Energy Transformation Implementation Unit

Transformation Design and Operation Working Group Meeting 27

Market Settlement – Part 2

2 November 2020

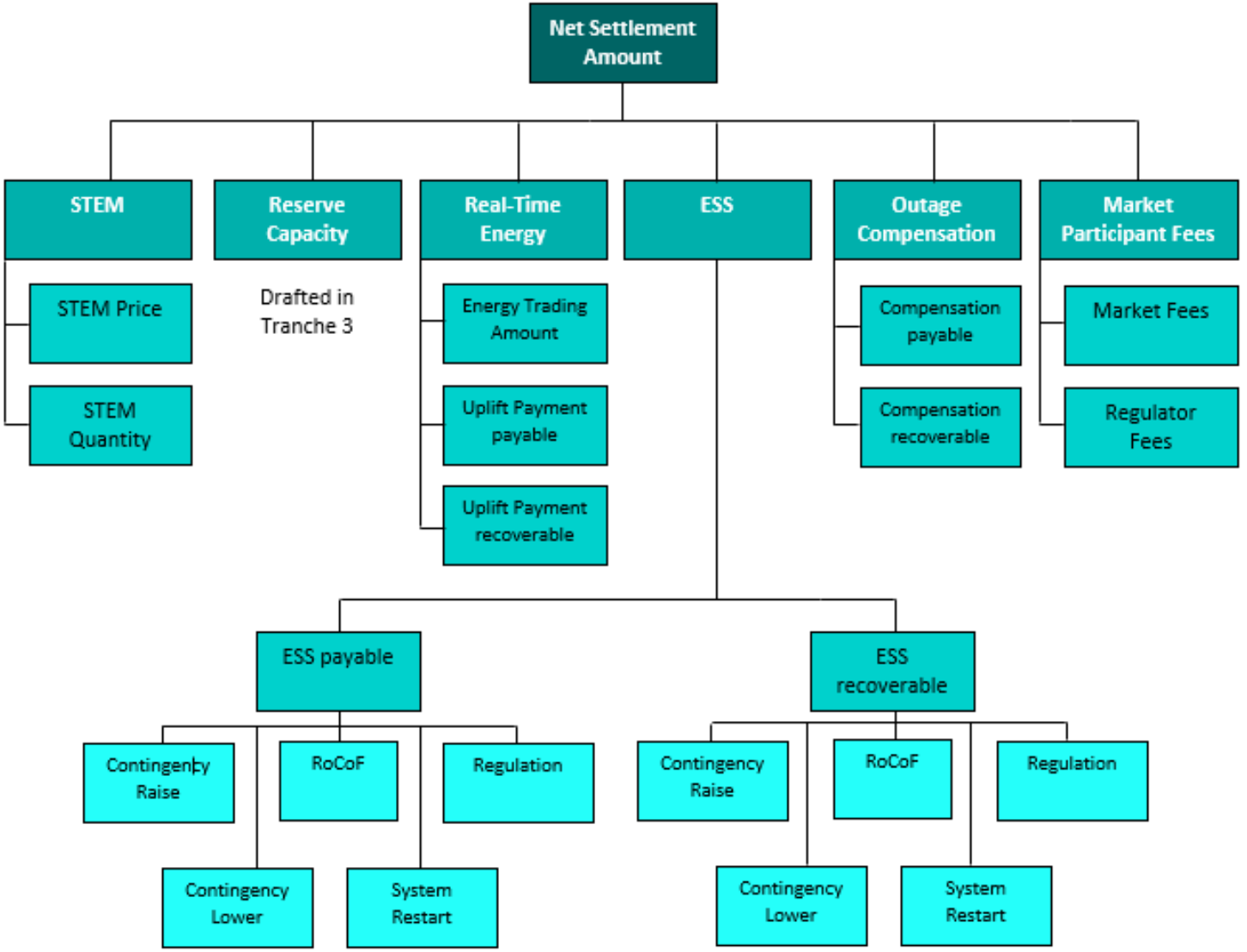
Ground rules and virtual meeting protocols

- Please place your microphone on mute, unless you are asking a question or making a comment.
- Please keep questions relevant to the agenda item being discussed.
- If there is not a break in discussion and you would like to say something, you can ‘raise your hand’ by typing ‘question’ or ‘comment’ in the meeting chat. Questions and comments can also be emailed to TDOWG@energy.wa.gov.au after the meeting.
- The meeting will be recorded. However no minutes will be issued.
- Please state your name and organisation when you ask a question.
- If you are having connection/bandwidth issues, you may want to disable the incoming and/or outgoing video.

Agenda

- Essential System Services settlement
  - Section 9.10 – ESS component of net settlement amount
  - Appendix 2A – Runway share (used for Contingency Raise Cost Recovery and Additional RoCoF Control Requirement of the RoCoF Control Service Cost Recovery)
  - Appendix 2B – Minimum RoCoF Control Requirement of the RoCoF Control Service Cost Recovery)
  - Appendix 2C – SESSM Refunds

Settlement Calculations – Structure recap



Settlement Calculations – Net Settlement Amount recap

Section 9.6

- Each component is calculated for a Market Participant daily to provide a daily net settlement amount. This is then summed to a weekly net settlement amount.

$$Net\_SA(p,d) = STEM\_SA(p,d) + RC\_SA(p,d) + RTE\_SA(p,d) + ESS\_SA(p,d) + OC\_SA(p,d) + MFP\_SA(p,d)$$

$$Net\_SA(p,w) = \sum_{d \in w} Net\_SA(p,d)$$

Settlement Calculations – ESS

Section 9.10

The ESS settlement component includes:

- Contingency Reserve Raise
- Contingency Reserve Lower
- RoCoF
- Regulation Raise and Lower
- System Restart

$$ESS\_SA(p,d) = ESS\_Payable(p,d) - ESS\_Recoverable(p,d)$$

- Non-Cooptimised ESS is subject of a future workstream and will be settled off market on a contractual basis.
- All references to ESS mean FCESS.

Settlement Calculations – ESS Payable (1)

Sections 9.10.3-9.10.27

$$ESS\_Payable(p,d) = CR\_Payable(p,d) + CL\_Payable(p,d) + RCS\_Payable(p,d) + Regulation\_Payable(p,d) + SRS\_Payable(p,d)$$

- The payable amount for each ESS (except System Restart) is calculated for each Registered Facility for a Dispatch Interval. For example:

$$CR\_Payable(f,DI)$$

Real-time

$$= CR\_MCP(DI) \times \frac{5}{60} \times CR\_EnablementQuantity(f,DI) \times CR\_PerformanceFactor(f,DI)$$

SESSM

$$+ CR\_AvailabilityPayment(f,DI) - CR\_SESSMRefund(f,DI)$$

Settlement Calculations – ESS Payable (2)

Sections 9.10.3-9.10.27

$$CR\_Payable(f,DI) = CR\_MCP(DI) \times \frac{5}{60} \times CR\_EnablementQuantity(f,DI) \times CR\_PerformanceFactor(f,DI) + CR\_AvailabilityPayment(f,DI) - CR\_SESSMRefund(f,DI)$$

Variable	What	Source
CR_MCP(DI)	The CR Market Clearing Price	Dispatch Engine
5/60	Five-minute Dispatch Interval	-
CR_EnablementQuantity(f,DI)	The quantity of the ESS to be provided by the facility in the Dispatch Interval	Dispatch Engine
PerformanceFactor(f,DI)	Set to 1 at Market Start except for Contingency Reserve Raise	AEMO Market Procedure developed for clause 7.5.13
CR_AvailabilityPayment(f,DI)	The amount payable to the Market Participant for the facility for offering the required Availability Quantity for the ESS under each relevant SESSM Award.	Relevant SESSM Awards
CR_SESSMRefund(f,DI)	The amount refunded by the Market Participant for the facility for failing to meet its obligations under each relevant SESSM Award.	Calculated as per Appendix 2C

Settlement Calculations – ESS Payable (3)

Sections 9.10.3-9.10.27

- That amount is summed for each Dispatch Interval to calculate the Trading Interval amount. For example:

$$CR\_Payable(f,t) = \sum_{DI \in t} CR\_Payable(f,DI)$$

- This is then summed for all Trading Intervals in the Trading Day and all facilities registered to the Market Participant. For example:

$$CR\_Payable(p,d) = \sum_{f \in p} \sum_{t \in d} CR\_Payable(f,t)$$

Settlement Calculations – SESSM Refund (1)

Appendix 2C

- A Market Participant who **fails to make their capacity available** for ESS (under a SESSM Award with a non-zero Availability Payment) must pay a refund.

- The refund is levied on the **amount of capacity not made available**; for example if a Facility was supposed to provide 50 MW, and only provided 20 MW, then the refund will be charged on the 30 MW that was not provided.

- The **refund factor** is 3.

- **Refunds are capped** so AEMO never recovers more than the maximum that could have been paid to the Market Participant under the SESSM Award.

Settlement Calculations – SESSM Refund (2)

Appendix 2C

Variable	Definition
BaseQuantity(a,DI)	The **quantity of Essential System Service the Facility was already accredited** for at the time of making the SESSM Submission that resulted in award a. The Base Quantity can be different in different Dispatch Intervals.
AvailabilityQuantity(a,DI)	The quantity of the ESS the Facility **must offer in addition to the Base ESS Quantity** in a given Dispatch in at least MinAvailability(a)% of the time during the SESSM Service Timing.
MinAvailability(a)	The **% of relevant Dispatch Intervals** that the Market Participant must make the sum of the AvailabilityQuantity(a,DI) and BaseQuantity(a,DI) **available**.
AvailabilityPayment(a,DI)	The **price** per Dispatch Interval that the Market Participant will be paid for **offering the Availability Quantity** in a given Dispatch Interval.

Settlement Calculations – SESSM Refund (3)

Appendix 2C

$$SESSMRefund(a,DI) = \begin{cases} 0 & \text{if } SESSMOutageCount(a,DI) \le MaxUnavailability(a) \\ 0 & \text{if } \sum_{i=1}^{DI-1} SESSMRefund(a,i) \ge PaymentCap(a) \\ 0 & \text{if } AvailabilityQuantity(a,DI) = 0 \\ Min\left[\left(Max\left\{0, \frac{\left(\left(AvailabilityQuantity(a,DI) + BaseQuantity(a,DI)\right) - Max\{ESSOffer(f,c,DI), BaseQuantity(a,DI)\}\right)}{AvailabilityQuantity(a,DI)}\right\}\right), \right. & \text{otherwise} \\ \left. PaymentCap(a) - \sum_{i=1}^{DI-1} SESSMRefund(a,i)\right] \times SESSMRefundFactor \times AvailabilityPayment(a,DI) & \end{cases}$$

- No refund is payable for a Dispatch Interval if:
  - ESS Offer >= Base Quantity + Availability Quantity; or
  - ESS Offer < Base Quantity + Availability Quantity BUT:
    - SESSM Outage Count < Max Unavailability
    - Sum of refunds paid = Payment Cap; or
  - Availability Quantity = 0

Settlement Calculations – SESSM Refund (4)

Appendix 2C

$$Min\left[\left(SESSMRefundFactor \times AvailabilityPayment(a,DI) \times Max\left\{0, \frac{\left((AvailabilityQuantity(a,DI) + BaseQuantity(a,DI)\right) - Max\{ESSOffer(f,c,DI), BaseQuantity(a,DI)\}}{AvailabilityQuantity(a,DI)}\right\}\right), \left(PaymentCap(a) - \sum_{i=1}^{DI-1} SESSMRefund(a,i)\right)\right]$$

- If a SESSM Refund is payable, it is calculated as the minimum of:

SESSM Refund Factor

Multiplied by

Availability Payment

Multiplied by

Quantity (next slide)

and

Payment cap

Less

Refunds already paid

Settlement Calculations – SESSM Refund (5)

Appendix 2C

$$Min\left[\begin{array}{c} SESSMRefundFactor \times AvailabilityPayment(a,DI) \times \\ \left(Max\left\{0, \frac{\left((AvailabilityQuantity(a,DI) + BaseQuantity(a,DI)\right) - Max\{ESSOffer(f,c,DI), BaseQuantity(a,DI)\}\right)}{AvailabilityQuantity(a,DI)}\right\}\right), \\ PaymentCap(a) - \sum_{i=1}^{DI-1} SESSMRefund(a,i) \end{array}\right]$$

SESSM Refund Factor

Multiplied by

Availability Payment

Multiplied by

Maximum of zero; and

Amount to be made available *less* Amount made available

Availability Quantity

Settlement Calculations – SESSM Refund (6)

Appendix 2C

Worked example:

SESSMRefundFactor
3

Award 1 (F1,CR)	
MinAvailability(a)	100%
N(a)	9
MaxUnavailability(a)	0
PaymentCap(a)	540

Award 2 (F1,CR)	
MinAvailability(a)	75%
N(a)	12
MaxUnavailability(a)	3
PaymentCap(a)	480

Award 3 (F1,CR)	
MinAvailability(a)	75%
N(a)	11
MaxUnavailability(a)	2
PaymentCap(a)	550

		Award 1 (F1,CR)						Award 2 (F1,CR)						Award 3 (F1,CR)							
	ESSOfferQty(f,c,DI)	BaseQuantity(a,DI)	AvailabilityQuantity(a,DI)	AvailabilityPayment(a,DI)	IsAvailable(a,DI)	SESSMOutageCount(a,DI)	SESSMRefund(a,DI)	BaseQuantity(a,DI)	AvailabilityQuantity(a,DI)	AvailabilityPayment(a,DI)	IsAvailable(a,DI)	SESSMOutageCount(a,DI)	SESSMRefund(a,DI)	BaseQuantity(a,DI)	AvailabilityQuantity(a,DI)	AvailabilityPayment(a,DI)	IsAvailable(a,DI)	SESSMOutageCount(a,DI)	SESSMRefund(a,DI)	CR_AvailabilityPayment(f,DI)	CR_SESSMRefund(f,DI)
DI	f,DI	a,DI	a,DI	a,DI	a,DI	a,DI	a,DI	a,DI	a,DI	a,DI	a,DI	a,DI	a,DI	a,DI	a,DI	a,DI	a,DI	a,DI	a,DI	f,DI	f,DI
1/10/2020 8:00	20	10	6	60	1	0	0	16	4	40	1	0	0	20	5	50	0	1	0	150	0
1/10/2020 8:05	20	10	6	60	1	0	0	16	4	40	1	0	0	20	5	50	0	2	0	150	0
1/10/2020 8:10	20	10	6	60	1	0	0	16	4	40	1	0	0	20	5	50	0	3	150	150	150
1/10/2020 8:15	20	10	6	60	1	0	0	16	4	40	1	0	0	20	5	50	0	4	150	150	150
1/10/2020 8:20	20	10	6	60	1	0	0	16	4	40	1	0	0	20	5	50	0	5	150	150	150
1/10/2020 8:25	20	10	6	60	1	0	0	16	4	40	1	0	0	20	5	50	0	6	100	150	100
1/10/2020 8:30	20	10	6	60	1	0	0	16	4	40	1	0	0	20	5	50	0	7	0	150	0
1/10/2020 8:35	0	10	6	60	0	1	180	16	4	40	0	1	0	20	5	50	0	8	0	150	180
1/10/2020 8:40	15	10	6	60	0	2	30	16	4	40	0	2	0	20	5	50	0	9	0	150	30
1/10/2020 8:45	20	10	0	0	1	2	0	10	4	40	1	2	0	14	5	50	1	9	0	90	0
1/10/2020 8:50	20	10	0	0	1	2	0	10	4	40	1	2	0	14	5	50	1	9	0	90	0
1/10/2020 8:55	20	10	0	0	1	2	0	10	4	40	1	2	0	14	0	0	1	9	0	40	0

Settlement Calculations – SESSM Refund (6)

Appendix 2C

Worked example:

SESSMRefundFactor
3

Award 1 (F1,CR)	
MinAvailability(a)	100%
N(a)	9
MaxUnavailability(a)	0
PaymentCap(a)	540

Award 2 (F1,CR)	
MinAvailability(a)	75%
N(a)	12
MaxUnavailability(a)	3
PaymentCap(a)	480

Award 3 (F1,CR)	
MinAvailability(a)	75%
N(a)	11
MaxUnavailability(a)	2
PaymentCap(a)	550

		Award 1						Award 2						Award 3							
DI	ESSOfferQty(f,c,DI)	BaseQuantity(a,DI)	AvailabilityQuantity(a,DI)	AvailabilityPayment(a,DI)	IsAvailable(a,DI)	SESSMOutageCount(a,DI)	SESSMRefund(a,DI)	BaseQuantity(a,DI)	AvailabilityQuantity(a,DI)	AvailabilityPayment(a,DI)	IsAvailable(a,DI)	SESSMOutageCount(a,DI)	SESSMRefund(a,DI)	BaseQuantity(a,DI)	AvailabilityQuantity(a,DI)	AvailabilityPayment(a,DI)	IsAvailable(a,DI)	SESSMOutageCount(a,DI)	SESSMRefund(a,DI)		
	f,DI	a,DI	a,DI	a,DI	a,DI	a,DI	a,DI	a,DI	a,DI	a,DI	a,DI	a,DI	a,DI	a,DI	a,DI	a,DI	a,DI	a,DI	a,DI		
1/10/2020 8:00	20	10	6	60	1	0	0	16	4	40	1	0	0	20	5	50	0	1	0	150	0
1/10/2020 8:05	20	10	6	60	1	0	0	16	4	40	1	0	0	20	5	50	0	2	0	150	0
1/10/2020 8:10	20	10	6	60	1	0	0	16	4	40	1	0	0	20	5	50	0	3	150	150	150
1/10/2020 8:15	20	10	6	60	1	0	0	16	4	40	1	0	0	20	5	50	0	4	150	150	150
1/10/2020 8:20	20	10	6	60	1	0	0	16	4	40	1	0	0	20	5	50	0	5	150	150	150
1/10/2020 8:25	20	10	6	60	1	0	0	16	4	40	1	0	0	20	5	50	0	6	100	150	100
1/10/2020 8:30	20	10	6	60	1	0	0	16	4	40	1	0	0	20	5	50	0	7	0	150	0
1/10/2020 8:35	0	10	6	60	0	1	180	16	4	40	0	1	0	20	5	50	0	8	0	150	180
1/10/2020 8:40	15	10	6	60	0	2	30	16	4	40	0	2	0	20	5	50	0	9	0	150	30
1/10/2020 8:45	20	10	0	0	1	2	0	10	4	40	1	2	0	14	5	50	1	9	0	90	0
							0												0	90	0
							0												0	40	0

3. Failure to offer the service:
-No refund applies for the first two DIs where the energy is not offered, as MaxUnavailability=2.
-The third interval incurs in a full refund, as the MaxUnavailability has been reached.
-In the interval 8:25, the PaymentCap is reached, so no refunds apply thereafter.

1. Outage @ 8:35:
-Full refund for Award1, as MaxUnavailability = 0
-No refund for Award2, as OutageCount < MaxUnavailability

2. Partial Outage @ 8:40:
-Partial refund for Award1, as failed to offer 1 MW (out of 6).
-Still no refund for Award2, as OutageCount < MaxUnavailability

Settlement Calculations – ESS Payable recap Sections

$$CR\_Payable(f,DI) = CR\_MCP(DI) \times \frac{5}{60} \times CR\_EnablementQuantity(f,DI) \times CR\_PerformanceFactor(f,DI) + CR\_AvailabilityPayment(f,DI) - CR\_SESSMRefund(f,DI)$$

$$CR\_Payable(f,t) = \sum_{DI \in t} CR\_Payable(f,DI)$$

$$CR\_Payable(p,d) = \sum_{f \in p} \sum_{t \in d} CR\_Payable(f,t)$$

$$ESS\_Payable(p,d) = CR\_Payable(p,d) + CL\_Payable(p,d) + RCS\_Payable(p,d) + Regulation\_Payable(p,d) + SRS\_Payable(p,d)$$

Settlement Calculations - System Restart Amount Payable

Section 9.10.25-9.10.26

- Procured on a contract basis and calculated at Trading Interval granularity.

$$SRS\_Payable(p,t) = \sum_{SRS\ contracts\ c \in p} SRS\_Payable(c,t)$$

$$SRS\_Payable(p,d) = \sum_{t \in d} SRS\_Payable(p,t)$$

Settlement Calculations – Aggregating Amounts for Cost Recovery

- This is required for each ESS to input into the ESS recoverable equations.
- The total amount payable is calculated per Dispatch Interval for Contingency Reserve Raise, and summed to Trading Interval for the other ESSs.

$$CR\_Payable(DI) = \sum_{f \in Facilities\ providing\ CR} CR\_Payable(f, DI)$$

$$CL\_Payable(t) = \sum_{f \in Facilities\ providing\ CL} CL\_Payable(f, t)$$

Settlement Calculations – Splitting RoCoF Amounts for Cost Recovery

Clauses 9.10.12-9.10.19

- RoCoF is separated into two components:
  - Minimum RoCoF Control Requirement

$$MinRCS\_Payable(DI) = RCS\_Payable(DI) \times \frac{MinRoCoFControlRequirement(DI)}{RoCoFControlRequirement(DI)}$$

$$MinRCS\_Payable(t) = \sum_{DI \in t} MinRCS\_Payable(DI)$$

  - Additional RoCoF Control Requirement

$$AdditionalRCS\_Payable(DI) = RCS\_Payable(DI) - MinRCS\_Payable(DI)$$

- The cost of these two components are allocated differently:
  - Minimum RoCoF Control Requirement (using shares calculated in Appendix 2B)
  - Additional RoCoF Control Requirement (using shares calculated in Appendix 2A).

Settlement Calculations – ESS Recoverable Amounts

Sections 9.10.3-9.10.27

$$ESS\_Recoverable(p,d) = CR\_Recoverable(p,d) + CL\_Recoverable(p,d) + RCS\_Recoverable(p,d) + Regulation\_Recoverable(p,d) + SRS\_Recoverable(p,d)$$

ESS	Recovered from	Cost allocation Method	Granularity
Contingency Reserve Raise	Registered Facilities (scheduled and semi-scheduled generators greater than 10 MW)	Runway share (see appendix 2A)	Dispatch Interval
Contingency Reserve Lower	Loads	Consumption Share	Trading Interval
Rate of Change of Frequency (RoCoF) Control Service	For the Minimum RoCoF Control Requirement – from loads, generators and the Network Operator if they cannot demonstrate their Ride-Through Capability is greater than the RoCoF Safe Limit[2]	An equal share to each non-exempt group, and then by Metered Schedule within a category (see appendix 2B)	Trading Interval
	For the Additional RoCoF Control Requirement – from Registered Facilities (Scheduled and Semi-Scheduled generators)	Runway share (see appendix 2A)	
Regulation (Raise and Lower)	From Semi-Scheduled Facilities, Non-Scheduled Facilities and Non-Dispatchable Loads	Metered Schedule (Contributing Quantity)	Trading Interval
System Restart	Market Participants with consumption share	Consumption Share	Trading Interval

Settlement Calculations – Regulation Recoverable (1)

Sections 9.10.35-9.10.39

- Regulation Raise and Regulation Lower are combined as the cost of both services is allocated to Semi-Scheduled Facilities, Non-Scheduled Facilities and Non-Dispatchable Loads based on their Metered Schedule.

$$Regulation\_Recoverable(p,t) = Regulation\_Share(p,t) \times Regulation\_Payable(t)$$

Settlement Calculations – Regulation Recoverable (2)

Sections 9.10.35-9.10.39

$$Regulation\_Share(p,t) = \frac{RegulationContributingQuantity(p,t)}{RegulationContributingQuantity(t)}$$

$$\begin{aligned} &RegulationContributingQuantity(p,t) \\ &= \sum_{SSF \in p} |MeteredSchedule(SSF,t)| \\ &+ \sum_{NSF \in p} |MeteredSchedule(NSF,t)| \\ &+ \sum_{NDL \in p} |MeteredSchedule(NDL,t)| \end{aligned}$$

$$\begin{aligned} &RegulationContributingQuantity(t) \\ &= \sum_{p \in P} RegulationContributingQuantity(p,t) \end{aligned}$$

Settlement Calculations – Contingency Reserve Lower Recoverable

Sections 9.10.31-9.10.32 and 9.5.6-9.5.7

- The cost of Contingency Reserve Lower is recovered from Market Participants based on consumption share.

$$CL\_Recoverable(p,t) = CL\_Payable(t) \times ConsumptionShare(p,t)$$

$$ConsumptionShare(p,t) = \frac{ConsumptionContributingQuantity(p,t)}{\sum_{p \in P} ConsumptionContributingQuantity(p,t)}$$

$$ConsumptionContributingQuantity(p,t) = \sum_{f \in p} MeteredSchedule(f,t)$$

- f∈p includes facilities, including the NWM, that have a negative Metered Schedule in the Trading Interval.

Settlement Calculations – System Restart Recoverable Amount

Clauses 9.10.40-9.10.41

Recovered from Market Participants based on Consumption Share.

$$SRS\_Recoverable(p,t) = SRS\_Payable(t) \times ConsumptionShare(p,t)$$

$$SRS\_Recoverable(p,d) = \sum_{t \in d} SRS\_Recoverable(p,t)$$

Settlement Calculations – Contingency Reserve Raise Recoverable

Sections 9.10.29-9.10.30 and Appendix 2A

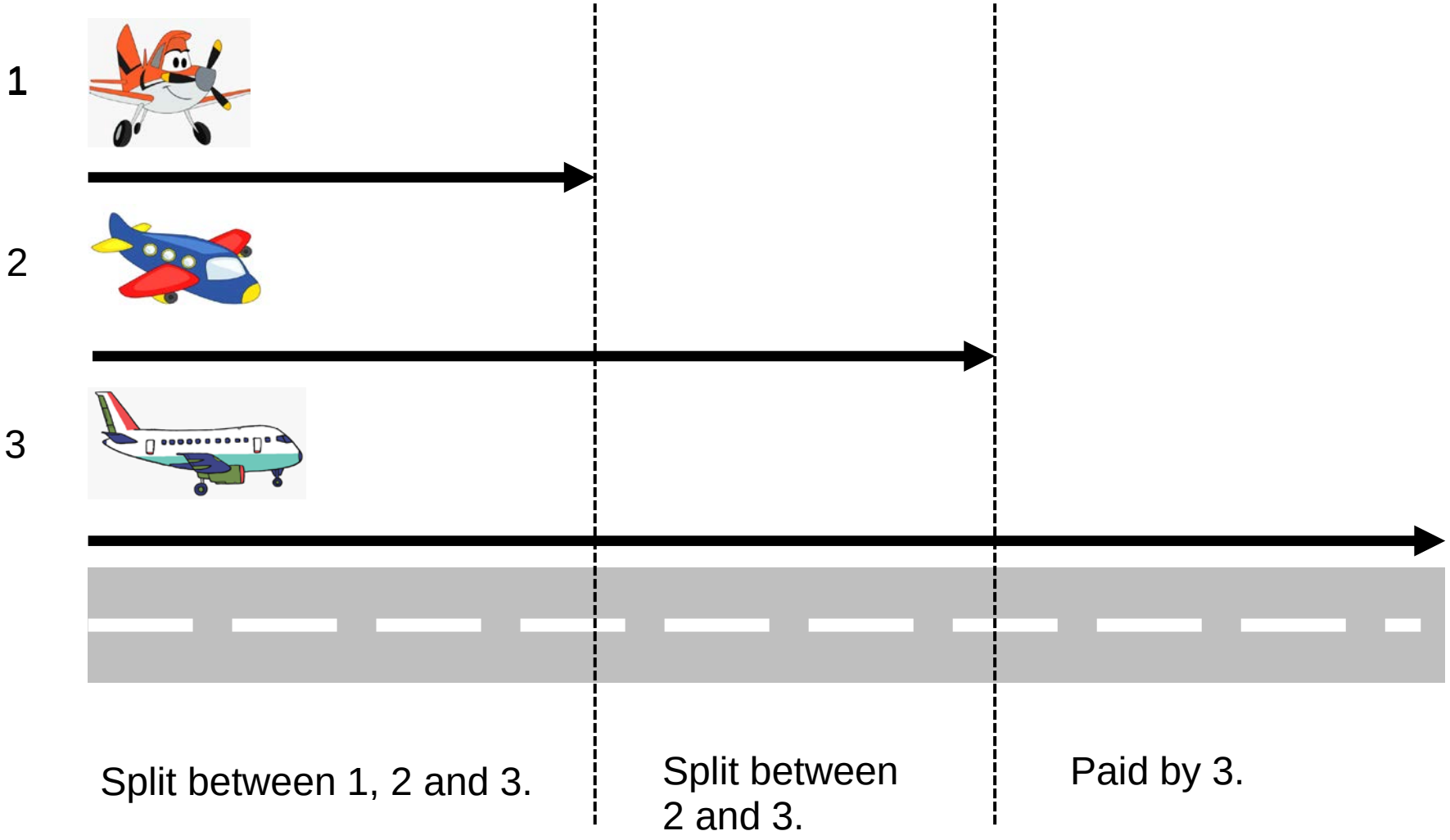
- The cost of Contingency Reserve Raise is recovered from Market Participants based on their runway share.

$$CR\_Recoverable(p,t) = \sum_{DI \in t} CR\_Payable(DI) \times TotalRunwayShare(p,DI)$$

- The runway share is calculated in Appendix 2A.
- The runway share calculation currently does not include intermittent loads. The appendix will be amended once the registration amending rules are complete.
- The runway share is also used to allocate the cost of the Additional RoCoF Control Requirement component of the RoCoF Control Service.

Settlement Calculations – Runway Share (1)

Appendix 2A



Settlement Calculations – Runway Share (2)

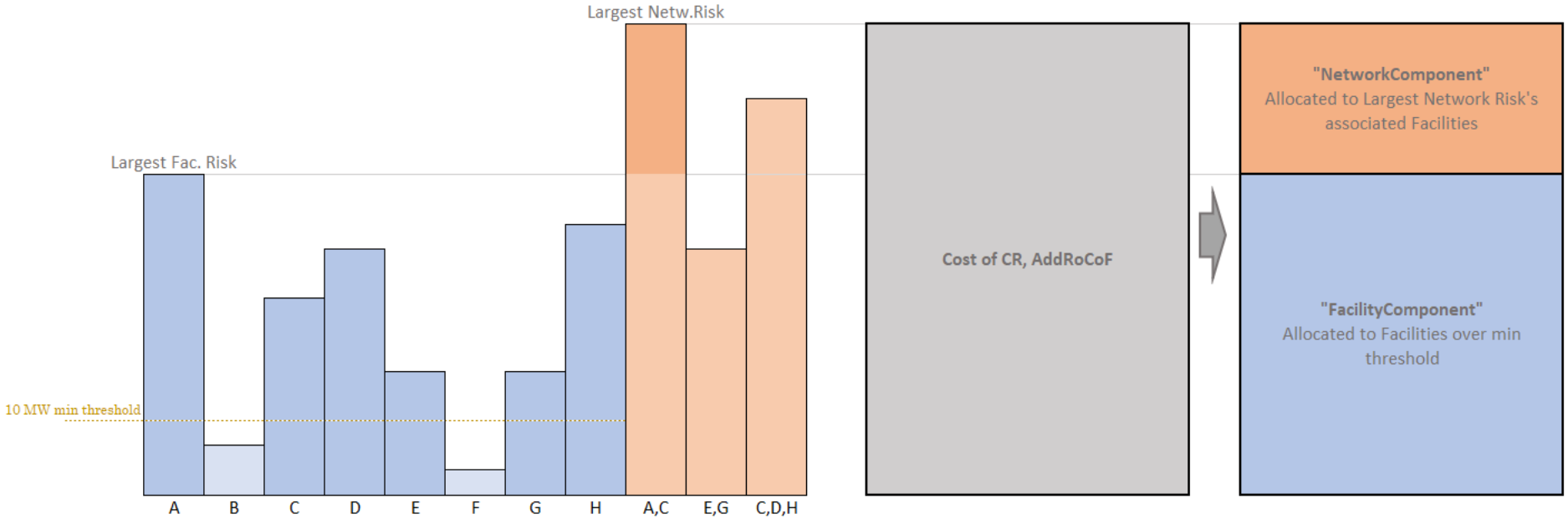
Sections 9.10.29-9.10.30 and Appendix 2A

Term	Definition
Facility Contingency	Means a **Credible Contingency Event** associated with the unexpected automatic or manual disconnection of, or the unplanned change in output of, **one or more operating energy producing units or Facilities**.
Facility Risk	Means, for a Facility whose unexpected failure constitutes a Credible Contingency Event in a Dispatch Interval, the **sum of energy, Contingency Reserve Raise and Regulation Raise cleared from the relevant Facility** in that Dispatch Interval.
Network Contingency	A **Credible Contingency Event associated with the unexpected disconnection of one or more major items of Network equipment,** but excludes from that meaning the loss of output from a Facility arising as a result of failure of generating equipment at the Facility or the loss of the network connection point associated with the Facility.
Network Risk	Means, for a Network Contingency in a Dispatch Interval, the sum in MW of **the Facility Risks for any Registered Facilities less the forecast consumption of any relevant Loads that are connected to the part of the Network affected by that Network Contingency,** and that would lose the ability to Inject or Withdraw from the Network as a result of that Network Contingency.
Largest Credible Supply Contingency	**Means the maximum possible net MW Injection that could be lost in a Dispatch Interval** or Pre-Dispatch Interval due to a single Credible Contingency Event based on the output of the Dispatch Algorithm, accounting for any associated change in Withdrawal as a result of the same Credible Contingency Event.

Settlement Calculations – Runway Share (3)

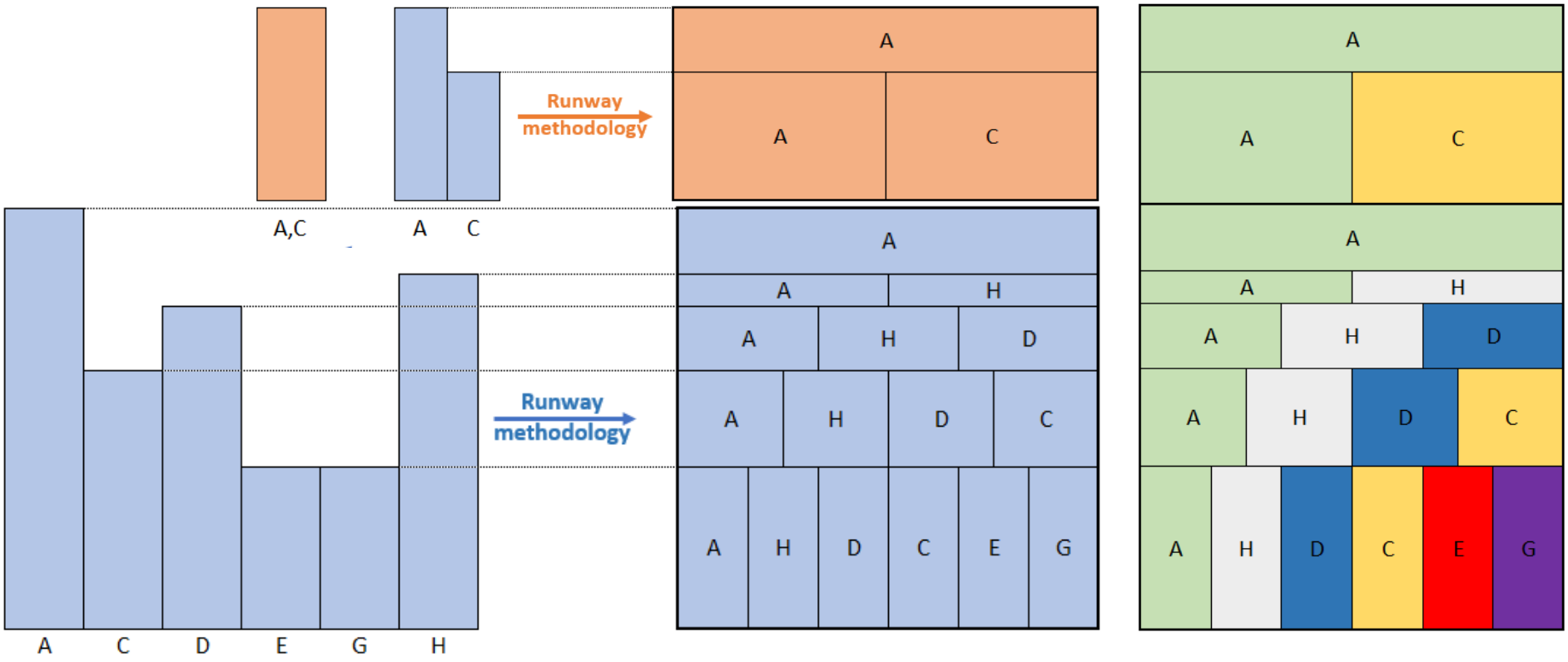
Appendix 2A

- The relevant ESS cost is allocated to:
  - those Facilities that form part of the Largest Facility Contingency (facility component); and
  - the Facilities comprising the Largest Network Risk if it is larger than the largest Facility Risk (network component).
- The cost of each component is allocated separately.



Settlement Calculations – Runway Share (4)

Appendix 2A

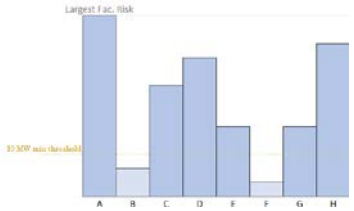


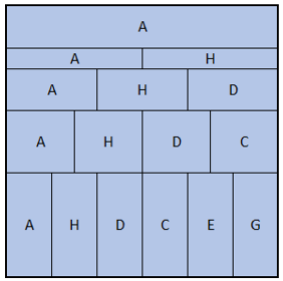
Settlement Calculations – Runway Share (5)

Appendix 2A

1. Interpretation
2. Define 'Applicable Facilities' Set
   - Scheduled and Semi-Scheduled Facilities
   - Risk > 10MW

3. Applicable Facilities Shares
   - Rank in ascending order
   - Calculate Facility Runway Share





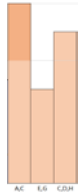
$$FacilityRunwayShare(f, DI) = \sum_{i=1}^{Rank(f,DI)} \frac{FacilityMW(i, DI) - FacilityMW(i-1, DI)}{FacilityMW(n, DI) \times (n + 1 - i)}$$

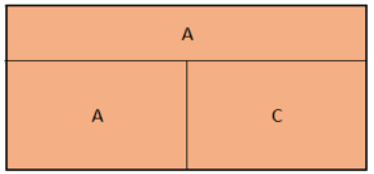
Settlement Calculations – Runway Share (6)

Appendix 2A

4. Calculate Network Contingency Share

- Define the set of Network Contingencies that are taking into account when setting the Contingency Reserve Raise Requirement.
- If the largest Network Contingency is the Largest Credible Supply Contingency then it is the Network Risk (otherwise it is 0).
- Rank the Causer Facilities.
- Calculate the runway share for each Causer Facility.





$$NetworkRunwayShare(nc, f, DI) = \sum_{i=1}^{Rank(nc,f,DI)} \frac{NetworkMW(nc, i, DI) - NetworkMW(nc, i-1, DI)}{NetworkMW(nc, n_{nc}, DI) \times (n_{nc} + 1 - i)}$$

Settlement Calculations – Runway Share (7)

Appendix 2A

5. Cost shares

- Calculate the Facility component and Network component of the total cost.

$$NetworkComponent(DI) = \frac{Max(0, LargestNetworkRisk(DI) - LargestFacilityRisk(DI))}{LargestNetworkRisk\ (DI)}$$

$$FacilityComponent(DI) = 1 - NetworkComponent(DI)$$

Settlement Calculations – Runway Share (8)

Appendix 2A

- Calculate the runway share for each Market Participant.

$$TotalRunwayShare(p, DI) =$$

$$FacilityComponent(DI) \times \sum_{f \in ApplicableFacilities(p,DI)} FacilityRunwayShare\,(f, DI)$$

$$+ NetworkComponent(DI)$$

$$\times \sum_{nc \in ApplicableNetworkContingencies(DI)} \sum_{f \in CauserFacilities(p,nc,DI)} NetworkShare(f, nc, DI)$$

Input into the CR calculation (clause 9.10.30)

$$CR\_Recoverable(p, t) = \sum_{DI \in t} CR\_Payable(DI) \times TotalRunwayShare(p, DI)$$

Settlement Calculations – Runway Share (9)

Appendix 2A

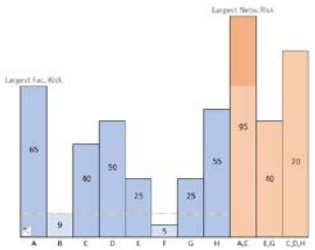
- If two (or more) Network Contingencies were the largest Network Risk then they would both have allocated the Network component (equally).

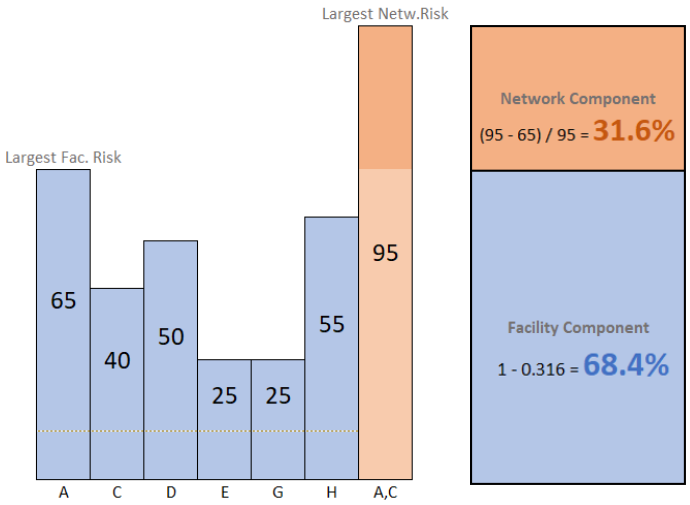
$$NetworkShare(f, nc, DI) = \frac{1}{m(DI)} \times NetworkRunwayShare(f, nc, DI)$$

Settlement Calculations – Runway Share (10)

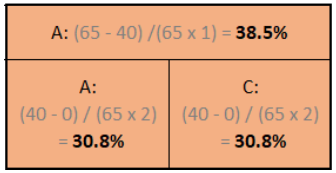
Appendix 2A

Worked example: (by Facility)



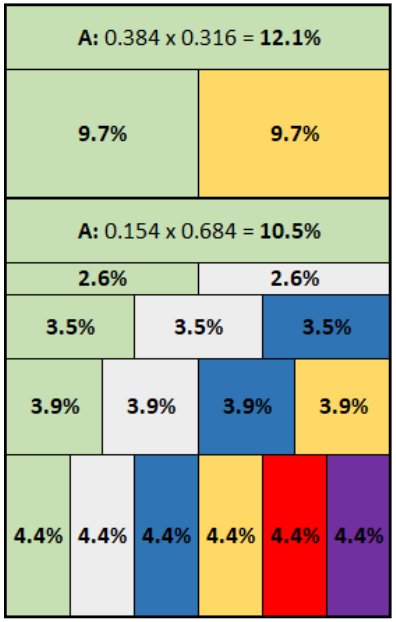


NetworkShare:

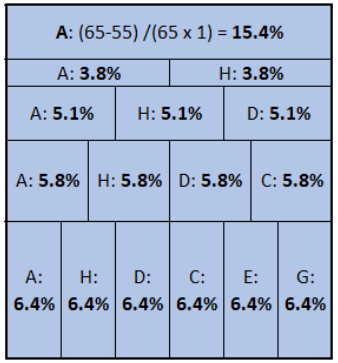


x 31.6%:

TotalRunwayShare:



FacilityRunwayShare:



x 68.4%:

Facility	A	B	C	D	E	F	G	H
FacilityRisk(f,DI)	*65*	*9*	*40*	*50*	*25*	*5*	*25*	*55*
FacilityRunwayShare(f,DI)	36.5%	-	12.2%	17.3%	6.4%	-	6.4%	21.2%
NetworkShare(f,DI)	69.2%	-	30.8%	-	-	-	-	-
TotalRunwayShare(f,DI)	46.9%	0.0%	18.0%	11.8%	4.4%	0.0%	4.4%	14.5%

Settlement Calculations – RoCoF

Clauses 9.10.33 – 9.10.34 and Appendix 2B

- The cost of the RoCoF Control Service is recovered:
  - For the Minimum RoCoF Control Requirement component – using the Min RCS Share.
  - For the Additional RoCoF Control Requirement component – using the Total Runway Share (as for Contingency Reserve Raise).

$$RCS\_Recoverable(p,t) = MinRCS\_Payable(t) \times MinRCSShare(p,t) + \sum_{DI \in t} AdditionalRCS\_Payable(DI) \times TotalRunwayShare(p,DI)$$

$$RCS\_Recoverable(p,d) = \sum_{t \in d} RCS\_Recoverable(p,t)$$

Settlement Calculations – Min RCS Share (1)

Appendix 2B

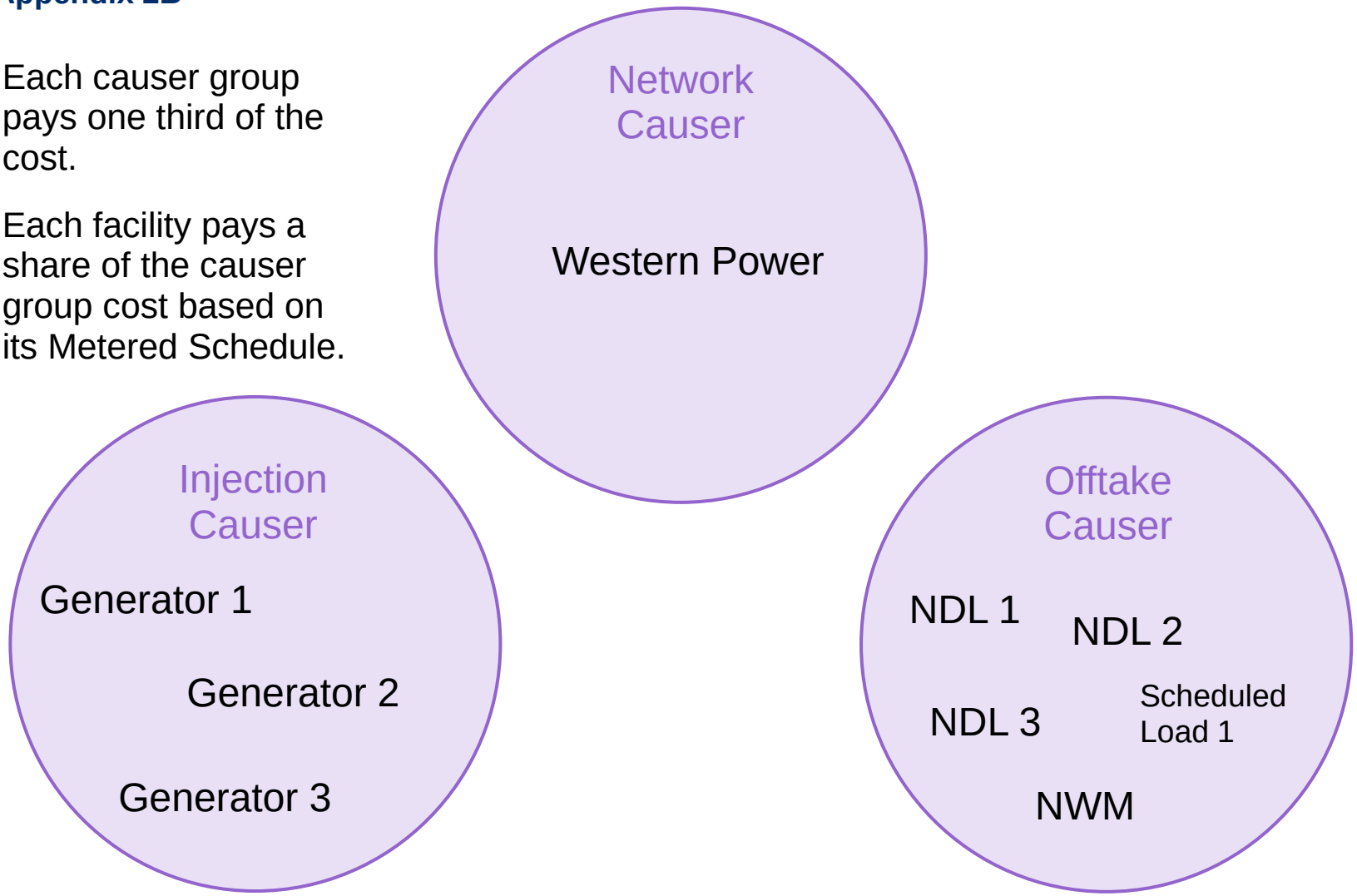
- The Minimum RoCoF Control Requirement component of the RoCoF Control Service costs in a Trading Interval is to be shared across three causer groups in equal shares:
  - **Network Causer group:** Network Owners (this group has one member only);
  - **Injection Causer group:** Registered Facilities with generation systems or storage systems (i.e. energy producing systems); and
  - **Offtake Causer group:** Non-Dispatchable Loads and Registered Facilities comprising only Scheduled Loads (end-users).
- Members of each group can exempt themselves by indicating to AEMO that the RoCoF Ridethrough Capability of their facilities are greater than or equal to the RoCoF Safe Limit. (This will be in standing data – added in a future tranche of Amending Rules).
- If all facilities in a causer set are exempt then the RoCoF cost is allocated equally to the remaining sets.

Settlement Calculations – Min RCS Share (2)

Appendix 2B

Each causer group pays one third of the cost.

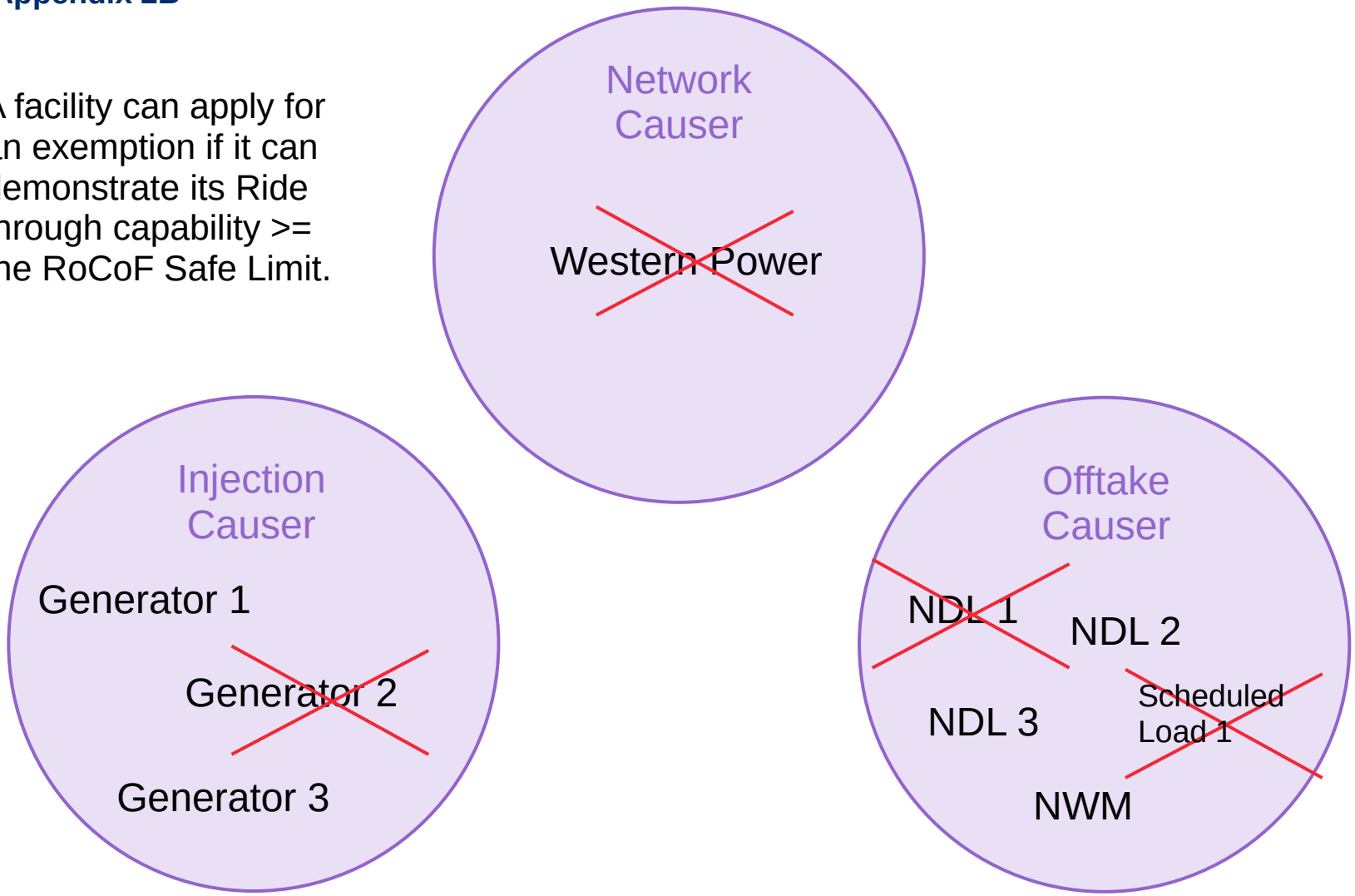
Each facility pays a share of the causer group cost based on its Metered Schedule.



Settlement Calculations – Min RCS Share (3)

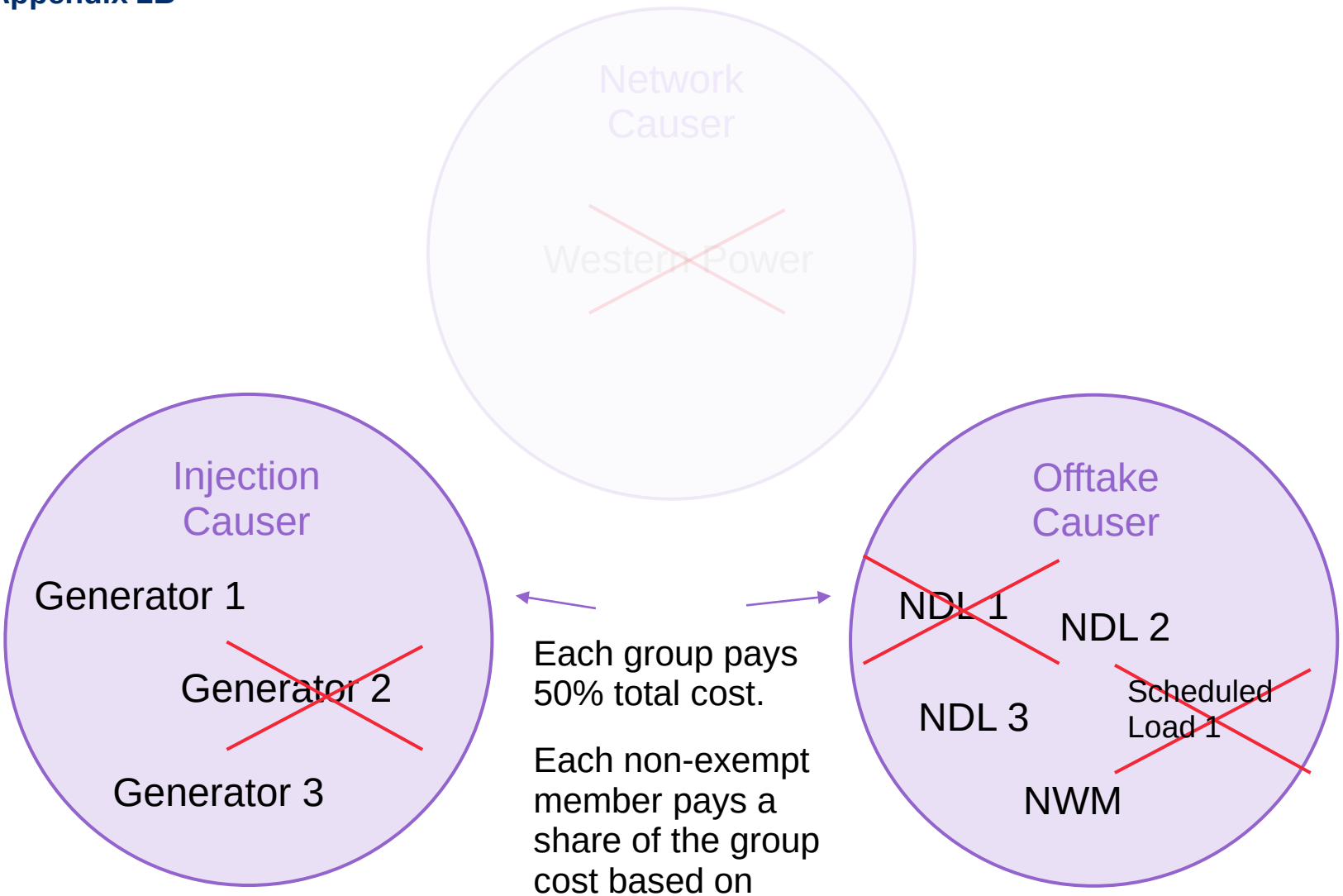
Appendix 2B

A facility can apply for an exemption if it can demonstrate its Ride through capability >= the RoCoF Safe Limit.



Settlement Calculations – Min RCS Share (4)

Appendix 2B



Settlement Calculations – Min RCS Share (5)

Appendix 2B

Define a Causer Factor for each causer set for each Trading Interval.

$$NetworkCauserFactor(t) = \begin{cases} 0 & if\ the\ Network\ Causer(t)\ subset\ is\ empty \\ 1 & otherwise \end{cases};$$

$$InjectionCauserFactor(t) = \begin{cases} 0 & if\ the\ Injection\ Causer(t)\ subset\ is\ empty \\ 1 & otherwise \end{cases};$$

and

$$OfftakeCauserFactor(t) = \begin{cases} 0 & if\ the\ Offtake\ Causer(t)\ subset\ is\ empty \\ 1 & otherwise \end{cases}$$

Calculate the number of causer sets to allocate Min RCS cost to.

$$n(t) = NetworkCauserFactor(t) + InjectionCauserFactor(t) + OfftakeCauserFactor(t)$$

Settlement Calculations – Min RCS Share (6)

Appendix 2B

Determine the cost share for the member of each subset.

$$NOShare(p,t) = \frac{1}{n(t)} \times NetworkCauserFactor(t)$$

$$InjectionShare(f,t) = \frac{1}{n(t)} \times InjectionCauserFactor(t) \times \frac{|MeteredSchedule(f,t)|}{\sum_{i \in InjectionCauser(t)} |MeteredSchedule(i,t)|}$$

$$OfftakeShare(l,t) = \frac{1}{n(t)} \times OfftakeCauserFactor(t) \times \frac{|MeteredSchedule(l,t)|}{\sum_{i \in OfftakeCauser(t)} |MeteredSchedule(i,t)|}$$

Settlement Calculations – Min RCS Share (7)

Appendix 2B

Determine the Min RCS Share for a Rule Participant for a Trading Interval.

$$MinRCSShare(p,t) = \sum_{f \in p} InjectionShare(f,t) + \sum_{l \in p} OfftakeShare(l,t) + NOShare(p,t)$$

Input in to the RCS Recoverable equation in clause 9.10.34.

$$RCS\_Recoverable(p,t) = MinRCS\_Payable(t) \times MinRCSShare(p,t) + \sum_{DI \in t} AdditionalRCS\_Payable(DI) \times TotalRunwayShare(p,DI)$$

Settlement Calculations – ESS recap

Sections 9.10.3-9.10.27

$$ESS\_Payable(p,d) = CR\_Payable(p,d) + CL\_Payable(p,d) + RCS\_Payable(p,d) + Regulation\_Payable(p,d) + SRS\_Payable(p,d)$$

$$ESS\_Recoverable(p,d) = CR\_Recoverable(p,d) + CL\_Recoverable(p,d) + RCS\_Recoverable(p,d) + Regulation\_Recoverable(p,d) + SRS\_Recoverable(p,d)$$

$$ESS\_SA(p,d) = ESS\_Payable(p,d) - ESS\_Recoverable(p,d)$$

$$Net\_SA(p,d) = STEM\_SA(p,d) + RC\_SA(p,d) + RTE\_SA(p,d) + ESS\_SA(p,d) + OC\_SA(p,d) + MFP\_SA(p,d)$$

Meeting close

Questions or feedback can be emailed to TDOWG@energy.wa.gov.au or contact:

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6551 4620

Reminder: Consultation on the following procedures closes Friday 6 November.

- Western Power WEM Procedure: Development of Limit Advice
- AEMO WEM Procedures:
  - Limit Advice Requirements
  - Constraint Formulation

Please provide feedback directly to Western Power or AEMO.