WEM Standalone Calculations

Australian Energy Market Operator

Applicable Trading Days: 1 October 2023
Version 2.0
Version published: 25 August 2023

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Version Control

A major version change occurs when the WEM Rules or WEM Procedures require changes to the equations from a particular Trading Day onward.

A minor version change may occur for editorial changes, manifest errors or implementation changes that will apply to the same Trading Day period as dictated by the major version.

Version	Changes	Author(s)	Approver
1.0	Original formulation consistent with WEM Rules effective 1 October 2021.	Stuart MacDougall	Mark Katsikandarakis
1.1	Correction of Priority Payments formulae for Short Payments related to Non-STEM invoices.	Stuart MacDougall	Nicholas Nielsen
2.0	Publication consistent with WEM Reform Rules effective 1 October 2023	Lisa Laurie	Nicholas Nielsen

Contents

1 Introduction

The purpose of this document is to:

- outline standalone calculations, separate to the main WEM Metering, Settlement and Prudential calculations, as equations; and

- provide additional context or structure equations in such a way that assists in understanding.

This document defines many variables that are used in equations. Each variable will have the following attributes stated to assist in understanding:

Attribute	Explanation	Example
Variable	The name of the variable	$STEMP\_G\_I$
Units	\$, {}, MW, MWh, MWs, \$/MW, \$/MWh, Flag, °C, Hz/s	\$/MWh
Scope (SC)	Tranche (T), Channel (CH), NMI (N), Contract(C), SESSM Award (SA), Essential System Service (E), Facility-Essential System Service (FE), Network Contingency (NC), Facility-Network Contingency (FNC), Capacity Credit Allocation (A), Separately Certified Component (SCC), Facility (F), Participant (P), Global (G)	G
Granularity (GR)	Dispatch Interval (DI), Trading Interval (I), Trading Day (D), Trading Week (W*), Trading Month (M), Capacity Year (CY), Financial Year (FY), Independent from time (X)	I
Rule	WEM Rule reference	6.9.7
Description	A description of the variable	STEM Clearing Price for Trading Interval i
Ref	Either the equation number where it is defined in this document, or 'I' to denote an input	I

* Trading Week granularity will include a numeric suffix that indicates on which day of the week the Trading Week commences on i.e. 0 = Sunday, 1 = Monday, ... 4 = Thursday etc. This suffix will be included where the granularity is used but not in the variable name e.g. $ESTIMATIONFlag\_G\_W(w)$ and not $ESTIMATIONFlag\_G\_W0(w)$.

Granularity has a strict hierarchy: a Capacity Year is comprised of Trading Months, which are comprised of Trading Days which are comprised of Trading Intervals. These hierarchies are represented below:

- $I \in D \in M \in CY$; or

- $I \in D \in M \in FY$.

When defining a variable, it will always be defined for its granularity. For example, The variable $CS\_P\_M(p, m)$ is defined for a particular Trading Month m. It will only be defined by variables with a granularity of Trading Month or coarser. However, when the variable is used to define other equations it may be expressed using a granularity argument more fine than its defined granularity, for example $CS\_P\_M(p, i)$. When the variable is expressed like this, it is implicit that it refers to the Trading Month m, in which Trading Interval i falls.

A similar hierarchy (and convention) is adopted for scopes.

2 Defined Terms, Sets and Associations

Defined terms are used throughout the rules. These defined terms often convey specific information, for example the term Scheduled Facility requires the facility to be registered with AEMO as outlined in the definition. Similarly, some specific calculations only apply, or are interpreted based on these defined terms. In the implementation, these defined terms are often represented as a set of Facilities (or Participants) that meet the definition of the defined term. Furthermore, there are often associations between defined terms within the rules, for example Facilities are associated to participants through registration.

This document defines all sets with the following conventions:

- The definition of each set variable is always Global and for a Trading Day and therefore the variable name omits information about scope and granularity. For example the set of Scheduled Facilities in Trading Day d is represented as $SF(d)$, rather than being named $SF\_G\_D(d)$.

- Subsets are defined by adding a scope argument. For example $SF(p, d)$ represents the subset of $SF(d)$ associated with participant p.

2.1 Participant Sets

2.1.1 Axiomatic Participant Sets in AEMO systems

Calculations defined in the rules depend on different sets of participants. The participant sets outlined below are considered to be axiomatic, or the base sets, upon which all other sets will be created. These base sets are defined in terms of how AEMO's systems have been created. Sets which are calculated later are often sets of participants which are defined in the rules, and in these instances the rule reference is provided.
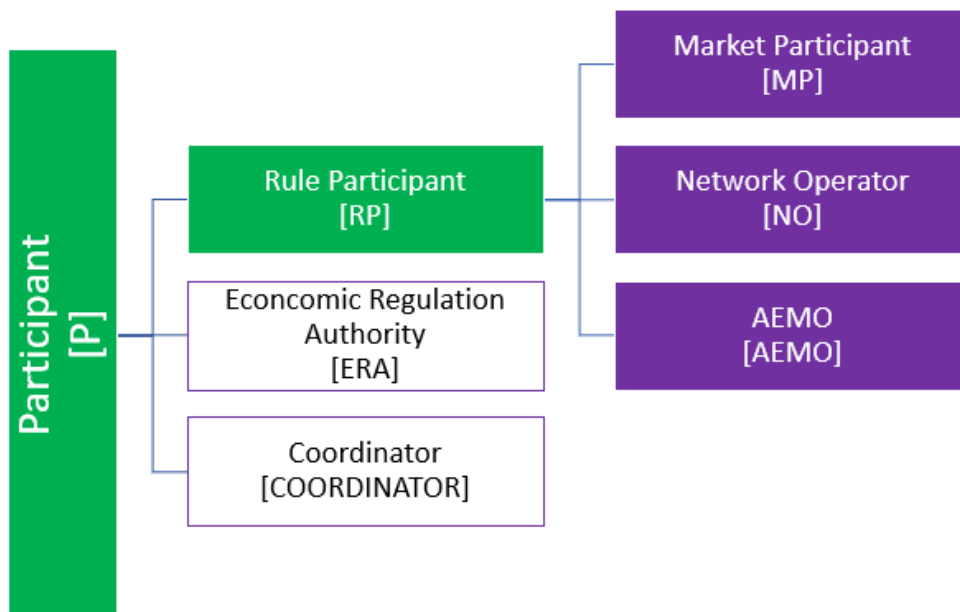
Variable	Units	SC	GR	Rule	Description	Ref
WEMS_MP(d)	{}	G	D		Set of participants with MP participant class in WEMS in Trading Day d	I
WEMS_NO(d)	{}	G	D		Set of participants with NO participant class in WEMS in Trading Day d	I
WEMS_PREG(d)	{}	G	D		Set of participants registered in WEMS in Trading Day d	I

2.1.2 Sets of Rule Participant classes

The following are classes of Rule Participants [MR 2.28.1]:

- Network Operator (NO)

- Market Participant (MP)

- AEMO (AEMO)

The diagram below shows the relationship between Rule Participant classes (purple) and other sets of participants (green).

These sets are defined as follows:

$$P\_W(w) = \bigcup_{d \in D(w)} P(d) \tag{1}$$

$$P(d) = COORDINATOR(d) \cup ERA(d) \cup RP(d) \tag{2}$$

$$COORDINATOR(d) = \{COE\} \tag{3}$$

$$ERA(d) = \{ERA\} \tag{4}$$

$$RP(d) = MP(d) \cup NO(d) \cup AEMO(d) \tag{5}$$

$$MP(d) = WEMS\_PREG(d) \cap WEMS\_MP(d) \tag{6}$$

$$AEMO(d) = \{IMOWA\} \tag{7}$$

$$NO(d) = WEMS\_PREG(d) \cap WEMS\_NO(d) \tag{8}$$

Variable	Units	SC	GR	Rule	Description	Ref
P_W(w)	{}	G	W0		Set of participants (Rule Participants, ERA and the Coordinator) in Trading Week w	(1)
P(d)	{}	G	D		Set of participants (Rule Participants, ERA and the Coordinator) in Trading Day d	(2)
COORDINATOR(d)	{}	G	D	11	Set containing the Coordinator	(3)
ERA(d)	{}	G	D	11	Set containing the ERA	(4)
RP(d)	{}	G	D	11	Set of Rule Participants in Trading Day d	(5)
MP(d)	{}	G	D	11	Set of Market Participants in Trading Day d	(6)
AEMO(d)	{}	G	D	11	Set containing the AEMO	(7)
NO(d)	{}	G	D	11	Set containing Network Operators in Trading Day d	(8)
WEMS_MP(d)	{}	G	D		Set of participants with MP participant class in WEMS in Trading Day d	I
WEMS_NO(d)	{}	G	D		Set of participants with NO participant class in WEMS in Trading Day d	I
WEMS_PREG(d)	{}	G	D		Set of participants registered in WEMS in Trading Day d	I
D(w)	{}	G	W0		Set of Trading Days in Trading Week w	I

2.2 Facility Sets

There are no facility sets required for these calculations.

2.3 Associations

There are no associations required for these calculations.

3 Short Payments

A Payment Default occurs when a Rule Participant fails to make a payment before it is due. In this situation AEMO may draw upon Credit Support to meet the payment [MR 9.20.1]. In the event that there is insufficient Credit Support to meet the payment, AEMO's liability is limited to the Total Amount of funds received [MR 9.20.3], and therefore some participants must be short-paid. The calculations in this section determine the amount each participant is short-paid for Payment Defaults on a WEM invoice.

3.1 Invocation

The following table outlines the invocation for the high-level calculations.

Variable	Scope Set
$Short\_P\_W(p, w)$ for $adj\_G\_W(w)$	$\forall p \in P\_W(w)$

Variable	Units	SC	GR	Rule	Description	Ref
Short_P_W(p, w)	$	P	W0		The amount participant p is short-paid related to the Payment Default on the WEM invoice for Trading Week w, adjustment $adj\_G\_W(w)$	(9)
P_W(w)	{}	G	W0		Set of participants (Rule Participants, ERA and the Coordinator) in Trading Week w	(1)
adj_G_W(w)		G	W0		Adjustment number of the WEM invoice subject to a Payment Default	I

3.2 Calculations

$$Short\_P\_W(p, w) = ShortP\_P\_W(p, w) + ShortNP\_P\_W(p, w) \tag{9}$$

$$ShortP\_P\_W(p, w) = IPP\_P\_W(p, w) - APP\_P\_W(p, w) \tag{10}$$

$$ShortNP\_P\_W(p, w) = NAP\_P\_W(p, W) - AAP\_P\_W(p, w) \tag{11}$$

Variable	Units	SC	GR	Rule	Description	Ref
Short_P_W(p, w)	$	P	W0		The amount participant p is short-paid related to the Payment Default on the WEM invoice for Trading Week w, adjustment $adj\_G\_W(w)$	(9)
ShortP_P_W(p, w)	$	P	W0		The amount participant p is short-paid related to the priority payments of Payment Default on the WEM invoice for Trading Week w, adjustment $adj\_G\_W(w)$	(10)
ShortNP_P_W(p, w)	$	P	W0		The amount participant p is short-paid related to the non-priority payments of Payment Default on the WEM invoice for Trading Week w, adjustment $adj\_G\_W(w)$	(11)
APP_P_W(p, w)	$	P	W0	9.20.4(a)	Actual priority payments made to Rule Participant p related to the Payment Default on the WEM invoice for Trading Week w, adjustment $adj\_G\_W(w)$	(12)
AAP_P_W(p, w)	$	P	W0	9.20.4(b)	Actual non-priority payments made to Rule Participant p related to the Payment Default on the WEM invoice for Trading Week w, adjustment $adj\_G\_W(w)$	(20)

Variable	Units	SC	GR	Rule	Description	Ref
IPP_P_W(p, w)	$	P	W0	9.20.4(a)	Intended priority payment for Rule Participant p related to the Payment Default on the WEM invoice for Trading Week w, adjustment $adj\_G\_W(w)$	(15)
NAP_P_W(p, w)	$	P	W0	9.20.4(b)	Net Amount payable (after priority payments) to participant p related to the Payment Default on the WEM invoice for Trading Week w, adjustment $adj\_G\_W(w)$	(22)

3.2.1 Priority Payments

$$APP\_P\_W(p,w) = APproportion\_G\_W(w) \times IPP\_P\_W(p,w) \tag{12}$$

$$APproportion\_G\_W(w) = \begin{cases} min\left(1, \dfrac{TA\_G\_W(w)}{IPP\_G\_W(w)}\right) & \text{for } IPP\_G\_W(w) \neq 0 \\ 1 & \text{for } IPP\_G\_W(w) = 0 \end{cases} \tag{13}$$

$$IPP\_G\_W(w) = \sum_{p \in P\_W(w)} IPP\_P\_W(p,w) \tag{14}$$

$$IPP\_P\_W(p,w) = IPPRRSA\_P\_W(p,w) + IPPContracts\_P\_W(p,w) \tag{15}$$

$$IPPRRSA\_P\_W(p,w) = max(0, SFMFSAinv\_P\_W(p,w)) + max(0, SFRFSAinv\_P\_W(p,w)) \\ + max(0, SFCFSAinv\_P\_W(p,w)) \tag{16}$$

$$IPPContracts\_P\_W(p,w) = min\Big((1 + GST\_G\_W(w)) \times (IPPSUPCAP\_P\_W(p,w) + IPPSRS\_P\_W(p,w)), \\ max(0, TOTALinv\_P\_W(p,w))\Big) \tag{17}$$

$$IPPSUPCAP\_P\_W(p,w) = max(0, SUPCAPSAinv\_P\_W(p,w)) \tag{18}$$

$$IPPSRS\_P\_W(p,w) = max(0, SRSinv\_P\_W(p,w)) \tag{19}$$

Variable	Units	SC	GR	Rule	Description	Ref
APP_P_W(p, w)	$	P	W0	9.20.4(a)	Actual priority payments made to Rule Participant p related to the Payment Default on the WEM invoice for Trading Week w, adjustment $adj\_G\_W(w)$	(12)
APproportion_G_W(w)		G	W0	9.20.4(a)	Proportion of intended priority payments that can actually be made related to the Payment Default on the WEM invoice for Trading Week w, adjustment $adj\_G\_W(w)$	(13)
IPP_G_W(w)	$	G	W0	9.20.4(a)	Intended priority payment related to the Payment Default on the WEM invoice for Trading Week w, adjustment $adj\_G\_W(w)$	(14)
IPP_P_W(p, w)	$	P	W0	9.20.4(a)	Intended priority payment for Rule Participant p related to the Payment Default on the WEM invoice for Trading Week w, adjustment $adj\_G\_W(w)$	(15)

Variable	Units	SC	GR	Rule	Description	Ref
IPPRRSA_P_W(p, w)	$	P	W0	9.20.4(a)i	Intended priority payment for Service Fee Settlement Amounts for Rule Participant p related to the Payment Default on the WEM invoice for Trading Week w, adjustment $adj\_G\_W(w)$	(16)
IPPContracts_P_W(p, w)	$	P	W0	9.20.4(a)ii	Intended priority payment for contracts for Rule Participant p related to the Payment Default on the WEM invoice for Trading Week w, adjustment $adj\_G\_W(w)$	(17)
IPPSUPCAP_P_W(p, w)	$	P	W0	9.20.4(a)ii	Intended priority payment for Supplementary Capacity Contracts for Rule Participant p related to the Payment Default on the WEM invoice for Trading Week w, adjustment $adj\_G\_W(w)$	(18)
IPPSRS_P_W(p, w)	$	P	W0	9.20.4(a)ii	Intended priority payment for System Restart Service Contracts for Rule Participant p related to the Payment Default on the WEM invoice for Trading Week w, adjustment $adj\_G\_W(w)$	(19)
SFMFSAinv_P_W(p, w)	$	P	W0	9.13.2	Service Fee Settlement Amount (as invoiced) paid to AEMO related to the Payment Default on the WEM invoice for Trading Week w, adjustment $adj\_G\_W(w)$	I
SFRFSAinv_P_W(p, w)	$	P	W0	9.13.3	Service Fee Settlement Amount (as invoiced) paid to the ERA related to the Payment Default on the WEM invoice for Trading Week w, adjustment $adj\_G\_W(w)$	I
SFCFSAinv_P_W(p, w)	$	P	W0	9.13.4	Service Fee Settlement Amount (as invoiced) paid to the Coordinator related to the Payment Default on the WEM invoice for Trading Week w, adjustment $adj\_G\_W(w)$	I
SUPCAPSAinv_P_W(p, w)	$	P	W0	9.20.4(a)ii	Payment (as invoiced) for Supplementary Capacity Contracts to Rule Participant p related to the Payment Default on the WEM invoice for Trading Week w, adjustment $adj\_G\_W(w)$	I
SRSinv_P_W(p, w)	$	P	W0	9.20.4(a)ii	Payment (as invoiced) for System Restart Service Contracts for Rule Participant p related to the Payment Default on the WEM invoice for Trading Week w, adjustment $adj\_G\_W(w)$	I
TA_G_W(w)	$	G	W0	9.20.3	Total Amount (including applicable GST) received by AEMO in cleared funds related to the Payment Default on the WEM invoice for Trading Week w, adjustment $adj\_G\_W(w)$	I
TOTALinv_P_W(p, w)	$	P	W0		Total settlement amount (including GST and interest) for Rule Participant p related to the Payment Default on the WEM invoice for Trading Week w, adjustment $adj\_G\_W(w)$	I
GST_G_W(w)		G	W0		GST rate for Payment Default on the WEM invoice for Trading Week w, adjustment $adj\_G\_W(w)$	I
P_W(w)	{}	G	W0		Set of participants (Rule Participants, ERA and the Coordinator) in Trading Week w	(1)

3.2.2 Remaining Payments

$$AAP\_P\_W(p,w) = \begin{cases} \dfrac{NAP\_P\_W(p,w)}{NAP\_G\_W(w)} \times MAA\_G\_W(w) & \text{for } NAP\_G\_W(w) \neq 0 \\ 0 & \text{for } NAP\_G\_W(w) = 0 \end{cases} \tag{20}$$

$$NAP\_G\_W(w) = \sum_{p \in P\_W(w)} NAP\_P\_W(p,w) \tag{21}$$

$$NAP\_P\_W(p,w) = max(0, TOTALinv\_P\_W(p,w)) - IPP\_P\_W(p,w) \tag{22}$$

$$MAA\_G\_W(w) = TA\_G\_W(w) - APP\_G\_W(w) \tag{23}$$

$$APP\_G\_W(w) = \sum_{p \in P\_W(w)} APP\_P\_W(p,w) \tag{24}$$

Variable	Units	SC	GR	Rule	Description	Ref
AAP_P_W(p, w)	$	P	W0	9.20.4(b)	Actual non-priority payments made to Rule Participant p related to the Payment Default on the WEM invoice for Trading Week w, adjustment $adj\_G\_W(w)$	(20)
NAP_G_W(w)	$	G	M	9.20.4(b)	Net Amount payable (after priority payments) related to the Payment Default on the WEM invoice for Trading Week w, adjustment $adj\_G\_W(w)$	(21)
NAP_P_W(p, w)	$	P	M	9.20.4(b)	Net Amount payable (after priority payments) to participant p related to the Payment Default on the WEM invoice for Trading Week w, adjustment $adj\_G\_W(w)$	(22)
TOTALinv_P_W(p, w)	$	P	M		Total settlement amount (including GST and interest) for Rule Participant p related to the Payment Default on the WEM invoice for Trading Week w, adjustment $adj\_G\_W(w)$	I
IPP_P_W(p, w)	$	P	M	9.20.4(a)	Intended priority payment for Rule Participant p related to the Payment Default on the WEM invoice for Trading Week w, adjustment $adj\_G\_W(w)$	(15)
APP_P_W(p, w)	$	P	M	9.20.4(a)	Actual priority payments made to Rule Participant p related to the Payment Default on the WEM invoice for Trading Week w, adjustment $adj\_G\_W(w)$	(12)
APP_G_W(w)	$	G	M	9.20.4(a)	Actual priority payments made related to the Payment Default on the WEM invoice for Trading Week w, adjustment $adj\_G\_W(w)$	(24)
MAA_G_W(w)	$	G	M	9.20.4(b)	Remainder of the Total Amount (after priority payments) related to the Payment Default on the WEM invoice for Trading Week w, adjustment $adj\_G\_W(w)$	(23)
TA_G_W(w)	$	G	M	9.20.3	Total Amount (including applicable GST) received by AEMO in cleared funds related to the Payment Default on the WEM invoice for Trading Week w, adjustment $adj\_G\_W(w)$	I

Variable	Units	SC	GR	Rule	Description	Ref
P_W(w)	{}	G	M		Set of participants (Rule Participants, ERA and the Coordinator) in Trading Week w	(1)