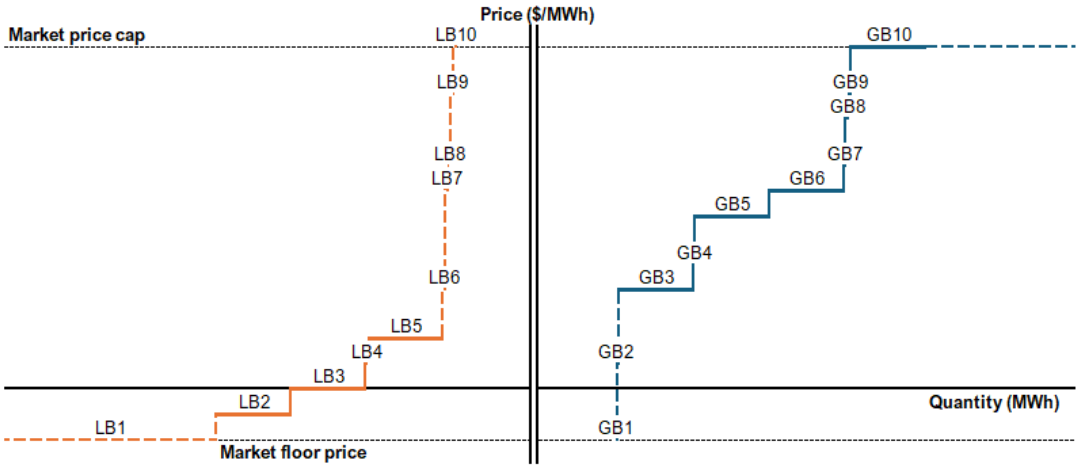
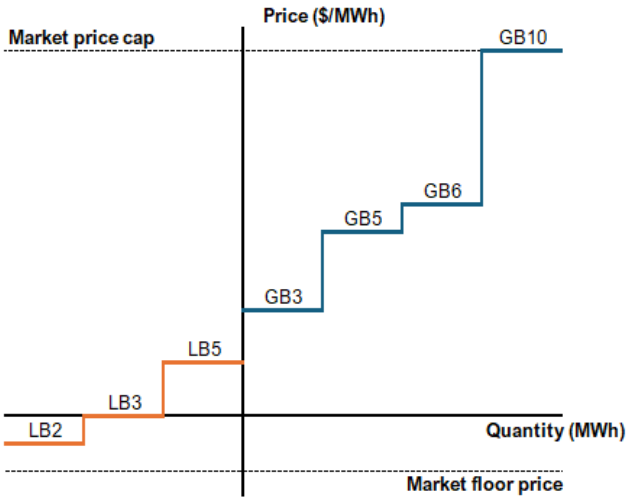


Figure 3 reflects only the effective price bands from Figure 2. Note that LB1 and GB1 have the same price (Market Floor Price) however they are not effective price bands. Similarly, LB10 and GB10 have the same price (Market Price Cap) but only GB10 is an effective price band.

Figure 3 Typical 20 price bands for scheduled BDUs – view with combined effective price bands only



Fact Sheet

BDU price band validation

The BDU price band validation ensures that bids are monotonically increasing across the combined consumption and generation bands, so that consumption and generation quantities cannot be simultaneously selected at a single energy price.

As part of this validation, the prices relate to the applicable regional reference node (RRN), noting that BDUs have separate marginal loss factors (MLFs) applied to the consumption and generation bands. The bid price at the regional reference node (RRN) is calculated as

$$P_{RRN} = P_{CP}/LF$$

Where:

P_{RRN} and **P_{CP}** are the prices referenced to the RRN and the connection point, respectively

LF is the relevant (consumption or generation-side) loss factor

Example A: Impact of loss factor adjustment on BDU bid prices and validation

To demonstrate the effect of the loss factor adjustment, consider a BDU with marginal loss factors of $LF_G = 0.99$ and $LF_C = 0.98$ on the generation and consumption bands respectively.

Table 2 shows how a consumption-side bid price may be less than a generation-side bid price at the connection point, but greater when adjusted by the loss factor to apply at the RRN. The validation will ensure that bid prices remain monotonically increasing after adjustment by the MLF.

Table 2 Valid and invalid BDU bids after adjustment by the respective MLFs

	Last consumption effective price band		First generation effective price band	
	At connection point	Adjusted to RRN	At connection point	Adjusted to RRN
Invalid bid	\$299/MWh	\$299/0.98 = \$305.10/MWh	\$300/MWh	\$300/0.99 = \$303.03/MWh
Valid bid	\$295/MWh	\$295/0.98 = \$301.02/MWh	\$300/MWh	\$300/0.99 = \$303.03/MWh

The MLF-adjustment for bid validation is summarised below:

- MLF-adjusted price bands must monotonically increase over the ten price bands for the consumption side - from Load Band 1 through to Load Band 10.
- Similarly, MLF-adjusted price bands must monotonically increase over the ten price bands for the generation side - from Generation Band 1 through to Generation Band 10.
- MLF-adjusted price bands for **effective price bands** must monotonically increase from Load Bands through to Generation Bands.

The bid validation considers each interval independently. This allows participants to adjust bid quantities throughout the day as conditions change.

It should be noted that while the bid maximum availability does limit the effective price bands, the primary purpose of the maximum availability is to inform the market scheduling and PASA processes[1] on the physical availability of the plant.

Example B: Allowable overlapping generation and consumption-side bids

A price at which a participant wishes to sell energy at one time of the day may later be a price at which the participant wishes to buy energy (under the expectation that prices will be even higher later). The BDU bid price validation allows this because it is applied interval-by-interval on effective price bands only, as shown in Table 3. Here, band 9 for consumption is priced greater than band 2 for generation, which is acceptable if these price bands are not effective concurrently in any trading interval (TI).

Table 3 Allowable overlapping generation and consumption-side bids, where the quantity offered is for consumption or generation at that price.

TI	Load Band 1	Load Band 2 …	Load Band 8	Load Band 9 …	Gen Band 2	Gen Band 3 …	Gen Band 9	Gen Band 10
Prices	-$999	-$300	$29	$149	$30	$150	$1000	$15000
…	…	…	…	…	…	…	…	…
15:00	100	50	50	50	0	0	50	100
15:05	100	100	50	0	0	50	0	100
15:10	100	150	0	0	50	50	50	0
…	…	…	…	…	…	…	…	…

[1] Projected assessment of system adequacy (PASA). See also: https://aemo.com.au/en/energy-systems/electricity/national-electricity-market-nem/nem-forecasting-and-planning/forecasting-and-reliability/projected-assessment-of-system-adequacy

Example C: Structuring a BDU bid for different scenarios

The BDU is a +/-250 MW capacity battery with marginal loss factors of LF_G = 0.99 and LF_C = 0.98 on the generation and load sides respectively. Typically, both the load and generation bids will include price bands that range from the Market Floor Price to the Market Price Cap.

Table 4 presents a valid bid for a set of scenarios, each in a different trading interval. In each scenario the price band capacity has been adjusted to match the operational intent and ensure the effective price bands on the generation side increases in price compared with the load side. The maximum availability has only been used in the scenarios that align with the physical capability of the unit, and to enable:

- generation to be bid at the Market Floor Price, or
- load to be bid at the Market Price Cap.

The highlighted band for each interval is the effective price band.

Table 4 Structuring a BDU bid for different scenarios

TI	Load Max Avail	Load Band 1	Load Band 2 …	Load Band 5 …	Load Band 9	Load Band 10	Gen Band 1	Gen Band 2 …	Gen Band 5 …	Gen Band 9	Gen Band 10	Gen Max Avail
Bid Prices		-$980	-$800	-$100	$4,949	$16,268	-$990	-$80	$60	$5,000	$16,434	
Bid Prices at RRN		-$1,000	-$816	-$102	$5,050	$16,600	-$1,000	-$81	$61	$5,051	$16,600	
…	…	…	…	…	…	…	…	…	…	…	…	…
12:00	250	0	150	100	0	0	0	0	100	50	100	250
…	…	…	…	…	…	…	…	…	…	…	…	…
13:00	250	0	0	0	250	0	0	0	0	200	50	100
…	…	…	…	…	…	…	…	…	…	…	…	…
14:00	250	0	0	0	0	250	0	0	0	0	250	0
…	…	…	…	…	…	…	…	…	…	…	…	…
15:00	250	0	0	250	0	0	0	250	0	0	0	250
…	…	…	…	…	…	…	…	…	…	…	…	…
16:00	0	250	0	0	0	0	250	0	0	0	0	250
…	…	…	…	…	…	…	…	…	…	…	…	…

Interval 12:00: The intent to consume when prices are low and generate when prices are high.

Interval 13:00: Battery storage is low, and the intent is to consume unless the price is very high.

Interval 14:00: The battery has no charge, and the intent is to consume energy even at high prices by placing all load at the market price cap and setting the generation maximum availability to zero.

Interval 15:00: Battery storage is close to full, and the intent is to generate unless the price is very low.

Interval 16:00: The battery is fully charged, and the intent is to generate energy even at low prices by placing all generation at the Market Price Floor and setting the load maximum availability to zero.

Where can I find more information?

AEMC's IESS determination & rule	https://www.aemc.gov.au/rule-changes/integrating-energy-storage-systems-nem
AEMC's Implementing IESS determination & rule	https://www.aemc.gov.au/rule-changes/implementing-integrated-energy-storage-systems
AEMO's IESS participant toolbox	https://aemo.com.au/initiatives/major-programs/integrating-energy-storage-systems-project/integrating-energy-storage-systems-faqs
AEMO's IT change and release management	https://aemo.com.au/energy-systems/market-it-systems/it-change-and-release-management

For any further enquiries, please contact AEMO's Information and Support Hub via

- supporthub@aemo.com.au or
- call 1300 236 600

This fact sheet is only a summary of the BDU price band bid validation arrangements. Applicants are responsible for ensuring they understand the relevant provisions of the National Electricity Rules and other applicable instruments, which prevail in the case of any inconsistency.