CORE ENERGY GROUP

Gas Storage Facilities

Eastern and South Eastern Australia

February 2015

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Definitions and Acronyms

Unless otherwise stated, the definitions detailed in Table 1.1 and acronyms listed in Table 1.2 apply throughout this report.

Table 1.1 Report Definitions

Term	Definition
d	day
GJ	Gigajoule: a unit of energy measurement equal to 10^9 joules
km	Kilometres: a unit of distance measurement equal to 10^3 meters
PJ	Petajoule: a unit of energy measurement equal to 10^{15} joules
TJ	Terajoule: a unit of energy measurement equal to 10^{12} joules
TJ/d	Terajoules per day: a measure of gas consumed or transported in one day
TJ p.a.	Terajoules per annum: a measure of gas consumed or transported in one year
$ or AUD	Australian dollars

Table 1.2 Acronyms

Acronym	Definition
2P	Proved and probable reserves
ACQ	Annual Contract Quantity
ACT	Australian Capital Territory
AEMO	Australian Energy Market Operator
AGL	AGL Limited
APLNG	Australia Pacific LNG
AUD	Australian dollar
CBJV	Cooper Basin Joint Venture
Core	Core Energy Group
CSG	Coal seam gas
GJ	Gigajoule
GPG	Gas Powered Generation
GSOO	Gas Statement of Opportunities
LNG	Liquefied natural gas
Mcf	Million cubic feet
NSW	New South Wales
PJ	Petajoule
Qld	Queensland
SA	South Australia
Tas	Tasmania
UGS	Underground Gas Storage
Vic	Victoria

1. INTRODUCTION

1.1 Introduction

Core has been engaged by AEMO to provide an overview of gas storage capacity in eastern and south eastern Australia ("**EA**"). The terms of Reference for this element of the broader Core engagement are included as Attachment 1.

1.2 Background

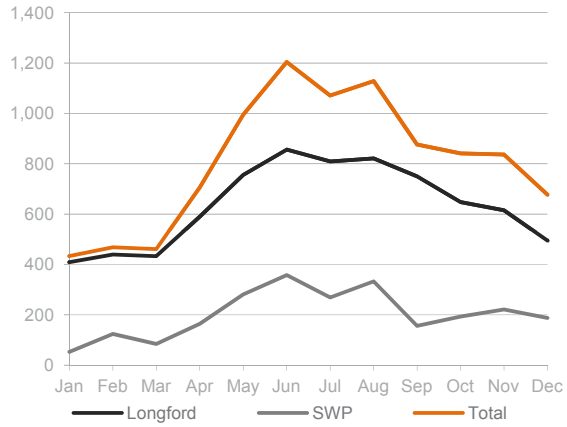
As illustrated by Figure 1.4, the EA region experiences a significant degree of variability between average daily demand and peak daily demand. This is largely attributable to seasonal climatic factors which influence the intensive use of heating and cooling appliances. This variability is a critical feature of the EA gas market.

Over recent history, a few large supply sources have accounted for the majority of peak supply. In particular, the Cooper Basin JV ("**CBJV**") and Gippsland Basin JV ("**GBJV**") have provided substantial flexible supply, under long standing contracts into Vic NSW, SA and ACT.

The relationship between peak supply and peak demand is highlighted in Figures 1.1. to 1.4.

A significant portion of CBJV and GBJV contracted supply reaches the end of its term in 2016 and 2017, respectively Therefore, it is considered timely to consider the adequacy of peak supply capacity to meet future peak demand.

Figure 1.1 Vic Monthly Peak Gas Flow |TJ/d



Source: Core Energy & GBB

Figure 1.2 NSW & ACT Monthly Peak Gas Flow |TJ/d

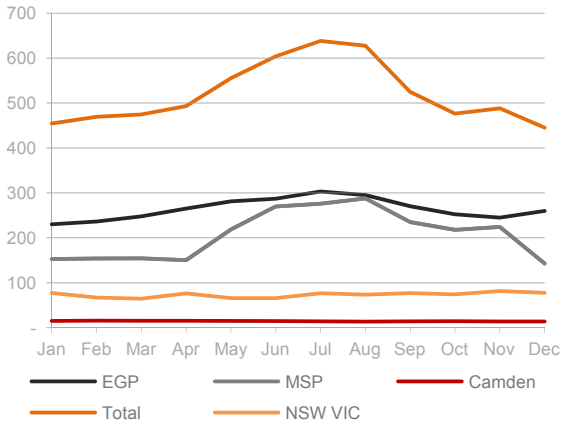
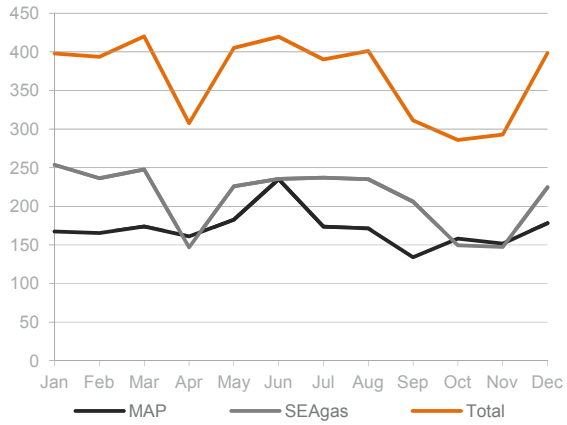
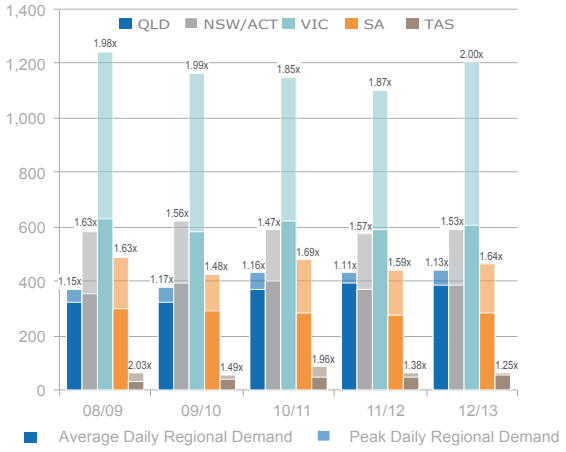


Figure 1.3 SA Monthly Peak Gas Flow |TJ/d



Source: Core Energy & GBB

Figure 1.4 Average and Peak Daily Demand |TJ/d



2. PEAK DEMAND AND SUPPLY

2.1 Historical Peak Demand and Supply

2.1.1 Demand

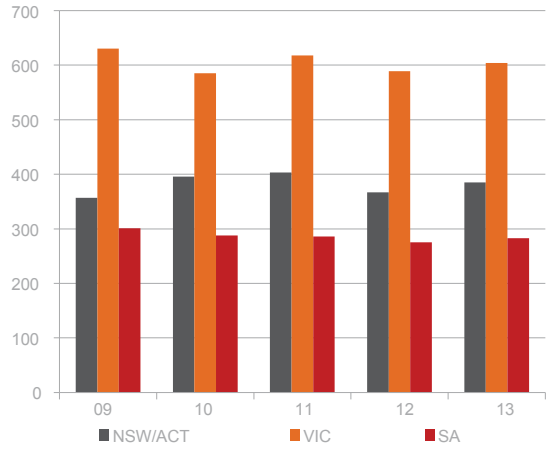
Historical average daily demand for Vic has been ~600TJ, NSW and ACT 350–400TJ and SA 275–300TJ.

Peak demand over the same five year term has been~1,200TJ in Vic, NSW/ACT ~600TJ and SA 400–500TJ.

The relationship between average and peak demand or load factor (peak as a multiple of daily average) is VIC — 2.0, NSW/ACT — 1.5–1.6, and SA — 1.6 times average daily demand.

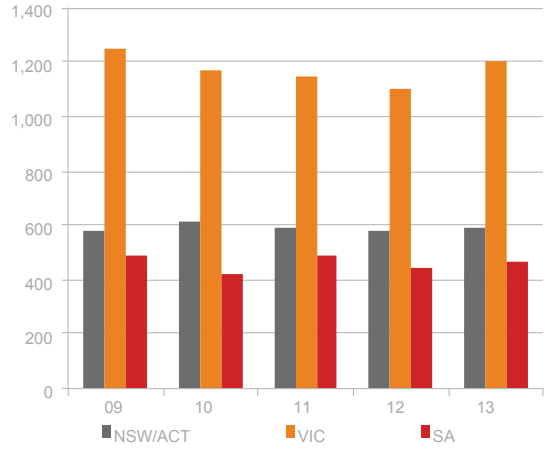
The variance between average and peak demand has been approximately 600TJ in Vic, 200TJ in NSW and up to 150TJ in SA.

Figure 2.1 Average Daily Demand by Region |TJ/d



Source: Core Energy and AER

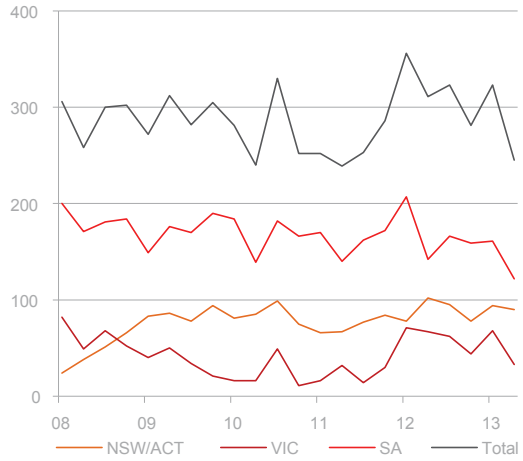
Figure 2.2 Peak Daily Demand by Region |TJ/d



Source: Core Energy and AER

A key factor influencing the volatility is weather conditions and the related use of gas heating and GPG for cooling. The volatility in GPG demand is highlighted in Figure 2.4.

Figure 2.3 Average GPG Demand |TJ/d



Source: Core Energy Group and AER

Figure 2.4 Peak GPG Demand |TJ/d

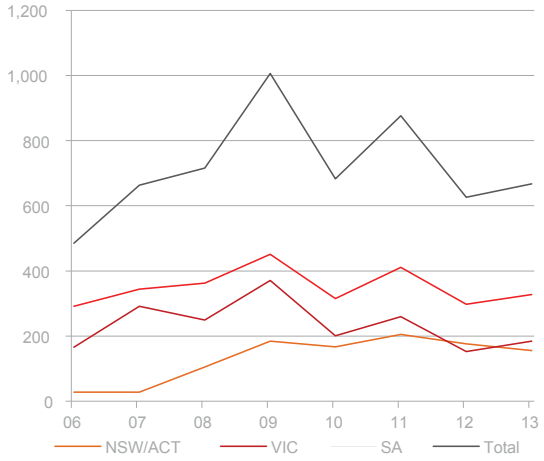


Figure 2.5 Source: Core Energy and NEM Review

2.1.2 Supply

Figure 2.5 summarises the average daily contribution by production area , for three main seasonal markets, over the last five year period. Of particular interest is the major role of Longford, Moomba, Otway and Iona/WUGS in meeting peak seasonal demand.

Victoria

Vic demand peaks in winter, primarily due to gas heating use. Peak gas supply has been sourced largely from Longford (GBJV gas contract) and the MSP (CBJV contract) (Refer Figure 2.6).

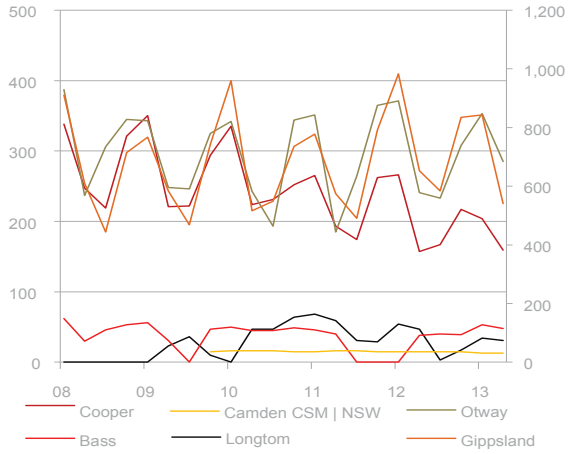
New South Wales & ACT

NSW and ACT demand also peaks in winter, with peak gas supply sourced largely from EGP (GBJV gas contract) and the MSP (CBJV contract, including Moomba storage) (Refer Figure 2.7).

South Australia

SA peaks in both winter and summer due to winter gas heating and summer air-conditioning load supplied by GPG. Supply is met largely from the MAP (CBJV) and SEAGas (Otway) (Refer Figure 2.8).

Figure 2.6 Avg. Daily Supply by Production Area |TJ/d



Note: Gippsland propduction is represented on the secondary ascis on the RHS.

Figure 2.7 Vic Peak Demand |TJ/d; 2013

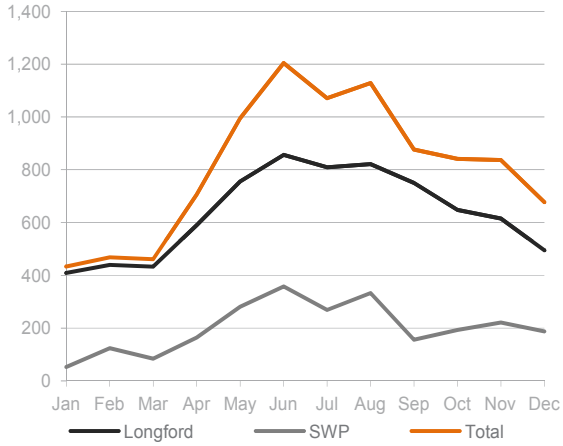


Figure 2.8 NSW/ACT Peak Demand |TJ/d; 2013

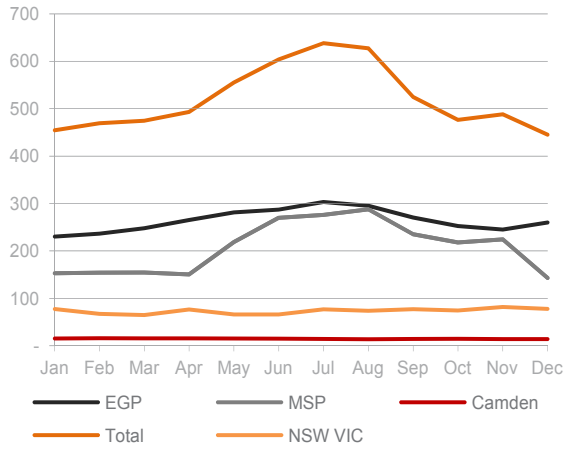
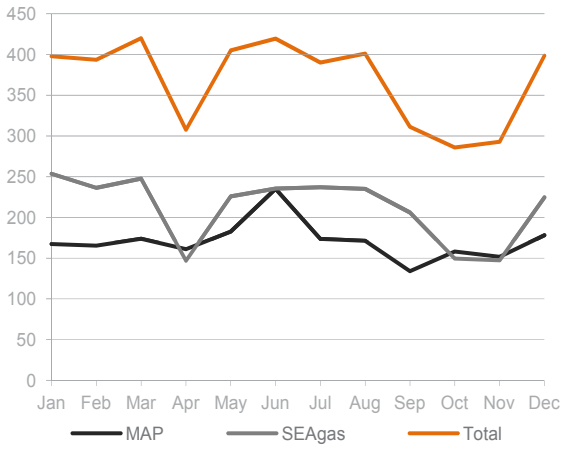


Figure 2.9 SA Peak Demand |TJ/d; 2013



Source: Core Energy and AER

3. STORAGE CAPACITY

3.1 Overview of Existing and Committed Storage Facilities

3.1.1 Introduction

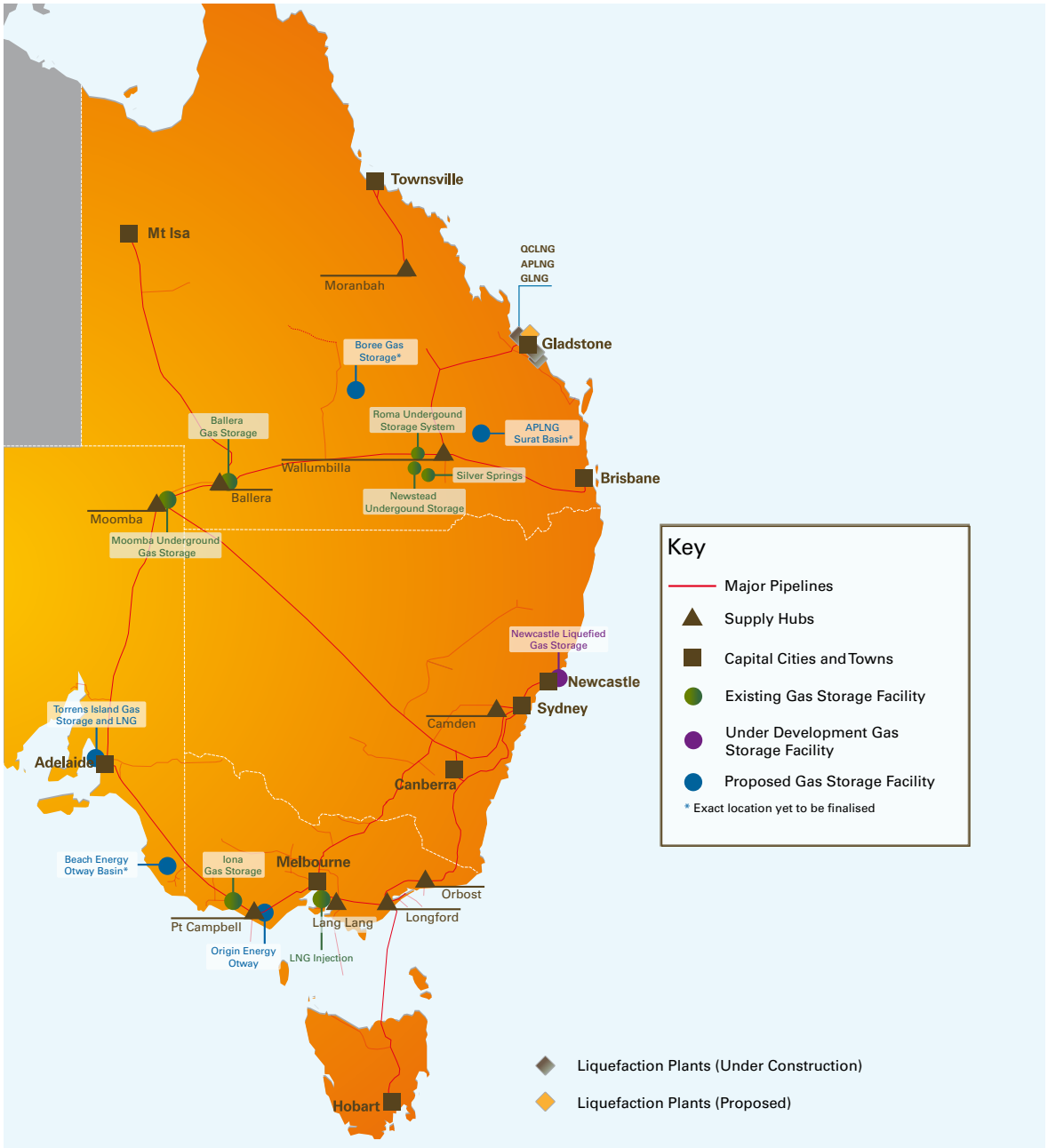
Existing and committed storage facilities are summarised in Figure 3.1 and Table 3.1.

Historically, three facilities have provided the majority of EA storage capacity:

- Moomba storage (CBJV)
- Iona/WUGS (Energy Australia)
- Dandenong LNG (APA).

However, in absolute terms, these facilities have provided relatively modest peaking services, due to the large degree of flexibility available via field production, under existing contracts.

Figure 3.1 EA Storage Facilities



Source: Core Energy Group

3.1.2 Existing Storage Facilities

Table 3.1 Existing and Under Development Storage Facilities

Storage Facility	Operator	Location	Injection Capacity |TJ/d	Withdrawal Capacity |TJ/d	Storage Capacity | PJ
Existing Storage Facilities					
Ballera Gas Storage Facility (Chookoo)	Santos	SW Qld	NPA	NPA	10.0
Dandenong LNG Storage Facility	APA	Vic	8	238	0.7
Iona Storage Facility	EnergyAustralia	Vic	129	500	22.0
Moomba Gas Storage Facility	Santos	SA	NPA	32	85
Newstead Gas Storage Facility	Origin Energy	NSW	na	8	2
Roma Underground Storage Facility	GLNG	Qld	75	75	>50
Silver Springs Gas Storage Facility	AGL	Central Qld	30	30	35
Committed Storage Facilities					
Newcastle LNG Storage Facility	AGL	Tomago, NSW	10	120	1.5

* NPA – Not publicly available

Given the recontracting that will take place in 2016 to 2018, it is considered timely to examine the adequacy of these facilities to meet future peak demand — refer paragraph 3.2 below.

3.2 Adequacy of Storage Capacity

3.2.1 Introduction

The adequacy of storage capacity cannot be determined in isolation from other sources of supply. Ultimately peak demand will be met by a combination of supply sources including:

- MDQ capacity under future contracts
- Linepack capacity available via existing transmission pipelines
- Underground gas storage facilities (included within definition of storage)
- LNG peak shaving facilities (included within definition of storage).

The adequacy of peak supply in EA (including storage) to meet peak demand, is examined below.

3.2.2 Projected Peak Demand

Core has developed forecasts of peak demand on an annual basis over the forward ten year period. Core modelling indicates that there is likely to be modest , if any growth in peak demand over the forecast period (with the exception of Qld).

Therefore an assessment of the adequacy of peak supply capacity is based on the following assumed seasonal variation in demand:

- Vic - range from average of 600TJ to peak of 1,200 TJ
- NSW - range from average of 400TJ to peak of 600TJ
- SA - range from average of 300TJ to peak of 450TJ.

3.2.2.1 Vic

Core analysis indicates that Vic peak supply capacity is adequate to meet projected peak demand to 2024. Major supply sources include:

Table 3.2 Vic Peak Supply Sources

Peak Supply Source	TJ/d
Longford (assumed Vic capacity allocation)	500
SWP	350
Dandenong LNG Storage	238
Iona Storage	500
NVI	50

3.2.2.2 NSW

Core analysis indicates that NSW peak supply capacity is adequate to meet projected peak demand to 2024. Major supply sources incude:

Table 3.3 NSW Peak Supply Sources

Peak Supply Source	TJ/d
Longford (assumed VNSW capacity allocation)	300
MSP (contracts and linepack)	100
Newcastle LNG Storage	110
NVI	100
Other linepack	50

3.2.2.3 SA

Core analysis indicates that SA peak supply capacity is adequate to meet projected peak demand to 2024. Major supply sources include:

Table 3.4 SA Peak Supply Sources

Peak Supply Source	TJ/d
MAP	75
SEAGas	225
Moomba	50
Ioana	100
Other linepack	50

3.3 New storage options

3.3.1 Introduction

Over recent years a range of new storage facilities have been proposed to provide additional peak demand capacity. These facilities are outlined below.

3.3.2 Previously Proposed Storage Facilities

Several gas storage projects have been proposed in the past, mainly prior to the development of the Gladstone LNG projects.

Table 3.5 Proposed Storage Facilities

Storage Facility	Operator	Location	Additional comments
Boree Gas Storage	Innovative Energy Consulting	Adavale Basin, Qld	Storage capacity - 7.5 Bcf salt cavern, 5 salt caverns in total. Intends to supply CSG to the LNG hub in Gladstone, and emerging Wallumbilla/Roma gas hub, some 900km and 450km away respectively.
Origin Otway Gas Storage Facility	Origin Energy	Vic	Reservoir storage, utilising depleted onshore gas fields
Torrens Island Gas Storage and LNG	AGL	Torrens Island, SA	The proposed Torrens Island Gas Storage Facility was to be built on Torrens Island in SA. AGL Energy has proposed the project - comprising an LNG production plant, storage tank and re-gasification units that convert LNG to pipeline quality gas. AGL has obtained approval under Section 49 of the Development Act 1993: Crown Development and Public Infrastructure.

3.4 Cost analysis

3.4.1 Cost of Firm Storage Capacity

Core has undertaken analysis of the cost of services provided by existing storage facilities and the estimated cost of the committed Newcastle facility (utilising a 7% real WACC) to derive an estimate of the cost of EA storage services.

Based on this analysis, Core has derived a service cost in the range of AUD0.50–0.65 GJ/day or AUD180–240/GJ/annum.

A lower charge would apply to interruptible service.

3.4.2 Variable Cost

In addition to the above base storage service, there is a variable charge associated with injection and withdrawal. This fee is held confidential by storage operators but Core believes a cost of approximately 10–15% of the base service charge is a reasonable guide.

Attachment 1 | Consultancy Scope

The consultancy purpose is to:

- Provide an update of current status of existing storage facilities, including details on maximum capacity, maximum injection and withdrawal rates and a description of any conditions that might affect withdrawal or injection behaviour.
- Use best endeavours to assist AEMO to source information regarding operating costs, and any requirements for reprocessing facilities. As a minimum Core will provide benchmark costs for similar facilities.
- Investigate and report upon the potential options that exist for new storage facilities.

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