

# NTEM Priority Reform Program: Review of essential system services

Draft Position Paper

January 2021

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## Summary

In line with the scope outlined in the Review Issues Paper published in July 2020, the Design Development Team has reviewed the arrangements for the provision of essential system services in the Northern Territory's regulated power systems (Darwin-Katherine, Alice Springs and Tennant Creek) and developed a series of draft proposals for stakeholder feedback and advice.

In developing its draft proposals, the Design Development Team has considered submissions to the review Issues Paper published in July 2020 and sought expert advice from engineering and economic consultants.

## Service types and responsibility

The types of essential system services currently enacted in the System Secure Guidelines (SSG), spinning reserve and regulating frequency management services, are in and by themselves not suitable to meet the future requirements of the NT regulated systems. Although the SSG makes provision for a variety of other appropriate types of essential system services, to date these services have not been enacted.

The Design Development Team proposes that the set of essential system services outlined in Table A apply across the NT regulated power systems. These services have been selected to be technology neutral, and alignment across the NT regulated systems will enhance clarity about the services and their requirements.

Procurement of services which have a system-wide requirement should be the responsibility of the System Controller.

Procurement of services which have a locational requirement, and for which network augmentation may be an alternative, should be the responsibility of the Network Operator. The Network Operator should advise the System Controller of any voltage management/network support and system strength contracts with details it needs for dispatch purposes.

Regulatory arrangements should require the System Controller to develop and publish detailed descriptions of each type of essential system service and the performance parameters and requirements which must be satisfied in order for a service to qualify as the relevant essential system service.

Confidence to invest in the NT regulated systems would be enhanced if the types of essential system services for use in the NT regulated systems are codified, and changes to detailed descriptions, performance parameters and requirements made by the System Controller are subject to the approval of the Utilities Commission.

Where a shortfall in power system capability is identified resulting in a system security issue that cannot be managed through the planning timescale, the framework should allow the flexibility for the System Controller to define and procure additional essential system services on a time-limited basis where required and subject to the prior approval of the Utilities Commission.

**Table A Proposed essential system service types – NT regulated systems**

Essential system service	Purpose	Procurement responsibility
Rate of Change of Frequency (RoCoF) Control	<ul style="list-style-type: none"> <li>Control maximum RoCoF on power systems.</li> <li>Ensure system security for credible contingency events and 'protected events'.</li> </ul>	System Controller
Contingency frequency control (raise)	<ul style="list-style-type: none"> <li>Stabilise frequency within 'emergency' defined operating band after a credible contingency resulting in the net disconnection of generation.</li> <li>Ensure system security without Under Frequency Load Shedding for all credible contingency events.</li> </ul>	System Controller
Contingency frequency control (lower)	<ul style="list-style-type: none"> <li>Stabilise frequency within 'emergency' defined operating band after a credible contingency resulting in the net disconnection of load.</li> <li>Ensure system security without over frequency generator tripping for all credible contingency events.</li> </ul>	System Controller
Regulating frequency control	<ul style="list-style-type: none"> <li>Regulate power system frequency within normal defined frequency operating band.</li> </ul>	System Controller
Voltage management / network support	<ul style="list-style-type: none"> <li>Management of network voltage control issues where required.</li> <li>Management of network capacity shortfall issues where required.</li> </ul>	Network Operator
System restart	<ul style="list-style-type: none"> <li>Enable the restart of the regulated power systems from a 'black system' event.</li> </ul>	System Controller
System strength	<ul style="list-style-type: none"> <li>Sufficient system strength capability to ensure voltage stability and sufficient fault current.</li> </ul>	Network Operator
Additional services	<ul style="list-style-type: none"> <li>Services necessary to address a system security issue that cannot be managed through the planning timescales, as approved by the Utilities Commission.</li> </ul>	System Controller

## Service requirements

The amounts of essential system services procured and dispatched have a direct bearing on the resulting security of the system and electricity supply costs.

Given the importance of service requirement forecasts to overall costs, and the scope for contention and disagreement regarding essential system service requirements, there would be benefit from introducing transparency and oversight arrangements for the determination of service requirements on the NT regulated systems.

A process should be codified for the annual review and determination of the amounts of essential system services to be procured by the System Controller to ensure the levels remain appropriate given changing power system needs.

This process should involve the System Controller preparing, on an annual basis for the coming financial year, an Essential System Services Plan setting out:

- updated essential system service standards for each of the NT regulated systems, supported by an evidence-based methodology
- forecast requirements to meet to meet the service standards
- how the System Controller will procure the required essential system services
- a budget for the procurement of the required essential system services.

Enactment of the Essential System Services Plan should be subject to approval or redetermination by the Utilities Commission.

Where the System Controller identifies that a material deficiency in service requirements against the Essential System Services Plan is likely to occur before the next annual Plan, the System Controller should be permitted to reassess the essential system service standards, requirements and budget with the approval of the Utilities Commission.

## Provision framework

The current approach to essential system service provision is not a competitive process and therefore won't facilitate the procurement and least cost dispatch of essential system services as more potential providers enter the market.

At this stage of the NT regulated systems' development, the most appropriate balance between costs and benefits would be achieved by the System Controller procuring essential system services through bilateral contracts that are entered into following a competitive tender or reverse auction process.

A competitive provision framework for essential system services should empower and oblige the System Controller to enter into an essential system services contract, where:

- it does not consider it can meet the essential system services requirements from Territory Generation's (T-Gen) existing facilities; or
- it considers an essential system services contract provides a less expensive alternative to essential system services provided by T-Gen's 's existing facilities.

The provision of regulating frequency control is the service most suited to provision through a spot market. As the market for regulating frequency control becomes more competitive, the potential to provide it through a spot market could be reviewed.

## Administered pricing and market power mitigation

Under the scope of this Review, there is a need to address administered pricing for the provision of essential system services by T-Gen under the current monopoly provision arrangements, and market power mitigation arrangements appropriate under a competitive provision framework.

### Monopoly provision

Under the current arrangements for the monopoly provision of essential system service by T-Gen, an administered price is necessary because there is no market to determine prices for essential system services.

A codified process should be established to ensure that the administered prices received by T-Gen as the default provider for each essential service it provides continue to reflect the actual costs of providing the services over time.

This process should require, on an annual basis for the coming financial year:

- the System Controller providing a draft Essential System Services Plan to T-Gen, including draft updated essential system service standards for each of the NT regulated systems and forecast requirements to meet those standards
- based on the draft Essential System Services Plan, T-Gen providing the System Controller updated auditable actual estimated costs for each of the essential system services required, including unit variable, enablement and fixed costs
- the System Controller to publish the proposed administered prices in its Essential System Services Plan, with the prices subject to the approval of the Utilities Commission.

## Competitive provision

Under the proposed competitive arrangements for the provision of essential system services, market power mitigation measures will be required because of the potential incentive or ability of system participants to exert market power given the small size of the NT regulated systems, small number of system participants and current dominance of T-Gen.

The market power mitigation measures should include:

- constraints on offer prices in any market mechanism, equivalent to the estimated long-run marginal cost (LRMC) of providing the service
- an obligation on T-Gen, when fulfilling its role as the default provider, to supply required amounts of essential system services with the price it receives capped by its actual costs.

Requirements should be codified to implement the market power mitigation measures, including:

- for the System Controller to publish estimates of the LRMC of providing each essential system service in the annual Essential System Services Plan, as a cap on market offers in any competitive procurement process and as a guide to when it will seek to undertake competitive procurement
- for the System Controller to publish the price to be received for services provided by T-Gen when fulfilling its role as the default provider (as per the proposed codified process under 'monopoly provision').

## Cost allocation and settlement

The current arrangements, which allocate essential system services costs to licenced generators based on their proportion of total energy sent out, are inequitable and inefficient because they do not allocate costs on the basis of benefits received or contribution to requirements.

Costs for essential system services should instead be allocated according to the principle of 'causer pays'. Although this approach is administratively more costly than the current approach, it is more efficient as the costs of providing essential system services are paid by the parties causing the need for those services. For this reason, it provides an incentive to parties to minimise their contribution to essential system services requirements.

The Design Development Team's proposed allocation of costs by essential system service type is outlined in Table B.

**Table B Party liable for each essential system service**

<b>Option</b>	<b>Allocation</b>
Contingency raise	Generators
Contingency lower	Customers
RoCoF	Parties that cause the service to be enabled
Regulation	Generators and customers that cause frequency deviations Customers without SCADA – balance
Voltage management / network support	Customers
System Restart	Generators and customers
System Strength	Where possible, party responsible for the system strength issue Customers – balance

Detailed calculations for cost allocation would need to be determined as part of the development of the detailed essential system services settlement rules.

The existing arrangements for settlement of essential system services, whereby the System Controller prepares statements for invoicing by T-Gen, would be inadequate under a competitive service provision framework.

As part of the NTEM Priority Reform Program, priority dispatch and settlement changes are being progressed. Pending their final design, there may be a need for some consequential amendments to dispatch and settlement arrangements to accommodate the proposed essential system services reforms.

## Implementation

Based on a range of factors including ease of reference for system participants, implementation and maintenance of provisions, the proposed changes to the essential system services arrangements should be implemented through:

- the System Control Technical Code (SCTC) and Network Technical Code and Planning Criteria (NTC), for elements of the new essential system services framework which are bespoke to the NT
- the Northern Territory National Electricity Rules, SCTC and NTC, for elements of the new essential system services framework for which there are equivalent frameworks in the National Electricity Market.

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# 1. Introduction

The Northern Territory Government has identified reforms to the arrangements for the provision of essential system services in its Northern Territory Electricity Market (NTEM) Priority Reform Program<sup>1</sup>.

With the growing uptake of utility scale and behind-the-meter solar PV and emergence of new technologies capable of providing essential system services, it is timely for the arrangements on the NT regulated systems (Darwin-Katherine, Alice Springs and Tennant Creek) to be reviewed to ensure that the delivery of essential system services delivery is efficient and meets consumer expectations.

Reforming the essential system services arrangements is a complex process and requires careful coordination with other reforms being implemented as part of the Priority Reform Program.

This paper presents the Design Development Team's draft position for stakeholder feedback and advice.

## 1.1. Overview of current arrangements

Essential system services (also commonly referred to as ancillary services) are required in addition to the supply of energy, to support the power system to produce, transmit and distribute power of acceptable quality to consumers and continuously maintain the demand/supply balance during normal and abnormal system conditions.

Essential system services can be defined in a number of ways but generally fall into three broad categories.

- *Frequency management* – to maintain power frequency within acceptable standards at all times.
- *Voltage management* – to manage voltages at different points of the network and maintain stability following disturbances.
- *Restart services* – to re-establish the power system following a significant event that has resulted in complete (or significant partial) system blackout.

Historically these services have been considered a beneficial by-product of the supply of electricity from large synchronous generation.

As the generation mix changes to include an increasing amount of non-synchronous generation, such as solar PV, it has become apparent that these so called 'ancillary' services, are in fact 'essential'. Given this and an increasing requirement for essential system services as the result of increased production of electricity from solar PV, essential system services are becoming a material portion of the total cost of power supply.

On the NT regulated systems, the provision and procurement of essential system services are governed by various obligations within the Network Technical Code and Planning Criteria (NTC), the System Control Technical Code (SCTC) and Secure System Guidelines (SSG).

Under these instruments, the magnitude of essential system services requirements is specified by the System Controller and provided by Territory Generation (T-Gen) via a bundled 'spinning reserve' service and separate regulation service. Third party licenced generators are required to pay T-Gen for the provision of these services at a combined single fixed rate per megawatt hour (MWh) of electricity sent out.

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<sup>1</sup> Northern Territory Government 2020, *Northern Territory Electricity Market Priority Reform Program – Introductory notes on scope and work program*, June.

The NT Government has committed to producing 50 per cent renewable energy by 2030 for electricity consumed by households and businesses, while at the same time maintaining security, reliability and affordability of electricity supply.

The transition to 50 per cent renewable energy by 2030 is well underway with small-scale solar PV generation already providing significant contributions to the energy supply and large-scale solar PV systems beginning to emerge. With current and committed large-scale solar PV projects planned for construction in 2020–21, and projected residential and commercial rooftop solar PV installations, renewable energy is expected to supply up to 16 per cent of electricity consumption by the end of 2021.

The increased uptake of solar PV presents two challenges for the maintenance of adequate essential system services to maintain system security:

- solar output requires additional essential system services to manage its higher level of variability
- solar output displaces the gas-fired synchronous generation plant that inherently provides the essential system services needed.

The above challenges will result in a need to maintain higher levels of essential system services in the future not associated with or required for energy production.

The challenges posed by the increased solar PV penetration have exposed shortcomings in the NT regulated systems' current essential system services arrangements.

- The increased requirements for essential system services result in higher costs of maintaining adequate levels using existing technologies.
- The historic inherent provision of essential system services as a by-product of electricity produced by gas-fired synchronous generators means that individual service types have not been adequately defined or specified.
- The monopoly provision of essential system services by T-Gen forgoes opportunities for their provision by other, potentially lower cost, providers.
- The current definitions and specifications of essential system services preclude other, potentially lower cost, technologies from providing them, including large- and small-scale solar PV and batteries.

Although at present, the NT regulated systems' installed gas-fired generation fleet provides sufficient essential system services to maintain system security, it does so at a comparatively high cost. There will also become a point when the existing generation fleet will not have sufficient capability to maintain system security and reforms of the essential system services arrangements will become critical.

## 1.2. Review scope

As identified in the NTEM Priority Reform Program Introductory Notes, the proposed changes to essential system services arrangements are:

- updating the quantum of the rate paid to T-Gen for essential system services by other generators
- codifying the process for reviewing and updating the quantum of the rate to ensure the rate remains up to date
- improving the transparency of costs for individual and categories of services captured in the rate, such as by defining and separately costing each essential system service required.

In addition to the implementation of changes to the provision of essential system services by T-Gen, the Northern Territory Government recognises that there may be benefits from contestability in the provision of these services.

In reviewing essential system services, the Design Development Team will review potential arrangements for the competitive provision of essential system services in the NT regulated systems for consideration by the Government.

## 1.3. Context and approach

### 1.3.1. Relationship with the Northern Territory Electricity Market Priority Reform Program

The increasing diversity of the NT's electricity systems, in terms of technologies and participants, is being facilitated by implementation of the NTEM Priority Reform Program, of which this review of essential system services arrangements forms part. The other key reforms to the current Interim Northern Territory Electricity Market (I-NTEM) which has operated in the Darwin-Katherine system since 2015, are:

- establishing a reliability standard and associated framework for ensuring the standard is met
- changes to dispatch arrangements to improve the efficiency of generator dispatch in the context of significant intermittent solar PV
- introduction of centralised financial settlement for the energy market to accommodate a range of foreseeable types of contractual arrangements between generators and retailers.

Of the other priority electricity market reforms, the dispatch and settlement reforms are key precedents for this review of essential system services, as dispatch for energy may need to be coordinated with dispatch for essential system services and settlement of payments will also be required.

The announcement of the Government's Priority Reform Program follows public consultation by the Department of Treasury and Finance on the development of a market design for the NTEM<sup>2</sup>.

### 1.3.2. Generator Performance Standards

New Generator Performance Standards (GPS) approved by the Utilities Commission in March 2020 require that all new licenced generators are predictable and controllable. As a result, new large-scale solar PV should not substantially add to the requirement for additional system services, and if required, can be otherwise controlled to avoid compromise to system security.

However, the GPS imposes mandatory essential system services (frequency management) capability on generators, subject to energy source availability. This effectively means that large-scale solar PV may be called on to provide contingency lower frequency control services, but would not have their output constrained to provide contingency raise frequency control services. Given new large-scale solar PV will have capability to provide some kinds of essential system services, there is added impetus to ensure it can be compensated for this when enlisted.

In its submission to the Issues Paper, Eni Australia stated that limited reference was made to the capacity forecasting requirements of the GPS. The Design Development Team has included commentary on the GPS capacity forecasting requirements at various points in this Draft Position Paper, as relevant to the review scope.

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<sup>2</sup> Department of Treasury and Finance 2019, *Northern Territory Electricity Market Consultation Draft Functional Specification*, February.

### 1.3.3. Large-scale battery for the Darwin-Katherine system

The NT Government has recently approved in-principle the procurement of a large-scale Battery Energy Storage System (BESS) for the Darwin-Katherine system to more efficiently provide essential system services. The BESS is intended to deliver:

- increased stability and reliability of power supply from reduced reliance on gas-fired generation
- reduction in carbon emissions
- reduction in costs for T-Gen.

Procurement will take place in 2020-21 with the BESS expected to become operational in the second half of 2022. Notwithstanding the broader scope of this review, the introduction of the BESS will require reform to the existing essential system service arrangements to be effective.

### 1.3.4. Adoption of the National Electricity Rules

The *National Electricity (Northern Territory) (National Uniform Legislation) Act 2015* (NT) provides for the adoption of the National Electricity Law and the National Electricity Rules (NER) in the Territory from 1 July 2016.

The Northern Territory NER, a version of the NER modified by regulations to suit the NT's circumstances, govern the arrangements for metering, economic regulation and network connection in the regulated power systems.

The NT has not applied a number of components of the NER, including those governing the operation of wholesale markets and power system security, which continue to be governed by the SCTC and NTC. T-Gen, in its submission to the Issues Paper, highlighted that the NT has not applied sections of the NER relevant to essential system services, which are to be revisited as part of the phased implementation of the NER in the NT, including:

- 5.3A.12 Network support payments and functions
- 5.20B Inertia subnetworks and requirements
- 5.20C System strength requirements.

## 1.4. Review framework

The NT has adopted the National Electricity Law (NEL) for the regulated power systems of Darwin-Katherine, Alice Springs and Tennant Creek, and its focus on promoting the long-term interests of consumers of electricity. As such, in the Issues Paper the Design Development Team proposed that its overarching assessment framework for this review be aligned to the National Electricity Objective (NEO) as defined under the NEL, which is:

*“... to promote efficient investment in, and efficient operation and use of, electricity services for the long term interests of consumers of electricity with respect to –  
(a) price, quality, safety, reliability and security of supply of electricity ...”<sup>3</sup>*

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<sup>3</sup> *National Electricity (South Australia) Act 1996 (SA)*, National Electricity Law, sch 1 s 7.

Consistent with the NEO, the following principles were proposed in the Issues Paper to be used to frame the review of the provision of essential system services in the NT’s regulated power systems.

- Required security standards must be met.
- Services should be acquired at least cost.
- Essential system services acquisition is to be technology neutral.
- To the extent possible, the proposed arrangements should deliver certainty to industry participants, so as to provide the confidence to invest.
- Arrangements must support the achievement of the Government’s 50 per cent renewables by 2030 target and reductions to greenhouse gas emissions.
- Reforms must improve the overall efficiency of electricity supply, putting downward pressure on the combined cost of ESS, wholesale electricity and network services.

In submissions to the Issues Paper, stakeholders supported aligning the review framework with the National Electricity Objective (Eni Australia, T-Gen, Jacana, Sun Cable). However, stakeholders sought that particular attention be given to certain other aspects or context of essential system services, including the GPS (Eni Australia), network support services and generator support services (T-Gen), the role of distributed energy resources (Jacana) and sustainability of electricity supply (Sun Cable).

## 1.5. Stakeholder consultation and review timeframes

The Design Development Team’s consultation with stakeholders commenced with the release of an Issues Paper in June 2020. Five written submissions were received from T-Gen, Jacana Energy, Eni Australia, Epuron and Sun Cable.

The Design Development Team intends to continue its consultation as the review progresses, including through consideration of submissions to this Draft Position Paper and a stakeholder workshop in early 2021.

The Design Development Team plans to provide a Final Report to the Northern Territory Government for consideration in April 2021.

The review actions and expected timing are outlined in Table 1-1.

**Table 1-1 Actions and expected timing**

Action	Expected timing
Draft Position Paper	January 2021
Final Position Paper	April 2021
Regulatory or code changes	Mid 2021
Procedures and systems	Mid-Late 2021
Commencement of changes	Late 2021

## 2. Service definitions

Clear identification and specification of discrete services necessarily underpin any reforms to essential system services arrangements in the Northern Territory's regulated power systems.

Under and in addition to the three broad categories of essential system services referred to in Section 1.1 – Frequency Management, Voltage Management and Restart Services – a range of more specific electricity system support services have been defined for use in the NT and other Australian electricity systems.

Appropriately defining essential system services for the NT context is critical, and is a complex and technical exercise. The Design Development Team has engaged GHD Advisory Services to advise it on appropriate essential system service definitions.

### 2.1. Background

#### 2.1.1. Current service types

The current essential system services definitions and provisions related to their delivery are set out in various codes and guidelines, meaning there is no single point of reference for these services (which are currently referred to in all codes as 'ancillary services').

The Network Technical Code (NTC) defines essential system services as comprising 'voltage control, reactive power control, frequency control, control system services, spinning reserve and post-trip management' but the System Control Technical Code (SCTC) has an alternative definition, of 'voltage control, reactive power control, frequency control, and black start capability'.

In practice, the requirements for essential system services and what they must accomplish in terms of power quality and system security are set out in Chapter 5 of the SCTC while further guidance on how these services are specified and procured by the System Controller is given in the Secure System Guidelines (SSG).

The current arrangements for essential system services, as defined in the SSG, are outlined in Table 2-1.

**Table 2-1 Current essential system service types – NT regulated systems**

Type of service	Service
Frequency management	Regulating Frequency Control Ancillary Services (R-FCAS)
	Contingency Frequency Control Ancillary Service (C-FCAS)
	<ul style="list-style-type: none"> <li>• Raise – fast, slow, delayed</li> <li>• Lower – fast, slow, delayed</li> </ul>
	Inertia Frequency Control Ancillary Services (I-FCAS)
Voltage management	Spinning reserve
	Voltage control
System restart	Reactive power reserve
	Black start capability

Although the SSG makes provision for the procurement of a variety of different essential system services, in practice the majority of these services are not currently enacted. The SCTC does not codify precisely

how essential system services should be procured, instead giving guidance on the outcomes expected of essential system services. Therefore, there is significant scope available for guidance in the SSG to change in line with new technologies or to meet new system requirements.

### Frequency management services

The current ancillary service arrangements as defined in the SSG recognise the need for separate services to manage frequency regulation, frequency under contingencies and Rate of Change of Frequency (RoCoF). However, in practice the actual services procured are not entirely separated. While a separate 'R-FCAS' regulating service (also referred to as "regulating reserve") is currently procured, the SSG also lays out guidelines for the procurement of C-FCAS to control frequency under contingencies and I-FCAS to control RoCoF, however, these are not currently enacted. The current "spinning reserve" ancillary service instead provides a frequency response under contingencies, and inherently provides inertia to control RoCoF as a by-product of synchronous generators holding the spinning reserve.

The minimum requirements and the current use of essential system services is summarised for each of the regulated power systems in Table 2-2.

In practice, the System Controller maintains higher combined levels of R-FCAS and Spinning Reserve in the Darwin-Katherine system than specified due to the size of the generators in the system and their minimum safe loadings (and other constraints on operation). The system is actually generally operated with an average level of reserve capacity of about 40 megawatts (MW), compared to a minimum specified capacity of 25 MW.

There is also discrepancy between the current codified requirements for spinning reserve and the way they are procured. For example, the Alice Springs system currently has an operational battery energy storage system (BESS) which is used to provide a C-FCAS response (rather than the officially enacted spinning reserve response), however as the requirements are written it is not clear whether this is considered to contribute to the spinning reserve total or not.

### Voltage management services

Under the current framework, voltage control requirements are defined in the SCTC and NTC. There is currently no formalised essential system service for voltage control on the NT regulated systems defined in the SSG, although there is provision for a service in the SCTC. In practice, voltage control mandates applied by the System Controller can be used to require the provision of voltage control services by system participants.

Voltage management services on the NT transmission power systems are provided by switching of reactive network devices, tapping of transformers and generators. The Generator Performance Standards (GPS) currently enacted in the NTC, require all generators to provide reactive power capability and control systems that ensure reactive power is provided as and when required to control voltage on the network (refer to section 2.1.2).<sup>4</sup> Operational practice is for existing synchronous generators to be instructed to manage network constraints by being constrained on or off to provide localised active and reactive power support, particularly after contingencies where network capacity may be limited.

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<sup>4</sup> NTC (clauses 3.3.5.1 & 3.3.5.13)



**Table 2-2 Current essential system services provisions and operational use – NT regulated systems**

Service	Codified requirements <sup>5</sup>	Operational use of service
Regulating Frequency Control Ancillary Service (R-FCAS)	<p><b>Darwin-Katherine</b> The greater of 5 MW or anticipated change in system load over 30 minutes.</p> <p><b>Alice Springs</b> The greater of 2 MW or anticipated change in system load over 10 minutes.</p> <p><b>Tennant Creek</b> The greater of 0.5 MW or anticipated change in system load over 10 minutes.</p>	In use
Contingency Frequency Control Ancillary Service (C-FCAS)	<p>The SSG provides guidance as to how each C-FCAS service provider’s contribution to the overall C-FCAS requirement can be assessed by the System Controller. The SSG provides that the C-FCAS requirements are to be assessed by and approved at the discretion of the System Controller.</p> <p>The System Controller is yet to procure this service and yet to specify to the market the overall requirement for the system.</p>	Implementation date not set
Inertia Frequency Control Ancillary Service (I-FCAS)	<p>Principles for determining a minimum requirement is set out in the SSG.</p> <p>The SSG also provides that all inertia contributions (whether synchronous or emulated) towards the I-FCAS are only accredited by the System Controller. Minimum requirements and implementation date are yet to be determined.</p>	Implementation date not set
Spinning reserve	<p><b>Darwin-Katherine</b> 25 MW at all times, including a minimum of two Frame 6 machines that are:</p> <ul style="list-style-type: none"> <li>• on different nodes</li> <li>• loaded to 26 MW or below</li> <li>• not restricted in capacity or response.</li> </ul> <p><b>Alice Springs</b> The larger of either:</p> <ul style="list-style-type: none"> <li>• 8 MW during the day</li> <li>• 5 MW at night, or</li> <li>• the largest machine’s output in MW.</li> </ul> <p><b>Tennant Creek</b> 0.8 MW at all times.</p>	In use

## Restart services

The SCTC references a black system procedure in its essential system services section, however, in practice the capability for black start is currently provided by Territory Generation (T-Gen) generators, consistent with the monopoly provision of other ancillary services. The System Controller is held responsible for the black start procedure, is required to have a single restart procedure for each regulated power system, and is required to review arrangements for the procedure annually.

## System strength

There is currently no essential system service for system strength defined on any of the NT regulated power systems.

The NTC presents a framework for addressing adverse system strength impacts created by the connection of new generators or by modifying existing generating systems.<sup>6</sup> The framework was introduced in March 2020 and requires the Network Operator to develop system strength impact assessment guidelines that describe how adverse system strength impacts will be assessed. Any generator that creates an adverse system strength impact is required to fund the investments required to mitigate those impacts.

The framework in the NTC provides a means of assessing whether a new generation development or modification of an existing generating system is likely to cause an adverse system strength impact and if necessary provides a mechanism for the applicant to fund any necessary mitigation measures. However, the system strength framework in the NTC as currently implemented may not be able to address all system strength issues that could arise in the NT regulated power systems.

Retirement of existing synchronous generators may reduce system strength creating adverse impacts. If those retirements are not linked explicitly to the connection of a new generator then the framework in the NTC may not provide a mechanism to address the adverse system strength impact.

### 2.1.2. Mandatory requirements

There are mandatory requirements for generators connected to the NT regulated systems, which are not essential system services, but have a direct impact on essential system service requirements, especially with regards to frequency regulation.

There are currently mandatory requirements for frequency response applied to generators on the NT regulated power systems.<sup>7</sup>

A move in the National Electricity Market (NEM) away from this mandatory approach when essential system service markets were first implemented<sup>8</sup> led to a significant decline in the quality of frequency regulation around 50 Hz, with an increased burden on the providers of frequency regulation essential system services. Changes have recently been introduced in the NEM that require all generators to

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<sup>5</sup> All services are outlined in the SSG however some do not have an implementation date, and are not in practice enacted.

<sup>6</sup> NTC Clause 3.3.5.16

<sup>7</sup> The GPS specified in the NTC require a frequency response capability with a deadband settable within the range of  $0 \pm 1.0$  Hz and a droop of between 1 per cent and 6 per cent. The deadband and droop settings are to be agreed with the System Controller.

<sup>8</sup> Allowing generators to switch off their governors when not contracted to provide FCAS and to implement deadbands set to the limits of the normal frequency band.

implement changes to their control systems to provide primary frequency response meeting requirements developed by the Australian Energy Market Operator.<sup>9</sup>

Another measure taken by Power and Water Corporation and the Utilities Commission to assist with the regulation of frequency was the introduction of updated GPS through revisions to the NTC. The new GPS approved in March 2020 require that all new licenced generators, which exceed the materiality threshold specified in the NTC, are predictable and controllable. As a result, new large-scale solar PV, for example, should not substantially add to the requirement for additional volumes of essential system services in terms of frequency regulation. Under the revised GPS, new generation systems should be capable of meeting their dispatch targets each half hour. The revised GPS also requires that all generators, that exceed the materiality threshold specified in the NTC, contribute to responding to frequency deviations recognising that this response will be subject to energy source limitations.<sup>10</sup>

The current reformed GPS will reduce the burden on frequency regulation that would otherwise be imposed by the connection of non-dispatchable generation.

### 2.1.3. Case for change

#### Frequency management

The existing frequency management needs of the NT regulated systems are met by the existing spinning reserve and regulating frequency management services. However, the current needs of the system do not reflect its future requirements due to significant changes in the mix of technologies connecting and a number of issues with the current arrangements have been identified.

- The Northern Territory Government has a 50 per cent renewable energy target by 2030, which will require a higher penetration of non-synchronous solar PV. As this target is met, it will inherently displace synchronous generators, the only generators capable of providing spinning reserve.
- Continuing to procure spinning reserve as the only essential system service controlling frequency following contingencies will result in the substantial curtailment of non-synchronous generation as this arrangement will require the constraining on of synchronous generators to provide the service.
- Spinning reserve inherently requires generators to be dispatched at less efficient output levels.
- A displacement of synchronous generators will cause a reduction in inertia on the NT regulated systems, making the systems more likely to experience potentially damaging high RoCoF events. There will be a need for other methods of controlling RoCoF in the future.
- Frequency management essential system services can be provided by other technologies, including BESS, loads capable of reducing/increasing power output and in some cases, non-synchronous generators. The current arrangements for frequency management services are not technology neutral, and prevent alternative technologies providing essential system services.

#### Voltage management / network support

The existing GPS mandating the provision of adequate reactive power from generators are fair and equitable, as all generators participate equally in providing investments necessary to support voltage control on the NT regulated systems. There are therefore limited circumstances under which a voltage control service would require procurement. However, an outage of a network element may require a

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<sup>9</sup> These changes require generators to implement narrow deadbands set well within the normal frequency band and to provide a 5% droop. Generators are required to provide frequency response (subject to energy source limitations) whenever they are synchronised.

<sup>10</sup> In addition, the GPS places obligations on generating systems to ride through a RoCoF of up to  $\pm 4$  Hz/s.

generator to provide an active power response to support a load due to a network constraint. The current arrangements for provision of these network support services are not adequate for the system going forward. Mandatory provision of network support services by system participants can lead to generation dispatched out of merit order to maintain voltage control, contributing to inefficient system operation.

- Where generators are required to provide reactive capability when producing no active power, for example, solar PV at night, this falls outside the GPS and should be considered as an essential system service if required to operate the system.
- Mandatory provision of network support services by system participants under the current monopoly framework will not be tenable for localised issues going forward. Where T-Gen is not capable of providing a solution to a localised issue, provision of a voltage control service from an independent generator will be without any explicit compensation.
- Lack of unbundling of pricing of network support or voltage management services means there is no signalling or incentive for the Network Operator to resolve issues.
- Under a clear and transparent framework, shortfalls identified in reactive power reserve or network capacity could be met by a broader range of providers including both generators and loads, despite geographical limitation for providers of each service.

### System restart

Current black start arrangements, as defined, are not open to be provided by grid forming inverters, or other future technologies which are technically capable of providing such a service. This will become more important as inverter connected generation increases its presence on the system.

### System strength

Currently there are no specified essential system services for system strength and this may be a necessary requirement for future reliable operation of the power system. An essential system service may be required to manage adverse system strength impacts resulting from the retirement of synchronous generation rather than those effects directly attributable to the connection of new non-synchronous generation utilising grid following inverters. The essential system service would complement the system strength framework recently added to the NTC.

## 2.2. Submissions

In the Issues Paper, the Design Development Team sought feedback on appropriate categories and definitions of essential system services for the NT's regulated systems and arrangements for their governance.

### 2.2.1. Service types and definitions

Few stakeholders suggested specific service types and definitions. T-Gen suggested that the three services it currently provides, being capacity, network support and generation testing support, were not identified in the Issues Paper.

Jacana also identified a need for responsibility of network support services to be clarified, stating:

*As part of this definition process, the role of network support services and the responsibility for their provision needs to be clearly defined. Jacana Energy has previously highlighted the fact that the Katherine Power Station, operated by Territory Generation, currently provides network support services. Consequently, costs associated with this station are currently paid for directly by customers through retail energy prices (which reflect wholesale energy purchase costs), rather than the network*

*operator recovering these costs via the regulated asset base and associated network access charges. Under the current arrangements, there is no incentive for the network operator to consider how the costs of providing network support services could be reduced.*<sup>11</sup>

Epuron suggested that essential system services categories be classified as R-FCAS, C-FCAS raise and C-FCAS lower, and noted that, although the NEM essential system service types include different time periods for each FCAS, a 'simpler version of this without the time periods could be more effective due to the smaller market and the likelihood that the majority of ESS will be from a few providers. This would then require minimum C-FCAS response times which is appropriate'.<sup>12</sup>

There was general agreement by stakeholders (T-Gen, Epuron, Sun Cable) that, despite differences in system size, a common set of service types and definitions should apply across the NT regulated systems. T-Gen commented that this was 'with the exception that specific Network Support Services will apply for each power system'.<sup>13</sup>

## 2.2.2. Governance

### Responsibility for detailed definitions/specifications

Some stakeholders (Epuron, Jacana) considered that the System Controller should be responsible for developing detailed definitions/specification of essential system services; but there was a need for independent oversight or specification. However, T-Gen indicated that the common ownership of the System Controller and Network Operator warranted the Utilities Commission to be responsible for the development of essential system services definitions to provide confidence of independence for all stakeholders.

Eni Australia, identified that broader reform, such as the establishment of an independent market operator, was warranted, and identified a requirement for a well-resourced overseer of essential system services definitions, stating:

*At the very least, this situation demands a strong degree of regulatory oversight from the Utilities Commission (UC), which needs to have sufficient technical resources of its own to provide effective regulation of the electricity industry. If this can't be achieved, alternative regulators like the Australian Energy Regulator (AER) should be considered instead, who have the necessary technical and economic resources for the task. EAL notes that the AER has already taken over the economic regulation of the power transmission and distribution network owned by Power and Water Corporation (PWC).*<sup>14</sup>

### Flexibility to procure other types of essential system services

Stakeholders (T-Gen, Epuron, Jacana, Sun Cable) considered that the pace of technological change in the NT regulated systems warranted some flexibility for the System Controller to procure additional undefined essential system services if required, but considered this needed to be subject to checks and balances.

T-Gen considered that the governance arrangements for a catch-all essential system services provision should include:

- i. *Appropriate oversight/approval.*

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<sup>11</sup> Jacana Energy 2020, *Submission to Issues Paper*, p. 2.

<sup>12</sup> Epuron 2020, *Submission to Issues Paper*, p. 2.

<sup>13</sup> T-Gen 2020, *Submission to Issues Paper*, p. 4.

<sup>14</sup> Eni Australia 2020, *Submission to Issues Paper*, p. 4.

- ii. *Limiting the time frame that such a provision can be relied upon. The limitation of time would be such that this 'catch-all' provision could effectively provide the System Controller with a means to rapidly introduce new requirements as they emerge and to bridge the gap until they can go through the regulatory change process to implement long term arrangements for these new requirements.*
- iii. *Procurement of services must come with a framework for compensation, either by the causer of the requirement or the system controller.*

Epuron identified that the Utilities Commission could provide independent oversight.

Sun Cable suggested that additional essential system service types and definitions should be governed by a rule change process:

*The ESS framework should provide for any party, including the System Controller, to request rule changes from the Utilities Commission (or other regulatory bodies in the NT) that would allow such provision via the addition of new categories of ESS. Such proposals should be put through a public consultation and review process, with the final decision being committed to by the Utilities Commission (or another independent body). Key to this process should be the consideration that provision of newly defined services be open to competition in order to bring price, efficiency and environmental outcomes in line with the expanded NEO.<sup>15</sup>*

### Arrangements for inertia and system strength

Regarding arrangements for the provision of inertia and system strength, stakeholders addressed varying technical and governance aspects. T-Gen suggested that RoCoF rather than inertia was the more relevant technical consideration:

*Inertia is primarily considered to limit the RoCoF for anticipated events in the power system. New technologies are emerging that show potential to be able to provide an equivalence in limiting RoCoF. Specifying required inertia levels may therefore be restricting alternative technologies. TGen believes it may be more appropriate to specify the requirements in terms of RoCoF limiting services that would allow inertia from synchronous machines and alternative technologies to provide these services.<sup>16</sup>*

Epuron considered that inertia/RoCoF should be the responsibility of the Network Operator as part of network planning. Similarly, T-Gen also considered that system strength should be the responsibility of the Network Operator.

Sun Cable considered that inertia and system strength should be considered as essential system services, and that *'the System Controller is better placed to understand and proactively manage the dynamic properties of these essential services'*<sup>17</sup>.

## 2.3. Analysis

The Design Development Team, informed by its advisers GHD Advisory, considered the appropriate essential system service definitions for the NT regulated systems; and arrangements related to their governance.

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<sup>15</sup> Sun Cable 2020, *Submission to Issues Paper*, p. 4-5.

<sup>16</sup> T-Gen 2020, *Submission to Issues Paper*, p. 5.

<sup>17</sup> Sun Cable 2020, *Submission to Issues Paper*, p. 5.

### 2.3.1. Service types

#### Frequency management

There are three forms of frequency management which together are required to give the NT regulated systems a flexible, suitable approach to managing frequency going forward.

- RoCoF control service
- Contingency frequency control service
- Regulating frequency control service

As identified in the following, there is overlap in the requirements proposed for the future and the existing provisions in the SSG.

#### RoCoF control service

The purpose of a RoCoF control service is to control the rate of change of frequency on the power system following contingencies.

The Inertia Frequency Control Ancillary Service (I-FCAS) specified in the SSG, if enacted, is a technical equivalent to a RoCoF control essential system service. The Design Development Team proposes that this service be defined as a RoCoF control service – this provides a technology-neutral description of the required services, whereas inertia (and therefore I-FCAS) is a characteristic of synchronous machines. This is likely to become more important going forward as more technologies become capable of providing RoCoF control and avoids the description of such technologies as 'emulated inertia' where this may not be appropriate.

RoCoF control has previously been provided on the NT regulated systems as an inherent by-product of spinning synchronous generators, which provide inertia, limiting the total RoCoF which occurs after contingencies. This has not previously required a specific service, due to the inherent capabilities of synchronous generators. Increasing penetration of solar PV, which provides no inherent inertia, will increase the need for a RoCoF control service to be explicitly defined and procured to ensure secure and stable operation of the regulated systems.

#### Contingency frequency control service

The purpose of a contingency frequency control service is to arrest a change in frequency following a contingency event. The service operates to prevent Under Frequency Load Shedding or Over Frequency Generation Shedding, thereby stabilising the power system frequency such that it remains within safe limits until a redispatch can return the system to 50 Hz.

#### *Contingency raise and lower*

The separation of contingency frequency control services into raise and lower contingency control services is already contemplated in the SSG, although the C-FCAS provisions are not currently used by the System Controller in operating the power system.

Separation of contingency frequency control into two distinct services allows for a clear price signalling where a trade-off between the costs of managing generator contingencies can be made using either:

- generator curtailment; or
- procuring greater volumes of contingency frequency control raise.

Another advantage of this approach is to encourage market participation from participants who may be unwilling (or unable) to provide both services. For example, renewable generators may not want to participate in a 'contingency raise' service which requires them to constantly operate below their maximum output, and to install greater backup storage capacity to ensure they are capable of providing the service when called. This is likely to be a more significant issue for renewable generators, which have no marginal cost of production and therefore typically have more to gain from every kWh generated. However, these generators may still wish to provide a 'contingency lower' service that requires them to turn down for a dispatch period. The same argument may hold for a synchronous generator that is operating at minimum output – while the synchronous generator would be able to provide a contingency raise service it would not be capable of providing a contingency lower service.

Finally, separation of the two types of contingency frequency control services has the advantage of allowing different volumes to be specified for 'raise' and 'lower' capacity, as required by the system. This would allow the extent of service dispatched at any time to meet the needs of the actual power system at that time.

#### *Fast / slow / delayed contingency control*

'Fast' contingency frequency control is required to arrest a change in frequency following a contingency event, and prevent frequencies falling outside of the frequency operating standards applied in the NTC for contingency events, in this case 47–52 Hz. As higher RoCoF on the system becomes standard following contingencies, this increases the requirement for a faster responding contingency frequency control service.

An efficient approach to procuring this service would determine the fastest possible response time required to cater for the most onerous credible contingency event (protected events can violate the 47-52 Hz frequency operating standards and undergo load shedding). For example, a contingency event resulting in a 2 Hz/second RoCoF, would require a response within 1.5 seconds to prevent a frequency nadir below 47 Hz, or a response within 1 second to prevent an over frequency event exceeding 52 Hz.

The requirement to procure a 'slow' or 'delayed' service, as currently specified in the SSG, is to establish a new settled frequency close to 50 Hz, inside the normal frequency operating band. This requirement is unnecessary if sufficient 'fast' response can be procured to accomplish this requirement. The rationale behind procuring separated contingency services by speed has historically been to do with the technologies capable of providing a contingency response. Providers with slower responding equipment may form a more competitive market for the slower services. For example, although batteries or modern gas plant governors may be the only equipment capable of providing a 'fast' active power response, they cannot sustain this level of output for long. Older coal-fired generators' governors may be capable of providing a slower response, and maintain it over a longer period. Hence automatic generation control of generators may be required to provide a 'delayed' response to return to 50 Hz or within the normal frequency operating band. Slower response may also be provided by contracted demand response whereby a load agrees to reduce consumption to correct an under-frequency event.

#### *Dynamic requirements*

Contingency frequency control raise and lower services should cater for the largest 'credible' contingency event.<sup>18</sup> Credible contingency events are typically events such as the loss of the largest generator, loss of a transmission element that also disconnects generation, or the loss of the largest load.

The dispatch and load conditions of each of the NT regulated systems varies, as do the credible contingency events that need to be considered. Securing against larger contingency events without load shedding will be more onerous and costly. A mechanism used in other power systems limits the maximum

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<sup>18</sup> Credible contingency events are currently defined in the SSG.



loss of a single infeed to the system, to manage the impacts on required essential system services for both RoCoF and contingency response. Even where a transmission contingency sets the largest contingency event, as is the case on the Darwin-Katherine system, a similar approach could be used to limit the aggregate dispatch across a number of generators to limit the transmission line flow and hence the size of the contingency.

The most onerous system conditions and events will change over time as the system develops. Similarly, the appropriate volume of contingency frequency control raise and lower services should be dynamically specified in line with system dispatch and load conditions. For example, where the most onerous single contingency event on a system is the loss of multiple solar power stations connected to a single transmission line, contingency response service will be required to secure against the loss of the line during the day. However, the MW loss from a fault on the transmission line will vary throughout the day as the output of the connected solar PV changes. The essential system service volume required to secure against the loss of the line will therefore also change across the day. Therefore, a dynamic requirement will be able to avoid the over procurement of the raise and lower services.

### **Regulating frequency control service**

Regulating frequency control is required to maintain frequency at close to 50 Hz, within the normal frequency operating band specified in the SSG. Although demand and supply are matched with every redispatch of generation, small changes in system load and output variation from unregulated generation occurring between dispatch instructions taking effect must be managed by a regulating frequency control service.

#### *Dispatch period interaction*

In relatively small power systems such as the NT regulated systems, the amount of regulation service available at any time needs to be sufficient to provide the regulation requirement over the period it would take to bring another regulation service online. The regulation requirement is therefore set by the time expected to bring additional services online and the extent of variation in demand expected across that time. The requirement is therefore unlikely to change significantly unless the technology relied on to provide the service changes. Technology change could reduce the average time taken for service providers to come online and hence allow a lower R-FCAS requirement. The current approach to scheduling and dispatch, allows the System Controller to redispatch the system on an as-required basis. This process allows redispatch to be used when necessary to replenish the available regulation services. Sufficient service is however required to allow time for the redispatch to take effect.

### **Voltage management / Network support**

Transmission level voltages on a power system are typically managed through a combination of reactive power control from connected generation, and ancillary reactive compensation equipment, including capacitor banks, Static Volt Ampere Reactance ('VAR') Compensators (SVCs) and Static Synchronous Compensators (STATCOMs).

Most voltage issues are resolved at a planning stage by the Network Operator through specification of sufficient reactive compensation equipment or through the existing GPS in connection agreements. Network capacity constraints are typically also resolved at a planning stage, but may become a more significant issue due to temporary equipment outages.

Freedom to procure a voltage management service from a generator producing no active power, or a network support service by constraining on a generator, may therefore have key advantages for the system, namely the opportunity to appropriately optimise between procurement of essential system services and alternative system reinforcement solutions.

Where an essential system service for voltage management or network support is not defined, the network operator will be forced to manage voltage or capacity issues through reinforcement, which may result in the requirement for procurement of more expensive solutions such as installation of SVCs and STATCOMs for reactive power support, or through conventional capacity reinforcements such as larger cables / overhead lines. A holistic approach that considers all technical solutions would result in overall lower costs for the consumer in the NT by avoiding reinforcement costs where a lower cost solution is available.

### **Restart services**

Restart or black start services and associated procedures are a function of every power system. While not part of normal system operation, these services are essential for restoring power as soon as reasonably achievable after a system black event.

There is no need to change the fundamental nature of the current black start essential system services. However, the service and associated procedures defined in the SCTC and SSG require updating to reflect the changing conditions on the NT regulated systems. In particular, the ability for new large-scale solar PV to provide the service should be considered.

### **System strength**

The definition of an essential system service requirement for system strength may be desirable to manage issues that cannot be resolved in a cost effective manner through system reinforcement, or where issues arise that are not resolvable in planning timescales, such as unexpected generator breakdown or retirement. System strength shortfalls are likely to become an emerging issue on the NT regulated systems as traditional synchronous generation is displaced and/or replaced with a different generation mix, and the definition of a system strength essential system service will help manage this issue.

Detailed electromagnetic transient studies are required to investigate system strength issues and identify optimal mitigation measures. The NTC requires that the Network Operator undertake those studies with provisions in the NTC ensuring that the Network Operator has access to the detailed models required. It is therefore appropriate that the Network Operator assess any requirement for a system strength essential system service.

### **Additional services**

As a general principle, where a need for an additional essential system service is identified through a transparent and open framework, the framework should leave open the possibility to define additional essential system services as required to retain security of supply on the NT regulated systems. Additional services may be required going forward if they are considered to be an efficient and cost-effective approach to retain power system security and power quality compared to alternatives. Examples of issues that could arise on the power system requiring a defined essential system service include the following.

- Failure of installed generation ramping capability to meet a rapid increase in system load from midday to evening caused by a reduction in distribution energy resource output. While such an issue is not expected to present as an issue on the NT regulated systems in the short term, freedom to procure a 'ramping service' may be an efficient way to manage this issue if it arises and not sufficiently managed by regulating frequency control.
- Generation exceeding load on the Alice Springs system solely due to the penetration of increased rooftop solar PV is possible within seven years. A 'load / demand management' service, for instance, paying loads to consume power at times of minimum demand, may be a cost-effective way to manage this outcome in the short term.

## Use of common definitions across the NT regulated systems

In redefining the essential system services there is an opportunity to either develop different definitions, services, and specification methods for each of the NT regulated systems or to adopt a common set of provisions across the systems.

Although the three regulated systems vary significantly in size, as well as in terms of the number and type of connected generators and equipment, a unified framework for essential system services across the three systems is desirable as maintaining three sets of rules (including definitions) is likely to create extra administration and unnecessary complexity. Further, provisions can be crafted to allow the System Controller flexibility in procuring the specified services and the level of service that it procures.

Although governance arrangements, service definitions and method or principles applied to determine service level requirements can be considered 'common' between systems, practical requirements and implementation will differ due to each system's unique characteristics. For implementation in each system to be suitable, detailed specification of the level of services, alignment with market dispatch where this applies, and sections of the procedures used to manage the services must be unique to the requirements of each system.

### 2.3.2. Governance

Broadly defining types of essential system services in the regulatory framework would potentially allow for a framework which is more agile and adaptable to technology and power system changes. However, where this approach is taken, the regulatory framework will need to provide for the System Controller or some other party to develop and publish detailed specifications or descriptions of each essential system service from time to time and requirements for services to qualify as the relevant essential system service.

The essential system services framework in the National Electricity Market (NEM) requires the Australian Energy Market Operator to:

- develop and publish a detailed description of each kind of Market Ancillary Service and the performance parameters and requirements which must be satisfied in order for a service to qualify as the relevant market ancillary service
- develop and publish detailed descriptions of each type of Network Support and Control Ancillary Service.<sup>19</sup>

The National Electricity Rules also impose requirements for consultation regarding changes to the essential system service specifications and descriptions.

A similar arrangement could be adopted in the NT. However, local institutional and industry arrangements could warrant more robust regulatory prescription and oversight to secure industry confidence in the essential system services framework.

As the System Controller has the relevant expertise and familiarity with the requirements of the NT regulated systems, it would be best placed to develop and publish detailed specifications for essential system services from time to time.

The specification of essential system services has critical bearing on the technologies and facilities which are deemed capable of providing them, and so has significant importance to system participants. Approval of detailed essential system services specifications (including for any additional services) and service requirement calculation methods by the Utilities Commission, as the independent industry regulator, would

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<sup>19</sup> Australian Energy Market Commission 2020, National Electricity Rules Version No. 140, May, rule 3.11.4(a1).

provide additional confidence to industry participants in the appropriateness of the detailed essential system services definitions and specifications.

## 2.4. Draft position

The types of essential system services currently enacted in the SSG, spinning reserve and regulating frequency management services, are in and by themselves not suitable to meet the future requirements of the NT regulated systems. Although the SSG makes provision for a variety of other appropriate types of essential system services, to date these services have not been enacted.

The Design Development Team proposes that the set of essential system services outlined in Table 2-3 apply across the NT regulated power systems. These services have been selected to be technology neutral, and alignment across the NT regulated systems will enhance clarity about the services and their requirements.

**Table 2-3 Proposed essential system service types – NT regulated systems**

Essential system service	Purpose	Procurement responsibility
Rate of Change of Frequency (RoCoF) Control	<ul style="list-style-type: none"> <li>Control maximum RoCoF on power systems.</li> <li>Ensure system security for credible contingency events and 'protected events'.</li> </ul>	System Controller
Contingency frequency control (raise)	<ul style="list-style-type: none"> <li>Stabilise frequency within 'emergency' defined operating band after a credible contingency resulting in the net disconnection of generation.</li> <li>Ensure system security without Under Frequency Load Shedding for all credible contingency events.</li> </ul>	System Controller
Contingency frequency control (lower)	<ul style="list-style-type: none"> <li>Stabilise frequency within 'emergency' defined operating band after a credible contingency resulting in the net disconnection of load.</li> <li>Ensure system security without over frequency generator tripping for all credible contingency events.</li> </ul>	System Controller
Regulating frequency control	<ul style="list-style-type: none"> <li>Regulate power system frequency within normal defined frequency operating band.</li> </ul>	System Controller
Voltage management / network support	<ul style="list-style-type: none"> <li>Management of network voltage control issues where required.</li> <li>Management of network capacity shortfall issues where required.</li> </ul>	Network Operator
System restart	<ul style="list-style-type: none"> <li>Enable the restart of the regulated power systems from a 'black system' event.</li> </ul>	System Controller
System strength	<ul style="list-style-type: none"> <li>Sufficient system strength capability to ensure voltage stability and sufficient fault current.</li> </ul>	Network Operator
Additional services	<ul style="list-style-type: none"> <li>Services necessary to address a system security issue that cannot be managed through the planning timescales, as approved by the Utilities Commission.</li> </ul>	System Controller

Procurement of services which have a system-wide requirement should be the responsibility of the System Controller.

Procurement of services which have a locational requirement, and for which network augmentation may be an alternative, should be the responsibility of the Network Operator. The Network Operator should advise the System Controller of any voltage management/network support and system strength contracts with details it needs for dispatch purposes.

Regulatory arrangements should require the System Controller to develop and publish detailed descriptions of each type of essential system service and the performance parameters and requirements which must be satisfied in order for a service to qualify as the relevant essential system service.

Confidence to invest in the NT regulated systems would be enhanced if the types of essential system services for use in the NT regulated systems are codified, and changes to detailed descriptions, performance parameters and requirements made by the System Controller are subject to the approval of the Utilities Commission.

Where a shortfall in power system capability is identified resulting in a system security issue that cannot be managed through the planning timescale, the framework should allow the flexibility for the System Controller to define and procure additional essential system services on a time-limited basis where required and subject to the prior approval of the Utilities Commission.

## 3. Service requirements

Once the services are defined and specified, it will be possible to more accurately determine combinations and amounts of essential system services required to meet the system needs.

Further, it will be desirable for long-term efficiency of essential system services procurement and provision to forecast the future requirements for individual essential system services over a longer time horizon (relative to real-time).

### 3.1. Background

Essential system services requirements in the NT regulated systems (Darwin-Katherine, Alice Springs and Tennant Creek) are determined by the System Controller in the context of system standards and service standards.

There is no requirement in the technical codes for the System Controller to publish information about the essential system services dispatched or to forecast requirements.

#### 3.1.1. System standards

System standards define the technical parameters for the NT's regulated systems.

The SCTC requires the System Controller to arrange the required essential system services to maintain power system security, defined as:<sup>20</sup>

- maintaining an adequate power system frequency
- maintaining power system voltages within the declared standards and limits
- maintaining the stability of a power system
- ensuring that under credible contingency events, the components of a power system are not overloaded
- carrying out all appropriate actions to restore a power system to a secure condition following either a minor or major disruptive event.

The SSG defines the technical levels of frequency and voltage that are deemed to be adequate.<sup>21</sup>

#### 3.1.2. Service standards

In the NT's regulated systems, standards for the provision of essential system services serve as a guide for system participants regarding service requirements to maintain the system within the system standards.

The SSG outlines minimum service standards for Regulating Reserve (R-FCAS) and contingency spinning reserve for each of the NT's three regulated power systems as follows.

- Darwin-Katherine – minimum Regulating Reserve equivalent to the larger of 5 megawatts (MW) or anticipated change in system load over 30 minutes; and minimum contingency Spinning Reserve at all times of 25 MW, including a minimum of two Frame 6 machines.

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<sup>20</sup> Power and Water Corporation 2020, *System Control Technical Code Version No. 6*, March, s. 3.3.2.

<sup>21</sup> Power and Water Corporation 2017, *Secure System Guidelines Version No. 4*, March, s. 5, 12.

- Alice Springs – minimum Regulating Reserve equivalent to the larger of 2 MW or anticipated change in system load over 10 minutes; and minimum contingency Spinning Reserve of the larger of either 8 MW during the day or 5MW at night, or the largest machine's output in MW.
- Tennant Creek – minimum Regulating Reserve equivalent to the larger of 0.5 MW or anticipated change in system load over 10 minutes; and minimum contingency Spinning Reserve of 0.8 MW at all times.

In practice, the System Controller maintains higher combined levels of Regulating Reserve and contingency Spinning Reserve in the Darwin-Katherine system than specified due to the size of the generators in the system and their minimum safe loadings (and other constraints on operation). The system is actually generally operated with an average level of reserve capacity of about 40 MW.

There are no service standards for Voltage Management.

Notwithstanding reference to it in the SCTC<sup>22</sup>, a system restart standard has not been developed by the System Controller.

### 3.1.3. Case for change

There is an inherent tension between the need to procure sufficient essential system services for system security and the cost of their procurement.

Under future arrangements, there will continue to be a requirement for the System Controller to determine and dispatch essential system services to meet service requirements.

Service requirements are a key driver of the costs of essential system services provision and have been a contentious issue for system participants. System participants and the System Controller may have different incentives regarding the procurement and dispatch of essential system services. The System Controller, whose role is to maintain system security, may hold a different view on appropriate service requirements, than system participants who supply essential system services or from whom costs are recovered.

Transparency of the decisions of the System Controller will be critical to providing system participants with confidence in the essential system services framework. Under the NT's current essential system services arrangements there is not the same level of transparency and oversight of services requirements and costs as exist in other Australian electricity markets, potentially contributing to scope for contention regarding their procurement and dispatch in the NT regulated systems.

## 3.2. Submissions

The Issues Paper sought stakeholders' views on whether the essential system services arrangements should incorporate service standards, in addition to system standards; how service standards should be applied; and what oversight and transparency measures should apply to the System Controller's determination of service requirements.

Stakeholders either explicitly supported (Jacana, T-Gen), or did not comment on the desirability of service standards for essential system services on the NT regulated systems.

Stakeholders (T-Gen, Jacana, Eni Australia) also indicated support for a high degree transparency and oversight of the System Controller's determination of service requirements, including for service standards to be incorporated into regulatory instruments.

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<sup>22</sup> Power and Water Corporation 2020, *System Control Technical Code Version No. 6*, March, clause 3.2.10(c)(4).

Jacana stated:

*ESS standards should be established by a separate organisation that considers the trade-offs between ESS costs and energy security. Once set, System Control should then be responsible for ensuring that the standards are met and made accountable when deviations in technical performance arise. These deviations could arise from the non-performance of ESS suppliers (e.g. generators) and the network operator, or due to the failure of System Control to follow procedures.*<sup>23</sup>

Similarly, T-Gen considered:

*... these standards should be applied in a regulatory instrument that is not a System Controller instrument. System Controller must apply to make changes to the service standards in the same manner that any other system participant is required to do.*<sup>24</sup>

T-Gen suggested that governance arrangements should also address situations where the System Controller makes suboptimal decisions:

*A mechanism for recovery of costs by a service provider from the System Controller should be considered where an audit identifies that the System Controller has not genuinely consulted, or is found to have not implemented the lowest cost solution to a ESS requirement.*<sup>25</sup>

### 3.3. Analysis

The opaqueness of the current arrangements for the determination of essential system services requirements for the NT regulated systems is in contrast to those in the NEM and WEM, which have defined transparency and oversight mechanisms.

#### 3.3.1. Service standards

Contemporary service standards – that define system standards in terms of the essential system services required to maintain them – can provide a benchmark against which to compare the essential system services dispatched by the System Controller and are likely to increase the confidence of market participants in the essential system services framework.

In the WEM, service standards are set out in the Market Rules for each essential system service – Load Following Ancillary Service (frequency regulation), Spinning Reserve Service (contingency frequency raise) and Load Rejection Reserve Service (contingency frequency lower) (Table 3-1).<sup>26</sup>

The WEM Market Rules also specify that the standard for the System Restart Service must be a level which is sufficient to meet the operational plans developed by System Management – a standard has been published setting out the amount of time within which System Restart Services are required to restore supply to a specified level and how this is to be achieved.<sup>27</sup> Amendments to the WEM Market Rules are subject to a public consultation process and a decision by an independent rule change panel.

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<sup>23</sup> Jacana Energy 2020, *Submission to Issues Paper*, p. 3-4.

<sup>24</sup> T-Gen 2020, *Submission to Issues Paper*, p. 6.

<sup>25</sup> T-Gen 2020, *Submission to Issues Paper*, p. 6.

<sup>26</sup> Electricity Industry (Wholesale Electricity Market) Regulations 2004, *Wholesale Electricity Market Rules*, 30 March 2020, rule 3.10.

<sup>27</sup> Western Power System Management 2014, *System Restart Standard*, October.



**Table 3-1 Western Australian Wholesale Electricity Market Service Standards**

Essential system service	Service standard (extract)
Load Following Service	<ul style="list-style-type: none"> <li>provide Minimum Frequency Keeping Capacity, where the Minimum Frequency Keeping Capacity is the greater of: <ul style="list-style-type: none"> <li>30 MW; and</li> <li>the capacity sufficient to cover 99.9% of the short term fluctuations in load and output of Non-Scheduled Generators and uninstructed output fluctuations from Scheduled Generators, measured as the variance of 1 minute average readings around a thirty minute rolling average</li> </ul> </li> </ul>
Spinning Reserve Service	<ul style="list-style-type: none"> <li>the level must be sufficient to cover the greater of: <ul style="list-style-type: none"> <li>70% of the total output, including Parasitic Load, of the generation unit synchronised to the [South West Interconnected System] with the highest total output at that time; and</li> <li>the maximum load ramp expected over a period of 15 minutes;</li> </ul> </li> </ul>
Load Rejection Reserve Service	<ul style="list-style-type: none"> <li>the level sufficient to keep over-frequency below 51 Hz for all credible load rejection events;</li> <li>may be relaxed by up to 25% by System Management where it considers that the probability of transmission faults is low.</li> </ul>

Source: Wholesale Electricity Market Rules, 1 December 2020, s. 3.10.

In the NEM, service standards are not specified in regulatory instruments. However, the Reliability Panel determines a System Restart Standard which sets out the requirements that are to be met by the Australian Energy Market Operator (AEMO) in acquiring sufficient System Restart essential system service. The current standard requires AEMO to procure sufficient system restart ancillary services to:

- re-supply and energise the auxiliaries of power stations within 1.5 hours of a major supply disruption occurring to provide sufficient capacity to meet 40 per cent of peak demand in that sub-network; and
- restore generation and transmission such that 40 per cent of peak demand in that sub-network could be supplied within four hours of a major supply disruption occurring.

Codification of service standards in regulatory instruments can introduce inflexibility in service provision, particularly if the conditions in the system are changing. Requirements for services are likely to change based on system constraints, generation mix, load growth and other factors. An ongoing review process is likely to be required to ensure the specified quantity requirements for essential system services continue to be appropriate for the NT regulated systems going forward.

### 3.3.2. Transparency and oversight

In the NEM, the National Electricity Rules require that:<sup>28</sup>

- the Australian Energy Regulator publishes quarterly reports on the volume and cost of Market Ancillary Services dispatched by AEMO

<sup>28</sup> Australian Energy Market Commission 2020, *National Electricity Rules Version No. 140*, May, rules 3.11.2A(b), 3.11.5(k), 3.11.10(a).

- AEMO publishes the total estimated annual costs and quantities of each type of Network Support and Control Ancillary Service acquired by it under ancillary services agreements
- at least once each year, AEMO prepares and publishes a report detailing the total estimated annual cost for the provision of System Restart Ancillary Service, broken down by charges for availability and use.

In the WEM, AEMO must submit essential system service requirements for the coming year to the Economic Regulation Authority for approval. The Economic Regulation Authority must audit AEMO's determination of the essential system services requirements and may require AEMO to redetermine the requirements.<sup>29</sup>

### 3.4. Draft position

The amounts of essential system services procured and dispatched have a direct bearing on the resulting security of the system and electricity supply costs.

Given the importance of service requirement forecasts to overall costs, and the scope for contention and disagreement regarding essential system service requirements, there would be benefit from introducing transparency and oversight arrangements for the determination of service requirements on the NT regulated systems.

A process should be codified for the annual review and determination of the amounts of essential system services to be procured by the System Controller to ensure the levels remain appropriate given changing power system needs.

This process should involve the System Controller preparing, on an annual basis for the coming financial year, an Essential System Services Plan setting out:

- updated essential system service standards for each of the NT regulated systems, supported by an evidence-based methodology
- forecast requirements to meet the service standards
- how the System Controller will procure the required essential system services
- a budget for the procurement of the required essential system services.

Enactment of the Essential System Services Plan should be subject to approval or redetermination by the Utilities Commission.

Where the System Controller identifies that a material deficiency in service requirements against the Essential System Services Plan is likely to occur before the next annual Plan, the System Controller should be permitted to reassess the essential system service standards, requirements and budget with the approval of the Utilities Commission.

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<sup>29</sup> Electricity Industry (Wholesale Electricity Market) Regulations 2004, *Wholesale Electricity Market Rules*, 30 March 2020, rules 3.11.6; 3.11.2.

## 4. Service provision framework

The service provision framework governs how the System Controller procures the essential system services required to maintain system security.

In undertaking its review of essential system services arrangements, the Design Development Team, informed by its advisers GHD Advisory and ACIL Allen, has reviewed potential arrangements for the competitive provision of essential system services in the Northern Territory's regulated systems (Darwin-Katherine, Alice Springs and Tennant Creek).

### 4.1. Background

At a high level, there are three broad potential frameworks for procurement of essential system services:

- regulation (including regulated tariffs and mandated provision)
- bilateral contracts
- pricing and dispatch through a spot market.

The current essential system services framework in the NT regulated systems is characterised by regulation with a mix of regulated tariff and mandated provision elements.

It is a requirement of the System Control Technical Code (SCTC) that a regulatory mechanism for the procurement and responsibility for essential system services be developed<sup>30</sup>, and for system participants to be remunerated for essential system services based on the type and amount of service provided.<sup>31</sup> No arrangements have been developed to date.

Instead, the SCTC makes provision for generators to pay Territory Generation (T-Gen) for provision of essential system services at a rate of \$5.40/megawatt hour of electricity sent out.<sup>32</sup>

Other generators may be called on by the System Controller to provide essential system services, but there is no formal mechanism to compensate them for this. There is also no incentive, other than through sub-contracting by T-Gen, for third parties to provide essential system services voluntarily.

New Generator Performance Standards (GPS) approved by the Utilities Commission in March 2020 mandate essential system service (frequency management) capability for generators, subject to energy source availability. This effectively means that large-scale solar PV may be called on to provide contingency lower frequency control service, but would not have their output constrained to provide contingency raise frequency control service.<sup>33</sup>

#### 4.1.1. Case for change

The current framework excludes private proponents from providing innovative and potentially cheaper essential system services. Competitive provision of essential system services would expose T-Gen to competitive tension and promote provision of more cost and technology competitive supply, putting downward pressure on electricity costs for the benefit of consumers.

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<sup>30</sup> Power and Water Corporation 2020, *System Control Technical Code Version No. 6*, March, section 5.1.

<sup>31</sup> Power and Water Corporation 2020, *System Control Technical Code Version No. 6*, March, section 5.

<sup>32</sup> Power and Water Corporation 2020, *System Control Technical Code Version No. 6*, March, section A6.11(b).

<sup>33</sup> Power and Water Corporation 2020, *Network Technical Code and Planning Criteria Version No. 4*, March, clauses 3.3.5.11, 3.3.5.15.

In addition, in the context of the GPS approved in March 2020 which are likely to require connecting large-scale solar PV to install or contract for battery capacity, the competitive provision of essential system services may:

- increase revenue opportunities, because solar PV and battery facilities required to meet capacity forecasting requirements could also be deployed to provide essential system services under competitive arrangements; and/or
- reduce the cost of contracting battery capacity, as potential third-party service providers may also have opportunities to benefit from potential essential system services revenue streams.

In its final March 2020 decision on the GPS, the Utilities Commission highlighted the potential impact of the current monopoly provision arrangements for essential system services could have on large-scale solar PV being able to independently contract for battery capacity, stating:

*The lack of a competitive ancillary services market whereby other parties can be paid for providing at least some of these services, means that the provision of a centralised battery solution by a private party would be less profitable than if provided by TGen and may not eventuate.<sup>34</sup>*

## 4.2. Submissions

The Issues Paper sought stakeholders' views on what types of essential system services are most suitable for competitive provision, the likely costs and benefits of spot market procurement and what service provision framework would deliver the most appropriate balance between costs and benefits.

### 4.2.1. Prospects for competitive provision

All stakeholders were of the view that essential system services in each of the regulated systems were suitable for competitive provision. However, there were some differences in view between them as to the best way to structure the market(s) in which services are procured.

T-Gen submitted that all essential system services currently provided by it could be provided by other providers in all the regulated power systems, but would need to be formally recognised as suppliers of those services. Epuron expressed a similar view.

Regarding the types of essential system services most suitable for competitive provision and in which systems, Epuron stated:

*All types of ESS are required for all systems and should be able to be delivered by any registered generator. Specifying Territory Generation in the network code removes the opportunity for the market to deliver ESS at cheaper cost.*

*Private companies and Independent Power Producers (such as Epuron) would like to have the opportunity to provide ESS to the market. However this would require the ability to directly procure an income stream from providing the ESS. At the moment TGEN is specified as the sole provider of ESS so this is not possible.<sup>35</sup>*

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<sup>34</sup> Utilities Commission 2020, *Final Decision – Power and Water Corporation's Proposed Amendments to Code – Generator Performance Standards*, p. 8-9.

<sup>35</sup> Epuron 2020, *Submission to Issues Paper*, p. 3.

Similarly, Jacana stated:

*In other markets in Australia, ESS is increasingly being provided through competitive markets and alternative technologies (e.g. synchronous condensers, standalone batteries, co-located renewables and batteries, and even standalone renewable facilities) are being used to provide these services. Relying on markets to procure and dispatch ESS is likely to result in the least cost mix of technologies being deployed to provide many of these services.*<sup>36</sup>

#### 4.2.2. Costs and benefits of spot markets

As stakeholders generally did not support the development of a spot market for the provision of ESS, many did not comment on the costs and benefits of spot market arrangements.

Sun Cable submitted that the potential anti-competitive outcomes of a spot market in small systems, such as those in the NT, may hinder the lowest cost procurement of essential system services. It was of the view that there are not enough participants in the short to medium term to ensure the efficient operation of a spot market:

*... a spot market built on a monopoly (featuring only Territory Generation) or an oligopoly (featuring, for example, Territory Generation, Sun Cable and one or two other participants) may enable the exercise of extreme market power, which would be to the detriment of both consumers and generators ...*<sup>37</sup>

Additionally, Sun Cable was of the view that large-scale capital investments, that may be required to deliver essential system services, are rarely made on a spot market merchant basis.

T-Gen submitted that the costs of providing essential system services through a spot market are unlikely to be lower than the current arrangements, because of the need to set up a 24/7 trading desk and because one or more services may still need to be provided by a synchronous generator, which would increase the costs associated with providing that service. It also raised the risk that there may be no generator to provide energy or essential system services.

Eni Australia's response was focused on the Darwin-Katherine system. It was of the view that the scale of Darwin-Katherine does not justify full spot market provision.

Epuron was of the view that procuring essential system services through a spot market would be the lowest cost provision of essential system services, however suggested the overhead costs associated with doing so would be high.

Only Jacana stated clear support for frequency control services to be provided through spot markets, while other services are better acquired through competitive tender arrangements. It suggested that competition with T-Gen for the provision of essential system services will increase gradually over time with the retirement of T-Gen units and increased investment by others.

#### 4.2.3. Appropriate service provision framework

Stakeholder views on the appropriate service provision framework varied.

T-Gen was of the view that all essential system services should be provided centrally until all services can be supplied independently.

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<sup>36</sup> Jacana Energy 2020, *Submission to Issues Paper*, p. 1.

<sup>37</sup> Sun Cable 2020, *Submission to Issues Paper*, p. 6.

Eni Australia submitted that there should be a default provider of essential system services that should not be T-Gen. The private providers should be given the opportunity to bid into a competitive procurement process to provide the services over a ten year period, which it considered would be ‘... *an appropriate compromise between competitive tension on the one hand and capital recovery for the proponent on the other*’<sup>38</sup>.

Eni Australia was also of the view that the development of a new battery announced by the Government should be the subject of a competitive procurement process. It considered that if the battery is to be built by T-Gen to provide essential system services, it should not be a barrier to the development of a competitive market for the provision of essential system services.

Sun Cable suggested that frequency control essential system services be procured through bilateral contracts, which could be negotiated on an individual or over-the-counter bilateral basis, or administered via a regulated market mechanism, such as a reverse auction mechanism, with a contingency essential system services supplier of last resort. It proposed that system restart services be open to procurement from third parties with relatively long-term contracting to assist investment decisions.

Jacana proposed the arrangements for each type of service as set out in Table 4-1.

**Table 4-1 Service provision framework proposed by Jacana**

Type of service	Proposed arrangement
Frequency regulation and contingency services	<ul style="list-style-type: none"> <li>• Darwin-Katherine System – competitive spot market</li> <li>• Other regulated systems – competitive tendering arrangements, with default service provision arrangements with T-Gen</li> </ul>
Rate of Change of Frequency control service	<ul style="list-style-type: none"> <li>• Constrained off/on payment system</li> </ul>
Other services such as network control services, voltage support and system restart services	<ul style="list-style-type: none"> <li>• Competitive tendering arrangements, with default service provision arrangements with T-Gen</li> </ul>

Source: ACIL Allen based on Jacana 2020, Submission to Issues Paper, pp. 5-6

### 4.3. Analysis

The principles for reviewing the essential system services include that the services should be acquired at least cost, and that the reforms should improve the overall efficiency of the electricity supply, putting downward pressure on the combined cost of essential system services, wholesale electricity and network services.

Essential system services are most likely able to be acquired at least cost when they are acquired through some form of competitive process and there are sufficient potential providers of those services participating in the process to apply competitive tension.

At present T-Gen is the predominant provider of essential system services using synchronous generators, however as the NT’s electricity supply transitions to new renewable energy generators and batteries over the period to 2030, there is the opportunity to introduce additional providers of essential system services to apply more competitive tension as part of any competitive process. There is more opportunity to apply

<sup>38</sup> Eni Australia 2020, *Submission to Issues Paper*, p. 9.

competitive tension in the Darwin-Katherine system than in the smaller Alice Springs and Tennant Creek systems.

Given the electricity system transition over the next decade, and assuming there is a move towards more competitive provision of essential system services, the timing and transition path will be important to be able to leverage the benefits of competition but without incurring a penalty in the transition period when competition may not be effective.

#### 4.3.1. Prospects for competitive service provision

The key characteristic for a service to be suitable for competitive provision is for the requirement to be able to be served by more than one provider.

The currently enacted spinning reserve regime can inherently only be provided by synchronous generators and limits the potential for competition, notwithstanding that there is an incumbent independent gas-fired generator in the Darwin-Katherine system and another independent gas-fired generator under construction.

At present, the capability of existing system participants to provide essential system services may be quite limited, however the revisions to the GPS approved by the Utilities Commission in March 2020, require connecting generators to meet a capacity forecasting requirement. Meeting this requirement can be done through a variety of measures, but is likely to result in renewable generators installing or contracting with energy storage systems, likely in the form of Battery Energy Storage Systems (BESS).

This section highlights the likely potential for future competition in the essential system services proposed by the Design Development Team in section 3.4.

##### Frequency management

##### RoCoF control service

Keeping power system RoCoF controllable under a contingency currently utilises post-contingent synchronous inertia, which inherently instantaneously controls RoCoF as a physical consequence of the rotating mass connected to the power system by a synchronous machine.

'Zero-inertia' power systems, with no synchronous plant, and a BESS providing 'grid forming' RoCoF control capability are technically possible and practicable, but in practice they have only been implemented on small islanded microgrids and stand-alone power systems, where control systems implementing grid forming algorithms can be co-ordinated. Implementation on larger power systems, which require integration with synchronous plant control schemes or interactions between multiple inverter control systems to retain a stable frequency following contingencies is still an area of development and it is therefore unlikely that the Alice Springs or Darwin-Katherine power systems will be capable of zero-inertia operation in the short to medium term.

However, developments in technologies are likely to improve the performance and potentially the capability of alternative technologies to provide a RoCoF control service equivalent to synchronous inertia.

##### Contingency frequency control service

There are no technical barriers to a contingency frequency control service being provided by alternative technologies to the existing synchronous generators on the NT regulated systems. BESS and inverter connected renewable generation can both provide contingency frequency control lower services, often with response times below that of synchronous generation. BESS can also provide contingency raise services. Interruptible loads may also be capable of providing demand side response to contingency events, through tripping. However, as explained in section 2.3.1.1, inverter connected generation may find it uneconomic to provide contingency frequency control raise services.

BESS are proven providers of contingency frequency services in other markets. This service is provided in South Australia by the Hornsdale Power Reserve, and in the United Kingdom where distributed battery systems participate in frequency response markets. A BESS is also currently installed in Alice Springs, where it is used to provide a C-FCAS response, despite this arrangement not currently being formally enacted in the SSG.

Contracted load interruption can also be an effective option for providing contingency frequency control raise services. This could take the form of either, individual large loads agreeing to be disconnected in response to an under-frequency event; or for an equivalent response to be provided by aggregated facilities.

### **Regulating frequency control service**

A BESS that permits a renewable generator to comply with the capacity forecasting requirements under the GPS may also be technically capable of providing an additional regulating frequency control service. It is therefore likely that there will be a wider pool of potential providers for a regulating control frequency service, including both synchronous generators and BESS.

Although BESS may be capable of meeting capacity forecasting requirements and providing a regulating frequency control service, they will not be capable of providing other services while meeting capacity forecasting requirements unless significantly oversized. Although providing a contingency response or RoCoF control service would typically deplete the energy stored in a battery system, a regulating frequency control service typically has a lower energy requirement, instead requiring constant charging and discharging cycles, or adjustments to output for a generator.

### **Voltage management / Network support**

A voltage management or network support service should be open to provision from any technology capable of providing reactive and active power support for procurement by the Network Operator. This can include inverter-connected technologies such as BESS and solar PV, as well as conventional synchronous plant. Where network capacity is a temporary issue, for example only occurring at peak demand, some loads may be willing to provide demand side response for limited periods to resolve this issue.

### **Restart services**

In the short term, restart services are likely to continue being provided by T-Gen due to the lack of alternatives currently available.

Restart services can be provided by either synchronous generators, or by large-scale inverter connected generation and energy storage systems with 'grid forming' capabilities.

Regardless of the technology utilised, a black start service provider needs sufficient capacity to not only restart themselves but to also support the re-energisation of transmission corridors to allow reconnection of loads and other generators. Hence the technology deployed, its capacity and location of a facility are all factors that need to be considered when assessing whether it can act as a viable black start service provider.

### **System strength**

System strength can be provided by technologies capable of contributing sufficient fault current. Rotating plant in the form of either synchronous generators or synchronous condensers are most suited to providing system strength support, however other emerging technologies are capable of providing a fault current contribution.

Mitigation measures that can be effective in addressing system strength issues include:

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- contracting with generators with synchronous generating systems for the provision of system strength services
- augmenting the network to reduce the impedance between inverter connected generators and synchronous generators providing system strength
- retuning the controls on grid following inverters to reduce the likelihood of unstable behaviour
- replacing grid following with grid forming inverters that are less susceptible to low system strength performance issues
- implementing post-contingent control schemes that can disconnect part or all of an inverter-based generator to avoid unstable operation.

#### 4.3.2. Appropriate procurement mechanisms

The two types of competitive service provision framework canvassed in the Issues Paper are:

- bilateral contracts
- pricing and dispatch through a spot market.

##### Efficient provision of services

Spot markets have the advantage of (usually) being highly visible and transparent. However, the disadvantage with the spot market approach, particularly in the context of high fixed (capital) costs, is risk.

With a typical spot market approach, such as the spot wholesale markets used in the National Electricity Market (NEM), acquisition is frequent and for a short period. This means that, based on spot markets alone, suppliers cannot be confident of being able to supply the service in question for long enough to earn a reasonable return on their investment and are thus less likely to invest.

To overcome this, energy projects are invariably underpinned by power purchase agreements (PPAs). This occurs even though the generators in question are required to sell all of their output through the NEM spot market. In effect, the market for PPAs becomes as important, if not more so, for driving efficiencies in generation investment. The spot market is used as a guide to the current and future price of electricity and, as such, as an information input to the PPA.

New renewable energy generators will need to be developed to meet the Government's renewable energy target. These generators are likely to be accompanied by batteries (or other technologies) to meet the GPS, and will be able to provide some or all of the essential system services. This will require capital investment which will only be made if the investor has reasonable confidence in recovering it. For this reason, a market based around longer-term contracts, rather than a short and frequent spot market, is likely to be more suitable.

The use of bilateral contracts to procure essential system services has the potential to provide sufficient investment certainty, however that certainty is dependent on the tenure of the contracts. To provide investment certainty, contracts would need to be of a longer tenure (such as 5-10 years) for services that are provided infrequently and for which a revenue stream is required to ensure that they are available as and when required, such as system restart services. Contracts could be of a shorter tenure (say two to three years) for services which could be provided with low fixed (capital) costs, or where the fixed costs could be apportioned between the provision of essential system services and energy services.

### Co-optimising dispatch of energy and essential system services

Judging the most cost-effective trade-off between energy market dispatch and adjustments to minimise frequency control costs is managed in some markets via the co-optimisation of frequency control services and energy market dispatch through a dispatch algorithm.

Further work is required to define the details of co-optimisation of energy and any essential system services in the NT regulated systems. It is more likely to be feasible for the Darwin-Katherine system, subject to consideration and development of a compatible form of settlement through the proposed contractual arrangements and given the Northern Territory Electricity Market reforms compared with the other NT power systems, which will not have a market arrangement which lend themselves to co-optimisation.

Use of a competitive contract procurement arrangement does not facilitate co-optimisation as compared to an essential system services spot market. However, the merits of co-optimisation in the NT regulated systems must be considered with the counterfactual cost of setting up a spot market for the procurement of essential system services.

Where BESS provide essential system services, co-optimisation with dispatch is not required. A move to focus solely on co-optimising dispatch and essential system services could miss efficiencies of procurement of essential system services from new technologies, which are not capable of or constrained by co-optimising with dispatch.

### Administrative costs

Under the bilateral contracts option, there would be upfront costs associated with conducting some form of competitive process to tender for the services and award contracts to the successful tenderers. These upfront costs would be incurred each time the services are retendered. The more frequently the services are retendered, the higher the administrative costs. Once bilateral contracts have been entered into, the System Controller would dispatch the services as required in accordance with the terms of the contract.

Under the spot market option, there would be upfront costs to establish the rules, processes and systems for the spot market, in which processes and systems are required to be established by the System Controller and the providers of services. There are ongoing costs associated with the registration of providers, the bidding of services by providers and settling payments as well as the dispatch of services as required by the System Controller in accordance with the bids received. While the System Controller must dispatch essential system services under each of the options, under a spot market arrangement the System Controller would need to dispatch the services under the more dynamic circumstances associated with that market.

As a consequence, the administrative costs associated with the spot market option are higher than the administrative costs associated with the bilateral contracts option. An estimate of the administrative costs under each of the options is provided in Table 4-2.

**Table 4-2 Estimated administrative costs for each service provision option**

Option	Upfront costs	Ongoing costs
Bilateral contracts	<ul style="list-style-type: none"> <li>\$200 000 – \$500 000 each time tender process is conducted plus 1 FTE through the tendering and contracting period</li> </ul>	<ul style="list-style-type: none"> <li>Part of 24/7 operation of the control centre</li> </ul>
Spot market	<ul style="list-style-type: none"> <li>\$2 million – \$10 million to establish the rules, processes and systems</li> </ul>	<ul style="list-style-type: none"> <li>Part of 24/7 operation of the control centre, with a higher level of resourcing than the bilateral contracts option</li> </ul>

Source: ACIL Allen

#### 4.4. Draft position

The current approach to essential system service provision is not a competitive process and therefore won't facilitate the procurement and least cost dispatch of essential system services as more potential providers enter the market.

At this stage of the NT regulated systems' development, the most appropriate balance between costs and benefits would be achieved by the System Controller procuring essential system services through bilateral contracts that are entered into following a competitive tender or reverse auction process.

A competitive provision framework for essential system services should empower and oblige the System Controller to enter into an essential system services contract, where:

- it does not consider it can meet the essential system services requirements from T-Gen's existing facilities; or
- it considers an essential system services contract provides a less expensive alternative to essential system services provided by T-Gen's existing facilities.

The provision of regulating frequency control is the service most suited to provision through a spot market. As the market for regulating frequency control becomes more competitive, the potential to provide it through a spot market could be reviewed.

## 5. Administered pricing arrangements and market power mitigation

The Northern Territory's current Interim Northern Territory Electricity Market (I-NTEM) arrangements include an administered price for essential system services provided by Territory Generation (T-Gen) in the Darwin-Katherine system. The administered price is necessary because there is no market to determine prices for essential system services.

However, even under competitive arrangements for the provision of essential system services, as proposed by the Design Development Team, some form of administered pricing or other market power mitigation measure for essential system services will be required because of the potential incentive or ability of system participants to exert market power given the small size of the NT regulated systems, small number of system participants and current dominance of T-Gen.

Under the scope of this Review (outlined in section 1.2), there is a need to address administered pricing for the provision of essential system services by T-Gen under the current monopoly provision arrangements, and also appropriate administered pricing and/or other market power mitigation arrangements that would be appropriate under a competitive framework.

### 5.1. Background

The SCTC makes provision for generators in the Darwin-Katherine system to pay T-Gen for provision of essential system services at a rate of \$5.40/megawatt hour (MWh) of electricity sent out.

There are no specific arrangements for pricing or recovery of essential system services in the Alice Springs and Tennant Creek systems under the System Control Technical Code (SCTC) or any other code, and to date, the monopoly provision of generation in these systems by or under contract to T-Gen has meant these arrangements have not been required.

#### 5.1.1. Arrangements in other markets

In the National Electricity Market, in response to concerns about Hydro Tasmania's dominance of the Tasmanian energy generation market and the spot market for FCAS, in 2011 the Tasmanian Economic Regulator (TER) decided to implement pricing regulation. Under the TER's determination, Hydro Tasmania was required to offer a 'safety net' FCAS hedge contract to other generators to meet their market liabilities and for which the price was based on Hydro Tasmania's costs of physically delivering to the spot market the amount of FCAS nominated.<sup>39</sup> The pricing regulation was revoked by the TER in 2015.

In the Western Australian Wholesale Electricity Market, where the government-owned generator-retailer Synergy has a considerable market share, arrangements to mitigate market power include:

- a requirement in the market rules for Synergy to make essential system services available to the System Controller on request as the default provider; and
- regulation of payments received by Synergy for the provision of non-market essential system services, according to market rules and parameters approved by the Economic Regulation Authority of Western Australia.

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<sup>39</sup> Tasmanian Economic Regulator 2020, *2010 Frequency Control Ancillary Services (FCAS) Investigation*, [https://www.economicregulator.tas.gov.au/electricity/pricing/wholesale-pricing/frequency-control-ancillary-services-fcas/2010-frequency-control-ancillary-services-\(fcas\)-investigation](https://www.economicregulator.tas.gov.au/electricity/pricing/wholesale-pricing/frequency-control-ancillary-services-fcas/2010-frequency-control-ancillary-services-(fcas)-investigation) (accessed 1 June).

### 5.1.2. Case for change

The current administered price for essential system services for the Darwin-Katherine system was included in amendments to the SCTC in 2015 that introduced the I-NTEM. It is understood the price of \$5.40 per MWh was based on a high-level assessment of costs to T-Gen of providing essential system services at that time. However, in the instrument approving the SCTC amendments, the Utilities Commission stated that the Power and Water Corporation (PWC) should commence a review of essential system services within six months, and subsequent to the completion of the review, it would make a determination relating to prices for providing essential system services.<sup>40</sup> To date, no review of essential system services by PWC or determination on pricing by the Utilities Commission has been made.

There has been substantial activity in the Darwin-Katherine system since 2015 that is likely to have impacted on the provision of essential system services and thus T-Gen's costs to provide them. The administered price is now regarded as a 'placeholder' in lieu of any other alternative and needs to be reviewed.

Other deficiencies in the current administered pricing arrangements include that:

- the single bundled price does not provide system participants with an understanding of the costs of individual or categories of essential system services captured by the rate, and introducing this further degree of transparency would provide for a better understanding by government and industry of the cost of key services required to support power system security
- there is no mechanism for the administered price to change over time with changing conditions, such as the introduction of substantial new generation and emerging technologies for providing essential system services, and formalising arrangements for the price to remain up to date on an ongoing basis would enhance certainty for system participants.

The lack of any arrangement for pricing or cost recovery of essential system services provision in Alice Springs and Tennant Creek has not posed significant difficulties to date while T-Gen has provided all generation directly or under contract from private providers. However, the Alice Springs and Tennant Creek power systems are subject to open access arrangements and this situation may change in the future. An application by a private entity to generate electricity in Alice Springs is currently under consideration by the Utilities Commission<sup>41</sup> and highlights the need to plan for competition in generation in these systems.

## 5.2. Stakeholder submissions

The Issues Paper sought stakeholder views on what method should be used to determine prices for essential system services, processes to ensure administered prices remain up to date and appropriate market power mitigation measures under a competitive provision framework.

### 5.2.1. Administered pricing essential system services

Jacana submitted that, with the move to competitive arrangements, having default supplier arrangements in place (i.e. T-Gen) will ensure that services are delivered efficiently (that is, at a regulated price) if there are limited alternative suppliers of services for a particular service category or in a particular regulated network.

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<sup>40</sup> Utilities Commission 2015, *Approval of Amendments to the System Control Technical Code*, May.

<sup>41</sup> Utilities Commission 2020, *Generation licence application – RPS1101 Pty Ltd*, <https://utilicom.nt.gov.au/projects/projects/Generation-licence-application-RPS1101-Pty-Ltd> (accessed 7 December).

Although Sun Cable recommended replacing the administered pricing arrangements with market mechanisms, it is of the view that the administered pricing arrangements are useful as they provide an estimated upper bound for market outcomes, and could be used either as a market cap or regulatory guide to examine whether market power is being exercised over the long term.

Eni Australia does not support the current administered pricing arrangement. It is of the view that it is ‘... the result of a monopoly that is expensive, inappropriate and a significant deterrent to private investment in the DKIS’<sup>42</sup>.

Eni Australia also does not support administered prices moving forward. Rather, it is of the view that essential system services should be procured on a competitive basis over the long term (for example, ten years) to allow both investor certainty for cost recovery and competitive tension to manage the price, with all services procured at the same time so that synergies in the cost of providing multiple services at once can be realised.

### 5.2.2. Administered pricing methods

Epuron submitted that a base (administered) price could be developed which represents the cost to install a new generator to provide more essential system services than required in each market. In effect, this is the long-run marginal cost (LRMC) to provide additional essential system services. Sun Cable similarly recommended that the administered price be calculated based on the hypothetical marginal unit of supply to the system, while noting that it is of the view that this should only be used as a market cap or regulatory guide.

T-Gen submitted that the methodology for determining prices should be as follows:

- *cost reflective*
- *capacity charge to support installed capacity maintenance*
- *ESS dispatched before energy needs as ESS underpin the power system.*<sup>43</sup>

### 5.2.3. Processes to ensure administered prices remain up to date

Epuron submitted that the base (administered) price could be updated at set time periods (for example, annually). T-Gen also suggested that the administered prices be reviewed annually, with the administered prices auditable by the Utilities Commission.

Sun Cable suggested that, under constrained competition, prices be determined using an open tender or bilateral negotiation process. Sun Cable’s preferred tender process is a reverse auction. It noted that:

*In oligopolistic competition scenarios, a first-price auction is preferred, but it should be noted that such mechanisms are not strictly incentive compatible and may lead to a considerable amount of ‘shadowing’ of more expensive bids. There may be other mechanisms, such as second-price auctions, that may lead to more efficient outcomes if the market has enough bidders to produce competitive conditions.*<sup>44</sup>

### 5.2.4. Appropriate market power mitigation measures

As Eni Australia is of the view that T-Gen should not be the default provider of essential system services, it considered that there is no need for market power to be mitigated as T-Gen would not possess significant

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<sup>42</sup> Eni Australia 2020, *Submission to Issues Paper*, p. 10.

<sup>43</sup> T-Gen 2020, *Submission to Issues Paper*, p. 7.

<sup>44</sup> Sun Cable 2020, *Submission to Issues Paper*, p. 9.

market power. Similarly, Sun Cable is of the view that many of the more serious potential opportunities for the exercise of market power will be removed by avoiding the procurement of services through a real-time spot market with limited competition.

However, Sun Cable noted that market power could still be exercised in bilateral negotiations or under various tender processes. It submitted that regulators could utilise an administered price cap or price monitoring to ensure that prices are not pushed above expected levels in the long term. Reduction of market power could be achieved in a reverse auction or tender process through careful application mechanism design principles and in bilateral over-the-counter contracting with rules around open sharing of prices with regulators or anonymous mechanisms.

Epuron suggested the following market power mitigation measures:

- *administered minimum and maximum prices for the provision of ESS,*
- *constraints on offer prices in any market mechanism,*
- *an obligation to supply required volumes of ESS, such as a default provider arrangement in the absence of other providers,*
- *a capacity limit to ensure extra ESS capacity is not built beyond a margin above sufficient capacity. For example no payment for new capacity if existing capacity already exceeds 130% of required capacity.*<sup>45</sup>

T-Gen questioned how an efficient market can be established if it is the generator of last resort and provider of essential system services, and noted that a point of competition occurs with the negotiation of Wholesale Energy Supply Agreements between generators and retailers. It suggested the following market power mitigation measures include:

- *review by the Utilities Commission*
- *quasi-regulated costing*
- *minimisation of additional market compliance costs ...*<sup>46</sup>

### 5.3. Analysis

In section 4, the Design Development Team has proposed that the provision of essential system services in each of the NT regulated systems be opened to competition. As the NT's generation mix changes as it moves towards meeting the 50 per cent renewables target by 2030, there will be more prospective providers of essential system services than there are currently. However, early in this transition process, there may not be sufficient providers of essential system services to facilitate an effectively competitive market for each of the required services in each of the regulated systems.

At least in the short term for some services and for some systems, additional measures will be required to facilitate a transition to the competitive provision of essential system services while mitigating the potential for T-Gen or another system participant to exert any market power.

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<sup>45</sup> Epuron 2020, *Submission to Issues Paper*, p. 4.

<sup>46</sup> T-Gen 2020, *Submission to Issues Paper*, p. 7.

### 5.3.1. Appropriate market power mitigation measures

The Design Development Team, informed by its advisers ACIL Allen, considered the following market power mitigation measures:

- administered prices for the provision of essential system services
- limits on revenue that can be earned from providing essential system services
- constraints on offer prices in any market mechanism
- an obligation to supply required volumes of essential system services, such as a default provider arrangement.

#### Efficient provision of services

If T-Gen or another system participant able to exert market power in the supply of essential system services, there will be the potential for these services to be supplied inefficiently. The objective of introducing measures to mitigate the exercise of market power is to minimise the inefficiencies that would otherwise arise in the provision of essential system services, both in the short term and the long term. In the long term, services will be provided efficiently if there is an effectively competitive market.

#### *Administered prices*

Administered prices can be set based on the actual cost of providing services or the LRMC of providing those services (Box 5-1).

#### **Box 5-1 Actual cost and Long-Run Marginal Cost**

##### **Actual cost**

The total actual costs for providing a service would typically be estimated using a building block approach which comprises:

- the return of capital, that is, depreciation
- the return on capital
- fixed operating and maintenance costs
- variable costs over the life of the plant (including fuel)
- tax costs (if using a post-tax rate of return).

In the case of generators, the variable costs include the cost of fuel and in the case of batteries, includes the cost of charging the battery.

If the plant providing a service could produce energy as well as provide essential system services, the fixed costs (the capital costs and the fixed operating and maintenance costs) could be recovered through the sale of energy and in providing essential system services. The actual costs associated with the provision of essential system services could be determined on a marginal basis or on a fully absorbed cost basis.

If the actual costs associated with the provision of essential system services are determined on a marginal basis, the fixed costs would be fully recovered through the sale of energy. Any incremental fixed costs and the variable costs associated with the provision of essential system services would be recovered through the provision of essential system services.



If the actual costs associated with the provision of essential system services are determined on a fully absorbed cost basis, the fixed costs would be allocated between the two services – the sale of energy and the provision of essential system services. The actual costs for providing essential system services would be the allocation of the fixed costs and variable costs incurred in providing essential system services.

A unit cost would be calculated by dividing the total costs by the volume of services forecast to be provided.

### Long-run marginal cost

The marginal cost is the cost of producing a particular unit of output.

The marginal cost of the first unit of output is all the fixed costs and the variable costs of the first unit.

The marginal cost can be different in the short term, where some costs are fixed, and in the long term, where no costs are fixed.

When determining the LRMC to provide a service at a point in time, the period over which no costs are fixed (that is, all costs are considered to be variable) is the life of the plant that provides that service.

The LRMC is therefore defined as the cost of an incremental unit of capacity, spread across each unit of service provided over the life of the plant.

When calculating the LRMC for new plant, the costs considered include all costs relevant to the investment decision. These costs are:

- the capital cost (including connection and other infrastructure)
- other costs, including legal and project management costs
- fixed operating and maintenance costs
- variable costs over the life of the plant (including fuel)
- tax costs (if using a post-tax discount rate).

The LRMC is the average cost over the long term of supplying incremental service requirements.

There are two approaches to estimating the LRMC:

- A **standalone** or **greenfield** approach, which assumes that there is currently no plant to provide the required service. The approach theoretically builds, and prices, a whole new system that is least-cost. In effect, it re-prices all existing plant at efficient levels and includes the capital costs of new plant in the LRMC estimate.
- An **incremental** approach, which assumes that the existing mix of plant in the system is in place and that the required service can be provided using both existing plant and new plant. This approach prices services on the basis of the least-cost way of adding to the existing stock of plant and does not factor in the capital costs of existing plant as this is assumed to be sunk.

The standalone or greenfield approach is generally used for estimating the LRMC for regulatory purposes. The incremental approach results in a very low LRMC (more related to the short-run marginal cost) unless new plant is immediately required.

In a competitive market, the price outcomes will align with the LRMC over the long-term. If the price outcomes were lower than the LRMC over the long term, service providers would not be viable. If the

market is competitive then the price outcomes will not be higher than the LRM values over the long term.

In the short term, the actual cost of providing services may be lower than the LRM, depending on how the LRM is calculated and whether the services are provided by older plant that has already been depreciated over a number of years. However, if the actual cost is less than the LRM and administered prices are set based on the actual cost of providing services, competition may be stifled in the short term, which may lead to higher prices in the longer term. Competition will be facilitated in the longer term if administered prices are set based on LRM, but customers will pay more than they would otherwise and providers may earn windfall gains.

As new technologies for providing essential system services enter the market, the LRM of providing essential system services may decrease below T-Gen's actual cost of providing essential system services. If T-Gen continues to provide some of those services and is paid the LRM, it may incur losses in providing essential system services with those losses ultimately paid for by the NT's taxpayers. If it is paid the actual cost, customers will pay more than they otherwise would.

Services will be provided more efficiently if administered prices are set for each service and for each regulated system rather than setting an administered price for a bundle of services.

#### *Constraints on offer prices*

Similarly, if constraints are placed on offer prices based on LRM rather than the actual costs of providing services, services will be provided more efficiently in the longer term, and will be more efficient if the constraints are placed on the price of each service in each regulated system rather than a constraint on a bundled service. However, in the case of constraints placed on offer prices, there is the potential for proponents to bid lower than the constraint price rather than to have an administered price imposed. This will lead to a more efficient outcome in the shorter term than administered pricing.

#### *Limit on revenue*

While some of the costs associated with providing essential system services are fixed in nature, others are variable in nature. The revenue derived from those services for which the costs are variable in nature will be a function of the price and volume. A limit on revenue will therefore need to consider both the price and the volume of services.

The price that is factored into a revenue limit could be based on the actual cost of providing services or the LRM, as discussed above. To facilitate competition and the efficient provision of services in the longer term, the price would need to be set based on LRM rather than the actual cost of providing services. However, if the LRM is higher than the actual cost, this could result in a revenue limit that is substantially higher than the actual cost of providing services in the short term and windfall gains for the provider.

In addition, any consideration of a revenue limit would also need to consider the volume of services, which will vary from year to year and will vary over time as the generation mix changes. If the revenue limit is based on a volume of services that is too low, it may constrain the provision of services below those required. If the revenue limit is based on a volume of services that is too high, it will have no practical effect.

#### *Default provider*

Placing an obligation to supply on a default provider may not facilitate the efficient provision of services over the longer term, more so if there is one default provider for all services.

The price of essential system services under a default provider arrangement could be the actual cost or LPMC. As the default provider arrangement will not facilitate a competitive market, the price need not be set at LPMC to incentivise new market entrants.

If the price is set at the LPMC and the actual cost is less than the LPMC, the service providers will get a windfall gain and customers will pay more than they would otherwise. If the actual price is more than the LPMC, then no providers other than T-Gen would provide the services. T-Gen would incur losses with those losses paid for by the NT's taxpayers.

#### **Administrative costs**

Estimating the LPMC for each service is complex. If administered prices are set or there are constraints on offer prices, there are the upfront costs associated with determining the prices and to codify them. Similarly, if there is a default provider, there are the upfront costs to set up these arrangements.

The upfront costs associated with determining a revenue limit would be higher than for setting an administered price or constraints on offer prices because the volume of services needs to be considered in addition to the unit cost of providing services. In addition, there would be the ongoing costs to monitor the revenue earned relative to the revenue limit. ACIL Allen has estimated a revenue limit arrangement would cost equivalent to an additional 0.25 full time employees (FTE) to the service provision framework cost estimates in Table 4-2.

## **5.4. Draft position**

Under the scope of this Review, there is a need to address administered pricing for the provision of essential system services by T-Gen under the current monopoly provision arrangements, and market power mitigation arrangements appropriate under a competitive provision framework.

#### **Monopoly provision**

Under the current arrangements for the monopoly provision of essential system service by T-Gen, an administered price is necessary because there is no market to determine prices for essential system services.

A codified process should be established to ensure that the administered prices received by T-Gen as the default provider for each essential service it provides continue to reflect the actual costs of providing the services over time.

This process should require, on an annual basis for the coming financial year:

- the System Controller providing a draft Essential System Services Plan to T-Gen, including draft updated essential system service standards for each of the NT regulated systems and forecast requirements to meet those standards
- based on the draft Essential System Services Plan, T-Gen providing the System Controller updated auditable actual estimated costs for each of the essential system services required, including unit variable, enablement and fixed costs
- the System Controller to publish the proposed administered prices in its Essential System Services Plan, with the prices subject to the approval of the Utilities Commission.

#### **Competitive provision**

Under the proposed competitive arrangements for the provision of essential system services, market power mitigation measures will be required because of the potential incentive or ability of system

participants to exert market power given the small size of the NT regulated systems, small number of system participants and current dominance of T-Gen.

The market power mitigation measures should include:

- constraints on offer prices in any market mechanism, equivalent to the estimated LRMC of providing the service
- an obligation on T-Gen, when fulfilling its role as the default provider, to supply required amounts of essential system services with the price it receives capped by its actual costs.

Requirements should be codified to implement the market power mitigation measures, including:

- for the System Controller to publish estimates of the LRMC of providing each essential system service in the annual Essential System Services Plan, as a cap on market offers in any competitive procurement process and as a guide to when it will seek to undertake competitive procurement
- for the System Controller to publish the price to be received for services provided by T-Gen when fulfilling its role as the default provider (as per the proposed codified process under 'monopoly provision').

## 6. Cost allocation and settlement

The cost of procuring ancillary services must be recovered by the party responsible for procuring them.

Of the seven types of essential system services set out in Table 2-3, five are suited to be procured by the System Controller, in that they are system-wide and do not have significant network augmentation alternatives. These are rate of change of frequency (RoCof) control, contingency frequency control (raise & lower), regulating frequency control and system restart.

The remaining two proposed essential system services, voltage management/network support and system strength, have localised requirements and significant network augmentation alternatives, and the Network Operator would be best able to assess the efficient solutions and should be responsible for their procurement.

### 6.1. Background

Under the System Control Technical Code (SCTC), Territory Generation (T-Gen) is the mandated provider of essential system services and is entitled to receive payment from other licenced generators of \$5.40/megawatt hour of electricity they send out in each settlement period (one calendar month). Settlement is facilitated by the Market Operator, which calculates the sent out quantity for each generator and issues a settlement statement. T-Gen then issues invoices to other generators, which are required to be paid within 30 days.

#### Islanding events

Under certain circumstances, such as when Pine Creek is islanded, the generator at Pine Creek (EDL) is required by the System Controller to provide essential system services. To avoid unduly charging EDL for services it provides, the System Controller reduces the essential system services price for EDL in proportion to the period within each market interval (30 minutes) that EDL was required to provide essential system services (this is a workaround required because the SCTC does not permit the System Controller to amend essential system services quantities).<sup>47</sup>

#### 6.1.1. Case for change

The current cost allocation arrangement under the SCTC, whereby essential system services costs are allocated to licenced generators based on their proportion of total energy sent out, is inequitable and inefficient.

The arrangement is *inequitable* because it does not allocate costs between system participants on the basis of the benefits received from the essential system services provided. Although licenced generators benefit from the provision of essential system services, all other system participants also benefit, including unlicensed generators such as small-scale solar PV and consumers.

The arrangement is *inefficient* as it does not provide incentives for system participants to manage their contribution to, or assist with the correction of, frequency deviations which are the primary drivers of service requirements and costs of regulating frequency control.

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<sup>47</sup> Power and Water Corporation 2020, *Market-related network information*, <https://www.powerwater.com.au/market-operator/market-related-network-information> (accessed 29 May).

### 6.1.2. Arrangements in other markets

In mature markets, such as the National Electricity Market (NEM) and Western Australian Wholesale Electricity Market (WEM), essential system services costs are typically allocated to parties who are deemed to have caused the need for the services and have capacity to take action to reduce the need.

In the NEM, this has resulted in the following cost allocations.<sup>48</sup>

- Contingency raise services, which are required to manage the loss of the largest generator on the system, are recovered from generators based on their proportion of total energy production.
- Contingency lower services, which are required to manage the loss of the largest load or transmission element, are recovered from customers based on their proportion of total energy consumption.
- Regulation services, which are required to correct frequency deviations, are recovered from generators and customers that contribute to frequency deviations. Generators whose production and customers whose consumption causes frequency deviations, or that do not contribute to their correction, are allocated higher contribution factors than those that do not cause, or assist to correct, frequency deviations.
- Network Support services and System Restart services, which are required to assist with voltage control and restoration of the system, and which benefit all system participants, are recovered from all system participants in proportion to their energy production and consumption.

In the WEM, the independent market operator (the Australian Energy Market Operator) allocates the cost of essential system services between market participants on the following basis<sup>49</sup>:

- The monthly cost of load following is allocated amongst market participants in proportion to their monthly share of contributing quantity (metered load and non-scheduled generation).
- The monthly cost of spinning reserve is borne by generators in proportion to the deemed risk that the generator imposes on the system, based on the output of the generator in each Trading Interval during the month.
- The monthly costs for load rejection reserve, dispatch support and system restart are recovered from market customers in proportion to their monthly metered consumption.

## 6.2. Submissions

The Issues Paper sought stakeholder views on appropriate bases for the allocation of essential system services costs, alternatives to a 'causer pays' approach, technical barriers, transitional issues and appropriate oversight and regulatory arrangements.

### 6.2.1. Appropriate bases for the allocation of ESS costs

Jacana supported moving towards a causer pays model with the price of essential system services unbundled and cost reflective in the short term. Jacana and T-Gen noted that a portion of essential system services costs are usually fixed, reflecting the capacity required to supply services, and therefore support passing through essential system services charges via a combination of fixed and variable charges.

Epuron also supported moving to a causer pays approach.

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<sup>48</sup> Australian Energy Market Operator 2020, *Settlements Guide to Ancillary Services Payment and Recovery*, February.

<sup>49</sup> Independent Market Operator 2012, *Wholesale Electricity Market Design Summary*, 24 October.

Sun Cable supported the causer pays approach as adopted in the NEM for contingency raise and lower services, network support and system restart, but proposed an alternative approach for regulation services, as discussed in the next section.

By way of contrast, Eni Australia is of the view that, given the small scale of the Darwin-Katherine system, the causer pays model should be simplified relative to the models in other markets, fit for purpose, while encouraging the right behaviours from market participants. It considered that, given electricity customers fund all the costs of operating a power system, the cost of 'business as usual' essential system services should be funded directly by customers, without any margins applied by parties as the costs are passed through the supply chain. Generators should only pay for essential system services if they introduce a new credible contingency to the power system that requires higher levels of service.

### 6.2.2. Alternatives to causer pays

Sun Cable recommended the following alternative approach for the recovery of regulation essential system services costs:

- Generators – drawing on the existing Generator Performance Standards (GPS), generators contract with third parties so that their total impact on the grid (across a number of sites) is effectively non-existent. If these third party suppliers fail to provide the services required, any fees or charges resulting from the overall impact on the grid are passed on to these suppliers. Sun Cable refers to this as the hybrid causer-pays approach.
- Loads and distributed energy resources (DER) – the concept of causer pays falls on the market participant (i.e. the retailer or large industrial off-taker):
  - Loads and DER above a certain threshold (100 kW) – can be used to 'net off' grid impacts via the direct-contracting causer pays system
  - Loads and DER with smaller capacities – aggregated at the distribution level with grid impacts pro-rated across consumed / generated volumes across the distribution sector.

As discussed above, Eni Australia is of the view that, given that electricity customers should fund all the costs of operating a power system, retailers (representing customers) should be charged for essential system services unless there is justification to charge them to some other party. Eni Australia considered the only circumstance under which this could be justified is in the case of a contingency raise service if a generator introduces a new credible contingency that is greater than is currently being used.

T-Gen proposed an alternative model to the causer pays approach which would be a continuation of the current model of centralised supply of essential system services by T-Gen, with the services being more clearly identified and procured to enable 'asset improvement' in the future, and payment for some of the essential system services made by the Network Operator.

### 6.2.3. Technical barriers

T-Gen identified two technical barriers to moving to a causer pays approach:

- the ability to identify the causer where accumulation meters are still in use
- the ability to prioritise the service required at any point (which service is most needed, and why).

Eni Australia identified a significant overlap between the essential system services and the mandatory provisions on new generators as a technical barrier. It found it difficult to see how services that are mandated can then be remunerated and/or incentivised, and was of the view that if a legacy plant is currently providing essential system services, it should continue to provide these services as if they were new plant where these provisions are mandated.

Sun Cable identified that the hybrid causer-pays approach that it proposed requires live monitoring of any participating generators or loads, with the required monitoring and management tools available off-the-shelf.

#### 6.2.4. Transitional issues

T-Gen identified a number of transitional issues, including:

- capital investment required
- the settlement process – evidence of the need and supply of essential system services
- calculation of losses to the meter / generation connection point
- ability for the centralised supply of essential system services to generators under the Network Technical Code and the SCTC.

Sun Cable identified that, under the hybrid causer-pays approach it proposed, system participants over a given capacity threshold would be required to install high-frequency SCADA monitoring equipment and enter into contracts with potential essential system services providers, or install equipment to ensure a 'net zero' impact on the grid.

#### 6.2.5. Oversight and regulatory arrangements

T-Gen was of the view that the causer pays allocation should be accompanied by review and approval by the Utilities Commission.

Eni Australia considered there are a number of potential conflicts of interest associated with the entity that provides the System Controller functions. Given these potential conflicts of interest, it is of the view that the Utilities Commission needs to have sufficient technical resources of its own to provide effective regulation of the electricity industry. However, it noted that the Utilities Commission is heavily reliant on electricity industry consultants, many of which may face conflicting positions as they appear to also provide consultancy services to the Power and Water Corporation.

Sun Cable has proposed that, under the hybrid causer pays approach that it proposed, any fees or charges from the operator be initially performed by essential system services suppliers, with strict reporting and transparency obligations.

### 6.3. Analysis

#### 6.3.1. Cost allocation

Based on the options canvassed in the Issues Paper and stakeholder submissions received, the options assessed are:

- generators pay, which is the existing approach
- causer pays similar to that in the NEM, under which generators pay for contingency raise, customers pay for contingency lower, the causer pays for regulation and all system participants pay for network support and system restart
- hybrid causer pays as proposed by Sun Cable, which is as per the NEM approach except for regulation services
- customers pay, under which customers pay for all essential system services.



It should be noted that the introduction of the capacity forecasting GPS means that new renewable generators connecting to the NT regulated power systems should not result in increased requirements for regulating frequency control. It may therefore be expected that the majority of the cost for regulation services will be recovered from loads.

**Efficient provision of services**

The efficient provision of essential system services is facilitated when participants are incentivised to minimise the extent to which essential system services are required. This occurs to the greatest extent under the causer pays approach, similar to that adopted in the NEM.

The hybrid causer pays approach proposed by Sun Cable is the same as the causer pays approach for all services other than for regulation. The hybrid causer pays approach expands upon the GPS which require a generator’s total impact on the grid (across a number of locations) to be effectively non-existent. Generators can contract with third parties to correct for any frequency control impacts. Under Sun Cable’s model, the third party contracted by the generator would then be liable for any net frequency control impacts.

Any differences between the incentives under the two approaches are driven by the contractual arrangements between the generators and the third parties – the incentives under the hybrid causer pays approach could be aligned with the incentives under the causer pays approach or the liability could be transferred completely to the third parties as implied by Sun Cable’s submission.

The existing generator pays approach and the customer pays approach are similar in terms of efficiency. Under both of these approaches the costs associated with providing regulation control, RoCoF control and system strength are not paid for by the parties causing the need for those services.

**Administrative costs**

The administrative costs associated with the generator pays and customer pays approaches are relatively low. The total costs are either allocated to generators based on energy produced or customers based on energy consumed.

The administrative costs associated with the causer pays and hybrid causer pays approaches are higher as the equipment would need to be in place to be able to monitor the system, and the System Controller would need to use that information to allocate the costs associated with regulating frequency control, RoCoF control and system strength to the appropriate party. In the case of the hybrid causer pays approach, the System Controller would also need to understand the contractual arrangements between the generators and third parties to assess the ‘net’ impacts.

Arrangements would also need to be in place to resolve any disputes that arose from the allocation of costs under the causer pays and hybrid causer pays approaches.

**Table 6-1 Estimated administrative costs for each cost allocation option**

<b>Option</b>	<b>Estimated costs</b>
Generators pay	0.1 full time employees (FTE)
Causer pays	0.5 FTE plus \$0.2 million – \$1.0 million per annum for expert advice to resolve disputes that arise
Hybrid causer pays	0.5 FTE plus \$0.2 million – \$1.0 million per annum for expert advice to resolve disputes that arise
Customers pay	0.1 FTE

Source: ACIL Allen

### 6.3.2. Settlement

#### Services the responsibility of the System Controller

Under the Design Development Team's draft position that the provision of essential system services be opened to competition, the existing arrangements for settlement of essential system services, whereby the System Controller prepares statements for invoicing by T-Gen, would be inadequate.

Competitive provision arrangements would involve the System Controller procuring a variety of essential system services under contract from providers. The System Controller would then need to recover the costs of the essential system services procured from system participants under the proposed causer-pays framework.

As part of the Northern Territory Electricity Market Priority Reform Program, priority dispatch and settlement reforms outlined in this paper are being progressed. Pending their final design, there may be a need for some consequential amendments to settlement arrangements to accommodate the proposed essential system services reforms.

#### Services the responsibility of the Network Operator

Locational services, such as voltage management / network support and system strength, are appropriately procured by the Network Operator.

The Network Operator is subject to an incentive-based economic regulatory regime. Its revenues are determined on a five yearly basis by the Australian Energy Regulator, with prices set annually in accordance with the revenue determination. If the Network Operator is responsible for providing voltage management / network support and system strength services under the legislative and regulatory framework, then the revenue determined and the prices set to recover the costs associated with those services will be in accordance with the economic regulatory regime.

## 6.4. Draft position

The current arrangements, which allocate essential system services costs to licenced generators based on their proportion of total energy sent out, are inequitable and inefficient because they do not allocate costs on the basis of benefits received or contribution to requirements.

Costs for essential system services should instead be allocated according to the principle of causer pays. Although this approach is administratively more costly than the current approach, it is more efficient as the costs of providing essential system services are paid by the parties causing the need for those services. For this reason, it provides an incentive to parties to minimise their contribution to essential system services requirements.

The Design Development Team's proposed allocation of costs by essential system service type is outlined in Table 7-2.

**Table 7-2 Party liable for each essential system service**

<b>Option</b>	<b>Allocation</b>
Contingency raise	Generators
Contingency lower	Customers
RoCoF	Parties that cause the service to be enabled
Regulation	Generators and customers that cause frequency deviations Customers without SCADA – balance
Voltage management / network support	Customers
System Restart	Generators and customers
System Strength	Where possible, party responsible for the system strength issue Customers – balance

Detailed calculations for cost allocation would need to be determined as part of the development of the detailed essential system services settlement rules.

The existing arrangements for settlement of essential system services, whereby the System Controller prepares statements for invoicing by T-Gen, would be inadequate under a competitive service provision framework.

As part of the Northern Territory Electricity Market Priority Reform Program, priority dispatch and settlement changes are being progressed. Pending their final design, there may be a need for some consequential amendments to dispatch and settlement arrangements to accommodate the proposed essential system services reforms.

## 7. Implementation

The revision of the existing essential system services framework or the implementation of a new framework will require changes to regulations and codes.

### 7.1. Background

The Northern Territory's regulated systems (Darwin-Katherine, Alice Springs and Tennant Creek) currently operate under two electricity frameworks:

- *Industry Act*

The *Electricity Reform Act 2001* (NT) provides an overarching framework for regulation of the NT's electricity supply industry, declaring it to be a regulated industry, and setting out licencing requirements for electricity entities.

The *Electricity Reform Act* and Regulations provide the head of power for the Power and Water Corporation (PWC), as the licenced System Controller and Network Operator for the NT regulated systems, to manage the systems in accordance with the System Control Technical Code (SCTC) and Network Technical Code and Planning Criteria (NTC) approved by the Utilities Commission.

- *Northern Territory National Electricity Rules*

The *National Electricity (Northern Territory) (National Uniform Legislation) Act 2015* (NT) provides for the adoption of the National Electricity Law and the National Electricity Rules (NER) in the NT from 1 July 2016.

The Northern Territory NER, a version of the NER modified by regulations to suit the NT's circumstances, govern the arrangements for metering, economic regulation and network connection in the regulated power systems.

The NT has not applied a number of components of the NER, including those governing the operation of wholesale markets and power system security, which continue to be governed by the SCTC and NTC.

It may be feasible to implement a revised or new essential system services framework either through amendment to the technical codes under the *Electricity Reform Act* (SCTC, NTC) or through an NT specific chapter of the Northern Territory NER.

### 7.2. Submissions

The Issues Paper sought stakeholder views on issues to be considered in determining which legislative and regulatory framework would best accommodate changes to the NT's essential system services framework; and what improvements can be made to the governance of the framework

#### 7.2.1. Appropriate legislative and regulatory framework

Territory Generation (T-Gen) was the only stakeholder to comment on issues relevant to consideration of the legislative and regulatory framework, identifying the '*partially implemented regulatory regime*'<sup>50</sup> as a relevant consideration in addition to a number of operational considerations and pressures for its business.

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<sup>50</sup> T-Gen 2020, *Submission to Issues Paper*, p. 8.

## 7.2.2. Improvements to governance

In relation to improvements to governance of essential system services, Eni Australia highlighted the PWC's different roles as a source of conflict, stating:

*... the conflicts of interest inherent in PWC's various roles are both clear and untenable and EAL notes the consultation paper acknowledges that this may not reflect best practice. It is clear that ESS governance arrangements need to be changed in order for appropriate decisions to be made.<sup>51</sup>*

T-Gen considered all services need to be recognised, specified and compensated; generator of last resort requirements recognised and the legislative framework fully enabled or appropriately modified.

Jacana reiterated views previously expressed that the governance for the definition and provision of essential system services needs to be independent of the System Controller.

## 7.3. Analysis

Appropriate governance arrangements for the NT's essential system services framework will support investor confidence.

The current arrangements, whereby the System Controller and Network Operator are responsible for making the SCTC and NTC respectively, do not reflect best practice, but are improved by the requirement for changes to be subject to the approval of the Utilities Commission.

The undertaking of this review by the Design Development Team for consideration by the Government represents a further improvement to governance arrangements over System Controller and Network Operator led code changes.

Although wholesale incorporation of the NT's network, system control and market operation technical codes into the Northern Territory NER and changes to legislative and institutional arrangements to expand the scope of independent rule making could improve the NT's electricity governance framework further, the scale of changes required is beyond the scope of this review.

In weighing the appropriateness of the current legislative and regulatory frameworks to implement the proposed essential system services reforms, the Development Team considered that:

- amendments to the SCTC and NTC are a given, because of the need to remove redundant provisions
- there would be benefits for system participants in ease of reference from locating related obligations in the same instruments
- the ease of implementation and maintenance of the revised or new arrangements under either the Industry Act or Northern Territory NER frameworks are equivalent
  - implementation under the NTC and SCTC would require the approval of the Utilities Commission
  - implementation in the Northern Territory NER would require consultation with other Australian jurisdictions' Energy Ministers as per the requirements of the Australian Energy Market Agreement; and consideration of amendment regulations by Cabinet, the Executive Council and the Administrator

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<sup>51</sup> Eni Australia 2020, *Submission to Issues Paper*, p. 13.

- the principal benefit of implementation through the Northern Territory NER would be where the NER contains provisions equivalent to those required that can be easily adapted for application to the NT's regulated systems.

On this basis, the Design Development Team proposes the following high-level legislative and regulatory implementation strategy.

- Arrangements that are bespoke to the NT to be implemented through amendments to the SCTC and NTC. This would include:
  - essential system service types
  - process for detailed definitions, parameters and requirements for essential system services
  - the requirement for an annual Essential System Services Plan detailing service standards, service requirements, administered prices and market offer price caps.
- Arrangements for which there are equivalent NER provisions be considered for implementation through the Northern Territory NER, SCTC and NTC. This would include:
  - *Network support / Voltage Management, which are equivalent to arrangements in the NER for network support and control ancillary services* – A framework for the determination of need for network support, compensation for providers and recovery of costs, is contained in Chapter 5 Network Connection Access, Planning and Expansion, The NT has adopted Chapter 5 but relevant clauses are currently disabled in the Northern Territory NER.
  - *System Strength* – A framework for the determination of need for system strength remediation, compensation for providers and recovery of costs, are contained in Chapter 5 Network Connection Access, Planning and Expansion. The relevant provisions are currently disabled in the Northern Territory NER.

## 7.4. Draft position

Based on a range of factors including ease of reference for system participants and implementation and maintenance of provisions, the proposed changes to the essential system services arrangements should be implemented through:

- the SCTC and NTC, for elements of the new essential system services framework which are bespoke to the NT
- the Northern Territory NER, SCTC and NTC, for elements of the new essential system services framework for which there are equivalent frameworks in the National Electricity Market.

## 8. Making a submission

Interested parties are invited to email submissions on this Draft Position Paper to the Design Development Team at [electricityreform@nt.gov.au](mailto:electricityreform@nt.gov.au) by 12 March 2021.

Submissions should be provided in Adobe Acrobat or Microsoft Word format. On receipt of a submission a confirmation of receipt will be provided, however, it is the submitter's responsibility to ensure successful delivery of their submission.

The Design Development Team will publish submissions on its website, with the exclusion of confidential information. Submissions must clearly identify any confidential information and a version suitable for publication with the confidential information removed should be provided.

The Design Development Team may also exercise its discretion not to publish any submission based on content, such as submissions containing material that is offensive or defamatory.

Please contact the Design Development Team regarding any questions on the consultation by emailing [electricityreform@nt.gov.au](mailto:electricityreform@nt.gov.au).

## Appendix 1 Essential System Services Concepts

Essential system services (also commonly referred to as ancillary services) are required in addition to the supply of energy and capacity, to support the power system to produce, transmit and distribute power of acceptable quality to consumers and continuously maintain the demand/supply balance during normal and abnormal system conditions.

### Frequency management

#### Frequency regulation

In the Northern Territory, frequency is managed to a level of 50 Hz under normal operating conditions. Power system frequency reflects the balance between supply and demand. Maintaining frequency at 50 Hz therefore requires continuous balancing of generation and load. As generators are not redispatched continuously to adjust for every change in demand, frequency management services are required in power systems to maintain the balance, via constant frequency regulation.

The purpose of maintaining a regulated frequency at 50 Hz, is to ensure power quality for connected generators and loads to the system. Failure to regulate frequency close to 50 Hz, leads to increased “wear and tear” on synchronous generators, and loads, especially motors.

#### Rate of change of frequency

Rate of change of frequency (RoCoF, measured in Hz/second) is controlled on power systems by a combination of synchronous inertia, the store of kinetic energy provided by the aggregate rotating mass of all machines directly coupled to the grid, and the size of a contingency, causing a mismatch in power supply and demand and the resultant frequency change.

High RoCoF is undesirable and potentially threatening to secure system operation, due to:

- Pole slip – High RoCoF can cause pole slip. Pole slip is a loss of synchronisation between a synchronous generating unit and the power system resulting in significant damage to the generating unit. Failure to arrest high RoCoF on a power system will lead to synchronous generators tripping to protect themselves from pole slip, or alternatively sustaining severe damage as they lose synchronisation.
- Under frequency load shedding (UFLS) operation – UFLS relays operate at distinct frequency levels below 50 Hz and are set with a time delay for operation. A RoCoF level that is too high can cause a system frequency nadir below an acceptable level for system generation before UFLS relays have time to operate. Under these circumstances, generators will disconnect to protect themselves from the rapid decline in frequency.
- Contingency frequency or spinning reserve response time – A high RoCoF event requires a faster acting contingency frequency response to avoid the frequency nadir breaching specified limits. In this scenario frequency response providers need to quickly sense the frequency change and adjust their power output to arrest the frequency change.
- Anti-islanding protection – Many power systems use protection set on RoCoF to detect islanding or ‘loss of mains’ on a network for embedded generation. This results in a straightforward method to trip embedded generation after islanding, thereby de-energising the islanded power system and allowing for technicians to complete works safely to re-energise. However, if RoCoF settings are set too low, this can exacerbate a response to generator contingency events, with embedded generation tripping under high RoCoF events.

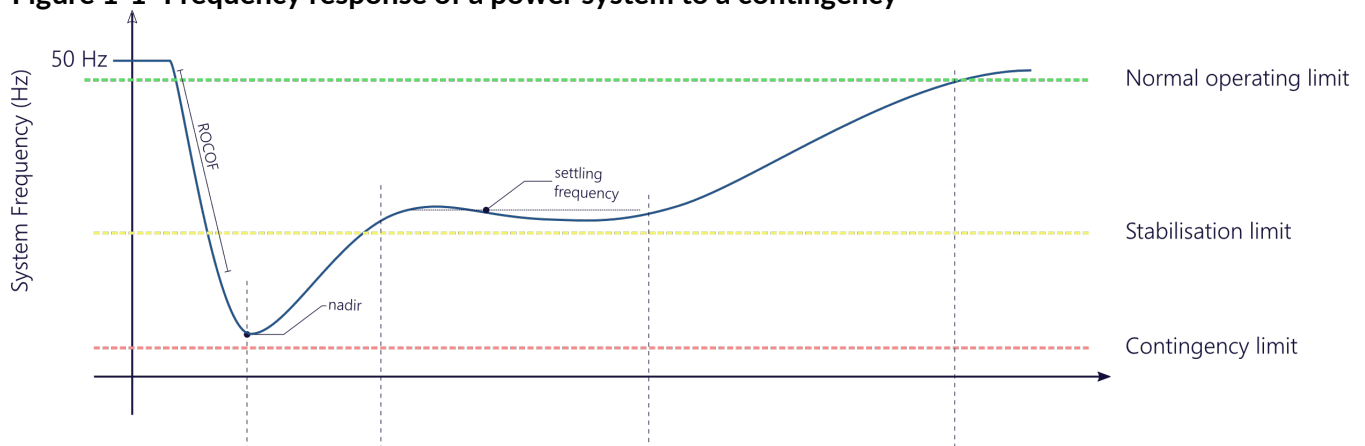


## Contingency frequency control

Contingency frequency control is required to arrest the change in frequency following generator and load contingencies and to restore the frequency to 50 Hz. Failure to arrest the change in frequency will lead to frequency operation outside of a defined contingency limit. This can, depending on severity of the event, result in either under frequency load shedding, or generators disconnecting to protect themselves. An active power response must therefore be provided to arrest frequency change and restore frequency to 50 Hz following a contingency.

Figure 1-1 illustrates the response of a power system to a contingency event involving the trip of a generator. The chart shows a frequency response characterised by the initial RoCoF, the nadir or lowest frequency reached before the frequency settles to a stable point. The frequency then gradually recovers back to 50 Hz. A similar response can be drawn for a load contingency with the frequency increasing beyond 50 Hz, reaching a maximum point before the settling frequency is reached.

**Figure 1-1 Frequency response of a power system to a contingency**



Source: Source: GHD Advisory, Essential System Service Framework review, report prepared for the Energy Transformation Implementation Unit (WA), July 2019

## Voltage management

Keeping voltages regulated between defined technical limits is required to allow voltage quality to be maintained for connected loads, which may suffer from mal-operation or failure due to lack of adequate voltage regulation. Historical studies of power quality requirements on systems have found a limited tolerance for operation below or above design voltages for loads. Low voltage may cause overheating, reduced torque and a shortened lifespan for a motor connected to the power system. Inverter connected equipment such as computers may also suffer from low or high voltages beyond design, with potential for damage and data loss.

Voltage regulation in steady state operation and under a contingency requires sufficient reactive power reserve to respond to the changing needs of the power system. Reactive power, which can be provided by equipment such as capacitor banks, static VAR compensators (SVCs), static synchronous compensators (STATCOMs), or by generators is required to compensate for the inherent inductive and capacitive elements of a power system, which otherwise could raise or lower voltage beyond defined limits.

Unlike frequency management, which is universal and power system-wide, in many areas of the power system, voltage management via essential system services will not be required because generators are inherently capable of producing adequate reactive power to keep voltages within acceptable levels and will provide this system support when dispatched.

However, in some areas of the network, ancillary equipment, such as reactors, capacitor banks, SVCs, STATCOMs and synchronous condensers may be required to control voltages, or voltage control could be provided through dispatch of a generator (where the generator is not already providing power).

## System restart

Restart services are required to restart the system from a total power outage on the network. While not relevant to day-to-day system operation, a restart essential system service is required to ensure the system can recover in a timely manner following a blackout event.

## System strength

System strength can be defined as the ability of the power system to maintain and control voltages and the voltage waveform at any given location on the power system, both during steady state operation and after a disturbance. Low system strength is distinct as an issue from voltage management, due to its cause, which is primarily due to an inability to maintain a robust voltage waveform and contribute sufficient fault current for reliable protection operation.

System strength is an emerging issue on many power systems, particularly where inverter connected generation utilising grid following inverters, forms an increasing proportion of the generation mix. The three-phase fault level at a point in the power system is often used as a high-level indicator of system strength. Declining fault current contribution from inverter connected generation technologies, compared with conventional synchronous generators, leads to declining system strength and issues with protection operation, and extreme voltage variations including a higher rate of change of voltage. In addition, grid following inverters can be susceptible to unstable operation when connected to areas of the power system with low system strength.

Grid following inverters rely on tracking the voltage angle to control their output. In areas of poor system strength, the voltage waveform is less robust and significant changes in voltage magnitude and phase can occur, which can result in disconnection of inverter connected generation or activation of fault ride through response. In areas of low system strength, the action of generation connected via grid following inverters can significantly influence the voltage waveform. The interaction of these generators can lead to poorly damped or unstable power system oscillations.