APPENDIX Y

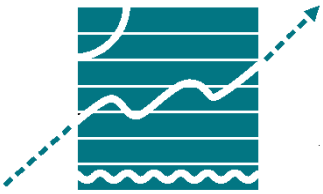
ECONOMIC ASSESSMENT

Snowy 2.0
Main Works
Economic Impact Assessment

Prepared for

EMM

By



Gillespie Economics
Email: gillecon@bigpond.net.au
Web: gillespieeconomics.com

September 2019

TABLE OF CONTENTS

EXECUTIVE SUMMARY

Snowy Hydro Limited (Snowy Hydro) proposes to develop Snowy 2.0, a large scale pumped hydro-electric storage and generation project which would increase hydro-electric capacity within the existing Snowy Mountains Hydro-electric Scheme (Snowy Scheme). This would be achieved by establishing a new underground hydro-electric power station that would increase the generation capacity of the Snowy Scheme by almost 50%, providing an additional 2,000 megawatts (MW) generating capacity, and providing approximately 350,000 megawatt hours (MWh) of storage available to the National Electricity Market (NEM) at any one time, which is critical to ensuring system security as Australia transitions to a decarbonised NEM. Snowy 2.0 will link the existing Tantangara and Talbingo reservoirs within the Snowy Scheme through a series of underground tunnels and hydro-electric power station. The maximum monthly direct employment provided by the project is 2,475.

Economic Impact Assessment Methods

This Economic Impact Assessment supports the Environmental Impact Statement for the Main Works. It documents two types of economic assessment:

- a computable general equilibrium (CGE) analysis of the impacts of the project on the NEM and hence State and National economies. This necessarily takes a holistic perspective and assumes connection to the NEM; and
- an assessment of the economic effects of Main Works construction in the locality, using input-output (IO) analysis.

Impacts on NSW and the National Electricity Market

CGE modelling identified three key drivers of the economic impact of Snowy 2.0:

- The investment phase which represents an additional expenditure on capital to establish Snowy 2.0, with consequential impacts on the levels of investment required in the remainder of the NEM as measured from reference case levels;
- A reduction in fossil fuel use across the NEM as a result of increased hydroelectric capacity, reducing the requirement for fossil fuel generation; and
- A flow on impact to electricity prices across the NEM.

Gross State Product

The impact of Snowy 2.0 on Gross State Product (GSP) across the NEM states and territories is estimated at $4,176M in net present value terms. The combined NSW/ACT modelling region experiences the greatest uplift in economic activity, most significantly during the initial construction period but also during ongoing operations, with a net present value impact on GSP of $2,692M.

Gross State Income

The impact of Snowy 2.0 on Gross State Income (GSI) across the NEM states and territories is estimated at $2,982M in net present value terms. Gross State Income increases by $1,608 million in net present value terms in the NSW/ACT modelling region

Employment

The average aggregate impact across the NEM regions over the evaluation period is an increase in employment of 324 annual full-time equivalent positions. The most significant impact on employment

is in the NSW/ACT region during the construction period, peaking at an economy wide impact of 451 full time equivalent employees in 2021/22, during which time other NEM regions experience only small increases or decreases in employment.

Impacts on Snowy Monaro Regional and Snowy Valley LGAs

The Snowy Monaro Regional LGA and the Snowy Valleys LGA will also experience an increase in economic activity mainly from direct employment and capture in the region of additional wage expenditure.

The economic impact of the average annual additional wage expenditure ($8M) in the regional economy would be:

- $11.60M in annual direct and indirect regional output;
- $6.76M in annual direct and indirect value-added;
- $2.58M in annual direct and indirect income; and
- 52 direct and indirect jobs.

In terms of employment, there would be an additional average annual 39 jobs sourced from the local labour market over the project construction, giving an average annual regional employment of 91 local workers. Local jobs would peak at 166 in year 2021.

Positive local employment and business opportunities can be maximised via:

- opportunities being given to the employment of local workers where they have the necessary skills and experience;
- providing and/or collaborating with local education facilities to provide, ongoing training and certification opportunities for local workers to ensure they have the necessary skills to work on the project;
- collaborating with Councils, economic development organisations, local chambers of commerce and State Government to:
  - inform local business of the goods and services required of the project, service provision opportunities and compliance requirements of business to secure contracts.
  - encourage local business to meet the requirements of the project for supply contracts.
  - develop relevant networks to assist qualified local and regional businesses tender for provision of goods and services to support the project.

1 Introduction

1.1 The project

Snowy Hydro Limited (Snowy Hydro) proposes to develop Snowy 2.0, a large-scale pumped hydro-electric storage and generation project which would increase hydro-electric capacity within the existing Snowy Mountains Hydro-electric Scheme (Snowy Scheme). Snowy 2.0 is the largest committed renewable energy project in Australia and is critical to underpinning system security and reliability as Australia transitions to a decarbonised economy. Snowy 2.0 will link the existing Tantangara and Talbingo reservoirs within the Snowy Scheme through a series of underground tunnels and a new hydro-electric power station will be built underground.

Snowy 2.0 has been declared to be State significant infrastructure (SSI) and critical State significant infrastructure (CSSI) by the former NSW Minister for Planning under Part 5 of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act) and is defined as CSSI in clause 9 of Schedule 5 of the *State Environmental Planning Policy (State and Regional Development) 2011* (SRD SEPP). CSSI is infrastructure that is deemed by the NSW Minister to be essential for the State for economic, environmental or social reasons. An application for CSSI must be accompanied by an environmental impact statement (EIS).

Separate applications are being submitted by Snowy Hydro for different stages of Snowy 2.0 under Part 5, Division 5.2 of the EP&A Act. This includes the preceding first stage of Snowy 2.0, Exploratory Works for Snowy 2.0 (the Exploratory Works) and the stage subject of this current application, Snowy 2.0 Main Works (the Main Works). In addition, an application under Part 5, Division 5.2 of the EP&A Act is also being submitted by Snowy Hydro for a segment factory that will make tunnel segments for both the Exploratory Works and Main Works stages of Snowy 2.0.

The first stage of Snowy 2.0, the Exploratory Works, includes an exploratory tunnel and portal and other exploratory and construction activities primarily in the Lobs Hole area of the Kosciuszko National Park (KNP). The Exploratory Works were approved by the former NSW Minister for Planning on 7 February 2019 as a separate project application to DPIE (SSI 9208).

This Economic Impact Assessment has been prepared to accompany an application and supporting EIS for the **Snowy 2.0 Main Works**. As the title suggests, this stage of the project covers the major construction elements of Snowy 2.0, including permanent infrastructure (such as the underground power station, power waterways, access tunnels, chambers and shafts), temporary construction infrastructure (such as construction adits, construction compounds and accommodation), management and storage of excavated rock material and establishing supporting infrastructure (such as road upgrades and extensions, water and sewage treatment infrastructure, and the provision of construction power). Snowy 2.0 Main Works also includes the operation of Snowy 2.0.

Snowy 2.0 Main Works is shown in Figure 1.1. If approved, the Snowy 2.0 Main Works would commence before completion of Exploratory Works.

The Snowy 2.0 Main Works do not include the transmission works proposed by TransGrid (TransGrid 2018) that provide connection between the cableyard and the NEM. These transmission works will provide the ability for Snowy 2.0 (and other generators) to efficiently and reliably transmit additional renewable energy to major load centres during periods of peak demand, as well as enable a supply of renewable energy to pump water from Talbingo Reservoir to Tantangara Reservoir during periods of low demand. While the upgrade works to the wider transmission network and connection between the cableyard and the network form part of the CSSI declaration for Snowy 2.0 and Transmission Project, they do not form part of this application and will be subject to separate application and approval processes, managed by TransGrid. This project is known as the HumeLink and is part of AEMO's Integrated System Plan.

With respect to the provisions of the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), on 30 October 2018 Snowy Hydro referred the Snowy 2.0 Main Works to the Commonwealth Department of the Environment and Energy (DoEE) and, on a precautionary basis, nominated that Snowy 2.0 Main Works has potential to have a significant impact on MNES and the environment generally.

On 5 December 2018, Snowy 2.0 Main Works were deemed a controlled action by the Assistant Secretary of the DoEE. It was also determined that potential impacts of the project will be assessed by accredited assessment under Part 5, Division 5.2 of the EP&A Act. This accredited process will enable the NSW Department of Planning, Industry and Environment (DPIE) to manage the assessment of Snowy 2.0 Main Works, including the issuing of the assessment requirements for the EIS. Once the assessment has been completed, the Commonwealth Minister for the Environment will make a determination under the EPBC Act.

1.2 Project location

Snowy 2.0 Main Works are within the Australian Alps, in southern NSW, about mid-way between Canberra and Albury. Snowy 2.0 Main Works is within both the Snowy Valleys and Snowy Monaro Regional local government areas (LGAs).

The nearest large towns to Snowy 2.0 Main Works are Cooma and Tumut. Cooma is located about 50 kilometres (km) south east of the project area (or 70 km by road from Providence Portal at the southern edge of the project area), and Tumut is located about 35 km north west of the project areas (or 45 km by road from Tumut 3 power station at the northern edge of the project area). Other townships near the project area include Talbingo, Cabramurra, Adaminaby and Tumbarumba. Talbingo and Cabramurra were built for the original Snowy Scheme workers and their families, while Adaminaby was relocated in 1957 to make way for the establishment of Lake Eucumbene.

The location of Snowy 2.0 Main Works with respect to the region is shown in Figure 1.1.

The pumped hydro-electric scheme elements of Snowy 2.0 Main Works are mostly underground between the southern ends of Tantangara and Talbingo reservoirs, a straight-line distance of 27 km. Surface works will also occur at locations on and between the two reservoirs. Key locations for surface works include:

- **Tantangara Reservoir** - at a full supply level (FSL) of about 1,229 metres (m) to Australian Height Datum (AHD), Tantangara Reservoir will be the upper reservoir for Snowy 2.0 and include the headrace tunnel and intake structure. The site will also be used for a temporary construction compound, accommodation camp and other temporary ancillary activities;

- **Marica** - this site will be used primarily for construction including construction of vertical shafts to the underground power station (ventilation shaft) and headrace tunnel (surge shaft), and a temporary accommodation camp;

- **Lobs Hole** - the site will be used primarily for construction but will also become the main entrance to the power station during operation. Lobs Hole will provide access to the Exploratory Works tunnel, which will be refitted to become the main access tunnel (MAT), as well as the location of the emergency egress, cable and ventilation tunnel (ECVT), portal, associated services and accommodation camp; and

- **Talbingo Reservoir** - at a FSL of about 546 m AHD, Talbingo Reservoir will be the lower reservoir for Snowy 2.0 and will include the tailrace tunnel and water intake structure. The site will also be used for temporary construction compounds and other temporary ancillary activities.

Works will also be required within the two reservoirs for the placement of excavated rock and surplus cut material. Supporting infrastructure will include establishing or upgrading access tracks and roads and electricity connections to construction sites.

Most of the proposed pumped hydro-electric and temporary construction elements and most of the supporting infrastructure for Snowy 2.0 Main Works are located within the boundaries of KNP, although the disturbance footprint for the project during construction is less than 0.25% of the total KNP area. Some of the supporting infrastructure and construction sites and activities (including sections of road upgrade, power and communications infrastructure) extends beyond the national park boundaries. These sections of infrastructure are primarily located to the east and south of Tantangara Reservoir. One temporary construction site is located beyond the national park along the Snowy Mountains Highway about 3 km east of Providence Portal (referred to as Rock Forest).

The project is described in more detail in Chapter 2.

1.2.1 Project area

The project area for Snowy 2.0 Main Works has been identified and includes all the elements of the project, including all construction and operational elements. The project area is shown on Figure 1.2. Key features of the project area are:

- the water bodies of Tantangara and Talbingo reservoirs, covering areas of 19.4 square kilometres (km^2) and 21.2 km^2 respectively. The reservoirs provide the water to be utilised in Snowy 2.0;
- major watercourses including the Yarrangobilly, Eucumbene and Murrumbidgee rivers and some of their tributaries;
- KNP, within which the majority of the project area is located. Within the project area, KNP is characterised by two key zones: upper slopes and inverted treelines in the west of the project area (referred to as the 'ravine') and associated subalpine treeless flats and valleys in the east of the project area (referred to as the 'plateau'); and
- farm land southeast of KNP at Rock Forest.

The project area is interspersed with built infrastructure including recreational sites and facilities, main roads as well as unsealed access tracks, hiking trails, farm land, electricity infrastructure, and infrastructure associated with the Snowy Scheme.

1.3 Proponent

Snowy Hydro is the proponent for the Snowy 2.0 Main Works. Snowy Hydro is an integrated energy business – generating energy, providing price risk management products for wholesale customers and delivering energy to homes and businesses. Snowy Hydro is the fourth largest energy retailer in the NEM and is Australia's leading provider of peak, renewable energy.

1.4 Purpose of this report

This Economic Impact Assessment supports the EIS for the Snowy 2.0 Main Works. It documents the economic impact assessment methods and results, and the mitigation and management measures proposed to maximise economic benefits for the region.

Two types of analysis have been undertaken:

- a computable general equilibrium (CGE) analysis of the impacts of the project on the National Electricity Market and hence State and National economies. This necessarily takes a holistic perspective and assumes connection to the NEM; and

- an assessment of the economic effects of Main Works construction in the locality, using input-output (IO) analysis.

1.4.1 Assessment guidelines and requirements

This Economic Impact Assessment has been prepared in accordance with the Secretary's Environmental Assessment Requirements (SEARs) for Snowy 2.0 Main Works, issued on 31 July 2019, as well as relevant government assessment requirements, guidelines and policies, and in consultation with the relevant government agencies.

The SEARs must be addressed in the EIS. Table 1.1 lists the matters relevant to this assessment and where they are addressed in this report.

Table 1.1 Relevant matters raised in SEARs

SEARs Requirement		Section addressed
Economic	An assessment of the economic impacts of the project on the locality and NSW	Impacts on the locality are addressed in Section 4. Impacts on NSW and other National Energy Market States and Territories are provided in Section 3.

To inform preparation of the SEARs, the DPIE invited relevant government agencies to advise on matters to be addressed in the EIS. These matters were taken into account by the Secretary for DPIE when preparing the SEARs.

1.5 Related projects

There are three other projects related to Snowy 2.0 Main Works, they are:

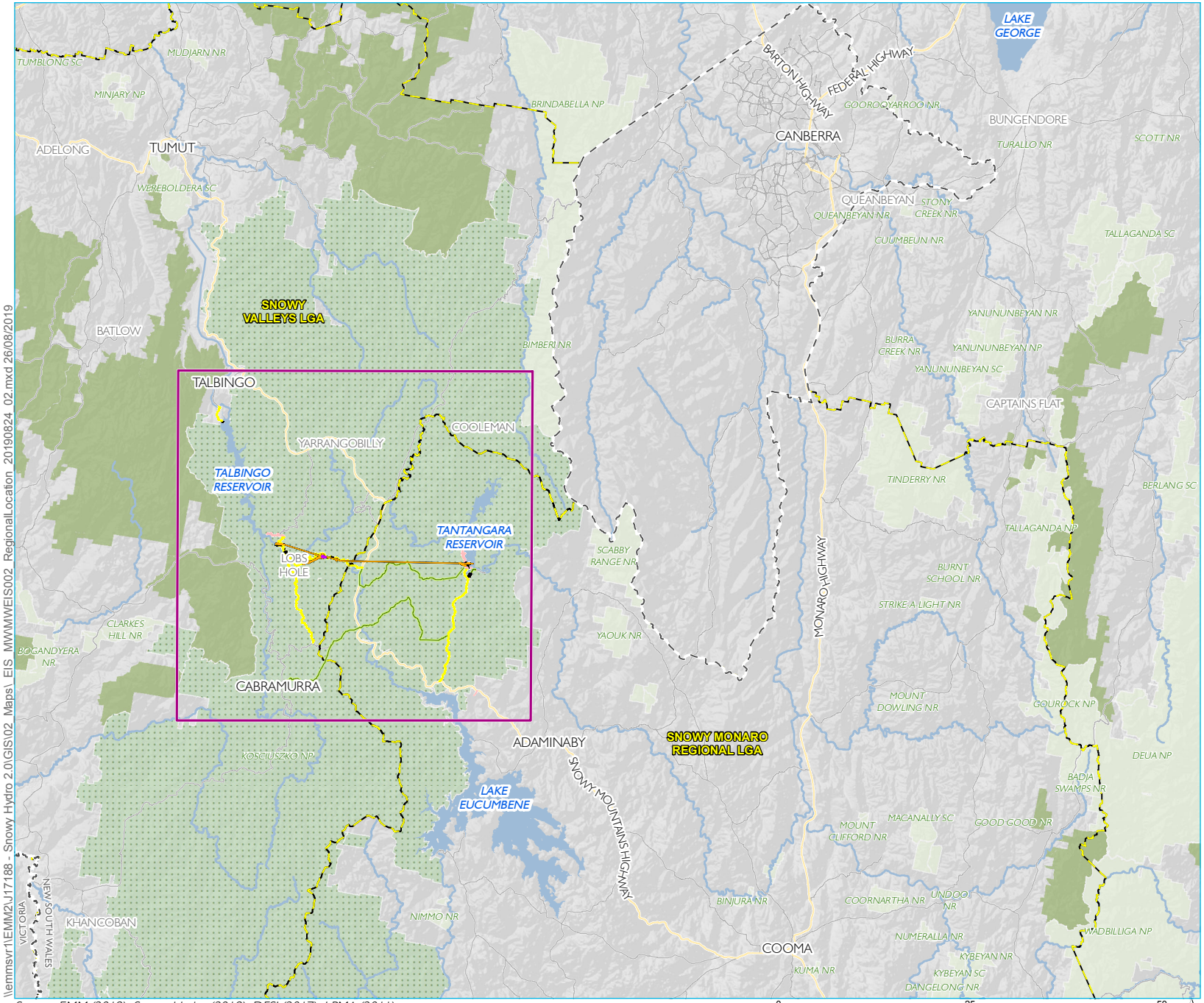
- Snowy 2.0 Exploratory Works (SSI-9208) – a Snowy Hydro project with Minister's approval;
- Snowy 2.0 Transmission Connect Project (SSI-9717) – a project proposed by TransGrid; and
- Snowy 2.0 – Segment Factory (SSI-10034) – a project proposed by Snowy Hydro.

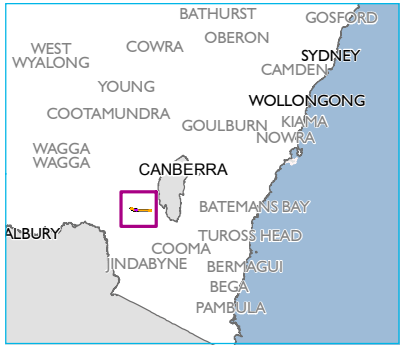
While these projects form part of the CSSI declaration for Snowy 2.0 and Transmission Project, they do not form part of Snowy Hydro's application for Snowy 2.0 Main Works. These related projects are subject to separate application and approval processes. Staged submission and separate approval is appropriate for a project of this magnitude, due to its complexity and funding and procurement processes. However, cumulative impacts have been considered in this report where relevant.

1.6 Other relevant reports

This Economic Impact Assessment has been prepared with reference to other technical reports that were prepared as part of the Snowy 2.0 Main Works EIS. The other relevant reports referenced in this Economic Impact Assessment are listed below.

- Social impact assessment (Elton Consulting Pty Ltd 2019) – Appended to the EIS.





KEY

- Project area

Snowy 2.0 Main Works operational elements

- Tunnels, portals, intakes, shafts
- Power station
- Utilities
- Permanent road

Snowy 2.0 Main Works construction elements

- Temporary construction compounds and surface works
- Temporary access road

Existing environment

- Main road
- Local road
- Watercourse
- Waterbodies
- Kosciuszko National Park
- NPWS reserve
- State forest
- Local government area boundary
- State boundary

Regional setting

Snowy 2.0
Economic assessment
Main Works
Figure 1.1

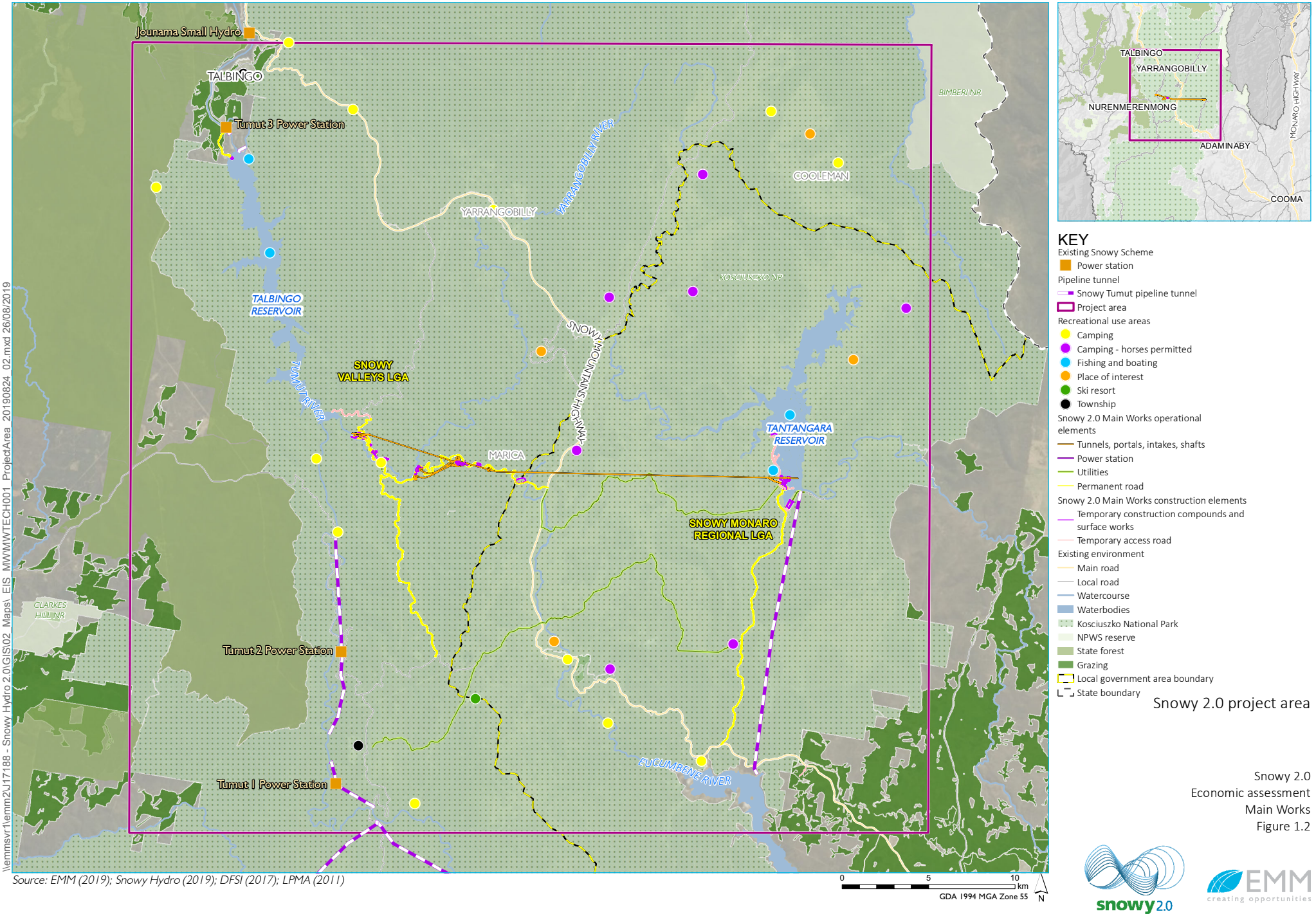
Source: EMM (2019); Snowy Hydro (2019); DFSI (2017); LPMA (2011)

0 25 50 km
GDA 1994 MGA Zone 55
N

\\emmsvr1\EMM2\J17188 - Snowy Hydro 2.0\GIS\02 Maps\ EIS MWMWEIS002 RegionalLocation 20190824 02.mxd 26/08/2019

snowy 2.0

EMM creating opportunities



KEY

Existing Snowy Scheme
- Power station

Pipeline tunnel
- Snowy Tumut pipeline tunnel
- Project area

Recreational use areas
- Camping
- Camping - horses permitted
- Fishing and boating
- Place of interest
- Ski resort
- Township

Snowy 2.0 Main Works operational elements
- Tunnels, portals, intakes, shafts
- Power station
- Utilities
- Permanent road

Snowy 2.0 Main Works construction elements
- Temporary construction compounds and surface works
- Temporary access road

Existing environment
- Main road
- Local road
- Watercourse
- Waterbodies
- Kosciuszko National Park
- NPWS reserve
- State forest
- Grazing
- Local government area boundary
- State boundary

Snowy 2.0 project area

Source: EMM (2019); Snowy Hydro (2019); DFSI (2017); LPMA (2011)

\\emmsvr1\emm2\J17188 - Snowy Hydro 2.0\GIS\02 Maps\ EIS MWMWTECH001 ProjectArea 20190824 02.mxd 26/08/2019

Snowy 2.0
Economic assessment
Main Works
Figure 1.2

snowy 2.0

EMM
creating opportunities

2 Project description

This chapter provides a summary of the Snowy 2.0 Main Works project. It outlines the functional infrastructure required to operate Snowy 2.0, as well as the key construction elements and activities required to build it. A more comprehensive detailed description of the project is provided in Chapter 2 (Project description) of the EIS, which has been relied upon for the basis of this technical assessment.

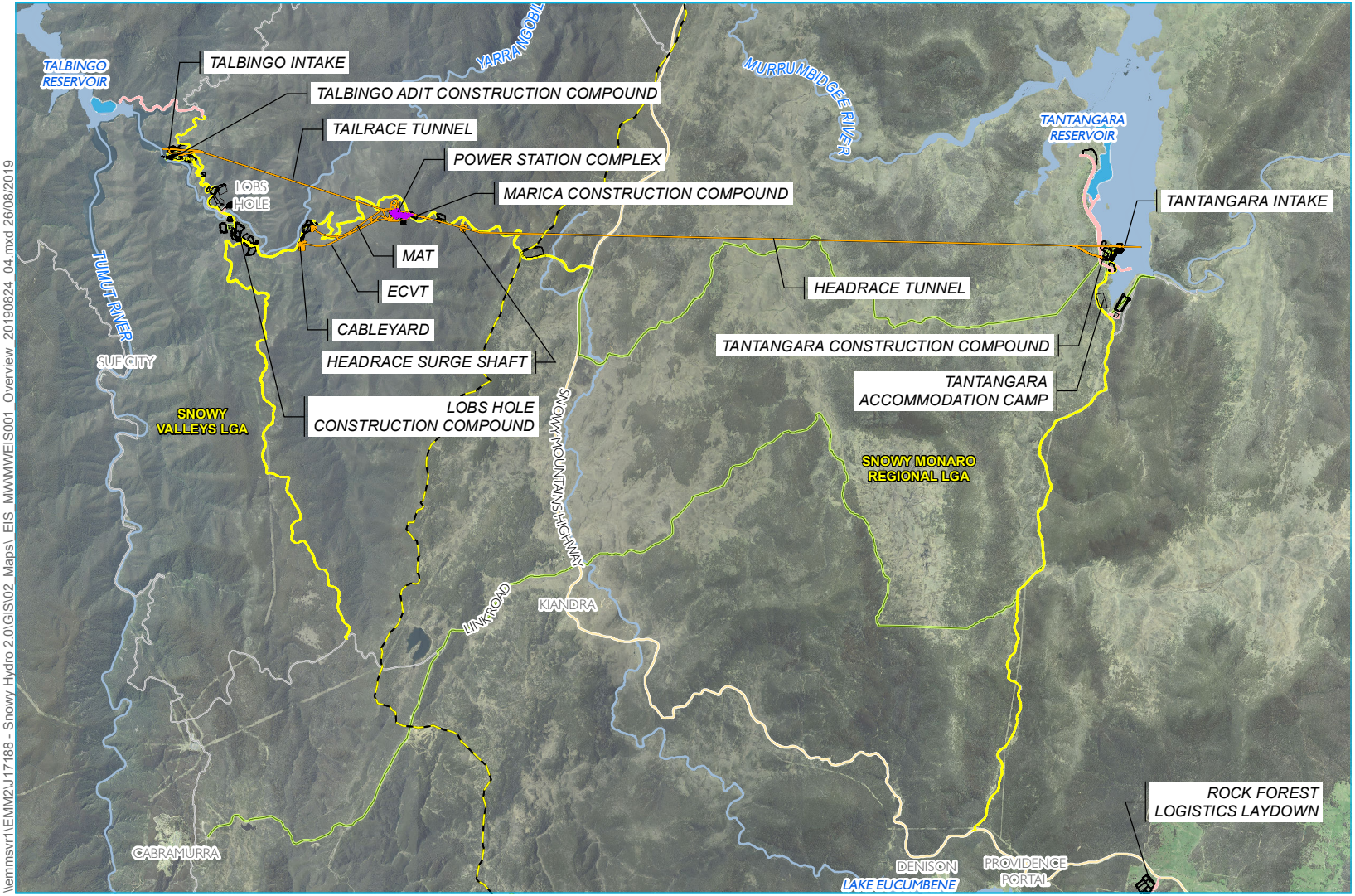
2.1 Overview of Snowy 2.0

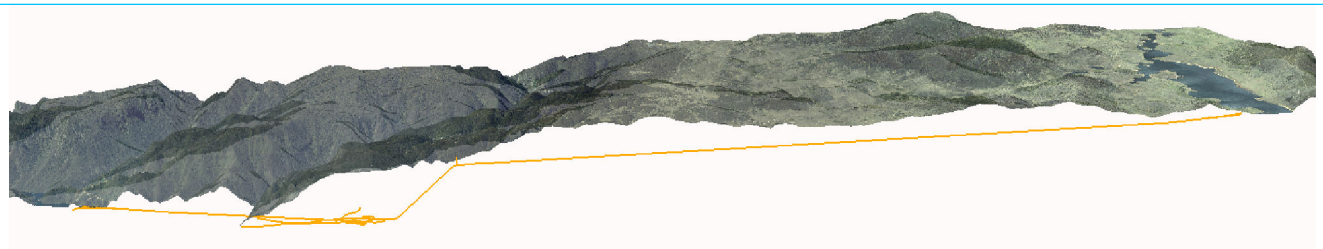
Snowy 2.0 will link the existing Tantangara and Talbingo reservoirs within the Snowy Scheme through a series of underground tunnels and a new hydro-electric power station will be built underground. An overview of Snowy 2.0 is shown on Figure 2.1, and the key project elements of Snowy 2.0 are summarised in Table 2.1.

Table 2.1 Overview of Snowy 2.0 Main Works

Project element	Summary of the project
Project area	The project area is the broader region within which Snowy 2.0 will be built and operated, and the extent within which direct impacts from Snowy 2.0 Main Works are anticipated.
Permanent infrastructure	Snowy 2.0 infrastructure to be built and operated for the life of the assets include the: • intake and gate structures and surface buildings at Tantangara and Talbingo reservoirs; • power waterway tunnels primarily comprising the headrace tunnel, headrace surge structure, inclined pressure tunnel, pressure pipelines, tailrace surge tank and tailrace tunnel; • underground power station complex comprising the machine hall, transformer hall, ventilation shaft and minor connecting tunnels; • access tunnels (and tunnel portals) to the underground power station comprising the main access tunnel (MAT) and emergency egress, communication, and ventilation tunnel (ECVT); • establishment of a portal building and helipad at the MAT portal; • communication, water and power supply including the continued use of the Lobs Hole substation; • cable yard adjacent to the ECVT portal to facilitate the connection of Snowy 2.0 to the NEM; • access roads and permanent bridge structures needed for the operation and maintenance of Snowy 2.0 infrastructure; and • fish control structures on Tantangara Creek and near Tantangara Reservoir wall.
Temporary infrastructure	Temporary infrastructure required during the construction phase of Snowy 2.0 Main Works are: • construction compounds, laydown, ancillary facilities and helipads; • accommodation camps for construction workforce; • construction portals and adits to facilitate tunnelling activities; • barge launch ramps; • water and wastewater management infrastructure (treatment plants and pipelines); • communication and power supply; and • temporary access roads.
Disturbance area	The disturbance area is the extent of construction works required to build Snowy 2.0. The maximum disturbance area is about 1,680 hectares (ha), less than 0.25% of the total area of KNP. Parts of the disturbance area will be rehabilitated and landformed and other parts will be retained permanently for operation (operational footprint).
Operational footprint	The operational footprint is the area required for permanent infrastructure to operate Snowy 2.0. The maximum operational footprint is about 99 ha. This is 0.01% of the total area of KNP.
Tunnelling and excavation method	The primary tunnelling method for the power waterway is by tunnel boring machine (TBM), with portals and adits using drill and blast methods. Excavation for other underground caverns, chambers and shafts will be via combinations of drill and blast, blind sink, and/or raise bore techniques.
Excavated rock	Excavated rock will be generated as a result of tunnelling activities and earthworks. The material

management	produced through these activities will be stockpiled and either reused by the contractor (or NPWS), placed permanently within Tantangara or Talbingo reservoirs, used in final land forming and rehabilitation of construction pads in Lobs Hole, or transported offsite.
Construction water and wastewater management	Water supply for construction will be from the two existing reservoirs (Talbingo and Tantangara) and reticulated via buried pipelines (along access roads). Raw water will be treated as necessary wherever potable water is required (eg at accommodation camps). Water to be discharged (comprising process water, wastewater and stormwater) will be treated before discharge to the two existing reservoirs (Talbingo and Tantangara) as follows: • treated process water will be reused onsite where possible to reduce the amount of discharge to reservoirs, however excess treated water will be discharged to the reservoirs; • collected sewage will be treated at sewage treatment plants to meet the specified discharge limits before discharge and/or disposal; and • stormwater will be captured and reused as much as possible.
Rehabilitation	Rehabilitation of areas disturbed during construction including reshaping to natural appearing landforms or returning to pre-disturbance condition, as agreed with NPWS and determined by the rehabilitation strategy. This includes construction areas at Lobs Hole which comprise surplus cut materials that are required for the construction. Areas to be used by Snowy Hydro in the long-term may be re-shaped and rehabilitated to maintain access and operational capabilities (eg intakes and portal entrances).
Construction workforce	The construction workforce for the project is expected to peak at around 2,000 personnel.
Operational life	The operational life of the project is estimated to be 100 years.
Operational workforce	The operational workforce is expected to be 8-16 staff, with fluctuations of additional workforce required during major maintenance activities.
Hours of operation	Construction of Snowy 2.0 will be 24/7 and 365 days per year. Operation of Snowy 2.0 will be 24/7 and 365 days per year.
Capital investment value	Estimated to be $4.6 billion.





KEY

Existing environment
- Main road
- Local road
- Watercourse
- Waterbodies
- Local government area boundary

Snowy 2.0 Main Works operational elements
- Tunnels, portals, intakes, shafts
- Power station
- Utilities
- Permanent road

Snowy 2.0 Main Works construction elements
- Temporary construction compounds and surface works
- Temporary access road
- Indicative rock emplacement area

Source: EMM (2019); Snowy Hydro (2019); DFSI (2017); LPMA (2011)

0 2.5 5 km

GDA 1994 MGA Zone 55

N

Snowy 2.0 project elements

Snowy 2.0
Economic assessment
Main Works
Figure 2.1

snowy 2.0

EMM creating opportunities

\\emmsvr1\EMM2\J17188 - Snowy Hydro 2.0\GIS\02 Maps\ EIS MWMWEIS001 Overview 20190824 04.mxd 26/08/2019

2.2 Construction of Snowy 2.0

A number of construction activities will be carried out concurrently, and across a number of different sites. Specific details on these activities as well as an indicative schedule of construction activities is provided in Chapter 2 (Project description) of the EIS. This section summarises the key construction elements of the project.

Table 2.2 provides an overview of the construction elements, their purpose and location within the project area.

Table 2.2 Snowy 2.0 construction elements

Construction element	Purpose	Location
Construction sites	Due to the remoteness of Snowy 2.0, construction sites are generally needed to: • Provide ancillary facilities such as concrete batching plants, mixing plants and on-site manufacturing; • Store machinery, equipment and materials to be used in construction; • Provide access to underground construction sites; and • Provide onsite accommodation for the construction workforce.	Each construction site needed for Snowy 2.0 is shown on Figures 2.2 to Figure 2.6.
Substations and power connection	One substation is required to provide permanent power to Snowy 2.0, at Lobs Hole. This substation is proposed as part of a modification to the Exploratory Works with a capacity of 80 mega volt amp (MVA). It will continue to be used for Main Works, however requires the establishment of further power supply cables to provide power to the work sites and TBM at Tantangara, as well as Talbingo, in particular to power the TBMs via the MAT, ECVT, Talbingo and Tantangara portals.	The supporting high voltage cable route mostly follows access roads to each of the work sites, using a combination of aerial and buried arrangements.
Communications system	Communications infrastructure will connect infrastructure at Tantangara and Talbingo reservoirs to the existing communications system at the Tumut 3 power station (via the submarine communications cable in Talbingo Reservoir established during Exploratory Works) and to Snowy Hydro's existing communications infrastructure at Cabramurra.	The cable will be trenched and buried in conduits within access roads. Crossing of watercourses and other environmentally sensitive areas will be carried out in a manner that minimises environmental impacts where possible, such as bridging or underboring.
Water and waste water servicing	Drinking water will be provided via water treatment plants located at accommodation camps. Water for treatment will be sourced from the nearest reservoir. There are three main wastewater streams that require some form of treatment before discharging to the environment, including: • Tunnel seepage and construction wastewater (process water); • Domestic sewer (wastewater); and • Construction site stormwater (stormwater).	Utility pipelines generally follow access roads. Water treatment plants (drinking water) will be needed for the accommodation camps and will be located in proximity. Waste water treatment plants will similarly be located near accommodation camps. Process water treatment plants will be at construction compounds and adits where needed to manage tunnel seepage and water during construction.
Temporary and permanent access	Access road works are required to:	The access road upgrades and establishment requirements are shown

roads	• provide for the transport of excavated material between the tunnel portals and the excavated rock emplacement areas; • accommodate the transport of oversized loads as required; and • facilitate the safe movement of plant, equipment, materials and construction workers into and out of construction sites. The access road upgrades and establishment requirements are shown on Figure 2.2 to Figure 2.6. These roads will be used throughout construction including use of deliveries to and from site and the external road network. Some additional temporary roads will also be required within the footprint to reach excavation fronts such as various elevations of the intakes excavation or higher benches along the permanent roads.	across the project area. Main access and haulage to site will be via Snowy Mountains Highway, Link Road and Lobs Hole Ravine Road (for access to Lobs Hole), and via Snowy Mountains Highway and Tantangara Road (for access to Tantangara Reservoir) (see Figure 2.1).
Excavated rock management	Approximately 9 million m3 (unbulked) of excavated material will be generated by construction and require management. The strategy for management of excavated rock will aim to maximise beneficial reuse of materials for construction activities. Beneficial re-use of excavated material may include use for road base, construction pad establishment, selected fill and tunnel backfill and rock armour as part of site establishment for construction. Excess excavated material that cannot be re-used during construction will be disposed of within Talbingo and Tantangara reservoirs, used in permanent rehabilitation of construction pads to be left in situ in Lobs Hole, or transported for on-land disposal if required.	Placement areas are shown on Figure 2.2 and Figure 2.6.
Barge launch facilities	Barge launch facilities on Talbingo Reservoir will have already been established during Exploratory Works for the placement of the submarine communications cable, and will continued to be used for Main Works for construction works associated with the Talbingo intake structure. The Main Works will require the establishment of barge launch facilities on Tantangara Reservoir to enable these similar works (removal of the intake plug).	Barge launch sites are shown on Figure 2.2 and Figure 2.6.
Construction workforce	The construction workforce will be accommodated entirely on site, typically with a FIFO/DIDO roster. Private vehicles will generally not be permitted and the workforce bused to and from site.	Access to site will be via Snowy Mountains Highway

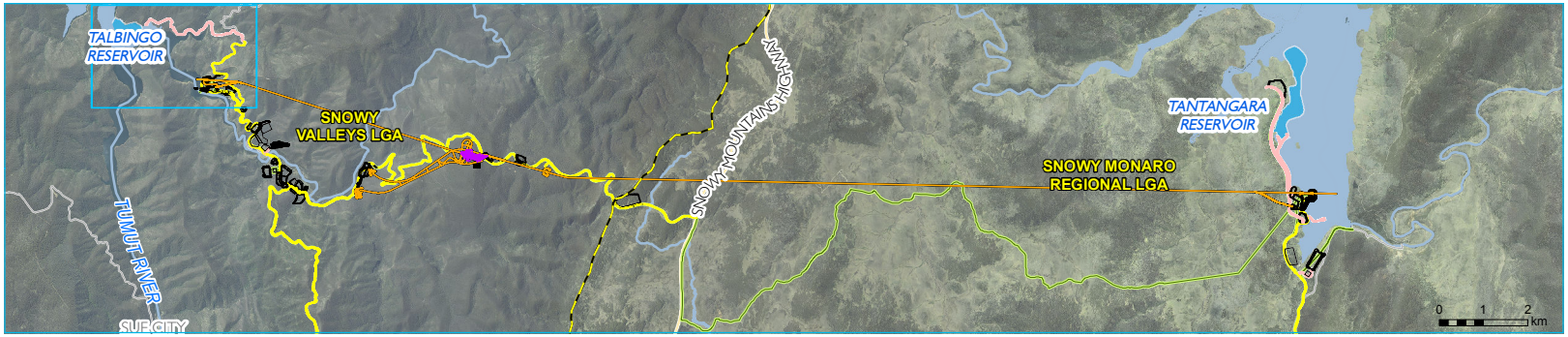
The key areas of construction are shown on Figure 2.2 to Figure 2.6 and can be described across the following locations:

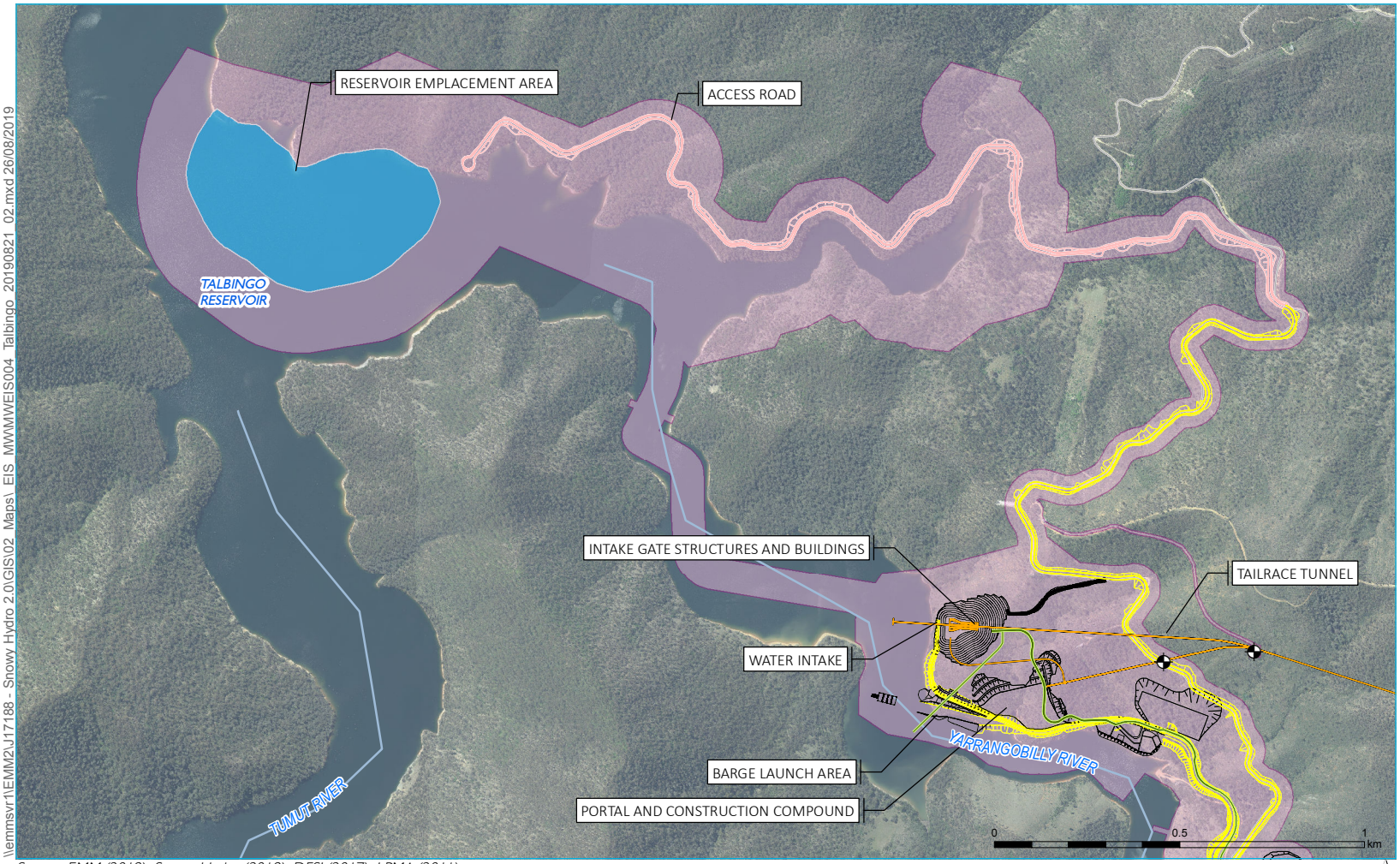
- Talbingo Reservoir – Talbingo Reservoir provides the lower reservoir for the pumped hydro-electric project and will include the tailrace tunnel and water intake structure. The site will also be used for temporary construction compounds and other temporary ancillary activities;
- Lobs Hole – this site will be used primarily for construction (including construction of the MAT and ECVT portals and tunnels to the underground power station and the headrace tunnel (and headrace tunnel surge shaft), underground tailrace surge shaft and a temporary accommodation camp);
- Marica – the site will be used primarily for construction to excavate the ventilation shaft to the underground power station as well as for the excavation and construction of the headrace surge shaft;

- Plateau – the land area between Snowy Mountains Highway and Tantangara Reservoir is referred to as the Plateau. The Plateau will be used to access and construct a utility corridor and construct a fish weir on Tantangara Creek;
- Tantangara Reservoir – Tantangara Reservoir will be the upper reservoir for the pumped hydro project and include the headrace tunnel and intake structure. The site will also be used for a temporary construction compound, accommodation camp and other temporary ancillary activities; and
- Rock Forest – a site to be used temporarily for logistics and staging during construction. It is located beyond the KNP along the Snowy Mountains Highway about 3 km east of Providence Portal.

During the construction phase, all work sites will be restricted access and closed to the public. This includes existing road access to Lobs Hole via Lobs Hole Ravine Road. Restrictions to water-based access and activities will also be implemented for public safety and to allow safe construction of the intakes within the reservoirs. Access to Tantangara Reservoir via Tantangara Road will be strictly subject to compliance with the safety requirements established by the contractor.

A key construction element for the project is the excavation and tunnelling for underground infrastructure including the power station, power waterway (headrace and tailrace tunnels) and associated shafts. The primary methods of excavation are shown in Figure 2.7 with further detail on construction methods provided at Appendix D of the EIS.





KEY

Existing environment

- Main road
- Local road
- Watercourse
- Waterbodies
- Local government area boundary

Snowy 2.0 Main Works operational elements

- Tunnels, portals, intakes, shafts
- Power station
- Utilities
- Permanent road

Snowy 2.0 Main Works construction elements

- Temporary construction compounds and surface works
- Temporary access road
- Geotechnical investigation
- Indicative rock emplacement area
- Disturbance area*

Note: the disturbance area is the extent of construction works required to build Snowy 2.0. It has been identified to allow an assessment of impacts for the EIS, and represents a defined maximum extent where construction works will be carried out. The area will be minimised as much as possible during detailed design.

Source: EMM (2019); Snowy Hydro (2019); DFSI (2017); LPMA (2011)

GDA 1994 MGA Zone 55

N

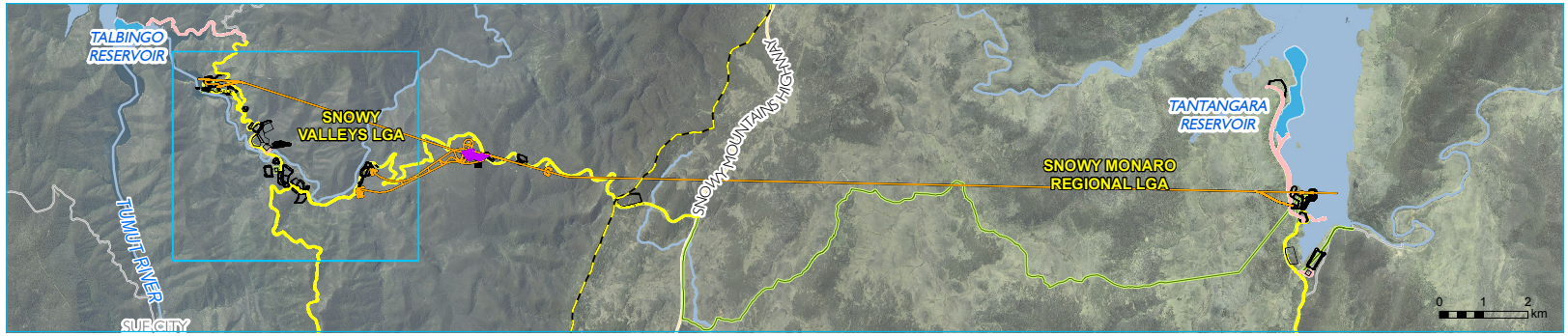
\\emmsvr1\EMM2\J17188 - Snowy Hydro 2.0\GIS\02 Maps\ EIS MWMWEIS004 Talbingo 20190821 02.mxd 26/08/2019

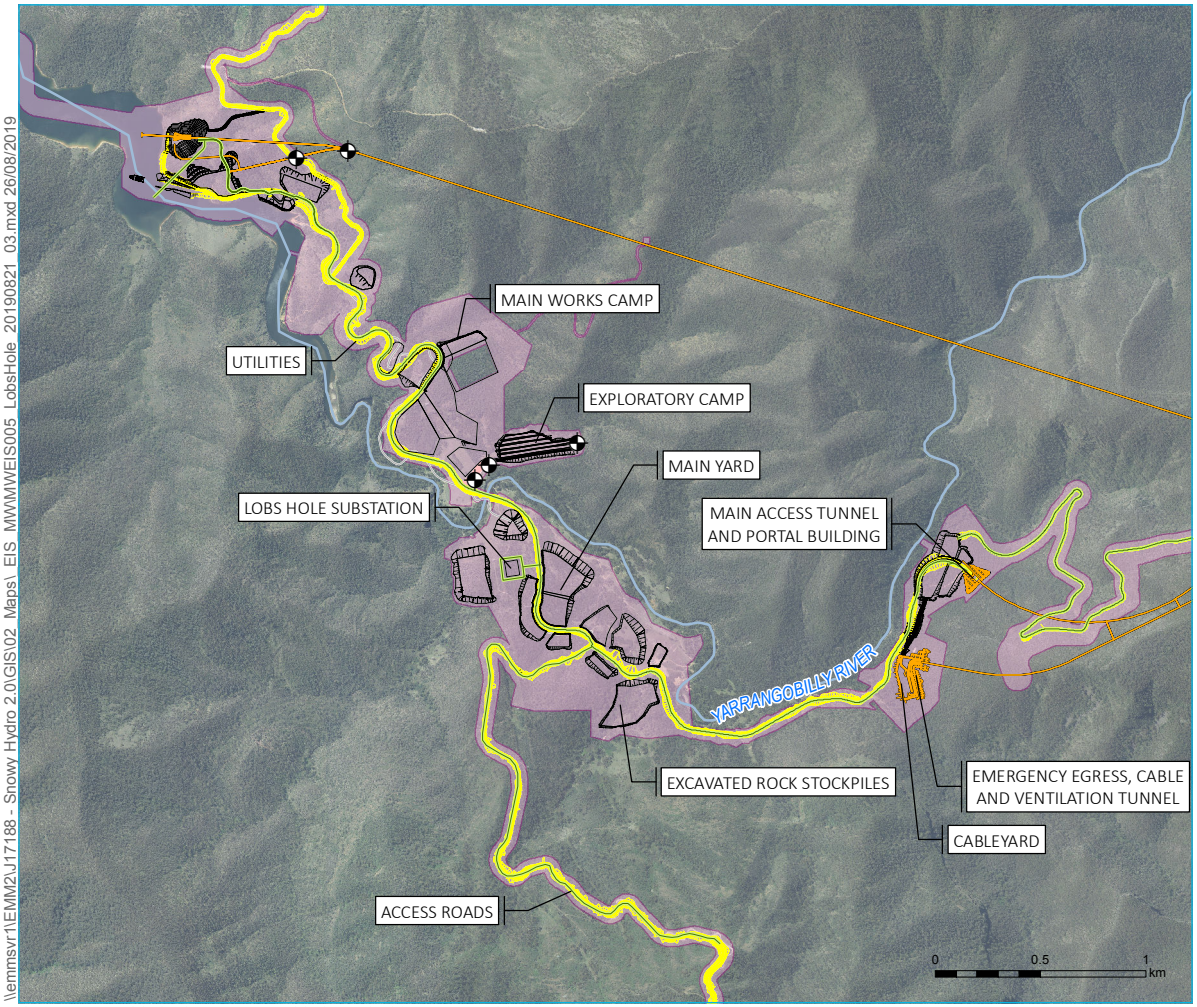
Talbingo Reservoir - project elements, purpose and description

Snowy 2.0
Economic assessment
Main Works
Figure 2.2

snowy 2.0

EMM creating opportunities





KEY

Existing environment
- Main road
- Local road
- Watercourse
- Waterbodies
- Local government area boundary

Snowy 2.0 Main Works operational elements
- Tunnels, portals, intakes, shafts
- Power station
- Utilities
- Permanent road

Snowy 2.0 Main Works construction elements
- Temporary construction compounds and surface works
- Temporary access road
- Geotechnical investigation
- Indicative rock emplacement area
- Disturbance area*

Note: the disturbance area is the extent of construction works required to build Snowy 2.0. It has been identified to allow an assessment of impacts for the EIS, and represents a defined maximum extent where construction works will be carried out. The area will be minimised as much as possible during detailed design.

Source: EMM (2019); Snowy Hydro (2019); DFSI (2017); LPMA (2011)

GDA 1994 MGA Zone 55

N

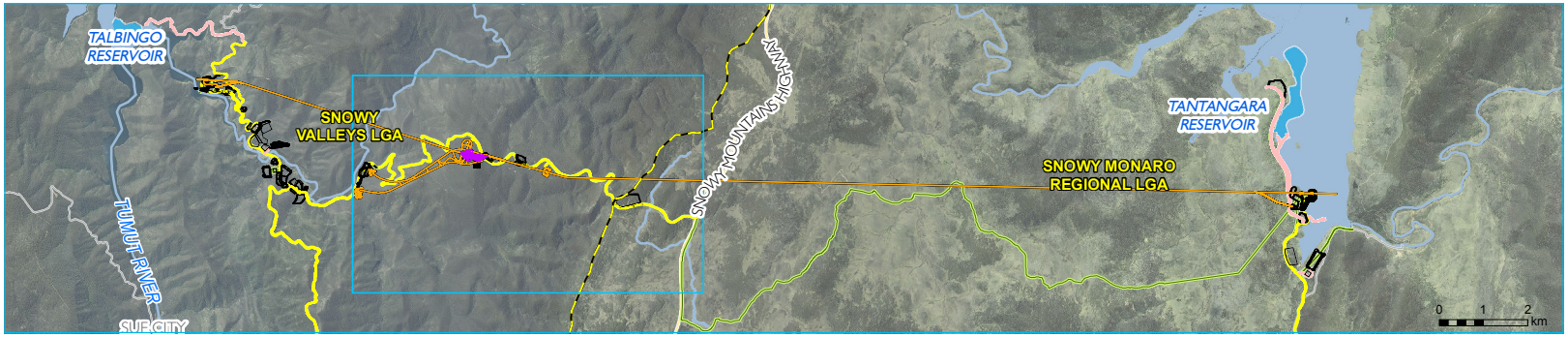
Lobs Hole - project elements, purpose and description

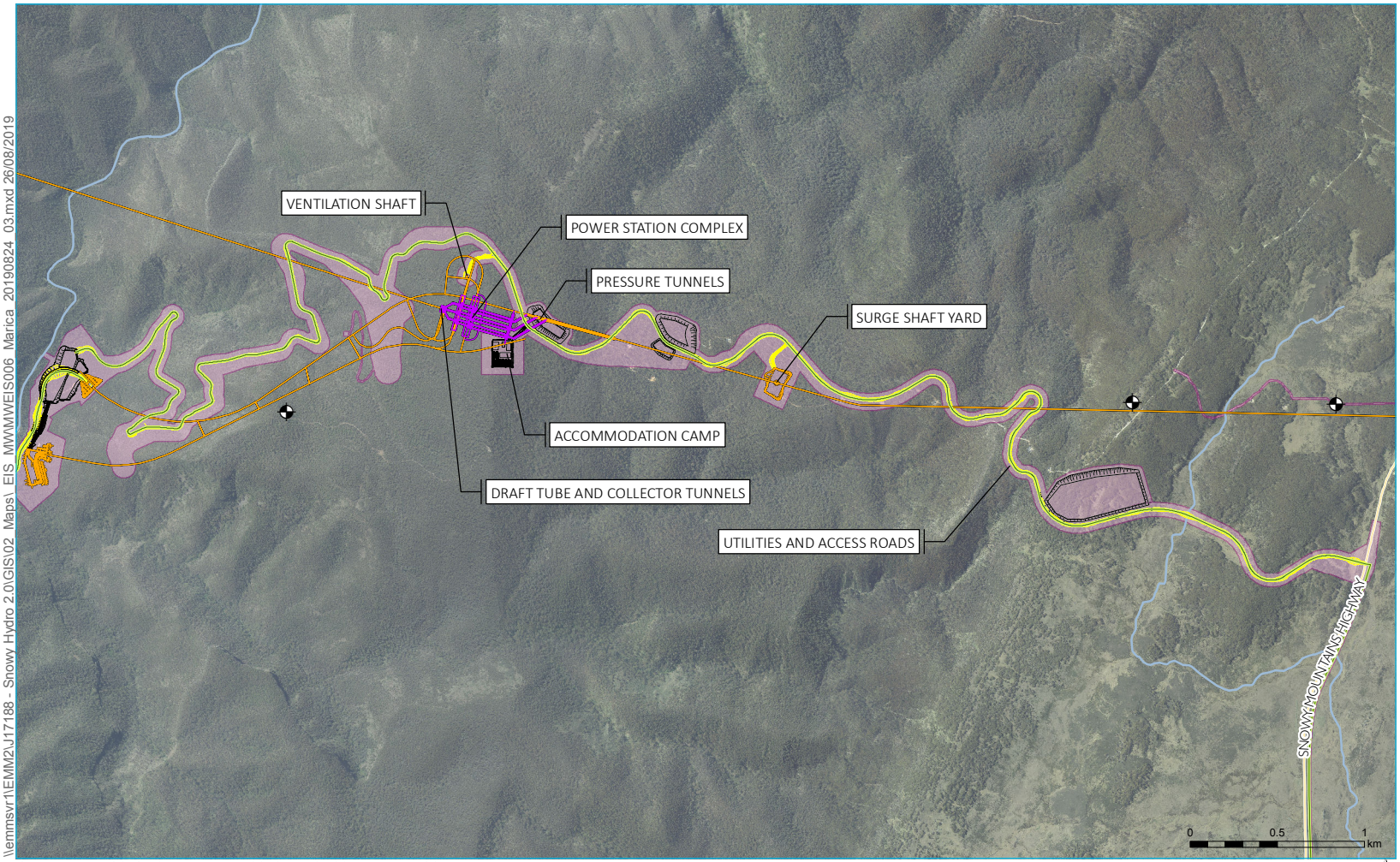
Snowy 2.0
Economic assessment
Main Works
Figure 2.3

snowy 2.0

EMM creating opportunities

\\emmsvr1\EMM2\J17188 - Snowy Hydro 2.0\GIS\02 Maps\ EIS MWMWEIS005 LobsHole 20190821 03.mxd 26/08/2019





KEY

Existing environment

- Main road
- Local road
- Watercourse
- Waterbodies
- Local government area boundary

Snowy 2.0 Main Works operational elements

- Tunnels, portals, intakes, shafts
- Power station
- Utilities
- Permanent road

Snowy 2.0 Main Works construction elements

- Temporary construction compounds and surface works
- Temporary access road
- Geotechnical investigation
- Indicative rock emplacement area
- Disturbance area*

Note: the disturbance area is the extent of construction works required to build Snowy 2.0. It has been identified to allow an assessment of impacts for the EIS, and represents a defined maximum extent where construction works will be carried out. The area will be minimised as much as possible during detailed design.

\\emmsvr1\EMM2\J17188 - Snowy Hydro 2.0\GIS\02 Maps\ EIS MWMWEIS006 Marica 20190824 03.mxd 26/08/2019

Source: EMM (2019); Snowy Hydro (2019); DFSI (2017); LPMA (2011)

GDA 1994 MGA Zone 55

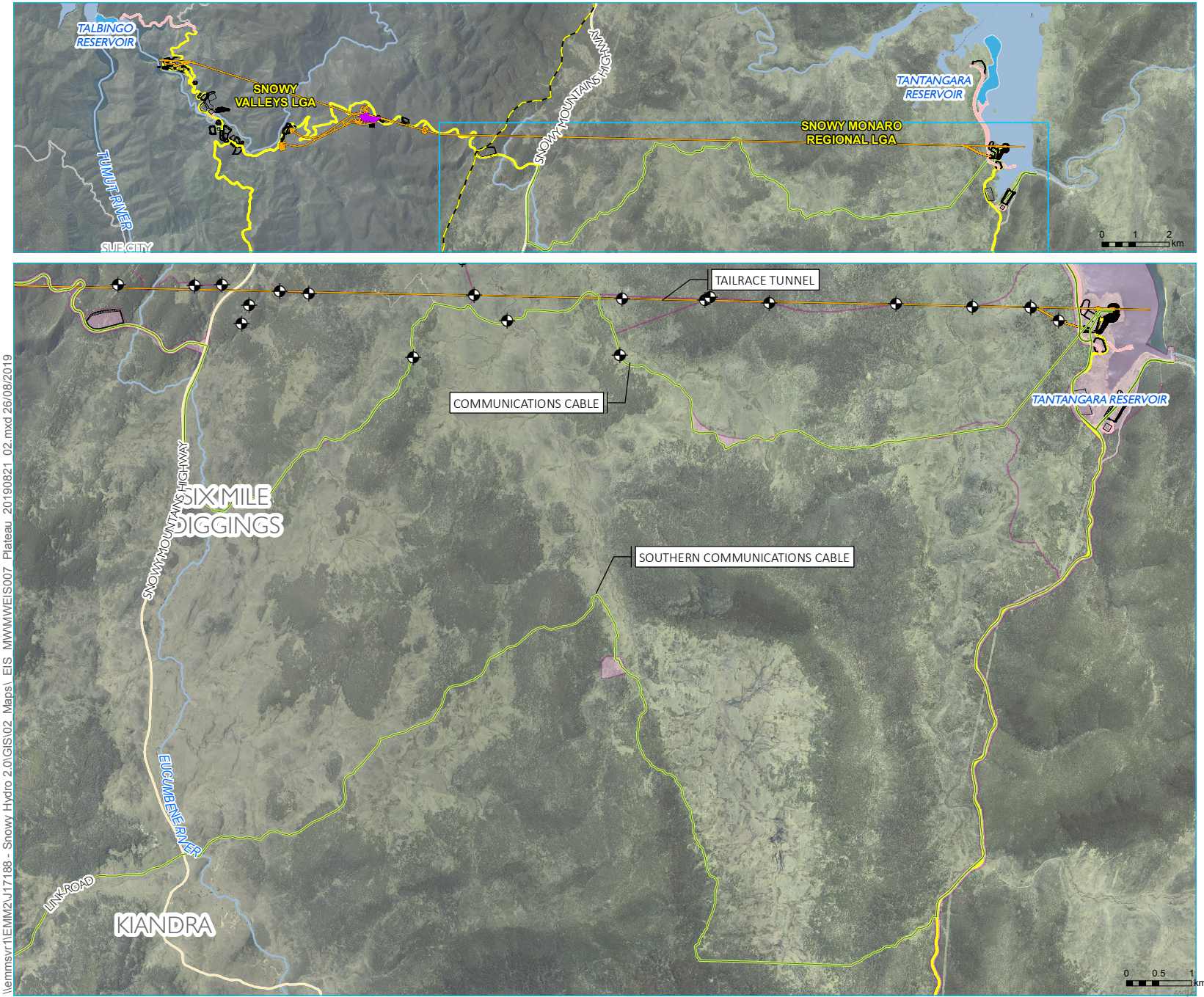
N

Marica - project elements, purpose and description

Snowy 2.0
Economic assessment
Main Works
Figure 2.4

snowy 2.0

EMM creating opportunities



KEY

Existing environment

- Main road
- Local road
- Watercourse
- Waterbodies
- Local government area boundary

Snowy 2.0 Main Works operational elements

- Tunnels, portals, intakes, shafts
- Power station
- Utilities
- Permanent road

Snowy 2.0 Main Works construction elements

- Temporary construction compounds and surface works
- Temporary access road
- Geotechnical investigation
- Indicative rock emplacement area
- Disturbance area*

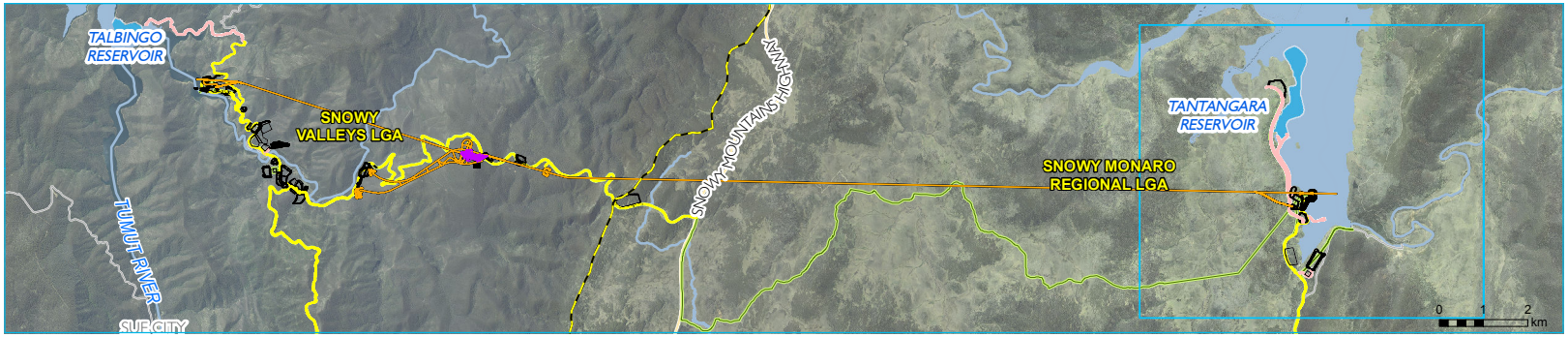
Note: the disturbance area is the extent of construction works required to build Snowy 2.0. It has been identified to allow an assessment of impacts for the EIS, and represents a defined maximum extent where construction works will be carried out. The area will be minimised as much as possible during detailed design.

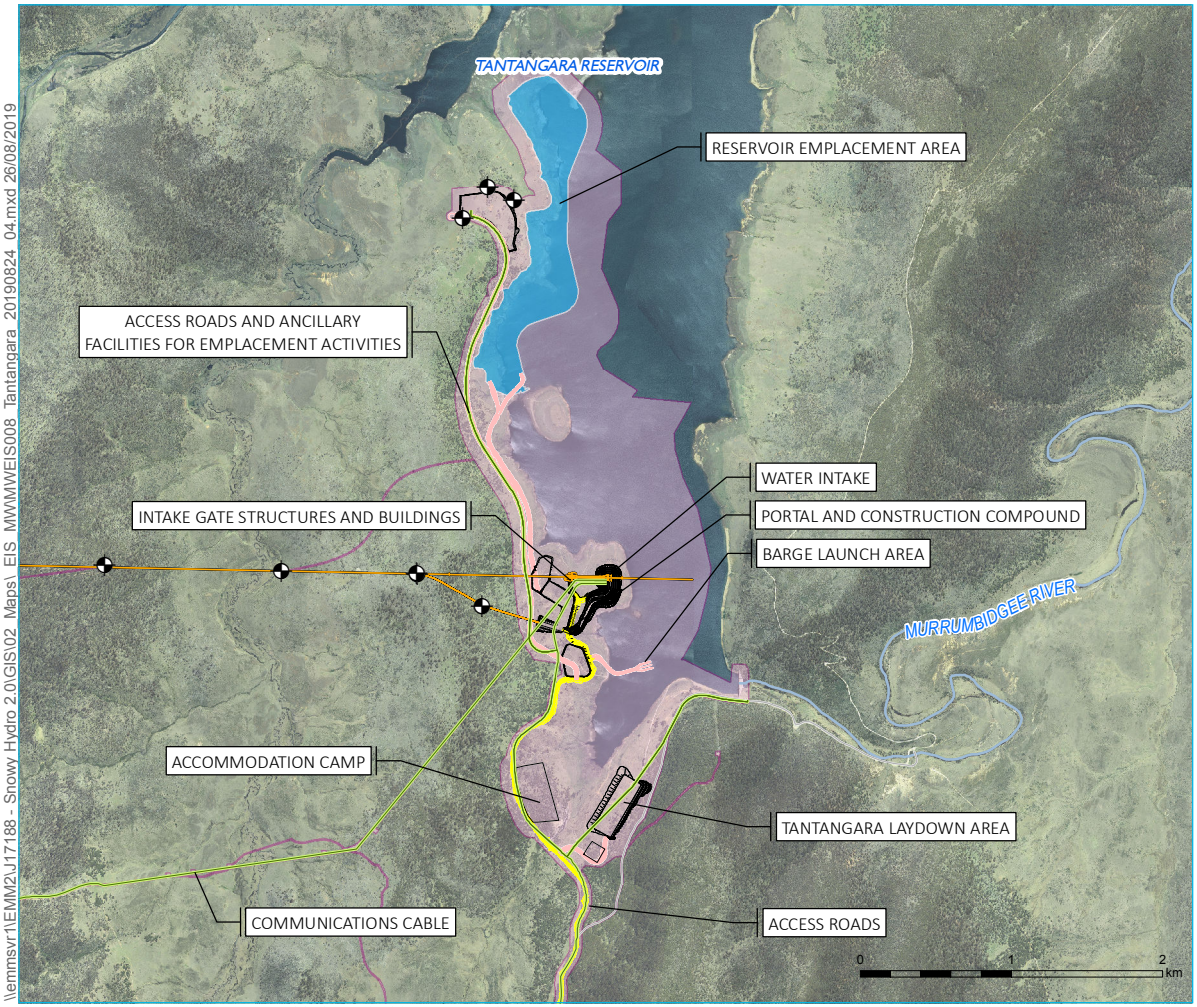
Plateau - project elements, purpose and description

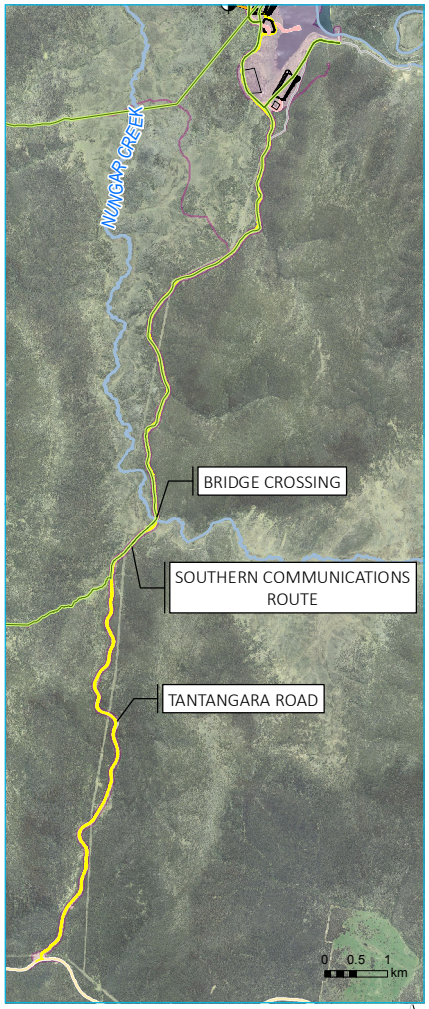
Snowy 2.0
Economic assessment
Main Works
Figure 2.5

Source: EMM (2019); Snowy Hydro (2019); DFSI (2017); LPMA (2011)

\\emmsvr1\EMM2\J17188 - Snowy Hydro 2.0\GIS\02 Maps\ EIS MWMWEIS007 Plateau 20190821 02.mxd 26/08/2019







KEY

Existing environment

- Main road
- Local road
- Watercourse
- Waterbodies
- Local government area boundary

Snowy 2.0 Main Works operational elements

- Tunnels, portals, intakes, shafts
- Power station
- Utilities
- Permanent road

Snowy 2.0 Main Works construction elements

- Temporary construction compounds and surface works
- Temporary access road
- Geotechnical investigation
- Indicative rock emplacement area
- Disturbance area*

Note: the disturbance area is the extent of construction works required to build Snowy 2.0. It has been identified to allow an assessment of impacts for the EIS, and represents a defined maximum extent where construction works will be carried out. The area will be minimised as much as possible during detailed design.

Source: EMM (2019); Snowy Hydro (2019); DFSI (2017); LPMA (2011)

GDA 1994 MGA Zone 55

N

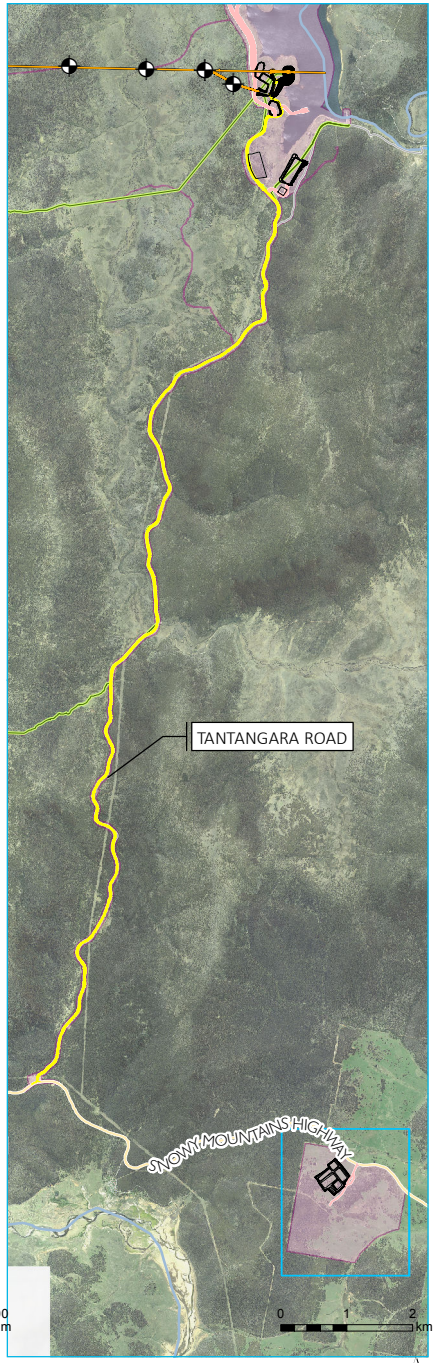
Tantangara Reservoir - project elements, purpose and description

Snowy 2.0
Economic assessment
Main Works
Figure 2.6

snowy 2.0

EMM creating opportunities

\\emmsvr1\EMM2\J17188 - Snowy Hydro 2.0\GIS\02 Maps\ EIS MWMWEIS008 Tantangara 20190824 04.mxd 26/08/2019



KEY

Existing environment
- Main road
- Local road
- Watercourse

Snowy 2.0 operational elements
- Tunnels, portals, intakes, shafts
- Utilities
- Permanent road

Snowy 2.0 contruction elements
- Temporary construction compounds and surface works
- Temporary access road
- Geotechnical investigation
- Disturbance area*

Note: the disturbance area is the extent of construction works required to build Snowy 2.0. It has been identified to allow an assessment of impacts for the EIS, and represents a defined maximum extent where construction works will be carried out. The area will be minimised as much as possible during detailed design.

GDA 1994 MGA Zone 55

N

\\emmsvr1\EMM2\u17188 - Snowy Hydro 2.0\GIS\02 Maps\ EIS MWMWEIS012 RockForest 20190824 03.mxd 26/08/2019

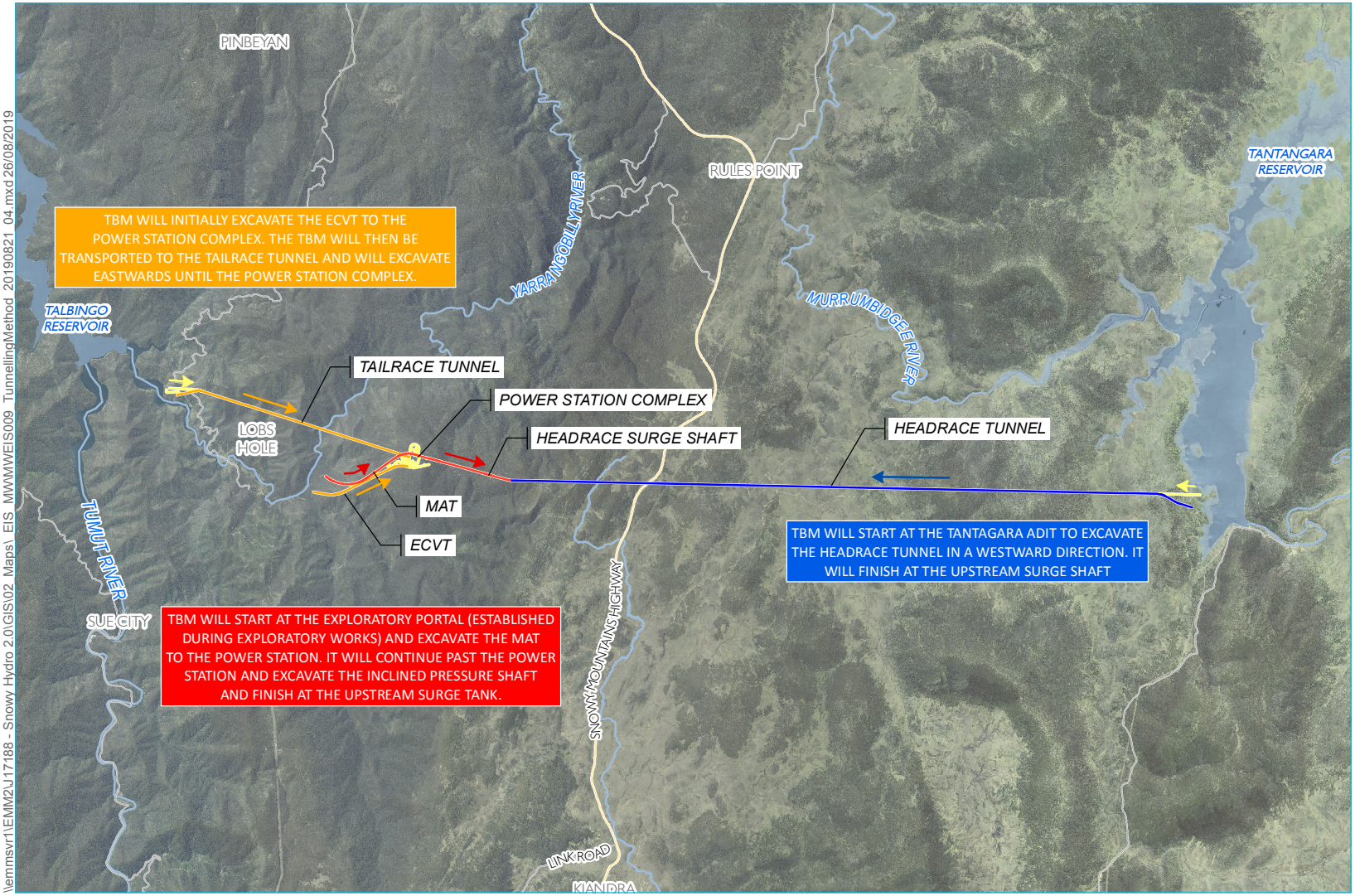
Source: EMM (2019); Snowy Hydro (2019); DFSI (2017); LPMA (2011)

Rock Forest - project elements, purpose and description

Snowy 2.0
Economic assessment
Main Works
Figure 2.7

snowy 2.0

EMM creating opportunities

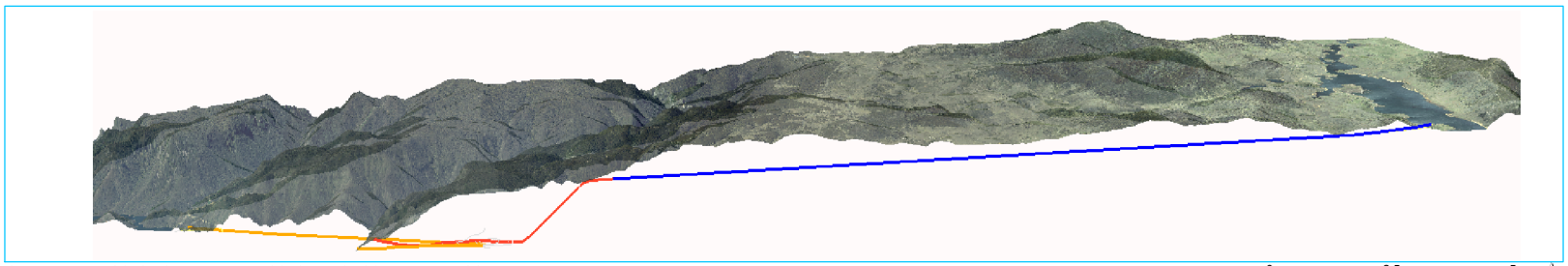


\\emmsvr1\EMM2\J17188 - Snowy Hydro 2.0\GIS\02 Maps\ EIS MWMWEIS009 TunnellingMethod 20190821 04.mxd 26/08/2019

KEY

Tunnelling method
- Drill and blast
- TBM 1
- TBM 2
- TBM 3
- Tunnelling direction

Existing environment
- Main road
- Local road
- Watercourse
- Waterbodies



Source: EMM (2019); Snowy Hydro (2019); DFSI (2017); LPMA (2011)

0 2.5 5 km

GDA 1994 MGA Zone 55

N

Primary excavation methods – drill and blast and tunnel boring machine

Snowy 2.0
Economic assessment
Main Works
Figure 2.8

snowy 2.0

EMM creating opportunities

2.3 Operation of Snowy 2.0

2.3.1 Scheme operation and reservoir management

Snowy 2.0 would operate within the northern Snowy-Tumut Development, connecting the existing Tantangara and Talbingo reservoirs.

Tantangara Reservoir currently has the following operational functions within the Snowy Scheme:

- collects releases from the Murrumbidgee River and the Goodradigbee River Aqueduct,
- provides a means for storage and diversion of water to Lake Eucumbene via the Murrumbidgee-Eucumbene Tunnel, and
- provides environmental releases through the Tantangara Reservoir river outlet gates to the Murrumbidgee River.

Talbingo Reservoir currently has the following operational functions:

- collects releases from Tumut 2 power station,
- collects releases from the Yarrangobilly and Tumut rivers,
- acts as head storage for water pumped up from Jounama Pondage, and
- acts as head storage for generation at Tumut 3 power station.

Due to its historic relationship to both the upstream Tumut 2 power station and downstream Tumut 3 power station, Talbingo Reservoir has had more operational functions than Tantangara Reservoir in the current Snowy Scheme.

Following the commencement of the operation of Snowy 2.0, both Tantangara and Talbingo reservoirs will have increased operational functions. Tantangara Reservoir will have the additional operational functions of acting as a head storage for generation from the Snowy 2.0 power station and also acting as a storage for water pumped up from Talbingo Reservoir. Talbingo Reservoir will have the additional operational function of acting as a tail storage from Snowy 2.0 generation.

As a result of the operation of Snowy 2.0, the water level in Tantangara Reservoir will be more variable than historically. Notwithstanding this, operations will not affect release obligations under the Snowy Water Licence nor will it involve any change to the currently imposed Full Supply Levels (FSLs). No additional land will be affected by virtue of the inundation of the reservoirs through Snowy 2.0 operations. Water storages will continue to be held wholly within the footprint of the existing FSLs.

2.3.2 Permanent access

Permanent access to Snowy 2.0 infrastructure is required. During operation, a number of service roads established during construction will be used to access surface infrastructure including the power station's ventilation shaft, water intake structures and gates, and the headrace tunnel surge shaft. Permanent access tunnels (the MAT and ECVT) will be used to enter and exit the power station. For some roads, permanent access by Snowy Hydro will require restricted public access arrangements.

2.3.3 Maintenance requirements

Maintenance activities required for Snowy 2.0 will be integrated with the maintenance of the existing Snowy Scheme. Maintenance activities that will be required include:

- maintenance of equipment and systems within the power station complex, intake structures, gates and control buildings;
- maintenance of access roads (vegetation clearing, pavement works, snow clearing);

- dewatering of the tailrace and headrace tunnel (estimated at once every 15 to 50 years, or as required); and
- maintenance of electricity infrastructure (cables, cable yard, cable tunnel).

2.4 Rehabilitation and final land use

A Rehabilitation Strategy has been prepared for Snowy 2.0 Main Works and appended to the EIS.

It is proposed that all areas not retained for permanent infrastructure will be revegetated and rehabilitated. At Lobs Hole, final landform design and planning has been undertaken to identify opportunities for the reuse of excavated material in rehabilitation to provide landforms which complement the surrounding topography in the KNP.

Given that most of Snowy 2.0 Main Works is within the boundaries of the KNP, Snowy Hydro will liaise closely with NPWS to determine the extent of decommissioning of temporary construction facilities and rehabilitation activities to be undertaken following the construction of Snowy 2.0 Main Works.

3 Methods

3.1 Computable General Equilibrium Analysis

Computable General Equilibrium (CGE) Analysis can be used to model the net economic activity of a project or policy on an economy. For this analysis the states and territories of Australia have been separately identified, with the exception of the Australian Capital Territory which is aggregated in with NSW.

CGE modelling is a recognised method for assessing the impacts of large projects on the economy. It is based on detailed representation of the economy, including the complex interactions between different sectors of the economy. CGE modelling is underpinned by an IO database as well as a system of interdependent behaviour and accounting equations which are based on economic theory.

A CGE model is able to analyse the impacts of the project in a comprehensive, economy-wide framework meaning the modelling captures:

- ***Direct increases in demand*** associated with the project, including construction activity as well as the assumed changes in electricity prices attributable to the project.
- ***Indirect increases in demand***, or flow-on effects associated with increased economic activity relating to construction phase of development and additional electricity production.
- ***Labour market displacement*** caused by the direct increase in demand from a project of this nature (and the associated investment) on other sectors of the economy bidding up wages and 'crowding out' other sectors of the economy.
- ***Revenue leakage*** associated with the expropriation of construction workers wages and electricity benefits.

The CGE analysis used modelling inputs from Marsden Jacob Associates (MJA) on the level and nature of investments required and investments deferred, the impacts on electricity prices including decomposed by user class (for example, heavy industrial through to household consumer), and the impact on flows across state borders.

This information was inputted into the Cadence Economics CGE model (CECGEM), a customised Computable General Equilibrium model which is a large scale, dynamic, multi-region, multi-sector model of the global economy, with an explicit representation of the NSW, rest of NEM and rest of Australia economies.

The CECGEM projects change in macroeconomic aggregates such as real gross state product (real GSP) which is an output measure of state economies and real gross state income (real GSI) which is a welfare measure for state residents. Although less widely known, Gross State Income is a superior metric to Gross State Product for measuring impact on economic welfare.

At a National level, the model projects change in real gross national product (real GNP) and real gross national income (real GNI). The model also projects state-wide and national employment, export volumes, investment and private consumption. At the sectoral level, detailed results such as output, exports, imports and employment can also be produced. A brief description of the model is presented in Box 1.

Box 1: An overview of CEGEM

CEGEM is a multi-commodity, multi-region, dynamic model of the world economy. Like all economic models, CEGEM is based on a range of assumptions, parameters and data that constitute an approximation to the working structure of an economy. Its construction has drawn on the key features of other economic models such as the global economic framework underpinning models such as Global Trade Analysis Project (GTAP) and Global Trade and Environment Model (GTEM), with state and regional modelling frameworks such as Monash Multi-Regional Forecasting (MMRF) and The Enormous Regional Model (TERM) models.

Labour, capital, land and a natural resource comprise the four factors of production. On a year-by-year basis, capital and labour are mobile between sectors, while land is mobile across agriculture. The natural resource is specific to mining and is not mobile. A representative household in each region owns all factors of production. This representative household receives all factor payments, tax revenue and interregional transfers. The household also determines the allocation of income between household consumption, government consumption and savings.

Capital in each region of the model accumulates by investment less depreciation in each period. Capital is mobile internationally in CEGEM, where global investment equals global savings. Global savings are made available to invest across regions. Rates of return can differ to reflect region specific differences in risk premiums.

The model assumes labour markets operate in a model where employment and wages adjust in each year so that, for example, in the case of an increase in the demand for labour, the real wage rate increases in proportion to the increase in employment from its base case forecast level.

CEGEM determines regional supplies and demands of commodities through optimising behaviour of agents in perfectly competitive markets using constant returns to scale technologies. Under these assumptions, prices are set to cover costs and firms earn zero pure profits, with all returns paid to primary factors. This implies that changes in output prices are determined by changes in input prices of materials and primary factors.

CEGEM is a recursive dynamic model that solves year-on-year over a specified timeframe. The model is used to project the relationship between variables under different scenarios over a predefined period.

A typical scenario is comprised of a reference case projection (or the Base case scenario) that forms the basis of the analysis. In this instance, the reference case assumes no project investment or electricity production. Set against this scenario is the policy scenario (or the project case) under consideration.

3.2 Input-Output Analysis

IO analysis is a cost effective and simple method for estimating the gross market economic activity i.e. financial transactions and employment, in a specified region that is associated with a project. It is the most widely used approach for assessing regional impacts (West and Jackson, 2005).

IO analysis essentially involves two steps:

- Construction of an appropriate IO table (regional transaction table) that can be used to identify the economic structure of the region and multipliers for each sector of the economy; and
- Identification of the initial impact or stimulus of the project (construction and/or operation) in a form that is compatible with the IO equations so that the IO multipliers and flow-on effects can then be estimated (West, 1993).

The IO method is based on a number of assumptions that are outlined in Attachment 1. Most notably IO analysis assumes that the regional economy has access to sufficient labour and capital resources (from both inside and outside the region) so that an individual project does not result in any regional price changes e.g. wages in other industries or house rentals, which would lead to contractions ("crowding out") of economic activity in other sectors in the same region. Any "crowding out" is assumed to occur outside the region where the project is concentrated and the regional impact analysis is focused. A dynamic CGE approach may overcome the limitation of IO analysis but is unlikely to be warranted at local or regional scale or with small scale impacts.

The consequence of the assumptions of IO analysis, is that IO modelling results provide an upper bound economic activity impact estimate.

IO analysis identifies the economic activity of a project on the economy in terms of four main economic activity indicators:

- Gross regional output – the gross value of business turnover;
- Value-added – the difference between the gross value of business turnover and the costs of the inputs of raw materials, components and services bought in to produce the gross regional output. These costs exclude income costs;
- Income – the wages paid to employees including imputed wages for self employed and business owners; and
- Employment – the number of people employed (including self-employed, full-time and part-time).

4 Impacts on National Electricity Market States and Territories

4.1 Introduction

The impacts of Snowy 2.0 on the NEM states and territories have been estimated using the CEGEM model. Refer to Attachment 4 for the full report.

The CGE modelling results compare two possible future scenarios, the first being a projection to 2050/51 without the Snowy 2.0 investment ('Without Snowy 2.0')[1], and the second being a projection to 2050/51 with the Snowy 2.0 investment ('With Snowy 2.0'). The difference in the economic indicators of GSP, GSI and employment, between these two scenarios, is the projected economic impact of the Snowy 2.0 investment.

In terms of the economic impact there are three key drivers to the analysis:

- The investment phase which represents an additional expenditure on capital to establish Snowy 2.0, with consequential impacts on the levels of investment required in the remainder of the NEM as measured from reference case levels;

- A reduction in fossil fuel use across the NEM as a result of increased hydroelectric capacity reducing the requirement for fossil fuel generation; and

- A flow on impact to electricity prices across the NEM.

4.2 Economic Drivers

4.2.1 The investment

Snowy 2.0 is a commercial investment, and is assumed to result in no additional generation capacity between the two scenarios. Rather, it replaces a pre-existing baseline of electricity generation.

The aggregated NEM investment path adopted in the CGE modelling is shown in Figure 4.1, comprising both the direct investment in the Snowy 2.0 project and the reduced requirement for investment in the remainder of the NEM as a consequence.

Over the period from 2019/20 to 2025/26 there is an increase in investment directly attributable to the construction of Snowy 2.0. Over the period from 2026/27 onwards there is a net present value reduction of $614 million (M) in NEM investment to maintain comparable reliability standards. In net present value[2] terms, investment in the NEM is increased by $4,005M. The Snowy 2.0 investment takes place in the NSW region, while the subsequent reduced investment in the NEM is assumed to be distributed across the remaining NEM states and territories according to their share of NEM generation.

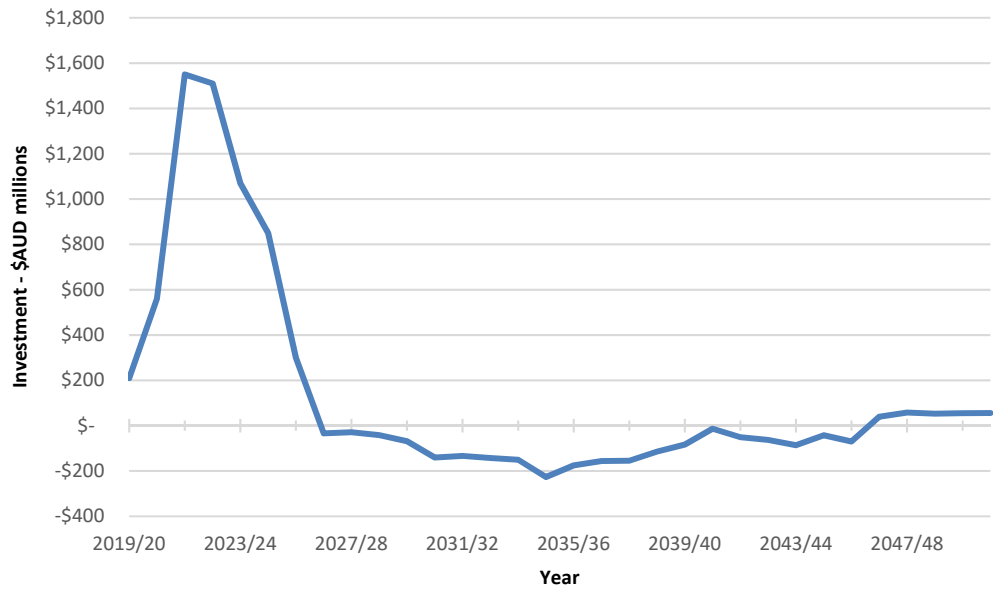
The increase in the capital stock in the NEM is a significant driver of the economic benefits in the modelling exercise.

[1] The key findings of the base case NEM modelling undertaken by MJA were that:
- coal-fired generation closures result in a capacity shortage that requires new (sustainable) dispatchable capacity
- intermittent generation affects the operation and costs of coal plant
- high levels of intermittent generation result in reduced economics of dispatchable generation
- battery storage is not sufficiently economic to address the intermittency and the capacity shortage associated with the coal-fired plant closures.

The lack of storage results in increasing costs associated with increased levels of renewable generation development.

[2] All net present value calculations in this report adopt a real discount rate of 7% over the period 2019/20 to 2050/51

Figure 4.1 – Modelled investment profile, $AUDM

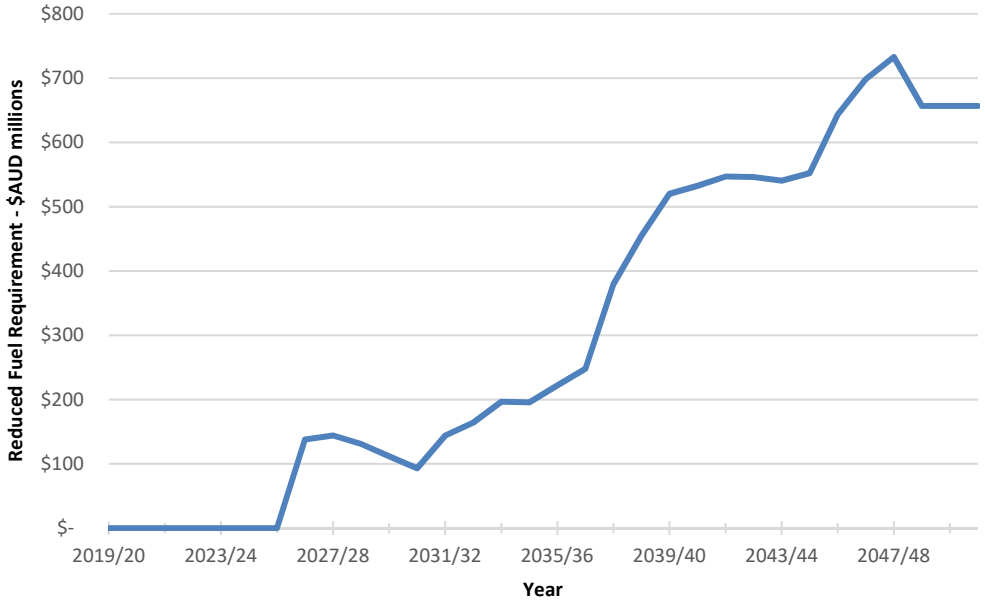


Source: Gillespie Economics, Marsden Jacob Associates

4.2.2 Reduced NEM fuel requirements

Figure 4.2 shows the modelled reduced fuel requirements in the NEM once the Snowy 2.0 capacity enters the market, with a peak saving of $733M in 2047/48, and with a net present value of $2,164M. The reduction in system expenditure on fossil fuel is a significant driver of the economic benefits in the CGM modelling.

Figure 4.2 – Value of reduced fuel requirement in the NEM, $AUDM



Source: Marsden Jacob Associates

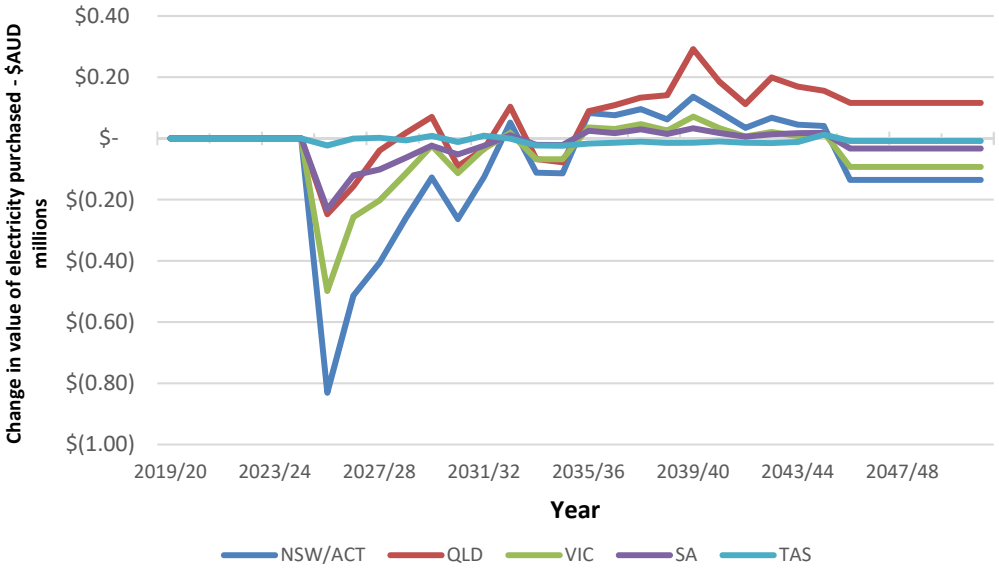
4.2.3 Electricity price effects

The results of market modelling by MJA indicate that electricity prices in the NEM are anticipated to fall on average over the modelling horizon. Figure 4.3 shows the change in the value of electricity purchased in each of the NEM regions as a result of price changes.

The changes in prices drive only modest savings across the NEM, reducing the value of electricity purchased by $2.37M in net present value terms over the modelling period. The combined New South Wales and Australian Capital Territory region experiences the largest saving of $1.39M (net present value), while the value of electricity purchased in Queensland increases by $0.17M.

The changes in the value of electricity purchased are a result of price changes alone.

Figure 4.3 – Change in value of electricity purchased, $AUDM



Source: Marsden Jacob Associates, Cadence Economics estimates

The combination of an increase in the electricity market capital stock, the reduced fuel requirement in the NEM, and a muted impact on prices reflects an increase in the value added share of the NEM market.

4.3 Economic Impacts on the NEM States and Territories

The construction and operation of Snowy 2.0 has significant impact on economic outcomes for the NEM states and territories, as demonstrated in Figures 4.4 through 4.6.

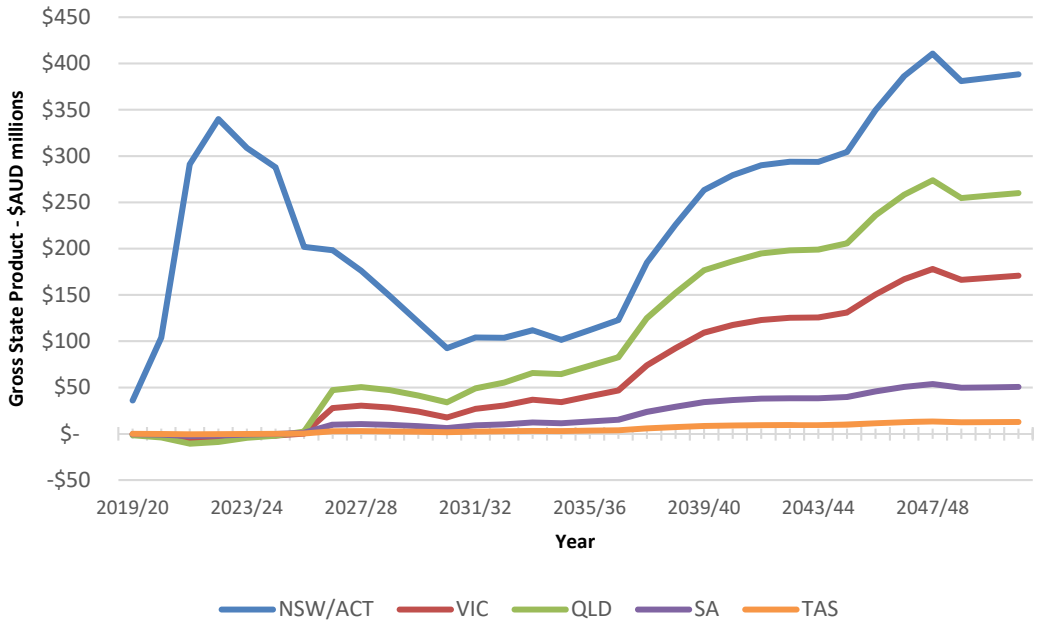
Gross State Product

The impact of Snowy 2.0 on Gross State Product (GSP)[3] is shown in Figure 4.4. The combined NSW/ACT modelling region experiences the greatest uplift in economic activity, most significantly during the initial construction period but also during ongoing operations, with a net present value impact on GSP of $2,692M.

[3] GSP is the state analogue of Gross Domestic Product

The combination of ongoing NEM fuel savings and indirect economic activity through trade of goods and services drive corresponding increases in economic activity in other NEM states once operation of Snowy 2.0 begins. In aggregate across the NEM states and territories GSP increases by $4,176M in net present value terms.

Figure 4.4 – Impact on Gross State Product, $AUDM

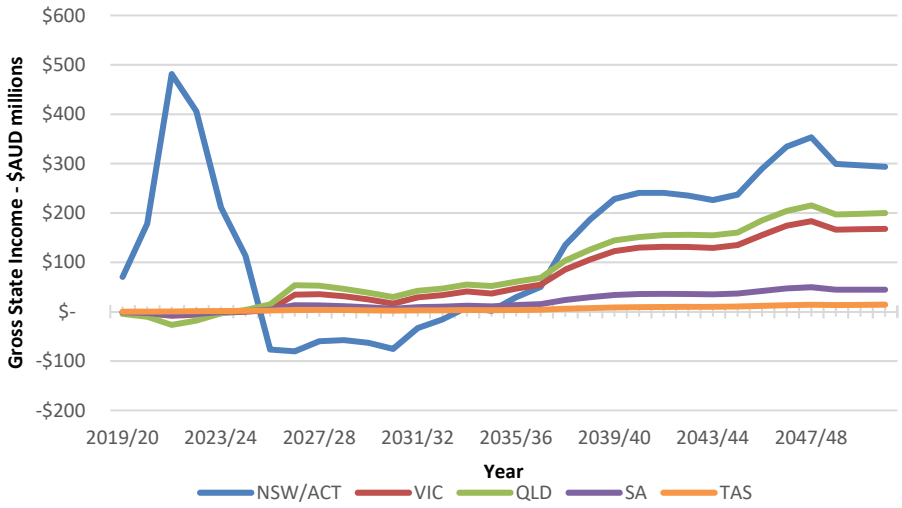


Source: Cadence Economics estimates

Gross State Income

Figure 4.5 shows the impact on Gross State Income (GSI)[4] for the NEM states and territories. GSI increases by $1,608M in net present value terms in the NSW/ACT modelling region, with an aggregate NEM region impact of $2,982M.

Figure 4.5 – Impact on Gross State Income, $AUDM



Source: Cadence Economics estimates

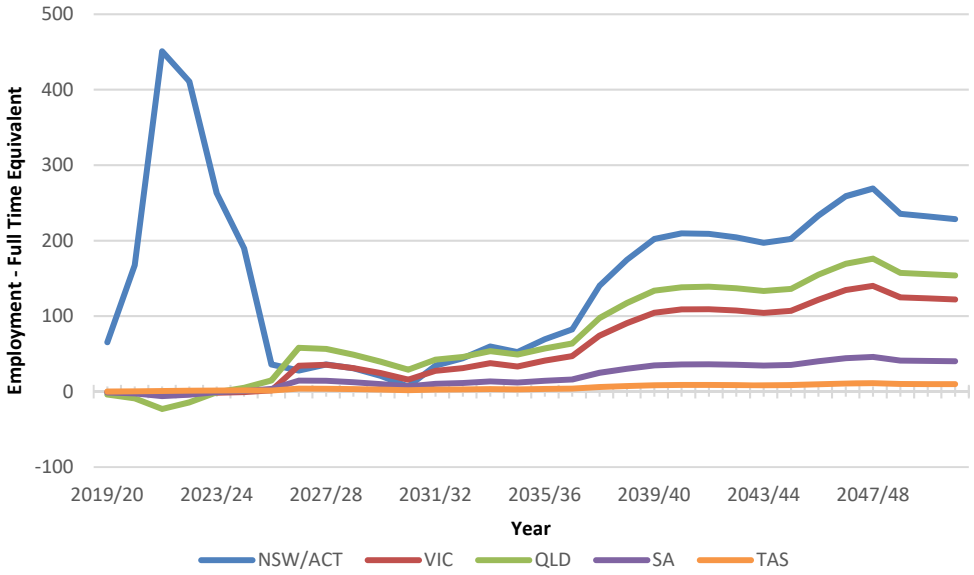
[4] GSI is the state analogue of Gross National Income.

Employment

The estimated impact on employment in the NEM states and territories is shown in Figure 4.6. The most significant impact on employment is in the NSW/ACT region during the construction period, peaking at an economy wide impact of 451 full time equivalent employees in 2021/22, during which time other NEM regions experience only small increases or decreases in employment.

The average aggregate impact across the NEM regions is an increase in employment of 324 FTE positions.

Figure 4.6 – Change in employment, FTE



Source: Cadence Economics estimates

5 Impacts on the Regional Economy

5.1 Introduction

Snowy 2.0 Main Works will be located in the Snowy Monaro Regional local government area (LGA) and the Snowy Valleys LGA.

5.2 Characterisation of the region

Snowy Monaro Regional LGA comprises an area of 15,162 square kilometres (5,854 sq mi) and occupies the higher slopes of the eastern side of the Great Dividing Range between the Australian Capital Territory to the north and the state boundary with Victoria to the south. Towns[5] in the Snowy Monaro Regional LGA include:

- Cooma (6,681);
- Jindabyne (2,629);
- Bombala (1,387);
- Berridale (1,197);
- Adaminaby (301); and
- Nimmitabel (2320) (ABS Census 2016, State Suburbs).

The Snowy Valleys LGA comprises an area of 8,960 square kilometres (3,460 sq mi) and covers the western side of the southern-most portion of the Great Dividing Range and foothills in New South Wales. Large sections of the local government area are contained within national parks. The main towns of the LGA are:

- Tumut (6,230);
- Tumbarumba (1,862);
- Batlow (1,313); and
- Adelong (943) (ABS Census 2016, State Suburbs).

An indication of the health of an economy can be gained from population changes. This theory of regional economic growth suggests that places that are able to attract population immigration create increased demand for goods and services and thus more jobs. This growth leads to increasing local multiplier effects, scale economies and an increase in the rate of innovation and capital availability (Sorensen, 1990). Conversely, population losses can contribute to a 'vicious cycle' of decline whereby reduced populations results in closure of services, which in turn makes it difficult to attract new populations (Sorensen, 1990).

Trends in regional economies of NSW as a result of globalization and associated structural adjustment include:

- loss of significant industries such as abattoirs and timber mills from many rural areas;
- increased mechanisation of agriculture and aggregation of properties, resulting in loss of employment opportunities in this industry;
- growth of regional centres, at the expense of smaller towns;
- preference of Australians for coastal living, particularly for retirement; and

[55] Populations are in brackets.

- preference of many of today's fastest growing industries for locating in large cities (Collits 2000).

The result is that there has been declining population in many rural LGAs that are located in non-coastal areas in NSW. There has also been a decline in the population of smaller towns even in regions where the population has been growing.

Against this backdrop, it is evident that the population of the Snowy Valleys LGA has been relatively static since 2006 while the Snowy Monaro Regional LGA has grown slightly. The total region has grown at a rate of 2.4% since 2006, less than that for NSW as a whole (14.2% between 2006 and 2016) and less than that for regional NSW.

Table 5.1 - Population growth

	2006	2011	2016	Growth 2006 - 2016	Growth 2011 - 2016	Growth Rate 2006 - 2016
Snowy Valleys	14,335	14,292	14395	-0.3%	0.7%	0.4%
Snowy Monaro Regional	19,452	19,689	20216	1.2%	2.7%	3.9%
Total Region	**33,787**	**33,981**	**34,611**	**0.6%**	**1.9%**	**2.4%**
New South Wales	**6,549,177**	**6,917,658**	**7,480,228**	**5.6%**	**8.1%**	**14.2%**

Source: ABS Census of Population and Housing, Place of Usual Residence

The NSW Department of Planning and Environment's (DPE) population forecasts for the two LGAs are given in Table 5.2. This suggests declining population in the region post 2026. The forecast small population growth in the region between 2016 and 2026 is driven by forecast small population growth in the Snowy Monaro LGA.

Table 5.2 - Population growth rate projections

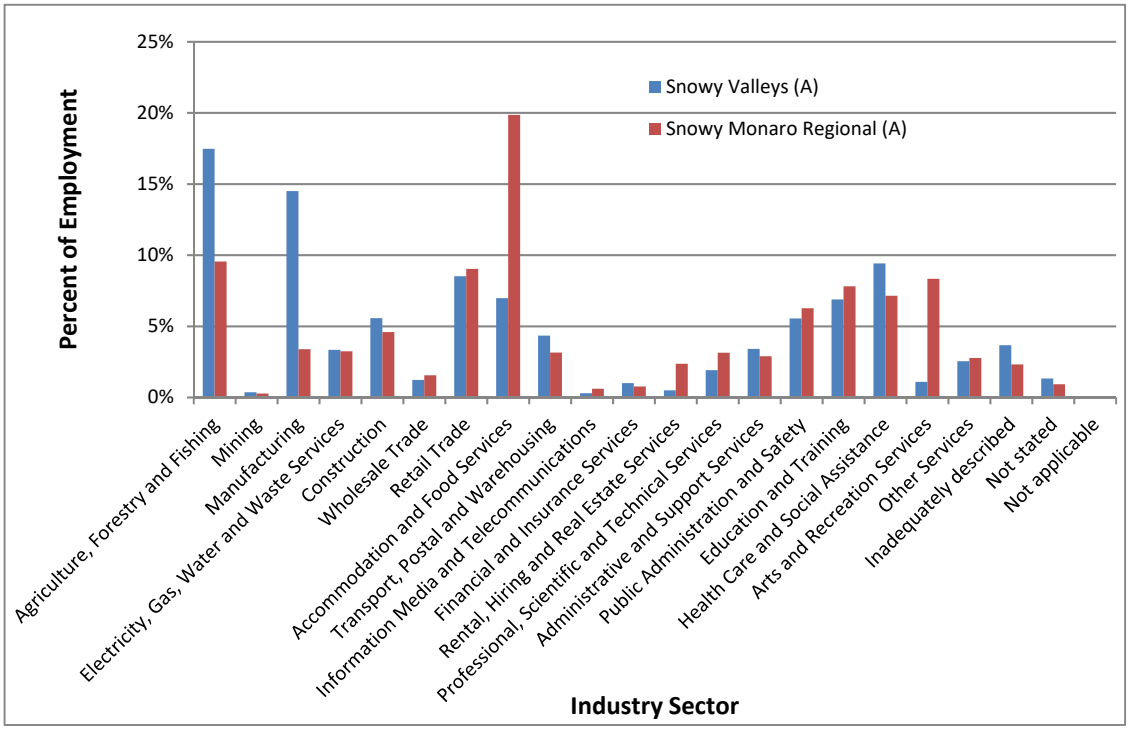
	2016 to 2021	2021 to 2026	2026 to 2031	2031 to 2036
Snowy Monaro	1.7%	1.2%	0.7%	0.2%
Snowy Valleys	-1.4%	-1.7%	-2.5%	-2.9%
Total Region	**0.4%**	**0.0%**	**-0.6%**	**-1.0%**

Source: NSW DPE (2019)

A broad indication of the nature of the economies can be gained by examining place of work employment by industry data for each of the LGAs - refer to Figure 5.1.

This indicates the significance of agriculture, forestry and fishing sector (predominantly beef cattle farming, sheep farming, fruit growing, forestry and logging), and manufacturing sector (timber and paper production manufacturing) to the Snowy Valleys LGA and the significance of accommodation and food services and retail trade sectors (reflecting the importance of tourism) and agriculture forestry and fishing (sheep and beef cattle farming) to the Snowy Monaro Regional LGA.

Figure 5.1 - Place of work employment by industry



Source: ABS Census of Population and Housing (2016), Place of Work.

A more detailed examination of the economy of the local region can be gained from preparation of an IO table for the economy.

A 2016 IO table of the regional economy was developed using the Generation of Input-Output Tables (GRIT) procedure (Attachment 3) using the 2015-16 IO table of the National economy (ABS 5209.0.55.001 Australian National Accounts: Input-Output Tables - 2015-16) as the parent table and a 2016 Census employment by industry data for NSW and the region. The 114 sector IO table of the regional economy was aggregated to 50 sectors and 8 sectors for the purpose of describing the economy.

A highly aggregated 2016 IO table for the regional economy is provided in Table 5.3. The rows of this table indicate how the gross regional output of an industry is allocated as sales to other industries, to households, to exports and other final demands (OFD - which includes stock changes, capital expenditure and government expenditure). For example, the manufacturing sector in the region sells $5M worth of output to the agriculture, forestry and fishing sector of the regional economy, $25M worth of output to the manufacturing sector of the regional economy etc. It also sells $27M of output directly to households and exports $461 worth of output from the region.

The corresponding column shows the sources of inputs to produce that gross regional output. These include purchases of intermediate inputs from other industries, the use of labour (household income), the returns to capital or other value-added (OVA - which includes gross operating surplus and net indirect taxes and subsidies) and goods and services imported from outside the region. The number of people employed in each industry is also indicated in the final row. For the manufacturing sector to produce $563M worth of output, it purchases $89M of inputs from the agriculture, forestry and fishing sector of the regional economy, $25M of inputs from the manufacturing sector of the regional economy etc. It also imports $175M of inputs from outside the region, generates $68M in other value added, employs 1,192 people and pays $91M in wages and salaries.

Output for the regional economy is estimated at $8B. Value-added for the regional economy is estimated at

$2B, comprising $975M to households as wages and salaries and $991M in OVA.

The total employment in the regional economy was 15,416 jobs.

The economic structure of the regional economy can be compared with that for NSW through a comparison of results from the respective IO models (Figures 5.2 and 5.3). This reveals that the agriculture/forest/fishing, manufacturing, utilities and trade/accommodation sectors in the regional economy are of greater relative importance than they are to the NSW economy, while the mining, and business services sectors are of less relative importance than they are to the NSW economy.

Figures 5.4 to 5.6 provide a more expansive sectoral distribution of gross regional output, employment, household income, value-added, exports and imports, and can be used to provide some more detail in the description of the economic structure of the regional economy. From these figures, it is evident that in terms of gross regional output, utilities, sheep, grains and beef, accommodation/restaurants and wood manufacturing are the most significant sectors (Figure 5.4). In terms of value-added, accommodation/restaurants and utilities are the most significant sectors (Figure 5.4). The accommodation/restaurants, retail trade and sheep, grains and beef sectors are the most significant sector in terms of regional employment (Figure 5.5) while the accommodation/restaurants, public administration and education sectors are the most significant sectors in terms of income (Figure 5.5). Major importing sectors include utilities and sheep, grains and beef, while major exporting sectors include sheep, grains and beef, wood manufacturing and accommodation and restaurants (Figure 5.6).

Table 5.3 - Aggregated Transactions Table: Regional Economy 2016 ($M)

	Ag, forestry, fishing	Mining	Manuf.	Utilities	Building	Trade/ Accom	Bus. Srvcs	Public/ Pers. Srvcs	TOTAL	Household Expenditure	OFD	Exports	Total
Ag, forestry, fishing	114	0	89	0	0	7	1	1	**213**	7	79	340	**640**
Mining	0	0	3	0	1	0	0	0	**5**	0	1	7	**13**
Manuf.	5	0	25	2	15	18	2	6	**73**	27	3	461	**563**
Utilities	11	0	10	158	3	9	10	10	**211**	25	240	78	**554**
Building	13	1	12	10	63	8	14	9	**130**	1	214	2	**347**
Trade/Accom	17	0	16	5	9	15	15	15	**92**	203	25	227	**547**
Bus.Srvcs	37	1	66	37	22	57	94	53	**367**	233	104	111	**815**
Public/Pers Srvcs	4	0	8	4	4	4	17	29	**70**	131	433	39	**674**
TOTAL	**202**	**3**	**229**	**216**	**117**	**119**	**154**	**123**	**1,162**	**628**	**1,099**	**1,264**	**4,153**
Household Income	97	2	91	50	69	180	184	301	**975**	-	-	-	**975**
OVA	177	3	68	62	43	116	283	92	**843**	90	57	1	**991**
Imports	165	5	175	225	119	131	195	157	**1,173**	504	114	46	**1,837**
TOTAL	**640**	**13**	**563**	**554**	**347**	**547**	**815**	**674**	**4,153**	**1,222**	**1,270**	**1,311**	**7,956**
Employment (no.)	**1,926**	**21**	**1,192**	**540**	**794**	**4,094**	**1,986**	**4,862**	**15,416**				

Figure 5.2 - Summary of Aggregated Sectors: Regional Economy (2016)

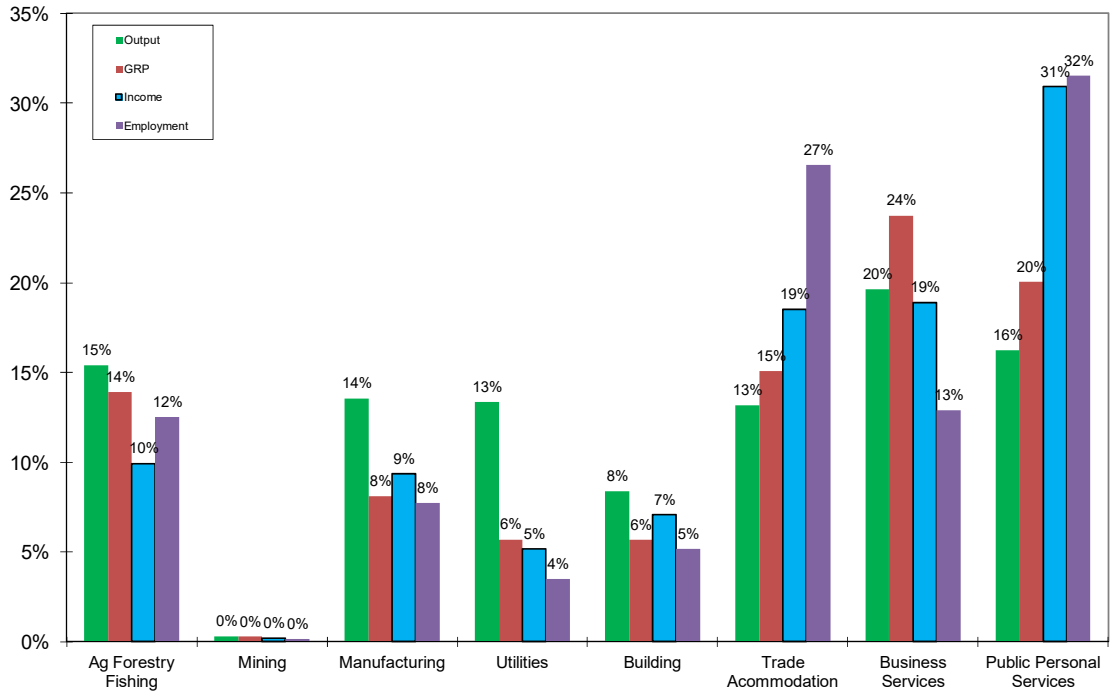


Figure 5.3 - Summary of Aggregated Sectors: NSW Economy (2016)

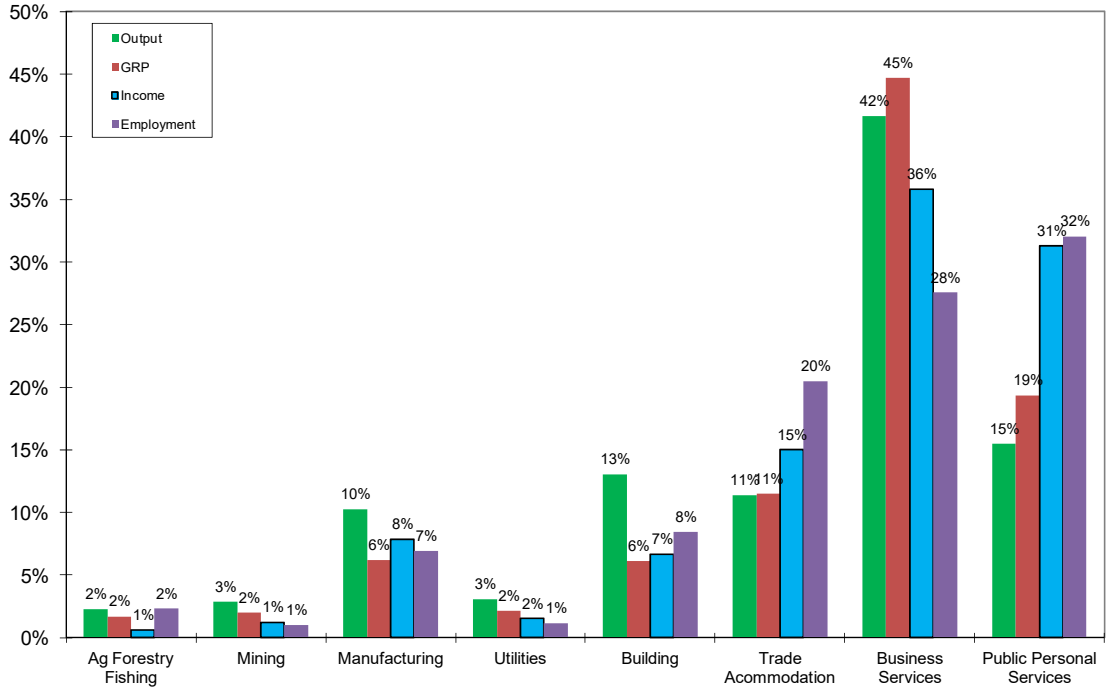


Figure 5.4 - Sectoral Distribution of Gross Regional Output and Value Added ($M)

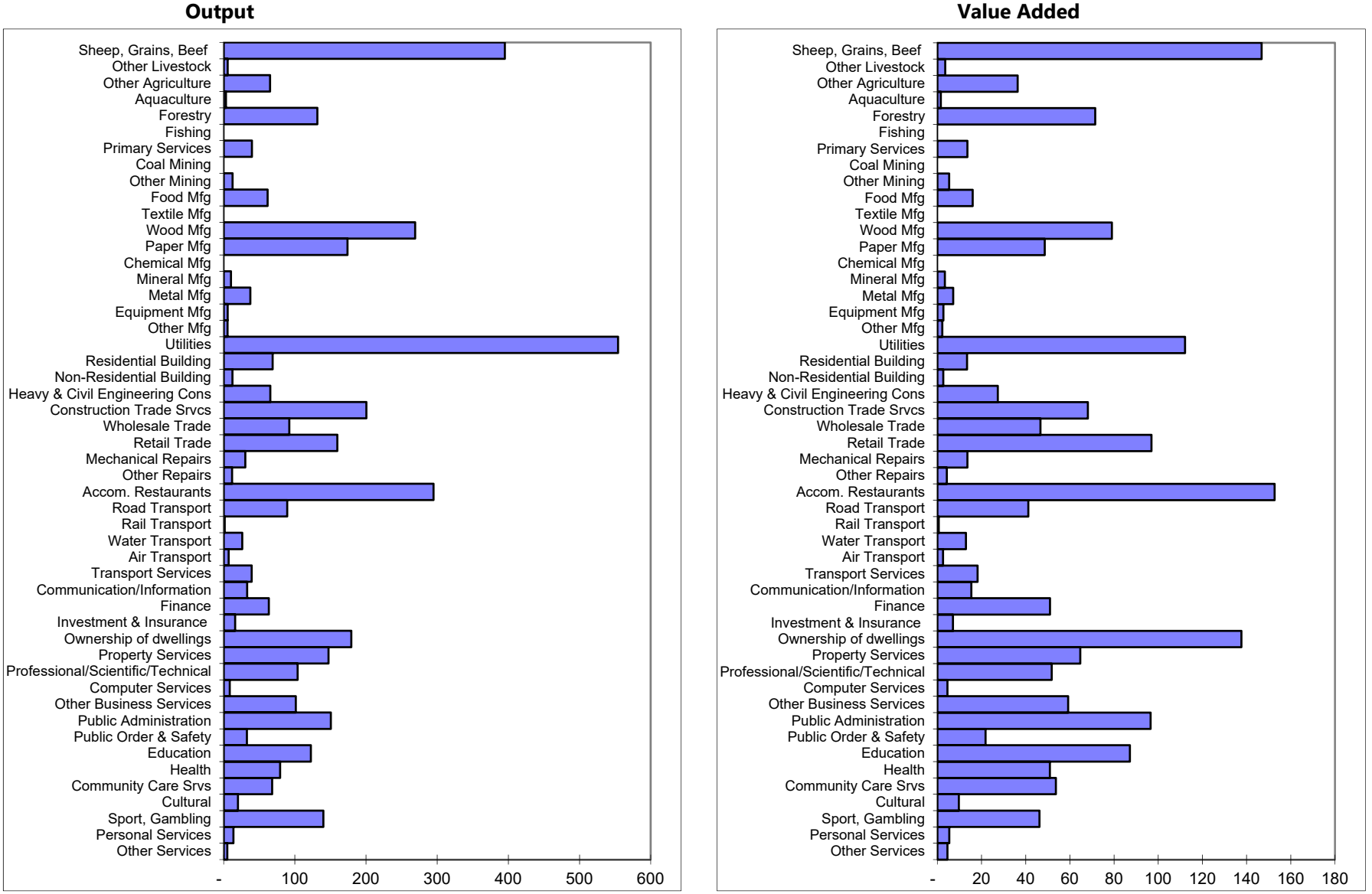


Figure 5.5 - Sectoral Distribution of Income ($M) and Employment (No.)

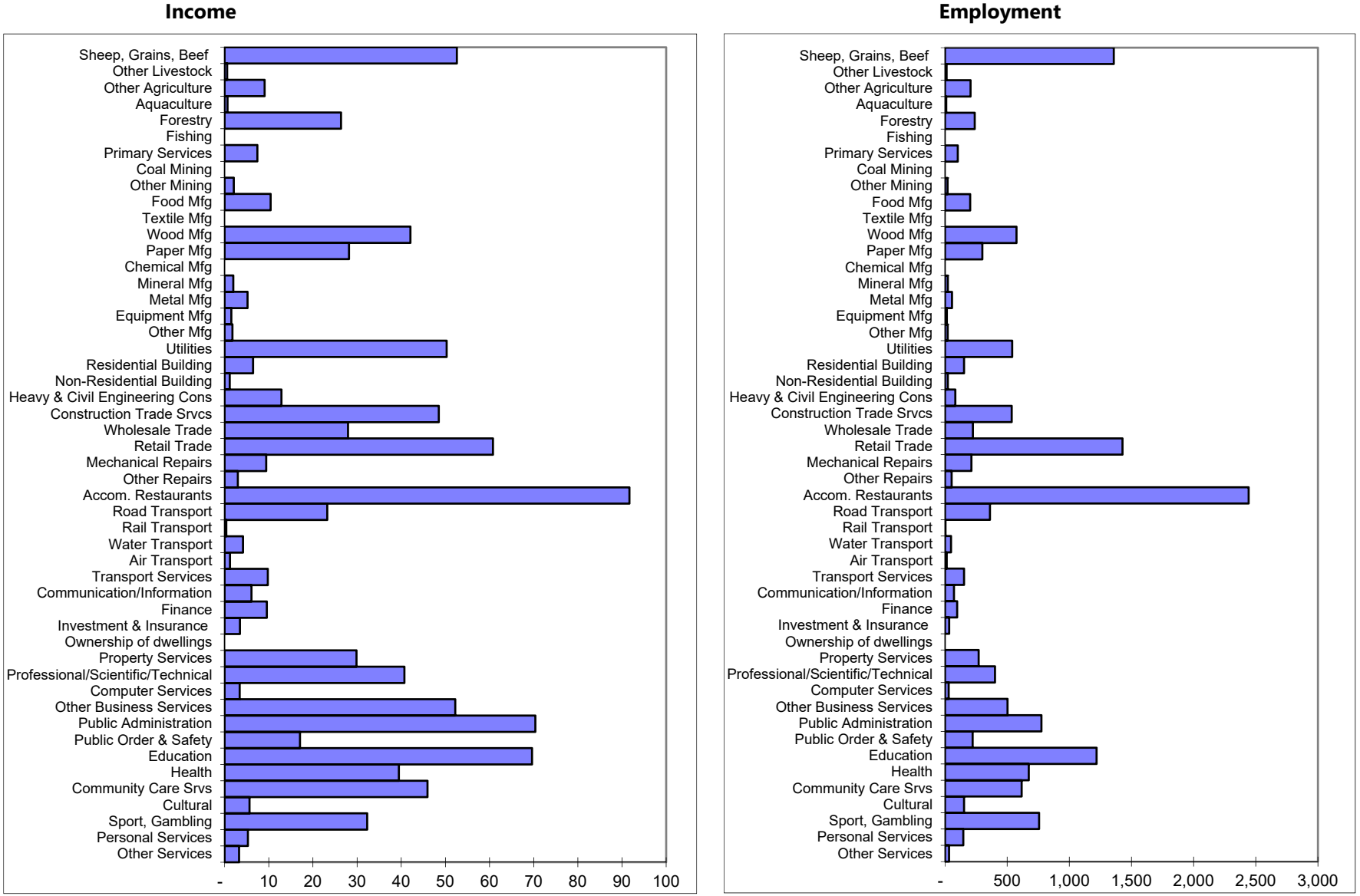


Figure 5.6 - Sectoral Distribution of Exports and Imports ($M)

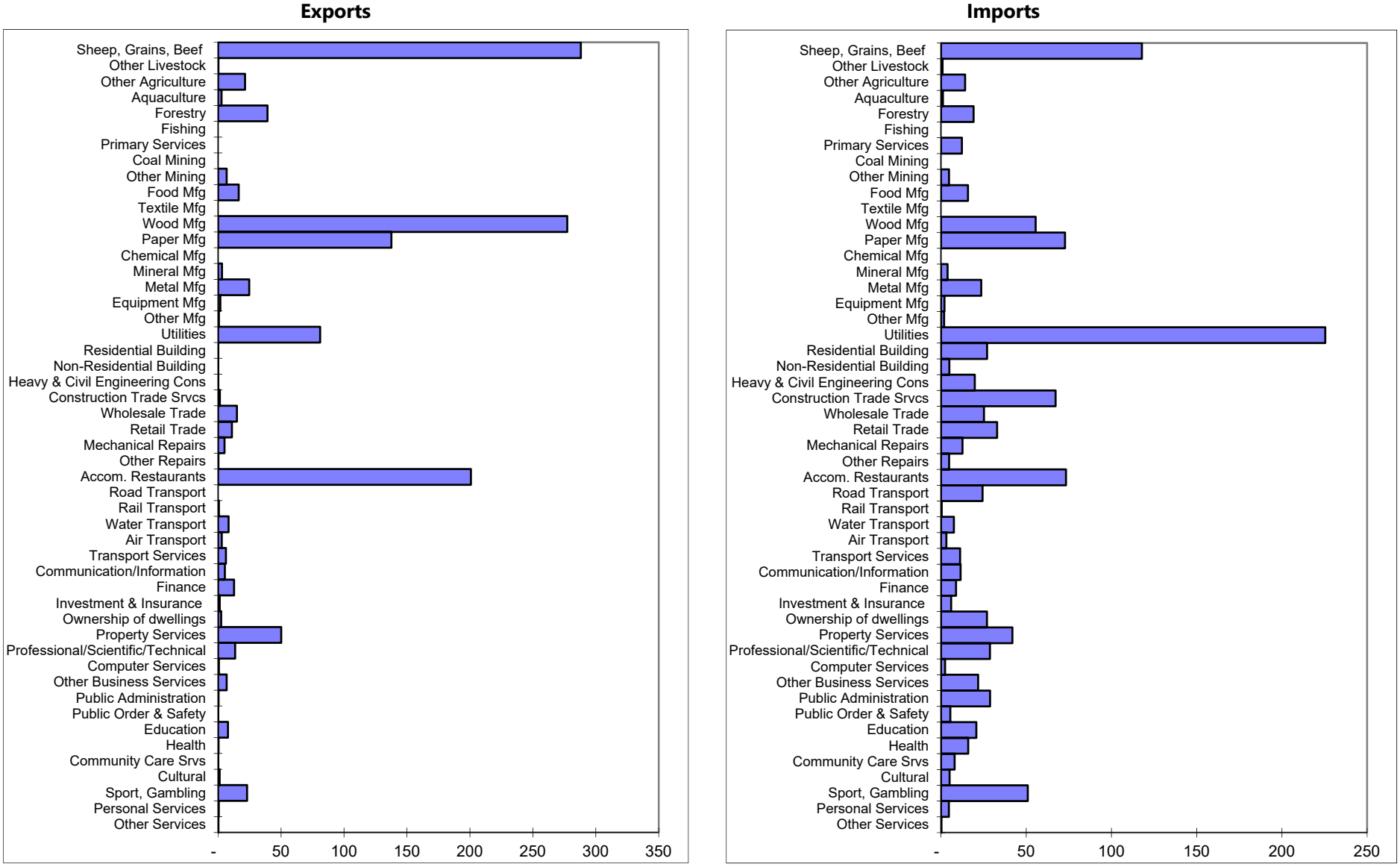
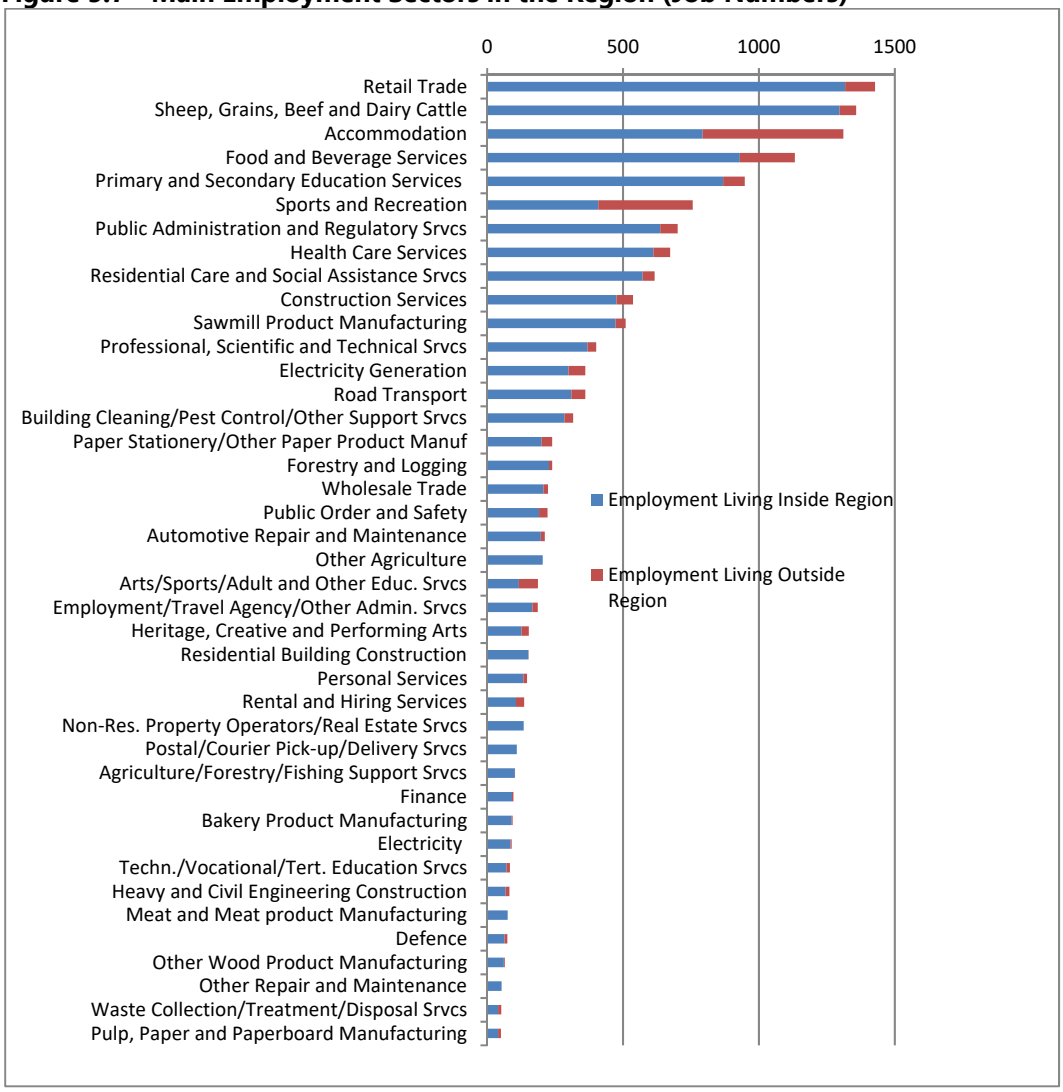


Figure 5.7 shows the top 40 individual industry sectors by employment number for the region. The five most significant employment providers in the region are retail trade, sheep/grains/beef/dairy cattle, accommodation, food and beverage services and primary and secondary education services. In the top 40 individual industry sectors by employment, 14% of the workforce resides outside the region. The sectors with the highest proportion of labour sourced from outside the region are accommodation, sport and recreation and food and beverage services.

Figure 5.7 - Main Employment Sectors in the Region (Job Numbers)



Source: Generated from ABS 2016 census 4 digit employment by industry by place of usual residence data.

5.3 Regional impacts

5.3.1 Introduction

The focus of the regional economic impact assessment is the economic activity that a project will bring to the local economy. The Main Works will have significant capital costs as well as some ongoing operational costs. Expenditure from the Main Works that can potentially be captured by the region within which it is located arises from:

- non-labour inputs; and
- expenditure of wages by labour.

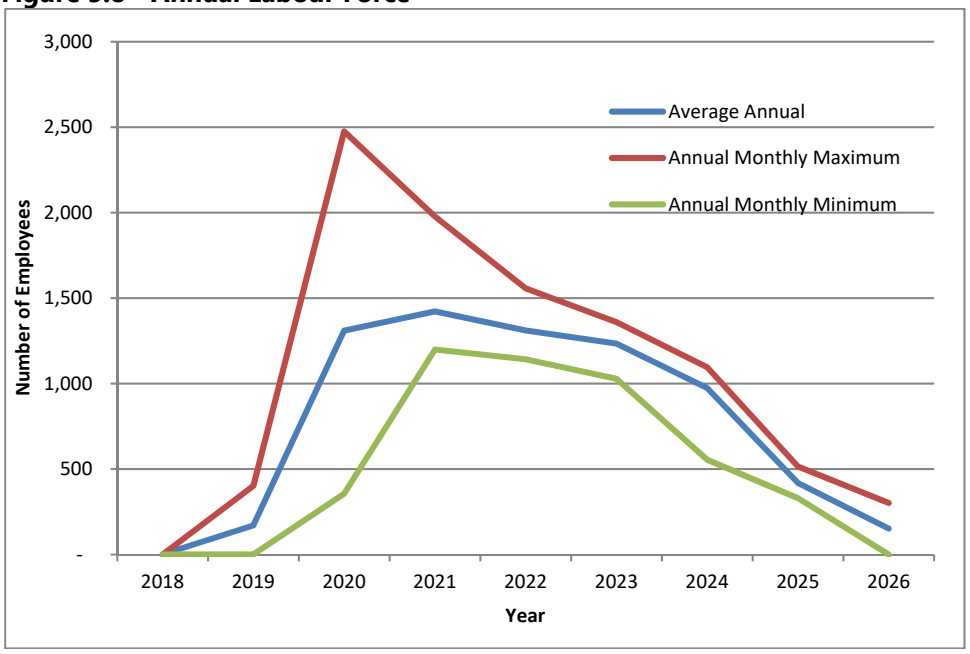
5.3.2 Non-labour inputs

Non-labour inputs to Main Works would include, but not be limited to, excavation and earthworks, buildings and sheds, reinforced concrete pipes, plant and equipment, concrete manufacturing, haulage and engineering services. These types of inputs are mainly from specialty manufacturing sectors, the heavy and civil engineering construction sector, road transport sector and from the professional, scientific and technical services sector. These types of sectors are poorly represented in the regional economy. Furthermore, the Main Works will be undertaken by a large, suitably qualified and experienced contracting company. The companies that undertake these types of developments frequently centralise their purchasing activities in capital cities, including overseas; tend to have an existing suite of suppliers that they have worked with before; and also often impose strict prequalification requirements which small to medium sized regional businesses find difficult and expensive to meet. Consequently, there is limited scope for the local supply of the major non-labour inputs to the project. Notwithstanding, some small regional businesses may be able to supply some of the minor non-labour inputs to production.

5.3.3 Labour inputs

Annual labour requirements for the project construction, measured as total number of employees, are illustrated in Figure 5.8.

Figure 5.8 - Annual Labour Force



The impact of the provision of employment in the region arises from:

- the additional wages spent in the region; and
- the ability of the regional economy to produce and provide the goods and services demanded by households.

The level of additional wages that are spent in the region depends initially on:

- where labour is sourced (which in turn depends on the location of labour that has the skills required for the Main Works); and
- where labour resides during the project while off shift.

The labour for the Main Works may potentially be sourced from:

- the local region either from:
  - the unemployment pool;
  - new entrants to the labour force; or
  - workers from other industries.
- outside the region with labour:
  - moving into the region to reside as a permanent resident during the employment period;
  - commuting from outside the region e.g. Fly-in-fly-out (FIFO) and Drive-in-drive-out (DIDO) and remaining in the region as a visitor when 'off swing'; or
  - commuting from outside the region e.g. Fly-in-fly-out (FIFO) and Drive-in-drive-out (DIDO) and returning home when 'off swing'.

Whether local labour is sourced from the unemployment pool, new labour force entrants or from other industries within the region, it can increase the level of wages in the region. The existence of job chain[6] effects means that whether employment is filled directly from the unemployment pool or from workers in other industries, the additional wages that accrue to the region approximates the difference between the wages in the new job and unemployment benefits. To the extent that the job chain effects is only partial, the additional wages in the region will be less than this. However, to the extent that the job chain effects reaches all the way to new participants in the labour force, the additional wages in the region will be greater than this.

Where labour is sourced from outside the region and migrates into the region to live, the additional wages in the region is equivalent to the full wages of the job.

The impact of commuting workers depends on the extent to which they spend money in the regional economy. However, generally commuting workers will repatriate most of their wages back to their home region. Therefore, a commuting workforce will invariably have a large leakage of wage and salary income away from the region in which they are working. This is particularly the case where the commuting workforce reside in a remote accommodation camp. Where this commuting workforce choose from time to time to temporarily stay in the region when off shift, to enjoy recreation and other activities in the region, some of the wages will be captured by the region.

Not all wages that accrue to labour in a region are spent in a region. The amount of wage spending that is captured by a region will depend on its economic structure and the ability to provide the goods and services demanded by people. Generally the smaller a region the greater the leakage of

[6] The job chain effect refers to the situation where labour is sourced from other industries in the region making jobs available in those industries which are subsequently filled by people either from the unemployment pool or other industries with the latter making jobs available in that industry, etc.

expenditure to other areas. Even where wages are spent in the region, unless goods are also manufactured in the region only the margins on sales will accrue to the region.

Notwithstanding, any additional local spending creates opportunities for businesses to expand and/or establish within the region so as to service the increased local demand. The opportunities that arise from additional local spending associated with wages are often more available to local regional businesses than are opportunities for providing non-labour inputs to major projects.

5.3.4 Impact estimate

Table 5.4 - Employment Assumptions

		2018	2019	2020	2021	2022	2023	2024	2025	2026
Total Employment										
Average Annual		1	170	1,310	1,422	1,311	1,234	974	419	152
Annual Monthly Maximum		1	402	2,475	1,977	1,558	1,360	1,096	515	302
Annual Monthly Minimum		1	1	356	1,199	1,143	1,028	554	330	-
Source of Labour										
Local @	5%	0	9	66	71	66	62	49	21	8
Nonlocal @	95%	1	162	1,245	1,351	1,245	1,172	925	398	144
1. Relocate to broad region - % of 95% @	15%	0	24	187	203	187	176	139	60	22
1a. Relocate to local region i.e. Snowy Monaro and Snowy Valley LGAs - % of 15% @	73%	0	18	136	148	136	128	101	44	16
1b. Relocate wider region e.g. Canberra and Wagga Wagga- % of 15%@	27%	0	7	50	55	50	47	37	16	6
2. FIFO/DIDO from Outside local and wider region - % of 95% @	85%	1	138	1,058	1,148	1,058	996	787	338	123
Temporary Stays of FIFO/DIDO Labour % of FIFO/DIDO from Outside local and wider region off swing at any one time	66%	1	91	698	758	699	658	519	223	81
% of those off swing that remain as a visitor in the local region i.e. Snowy Monaro and Snowy Valley LGAs	15%	0	14	105	114	105	99	78	33	12

Source: Manpower Data and Elton Consulting Main Works Workforce Impact Scenario Analysis

To estimate the impact of the Main Works on the regional economy the following assumptions were made:

- average annual employment is as per Figure 5.8 and Table 5.4;
- 5% jobs are sourced from the local labour force with 95% from the non-local labour force;
- 15% of nonlocal labour relocate into the wider region with their families to live, with 73% of these relocated to the Snowy Monaro and Snowy Valley LGAs;
- at any one time 66% of the FIFO/DIDO from outside the local and wider region are off swing with 15% of these staying as a visitor in local region;
- remaining workers are FIFO/DIDO.

Table 5.5 summarises the additional wages that initially accrue to the region assuming:

- an average wage of $208,000 (based on the average wage in the Heavy and Civil Engineering Construction sector in the National Input-Output Table);
- Newstart allowance of $14,000;
- labour sourced locally initially adds the difference between an average wage in the Heavy and Civil Engineering Construction sector and the Newstart allowance;
- labour relocating into the region initially adds the wage in the Heavy and Civil Engineering Construction sector; and

- 25% of the wage of those staying the region between swings initially accrues to the region.
- all FIFO/DIDO wages are repatriated to their home region

Table 5.5 - Potential additional annual wages accruing to the region ($000)

Category of Labour Contributing Additional Wages to the Region	2018	2019	2020	2021	2022	2023	2024	2025	2026	Total	Average Annual
Labour sourced locally	11	1,654	12,711	13,794	12,715	11,967	9,449	4,060	1,474	67,834	7,537
Inmigration with family	24	3,689	28,353	30,770	28,362	26,694	21,077	9,057	3,288	151,313	16,813
Stay in region between Swings	5	709	5,447	5,912	5,449	5,129	4,049	1,740	632	29,071	3,230
Total Additional Wages in Region	**39**	**6,051**	**46,511**	**50,476**	**46,526**	**43,790**	**34,575**	**14,857**	**5,393**	**248,217**	**27,580**
Wages Available for Expenditure (57%)	22	3,449	26,511	28,771	26,520	24,960	19,708	8,468	3,074	141,484	15,720
Wages Spent in Regional Economy (51%)	**11**	**1,759**	**13,521**	**14,673**	**13,525**	**12,730**	**10,051**	**4,319**	**1,568**	**72,157**	**8,017**

Based on the ABS Household Expenditure Survey, Australia: Summary of Results, 2015–16 for the highest Quintile of Disposable Household Income, 57% of these wages are available for expenditure on goods and services (i.e. after income tax and super etc). Based on the household sector in the IO table developed for the region using the Generation of Regional Input-Output Tables (GRIT) procedure (refer to Attachment 4), 51% of the expenditure that is available for goods and services, would accrue to the regional economy with the remainder leaking outside the region.

Assuming an expenditure profile as per the household sector in the regional IO table, the economic impact of the average annual additional wage expenditure ($8M) in the regional economy would be:

- $11.60M in annual direct and indirect regional output;
- $6.76M in annual direct and indirect value-added;
- $2.58M in annual direct and indirect income; and
- 52 direct and indirect jobs.

Table 5.6 - Direct and indirect impact of average annual additional wage expenditure in the region

	Direct Effect	Production Induced	Consumption Induced	Total Flow-on	TOTAL IMPACT
OUTPUT ($M)	8.02	1.94	1.64	3.58	11.60
Type 11A Ratio	1.00	0.24	0.21	0.45	1.45
VALUE-ADDED ($M)	4.89	0.91	0.96	1.87	6.76
Type 11A Ratio	1.00	0.19	0.20	0.38	1.38
INCOME ($M)	1.78	0.43	0.37	0.80	2.58
Type 11A Ratio	1.00	0.24	0.21	0.45	1.45
EMPLOYMENT (No.)	38	6	7	14	52
Type 11A Ratio	1.00	0.17	0.19	0.36	1.36

However, wage expenditure impacts would change annually as employment ramps up and down. The annual direct and indirect output, value-added, income and employment impacts of wage expenditure in the local area is summarised in Table 5.6.

Table 5.7 - Annual Impacts from Wage Expenditure Associated with the Main Works

Economic Activity Indicator	2018	2019	2020	2021	2022	2023	2024	2025	2026	Average Annual
Direct Output ($M)	0	2	14	15	14	13	10	4	2	8
Flow-on Output ($M)	0	1	6	7	6	6	4	2	1	4
Total Output ($M)	***0***	***3***	***20***	***21***	***20***	***18***	***15***	***6***	***2***	***12***
Direct Value-added ($M)	0	1	8	9	8	8	6	3	1	5
Flow-on Value-added ($M)	0	0	3	3	3	3	2	1	0	2
Total Value-added($M)	***0***	***1***	***11***	***12***	***11***	***11***	***8***	***4***	***1***	***7***
Direct Income ($M)	0	0	3	3	3	3	2	1	0	2
Flow-on Income ($M)	0	0	1	1	1	1	1	0	0	1
Total Income ($M)	***0***	***1***	***4***	***5***	***4***	***4***	***3***	***1***	***1***	***3***
Direct Employment (No.)	0	8	65	70	65	61	48	21	7	38
Flow-on Employment (No.)	0	3	23	25	23	22	17	7	3	14
Total Employment (No.)	***0***	***11***	***88***	***95***	***88***	***83***	***65***	***28***	***10***	***52***

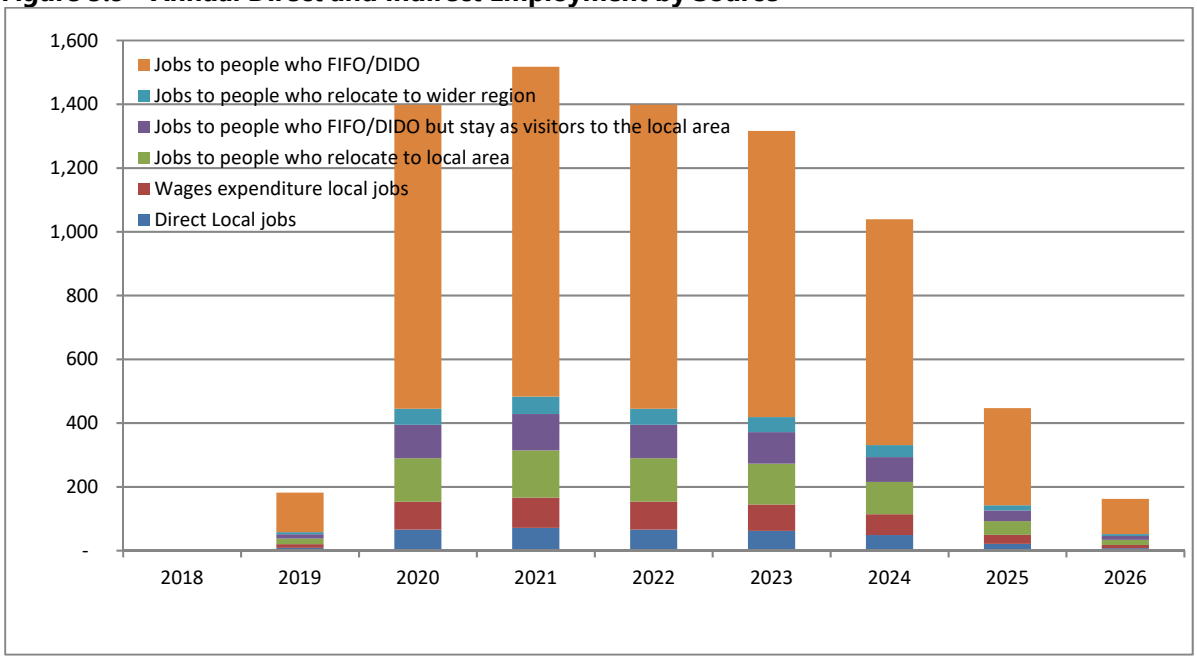
The local employment generated by wage expenditure is summarised in the final three rows of Table 5.7. To obtain the total local employment it is necessary to also add employment identified in Table 5.4 that is sourced locally. Hence, employment generated for those already living in the local area is summarised in Table 5.8 and averages 91 jobs.

Table 5.8 - Annual Local Employment Impacts of the Main Works

Economic Activity Indicator	2018	2019	2020	2021	2022	2023	2024	2025	2026	Average Annual
Direct Local Employment Engaged in Snowy 2.0 (No.)	0	9	66	71	66	62	49	21	8	39
Local Employment from Wage Expenditure (No.)	0	11	88	95	88	83	65	28	10	52
Total Local Employment (No.)	**0**	**20**	**153**	**166**	**153**	**144**	**114**	**49**	**18**	**91**

The annual direct and indirect employment by source is summarised by Figure 5.9.

Figure 5.9 - Annual Direct and Indirect Employment by Source



Positive local employment and business opportunities can be maximised via:

- opportunities being given to the employment of local workers where they have the necessary skills and experience;
- providing and/or collaborating with local education facilities to provide, ongoing training and certification opportunities for local workers to ensure they have the necessary skills to work on the project;
- collaborating with Councils, economic development organisations, local chambers of commerce and State Government to:
  - Inform local business of the goods and services required of the project, service provision opportunities and compliance requirements of business to secure contracts.
  - To encourage local business to meet the requirements of the project for supply contracts.
  - Develop relevant networks to assist qualified local and regional businesses tender for provision of goods and services to support the project.

6 CONCLUSION

The project will have positive economic activity impacts for the local economy and on the NEM and hence State and National economies.

In terms of GSP the NSW/ACT NEM modelling region experiences the greatest uplift in economic activity, most significantly during the initial construction period but also during ongoing operations, with a net present value impact on GSP of $2,692M. The combination of ongoing NEM fuel savings and indirect economic activity through trade of goods and services drive corresponding increases in economic activity in other NEM states once operation of Snowy 2.0 begins. In aggregate across the NEM states and territories GSP increases by $4,176M in net present value terms.

In terms of GSI, the impact of Snowy 2.0 is an increase of $1,608M in net present value terms in the NSW/ACT NEM modelling region, and an aggregate NEM region impact of $2,982M.

The most significant impact on employment is in the NSW/ACT NEM region during the construction period, peaking at an economy wide impact of 451 full time equivalent employees in 2021/22, during which time other NEM regions experience only small increases or decreases in employment. The average aggregate impact across the NEM regions is an increase in employment of 324 FTE positions.

The Snowy Monaro Regional LGA and the Snowy Valleys LGA will also experience an increase in economic activity mainly from direct employment and capture in the region of additional wage expenditure.

The economic impact of the average annual additional wage expenditure ($8M) in the regional economy would be:

- $11.60M in annual direct and indirect regional output;
- $6.76M in annual direct and indirect value-added;
- $2.58M in annual direct and indirect income; and
- 52 direct and indirect jobs.

In terms of employment, there would be an additional average annual 39 jobs sourced from the local labour market over the project construction, giving an average annual regional employment of 91 local workers. Local jobs would peak at 166 in year 2021.

7 REFERENCES

Australian Bureau of Statistics (2016) *Census of Population and Housing*.

Bureau of Industry Economics (1994) *Regional Development: Patterns and Policy Implications*, AGPS, Canberra.

Collits, P. (2000) *Small Town Decline and Survival: Trends, Success Factors and Policy*, Issues Paper presented to the "Future of Australia's Country Towns" Conference at La Trobe University, Bendigo, June 2000.

Marsden Jacobs and Associates (2017) *NEM Outlook and Snowy 2.0*.

NSW Department of Planning and Environment (2019) *Population Projections*, www.planning.nsw.gov.au/Research-and-demography/demogrpahy/population-projections

Sorensen, A.D. (1990) Virtuous Cycles of Growth and Vicious Cycles of Decline: Regional Economic Change in Northern NSW. In *Change and Adjustment in Northern New South Wales*. Ed D.J. Walmsley, University of New England, Armidale.

West, G. (1993) *Input-Output Analysis for Practitioners, Version 7.1, User's Guide*.

ATTACHMENT 1 – UNDERLYING ASSUMPTIONS AND INTERPRETATIONS OF INPUT-OUTPUT ANALYSIS AND MULTIPLIERS

1. "The *basic assumptions* in IO analysis include the following:

   - there is a fixed input structure in each industry, described by fixed technological coefficients (evidence from comparisons between IO tables for the same country over time have indicated that material input requirements tend to be stable and change but slowly; however, requirements for primary factors of production, that is labour and capital, are probably less constant);
   - all products of an industry are identical or are made in fixed proportions to each other;
   - each industry exhibits constant returns to scale in production;
   - unlimited labour and capital are available at fixed prices; that is, any change in the demand for productive factors will not induce any change in their cost (in reality, constraints such as limited skilled labour or investment funds lead to competition for resources among industries, which in turn raises the prices of these scarce factors of production and of industry output generally in the face of strong demand); and
   - there are no other constraints, such as the balance of payments or the actions of government, on the response of each industry to a stimulus.

2. The multipliers therefore describe *average effects, not marginal effects*, and thus do not take account of economies of scale, unused capacity or technological change. Generally, average effects are expected to be higher than the marginal effects.

3. The IO tables underlying multiplier analysis only take account of one form of *interdependence***,** namely the sales and purchase links between industries. Other interdependence such as collective competition for factors of production, changes in commodity prices which induce producers and consumers to alter the mix of their purchases and other constraints which operate on the economy as a whole are not generally taken into account.

4. The combination of the assumptions used and the excluded interdependence means that IO multipliers are higher than would realistically be the case. In other words, they tend to *overstate* the potential impact of final demand stimulus. The overstatement is potentially more serious when large changes in demand and production are considered.

5. The multipliers also do not account for some important pre-existing conditions. This is especially true of Type II multipliers, in which employment generated and income earned induce further increases in demand. The implicit assumption is that those taken into employment were previously unemployed and were previously consuming nothing. In reality, however, not all 'new' employment would be drawn from the ranks of the unemployed; and to the extent that it was, those previously unemployed would presumably have consumed out of income support measures and personal savings. Employment, output and income responses are therefore overstated by the multipliers for these additional reasons.

6. The most *appropriate interpretation* of multipliers is that they provide a relative measure (to be compared with other industries) of the interdependence between one industry and the rest of the economy which arises solely from purchases and sales of industry output based on estimates of transactions occurring over a (recent) historical period. Progressive departure from these conditions would progressively reduce the precision of multipliers as predictive device" (ABS 1995, p.24).

Multipliers indicate the total impact of changes in demand for the output of any one industry on all industries in an economy (ABS, 1995). Conventional output, employment, value-added and income

multipliers show the output, employment, value-added and income responses to an initial output stimulus (Jensen and West, 1986).

Components of the conventional output multiplier are as follows:

Initial effect - which is the initial output stimulus, usually a $1 change in output from a particular industry (Powell and Chalmers, 1995; ABS, 1995).

First round effects - the amount of output from all intermediate sectors of the economy required to produce the initial $1 change in output from the particular industry (Powell and Chalmers, 1995; ABS, 1995).

Industrial support effects - the subsequent or induced extra output from intermediate sectors arising from the first round effects (Powell and Chalmers, 1995; ABS, 1995).

Production induced effects - the sum of the first round effects and industrial support effects (i.e. the total amount of output from all industries in the economy required to produce the initial $1 change in output) (Powell and Chalmers, 1995; ABS, 1995).

Consumption induced effects - the spending by households of the extra income they derive from the production of the extra $1 of output and production induced effects. This spending in turn generates further production by industries (Powell and Chalmers, 1995; ABS, 1995).

The *simple multiplier* is the initial effect plus the production induced effects.

The *total multiplier* is the sum of the initial effect plus the production-induced effect and consumption-induced effect.

Conventional employment, value-added and income multipliers have similar components to the output multiplier, however, through conversion using the respective coefficients show the employment, value-added and income responses to an initial output stimulus (Jensen and West, 1986).

For employment, value-added and income, it is also possible to derive relationships between the initial or own sector effect and flow-on effects. For example, the flow-on income effects from an initial income effect or the flow-on employment effects from an initial employment effect, etc. These own sector relationships are referred to as ratio multipliers, although they are not technically multipliers because there is no direct line of causation between the elements of the multiplier. For instance, it is not the initial change in income that leads to income flow-on effects, both are the result of an output stimulus (Jensen and West, 1986).

A description of the different ratio multipliers is given below.

$$\text{Type 1A Ratio Multiplier} = \frac{\text{Initial + First Round Effects}}{\text{Initial Effects}}$$

$$\text{Type 1B Ratio Multiplier} = \frac{\text{Initial + Production Induced Effects}}{\text{Initial Effects}}$$

$$\text{Type 11A Ratio Multiplier} = \frac{\text{Initial + Production Induced + Consumption Induced Effects}}{\text{Initial Effects}}$$

$$\text{Type 11B Ratio Multiplier} = \frac{\text{Flow-on Effects}}{\text{Initial Effects}}$$

Source: Centre for Farm Planning and Land Management (1989).

REFERENCES

Australian Bureau of Statistics (1995) Information Paper Australian National Accounts Introduction to Input-Output Multipliers. Cat. No. 5246.0.

Centre for Farm Planning and Land Management (1989) *Consultants report to State plantations impact study*. CFPLM, University of Melbourne.

Jensen, R. and West, G. (1986) *Input-output for Practitioners: Theory and Applications*. Prepared for Department of Local Government and Administrative Services, Local Government and Regional Development Division, Australian Government Publishing Service.

Powell, R. and Chalmers, L. (1995) *The Regional Economic Impact of Gibraltar Range and Dorrigo National Park*. A Report for the NSW National Parks and Wildlife Service.

ATTACHMENT 2 – INPUT-OUTPUT ANALYSIS AND COMPUTABLE GENERAL EQUILIBRIUM ANALYSIS

Input-Output Analysis

- IO analysis is a cost effective and simple method for estimating the gross market economic activity i.e. financial transactions and employment, in a specified region that is associated with a project.
- IO analysis is the most widely used model for regional impact assessment (West and Jackson 2005).
- IO analysis can be undertaken at the LGA or aggregation of LGAs level.
- IO analysis can provide disaggregation of economic activity impacts across many sectors – 111 sectors based on current National IO tables.
- IO analysis was developed by Wassily Leontief for which he received the Nobel Prize in Economics.
- IO analysis is a static analysis that looks at economic activity impacts in a particular year e.g. a typical year of a projects operation.
- IO analysis has historically been applied at the regional level to assess the economic activity impacts of individual projects.
- IO analysis involves the development of an IO table representing the buying and selling of goods and services in the economy. These fixed average ratios are used to estimate the direct and indirect impacts of a change in expenditure in a region.
- IO analysis identifies the gross direct and indirect additional (positive) regional economic activity associated with a project in terms of a number of indicators of economic activity – output, income, value-added[7] and employment.
- Economic activity measures used in IO are not measures of benefits and costs relevant to a BCA.
- IO analysis does not attempt to examine non-market environmental, social or cultural impacts.
- IO analysis undertaken at the regional level does not depend on the assumption *"that there is a ghost pool of highly skilled yet unemployed people"* in a region as suggested by a Land and Environment Court Judgement.
- The estimation of economic activity impacts in IO analysis are based on a number of simplifying assumptions – most notable is that the regional economy has **access to** sufficient labour and capital resources (from both **inside** and **outside** the region) so that an individual project does not result in any regional price changes e.g. wages in other industries or house rentals, which would lead to contractions ("crowding out") of economic activity in other sectors in the region.
- For the assessment of the impacts of individual projects on small open regional economies, this is a reasonable assumption.
- Nevertheless, the results of IO modelling can be seen as representing an upper bound for the net economic activity associated with a project.

[7] Value-added is the difference between the gross value of business turnover and the costs of the inputs of raw materials, components and services bought in to produce the gross regional output.

Computable General Equilibrium Modelling

- CGE modelling is an alternative more expensive, complicated but theoretically more sophisticated method for estimating the economic activity associated with a project.
- CGE modelling can be dynamic or comparative static[8] and has historically been applied at the State and National level for determining the potential economic activity associated with the introduction of major government policy changes and investment in large infrastructure projects.
- CGE modelling can also be undertaken at a regional level but normally at no finer scale than the Statistical Subdivision level.
- CGE modelling estimates the additional net (positive and negative) economic activity associated with a project in terms of a number of economic indicators – including value-added and employment – but also real income, government tax revenue and components of value-added.
- Economic activity measures used in CGE modelling are not generally measures of benefits and costs relevant to a BCA, although CGE modelling can also be used to estimate market costs or market benefits, as part of a BCA, where the magnitude of a project will affect a large number of sectors and the effects will be spread more broadly throughout the economy.
- Economic activity impacts can be disaggregated by sector but this is not normally as disaggregated as in IO analysis.
- CGE modelling does not attempt to examine non-market environmental, social or cultural impacts.
- CGE modelling is underpinned by an IO database as well as a system of interdependent behaviour and accounting equations which are based on economic theory (but mostly without econometric backing at the regional level).
- The equations in CGE models ensure that any change in demand in a region, no matter how small, translates into some change in prices and hence there is always some 'crowding out' of other economic activity in the region.
- At the regional level, CGE results can be very sensitive to changes in these behavioural assumptions.
- 'Crowding out' of other economic activities estimated via CGE modelling does not reflect losses of jobs but the shifting of labour resources to higher valued economic activities.

[8] Comparative static models compare one equilibrium point with another but do not trace the impact path along the way. Dynamic models give year by year impacts of a shock.

ATTACHMENT 3 – THE GRIT SYSTEM FOR GENERATING INPUT-OUTPUT TABLES

The Generation of Regional Input-Output Tables (GRIT) system was designed to:

- combine the benefits of survey based tables (accuracy and understanding of the economic structure) with those of non-survey tables (speed and low cost);
- enable the tables to be compiled from other recently compiled tables;
- allow tables to be constructed for any region for which certain minimum amounts of data were available;
- develop regional tables from national tables using available region-specific data;
- produce tables consistent with the national tables in terms of sector classification and accounting conventions;
- proceed in a number of clearly defined stages; and
- provide for the possibility of ready updates of the tables.

The resultant GRIT procedure has a number of well-defined steps. Of particular significance are those that involve the analyst incorporating region-specific data and information specific to the objectives of the study. The analyst has to be satisfied about the accuracy of the information used for the important sectors; in this case the other mining sector. The method allows the analyst to allocate available research resources to improving the data for those sectors of the economy that are most important for the study.

An important characteristic of GRIT-produced tables relates to their accuracy. In the past, survey-based tables involved gathering data for every cell in the table, thereby building up a table with considerable accuracy. A fundamental principle of the GRIT method is that not all cells in the table are equally important. Some are not important because they are of very small value and, therefore, have no possibility of having a significant effect on the estimates of multipliers and economic impacts. Others are not important because of the lack of linkages that relate to the particular sectors that are being studied. Therefore, the GRIT procedure involves determining those sectors and, in some cases, cells that are of particular significance for the analysis. These represent the main targets for the allocation of research resources in data gathering. For the remainder of the table, the aim is for it to be 'holistically' accurate (Jensen, 1980). This means a generally accurate representation of the economy is provided by the table, but does not guarantee the accuracy of any particular cell. A summary of the steps involved in the GRIT process is shown in Table A31 (Powell and Chalmers, 1995).

Table A3.1
The GRIT Method

Phase	Step	Action
PHASE I		ADJUSTMENTS TO NATIONAL TABLE
	1	Selection of national input-output table (106-sector table with direct allocation of all imports, in basic values).
	2	Adjustment of national table for updating.
	3	Adjustment for international trade.
PHASE II		ADJUSTMENTS FOR REGIONAL IMPORTS
		(*Steps 4-14 apply to each region for which input-output tables are required*)
	4	Calculation of 'non-existent' sectors.
	5	Calculation of remaining imports.
PHASE III		DEFINITION OF REGIONAL SECTORS
	6	Insertion of disaggregated superior data.
	7	Aggregation of sectors.
	8	Insertion of aggregated superior data.
PHASE IV		DERIVATION OF PROTOTYPE TRANSACTIONS TABLES
	9	Derivation of transactions values.
	10	Adjustments to complete the prototype tables.
	11	Derivation of inverses and multipliers for prototype tables.
PHASE V		DERIVATION OF FINAL TRANSACTIONS TABLES
	12	Final superior data insertions and other adjustments.
	13	Derivation of final transactions tables.
	14	Derivation of inverses and multipliers for final tables.

Source: Bayne and West (1988).

REFERENCES

Bayne, B. and West, G. (1988) *GRIT – Generation of Regional Input-Output Tables: Users Reference Manual*. Australian Regional Developments No. 15, Office of Local Government, Department of Immigration, Local Government and Ethnic Affairs, AGPS.

Jensen, G. (1980) The concept of accuracy in regional input-output models. *International Regional Science Review*, 5:2, pp.139-54.

Powell, R. and Chalmers, L. (1995) *The Regional Economic Impact of Gibraltar Range and Dorrigo National Park*. A Report for the NSW National Parks and Wildlife Service.

ATTACHMENT 4 – CGE ANALYSIS OF SNOWY 2.0

cadence|economics

THE ECONOMIC IMPACTS OF INVESTING IN SNOWY 2.0

BRIEFING REPORT FOR EMM CONSULTING

JUNE 2019

SUMMARY REPORT

- Cadence Economics have been engaged by EMM Consulting to undertake analysis of the economy wide impacts of Snowy 2.0. Snowy 2.0 is a pumped-hydro expansion of the Snowy scheme, scheduled to increase generation capacity by 2,000 MW. Further detail may be found in the project EIS.

- The analysis in this report draws in particular on detailed market modelling undertaken by Marsden Jacob Associates (MJA), combined with additional detail provided by Gillespie Economics.

    - The market modelling undertaken by MJA separately identifies the price impact by National Electricity Market (NEM) state and territory, and across the customer categories of residential, small to medium enterprise, large corporate, and industrial.

    - The modelling undertaken by MJA requires comparable levels of unserved energy both with and without Snowy 2.0.

- In terms of the economic impact there are three key drivers to our analysis:

    - The investment phase which represents an additional expenditure on capital to establish Snowy 2.0, with consequential impacts on the levels of investment required in the remainder of the NEM as measured from reference case levels;

    - A reduction in fuel use across the NEM as a result of increased hydroelectric capacity reducing the requirement for fossil fuel generation;

    - A flow on impact to electricity prices across the NEM.

- Our analysis is based on application of the CEGEM model, Cadence Economics' computable general equilibrium model. Models of this nature are used widely by both the private and public sectors to analyse the economic consequences of policy and projects proposals, including in the electricity sector.

- The results in this report compare two possible future scenarios, the first being a projection to 2050/51 without the Snowy 2.0 investment ('Without Snowy 2.0'), and the second being a projection to 2050/51 with the Snowy 2.0 investment ('With Snowy 2.0'). The difference in economic indicators between these two scenarios is the projected economic impact of the Snowy 2.0 investment.

- The construction and ongoing operation of Snowy 2.0 is projected to have significant impacts on the key macroeconomic measures of Gross State Product, Gross State Income, and full time equivalent employment.

- The impact on NSW/ACT Gross State Product is projected to be $2,692 million in net present value terms, with an aggregate impact on the NEM region of $4,176 million.

- Gross State Income is projected to increase in the NSW/ACT region by $1,608 million in net present value terms as a result of Snowy 2.0, with an aggregate NEM impact of $2,982 million.

- Economy wide employment in NSW/ACT is projected to increase by 451 full time equivalent in 2020/21. Average employment in the NEM over the entire modelling period is projected to increase by 324 FTE positions.

The investment

- The aggregated NEM investment path adopted in our modelling is shown in Figure 1, comprising both the direct investment in the Snowy 2.0 project and the reduced requirement for investment in the remainder of the NEM as a consequence. In net present value[1] terms, investment in the NEM is increased by $4,005 million.

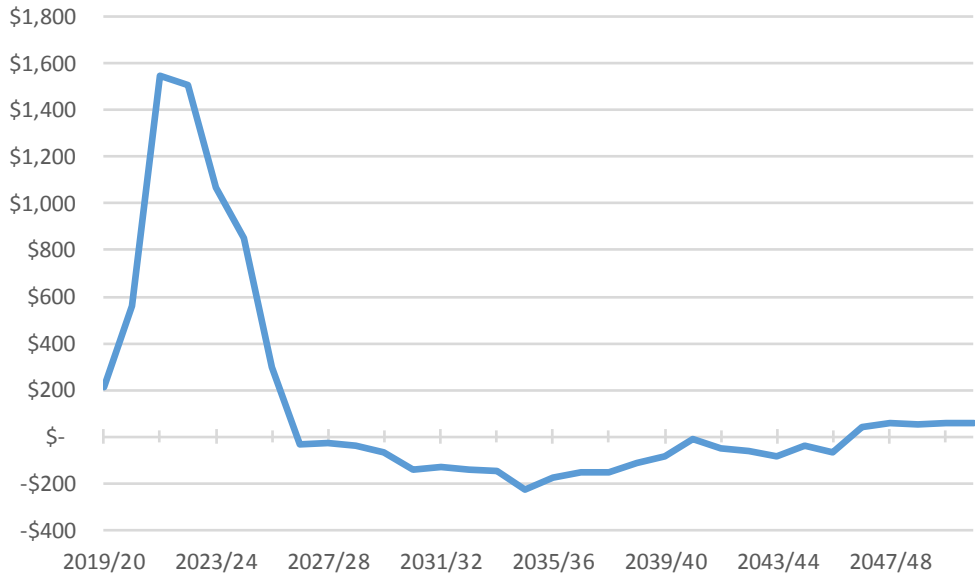
    - The investment profile shown represents the difference in NEM investment as a result of Snowy 2.0. That is, the level of investment with Snowy 2.0 versus the level of investment without Snowy 2.0.

    - Over the period from 2019/20 to 2025/26 there is an increase in investment directly attributable to the construction of Snowy 2.0

    - Over the period from 2026/27 onwards there is a net present value reduction in NEM investment to maintain comparable reliability standards of $614 million.

[1] All net present value calculations in this report adopt a real discount rate of 7% over the period 2019/20 to 2050/51

Figure 1 – Modelled investment profile, $AUD millions



Source: Gillespie Economics, Marsden Jacob Associates

- This is a commercial investment, and is assumed to result in no additional generation capacity between the two scenarios. Rather, it replaces a pre-existing baseline of electricity generation.

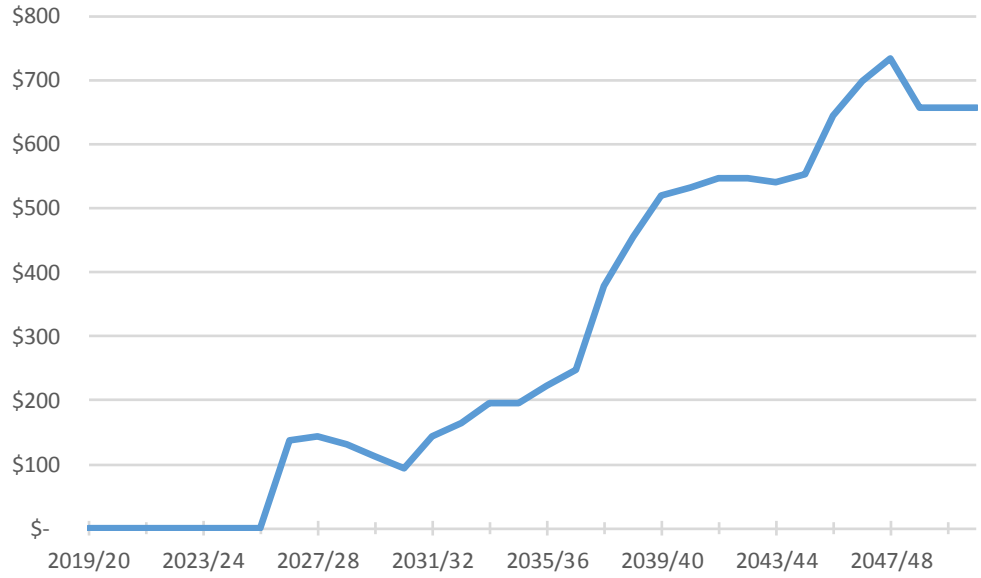
- The Snowy 2.0 investment takes place in the NSW region. The subsequent reduced investment in the NEM is assumed to be distributed across the remaining NEM states and territories according to their share of NEM generation.

- The increase in the capital stock in the NEM is a significant driver of the economic benefits in our modelling exercise.

Reduced NEM fuel requirements

- Figure 2 shows the modelled reduced fuel requirements in the NEM once the Snowy 2.0 capacity enters the market, with a peak saving of $733 million in 2047/48, and with a net present value of $2,164 million.

Figure 2 – Value of reduced fuel requirement in the NEM, $AUD millions



Source: Marsden Jacob Associates

- The reduction in system expenditure on fossil fuel is a significant driver of the economic benefits in our modelling exercise.

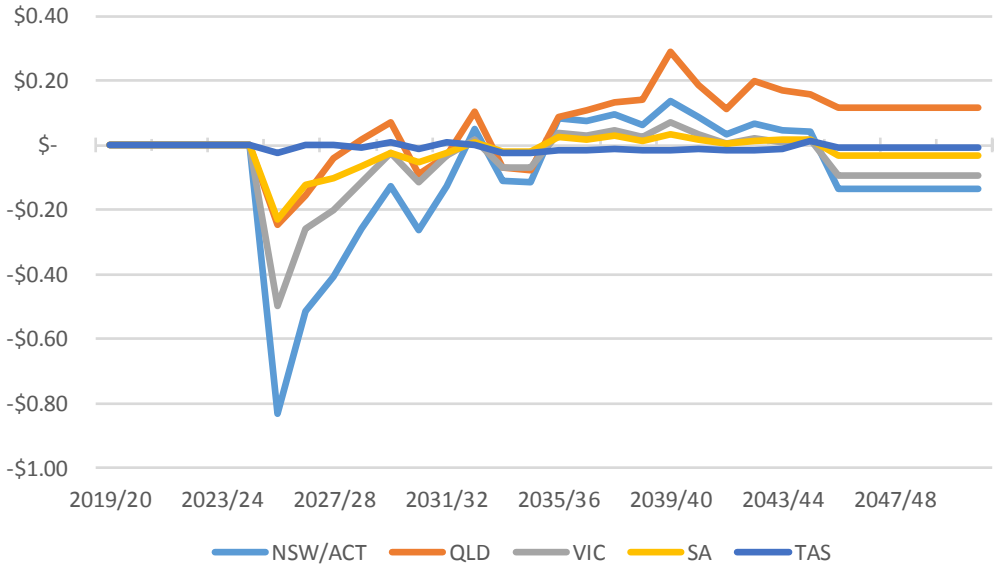
Electricity price effects

- The results of market modelling indicate that electricity prices in the NEM are anticipated to fall on average over the modelling horizon. Figure 3 shows the change in the value of electricity purchased in each of the NEM regions as a result of price changes.

    - The changes in prices drive only modest savings across the NEM, reducing the value of electricity purchased by $2.37 million in net present value terms over the modelling period. The combined New South Wales and Australian Capital Territory region experiences the largest saving of $1.39 million, while the value of electricity purchased in Queensland increases by $0.17 million.

    - The changes in the value of electricity purchased are a result of price changes alone.

Figure 3 – Change in value of electricity purchased, $AUD millions



Source: Marsden Jacob Associates, Cadence Economics estimates

- The combination of an increase in the electricity market capital stock, the reduced fuel requirement in the NEM, and a muted impact on prices reflects an increase in the value added share of the NEM market.

Our modelling approach

- The economy wide impacts of the market impacts described above have been estimated using our in-house computable general equilibrium model, the CEGEM model.

- This modelling does not take into account the value of any changes in greenhouse gas emissions as a result of the construction and ongoing operations of Snowy 2.0, nor any interaction between Snowy 2.0 and any state or territory emissions reduction schemes.

- Appendix 1 provides additional detail on the CEGEM model, however for this analysis the key features are:

    - Regional detail: The CEGEM model has flexible regional detail. For this analysis the states and territories of Australia have been separately identified, with the exception of the Australian Capital Territory which is aggregated in with NSW. This degree of detail allows us to implement the results of MJA electricity market modelling on a state by state basis.

    - Sectoral detail: The CEGEM model for this exercise has been specified with 17 separate industry classifications, covering all production sectors and allowing the impacts on small to medium enterprise, large commercial and industrial users to be individually imposed. Residential price changes are imposed on a standalone representative householder.

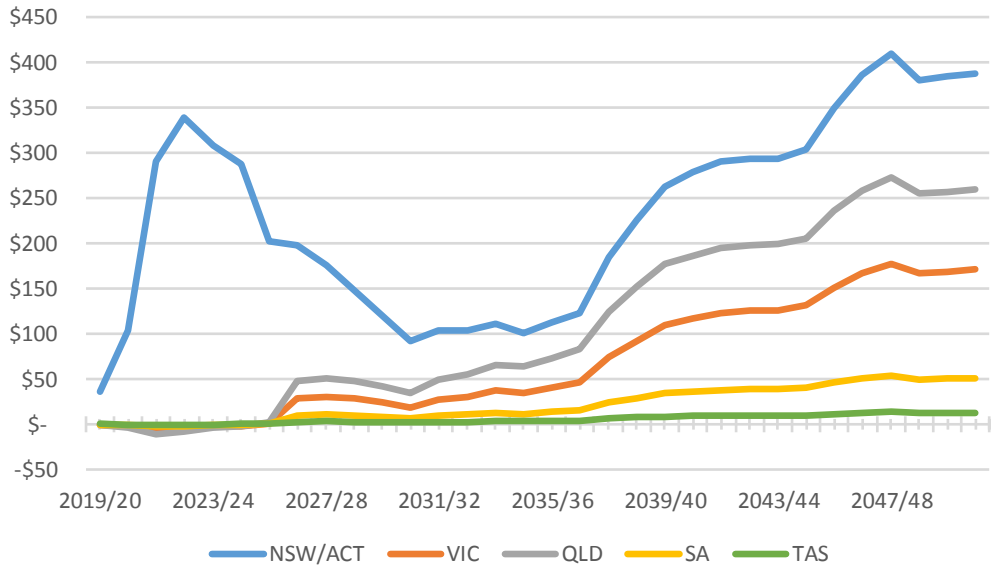
Results of the analysis

- The construction and operation of Snowy 2.0 has significant impact on economic outcomes for the NEM states and territories, as demonstrated in Figures 4 through 6.

- The Impact of Snowy 2.0 on Gross State Product (the state analogue of Gross Domestic Product) is shown in Figure 4. The combined NSW/ACT modelling region experiences the greatest uplift in economic activity, most significantly during the initial construction period but also during ongoing operations, with a net present value impact on GSP of $2,692 million.

- The combination of ongoing NEM fuel savings and indirect economic activity through trade of goods and services drive corresponding increases in economic activity in other NEM states once operation of Snowy 2.0 begins. In aggregate across the NEM states and territories Gross State Product increases by $4,176 million in net present value terms.

Figure 4 – Impact on Gross State Product, $AUD millions

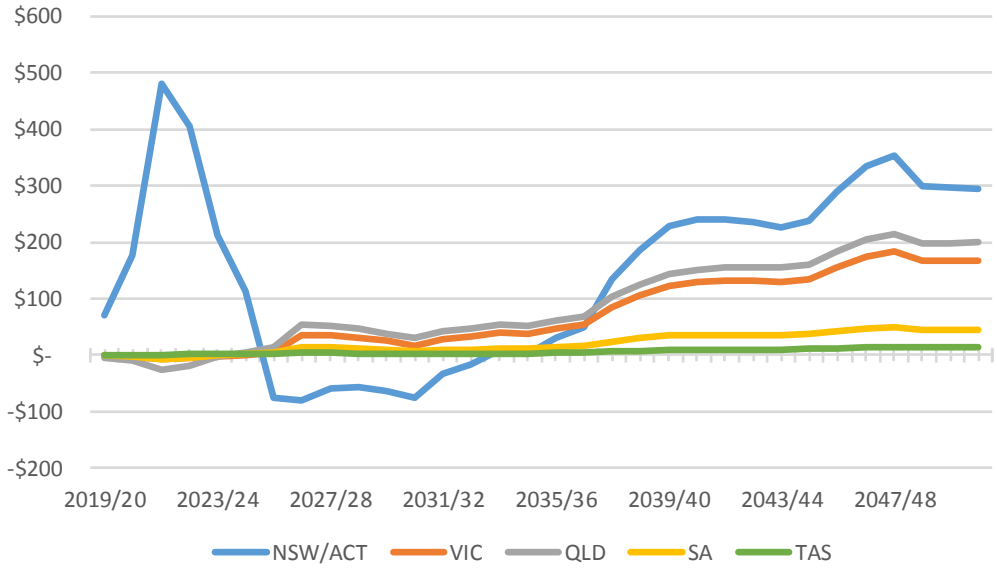


Source: Cadence Economics estimates

- Figure 5 shows the impact on Gross State Income (the state analogue of Gross National Income) for the NEM states and territories. Gross State Income increases by $1,608 million in net present value terms in the NSW/ACT modelling region, with an aggregate NEM region impact of $2,982 million.

    - Although less widely known, Gross State Income is a superior metric to Gross State Product for measuring impact on economic welfare.

Figure 5 – Impact on Gross State Income, $AUD millions

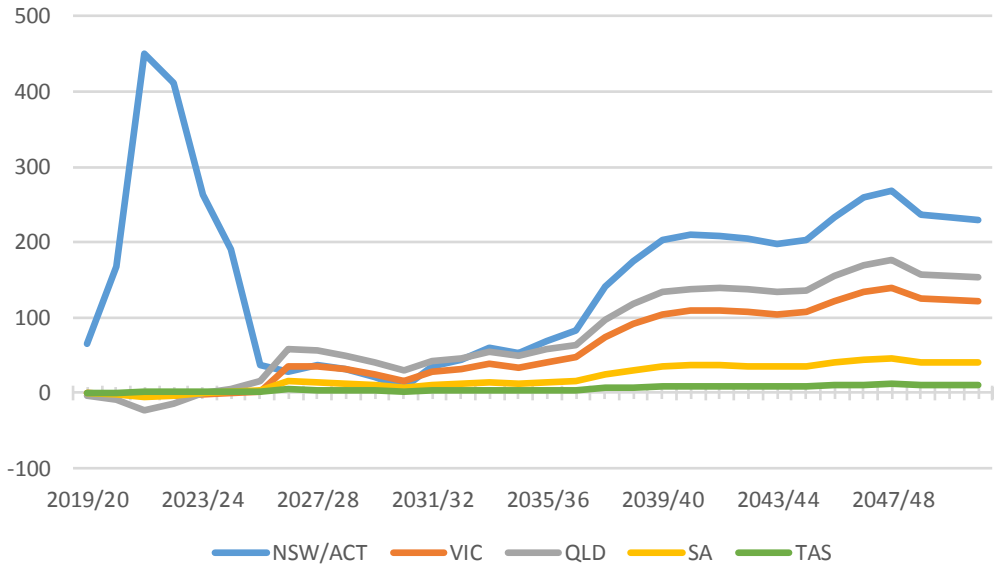


Source: Cadence Economics estimates

- The estimated impact on employment in the NEM states and territories is shown in Figure 6. The most significant impact on employment is in the NSW/ACT region during the construction period, peaking at an economy wide impact of 451 full time equivalent employees in 2021/22, during which time other NEM regions experience only small increases or decreases in employment.

- The average aggregate impact across the NEM regions is an increase in employment of 324 FTE positions.

Figure 6 – Change in employment, FTE



Source: Cadence Economics estimates

Attachment 1: CEGEM

The estimates in this report are based on the Cadence Economics General Equilibrium Model (CEGEM). CEGEM is an applied Computable General Equilibrium (CGE) model. A description of the model is presented in Box 1.

Australia has a long history of using applied CGE modelling to inform public policy dating back to the Industry Assistance Commission's use of the ORANI model in the debate around tariff protection in the early 1980s.

In the context of considering policy issues with widespread economic consequences, CGE modelling represents the standard approach adopted by central agencies within government. The main reason given for adopting CGE modelling is the ability of such models to account for resource constraints and reallocation, particularly in the labour market, which is a critical issue when considering the economic impacts of project investment in Australia.

Box 1: An overview of the CEGEM model

CEGEM is a multi-commodity, multi-region, dynamic model of the world economy. Like all economic models, CEGEM is a based on a range of assumptions, parameters and data that constitute an approximation to the working structure of an economy. Its construction has drawn on the key features of other economic models such as the global economic framework underpinning models such as GTAP and GTEM, with state and regional modelling frameworks such as Monash-MMRF and TERM.

Labour, capital, land and a natural resource comprise the four factors of production. On a year-by-year basis, capital and labour are mobile between sectors, while land is mobile across agriculture. The natural resource is specific to mining and is not mobile.

A representative household in each region owns all factors of production. This representative household receives all factor payments, tax revenue and interregional transfers. The household also determines the allocation of income between household consumption, government consumption and savings.

Capital in each region of the model accumulates by investment less depreciation in each period. Capital is mobile internationally in CEGEM where global investment equals global savings. Global savings are made available to invest across regions. Rates of return can differ to reflect region specific differences in risk premiums.

The model assumes labour markets operate in a model where employment and wages adjust in each year so that, for example, in the case of an increase in the demand for labour, the real wage rate increases in proportion to the increase in employment from its base case forecast level.

CEGEM determines regional supplies and demands of commodities through optimising behaviour of agents in perfectly competitive markets using constant returns to scale technologies. Under these assumptions, prices are set to cover costs and firms earn zero pure profits, with all returns paid to primary factors. This implies that changes in output prices are determined by changes in input prices of materials and primary factors.

The advantage of a global model such as CEGEM is that it accounts for bilateral trade flows of all commodities between regions. Goods are imperfect substitutes, implemented through the Armington assumption. The model does not require the regional current account to be in balance as the capital account can adjust to maintain balance of payments equilibrium.

Base data

The starting point for the base data in CEGEM is the global database produced by the Global Trade Analysis Project (GTAP). This database is comprised of 140 country and regional groups and 57 production sectors. The Australian component of this database was supplied by the Productivity Commission, and is based on Australian input-output tables produced by the Australian Bureau of Statistics (ABS). For the purposed of this exercise, the database has been aggregated to the 18 sectors shown in Table 1.

CEGEM is a model with customised regional detail. It models each region as an economy in its own right, with region-specific prices, region-specific consumers, region-specific industries, and so on. For this exercise, the regions included in the model are the states and territories of Australia and Rest of the World.

Table 1: Sectors and Regions represented in CEGEM

Number	Sector	Number	Region
1	Agriculture	1	New South Wales (inc ACT)
2	Coal	2	Victoria
3	Oil	3	Queensland
4	Gas	4	Western Australia
5	Other minerals	5	South Australia
6	Processed Foods	6	Tasmania
7	Manufacturing	7	Northern Territory
8	Electricity	8	Rest of World
9	Water		
10	Construction		
11	Trade		
12	Transport		
13	Communications		
14	Financial services		
15	Other business services		
16	Recreational services		
17	Government services		
18	Dwellings		

Dynamics

CEGEM is a recursive dynamic model that solves year-on-year over a specified timeframe. The model is then used to project the relationship between variables under different scenarios, or states, over a predefined period. This is illustrated in a stylised way in Figure A. This shows the baseline scenario, which forms the starting point for the analysis. The model is solved year-by-year from 2007/08 to a predetermined end year (in the case of this modelling exercise, 2050/51).

The variable represented on the vertical axis of Figure A (real GDP, for example, and similarly for various other economic indicators) has been converted to an index (= 1.0 in 2016/17) projected to increase by 2020/21.

Set against the baseline scenario is a policy scenario (the future path for the economy with all else held equal, but with (say) the specifications of the taxation reform imposed). This scenario represents the outlook for the economy with a different policy imposed compared with the baseline. That results in a new projection of the path of the variable over the simulation time period. The impacts of the policy change are the deviation (in levels, that is, GDPPolicy - GDPBaseline) between the policy and baseline scenarios for that variable at time T. It is important to note that the differences between the baseline and policy scenario are tracked over the entire timeframe of the simulation.

Figure A: Illustrative dynamic scenarios using CEGEM