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ESSENTIAL SERVICES COMMISSION OF SOUTH AUSTRALIA

EMBEDDED GENERATOR TECHNICAL STANDARDS

REVIEW OF REQUIREMENTS IN THE ELECTRICITY DISTRIBUTION CODE

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DOCUMENT CONTROL

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ACRONYMS AND GLOSSARY

Term	Definition
AEMC	Australian Energy Market Commission
AEMO	Australian Energy Market Operator
ARENA	Australian Renewable Energy Agency
AS/NZS	Australian Standard / New Zealand Standard
Code	See EDC
CSIP	Common Smart Inverter Profile
DEIP	Distributed Energy Integration Program
DER	Distributed Energy Resources
DOE	Dynamic Operating Envelopes
EDC	Electricity Distribution Code (of South Australia)
EG	Embedded Generator
ESB	Energy Security Board
ESCOSA	Essential Services Commission of South Australia
HV	High Voltage
IES	Inverter Energy System
kVA	Kilo Volt-Amps
kW	Kilowatt
LV	Low Voltage
MW	Megawatt
NER	National Electricity Rules
OTR	Office of the Technical Regulator
Requirements	Any set of conditions contained within a publication that must be complied with to meet regulations, connection agreements, industry standards or best practice. Enforceability of requirements differs depending on their type.
SAPN	SA Power Networks
SCADA	Supervisory Control and Data Acquisition
SIR	SA Power Networks Service and Installation Rules (Manual 32)
TIR	Technical Installation Rules
TS	Technical Standard
VAR	Volt-Amps Reactive

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Executive Summary

EXECUTIVE SUMMARY

Engevity has been engaged by the Essential Services Commission of South Australia (ESCOSA) to review clauses 3.9 to 3.17 (the “Clauses”) of the Electricity Distribution Code Version 13 [1] (the “Code”) to identify any duplication, inconsistencies or omissions with other regulatory requirements and to provide technical recommendations on changes to the Code. It is not intended to identify gaps / shortfalls in the Code.

Engevity found that most of the Clauses were either duplicated directly or in intent with other requirements that were equally enforceable by regulation. In particular, SA Power Networks’ (SAPN) 2022 Service and Installation Rules (SIR) and associated Technical Standards TS129, TS132, TS133 and TS134.

These Technical Standards were found to replicate many of the Clauses and typically provided more detail, specificity and/or modern terminology. The SAPN requirements found to be relevant were equally enforceable to the Clauses as they were each deemed a Technical Installation Rules (TIRs) under the South Australian Electricity Regulations.

Of the 24 clauses and sub-clauses within 3.9 to 3.17 of the Code:

- Sixteen (16) have been recommended to be removed as they are duplicated,
- Six (6) have been recommended to be retained as important requirements that have not been duplicated elsewhere, and
- Two (2) have been recommended to be retained but redrafted.

A summary of the recommendations for each clause is provided in Table 1–1 below:

Table 1–1: Summary of recommendations

Recommendation	Clauses	
Remove	3.9.1 a) to g) 3.10.1 a) & c) 3.11.2 3.12.1 a) to c)	3.14.1 3.15.1 3.16.1
Retain	3.10.1 b) 3.11.1 3.13.1 a) to d)	
Redraft	3.9.1 h) 3.17.1	

We recommend ESCOSA reviews the following Clauses to clarify their intent and/or interaction with SAPNs Technical Standards (refer Section 5.2.1 for further information):

- **3.10.1 b)**
- **3.10.1 c)**
- **3.11.1**
- **3.17.1**

Engevity also notes a potential gap in the Code being the lack of clarity with how battery energy storage systems are captured. The Code definition of *embedded generating unit* does not clearly capture batteries, and therefore it is unclear whether the Clauses reviewed also apply to battery systems.

In general, Engevity also recommends that ESCOSA consults on any changes to the Code with key stakeholders, including the OTR, SAPN and electricity customers, before implementing any of these recommendations.



Part 1: Introduction

1.0 INTRODUCTION

1.1 Background

The Electricity Distribution Code (the “Code”) stipulates technical requirements for Embedded Generators (EG) under clauses 3.9 through to 3.17 inclusive (referred to herein as the “Clauses”). There have been various changes to national regulations, state regulations and distributor standards over recent years which has prompted the Essential Services Commission of South Australia (ESCOSA) to review the appropriateness of these clauses in the Code.

Engevity was appointed by ESCOSA to review the Code’s technical requirements for EGs in these Clauses with respect to other relevant South Australian and national regulatory instruments.

We note that our findings were completed on a desktop review of the Code and did not involve consultation with third parties.

1.2 Objective

The objective of this report is to identify how the Clauses in the Code could be updated to:

- eliminate duplication
- resolve inconsistencies, and
- retain technical requirements not made elsewhere.

It is not intended to identify gaps or shortfalls in the Code, however is intended to assist ESCOSA, SA Power Networks and network customers to continue integrating embedded generation in an effective and efficient manner.


1.3 Principles

In undertaking this review, Engevity has focused on ensuring there is no duplication or inconsistency between the Code and other regulatory documents (and retain requirements that are not captured elsewhere) while being cognisant of the main objective as set out in 6(a) of the Essential Services Commission Act which is:

“...the protection of the long-term interests of South Australian consumers with respect to the price, quality and reliability of essential services...”

Engevity believes best practice regulatory policy also embodies the following additional principles, which shall also be reflected in any Engevity drafting recommendations:

- Technology agnosticism
- Futureproofing against expected evolutions in markets and technologies
- Clarity of interpretation for all parties
- Gapless coverage of key regulatory areas



Part 2: Requirements

2.0 REQUIREMENTS

This review is based on assessing both regulatory instruments as well as other technical requirements where they are required to be complied with via regulatory instruments or as a connection requirement. They are all presented for completeness.

Engevity has classified each relevant requirement into the following categories, in order of enforceability precedence as per Table 2–1.

Table 2–1: Classification of different types of relevant requirements

Requirement Category	Description/Enforcement
Regulation	A regulatory instrument defined by either ESCOSA or South Australian legislation (including the Electricity Regulations and the NER).
Technical Installation Rules (TIR)	A requirement by the distributor, enforceable via South Australian legislation. These are approved by the OTR and contained within SAPN’s SIR.
Distributor Connection Requirement	A requirement by the distributor as a criterion of connection. For SAPN, most of these are set out in the SIR and their Connection Agreements.
Technical Standard	A technical requirement that may need to be complied with if required explicitly by one of the above categories.

The focus of this review is regulatory instruments which encompasses regulations and TIRs (enforceable via regulation). However, Engevity highlights the current TIRs capture various Distributor Connection Requirements and Technical Standards, effectively elevating these captured requirements to enforceable regulation.

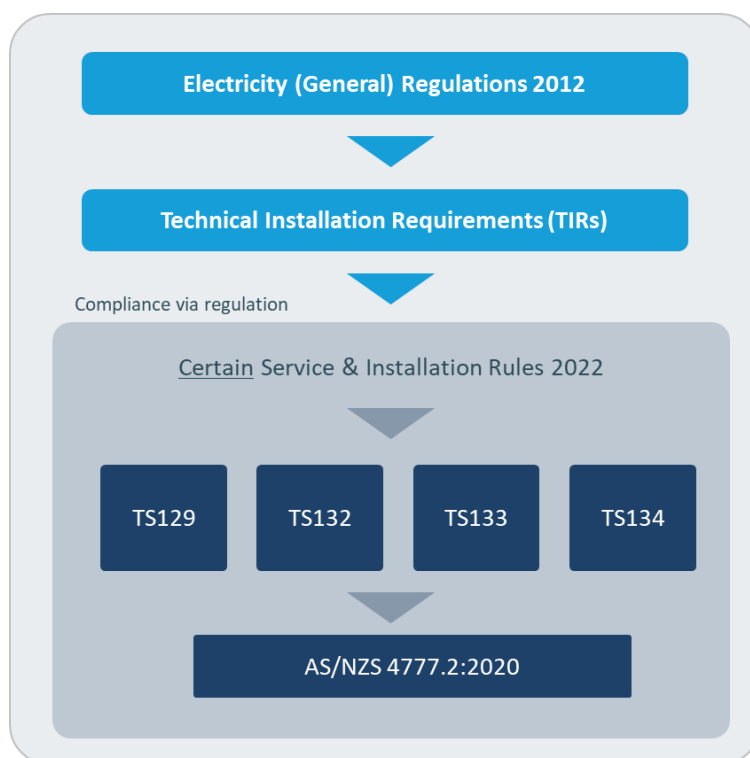
Later in our analysis, Code requirements are considered duplicated by SAPN's documents only where SAPN is given the power to set requirements for generators through the regulatory requirements (including where SIRs and TS are elevated as TIRs).

As shown in Figure 1 below, regulatory compliance with some Technical Standards and Distributor Connection Requirements is required by certain TIRs in SAPN’s SIR. Specifically:

- SIR 9.2.2 is a TIR that requires all embedded generators to comply with SAPN TS129, TS132, TS133 and TS134.
- TS129 4.3, TS132 4, and TS133 4. each require the inverter energy systems of all types of embedded generators to be compliant with AS/NZS 4777.2:2020. TS134 also requires compliance with AS/NZS 4777.2:2020. AS/NZS 4777.2:2020 therefore becomes a compliance requirement covered by the TIR SIR 9.2.2.

We note that compliance with the AS/NZS 4777 series is required via AS/NZS 3000:2018 which is in turn called upon by the Electricity Regulations. It is worth noting that the AS/NZS 3000:2018 references are primarily to do with the installation requirements rather than specific references to inverter requirements under AS/NZS 4777.2:2020.

Figure 1: Requirements with compliance covered by regulation



These captured requirements have therefore been considered regulatory requirements and compared to the Code for the purposes of this review.

2.1 List of Requirements

Engevity has listed the relevant Requirements it has considered in Table 1 below. Although some of these Requirements were not found to be directly relevant, they are included here for completeness as they have been assessed in detail in the process of this review.

Table 22–2: List of relevant Requirements

Reference	Name
AEMC ERC0301 [2]	Technical standards for distributed energy resources
AEMO Guide to generator exemptions [3]	Guide to generator exemptions and classification of generating units
AS/NZS 4777.2:2020 [4]	Grid connection of energy systems via inverters, Part 2: Inverter Requirements
CSIP-AUS 2030.5 [5]	Common Smart Inverter Profile – Australia
DEIP DOE Workstream [6]	Dynamic Operating Envelopes Working Group Outcomes Report
Electricity (General) Regulations 2012 [7]	South Australia Electricity (General) Regulations 2012 under the Electricity Act 1996
ESB Integration of DER [8]	(Incl. AEMC ERC0319) Governance of distributed energy resources technical standards
ESCOSA Model licence conditions [9]	Amended 2017 Model Licence Conditions for new generators

Reference	Name
NER v180 [10]	National electricity rules version 180
OTR D21012132 [11]	Generator Development Approval Procedure
SAPN 3603 [12]	Model terms & conditions for deemed standard connection contracts
SAPN 3604 [13]	AER approved – Deemed large customer connection contract
SAPN Manual 32 [14]	Service and Installation Rules (2022)
SAPN NICC270 [15]	Connection of Large Embedded Generation
SAPN TS129 [16]	Small EG Connections Technical Requirements - Capacity not exceeding 30kVA
SAPN TS132 [17]	Inverter Energy Systems (IES) above 30kW an up to or equal to 200kW Low Voltage Embedded Generation Connection Technical Requirements – Capacity above 30kVA
SAPN TS133 [18]	High Voltage Embedded Generation Connection Technical Requirements
SAPN TS134 [19]	Communication Systems (inc. SCADA) for Embedded Generation

2.2 Relationships Between the Various Requirements and the Code

A general summary of how each of the requirements relate to the Code is provided in Table 22–3. This table maps out each of the requirements against the topic areas covered by each of the Clauses in the Code. In addition, Engevity has classified the relevance of each Requirement to the Clauses as follows:

- **High:** Requirement directly related to the Clause(s)
- **Medium:** Requirement has some relation to the Clause(s)
- **Low:** Requirement has little relation to the Clause(s)
- **Flagged:** Future requirements for ESCOSA consideration with no relationship to the Clause(s)

Table 22–3: Matrix of how each Requirement may relate to each of the Clauses

Requirement	Relevance	Relevant Section	Relevance to the Clauses								
			3.9	3.10	3.11	3.12	3.13	3.14	3.15	3.16	3.17
			Protection & Control	Network Capacity	Operation & Ramp Rates	Plant Control & Response	Response to Disturbances	Voltage / Power Quality	Fault Levels	Earthing	Interference
SAPN Manual 32	High	Various	✓	✓	✓			✓	✓		✓
SAPN TS129	High	Various		✓			✓	✓	✓	✓	
SAPN TS132	High	Various	✓	✓	✓	✓	✓	✓	✓	✓	
SAPN TS133	High	Various	✓	✓	✓	✓	✓	✓	✓	✓	
SAPN TS134	High	Various	✓		✓						
AS/NZS 4777.2:2020	High	Part 2-6	✓		✓	✓	✓	✓		✓	
Electricity (General) Regulations 2012	Medium	Sch 4.5.2&3		✓						✓	
NER v180	Medium	Sch 5.2 Ch 5A	✓	✓	✓	✓	✓	✓	✓	✓	
SAPN 3603	Medium	Cl 6		✓	✓			✓	✓		
SAPN 3604	Medium	Cl 6		✓	✓			✓	✓		
ESCOSA Amended Model licence conditions	Medium	All				✓	✓		✓		
SAPN NICC270	Low	Ch 3	✓	✓	✓	✓	✓	✓	✓	✓	
OTR D21012132	Low	Pg. 5	✓		✓	✓					
AEMO Guide to generator exemptions	Low	Ch 3	✓	✓	✓	✓	✓	✓	✓	✓	
CSIP-AUS 2030.5	Flagged	Ch 4.4 Ch 5.2.4 Annex B		✓							
AEMC ERC0301	Flagged	See NER		✓			✓	✓	✓	✓	
ESB Integration of DER	Flagged	Various									
DEIP DOE Workstream	Flagged	Ch 4									



Part 3: Nomenclature & Categorisation of Embedded Generators

3.0 Nomenclature and Categorisation of Embedded Generators

Engevity notes that EGs are categorised differently in the various Requirements. These categorisations do not directly align, creating an additional challenge for Engevity’s review where technical obligations between requirements may be duplicated except in that they apply to slightly different subsets of embedded generators, as defined by their size, type or connection voltage.


Given the lack of convergence in the energy industry on the categorisation of embedded generators, Engevity has endeavoured to consider the practical implementation and intent of each requirement to best align different categorisations.

The key categorisations of EGs relevant to this review are those contained in the Code, the NER and SAPN’s SIR. An overview of these categorisations is presented in Figure 2 below.

The key observation is that there is no consistency in the definition of an embedded generator across the various regulatory instruments.

Figure 2: Categorisation of embedded generators in different requirements

The Code 13	NER v180	SAPN Manual 32 (2022)
<p>Small embedded generator: A generator that complies with the requirements of AS 4777 (considers IES generators <200kVA)</p> <p>Large embedded generator: Any other embedded generator.</p> <p>(Note that chapter 3 of the code only applies to large embedded generators that do not need to be registered, i.e. <5MW)</p>	<p>Micro embedded generator: A generator that is of the kind contemplated by AS 4777 (considers IES generators <200kVA)</p> <p>Non-registered embedded generator: An embedded generator that is not a micro embedded generator and not a registered participant.</p> <p>A generator with a generating system consisting of a combined nameplate rating of 5 MW or more is required to be registered (and hence meet the technical requirements under S5.2.5 of the NER), unless exempted.</p>	<p>Small embedded generator connection: An IES embedded generator ≥30kVA and connected at up to 1kV of network voltage.</p> <p>Low voltage embedded generator connection: An embedded generator >30kVA and ≤1.5MVA and connected at up to 1kV of network voltage.</p> <p>High voltage embedded generator connection: An embedded generator > 1.5MVA or any embedded generator connected at over 1kV of network voltage.</p>



Part 4: **Assessment of Duplication, Inconsistency or Omission**

4.0 Assessment of Duplication, Inconsistency or Omission

Engevity found that the majority of the Clauses are either duplicated or partially duplicated by SAPN’s revised SIRs and associated technical standards.

SA Power Networks is the only distribution network service provider regulated by the Australian Energy Regulator in South Australia. Further, SA Power Networks has the only distribution licence issued by the Commission that specifies compliance with the Code. Therefore, for the purpose of this task, it is only necessary to consider SA Power Networks' connection requirements in identifying duplication, inconsistency or omission with the Code.

The SIRs found to be relevant are all also TIRs enforceable via the Electricity Regulations. SIRs that are not TIRs are still enforceable by SAPN by way of approval of connection for, or forced disconnection of, an embedded generator.

Engevity has detailed its findings in Section 4.1.

4.1 Summary of Findings

Engevity has used categories for assessing duplication, inconsistency, or omission of the relevant requirements of the Clauses as set out in Table 4–1Table 1–1.

A summary of our findings against each EDC clause under review is presented in Table 4–2.

Table 4–1: Categories for assessment

Category	Description
Duplication	A relevant requirement, or group of relevant requirements in conjunction, duplicates the entire requirement and intent of the relevant Clause. The relevant requirement may also prescribe addition or more onerous requirements.
Partial Duplication	A relevant requirement(s) duplicates a part or aspect of the relevant Clause. The relevant requirement may also align with the overall intent of the Clause, and may result in more complete duplication when applied in practice.
Inconsistency	A relevant requirement(s) imposes a requirement that is at odds with the Clause in question. Particularly, the relevant requirement is opposed to the result or intent of a Clause, or the Clause is a more onerous requirement.
None (omission)	This requirement in the Code is not covered elsewhere. Other relevant requirements that are similar but do not directly relate to the Clause are provided for context.

Table 4–2: Assessment summary – duplication & inconsistency

EDC Clause	Duplicated/Inconsistent	Related code/rules	Type	Notes
3.9 Coordination of Large Embedded Generating Units				
3.9.1 Large embedded generators must comply with the following requirements:				
a) the embedded generating unit must be synchronised to the distribution network	Duplication	TS132 4.9.4, TS133 4.9.2.6	Technical Standard	SAPN's Technical Standards that apply to large embedded generators (TS132 & TS133) require automatic synchronisation as a condition of connection.
b) the embedded generating unit's real and reactive power output or voltage output must be automatically controlled within limits agreed with the distributor. A nominal full load power factor of 0.8 lagging must be provided	Inconsistent	SIR 6.2.2 (TIR), 10.3.2 (TIR)	Technical Installation Rule	(Power factor) The SIRs require customers that generate electricity to maintain certain leading and lagging power factors at the connection point depending on the size of the electrical installation and connection voltage. These power factors differ from the 0.8 lagging required by the Code clause 3.9.1(b) and apply at the connection point instead to the generating unit itself.
	Inconsistent	TS132 4.12.3	Technical Standard	(Power factor) Requires a fixed power factor control mode for non-IES large embedded generators <1.5MVA and connected at low voltage, including a power factor window of 0.9-0.95 lagging.
	Inconsistent	TS133 4.12.2	Technical Standard	(Power factor) Applies to large EGs >1.5MVA or connected at high voltage. Specifies that the customer must maintain a power factor specified by SAPN which can be modified from time to time.

EDC Clause	Duplicated/Inconsistent	Related code/rules	Type	Notes
	Partial Duplication	TS132 & 133 4.6.1, 4.6.2	Technical Standard	(Real and reactive power) SAPN's TS132 and TS133 sets out that an EG must have controls to automatically control real and reactive power output within agreed limits.
		TS134 5.	Technical Standard	(Real and reactive power) TS134 also requires all exporting large EGs to have SCADA to remotely set real and reactive power targets and limits. However, this does not apply to embedded generators that are non-exporting or less than 30kVA and inverter connected which would otherwise be capture by Code clause 3.9.1(b).
c) the embedded generator's voltage and frequency response times must be within the limits specified by the distributor. If the embedded generator's frequency rises above or falls below the system frequency for more than the time specified by the distributor, it must be disconnected from the distribution network	Duplication	T132 & 133 4.9.2.1	Technical Standard	TS132 and TS133 clearly sets out the distributor's (SAPN's) frequency limits and that EGs that are greater than 30kVA or non-IES must disconnect when system frequency exceeds this limit, including delay requirements and backup systems. This clause is a direct duplication of SAPN's connection requirements.

EDC Clause	Duplicated/Inconsistent	Related code/rules	Type	Notes
d) the embedded generating unit must be fitted with necessary protection relays, as agreed with the distributor, in order to coordinate its ability to isolate itself from the distribution network in the event of a fault on either the distributor's distribution network or the embedded generator's electricity infrastructure	Duplication	TS132 & 133 4.9	Technical Standard	SAPN's Technical Standards for IES generators >30kVA and any non-IES generator are prescriptive about the need for protection systems for generating systems which are able to respond to both faults on the network and faults in the generating system in different ways depending on fault type. This includes disconnection of the large embedded generator in response to faults. The SIR, TS132 and TS133 requires such connection systems to be coordinated with the network's response.
	Duplication	TS133 4.9.3	Technical Standard	SAPN uses the term 'disconnect' in most cases, with 'isolation' only specified for failsafe behaviour and customer connection circuit breakers. TS133 specifies that disconnection inacted by protection relays means to electrically isolate, however this specification is not mirrored in TS132.
	Duplication	SIR 5.2.5 (TIR)	Technical Installation Rules	Engevity notes that the Service & Installation Rules also requires circuit breakers and other protection/isolation systems for customer connections. This includes connection point circuit breakers for the purposes of customer isolation. However, it is TS132 and TS133 which are specific regarding protection devices related to embedded generators as opposed to customer connections in general.
e) the embedded generating unit must be equipped with lockable means of isolation from the distribution network	Duplication	SIR 10.4.5 (TIR)	Technical Installation Rules	Each connection point requires a lockable isolation device. Each EG unit behind a connection point would therefore also be behind a lockable isolation device. Note that SAPN requires a lockable isolation device at the connection point, not for each EG unit.
	Duplication	SIR 5.13.1 (TIR)	Technical Installation Rules	Specifies that each customer requires a lockable isolation device, including those with EGs.

EDC Clause	Duplicated/Inconsistent	Related code/rules	Type	Notes
	Duplication	TS132 & 133 4.7	Technical Standard	Captures all large EGs and specifies that a network isolation device must be installed as per the SIR.
f) unless otherwise agreed with the distributor, an embedded generator must allow for the connection of a communication link between the embedded generation unit and the distributor's substation to monitor and as necessary trip the generator in an emergency	Partial Duplication	TS134 4., 5.	Technical Standard	Most large EGs require a SCADA communication connection for monitoring and remote control. SCADA requirements do not apply to non-exporting IES EG or IES EG exporting IES ≤200 kVA, so these EGs may not be remotely monitored and controlled under SAPN requirements.
	Partial Duplication	TS134 5.1.3	Technical Standard	Permissive signalling enables remote signals to require disconnection of non-IES EGs but only ramp to 0MW for IES. This is different from disconnection and intentional. While AS/NZS 4777.2:2020 requires inverter capability to receive external disconnection signals, SAPN SIR or Technical Standards do not seem to specify the need for remote disconnection for IES (though it is unlikely it is not required through some mechanism).
	Partial Duplication	AS/NZS 4777.2:2020 4.6	Technical Standard	Requires AS/NZS 4777.2:2020 compliant generators to have the capability to be disconnected via external signal.
g) asynchronous embedded generating units must be equipped with controlled power factor correction capacitors to support necessary VAR loading requirements, and	Inconsistent	TS132 & 133 4.6.1	Technical Standard	TS132 and 133 required non-IES (asynchronous) EGs to have the capability to meet VAR loading requirements, including leading and lagging power factor limits. However, none specify the requirement for a power factor correction capacitor, rather imply that such additional devices may be needed as determined on a case by case basis through engineering studies. The intention of the code is the same and the outcomes would likely be duplicated, however 3.9.1(g) as it stands imposes a more prescriptive requirement than other regulatory instruments.

EDC Clause	Duplicated/Inconsistent	Related code/rules	Type	Notes
h) any other reasonable requirement of the distributor.	Duplication	EDC 3.5	Regulation	EDC 3.5 already states that the distributor is to connect a large embedded generator only after reasonable terms and conditions in the form of a connection agreement are negotiated.
	Duplication	SAPN 3603 & 3604 6.3	Distributor Connection Requirement	SAPN is able to make any other reasonable requirement of embedded generators as per its connection contract. SAPN requires compliance with its SIR and Technical Standards as a condition of connection as per its standard connection contract.
	Duplication	SIR	Technical Installation Rules	The SIR contains multiple requirements that apply to EGs. All requirements are conditions of connection, and many requirements are also TIRs.
	Duplication	SIR 9.2.2	Technical Installation Rules	The SIR also contains a TIR requiring EG compliance with the entire contents of TS129, TS132, TS133 and TS134.
3.10 Capacity				
3.10.1 The capacity of embedded generator's plant shall not exceed the capacity of the distribution network in terms of:				
a) its capacity to accept export energy	None (omission)	Electricity Regulations 55E(2)	Regulation	The Electricity regulations requires all new inverters to be capable of being exported limited with the ability to have these limits updated remotely. This is not a requirement that in itself provides protection for the network but is seen as a move towards dynamic limits.
	Duplication	SIR 6.2 (TIR)	Technical Installation Rules	Requires all customers to maintain their load/export within specified limits, including limits due to network capacity.

EDC Clause	Duplicated/Inconsistent	Related code/rules	Type	Notes
	Duplication	TS132&133 4.3.1	Technical Standard	Applies to all EGs >30kVA or connected to high voltage. Requires EGs not to breach export limits, which are dictated by network capacity.
	Duplication	TS129 4.1.5, 4.2.1	Technical Standard	Applies to all EGs <30kVA connected to low voltage. Requires EGs not to breach export limits, which are specified in the standard.
b) its capacity to provide emergency energy in the event of a generator trip, and	Partial Duplication	SIR 6.2.5 (TIR)	Technical Installation Rules	The SIR requires that customers must ensure that voltage disturbances caused by EGs to not result in voltage disturbances greater than prescribed limits to other customers. No regulation specifically refer to capacity limits under N-1 conditions.
	Partial Duplication	TS132 & 133 4.12.1.1	Technical Standard	Applies to all EGs >30kVA or connected to high voltage. Specifies that voltage disturbances caused by an EG must have limited impacts on other customers on the network. Other EG are not well specified.
	Partial Duplication	TS133 4.16.4	Technical Standard	TS133 allows SAPN discretion to require embedded generating systems to comply with NER s5.2.5.12 which does consider the impact of a generator on network capability under 'abnormal conditions'.
	Partial Duplication	NER S5.2.5.12	Regulation	Requires generators not to reduce power transfer capabilities of the power system or the ability to supply customer load. Compliance with this is assessed under a 'range' of operating conditions, which would include N-1 conditions.

EDC Clause	Duplicated/Inconsistent	Related code/rules	Type	Notes
c) its fault level.	Partial Duplication	TS132 & 133 4.3.1, 4.16.2.1	Technical Standard	<p>SAPN TS132 & TS133 require that EGs may (not*) contribute to network fault levels beyond network and equipment limits. Fault level contributions are to be determined case by case and any necessary issues remedied. Small EGs as covered by TS129 do not have any maximum fault level requirements, however this is likely because IES generation do not contribute as much fault current as synchronous generators.</p> <p><i>*4.16.2.1 actually states 'may' instead of 'may not', which we believe to be a typographical error based on context. As of the date of this publication, Engevity has not been able to clarify this error with SAPN.</i></p>
	None (omission)	ESCOSA Model License Conditions for New Generators Ch 11	Regulation	ESCOSA's model license conditions also require generators to operate under minimum fault level requirements, though these only apply to generators of capacity >100kVA. Engevity understands that minimum fault level limits were not considered in the original intent of clause 3.10.1(c).

EDC Clause	Duplicated/Inconsistent	Related code/rules	Type	Notes
3.11 Scheduling				
3.11.1 Unless otherwise agreed with the distributor, a large embedded generator with an embedded generating unit over 1 MW must advise the distributor prior to connection or disconnection of the embedded generating unit.	Partial Duplication	3603 & 3604 6.2	Distributor Connection Requirement	<p>SAPN's SIRs and connection agreement requires EGs to communicate with SAPN when undertaking permanent connection or disconnection processes, or when the generator is aware of a change in behaviour.</p> <p>However, the intent of this EDC clause seems to refer to day to day operational behaviour of a generating unit, as implied by the term 'scheduling'. There seem to be no other regulations that require a generator >1MW but <5MW to communicate with the distributor for the purposes of connecting or disconnecting a unit.</p> <p>This clause may not apply to generating systems with multiple smaller units however (e.g. a > 1 MW solar PV installation with multiple smaller inverters where a single inverter is considered to be a generating unit).</p>
	Partial Duplication	SIR 5.2	Distributor Connection Requirement	As above.
	None (omission)	TS134 5.1.3	Technical Standard	Permissive signalling requirements for exporting EGs results in SAPN continuously signalling to the generator whether it can remain connected or not. However, this is a distributor to generator communication requirement, not a generator to distributor communication requirement as required by this clause

EDC Clause	Duplicated/Inconsistent	Related code/rules	Type	Notes
3.11.2 The rate of change of an embedded generating unit over 1 MW must be agreed with the distributor.	Partial Duplication	TS132 & 133 4.6, 4.12.1.2	Technical Standard	SAPN TS132 & TS133, covering all EGs >1MW, specify maximum ramp rates for EGs as well stating that actual ramp rates will be agreed between EG and SAPN. 3.11.2 is therefore duplicated by SAPN TIRs.
3.12 Minimum requirements for Embedded Generating Units over 1 MW				
3.12.1 Unless otherwise agreed with the distributor, any embedded generating unit over 1 MW must:				
a) have an automatic excitation control system for volts and power factor	None (omission)	None	None	As discussed in 3.9.1 (b), SAPN requires capability to manage reactive power and power factor, but no explicit requirement for an 'automatic excitation control system', which is a specific system for voltage control relevant only to synchronous generators. The intent of this clause is likely captured by the SIRs and TSs discussed in 3.9.1(b).
b) have a governor control for speed (frequency) and load (MW) control, and	Duplication	TS132 & 133 4.6.2	Technical Standard	There is implicit requirement for governor controls on EGs (applies to synchronous generators only) by way of SAPN requiring adequate control over governors. As discussed in 3.9.1(b), there exists requirements for an active power control system on the generator, such as an automatic governor control. Both Non-IES and IES EGs >1MW are required to have frequency control capabilities.
	None (omission)	TS132 & 133 4.	Technical Standard	Applies to all EGs >30kVA or connected to high voltage. Requires large EGs that are inverter connected to comply with AS/NZS 4777.2:2020.

EDC Clause	Duplicated/Inconsistent	Related code/rules	Type	Notes
	None (omission)	AS/NZS 4777.2:2020 4.5.3	Technical Standard	Requires inverters to have an automatic droop response to manage frequency, equivalent to governor control on synchronous machines.
c) be equipped with protection and auto synchronising equipment as defined by the distributor.	Duplication	EDC 3.9.1(a) and (d)	Regulation	Duplicate of EDC 3.9.1(a) and (d).
3.13 Delivery performance requirements of Embedded Generation Units				
3.13.1 An embedded generator's plant shall be able to:				
a) respond safely to network disturbances	None (omission)	None	None	No explicit reference in other regulation to safe response to network disturbances. Safety requirements on EGs typically relate to safety of wiring and access.
b) shut down safely without external electricity supply	None (omission)	None	None	No explicit reference in other regulation to safe shut down or the requirement not to rely on external energy supply. However, the intent of this clause is likely covered by the variety of protection and disconnection requirements put on EGs by SAPN's SIRs and Technical Standards.
c) restart following loss and restoration of supply, and	None (omission)	None	None	No other requirements specify the capability for an EG to restart following loss and restoration of supply. SAPN's SIR only refer to the conditions under which a generator may reconnect to the distribution network via TS132 & 133 for and AS 4777.2. This does not necessary imply capability of the plant to do so.

EDC Clause	Duplicated/Inconsistent	Related code/rules	Type	Notes
	None (omission)	AS/NZS 4777.2:2020 4.7	Technical Standard	Reconnection conditions for inverter connected EGs.
	None (omission)	TS132 & 133 4.9.2	Technical Standard	Reconnection conditions for large EGs.
d) operate in a stable manner on the distribution network during system disturbances.	Partial Duplication	TS132 & 133 4.3.1	Technical Standard	<p>Applies to all EGs >30kVA or connected to high voltage. SAPN may undertake stability studies which would likely capture stability of operation during system disturbances. It is not specified under what circumstances stability studies are required.</p> <p>The NER does consider stability and generator response in its generator performance standards, however these would only apply to registered generators >5MW and so do not overlap with EDC 3.13.</p>
3.14 Voltage Quality				
3.14.1 An embedded generator must ensure that its embedded generating plant does not contribute to the permitted levels of voltage unbalance, voltage fluctuation and harmonic content	Duplication	SIR 6.2.3 (TIR) SIR 6.2.5 (TIR) SIR 6.2.6 (TIR)	Technical Installation Rules	SAPN sets out its customer obligations for its levels and limits for voltage unbalance, voltage fluctuation and harmonics in its service installation rules as TIRs. This clause is a duplication of SAPN's SIRs, all of which are TIRs.
	Duplication	TS132 & 133 4.12	Technical Standard	Applies to all EGs >30kVA or connected to high voltage. SAPN sets out its specific embedded generator obligations for its levels and limits for voltage unbalance, voltage fluctuation and harmonics in its service installation rules.

EDC Clause	Duplicated/Inconsistent	Related code/rules	Type	Notes
specified by the distributor being exceeded.	Duplication	AS4777 2.7, 2.8 and 2.11	Technical Standard	All inverter connected plant connecting to SAPN's network must also comply with AS/NZS 4777.2:2020 power quality requirements which include unbalance, fluctuation, and harmonics. This captures all other EGs not captured in TS132 & TS133 4.12.
3.15 Fault Levels				
3.15.1 An embedded generating unit must be designed to work within and not contribute (other than an agreed contribution) to the system maximum fault level and the feeder capacity to which it is connected.	Duplication	EDC 3.10.1(c)	Regulation	Engevity believes 3.15.1 duplicates the requirements in 3.10.1(c).
	Partial Duplication	TS132 & 133 4.3.1, 4.16.2.1	Technical Standard	SAPN TS132 & TS133 require that EGs may (not*) contribute to network fault levels beyond network and equipment limits. Fault level contributions are to be determined case by case and any necessary issues remedied. Small EGs as covered by TS129 do not have any maximum fault level requirements, however this is likely because IES generation do not contribute as much fault current as synchronous generators. <i>*4.16.2.1 actually states 'may' instead of 'may not', which we believe to be a typographical error based on context. As of the date of this publication, SAPN has not confirmed this interpretation.</i>
	Partial Duplication	SIR 10.2.8 (TIR)	Technical Installation Rules	For high voltage connections, customers are required to have equipment with minimum fault ratings suitable for the maximum fault level rating of the network.
	None (omission)	ESCOSA Model License Conditions for New Generators Ch 11	Regulation	ESCOSA's model license conditions also require generators to operate to minimum fault level requirements, though these only apply to generators of capacity >100kVA. Engevity understands that minimum fault level limits were not considered in the original intent of clause 3.10.1(c).

EDC Clause	Duplicated/Inconsistent	Related code/rules	Type	Notes
3.16 Earthing				
3.16.1 A large embedded generator must ensure that its embedded generating units are earthed in accordance with the distributor's earthing requirements. The embedded generator must provide earth fault protection to isolate each embedded generating unit from the distribution network under earth fault conditions.	Inconsistent	TS132 & 133 4.8 (Earthing)	Technical Standard	SAPN defines its earthing requirements for large EGs in TS132 & TS133 and its SIR as TIRs.
	Inconsistent	TS132 & 133 4.9.2.2 (Earth fault protection)	Technical Standard	For earth fault protection, large EGs that are <1.5MVA and connected to low voltage (as captured by TS132) do not require earth fault protection per SAPN's requirements. EDC 3.16 is therefore more onerous on these EGs. Further, for large EGs >1.5MVA or HV connected (as captured by TS133), SAPN specifies the earth fault protection is intended to look inwards to an EG, and therefore may not operate in response to a network side earth fault.

EDC Clause	Duplicated/Inconsistent	Related code/rules	Type	Notes
3.17 Interference				
3.17.1 If the distributor notifies the embedded generator that its embedded generating unit is causing interference above the limits set out in AS/NZS 2344, AS2279, AS/NZS 61000 3.2, 3.3 or 3.5, the embedded generator must reduce the level of interference to below these limits within 90 days.	Partial Duplication	SIR 5.2.4 (TIR)	Technical Installation Rules	While similar in intent, this SIR does not specify limits for the interference, nor does it specify a response timeframe by which the generator should reduce interference.

4.2 Commentary on Findings

Engevity notes that in SAPN's 2022 revision of the SIR, it has clearly considered EG technical requirements in detail and specificity. It is clear to Engevity that it has also taken care to be clear and explicit with the nature of its requirements. Engevity also notes that these new SIRs released on 1 May 2022 capture the entirety of their Technical Standards that relate to EGs (TS129, TS132, TS133 and TS134) as TIRs as well.

As such, Engevity considers that the TIRs in SAPN's SIRs are well considered requirements for EGs and that the clauses that duplicate these TIRs either directly or in practice and intent be removed from the Code. Similarly, where Engevity found inconsistency between the SIR TIRs and the Clauses, Engevity has recommended removal of the respective Code clause and deference to the TIR, on the basis that the TIRs are, on the whole, more specific and up-to-date requirements for EGs as appropriate for both customers and the distributor, SAPN. A complete summary of our findings for each clause is provided in Table 5–1.

Engevity notes that SAPN's Technical Standards, which are covered by a TIR, do not categorise EGs into small and large as per the Code. Instead, SAPN categorises EGs by size, voltage at the connection point and technology type. This is intentional of SAPN and these categories have been updated as of the 2022 revision of the SIRs. This means that TIRs in SAPN's SIRs that duplicate or otherwise replace the need for the Clauses may cover a slightly different range of EGs than those described in the Code as small, large or greater than 1MW. As per our reasoning above, Engevity believes SAPN's categorisations to be well-reasoned and therefore represent the most appropriate categorisations for different sizes and types of EGs.

Finally, we also draw ESCOSA's attention to SIR 9.2.5 (TIR) and TS132 & TS133 7.3 which require EGs¹ to demonstrate ongoing compliance with the SIR and the Technical Standards. This explicitly positions the SIR TIRs as ongoing regulatory compliance instruments as opposed to requirements that only apply at the time of connection, therefore aligning with the application of the clauses in the Code. Engevity did not find an equivalent requirement covering small EGs less than 30kVA, as are covered by SAPN's TS129.

¹ TS132 and TS133 cover all EGs except for inverter connected EGs smaller than 30kVA. For these EGs, covered by TS129, no demonstration of ongoing compliance is explicitly required.



Part 5: Recommendations

5.0 RECOMMENDATIONS

Engevity has found that most of the Clauses are duplicated or otherwise superseded by other regulatory requirements, and therefore should be removed from the Code to streamline regulatory requirements on EGs. The Clauses recommended to be retained are those that Engevity assessed to be important for the protection of generators, customers or the network, and are not duplicated by other regulatory requirements.

The Clauses recommended to be retained in the Code are generally those that related to the broader interaction between Embedded Generators (EGs) and the network and their resultant safety and stability, rather than technical control and / or protection requirements applied to EGs in isolation as typical of SAPN's requirements.

Engevity has recommended that out of the 24 parts that make up Clauses 3.9-3.17:

- 16 are removed
- Six are retained
- Two are redrafted

Engevity also recommends ESCOSA removes the definitions of small or large EGs within the Code in relation to the technical clauses 3.9 to 3.17 as the SIR specifies requirements for different EG sizes and technologies. Instead, ESCOSA should refer to the definition and categorisations of EGs as set out by SAPN in its SIR.

For each relevant EDC clause, Engevity has recommended the clause be retained, removed or redrafted. Engevity has also provided explanation and justification of our recommendations, including noting the specific requirements and the extent of duplication.

5.1 Summary of Recommendations

A complete summary of our recommendations for each Clause is presented in Table 5–1.

Table 5–1: Assessment of drafting recommendations

Clause	Duplicated/ Inconsistent	Related code	Type	Recommendation	Justification
3.9 Coordination of Large Embedded Generating Units					
3.9.1 Large embedded generators must comply with the following requirements:					
a) the embedded generating unit must be synchronised to the distribution network	Duplication	TS132 4.9.4, TS133 4.9.2.6	Technical Standard	Remove	Duplication, remove – SAPN TS132 4.9.4 & TS133 4.9.2.6 (TIRs) requires large EGs to be synchronised prior to connection to the network. We recommend removal of this clause as it is duplicated by SAPN TIRs.
b) the embedded generating unit's real and reactive power output or voltage output must be automatically controlled within limits agreed with the distributor. A nominal full load power factor of 0.8 lagging must be provided	Inconsistent	SIR 6.2.2 (TIR), 10.3.2 (TIR)	Technical Installation Rule	Remove	Inconsistent, remove and defer to TIRs - Automatic real and reactive power control requirement duplicated by TS132 & TS133 4.6.1 and 4.6.2. SAPN power factor requirements are more detailed and nuanced than this clause (SIR 6.5.3, 10.3.2, TS132 & TS133 4.6.1, 4.6.2, TS132 4.12.3, TS133 4.12.2). We recommend removal of this clause and defer to SAPN TIRs for power factor requirements.
	Inconsistent	TS132 4.12.3	Technical Standard		
	Inconsistent	TS133 4.12.2	Technical Standard		
	Partial Duplication	TS132 & TS133 4.6.1, 4.6.2	Technical Standard		
TS134 5.			Technical Standard		

Clause	Duplicated/ Inconsistent	Related code	Type	Recommendation	Justification
c) the embedded generator's voltage and frequency response times must be within the limits specified by the distributor. If the embedded generator's frequency rises above or falls below the system frequency for more than the time specified by the distributor, it must be disconnected from the distribution network	Duplication	T132 & TS133 4.9.2.1	Technical Standard	Remove	Duplication, remove - T132 & TS133 4.9.2.1 detail voltage and frequency limits, disconnection and response times. We recommend removal of this clause as it is duplicated by SAPN TIRs.

Clause	Duplicated/ Inconsistent	Related code	Type	Recommendation	Justification
d) the embedded generating unit must be fitted with necessary protection relays, as agreed with the distributor, in order to coordinate its ability to isolate itself from the distribution network in the event of a fault on either the distributor's distribution network or the embedded generator's electricity infrastructure	Duplication	TS132 & TS133 4.9	Technical Standard	Remove	<p>Duplication, remove - SIR 5.2.5 (TIR), TS132 & TS133 4.9 and TS133 4.9.3 detail protection requirements, disconnection and coordination for large EGs.</p> <p>We recommend removal of this clause as it is duplicated by SAPN TIRs.</p>
	Duplication	TS133 4.9.3	Technical Standard		
	Duplication	SIR 5.2.5 (TIR)	Technical Installation Rules		

Clause	Duplicated/ Inconsistent	Related code	Type	Recommendation	Justification
e) the embedded generating unit must be equipped with lockable means of isolation from the distribution network	Duplication	SIR 10.4.5 (TIR)	Technical Installation Rules	Remove	<p>Duplication of intent, remove - TS132 & TS133 4.7, SIR 5.13.1 (TIR), and SIR 10.4.5 (TIR) all require large EGs to have a lockable means of isolation at the connection point. We note that isolation at the connection point applies isolation to the whole EG system, not each unit as required by the wording in this clause. We do not see benefit in retaining this requirement such that it applies to each EG unit instead of at the connection point.</p> <p>We recommend removal of this clause as it is duplicated in intent by SAPN TIRs.</p>
	Duplication	SIR 5.13.1 (TIR)	Technical Installation Rules		
	Duplication	TS132 & TS133 4.7	Technical Standard		
f) unless otherwise agreed with the distributor, an embedded generator must allow for the connection of a communication link between the embedded generation unit and the distributor's substation to monitor and as necessary trip the generator in an emergency	Partial Duplication	TS134 4., 5.	Technical Standard	Remove	<p>Partial duplication, remove and defer to TIRs - TS134 4., TS134 5., and TS134 5.1.3 require large EGs to have a communication link to the distributor for monitoring and control. SAPN only explicitly require remote tripping capability (intertrip) for large EG's that are non-IES, or at their discretion.</p> <p>SAPN has intentionally not required most large EGs to have a link with the distributor to remotely trip the generator. We believe SAPN's requirements to be well-considered and therefore do not believe a stronger requirement, as set out by the clause, is needed.</p> <p>Therefore, we recommended removal of this clause and deference to SAPN's TIRs.</p>
	Partial Duplication	TS134 5.1.3	Technical Standard		
	Partial Duplication	AS/NZS 4777.2:2020 4.6	Technical Standard		

Clause	Duplicated/ Inconsistent	Related code	Type	Recommendation	Justification
g) asynchronous embedded generating units must be equipped with controlled power factor correction capacitors to support necessary VAR loading requirements, and	Inconsistent	TS132 & TS133 4.6.1	Technical Standard	Remove	<p>Inconsistent, remove and defer to TIRs - TS132 & 133 4.6.1, and TS133 4.12.2.1 requires non-IES EGs (asynchronous EGs) to manage VAR loading (reactive power control). No requirements specify the need for power factor correction capacitors.</p> <p>The requirement for power factor correction capacitors for asynchronous EGs is outdated and the intent of this clause is captured by the above SAPN TIRs.</p> <p>Therefore, we recommend removal of this clause and deference to SAPN TIRs.</p>
h) any other reasonable requirement of the distributor.	Duplication	EDC 3.5	Regulation	Redraft	<p>Duplication but retain and move - This is a catch all clause that can provide additional protection for distributors and may be valuable to retain.</p> <p>We recommend retaining this clause. We note that this clause would be the only clause retained under 3.9. It therefore may benefit from being moved to below clause 3.17 for contextual clarity as a catch-all clause following the more specific requirements retained between 3.10 and 3.16. Similarly, we recommend minor redrafting such that the catch-all applies to all EGs, instead of just large generators as the original clause is restricted to under 3.9. Suggested redrafting is provided in Appendix A.</p>
	Duplication	SAPN 3603 & 3604 6.3	Distributor Connection Requirement		
	Duplication	SIR	Technical Installation Rules		
	Duplication	SIR 9.2.2	Technical Installation Rules		

Clause	Duplicated/ Inconsistent	Related code	Type	Recommendation	Justification
3.10 Capacity					
3.10.1 The capacity of embedded generator’s plant shall not exceed the capacity of the distribution network in terms of:					
a) its capacity to accept export energy	None (omission)	Electricity Regulations 55E(2)	Regulation	Remove	Duplication, remove - Multiple SIR TIRs and SAPN's connection agreement relate to imposing export limits on EGs and refer to technical parameters that determine network capacity to set these limits. We recommend removal of this clause as it is duplicated by SAPN TIRs.
	Duplication	SIR 6.2 (TIR)	Technical Installation Rules		
	Duplication	TS132 & TS133 4.3.1	Technical Standard		
	Duplication	TS129 4.1.5, 4.2.1	Technical Standard		
b) its capacity to provide emergency energy in the event of a generator trip, and	Partial Duplication	SIR 6.2.5 (TIR)	Technical Installation Rules	Retain	Retain but clarify - This clause is not clear as to whether it is referring to a trip of 'the' generator or another generator ("a generator"). Regardless of this ambiguity, we found no other regulations that duplicate or conflict with the requirement for large EGs not to inhibit the capacity of the network to deliver 'emergency' energy in an N-1 event. We recommend retaining this clause (but clarify the reference to ‘a generator’) as it provides specific protection to the distributor in an
	Partial Duplication	TS132 & 133 4.12.1.1	Technical Standard		
	Partial Duplication	TS133 4.16.4	Technical Standard		

Clause	Duplicated/ Inconsistent	Related code	Type	Recommendation	Justification
	Partial Duplication	NER S5.2.5.12	Regulation		<p>'emergency' event, which has a broad definition in EDC 13 (see below).</p> <p>Emergency means an emergency due to the actual or imminent occurrence of an event which in any way endangers or threatens to endanger the safety or health of any person, or the maintenance of power system security, in the state of South Australia or which destroys or damages, or threatens to destroy or damage, any property in the state of South Australia.</p> <p>We recommend ESCOSA undertakes a review of this clause to clarify the context and intent.</p>
c) its fault level.	Partial Duplication	TS132 & 133 4.3.1, 4.16.2.1	Technical Standard	Remove	<p>Partial duplication, remove and defer to TIRs - SAPN requires that most EGs may not* contribute to network fault levels beyond network and equipment limits, covered by TS132 and TS133. Some small IES EGs covered by TS129 do not have the same requirements under SAPN as under this clause in the Code. This is an intentional choice by SAPN and reflects the fact that IES generation do not contribute as much fault current as synchronous generators.</p> <p>We recommend removal of this clause as the intent is covered in SAPN documents.</p> <p><i>*4.16.2.1 actually states 'may' instead of 'may not', which we believe to be a typographical error based on the context. As of the date of this publication, SAPN has not confirmed this interpretation.</i></p> <p>We recommend ESCOSA undertakes a review of this clause to clarify the context and intent.</p>
	None (omission)	ESCOSA Model License Conditions for New Generators Ch 11	Regulation		

Clause	Duplicated/ Inconsistent	Related code	Type	Recommendation	Justification
3.11 Scheduling					
3.11.1 Unless otherwise agreed with the distributor, a large embedded generator with an embedded generating unit over 1 MW must advise the distributor prior to connection or disconnection of the embedded generating unit.	Partial Duplication	3603 & 3604 6.2	Distributor Connection Requirement	Retain	<p>No duplication or conflict, retain - SAPN permissive signalling requirements enable SAPN to allow or prevent non-zero output for EGs >1MW, but there are no requirements on EGs to advise distributors of their intention to disconnect or reconnect.</p> <p>Given clear permissive signalling requirements protecting SAPN and its network, this clause becomes simply a requirement to give warning of intention. The wording "Unless otherwise agreed" allows SAPN not to apply this requirement if they do not find it is needed. In practice, this clause may not be needed in most cases but could allow SAPN to have greater visibility over unique larger EGs which may require special management.</p> <p>We recommend that this clause is retained. We also recommend that if retained, the clause should replace 'an embedded generating unit' with 'a total nameplate rating' such that an EG would only have to advise the distributor of the connection or disconnect of the entire system, not each generating unit over 1MW or omitting units less than 1MW that may be greater than 1MW in aggregate.</p> <p>We recommend ESCOSA undertakes a review of this clause to clarify the context and intent.</p>
	Partial Duplication	SIR 5.2	Distributor Connection Requirement		
	None (omission)	TS134 5.1.3	Technical Standard		

Clause	Duplicated/ Inconsistent	Related code	Type	Recommendation	Justification
3.11.2 The rate of change of an embedded generating unit over 1 MW must be agreed with the distributor.	Partial Duplication	TS132 & TS133 4.6, 4.12.1.2	Technical Standard	Remove	Duplication, remove - TS132 & 133 4.6, 4.12.1.2 specify maximum ramp rates for EGs over 1MW as well stating that actual ramp rates will be agreed between EG and SAPN. We recommend removal as this clause is duplicated by SAPN TIRs.
3.12 Minimum requirements for Embedded Generating Units over 1 MW					
3.12.1 Unless otherwise agreed with the distributor, any embedded generating unit over 1 MW must:					
a) have an automatic excitation control system for volts and power factor	None (omission)	None	None	Remove	Duplication of intent, remove - As discussed in 3.9.1 (b), SAPN requires capability to manage reactive power and power factor, but no explicit requirement for an 'automatic excitation control system', which is a specific system for voltage control relevant only to synchronous generators. We recommend removal as this clause is outdated and its intent is duplicated by SAPN TIRs.
b) have a governor control for speed (frequency) and load (MW) control, and	Duplication	TS132 & TS133 4.6.2	Technical Standard	Remove	Duplication of intent, remove - this clause applies to synchronous generators only. As discussed in 3.9.1(b), there exists requirements for an active power control system on the generator, such as an automatic governor control. Both Non-IES and IES EGs >1MW are required to have frequency control capabilities. IES generators are also required to have capabilities that are the digital equivalent of governor control. We recommend removal of this clause as its intent is duplicated by SAPN TIRs.
	None (omission)	TS132 & TS133 4.	Technical Standard		
	None (omission)	AS/NZS AS4777.2: 2020 4.5.3	Technical Standard		

Clause	Duplicated/ Inconsistent	Related code	Type	Recommendation	Justification
c) be equipped with protection and auto synchronising equipment as defined by the distributor.	Duplication	EDC 3.9.1(a) and (d)	Regulation	Remove	Duplication, remove - duplicates requirements of EDC 3.9.1(a) and (d). We recommend removal as these requirements are already addressed in our recommendations for 3.9.1(a) and (d).
3.13 Delivery performance requirements of Embedded Generation Units					
3.13.1 An embedded generator's plant shall be able to:					
a) respond safely to network disturbances	None (omission)	None	None	Retain	No duplication or conflict, retain - no other requirements explicitly address the delivery performance of EGs and the safety and impact of this performance on the distribution network, as opposed to requirements on each EG to respond locally and in isolation. We recommend retaining these clauses as they cover important areas of safety of performance and system stability. We note AEMO is currently working on better defining DER impacts on operational stability and that particularly part (d) will be increasingly pertinent to EGs in the future.
b) shut down safely without external electricity supply	None (omission)	None	None	Retain	
c) restart following loss and restoration of supply, and	None (omission)	None	None	Retain	
	None (omission)	AS/NZS 4777.2:2020 4.7	Technical Standard		
	None (omission)	TS132 & TS133 4.9.2	Technical Standard		

Clause	Duplicated/ Inconsistent	Related code	Type	Recommendation	Justification
d) operate in a stable manner on the distribution network during system disturbances.	Partial Duplication	TS132 & TS133 4.3.1	Technical Standard	Retain	
3.14 Voltage Quality					
3.14.1 An embedded generator must ensure that its embedded generating plant does not contribute to the permitted levels of voltage unbalance, voltage fluctuation and harmonic content specified by the distributor being exceeded.	Duplication	SIR 6.2.3 (TIR) SIR 6.2.5 (TIR) SIR 6.2.6 (TIR)	Technical Installation Rules	Remove	Duplication, remove - Limits of contribution to voltage unbalance, voltage fluctuation and harmonics are covered in detail for all categories of EGs in TIRs in the SIR, Technical Standards and AS/NZS 4777.2:2020 (compliance with which also covered by TIR). We recommend removal of this clause as it is duplicated by SAPN TIRs.
	Duplication	TS132 & TS133 4.12	Technical Standard		
	Duplication	AS/ NZS 4777 2.7:2020, 2.8 and 2.11	Technical Standard		
3.15 Fault Levels					
3.15.1 An embedded	Duplication	EDC 3.10.1(c)	Regulation	Remove	

Clause	Duplicated/ Inconsistent	Related code	Type	Recommendation	Justification
generating unit must be designed to work within and not contribute (other than an agreed contribution) to the system maximum fault level and the feeder capacity to which it is connected.	Partial Duplication	TS132 & TS133 4.3.1, 4.16.2.1	Technical Standard		Duplication, remove - This clause duplicates the requirements of clause 3.10.1(c). We recommend removal of this clause as the requirement is already covered in our recommendation for clause 3.10.1(c).
	Partial Duplication	SIR 10.2.8 (TIR)	Technical Installation Rules		
	None (omission)	ESCOSA Model License Conditions for New Generators Ch 11	Regulation		
3.16 Earthing					
3.16.1 A large embedded	Inconsistent	TS132 & TS133 4.8 (Earthing)	Technical Standard	Remove	Inconsistent, remove and defer to TIRs - SAPN earthing requirements are covered in TS132 & 133 4.8, and 4.9.2.2. For earth

Clause	Duplicated/ Inconsistent	Related code	Type	Recommendation	Justification
generator must ensure that its embedded generating units are earthed in accordance with the distributor's earthing requirements. The embedded generator must provide earth fault protection to isolate each embedded generating unit from the distribution network under earth fault conditions.	Inconsistent	TS132 & TS133 4.9.2.2 (Earth fault protection)	Technical Standard		<p>fault protection specifically, large EGs that are <1.5MVA (as captured by TS132) do not require earth fault protection per SAPN's requirements. EDC 3.16 is therefore more onerous on these EGs. SAPN has explicitly considered application of earth fault protection requirements for different EG categories and therefore has produced prescriptive requirements than this clause.</p> <p>We recommend removal of this clause and deference to SAPN's TIRs.</p>

Clause	Duplicated/ Inconsistent	Related code	Type	Recommendation	Justification
3.17 Interference					
3.17.1 If the distributor notifies the embedded generator that its embedded generating unit is causing interference above the limits set out in AS/NZS 2344, AS2279, AS/NZS 61000 3.2, 3.3 or 3.5, the embedded generator must reduce the level of interference to below these limits within 90 days.	Partial Duplication	SIR 5.2.4 (TIR)	Technical Installation Rules	Redraft	<p>Redraft - While similar in intent to this clause, SIR 5.2.4 does not specify limits for the interference, nor does it specify a response timeframe by which the generator should reduce interference. SIR 4.2 has reference to standards including the AS/NZS 61000 series however.</p> <p>Reference to compliance requirements for interference and power quality is found in TS132 and TS133 (4.12) only. TS129 likely discharges any requirements for meeting power quality or interference via AS/NZS 4777.2:2020.</p> <p>AS/NZS 2279 is a superseded standard which has been replaced by the AS/NZS 61000 series of standards so it should be removed from this clause.</p> <p>We recommend redrafting this clause to remove reference to AS/NZS 2279.</p> <p>We recommend a review of whether the explicitly mentioned Standards in this clause are appropriate as some of these are equipment standards and/or covered in the SAPN standards.</p> <p>We recommend ESCOSA undertakes a review of this clause to clarify the context and intent.</p>

5.2 Additional Recommendations

Engevity’s recommendations for modifications to clauses 3.9 to 3.17 of the Code are based on our desktop analysis of the Code and other relevant requirements. We recommend that ESCOSA consults on any changes to its Code with key stakeholders, including SAPN and electricity customers, before implementing any of the recommendations.

Given the technical nature of Engevity’s review and the multiple recommendations to defer to TIRs set out in SAPN documents in place of the Code, Engevity recommends ESCOSA discusses these recommendations with stakeholders such as SAPN and the OTR prior to making modifications to the Code.

5.2.1 Clause Clarifications

The intent of some Clauses was not clear and hence Engevity have recommended they not be amended until their intent is clear. We recommend that ESCOSA clarify the intent of the clauses as set out in Table 5–2.

Table 5–2: Code Clauses requiring clarification

Clause	Observations
3.10.1 b)	There is a lack of clarity of the intent of this clause. It is not clear if reference to generator trip is a trip of <i>the</i> EG or any other EG on the network. The reference to emergency energy is also ambiguous. ESCOSA should consider the original intent of the clause and whether this interpretation is aligned with expectations that SAPN has for EGs under N-1 conditions.
3.10.1 c)	Wording in SAPN Technical Standards uses ‘may’ instead of ‘may not’, which we believe to be a typographical error based on the context. This would otherwise materially change the application of the relevant requirement to the Clauses. As of the publication of this report, Engevity has not been able to confirm whether this wording is an error and recommend ESCOSA follow up with SAPN.
3.11.1	This Clause enables SAPN to require EG units larger than 1 MW to declare their operational intentions to SAPN prior to acting, analogously to ‘commitment’ intentions for large generators. While this obligation is only applied at the discretion of the distributor, it is worth ESCOSA consulting with SAPN as to whether the clause remains relevant and is fit-for-purpose in its current form.
3.17.1	This clause refers to the AS/NZS 61000 series of standards, some of which are equipment standards rather than requirements at a connection point. There is overlap with SAPNs Technical Standards so the need for equipment standards to remain in the Code should be reviewed. The Code requires reduction of interference to acceptable levels within 90 days, the context of which is not clear as usually connection agreements between a distributor and their customers stipulate the process and timing requirements. The appropriateness of the 90-day requirement should be reviewed.



Part 6: Additional Commentary

6.0 ADDITIONAL COMMENTARY

6.1 Industry Developments

Increasing uptake of DER across all jurisdictions in Australia has resulted in multiple institutions having workstreams on foot to develop strategies to optimally integrate large volumes of DER, including examining potential necessary DER technical standards and requirements. Such workstreams involve market bodies, the Energy Security Board, networks, ARENA and industry and range from early-stage information gathering to in-progress regulation changes.

While these requirements will likely impact EGs they have not been factored into Engevity's recommendations for any Code clause modification. As such, we have highlighted areas of potential additional review for ESCOSA's ongoing consideration.

The workstreams currently underway that Engevity believes may result in requirements relevant to Clauses are:

- DEIP DOE Workstream: See Dynamic Operating Envelopes Working Group Outcomes Report
- AEMC ERC0301: Technical standards for distributed energy resources
- ESB Integration of DER: (Incl. AEMC ERC0319 Governance of distributed energy resources technical standards)
- CSIP-AUS 2030.5: Common Smart Inverter Profile – Australia

Engevity recommends that ESCOSA continues to monitor these workstreams and others as they progress and in any future stakeholder consultation or code changes relating to EG requirements following this review.

6.2 Further Points for Consideration by ESCOSA

In undertaking this review, Engevity has also noted some content and characteristics of the Clauses could be improved for clarity and completeness. These items lie outside the scope of this review, however Engevity recommends they be further considered by ESCOSA.

Specifically, Engevity notes the following observations for ESCOSA consideration:

- The use of 'generating units', 'generator', and 'generator plant' – These terms have significantly different definitions, and using one over the other can result in a requirement applying to each plant terminal ('generating unit') rather than to the whole plant in aggregate at the connection point ('generator' or 'generator plant'). Engevity considers that sometimes the term used in the Clauses is misaligned with the practical intent of the clause. This can cause a couple of issues with the application of the code, the first being undue or unintended onerousness by applying a requirement to each unit instead of the total system. Otherwise, it can result in size thresholds for requirements that apply to each unit instead of the nameplate capacity of the entire generator, resulting in different obligations on EGs of the same size and same impact on the network depending on how many individual units that comprise them.
- Lack of clarity with how battery energy storage systems are captured – The Code definition of *embedded generating unit* does not clearly capture batteries, and therefore it is unclear whether the Clauses reviewed also apply to battery systems. Engevity also notes that SAPN's SIR requires energy storage systems to comply, as relevant, with the same technical standards as EGs (TS129, TS132, TS133 and TS134). However, this requirement, SIR 9.8.2, is not a TIR.

- Clause 3.17.1 relating to interference contains direct reference to specific standards – We recommend ESCOSA avoid referencing specific standards in the Code, as the Code then becomes outdated if the underlying standards are revised or superseded. Instead, we consider a preferable approach to be to refer to limits set by the distributor or other relevant bodies who more directly manage the impact of various standards and their updates on their requirements.

These observations and recommended rectifications have also been included in our summary of recommendation in Table 5–1 against the relevant clauses for ease of reference.



Part 7: Conclusion

7.0 CONCLUSION

Engevity's review of clauses 3.9 to 3.17 of the Code has resulted in our recommendation to remove the majority of the clauses as they were found to be duplicated or otherwise superseded by other regulatory instruments.

Engevity found that most of the Clauses were either duplicated directly or in intent with other requirements that were equally enforceable by regulation. In particular, SA Power Network's (SAPN) 2022 SIR and associated Technical Standards TS129, TS132, TS133 and TS134. These technical standards were found to replicate many of the Clauses and typically provided more detail, specificity and/or modern terminology. The SAPN requirements found to be relevant were equally enforceable to the Clauses as they were each deemed as Technical Installation Rules (TIRs). TIRs are technical requirements approved by the Office of the Technical Regulator and with which compliance is mandatory as per Clause 55 of the South Australian Electricity Regulations.

Of the 24 clauses and sub-clauses within 3.9 to 3.17 of the Code:

- Sixteen (16) have been recommended to be removed as they are duplicated,
- Six (6) have been recommended to be retained as important requirements that have not been duplicated elsewhere, and
- Two (2) have been recommended to be retained but redrafted.

We recommend ESCOSA conducts further consultation with SAPN on the following Clauses to clarify the impact of our recommended changes:

- 3.10.1 b)
- 3.10.1 c)
- 3.11.1
- 3.17.1

In general, Engevity also recommends that ESCOSA consults on any changes to the Code with key stakeholders, including SAPN and electricity customers, before implementing any of Engevity's recommendations.



Part 8: References

8.0 REFERENCES

- [1] Essential Services Commission of South Australia, Electricity Distribution Code Version EDC/13, 1 July 2020.
- [2] Australian Energy Market Commission, “Technical standards for distributed energy resources,” Feb 2021.
- [3] Australian Energy Market Operator, “Guide to generator exemptions and classification of generating units,” May 2022.
- [4] Australian / New Zealand Standards, “AS/NZS 4777.2:2020 Grid connection of energy systems via inverters, Part 2: Inverter Requirements,” Standards Australia, December 2020.
- [5] DER Integration API Technical Working Group, “Common Smart Inverter Profile – Australia,” June 2022.
- [6] Distributed Energy Integration Program, “Dynamic Operating Envelopes Working Group Outcomes Report,” March 2022.
- [7] South Australian Government, “South Australia Electricity (General) Regulations 2012 under the Electricity Act 1996,” July 2022.
- [8] Australian Energy Market Commission, “Governance of distributed energy resources technical standards,” March 2022.
- [9] Essential Services Commission of South Australia, “Amended 2017 Model Licence Conditions for new generators,” December 2021.
- [10] Australian Energy Market Commission, “National Electricity Rules Version 180,” April 2022.
- [11] Office of the Technical Regulator, “Generator Development Approval Procedure,” July 2017.
- [12] SA Power Networks, “Model terms & conditions for deemed standard connection contracts,” August 2020.
- [13] SA Power Networks, “AER approved – Deemed large customer connection contract,” April 2018.
- [14] SA Power Networks, “Service and Installation Rules,” May 2022.
- [15] SA Power Networks, “Connection of Large Embedded Generation,” August 2020.
- [16] SA Power Networks, “Small EG Connections Technical Requirements - Capacity not exceeding 30kVA,” July 2021.
- [17] SA Power Networks, “Low Voltage Embedded Generation Connection Technical Requirements – Capacity above 30kVA”.
- [18] SA Power Networks, “High Voltage Embedded Generation Connection Technical Requirements,” May 2022.
- [19] SA Power Networks, “Communication Systems (inc. SCADA) for Embedded Generation,” May 2022.

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Appendices

APPENDIX A. RECOMMENDED DRAFTING

Engevity notes that the following drafting of the Code reflect our technical recommendations only. The following recommended drafting does not represent legal mark ups or official changes to the Code.

A.1 Recommended Drafting – Clean Version

EDC/13

3 Connection of Embedded Generation Units

3.9 [Not Used]

3.10 Capacity

3.10.1 The capacity of embedded generator's plant shall not exceed the capacity the distribution network in terms of its capacity to provide emergency energy in the event of a generator trip.

3.11 Scheduling

3.11.1 Unless otherwise agreed with the **distributor**, a **large embedded generator** with an **embedded generating unit** over 1 MW must advise the **distributor** prior to **connection** or disconnection of the **embedded generating unit**.

3.12 [Not Used]

3.13 Delivery performance requirements of Embedded Generation Units

3.13.1 An **embedded generator's** plant shall be able to:

- a) respond safely to network disturbances
- b) shut down safely without external electricity **supply**
- c) restart following loss and restoration of **supply**, and
- d) operate in a stable manner on the **distribution network** during system disturbances.

3.14 [Not Used]

3.15 [Not Used]

3.16 [Not Used]

3.17 Interference

3.17.1 If the **distributor** notifies the **embedded generator** that its **embedded generating unit** is causing interference above the limits set out in **AS/NZS 2344**, **AS/NZS 61000 3.2**, **3.3** or **3.5**, the **embedded generator** must reduce the level of interference to below these limits within 90 days.

3.18 Coordination of Embedded Generators

- 3.18.1 Embedded generators must comply with any other reasonable requirement of the distributor.

A.2 Recommended Drafting – Redline Version

EDC/13

3 Connection of Embedded Generation Units

3.9 ~~[Not Used] Coordination of Large Embedded Generating Units~~

~~3.9.1 Large embedded generators must comply with the following requirements:~~

- ~~a) the embedded generating unit must be synchronised to the distribution network~~
- ~~b) the embedded generating unit's real and reactive power output or voltage output must be automatically controlled within limits agreed with the distributor. A nominal full load power factor of 0.8 lagging must be provided~~
- ~~c) the embedded generator's voltage and frequency response times must be within the limits specified by the distributor. If the embedded generator's frequency rises above or falls below the system frequency for more than the time specified by the distributor, it must be disconnected from the distribution network~~
- ~~d) the embedded generating unit must be fitted with necessary protection relays, as agreed with the distributor, in order to coordinate its ability to isolate itself from the distribution network in the event of a fault on either the distributor's distribution network or the embedded generator's electricity infrastructure~~
- ~~e) the embedded generating unit must be equipped with lockable means of isolation from the distribution network~~
- ~~f) unless otherwise agreed with the distributor, an embedded generator must allow for the connection of a communication link between the embedded generation unit and the distributor's substation to monitor and as necessary trip the generator in an emergency~~
- ~~g) asynchronous embedded generating units must be equipped with controlled power factor correction capacitors to support necessary VAR loading requirements, and~~
- ~~h) any other reasonable requirement of the distributor.~~

3.10 Capacity

3.10.1 The capacity of embedded generator's plant shall not exceed the capacity of the distribution network in terms of:

- ~~a) its capacity to accept export energy~~
- b) its capacity to provide emergency energy in the event of a generator trip, and
- c) its fault level.

3.11 Scheduling

3.11.1 Unless otherwise agreed with the distributor, a large embedded generator with an embedded generating unit over 1 MW must advise the distributor prior to connection or disconnection of the embedded generating unit.

~~3.11.2—The rate of change of an embedded generating unit over 1 MW must be agreed with the distributor.~~

3.12 ~~[Not Used]Minimum requirements for Embedded Generating Units over 1 MW~~

~~3.12.1—Unless otherwise agreed with the distributor, any embedded generating unit over 1 MW must:~~

- ~~a)—have an automatic excitation control system for volts and power factor~~
- ~~b)—have a governor control for speed (frequency) and load (MW) control, and~~
- ~~c)—be equipped with protection and auto synchronising equipment as defined by the distributor.~~

3.13 Delivery performance requirements of Embedded Generation Units

3.13.1 An embedded generator's plant shall be able to:

- a) respond safely to network disturbances
- b) shut down safely without external electricity supply
- c) restart following loss and restoration of supply, and
- d) operate in a stable manner on the distribution network during system disturbances.

3.14 ~~[Not Used]Voltage Quality~~

~~3.14.1—An embedded generator must ensure that its embedded generating plant does not contribute to the permitted levels of voltage unbalance, voltage fluctuation and harmonic content specified by the distributor being exceeded.~~

3.15 ~~[Not Used]Fault Levels~~

~~3.15.1—An embedded generating unit must be designed to work within and not contribute (other than an agreed contribution) to the system maximum fault level and the feeder capacity to which it is connected.~~

3.16 ~~[Not Used]Earthing~~

~~3.16.1—A large embedded generator must ensure that its embedded generating units are earthed in accordance with the distributor's earthing requirements. The embedded generator must provide earth fault protection to isolate each embedded generating unit from the distribution network under earth fault conditions.~~

3.17 Interference

3.17.1 If the distributor notifies the embedded generator that its embedded generating unit is causing interference above the limits set out in AS/NZS 2344, ~~AS2279~~, AS/NZS 61000 3.2, 3.3 or 3.5, the embedded generator must reduce the level of interference to below these limits within 90 days.

3.18 Coordination of Embedded Generators

3.18.1 Embedded generators must comply with any other reasonable requirement of the distributor.