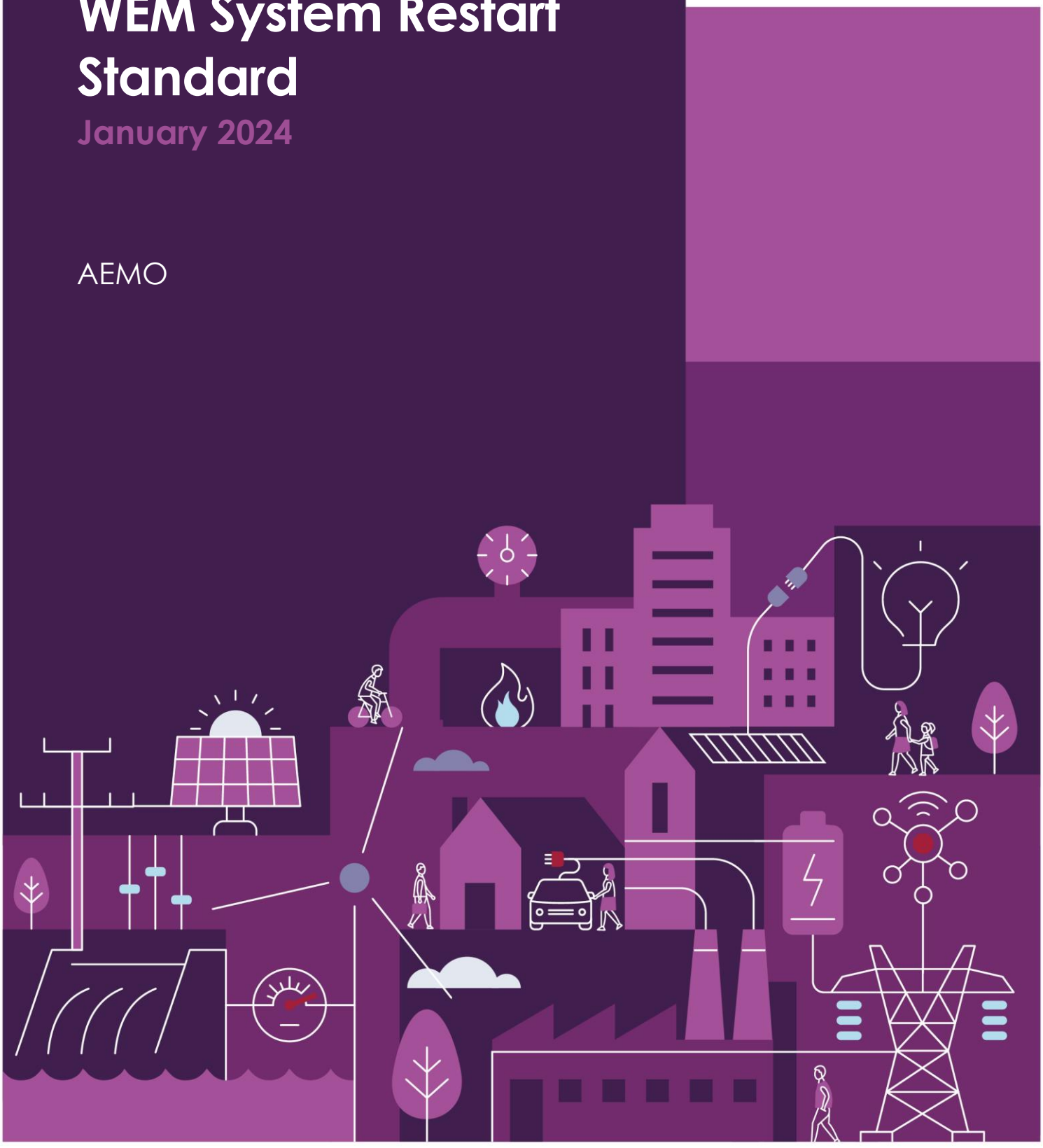
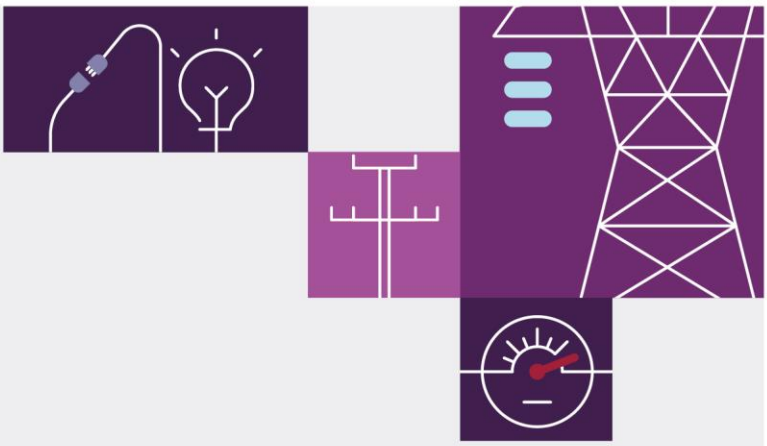
WEM System Restart Standard

January 2024

AEMO





Important notice

Disclaimer

This System Restart Standard is made by AEMO under clause 3.7.18 of the Wholesale Electricity Market Rules, and has effect only for the purposes set out in the WEM Rules. The WEM Rules prevail over this System Restart Standard to the extent of any inconsistency.

Version control

Version	Release date	Changes
1.0	01/06/2022	First Issue
1.1	09/01/2024	Updated Appendix A1 diagram to remove generators

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1 Introduction

1.1 Purpose and scope

This is the System Restart Standard (Standard) determined under clauses 3.7.1 and 3.7.2 of the Wholesale Electricity Market Rules (WEM Rules). The purpose of this Standard is to assist AEMO in developing a System Restart Plan for the purposes of managing and coordinating restart and restoration of the SWIS, and procuring sufficient SRS to support the System Restart Plan.

1.2 Definitions

(a) Terms defined in the *Electricity Industry Act 2004*, the WEM Regulations and the WEM Rules have the same meanings in this Standard unless the context requires otherwise.

(b) The following definitions apply in this Standard unless the context requires otherwise.

Table 1 Definitions

Term	Meaning
Agreed System Restart Pathway Components	Network equipment that AEMO (in consultation with the relevant Network Operator) considers must be covered by this Standard on the basis that the Network equipment is part of or required to support a System Restart Pathway.
BSU	A black start unit.
CPCC	Central Park Control Centre.
LBSP	Local Black Start Procedures developed by a Generator or Network Operator.
SRS	System Restart Service.
Stabilising Load Blocks	Blocks of load connected during the system restart process to assist stable operation of generation.
System Restart Pathway	Sequence of Network equipment that AEMO may use to restart the SWIS following a system shut down or major supply disruption.
TTHLU	A trip to house load unit, being an electrical islanding scheme using generating units that can disconnect from the Network following a major supply disruption and continue to supply their own auxiliaries on an isolated segment of system load.

1.3 Interpretation

The following principles of interpretation apply to this Standard unless otherwise expressly indicated:

(a) Clauses 1.3 to 1.5 of the WEM Rules apply in this Standard.

(b) References to time are references to Australian Western Standard Time.

(c) Terms that are capitalised, but not defined in this Standard, have the meaning given in the WEM Rules.

(d) A reference to the WEM Rules or WEM Procedures includes any associated forms required or contemplated by the WEM Rules or WEM Procedures.

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(e) Words expressed in the singular include the plural and vice versa.

(f) A reference to a paragraph refers to a paragraph of this Standard.

(g) A reference to a clause refers to a clause or section of the WEM Rules.

(h) References to WEM Rules in this Standard in bold and square brackets **[Clause XXX]** are included for convenience only, and do not form part of this Standard.

(i) Text located in boxes and headed as **Explanatory Note X** in this Standard is included by way of explanation only and does not form part of this Standard. The Standard prevails to the extent of any inconsistency with the explanatory notes contained within it.

(j) The body of this Standard prevails to the extent of any inconsistency with the appendices, schedules, annexures or attachments contained within this document.

1.4 Related documents

Table 2 Related documents

Title	Location
SWIS Local Black Start Procedure Guideline	WEM Website
WEM Procedure: System Restart	WEM Website

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2 Electrical sub-networks for system restart

Electrical sub-networks are geographically defined areas of the Network for which SRS are to be contracted. AEMO sets the electrical sub-network boundaries based on the physical and electrical characteristics of the system, taking into account ability to manage Power System Security within the electrical sub-networks, and considering how electrical sub-networks can be re-synchronised together if they need to be operated independently. While sub-networks should be capable of being operated independently, AEMO considers that the configuration of the SWIS is such that it is necessary to restart at least one of electrical sub-networks in order for SRS to restore supply in a timely manner. The number to be restarted will depend on the remaining infrastructure available during the black start event and the ability to control multiple islands.

2.1 Determining electrical sub-networks

AEMO has determined the electrical sub-networks in this Standard by taking into account the following primary factors[1]:

(a) the number and strength of transmission corridors connecting an electrical sub-network to the remainder of the SWIS;

(b) the electrical distance (length of transmission lines) between generation centres;

(c) whether there is a significant quantity of generation in an electrical sub-network (typically of the order of 100 MW or more);

(d) whether there is a significant quantity of load in an electrical sub-network (typically of the order of 100 MW or more); and

(e) the location of synchronising facilities to re-synchronise the electrical sub-network to the remainder of the SWIS.

2.2 Electrical sub-network boundaries

The following electrical sub-networks have been identified for SWIS system restart purposes:

- North Metro
- South Metro
- South Country

The boundaries for each of the electrical sub-networks are shown in A1.

[1] Note that this is not an exhaustive list of considerations, but intended to show primary considerations.

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3 Timing element of this Standard

Following a system shut down or major supply disruption, the process of restarting the SWIS occurs over a period of time, typically many hours (depending on the extent of the disruption). During this time it is essential that key services and capability remain accessible to AEMO to ensure the process of restarting the SWIS can be completed. This section describes the timing requirements for key infrastructure and services required to support the system restart process.

3.1 SRS requirements

System Restart Services in each electrical sub-network must ensure they have sufficient capability to operate independently within the electrical sub-network (i.e. under isochronous frequency control) for a minimum of 24 hours[2].

3.2 Network Operator requirements

Network Operators must ensure adequate communications and remote switching capability, including functioning synchronising facilities, remain available along System Restart Pathways to ensure visibility and control of key Network and generation components are maintained during the system restart process in the absence of primary electricity supply. Network Operators must ensure that remote visibility and control are maintained for specific Agreed System Restart Pathway Components for a minimum of 8 hours.

AEMO (when developing or revising the System Restart Plan) will consult with relevant Network Operators when determining the Agreed System Restart Pathway Components.

Beyond 8 hours for Agreed System Restart Pathway Components, Network Operators must use reasonable endeavours to ensure alternative means are available to manage control and visibility such that the Agreed System Restart Pathway Components are able to be utilised to support restoration of generation facilities via Local Black Start Procedures in the relevant electrical sub-network, and before any minimum timing limitations of System Restart Service Providers in the electrical sub-network are breached[3].

[2] Note that, once the SWIS has been successfully restarted, AEMO would typically no longer require a System Restart Service Provider to operate its Facility in isochronous frequency control mode.

[3] For example, ability to deploy people to a particular site on the restart path to manage switching within a period of 2 hours to ensure the System Restart Service Provider in the electrical sub-network does not run out of fuel before the system can be restarted.

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4 Reliability of SRS

The services used in the System Restart Plan must be highly reliable so that they are likely to perform in the manner intended if and when called upon to do so. The following attributes collectively determine the reliability requirements of this Standard:

(a) availability of SRS

(b) reliability of SRS

(c) reliability/availability of key Network elements

4.1 Availability of SRS

Each SRS must meet an availability target of 95% for a specified period, as determined by the SRS contract. Where a service is unavailable as a result of an act or omission of AEMO, a Planned Outage or a Consequential Outage, the unavailability is disregarded for the purpose of the availability target.

To mitigate against unreliability, AEMO must avoid approving Planned Outages that result in more than one System Restart Service being unavailable at a time.

4.2 Reliability of SRS

AEMO requires System Restart Service Providers to demonstrate reliability via testing to help ensure high levels of reliability is maintained. Each System Restart Service must be tested every six months, subject to AEMO exemption on a case-by-case basis, to ensure confidence in a reliable service provision. Where a service fails testing, the service will be regarded as unavailable until rectified. Where alternative means may be used to access the service (e.g. local/remote activation, multiple fuel types, etc), AEMO may include those alternative means in tests.

4.3 Reliability/availability of Network elements

To mitigate against unreliability AEMO must avoid approving concurrent Planned Outages of multiple Agreed System Restart Pathway Components across one or more electrical sub-networks unless there is a specific need for the concurrent outages and a risk assessment will be completed.

If Forced Outages of Agreed System Restart Pathway Components, or an inability of those components to function as required, result in a specific System Restart Pathway being unavailable for more than 5% of any calendar year, the Network Operator must propose a rectification plan for AEMO to review identifying a plan and timeframe to resolve the issue, allowing for reasonable adjustments to that plan and timeframe as proposed by AEMO.

The Network Operator must promptly respond to AEMO’s reasonable requests for further information or clarification of information in relation to Forced Outages or operation of Agreed System Restart Pathway Components.

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If requested by AEMO, and if reasonably practicable to do so without material adverse impact on Power System Security or the operation of connected plant other than SRS equipment, the Network Operator must use reasonable endeavours to plan and conduct a test of the Agreed System Restart Pathway Components in conjunction with an SRS test.

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5 Diversity and strategic location of SRS

It is important that there is an appropriate degree of independence between the services. The location of System Restart Service Providers must be appropriately considered, ensuring sufficient diversity to mitigate the risk of generating unit and Network element failures preventing the SWIS from being restarted.

5.1 Diversity

The following guidelines will apply in specifying the diversity of SRS:

(a) Electrical

Consideration should be given to the potential for a major power system disturbance to adversely affect more than one service at the same time, particularly in regard to any reasonably foreseeable potential single points of electrical or physical failure.

For the avoidance of doubt, the failure of a multiple generating units at a single location is a type of disturbance that should be reasonably catered for. Consequently, there should be no more than one SRS[4] for any single location.

(b) Technological

Diversity of technologies should also be considered to minimise the reliance of services on a common attribute. For example, a restoration strategy may be less robust if the services all relied on gas supplies, or all services were trip-to-house load.

(c) Geographic

Where there is potential for a natural disaster such as a severe bad weather event or earthquake or other event to adversely affect services that are closely located by geography, consideration should be given to achieving geographic diversity.

5.2 Strategic Location of SRS

SRS require access to a Network with a range of supporting characteristics to be effective in restarting the SWIS following a system shut down or a major supply disruption, including access to load and assisting other generating units to restart. Any strategic location should be well placed both geographically and electrically to facilitate restarting the SWIS.

The following factors should be taken into account:

(a) proximity to restart-critical transmission Network to allow energising in a timely manner

(b) complexity of the relevant parts of the Network,

(c) flexibility in re-configuring the relevant parts of the Network,

(d) simplicity in establishing a path between the SRS and large generating units,

[4] Note that a single SRS may still be comprised of one or more generating units at a single location.

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(e) proximity to stable load.

In some cases, there may be trade-offs between these factors. For example, a shorter path may be quicker to establish, but it may be characterised by less flexibility or proximity to other supporting characteristics (such as stable load). AEMO must take all factors into consideration in selecting what it considers are the best overall strategic locations for SRS.

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6 Technical Requirements for SRS Providers

6.1 SRS facilities

Further to the definition of “System Restart Service” in the WEM Rules, each generator in a SRS facility is either of the following:

- Black Start Unit (BSU): a generating unit that has the ability to start and close its synchronising circuit breaker(s) onto a dead bus without energy being supplied to it from other generating units following a system shut down or a major supply disruption occurring (unless on an approved outage) and supply an islanded power system controlling both its frequency and voltage[5]; or
- Trip to House Load Unit (TTHLU): a generating unit that will automatically island from the rest of the SWIS during a system shutdown and has the ability to close its synchronising circuit breaker(s) onto a dead bus without energy being supplied to it from other generating units following a system shut down or a major supply disruption occurring (unless on an approved outage) and supply an islanded power system controlling both its frequency and voltage.

6.2 General requirements for SRS facilities

The following requirements are applicable to all SRS facilities:

- SRS facilities must remain in stable operation for:
  - sudden changes in load of up to 10MW (e.g. block loading a network feeder); and
  - the start-up of a generating unit auxiliary motor and its associated mechanical load of up to 5 MW.
- Each SRS facility must be able to operate in isochronous governor control mode to automatically regulate frequency.
- When not operating in isochronous mode each SRS facility must be capable of operating in droop governor control mode with governor response enabled, at a minimum response value of 4% droop, unless otherwise specified under the relevant Registered Generator Performance Standard.
- The control systems of each SRS facility must be capable of setting generator output quantities at fixed MW values and setting generator terminal voltage to regulate at fixed voltage values.
- Each SRS facility must be capable of operating in a voltage range between 95% and 105% of its rated terminal voltage.
- SRS facilities connected to the SWIS at 330kV must be capable of energising a 330kV line section and 330/132kV bus-tie transformer[6] to enable load connection. This may be achieved by allowing generator excitation to commence whilst the generator circuit breaker is closed (i.e. “soft start” energisation).

[5] Note that a SRS may comprise one or more black start units located at the same site.

[6] Typically 490 MVA but may vary by location.

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- Each SRS facility must be capable of absorbing reactive power from the SWIS while operating within the stable under excitation area of its generator capability curve (leading VARs)[7].
- The ability of a SRS facility to restart the SWIS must be determined through steady state and transient analysis engineering studies and is only acceptable at AEMO's discretion[8].
- For any SRS facility that is not manned 24/7, AEMO may require remote control in the event of a system shutdown for the purpose of system restart.
- Depending on the specific characteristics of the SRS facility, AEMO may require additional SCADA indications to support the operation of the service.
- Each SRS facility must maintain an AEMO-approved emergency communication system.
- Each SRS facility must maintain an AEMO-approved emergency communications plan for mobilisation of its operating personnel to meet generator start-up time requirements as specified in paragraph 6.3 or 6.4 (as applicable to the relevant SRS facility).
- Each SRS facility must submit a testing plan to demonstrate the ability to restart and energise part of the network and will require testing every 6 months (subject to an exemption from AEMO for a specific test, which will be on a case-by-case basis).

6.3 Specific requirements for Black Start Units

The following requirements are specific to BSUs:

- Each BSU should have a nominal sent-out power output of not less than 50 MW, except where AEMO studies indicate a smaller unit may be accommodated. The black start machine will face a sudden reduction in load and must remain in stable operation upon synchronisation of the next large fast start machine.
- The ability to start and close its synchronising circuit breaker(s) onto a dead bus without energy being supplied to it from other generating units within 60 minutes.
- Sufficient on-site or uninterruptible fuel reserve should be available to run each BSU at the nominal power output for a minimum of 14 hours following a system shut down or a major supply disruption.
- The ability to provide at least three sequential black starts, to allow for possible tripping of the transmission/distribution system(s) during the restart process and possible tripping of the BSU during the black start starting sequence itself.
- A mitigation plan is required for common mode failure in critical starting equipment that renders black start units inoperable. For example, installation of an emergency connection for a mobile generator to replace a failed black start diesel generator.
- Permission from the environmental authority to waive any relevant air pollution restrictions for extended operation of a BSU at reduced load levels during a test or when restarting the SWIS.
- Stable operation at full voltage and no-load (0 MW) and at low loads (<10 MW).

[7] Due to the reactive power restrictions in the Eastern Goldfields region, generators located at Kalgoorlie are not suitable for SRS. Similar restrictions may apply for parts of the network in country areas at the end of long radial lines such as Geraldton, Albany and Merredin.

[8] This may require the SRS proponent to provide updated power system models to AEMO.

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6.4 Specific requirements for Trip to House Load Units

The following requirements are specific to TTHLUs:

- Permission from the environmental authority to waive any relevant air pollution restrictions for extended operation of a TTHLU at reduced load levels during a test or when restarting the SWIS following a system shut down or major supply disruption.
- The ability to close its synchronising circuit breaker(s) onto a dead bus without energy being supplied to it from other generating units within 30 minutes.
- Stable operation at 0 MW sent-out (net of house load).
- Each TTHLU must have a nominal sent-out generation not less than 50 MW, except where AEMO studies indicate a smaller net generation may be accommodated.

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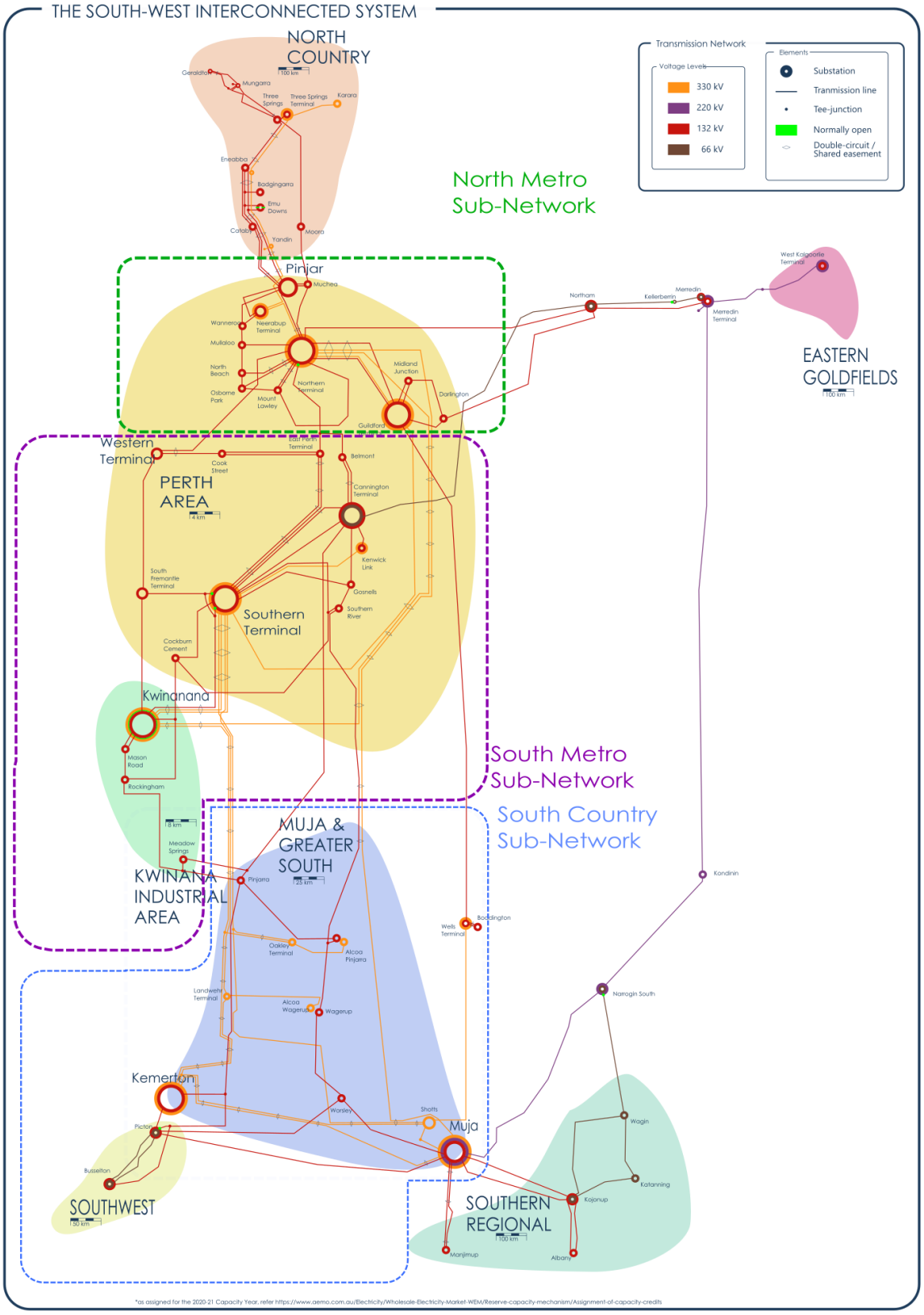
A1. Map of Electrical Sub-Networks



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