

SNOWY 2.0

Feasibility Study Summary

snowyhydro

THE MODERN SNOWY HYDRO

Snowy Hydro is a dynamic energy company supplying electricity to more than one million homes and businesses. Since the days of our pioneering past, Snowy Hydro has grown into the fourth largest player in the energy market.

Snowy Hydro not only operates the mighty Snowy Scheme (nine power stations including pumped storage at Tumut 3 Power Station and Jindabyne Pumping Station), it also operates gas and diesel peaking assets in New South Wales, Victoria and South Australia. We have a total generation capacity of 5,500 megawatts (MW) and offer energy insurance and other products that provide supply security and price certainty to customers in the energy market.

Snowy Hydro also owns the electricity and gas retail companies Red Energy and Lumo Energy, and the utility connections business, Direct Connect.

Snowy Hydro is a proud member and supporter of the Snowy Mountains community, and a major employer with more than 400 staff across the region.

In March 2017, Snowy Hydro announced its proposal to carry out a feasibility study into the expansion of pumped hydro-electric storage in the Snowy Scheme, also known as the Snowy 2.0 project (Project). Snowy 2.0 is a pumped hydro project that will increase the Snowy Scheme's generation capacity by up to 2,000 MW, and at full capacity, will provide about 350,000 megawatt hours of energy storage.



WHY DID WE UNDERTAKE THE SNOWY 2.0 STUDY?

Snowy Hydro is an integral part of the National Electricity Market (NEM). Our reliable, fast start capability means we underpin the security and reliability of the system. At times of peak demand, we keep the lights on.

The NEM is changing at a rapid rate and the time is now right for Snowy 2.0. This is what led to Snowy Hydro undertaking this feasibility study.

Snowy 2.0 has significant benefits for consumers. By pairing new dispatchable renewable generation with large scale energy storage, Snowy 2.0 will make renewables reliable and lower future energy prices. Snowy 2.0, along with the existing Snowy Scheme, will underpin an orderly transition from coal to renewables and help Australia meet its global climate change targets.

An independent economic analysis was commissioned for the feasibility study and conducted by leading experts Marsden Jacobs Associates (MJA). MJA's extensive modelling confirms Snowy 2.0's scale, strategic location and longevity make it by far the cheapest and best option to decarbonise.

MJA's analysis shows that if Snowy 2.0 is not built, batteries and gas peakers would need to be installed, at more than double the cost.

The first power generated from Snowy 2.0 is expected in 2024 and will underpin the reliability and stability of the NEM for generations to come. The need for large-scale storage will only increase and in the future Snowy Hydro could look to replicate Snowy 2.0 to create up to 8,000MW of pumped-hydro storage at this site.

The project will progress to final investment decision (FID) in late 2018.

The feasibility study demonstrates the key benefits of Snowy 2.0 which include:

- **System security and reliability** - Snowy 2.0's dispatchable energy generation can respond within minutes to changing market needs.
- **Lower energy prices** - putting downward pressure on future energy prices. Wholesale energy costs will be lower with Snowy 2.0 in the market than without.
- **Scale and central location** - power from Snowy 2.0 will reach all NEM users including the major load centres of Sydney and Melbourne directly and South Australia indirectly.
- **Supporting renewables** - Snowy 2.0 will enable a low emissions future at least cost by underpinning the stability of the NEM as more and more intermittent renewables enter the market to meet global targets.

The feasibility study also demonstrates that Snowy 2.0:

- Is technically feasible - that is, it can be physically built and we have a base case design, construction schedule and costing.
- Is financially feasible - it will generate returns that meet Snowy Hydro's stringent investment hurdles.
- Can be funded internally by Snowy Hydro, and we are looking at a range of financing options.
- Will not have any impact on downstream water users and doesn't change the water release obligations under Snowy Hydro's water licence.
- Will go through well established and robust planning and environmental approval processes.

The feasibility study is available on the Snowy Hydro website: snowyhydro.com.au

🔒 SNOWY 2.0 ENSURES FUTURE ENERGY SECURITY

The supply of electricity in the future will be increasingly generated by intermittent renewable sources and coal generation will continue to retire. The characteristics of intermittent renewables means that supply doesn't always match demand, especially when the wind isn't blowing or the sun isn't shining.

As the benchmark pumped-hydro storage project in Australia, Snowy 2.0, backed by the mighty Snowy Hydro, will serve the market and consumers by providing dispatchable generation to address supply volatility, as well as fast-start capability and large-scale storage to address intermittency issues.

The high degree of urgency with which Snowy Hydro is progressing the Project reflects the rate of change being experienced across the NEM. Factors that support the

development of Snowy 2.0 include the need for improved system stability, achieving emissions targets (even in the absence of any carbon tax), the limited ability of coal-fired plant to accommodate the intermittency of renewables, and the constraints imposed by gas supply infrastructure.

The NEM will need significant large-scale storage.¹ If Snowy 2.0 is not built, the NEM will find other solutions, however when compared to the alternatives (including battery storage and building gas peaking plants) Snowy 2.0 is by far the cheapest option.

This type of pumped-hydro expansion was part of the original design of the Snowy Scheme and has been looked at periodically over recent decades. At those times the Project was not justified and did not meet Snowy Hydro's investment hurdles because large amounts of coal fired generation was available at lower prices.



¹ It is noted that demand management has a role to play but any feasible trajectory for demand management cannot meet the market's requirements without major disruption to businesses and consumers.

🗣️ WHAT IS THE SNOWY 2.0 PROJECT?

Snowy 2.0 is a pumped-hydro expansion of the Snowy Scheme which will supercharge existing generation and large-scale storage capabilities.

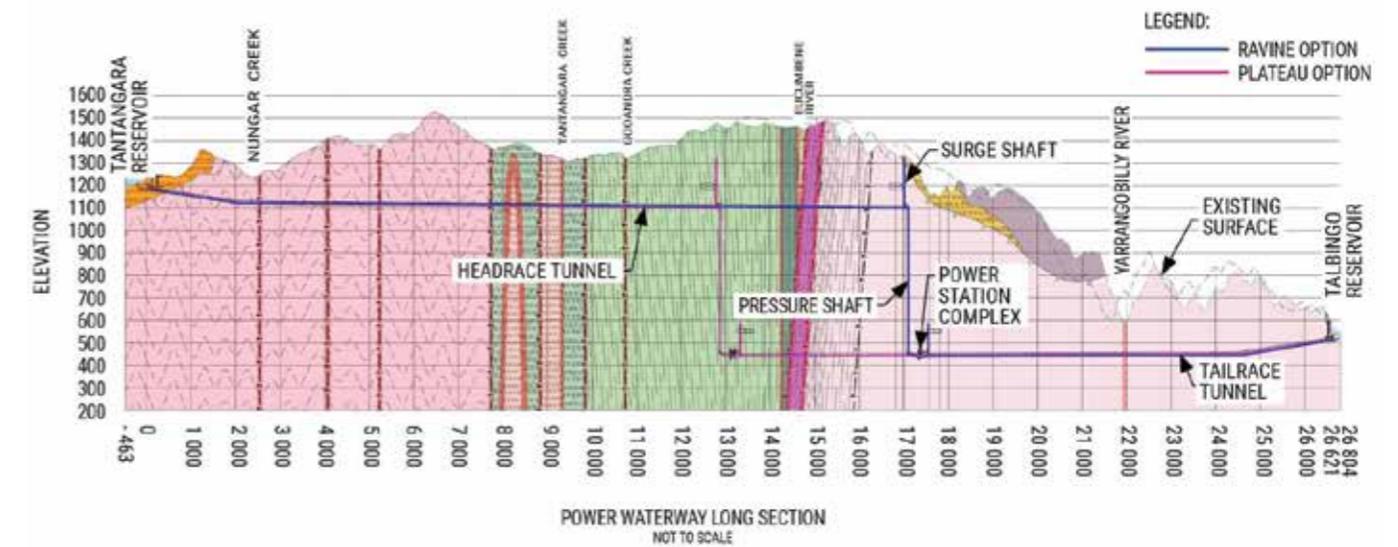
Pumped hydro works like a conventional hydro-electric scheme, but instead of releasing the water after energy has been generated, a pumped hydro scheme "recycles" or pumps water back to the upper reservoir to be used again.

The ability to pump and store water means Snowy 2.0 acts like a giant battery by absorbing, storing and dispatching energy. Snowy 2.0 will pump water using electricity at times of low demand and store it in the upper reservoir. Then, when energy is needed most, the stored water will be used to generate and dispatch electricity within minutes.

Pumping water at times of low demand means that Snowy 2.0 will have water ready to use for energy generation at times when consumers need it most.

If the wind is blowing in the middle of the night when consumers are asleep, Snowy 2.0 can absorb the wind energy through pumping and store the water in the upper reservoir. When households wake up and the demand for energy soars, Snowy 2.0 can quickly generate and dispatch energy across the grid.

Snowy 2.0 will link the two existing reservoirs of Tantangara and Talbingo through underground tunnels and there will be a new underground power station in between with pumping capabilities.



Full Project cross-section with geological features. Five major underground rock mass groups, three major fault zones and five rivers and creeks affect the dam-to-dam alignment.

✓ THE PROJECT IS TECHNICALLY FEASIBLE

Snowy 2.0 is technically feasible and there is a solid base case design. We engaged in an early contractor consultation process, that formally involved world leading civil construction and mechanical and electrical equipment companies, in the Project's design and refinement of the fit out for the power station and waterway complex.

For some aspects of the Project there are several technical options that are still being considered - this is appropriate at the current stage of the Project's development lifecycle. The final design will be refined as the Project progresses from feasibility stage to FID.

There is no doubt that Snowy 2.0 is an ambitious and challenging Project. Characteristics including high head (elevation differential between reservoirs), long waterways, fixed and variable speed units and the large underground excavation have required careful consideration.

As with the original Snowy Scheme, the engineering and construction of Snowy 2.0 will ensure it stands the test of time.

🔍 SNOWY 2.0 PROJECT SPECIFICATIONS

Physical works to be undertaken include intake and outlet structures, an underground network of tunnels, pressure shafts, surge chambers, the machine and transformer halls and supporting works such as access roads.

ENGINEERING AND CONSTRUCTION

Intake and outlet structures will be built at both Tantangara and Talbingo Reservoirs. About 27 kilometres of tunnels will be constructed to link the two reservoirs. They are nine metres in diameter and mostly concrete lined to ensure longevity and low maintenance.

The power station complex will be located almost 1 kilometre underground. Two main caverns will be constructed:

- ✦ Machine Hall - approx. 190m (long) x 55m (high) x 30m (wide)
- ✦ Transformer Hall - approx. 180m (long) x 29m (high) x 20m (wide)

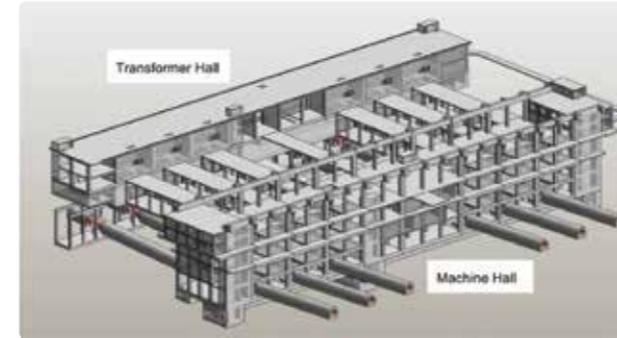
Six galleries run between the two halls and carry cables that connect the generators with the transformers. To reinforce the structure, rock bolts of 15 to 20 metres in length will be drilled into the rock at the top and sides of each cavern.

A mix of tunnel boring machines as well as drill and blast techniques will be used for the tunnelling and excavation.

MECHANICAL SPECIFICATIONS

The power station will consist of six reversible Francis pump-turbine and motor-generator units that can generate 2,000 MW.

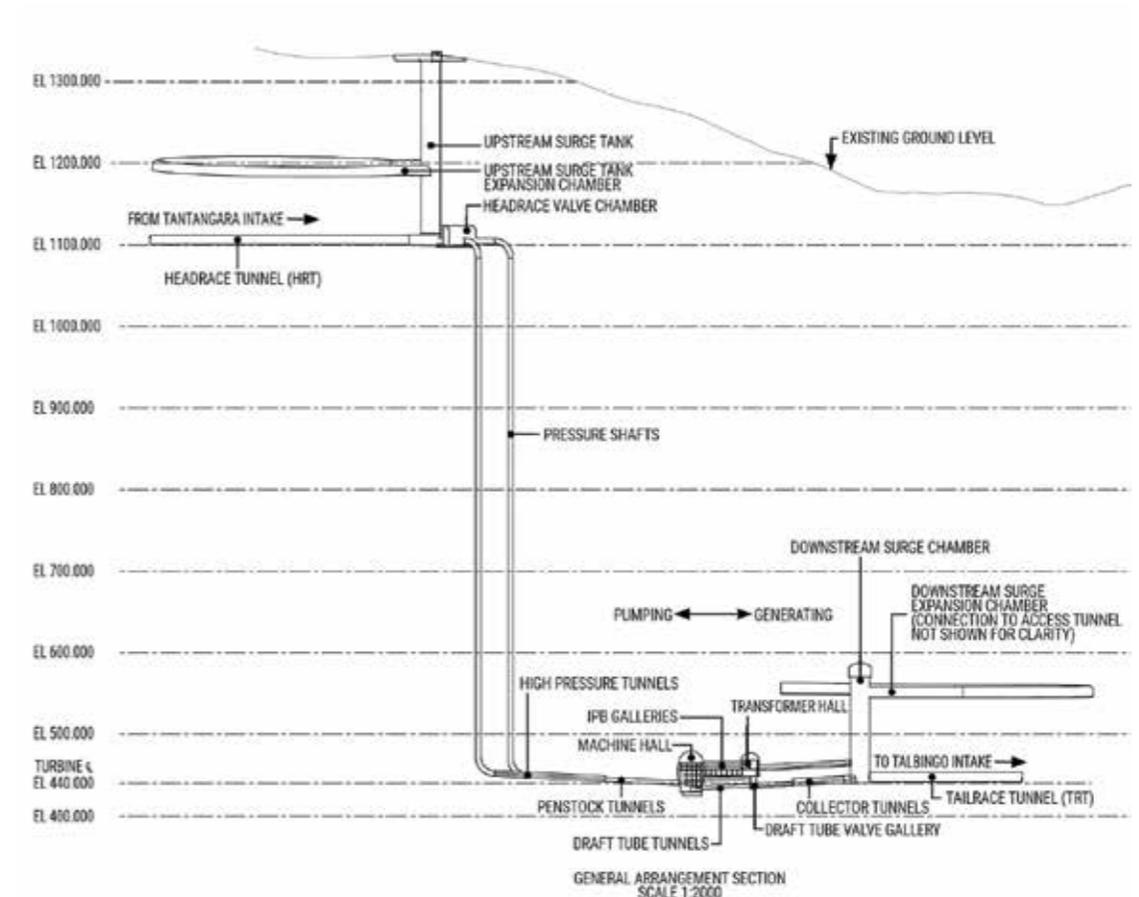
Three units will be synchronous (fixed) speed and three will be variable speed. The units will be arranged in the power station in alternating order and in pairs will share a pressure shaft and penstock (the tunnel that feeds water into the units).



Underground Power Station in 3D



Computer graphics model showing Tantangara intake structure



Major power waterway components



THE PROJECT IS FINANCIALLY VIABLE - THE INVESTMENT CASE

Snowy 2.0 will generate a return on investment that meets Snowy Hydro's stringent investment hurdles. The funding strategy for Snowy 2.0 is based on internal financing by Snowy Hydro.

The detailed financial evaluation and commercial conclusions are confidential to Snowy Hydro.

The benefits to Snowy Hydro have been modelled under a range of scenarios and future NEM outcomes. The financial benefits that have been modelled are conservative and are likely to understate the potential earnings that could be realised by Snowy 2.0



PROJECT COSTINGS AND CONSTRUCTION SCHEDULE

Snowy Hydro engaged consultants Turner and Townsend to provide a fully integrated cost estimate and Project schedule. Costs were refined with the assistance of tier-one civil, mechanical and electrical companies which were part of the early contractor consultation process.

The first power generated from Snowy 2.0 is expected in 2024. The base case schedule for the completed Project is about seven years from FID.

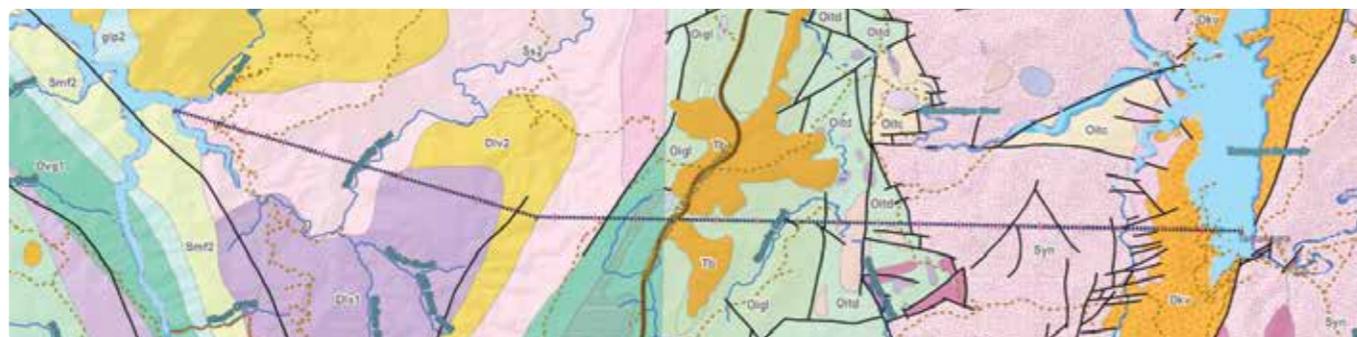
The capital cost estimate will be further refined as the Project moves to FID but the current estimate is between \$3.8 - \$4.5 billion. The costs take into account the need for extensive reinforcement of the Project's structures due to the challenging geological conditions that were uncovered during the geotechnical drilling program.



GEOLOGY OF THE SNOWY 2.0 SITE

As part of the study, Snowy Hydro commenced an extensive geotechnical drilling program to collect information about the geology across the Project route and at key sites.

The geological, geotechnical and hydrogeological conditions vary significantly along the alignment of Snowy 2.0 which placed different constraints on the base case design. The mountainous terrain and difficult underground geology has contributed significantly to the Project costs and construction schedule.



Geology of the Snowy 2.0 alignment



JOBS, SOCIAL AND COMMUNITY IMPACTS

JOBS

It's estimated that Snowy 2.0 will create up to 5,000 direct and indirect jobs across the region over the construction period. A workforce plan will be developed as the Project progresses to FID and a lead civil works contractor is appointed. The Project workforce will grow from a small base in year one, to an estimated 1,000 - 2,000 at peak times across different locations across the region.

Businesses interested in getting involved with the Project can register their interest by emailing:
shlprocurement@snowyhydro.com.au

Snowy Hydro is working with local councils, NSW Government agencies and the local community to ensure that the long term benefits of the Project are maximised and any impacts on services are identified and appropriately managed.

RECREATIONAL USE OF THE PARK

Snowy Hydro is very aware of the recreational usage of the Kosciuszko National Park (Park) by tourists and locals alike. While we will do everything possible to minimise disturbances and impacts on recreational areas, due to the nature of the works being undertaken during construction and for safety reasons, public access will be restricted in some areas while works are underway.



✓ PLANNING AND ENVIRONMENTAL APPROVALS

Snowy 2.0 will go through a comprehensive, well established and transparent planning and environmental approvals process. The Park is our backyard. We take our duty to operate the Scheme in an environmentally responsible way very seriously and have a proven track record over many decades.

Only once the relevant approvals are in place can construction of the Project commence. To ensure the environmental impacts of the Project are fully and adequately considered throughout the study and beyond, Snowy Hydro engaged an expert environmental consultancy firm to undertake a thorough impact assessment.

In New South Wales, we have submitted an application to have the Project declared as Critical State Significant Infrastructure (CSSI) under the Environmental Planning and Assessment Act 1979 (NSW). If the Project is declared as CSSI, Snowy Hydro will prepare a comprehensive Environmental Impact Statement (EIS) that will thoroughly address the environmental, social and economic impacts of the Project. This EIS will be available for the public to review and make submissions.

In addition to NSW state planning approvals, it is likely that the Project will require approval from the Commonwealth government under the Environment Protection and Biodiversity Conservation Act 1999 (Cth).



ENVIRONMENTAL CONSIDERATIONS

THE ENVIRONMENT

Based on the proposed construction methodology and operational characteristics of the Project, a range of potential environmental impacts are likely to be associated with the works.

These impacts will be the subject of further and thorough investigation during the EIS phase and appropriate mitigation measures will be developed to reduce any potential impacts.

Although the Project is expected to provide broad scale environmental benefits through its long term displacement of more carbon intensive generation, at the localised level there will be impacts from surface works.

The key environmental aspects and their potential impacts include the following:

- ✦ Establishment of construction work areas that may restrict the access of recreational users and temporarily impact the amenity of the Park
- ✦ Establishment of surface earthworks that require the clearing of vegetation, may damage critical habitat and fauna, and may spread weeds
- ✦ Underground excavation that may cause changes in groundwater levels
- ✦ Spoil disposal that may impact surface waters and terrestrial environments
- ✦ Inter-catchment water transfers that may spread pest species of fish

There is potential to positively offset any unavoidable local impacts for the benefit of the environment across the Park. A range of potential offset and contribution options are being discussed, in particular with National Parks and Wildlife Services. The objective is to identify opportunities for habitat improvement and catchment health works with a direct positive benefit to the Park's biodiversity and ecological processes.

SNOWY WATER LICENCE

The Snowy Scheme operates under a strict water licence issued by the NSW Government. Snowy 2.0 will not in any way impact on Snowy Hydro's continued compliance with the water licence.

There will be no change to its water release obligations from both the Murray and Tumut developments, and no change to environmental release obligations. Therefore, Snowy 2.0 will not have any impact on downstream water users or environmental flows.

Snowy 2.0 will also further drought proof the Snowy Scheme. This is because in a pumped hydro system, water is 'recycled' between the two storages so the same water can be used to generate power, more than once. It will also provide Snowy Hydro with more options to manage inflows and water shortages in times of drought.



TRANSMISSION

Transmission augmentation is required to get Snowy 2.0's power into New South Wales and Victoria and indirectly into South Australia. The proposed upgrades to the grid will be part of the shared transmission network that other renewable energy projects will also connect to as they come online.

Snowy Hydro (as a generator) does not own or operate the shared grid, which is the responsibility of the transmission network operators. In addition, because the grid is shared with other energy companies who have open access to connect to it, there is a regulatory framework in place to fund the cost to upgrade the shared transmission network.

Therefore, the cost associated with the transmission network upgrades has not been, and cannot be included, in the Project's costs. However, what will be funded by the Project is the cost of the lines that are required to connect Snowy 2.0 to the shared network, which are connection assets to be used solely by Snowy Hydro.

Due to the critical role that Snowy 2.0 will play in ensuring the security and reliability of energy supply in the NEM, Snowy Hydro will continue to work with the Government, network operators and the Australian Energy Market Operator (AEMO) to resolve the issue of transmission augmentation prior to FID. This includes ensuring that the necessary upgrades to the transmission lines are included in AEMO's integrated grid plan that provides the planning umbrella for the future NEM.



Illustration showing existing and proposed solar/wind energy development and how they would relate to Snowy 2.0. This also shows how Snowy 2.0 connects to the main load centres north and south.
Source: AEMO Victorian Annual Planning Report 2017 and TransGrid Transmission Annual Report 2017.

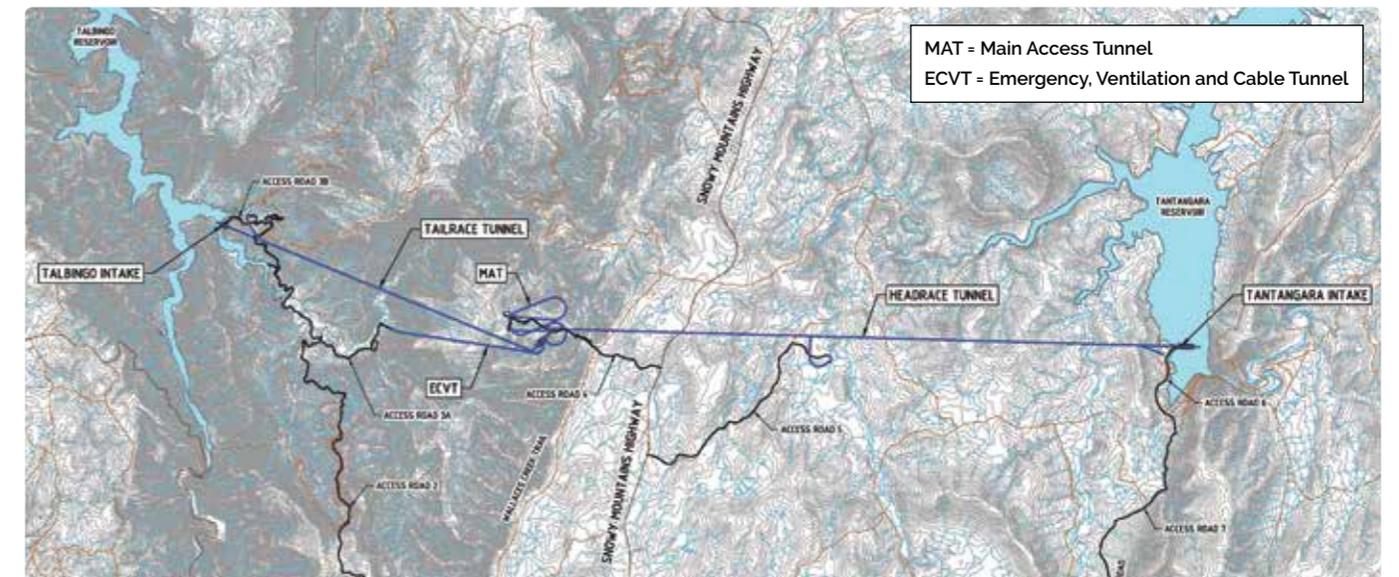
WHAT ARE THE NEXT STEPS?

The Snowy 2.0 feasibility study has been carefully considered by Snowy Hydro's independent Board of Directors. The Board's decision is to progress the Project from feasibility stage and undertake further work and Project refinements so a final investment decision can be made.

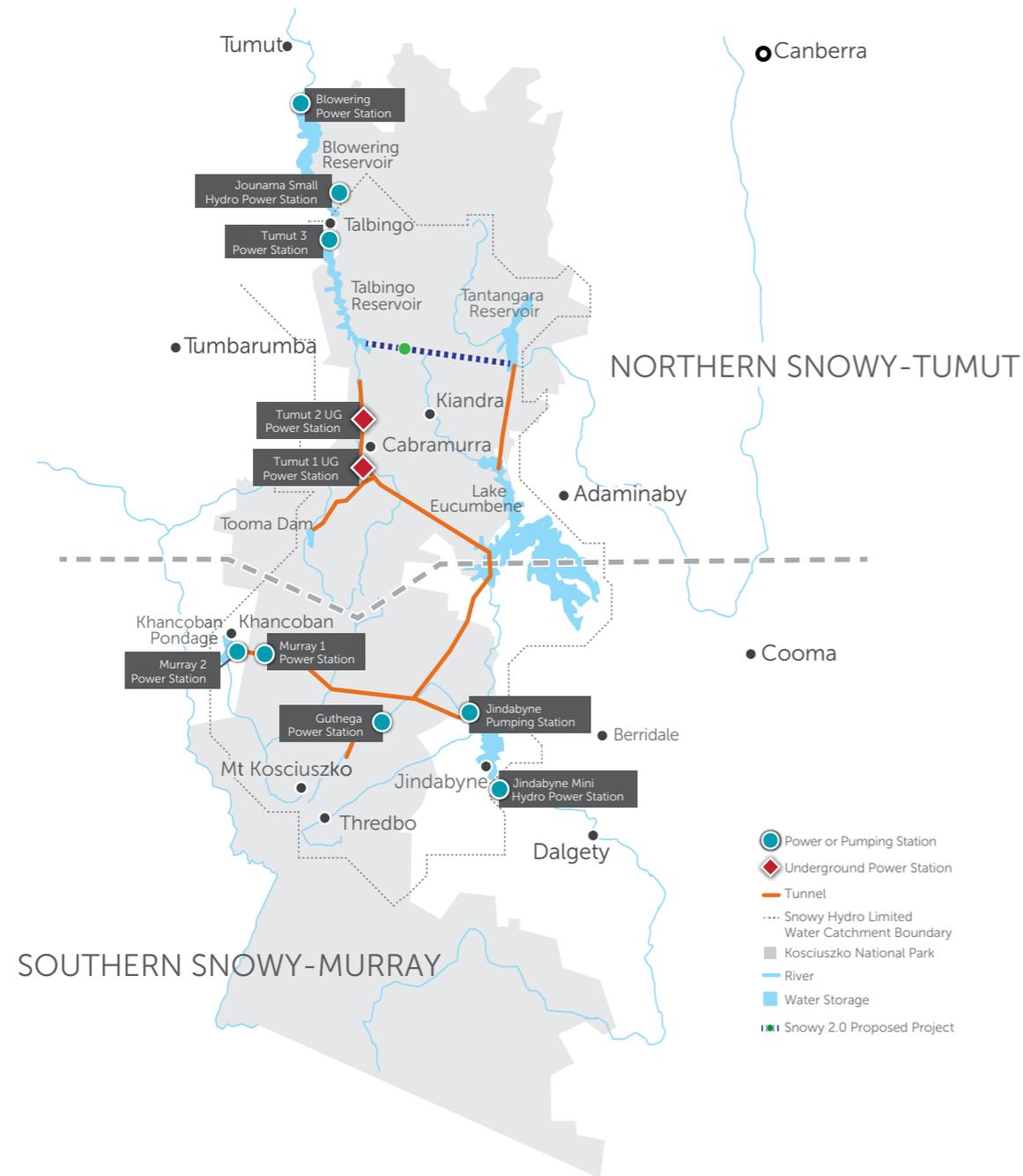
The final investment decision is expected to be made in late 2018, subject to the approval of our shareholders.

SNOWY 2.0 FAST FACTS

- Public benefits:** the large scale and central location of this Project will underpin an orderly transition from coal to renewables by ensuring the security and reliability of the NEM and lowering future energy prices, and will support the growth of renewables.
- Energy generation:** 2,000 MW generation capacity.
- Large-scale storage:** 350,000 megawatt hours of large-scale storage.
- Capacity:** Snowy 2.0 could run for over seven days continuously or 15 days at times of peak demand without 'recharging'.
- Timeframe:** the first power generated from Snowy 2.0 is expected in 2024. The base case construction schedule for the completed project is about seven years from FID.
- Project costs:** cost estimate is between \$3.8 - \$4.5 billion.



Overall base case plan of the Project



Map of the Snowy Scheme including Snowy 2.0

IMPORTANT NOTICE

You must read this notice and disclaimer if you intend to read this Feasibility Study Summary (Study). By continuing to read the Study, you accept that this Study is provided on the terms and conditions of this notice. If the terms and conditions are not acceptable, this Study and any copy of it, in your possession or control, must be destroyed or returned immediately to Snowy Hydro.

This Study has been prepared by Snowy Hydro Limited (ACN 090 574 431) (Snowy Hydro) solely for the benefit of Snowy Hydro, and only addresses issues that are relevant to Snowy Hydro.

The concepts and information contained in this document are the property of Snowy Hydro. Use or copying of this Study in whole or in part without the written permission of Snowy Hydro constitutes an infringement of copyright.

Nothing contained in this Study is, or may be relied upon as a promise, representation, or warranty, whether as to the past, present, or future. No express or implied representation or warranty is made by Snowy Hydro to any third party that the contents of the Study are suitable for any purpose. Snowy Hydro does not accept a duty of care or any other legal responsibility whatsoever and however arising to any person in relation to this Study. Any person who receives a copy of this Study does so on the basis that he or she acknowledges and accepts that he or she may not rely on this Study nor any related information provided by Snowy Hydro.

To the fullest extent permitted by law, Snowy Hydro disclaims all responsibility, liability, direct, indirect, or consequential loss (and whether or not arising out of the negligence, default, or lack of care of Snowy Hydro) for any loss or damage suffered by any third party arising out of, or in connection with, any use of or reliance on this Study.

Copyright © Snowy Hydro Limited. All rights reserved.



snowyhydro

snowyhydro.com.au