



SNOWY 2.0 DOESN'T STACK UP

This Paper, prepared by the National Parks Association of NSW, contends that the case for Snowy 2.0 does not stack up on either economic or environmental grounds

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Cover Photo: Thredbo River in Winter. © Gary Dunnett



National Parks Association of NSW is a non-profit organisation that seeks to protect, connect and restore the integrity and diversity of natural systems in NSW.

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SUMMARY

On 15 March 2017 Prime Minister Turnbull announced the ‘Snowy 2.0’ pumped hydro-electric storage project:

“The Turnbull Government will start work on an electricity game-changer: the plan for the Snowy Mountains Scheme 2.0. This plan will increase the generation of the Snowy Hydro scheme by 50%, adding 2000 megawatts of renewable energy to the National Electricity Market”.

Snowy 2.0 was to cost \$2 billion, be completed in 4 years, entirely funded by Snowy Hydro Ltd.

Two years later, on 26 February 2019, Prime Minister Morrison announced Government approval of the Business Case, at an estimated cost of \$3.8 billion (with an upper limit of \$4.5 billion):

*“following Snowy Hydro Board’s final investment decision on 12 December 2018, **the Government has reviewed the project’s business case and is satisfied that the project stacks up.** The Government will commit up to \$1.38 billion in an equity investment for Snowy 2.0.”*

The Business Case has not been released.

NPA fully supports renewable energy and the associated need for additional electricity storage, through pumped hydro and other means. But Snowy 2.0 is not a suitable project environmentally, nor is it economic, and its claimed benefits are overstated – it’s the wrong project in the wrong place. There are alternatives with far less environmental impacts and a far lower cost.

This Summary highlights NPA’s concerns with Snowy 2.0 under 8 headings, followed by recommendations and a detailed appraisal of each of the concerns (page 26 onwards):

1. Lack of an overall Plan, premature approval before completion of EIS process
2. Optimistic estimates and understated costs
3. Insupportable subsidies
4. Economically unviable
5. Overstated benefits
6. Other, better alternatives not analysed
7. Unacceptable environmental impacts
8. The Business Case should be revoked

1. Lack of an overall Plan, premature approval before completion of EIS process

1.1. A disconcerting genesis

The Commonwealth Government announced the Snowy 2.0 project within two weeks of being informed of the proposal, without even advising the two other Snowy Hydro shareholders at the time, the NSW and Victorian Governments.

Three basic premises were postulated – \$2 billion cost, 4-year construction period and fully funded by Snowy Hydro. None of these premises have turned out to be anywhere near realistic.

Also, no information was provided then, or has been since, justifying Snowy 2.0 as the most suitable energy storage project of the many alternatives.

1.2. No comprehensive Business Case for the entire project

Snowy 2.0 has been split into 4 components/stages – Exploratory Works, Main Works, the electricity transmission lines through Kosciuszko National Park and the transmission circuits connecting to the grid. This staged approach and the incremental and limited release of information means that neither the Commonwealth Government, as the (now) sole Shareholder of Snowy Hydro, nor the public can comprehensively assess the entire project at one time before it is well underway.

The already-approved Final Investment Decision and Business Case were not based on a realistic cost estimate and could not have encompassed the entire project or identified and addressed all crucial aspects (economic, engineering and environmental).

1.3. Disregard for EIS process

It is over 2½ years since Snowy 2.0 was announced. Over that period the Snowy Hydro Board has authorised the Final Investment Decision, the Government has approved the project and kicked in \$1.38 billion, the major works contract has been awarded, construction has commenced and major equipment is being ordered.

Despite construction being underway since February 2019, the ‘Main Works’ Environmental Impact Statement (EIS) has only just been exhibited. The EIS for the transmission lines through Kosciuszko National Park has yet to be revealed (expected later in 2019).

Not waiting till the completion of the EIS process, as fractured and piece-meal as it is, before commencing construction and ordering major equipment, is reprehensible for a project anywhere, let alone in a National Park. And it carries a risk of refusal of the EIS or the imposition of conditions that render the project uneconomic.

1.4. Lack of robust review of the (partial) Business Case or alternatives

The Government’s review of the (partial) Business Case appears to have relied heavily upon advice from Snowy Hydro and its consultants.

With a project of this size, complexity, risk and cost, it is most unusual and remiss for a government not to commission an independent review. This is even more relevant when a sizeable government subsidy (\$1.38 billion) is involved. And such review should encompass the whole project, including transmission, not just the hydro aspects.

Further, before approving Snowy 2.0 it was incumbent on the Government to examine alternatives and determine a comprehensive policy on providing energy storage to the National Electricity Market over the coming decades.

1.5. Risk of premature approval already demonstrated

The financial risk of premature approval by the Commonwealth was demonstrated in April 2019, barely six weeks after approval of the Business Case, when Snowy Hydro awarded a \$5.1 billion contract. That single contract eclipsed the \$3.8 billion estimate for the entire project. Snowy Hydro must surely have been aware of the underestimate while the Business Case was being reviewed by Government.

Clearly the Final Investment Decision and the Business Case were based on a substantially understated capital cost. The Commonwealth Shareholding Ministers should revoke approval of Snowy 2.0. The sooner this action is taken, the less sunk costs will be wasted.

Snowy Hydro is a Government Corporation and Australian taxpayers will ultimately bear its losses.

2. Optimistic estimates and understated costs

2.1. Completion time has more than doubled

When first announced (March 2017), Snowy 2.0 was to be completed in 4 years (i.e. end-2021).

That time frame has progressively slipped. The latest estimate, including remediation, is 8 years from 2019 – i.e. Snowy 2.0 will not be completed till the second half of the next decade.

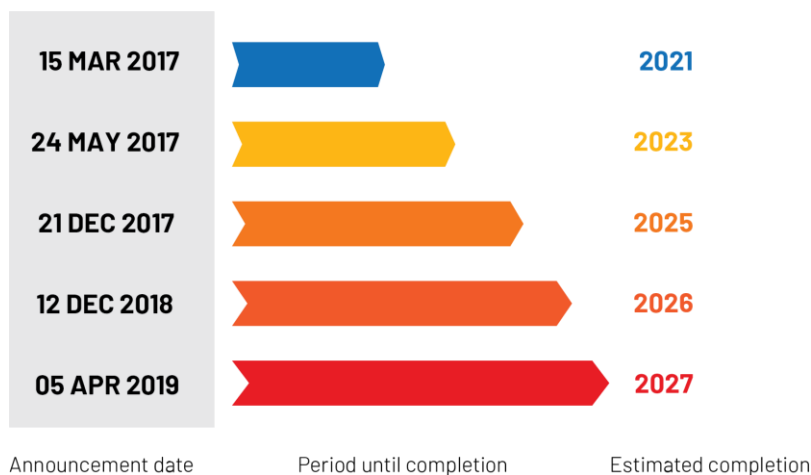


Figure 1: Ever-stretching Completion Dates

2.2. Cost of pumped storage component has increased by 400%

When first announced, Snowy 2.0 was to cost \$2 billion. That estimate doubled to \$3.8 - \$4.5 billion (expected to be at the lower end of the range) when the Feasibility Study was released in December 2017.

Alarming, the Feasibility Study contains a brief note stating that this estimate does not cover 'excluded costs' such as financing, project management, operational spares and GST. Additionally, there is no mention of other project costs such as capitalised interest and transmission. Not including all costs in the publicly released estimate is highly irregular.

However, that \$3.8 billion estimate is now seen as more understated after the awarding of a \$5.1 billion contract for Civil and Electro-mechanical Works.

The recently-released Main Works EIS repeats the previous practice with a 'Capital investment Value' of \$4.6 billion, again excluding the above costs plus a few more.

In our view, the major works contract plus variations, expenditure to-date, additional contracts, excluded costs and capitalised interest, is likely to result in a total capital cost for the pumped storage component of the project in the order of \$8 billion.

2.3. Minimal allowance for transmission cost

The national electricity grid will require substantial augmentation to transmit 2000 MW to and from Snowy 2.0, as it will constitute the largest single load ever to be added and the largest generator for 35 years. An indicative cost of the augmentations north to Sydney is \$2 billion, with further as-yet-uncosted augmentations south to Melbourne. Whilst these new lines will also strengthen the grid and provide other wider benefits, Snowy 2.0 is a prime reason for their construction, timing and routing.

In accordance with established electricity industry capital contributions policies, Snowy 2.0 should

pay an equitable proportion of these extensions, especially as it will gain double the benefit from being both a generator and a 'load' (i.e. a consumer of electricity for pumping). Snowy Hydro has made no allowance for the cost of electricity transmission in the Business Case, other than the 10 km of lines through Kosciuszko National Park, which constitute just 1.5% of the 630 km of new lines to the north alone.

Irrespective of whether Snowy 2.0 is ultimately required to contribute to the remaining 98.5% of transmission, that cost is ultimately borne by electricity consumers and hence a significant portion should be regarded as attributable to the Snowy 2.0 project.

2.4. Total cost could be \$10 billion, 500% of the original estimate

After adding transmission, in our view the total cost for the project could soar as high as \$10 billion, a 500% increase on the initial estimate of \$2 billion.

To put this staggering amount into context, it is more than the recently assessed \$7.8 billion market value of the whole of Snowy Hydro Ltd, which owns the Snowy Scheme and other significant assets (gas generators, retail companies). And that market value looks to be significantly overstated (see Section 3.2), further increasing the gap between the true market value of Snowy Hydro and cost of Snowy 2.0.

A \$10 billion cost (or ~\$8 billion without transmission) renders Snowy 2.0 totally uneconomic.

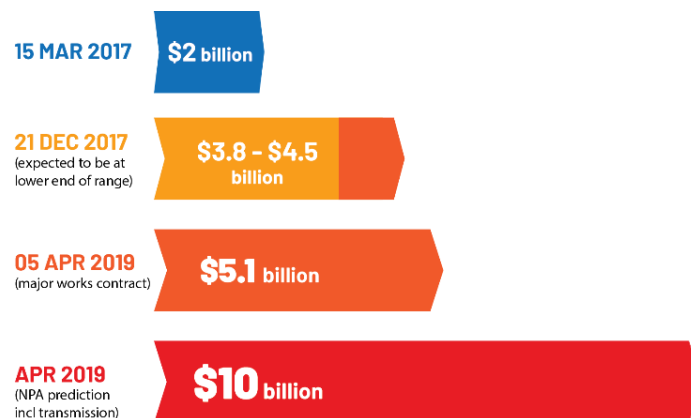


Figure 2: Ever-increasing Capital Cost Estimates

2.5. Even further time and cost increases should be allowed for

It does not bode well that both the estimated completion time and cost have blown out by over 200% and 500% respectively in just 2½ years, and before the major works are underway. Invariably, overruns also occur during the construction of large, complex infrastructure projects.

Snowy Hydro should provide updated, realistic estimates on the completion date and capital cost.

2.6. Cost comparison with 'greenfield' pumped hydro schemes

Compared to typical new pumped hydro schemes, Snowy 2.0 is five times the cost for power generation¹ (\$4000/kW vs \$800/kW) and a third the cost for energy (\$25/kWh vs \$70/kWh). Snowy 2.0's apparent lower cost of energy moves closer to the typical figure if the practical deliverability of its claimed storage capacity is applied (see Section 5.4).

¹ Power is what can be delivered at any moment (watts) and energy is the amount of power delivered over time (watt-hours)

3. Insupportable subsidies

3.1. Why are taxpayers providing a \$1.38 billion subsidy?

When first announced, Snowy 2.0 was to be fully funded by Snowy Hydro, without any taxpayer funding.

There are conflicting statements by the Government and Snowy Hydro on the purpose of the \$1.38 billion subsidy/ equity injection. But there should be no need for a taxpayer-funded subsidy for a project that is supposedly economic in its own right, especially as any subsidy provides an unfair advantage against competitors in the National Electricity Market.

The rationale for this enormous subsidy needs to be disclosed.

3.2. Did the Commonwealth pay a premium for Snowy Hydro to facilitate Snowy 2.0?

In March 2018 the (then) three government shareholders decided that the Commonwealth would assume sole ownership of Snowy Hydro, to facilitate the approval and construction of Snowy 2.0. The agreed market value was \$7.8 billion. The Commonwealth paid \$6.23 billion for the NSW and Victorian Government shares.

\$7.8 billion is over twice a previous valuation for Snowy Hydro of \$2.2 - \$4 billion (converted to 2018 dollars). Also, anticipated future dividends (\$275 million p.a.) represent a meagre 3.5% return on the Commonwealth's total investment.

It looks doubtful that this was a sound investment for the Commonwealth Government and Australian taxpayers. If a premium price was paid, it represents another 'subsidy' to facilitate the construction of Snowy 2.0.

Further, the Commonwealth's investment in Snowy Hydro will rise to \$9.18 billion with the addition of the \$1.38 billion equity injection/ subsidy.

3.3. Minimal payment for commercial use of Kosciuszko National Park

It is understood that a lease fee of \$1.6 million p.a. has been negotiated for Snowy 2.0's occupation of Kosciuszko National Park. This is in addition to the current annual fee of a mere \$0.75 million for the existing Snowy Hydro assets.

To put this into perspective, an annual lease fee of \$2.35 million accounts for just 0.09% of Snowy Hydro's current revenue (\$2.6 billion), or 1.1% of its profit (\$210 million).

The lease fee supposedly remunerates the NSW community for Snowy Hydro's exclusive use of Kosciuszko National Park, for its 16 major dams and reservoirs, 12 major tunnels, numerous aqueducts, 9 (+1) power stations, 2 (+1) pumping stations and other related infrastructure. No other electricity generator, or business, is gifted a token rental for such assets, let alone in a National Park. If this situation prevails, Snowy Hydro will continue to be subsidised and advantaged compared to its competitors in the National Electricity Market.

Whether or not Snowy 2.0 proceeds, this is an appropriate time to negotiate a new lease arrangement on proper commercial grounds for the whole of the Snowy Scheme.

3.4. No payment for water

Whilst Snowy 2.0 will have no impact on Snowy Hydro's downstream water obligations, is it reasonable for a corporate body to be able to derive commercial gain from the use of a 'public asset' for no fee?

4. Economically unviable

4.1. How could Snowy 2.0 cover its interest payments?

A simplistic calculation of the interest payment on an \$8 - \$10 billion loan at Snowy Hydro's stated rate of 5.7% p.a., is \$460 - \$570 million per annum. We consider it inconceivable that Snowy 2.0 could cover debt financing charges anywhere near this magnitude. This figure is more than double the annual profit of the whole of Snowy Hydro (\$210 million).

We expect that Snowy 2.0 would not only make substantial losses but jeopardise the financial viability of Snowy Hydro.

Snowy Hydro should release its financial analysis and demonstrate how Snowy 2.0 could service its debt and still make a profit.

4.2. Market benefit is half its cost

Snowy Hydro issued a consultant's report that estimates the market benefit of Snowy 2.0 to be between \$4.3 and \$6.6 billion over 50 years. Several expert analysts have questioned the optimistic assumptions and rigour of that report, especially over a period extending to 2075.

Nevertheless, the latest revelations, indicating a total project cost of \$10 billion, mean that the (optimistic) estimated market benefit of Snowy 2.0 is half the project cost.

4.3. Estimated Rate of Return (ROR) is low, and now needs to be recalculated

No substantiation has been provided on the estimated ROR of 8%, which is low for a project of this size, complexity and risk.

4.4. How will Snowy 2.0 get sufficient spread between its buying and selling price?

No information is provided on predicted buy and sell prices nor on forecast revenues.

4.5. Widespread scepticism of the viability of Snowy 2.0

In undertaking research for this Paper, the widespread scepticism about Snowy 2.0 was surprising. That scepticism reflects the lack of detailed information; substantial and ever-increasing cost; questionable commercial viability; complexity and challenging construction; enormous size; swamping of the market for pumped hydro storage and hence dampening of competition; the \$1.38 billion taxpayer subsidy and preferential treatment by the Government; lack of analysis of alternatives; and the significant, permanent environmental damage to Kosciuszko National Park.

5. Overstated benefits

5.1. Lack of analysis of cheaper electricity claim

No substantive analysis has been provided to verify the claimed reduction in electricity prices. When all costs are taken into account, particularly for extra transmission, there may well be a net increase in electricity prices to consumers rather than a decrease.

5.2. Snowy 2.0 is markedly different to other pumped hydro schemes

Snowy 2.0 is markedly different to all other large pumped hydro storage schemes in the world in two respects- the first difference is a major negative and the second a positive (though overstated):

- i. the distance between the two reservoirs is far longer – 27 km, versus typically 0.5-3 km
- ii. a very large reservoir capacity compared with typical pumped hydro schemes, providing a

claimed storage capacity of 350 GWh, able to generate 2,000 MW for 175 hours

It is clear that using two existing large reservoirs, at a major head differential, was the reason for choosing the Tantangara/Talbingo option for Snowy 2.0. But that advantage is more than offset by the extraordinarily long interconnecting tunnel, resulting in an enormous cost and the need to dispose of massive quantities of spoil.

We can find no pumped hydro scheme in the world with a distance between reservoirs of anywhere near 27 km. This will result in Snowy 2.0 having a lower 'round-trip' efficiency than equivalent plant.

5.3. How often will Snowy 2.0 be needed to supply 350 GWh?

It has not been demonstrated how often a situation might arise in the National Electricity Market where Snowy 2.0 would be called upon to generate continuously at full capacity for 175 hours.

The Feasibility Study indicates that prior to 2040 Snowy 2.0 will operate at full capacity for less than 87 hours per year.

5.4. Cycling energy storage capacity (350 GWh) is considerably overstated

Snowy 2.0's claimed 350 GWh capacity is based on Tantangara Reservoir being full. Of course, the deliverable energy capacity is less when Tantangara is not full and is zero when Tantangara is at minimum level.

The energy storage capacity of a pumped hydro scheme is determined by the volume of water that can be recycled between its two reservoirs. As Talbingo Reservoir has only two-thirds the active storage volume of Tantangara, the closed-circuit energy capacity of Snowy 2.0 based on the maximum amount of water that can be cycled up and down between the two reservoirs is approximately two-thirds of 350 GWh – i.e. 230 GWh (115 hours at 2000 MW, not 175 hours).

However, this assumes Snowy 2.0 is a closed system with exclusive use of Talbingo. But Talbingo is also the upper storage of Tumut 3 pumped hydro station and its operation will impinge on the volume available for recycling water within Snowy 2.0.

Even in the best of circumstances when Tantangara Reservoir happened to be full, and Talbingo empty, at a time when Snowy 2.0 was called upon to generate continuously for 7 days until Tantangara was emptied, at least one-third of its water would be 'lost' from the Snowy 2.0 system and flow into Blowering Reservoir. If Talbingo did not start empty, as would be the case for Tumut 3 to be operational, then even more Tantangara water would be lost from the Snowy 2.0 cycle.

Snowy Hydro should provide information on the integration of Snowy 2.0 into the Tumut Scheme and the future operating regime, together with the practical energy storage capacity of Snowy 2.0 based on the fixed volume of water that can be recycled between its two reservoirs. In our view the claimed recyclable capacity of 350GWh is considerably understated.

5.5. It will take months to replenish Tantangara

Whenever Tantangara is emptied, in practice it will take many months to be refilled and for Snowy 2.0's full energy capacity to be available again. In reality, if the full capacity were ever used it is a once-a-season shot, belying the claim of Snowy 2.0 being a 'water battery' able to regularly cycle 350 GWh back-and-forth.

5.6. Snowy 2.0 is a net consumer of electricity

In common with all pumped storage schemes, Snowy 2.0 will be a net consumer of electricity, not a net generator. For every 100 units of electricity used to pump water up to Tantangara Reservoir,

only about 70 units will be generated when that water flows back down through the turbine generators to Talbingo Reservoir – i.e. 30 units are consumed/lost (70% efficient).

Every hour that Snowy generates 2000 MW will require nearly 1½ hours of pumping to replenish the water used. Putting it another way, if Snowy 2.0 ever generated its claimed 350 GWh of energy, it would take 500 GWh of pumping to be re-charged, incurring 150 GWh of losses.

5.7. Snowy 2.0 is only 60% efficient overall

As well as having a ‘round-trip’ loss of 30% within the pumping/ generation cycle, there are also losses in transmitting electricity to and from Snowy 2.0 of typically 3-5% each way.

So, for every 100 units of electricity purchased by Snowy 2.0 for pumping, it will only generate and deliver about 60 units to the load centres. Or putting it the other way around, it will take 170 units of pumping energy to deliver 100 units of electricity to the load centres.

Being only 60% efficient means that Snowy 2.0 will need to sell the electricity it generates at a price of at least twice the cost of electricity it purchases for pumping to avoid making a financial loss.

5.8. Most pumping electricity will come from coal-fired generators initially

Snowy 2.0 is promoted as being a ‘green battery’ for renewable energy. For at least the next decade or so most of Snowy 2.0’s pumping electricity will come from coal-fired generators and, perversely, result in an increase of coal-fired generation and emissions of greenhouse gases (due to Snowy 2.0’s round-trip losses of 40%).

5.9. Limited past operation of Tumut 3 pumped hydro station is cause for concern

Tumut 3, a similarly sized pumped hydro station (1800/600 MW) to Snowy 2.0, has been significantly underutilised during its 50-year life. During 7 of the 17 years from 2002 to 2018 pumping occurred on less than 10 days per year - in 2013 Tumut 3 pumps didn’t run at all. Over the past decade Tumut 3 pumps have operated on average for 281 hours per year at a capacity factor of just 1.6%.

Snowy 2.0 cannot be justified until Tumut 3 is near full capacity, otherwise it would be supplanting an existing, fully depreciated asset.

Historical operation is not directly translatable to the future, but at least for this decade the market situation is unlikely to be significantly dissimilar for Snowy 2.0.

5.10. Differing representations of Snowy 2.0 operation

Snowy 2.0 was originally portrayed as purchasing electricity from solar generators during daylight hours to pump then using that water for generation at night.

However, the recently-released Main Works EIS shows pumping during the early hours of the morning and generating during the evening peak. This is consistent with this Paper’s contention that Snowy 2.0 will, at least in its first years of operation, pump mainly during the night-time off-peak hours when most generation is from coal-fired plant.

Realistic and consistent information on the expected operation of Snowy 2.0 is needed, as this is fundamental to its financial viability.

5.11. Snowy 2.0 is additional to existing plant, forestalling its full utilisation

Snowy Hydro currently generates about 5000 GWh annually, with substantial capability to load-shift over minutes to months due to the flexibility in releasing water to the major storages (Blowering and Hume) for both the Tumut and Murray schemes.

Snowy 2.0 would be additional to existing power/ pumping stations, not a stand-alone development, thereby imposing constraints on operation and limiting financial returns. This is especially relevant for the Tumut 1, 2 & 3 power stations, all of which 'share' Talbingo Reservoir.

It seems unlikely that Snowy 2.0 would be fully utilised in the initial years due to unused capacity in Tumut 3 pumped hydro station and limited market demand for 3800 MW/ 2600 MW of combined generation/ pumping capacity. Also, whenever it is economic for Snowy Hydro to generate, Snowy 2.0 would not necessarily be the first of its 6100 MW portfolio of 9 hydro-power stations to be despatched. In fact, from a financial assessment perspective it should be the last.

The combined Snowy system needs to be analysed to determine the true incremental value of Snowy 2.0, especially when assessing market scenarios and forecasting returns.

5.12. Snowy 2.0 may dampen commercial opportunities

A concern expressed by industry analysts is that Snowy 2.0 would enable Snowy Hydro to corner the pumped hydro and storage market and reduce the potential for new entrants. It would also give Snowy Hydro significant market power.

6. Other, better alternatives not analysed

6.1. Snowy Hydro should reveal why Snowy 2.0 is the best option

Snowy Hydro has focused on the 'Snowy 2.0' Tantangara/ Talbingo project. Little information has been provided on why Snowy 2.0 is the best option at this point in time, other than a brief reference to a 1991 study of a few possible projects within the Snowy Scheme. Other alternatives clearly exist. Snowy Hydro has itself alluded to Snowy 3.0 and 4.0 and a further 6000 MW of pumped hydro within the Snowy Scheme.

Alternatives potentially entail less construction, cost and risk, are more modular and manageable, have significantly less (or negligible) environmental impact and only require minor transmission upgrades. In the absence of any alternatives from Snowy Hydro this Paper provides a few examples within the existing Snowy Scheme.

Snowy Hydro should have analysed all feasible alternatives in detail and demonstrated why Snowy 2.0 is the best option on economic, technical and, most importantly in our view, environmental grounds.

6.2. Why is 2000 MW the optimal size?

Previous studies for a Tantangara/Talbingo pumped hydro scheme were based on a 990 MW station.

A smaller sized Snowy 2.0 could run for a longer period and have less environmental impact, especially for transmission. Its cost/MW may be similar to a 2000 MW station, but it would be more fully utilised and hence the overall cost/GWh may well be less.

What analysis was undertaken to determine the optimal size of 2000 MW for generation and pumping, both in terms of the cost and environmental impacts, especially as previous studies were based on a scheme half the size?

6.3. Snowy Hydro hasn't complied with the regulation requiring analysis of alternatives

No analysis of alternatives to Snowy 2.0 was included in the Exploratory Works EIS and only cursory comments are provided in the Main Works EIS. This is despite the Environmental Planning and Assessment Regulation 2000 requiring "*an analysis of any feasible alternatives to the carrying out of*

the development, activity or infrastructure”.

6.4. The Government should have reviewed alternatives, including outside Kosciuszko National Park

Many other pumped hydro storage opportunities have been identified throughout NSW, with a combined capacity of 29,000 GWh, considerably greater than Snowy 2.0. Before committing to Snowy 2.0 and providing a \$1.38 billion subsidy, it was incumbent on the Government to review other storage options, including batteries and demand response as well as pumped hydro.

There is no need to hastily proceed with Snowy 2.0 on the pretext it is urgently required and is the only option for electricity storage.

7. Unacceptable environmental impacts

7.1. A project of this size and impact should not even be contemplated in a National Park

Snowy 2.0 and its interconnecting transmission lines are located within Kosciuszko National Park. It is totally inappropriate and incompatible for infrastructure of such magnitude and environmental consequences to be permitted within the delicate alpine and sub-alpine environments of the Park.

NPA is not aware of an infrastructure project ever being constructed within a National Park in NSW, let alone a project as huge and with such devastating environmental impacts as Snowy 2.0.

Snowy 2.0 should not even be contemplated in the first place due to its location.

7.2. A 1½ year EIS process

Only now has the enormity of the project and its substantial, permanent damage to Kosciuszko National Park become evident.

Some impacts were revealed in the Exploratory Works EIS (July 2018). Considerably more information has been provided in the Main Works EIS, released on 26 September 2019. The complete environmental impact of the project should be evident when the EIS for the four transmission lines through the Park is released (expected December 2019) – an EIS process taking 1½ years!

It is considered to be highly inappropriate for Snowy 2.0 to be approved and construction commenced before all impacts are identified and assessed. Also, some impacts may result in approval conditions that significantly affect the engineering and costs of the project.

As a further example of the irresponsibility of commencing construction before the environmental assessment process has been completed, an application to extensively modify the Exploratory Works EIS was exhibited on 26 June 2019 and a further application has been flagged.

7.3. The Main Works EIS has finally revealed the enormity of impacts on the Park

Whilst previous Snowy 2.0 documents gave some indication of the scope of the project, the extent of environmental impacts on the Park only became evident with the release of the Main Works EIS:

- ‘project area’ covering 250,000 hectares (2,500 square kms) – one-third of Kosciuszko National Park
- 100 km² of KNP will be significantly and permanently impacted
- 1,053 ha of native vegetation will be totally destroyed, including 992 ha of habitat for threatened species

- 14,000,000 cubic metres of excavated rock will be dumped in the Park, some having naturally occurring asbestos and being acidic. 6,000,000 m³ is to be dumped on land and, unbelievably, over 8,000,000 m³ in reservoirs
- 100 km of roads and tracks built/upgraded/widened throughout the project
- the water table in the vicinity of sections of the 27 km tunnel will be depressed, impacting above-ground flows and habitat
- pest species spread throughout the Snowy Scheme and downstream rivers
- visual blight on the pristine Park landscape
- a flawed, totally inappropriate offsets strategy, inadequately attempting to compensate for the environmental damage

Any one of the above impacts would be more than enough to stop a proposed development anywhere, let alone in Kosciuszko National Park.

7.4. Enormous project footprint

The 'Project Area' covers approximately 50 km x 50 km (area of 2,500 square kms or 250,000 ha) encompassing a third of Kosciuszko National Park (690,000 ha) - twice the size of Greater Sydney.

The EIS refers to a 'Disturbance Footprint' of 1,680 ha, narrowly defined as the areas of physical disturbance. Also, the EIS states that 1,053 ha of native vegetation is to be lost, including 992 ha of habitat for 14 threatened species.

However, in NPA's estimation, 100 km² will be significantly and permanently impacted, some destroyed, not including waterways beyond Snowy 2.0 that will be infested by the pest species transported up from Talbingo, nor the visual blight on a pristine natural environment.

7.5. Destruction of threatened species habitat

Habitat will be lost for 14 threatened species, 1 native vegetation species, 3 groundwater dependent ecosystems and 2 migratory birds.

7.6. Dumping 14,000,000 m³ of waste rock spoil in the Park

The amount of rock spoil has increased 50% since the Feasibility Study, and it is now revealed that some has naturally occurring asbestos and some is acidic.

Between 12,900,000 m³ and 14,600,000 m³ (bulked volume) of rock and soil will be excavated. (enough to cover a football field to a height of 3 km). Over 8,000,000 m³ is to be dumped in Talbingo and Tantangara Reservoirs, decreasing their storage capacities.

If anyone proposed dumping 14,000,000 m³ of waste material, some contaminated, in a National Park they would be dismissively rebuffed, rightly so.

7.7. Twin high voltage transmission towers and lines through Kosciuszko National Park

Two side-by-side transmission towers and lines are to be constructed for 10 km through Kosciuszko National Park. The steel lattice towers will be typically 40 m high. A 120 m-wide easement swathe, covering an area of one square kilometre, will be largely cleared of native bush.

The towers, conductors and easement will dominate the landscape and be visible for some hundreds of square kilometres. The intrusion of such infrastructure on the natural environment of the Park will be overwhelming and reason alone to scrap Snowy 2.0.

7.8. Permanent damage to Lob's Hole area

The Exploratory Works will impact 400 ha along an 8 km stretch of the Yarrangobilly River. 100 ha of native vegetation is to be cleared and 75 ha of threatened native species habitat will be destroyed.

7.9. Tantangara will become a holding tank, occasionally empty and an eyesore

Currently the water levels in Tantangara Reservoir are relatively stable and fluctuate largely on a seasonal basis. When Snowy 2.0 operates, the level will vary by up to 5 metres/day and the shoreline will move in and out by up to 100's metres/day.

Rapid fluctuations in water volumes and occasional emptying will have a devastating impact on the aquatic environment and the reservoir's general attractiveness. Tantangara's relatively flat shoreline will often be exposed, sodden and barren. Whenever Tantangara is near minimum operating level (i.e. only 6% capacity) it will look like a large puddle surrounded by an extensive mud/ dirt shoreline.

Tantangara Reservoir will become little more than a holding tank.

7.10. Groundwater levels depressed

The water table in the vicinity of some sections of the 27 km tunnel will be depressed by over 50 m and by 0.5 m up to 2 km either side, drying up streams and bogs, reducing inflows to reservoirs and killing off habitat and native species (some threatened).

7.11. Transfer of pest species throughout the Snowy and downstream

The Feasibility Study referred to the presence of Redfin Perch, a Class 1 Noxious Pest, in Talbingo and the possibility of transportation by Snowy 2.0 pumps up to Tantangara, which is currently Redfin-free. It is illegal to transfer Redfin, a Class 1 Noxious Fish, between waterways in NSW.

The Main Works EIS has revealed that the issue is far more dire, with several pest species (fish, fish disease and weeds) in Talbingo Reservoir likely to be transferred to Tantangara. Snowy Hydro are proposing to contain the pests within Tantangara by physical barriers, which seems highly unlikely. These pest species will inevitably escape from Tantangara to the Upper Murrumbidgee River and Eucumbene Dam, from whence they will infiltrate the entire Snowy Scheme and downstream rivers (though they are already in some of these waterways).

7.12. Risible biodiversity offset payment so far

The Biodiversity Offset Strategy for the Exploratory Works has set compensation at a risible \$10.5 million. In NPA's view the offset strategy is a problematic and totally inadequate attempt to "pay back" the permanent environmental damage caused.

No appropriate offsets for the habitats that would be damaged or destroyed by Snowy 2.0 could be provided, given that all of the comparable alpine and subalpine areas of NSW are already included in Kosciuszko National Park.

7.13. Substantial modifications proposed for the Exploratory Works EIS, lack of consultation

Within 5 months of the Exploratory Works EIS being approved and construction commencing, substantial modifications have been proposed (on 26 June 2019) involving extensive additional environmental damage to Kosciuszko National Park – another demonstration of the injudiciousness of a piece-meal approach to planning the project.

A second modification to the Snowy 2.0 Exploratory Works is to be submitted soon, demonstrating yet again the injudiciousness of a piece-meal approach and lack of a whole-of-project plan.

7.14. Absence of life-cycle assessment of environmental impact

Snowy 2.0 is a massive project involving substantial energy and materials in its construction. No life-cycle analysis has been provided on the energy required to construct Snowy 2.0 to determine the net impact on carbon emissions.

It would be many decades into the future, if ever, before the fossil-fuels used to construct Snowy 2.0 and power its pumps in the initial years are exceeded by the renewable generation that is stored.

8. The Business Case should be revoked

8.1. Why was the Business Case commercially sensitive?

Snowy Hydro should have released the Business Case in the interests of transparency and accountability, and to address the widespread scepticism of the project. There appears to be no justifiable reason for not doing so.

Ultimately Snowy 2.0 will be paid for by electricity consumers and taxpayers; no rival can gain access to Snowy Hydro's facilities or build a pumped hydro station within Kosciuszko National Park; and any market information or projections made in 2018 are most unlikely to be of commercial relevance to competitors by the time Snowy 2.0 commences operation in 2024/5 (or later).

8.2. The flawed Business Case should be revoked

It has become clear that the Commonwealth's approval of Snowy 2.0 was based on a flawed and deficient Business Case.

On the basis of the information on the project now at hand, particularly the recently released Main Works EIS, it is time to stop this project before any more money is wasted and environmental damage is done.

The Commonwealth Shareholding Ministers should revoke approval of the Business Case on the grounds of inadequate estimation of the costs and projected returns of the project to the Australian public.

The NSW Minister for Planning should refuse approval for the Main Works EIS on the grounds of inconsistency between the enormous scale of the project and the National Park status of the proposed development site.

The sooner this action is taken, the less will be the sunk cost and the damage being wreaked on the Park.

Snowy Hydro is a Government Corporation. Australian taxpayers will ultimately bear any loss.

Snowy 2.0 doesn't stack up economically or environmentally and its claimed benefits are overstated – there are better alternatives.

Snowy 2.0 is the wrong project in the wrong place.

The remainder of this Paper canvasses the above and other related issues in more detail.

The Paper has been assembled from publicly available documents, articles and information, including the Snowy Hydro website, “2017 Snowy 2.0 Feasibility Study²”, the “Final Investment Decision of the Snowy Hydro Board³”, the Exploratory Works EIS⁴ and its Modification 1⁵ and the Main Works EIS⁶. These provide considerable detail particularly on the engineering and environmental aspects of the project. In contrast, information on financial matters has been redacted from the publicly available documents.

Care has been taken to validate the assertions in this Paper, but some may be unintentionally incorrect due to the lack of access to the Business Case and other detailed information. This emphasises the public interest grounds for disclosing these documents.

NPA forwarded an early draft of this Paper to Snowy Hydro and at a meeting with senior executives some verbal feedback was provided. NPA invited written comments but none have been received.

² “Snowy 2.0 Feasibility Study”. December 2017 <https://www.snowyhydro.com.au/our-scheme/snowy20/snowy-2-0-feasibility-study/>

³ “Snowy 2,0 Final Investment Decision information and supporting chapters”.
<https://www.snowyhydro.com.au/our-scheme/snowy20/fid/>

⁴ “Environmental Impact Statement for Snowy 2.0 Exploratory Works” 23 July 2018
http://majorprojects.planning.nsw.gov.au/index.pl?action=view_job&job_id=9208

⁵ “Snowy 2.0 Exploratory Works (Mod 1)” 26 June 2019 <https://www.planningportal.nsw.gov.au/major-projects/project/13601>

⁶ “Snowy 2.0 - Main Works EIS” 26 September 2019 <https://www.planningportal.nsw.gov.au/major-projects/project/12891>

RECOMMENDATIONS

1. That the Commonwealth Shareholding Ministers revoke the approval of the Snowy 2.0 Business Case on the grounds of inadequate estimation of the costs and projected returns of the project to the Australian public.
2. That the NSW Minister for Planning refuse approval for the Snowy 2.0 Main Works Environmental Impact Statement on the grounds of:
 - inconsistency between the scale of the proposal and the National Park status of the proposed development site;
 - the unacceptable intensity and permanence of substantial adverse environmental impacts on Kosciuszko National Park;
 - the scale and intensity of impacts on threatened species and threatened ecological communities; and
 - failure to adequately assess lower impact energy storage options within and outside the Snowy Mountains Scheme.
3. That the Commonwealth Minister for Environment refuse approval of the Snowy 2.0 project under the *Environment Protection and Biodiversity Conservation Act* because of the large scale, permanent adverse impact on matters of national environmental significance, including sites on the National Heritage List and nationally scheduled threatened species and ecological communities.
4. That the Commonwealth and NSW governments, in collaboration with the Chief Scientist, the Australian Energy Market Operator and appropriate industry experts, undertake a systematic assessment of alternative stored energy solutions. The assessment address the market potential and environmental costs of alternatives through consistent application of ESD principles.
5. The Snowy Hydro lease for the use of Kosciuszko National Park be renegotiated on commercial grounds.

DETAILS

The remainder of this Paper provides background on the project and the timeline, followed by a detailed appraisal of the issues highlighted in the Executive Summary under the same 8 headings and sub-headings (for ease of cross-referencing):

Snowy 2.0 in a nutshell

Timeline

1. Lack of an overall Plan, premature approval before completion of EIS process
2. Optimistic estimates and understated costs
3. Insupportable subsidies
4. Economically unviable
5. Overstated benefits
6. Other, better alternatives not analysed
7. Unacceptable environmental impacts
8. The Business Case should be revoked

Concluding comments

Appendices

Snowy 2.0 in a nutshell

Snowy 2.0 links Tantangara and Talbingo Reservoirs (upper and lower reservoirs, respectively), both part of the existing Snowy Mountains Hydro-electric Scheme, via a new 27 km long tunnel.



Figure 3: Location of Snowy 2.0

A new 2,000 MW power and pumping station is to be constructed just east of Lob’s Hole, 800 metres underground. The electricity storage capacity is claimed to be 350 GWh, which equates to 175 hours of generation at 2000 MW.

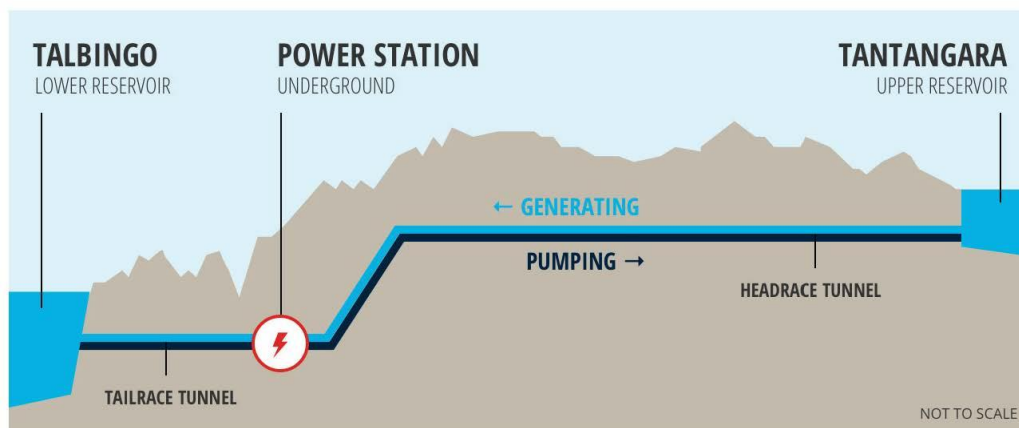


Figure 4: Snowy 2.0 Schematic Diagram

Two double circuit 330 kV transmission lines (i.e. four lines on two sets of towers) will connect the Snowy 2.0 power/pumping station to a new 'Maragle' 330/500 kV Switchyard to the west of Talbingo Reservoir, in the State Forest just outside Kosciuszko National Park.



Figure 5: Proposed Transmission Lines through Kosciuszko National Park

Two 500 kV lines are expected to be constructed from Maragle Switchyard north to Bannaby (near Marulan), one directly and the other via Wagga. Further augmentation of lines south to Melbourne are also expected.

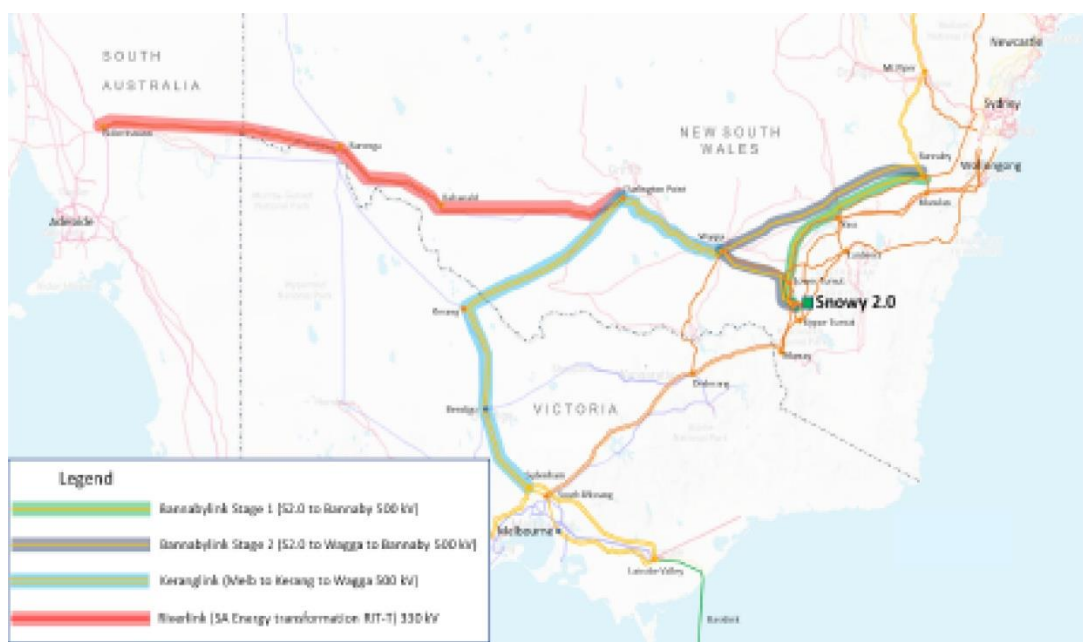


Figure 6: Likely Transmission Grid Augmentation

Timeline

15 March 2017: Prime Minister Turnbull issued a press release⁷ titled “Securing Australia’s Energy Future with Snowy Mountains 2.0”:

“The Turnbull Government will start work on an electricity game-changer: the plan for the Snowy Mountains Scheme 2.0. This plan will increase the generation of the Snowy Hydro scheme by 50%, adding 2000 megawatts of renewable energy to the National Electricity Market. A feasibility study is expected to be completed before the end of the year, and construction can commence soon after.”

Snowy 2.0 was to cost of \$2 billion, be completed in 4 years and be fully funded by Snowy Hydro Ltd.

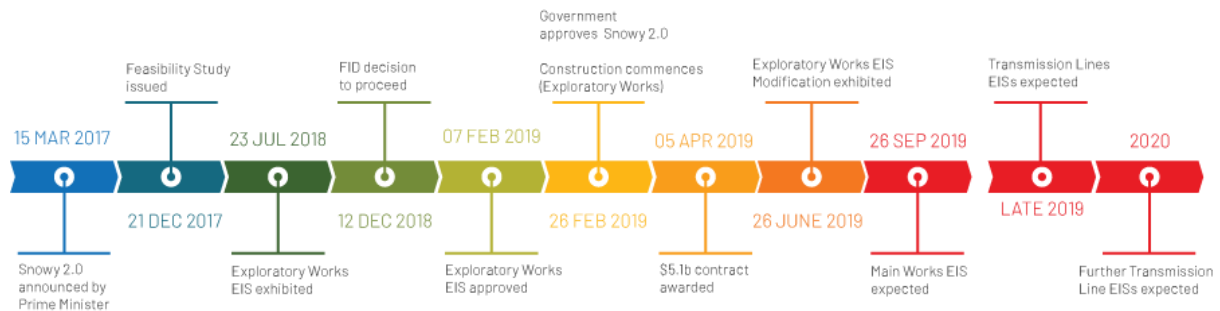


Figure 5. Snowy 2.0 Timeline 2017-20

21 December 2017: Snowy Hydro published a Feasibility Study concluding that “the Snowy 2.0 pumped hydro expansion project is both technically and financially feasible”. The Study cost \$34 million, with an \$8 million contribution from the Australian Renewable Energy Agency (ARENA). The Study estimated the base case cost as \$3.8 - \$4.5 billion and project execution to be 7 years from contract award. Progressive commissioning of generators/pumps was expected to take place between October 2024 and December 2025.

In an article titled “Snowy Hydro 2.0 could actually cost as much as \$4.5b - more than double the initial price tag”, Mr Broad stated⁸ the cost will be at the lower end of the range and that Snowy Hydro is to pay the full amount out of its balance sheet:

“the costs have increased from the initial \$2 billion price tag, to somewhere between \$3.8 and \$4.5 billion. The [Snowy Hydro] Board is committed to doing \$60 million worth of work in the next six months to refine those costs and we expect [the cost] is at the lower end of the spectrum. It's expensive, but it stacks up economically. The price had increased due to the complexity of the engineering and building tunnels in the mountains, but stressed the cost estimates were conservative. It won't be a cost to taxpayers, we will be paying for this out of the balance sheet of Snowy Hydro.”

2 March 2018: Prime Minister Turnbull announced that the Commonwealth Government would

⁷ “Securing Australia’s Energy Future with Snowy Mountains 2.0”. Press Release by Prime Minister Malcolm Turnbull, 16 March 2017 <https://www.malcolmtturnbull.com.au/media/securing-australias-energy-future-with-snowy-mountains-2.0>

⁸ “Snowy Hydro 2.0 could actually cost as much as \$4.5b - more than double the initial price tag”. ABC News 21 Dec 2017 [https://www.abc.net.au/news/2017-12-20/snowy-hydro-2.0-could-actually-cost-as-much-as-\\$4.5b/9277368](https://www.abc.net.au/news/2017-12-20/snowy-hydro-2.0-could-actually-cost-as-much-as-$4.5b/9277368)

become the sole owner of Snowy Hydro⁹. The shares held by the NSW Government (58%) and Victorian Government (29%) were to be purchased for \$4.15 billion and \$2.08 billion, respectively. The purchase was based on an agreed fair market value of Snowy Hydro of \$7.8 billion.

7 March 2018: The NSW Minister for Planning declared Snowy 2.0 to be Critical State Significant Infrastructure (CSSI) under the Environmental Planning and Assessment Act 1979 (EP&A Act):

“The declaration acknowledges that Snowy 2.0 is critical to the State for environmental, economic or social reasons, and means that the NSW Minister for Planning is the approval authority for all stages of the project, including the proposed Exploratory Works.”

15 March 2018: Snowy Hydro release a “Preliminary Environmental Assessment Exploratory Works”.

10 July 2018: The Commonwealth Assistant Minister for the Environment determined that the Exploratory Works are not a controlled action and therefore do not require any further assessment or approval under the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act).

23 July 2018: The EIS for the Exploratory Works was released for a 28-day public exhibition period. On 3 October 2018 Snowy Hydro’s Response to Submissions was issued.

12 December 2018: The Snowy Hydro Board announced¹⁰ its Final Investment Decision to proceed with Snowy 2.0:

“After almost two years of rigorous due diligence on every aspect of the Project, including detailed financial analysis and ongoing geotechnical drilling, the Board is confident Snowy 2.0 is a strong investment for the Company. The Board has informed the Shareholder of its decision to proceed with Snowy 2.0 subject to Shareholder approval.”

7 February 2019: The NSW Minister for Planning issued a Notice of Decision¹¹ for the Exploratory Works approving “the infrastructure application subject to the recommended conditions”.

26 February 2019: The Prime Minister, Minister for Energy and Minister for Finance & the Public Service issued a joint press release¹² titled “Historic Snowy 2.0 plan approved” announcing:

“shareholder approval for Snowy Hydro Limited (Snowy Hydro) to proceed with Snowy 2.0. Following Snowy Hydro Board’s final investment decision on 12 December 2018, the Government has reviewed the project’s business case and is satisfied that the project stacks up and will benefit energy consumers and the Snowy Mountains region. The Government will commit up to \$1.38 billion in an equity investment for Snowy 2.0, with the remainder of the project to be financed by Snowy Hydro Limited. The Government’s decision green lights the project to progress to the early works stage.”

⁹ “Historic Snowy Deal” Media release The Hon Malcolm Turnbull MP Prime Minister and The Hon Josh Frydenberg MP Minister for the Environment and Energy. 2 March 2018

<http://sjm.ministers.treasury.gov.au/media-release/015-2018/>

¹⁰ “Snowy 2.0 approved by the Board”. 12 December 2018

https://www.snowyhydro.com.au/news/news_snowy2approval/

¹¹ “Notice of decision – Snowy 2.0 Exploratory works (SSI 9208)” 7 February 2019

<https://www.planningportal.nsw.gov.au/major-projects/project/3221>

¹² “Historic Snowy 2.0 plan approved”. Joint Press Release The Hon. Scott Morrison MP, Prime Minister, The Hon. Angus Taylor MP, Minister for Energy, Senator The Hon. Mathias Cormann, Minister for Finance and the Public Service, 26 February 2019 <https://www.pm.gov.au/media/historic-snowy-20-plan-approved>

February 2019: Following Government approval, the Exploratory Works began, effectively commencing construction of the project.

5 April 2019: Snowy Hydro awarded a \$5.1 billion, 8-year contract¹³ for the Civil and Electro-Mechanical Works to 'Future Generation', a joint venture partnership between Clough and Salini Impregilo.

26 June 2019: An application by Snowy Hydro to modify the Exploratory Works EIS¹⁴ was exhibited.

26 September 2019: The EIS for the Main Works¹⁵ was exhibited, with a closure date for submissions of 6 November 2019.

To come:

October 2019 (expected): a second modification to the Exploratory Works EIS

December 2019 (expected): release of the EIS for the transmission lines through Kosciuszko National Park.

2020: release of the EISs for the two transmission lines to Bannaby (north of Marulan).

¹³ "Clough awarded the Civil and Electro-mechanical Works for the Snowy 2.0 Project". April 5, 2019 <https://www.clough.com.au/clough-awarded-the-civil-and-electro-mechanical-works-for-the-snowy-2-0-project/>

¹⁴ "Snowy 2.0 Exploratory Works (Mod 1)" 26 June 2019 <https://www.planningportal.nsw.gov.au/major-projects/project/13601>

¹⁵ "Snowy 2.0 - Main Works" 26 September 2019 <https://www.planningportal.nsw.gov.au/major-projects/project/12891>

1. Lack of an overall Plan, premature approval before completion of EIS process

1.1. A disconcerting genesis

From the outset there has been minimal Government analysis of Snowy 2.0.

Prime Minister Turnbull stated¹⁶:

"I gave a speech in February [2017] at the Press Club and got in touch with Snowy Hydro to talk about pumped storage opportunities. The Chief Executive, Paul Broad's response was 'have I got a scheme for you'."

Following discussions in March 2017 it took the Commonwealth Government less than two weeks to announce Snowy 2.0 (on 15 March 2017), as confirmed by Mr Broad¹⁷:

"There were discussions with the Prime Minister's office I think on the 3rd or the 5th of March. And the announcement was on the 16th of March."

It is interesting to note that at the time the Commonwealth was the minority shareholder of Snowy Hydro (with 13%), and yet the two other shareholders – the NSW and Victorian Governments – were not informed of the Snowy 2.0 proposal. The announcement of Snowy 2.0 by the Prime Minister without consulting the two State Government shareholders is summed up in the article¹⁸ "Snowy Hydro expansion won't be 'magical' solution to power problems, experts say":

"Collaboration between the Commonwealth and the two states that share ownership of the scheme is already off to a shaky start -- with the Victorian Energy Minister Lily D'Ambrosio telling RN Breakfast they were yet to be consulted about the project."

"The news is what we heard on the radio frankly and what we woke up to this morning," Ms D'Ambrosio said. "So this is the way that the Prime Minister is leading this country; when he comes up with ideas, [he] doesn't think them through, has no dialogue with the direct shareholders — NSW Government, Victorian Government — to work cooperatively on this issue."

The Commonwealth subsequently purchased the two State Government shareholdings (possibly for an inflated price - see Section 3.2).

At the time of the announcement no analysis was provided of alternatives and why Snowy 2.0 is the most appropriate energy storage project. Over 2½ years later, still no analysis has been provided.

Snowy 2.0 was to cost \$2 billion, be completed in 4 years, and be fully funded by Snowy Hydro. None of these three basic premises have turned out to be anywhere near realistic.

¹⁶ "Snowy Hydro 2.0" 27 August 2017 <https://www.youtube.com/watch?v=s-qN1IU8uaw>

¹⁷ "Snowy 2.0 plan approved by Prime Minister Malcolm Turnbull in less than two weeks; cost could skyrocket". ABC News 23 May 2017 <https://www.abc.net.au/news/2017-05-23/snowy-hydro-2.0-decision-made-by-turnbull-in-less-than-two-weeks/8551134>

¹⁸ "Snowy Hydro expansion won't be 'magical' solution to power problems, experts say" ABC News 16 March 2017 <https://www.abc.net.au/news/2017-03-16/snowy-hydro-expansion-wont-be-magical-solution-to-power-problems/8360320>

1.2. No comprehensive Business Case for the entire project

The Snowy 2.0 project has been split into 4 incremental components/stages, the first two being the responsibility of Snowy Hydro and the last two the responsibility of Transgrid:

- | | | |
|-----------|-----|--|
| Snowy | (1) | Exploratory Works |
| Hydro | (2) | Main Works (power/pumping station, tunnels etc) |
| TransGrid | (3) | four transmission lines from Snowy 2.0 through Kosciuszko National Park to a new substation west of Talbingo |
| | (4) | two transmission lines connecting to the grid |

The Environmental Impact Statement (EIS) for the Stage 1 Exploratory Works has been exhibited and approved, and work commenced in February 2019. The EIS for the Main Works has just been exhibited (September 2019). One modification to the Exploratory Works EIS has been submitted and another one is imminent. The EISs for the remaining two (transmission) stages are expected to be exhibited later in 2019 and 2020.

This staged approach and the incremental and limited release of information means that neither the Government nor the public can comprehensively assess the entire project at one time before it effectively commenced in February 2019. All four stages are inextricably linked – the new pumped storage scheme cannot operate without the transmission extensions, and the transmission extensions are not needed in the proposed layout if Snowy 2.0 doesn't proceed.

New information continues to emerge, invariably with more concerning details, giving further cause for alarm about this incremental, piecemeal approach.

It is clear that the Final Investment Decision and Business Case could not have been based on a realistic cost estimate or a comprehensive understanding of the economic, engineering and environmental aspects of the project and that approval was premature.

Also, of primary concern is that no detailed financial information has been publicly released.

1.3. Disregard for EIS process

On 8 March 2018, the NSW Minister for Planning declared¹⁹ Snowy 2.0 to have Critical State Significant Infrastructure (CSSI) status. The following day the Minister indicated that the EIS should be exhibited within a few months²⁰:

"The proponents are expected to request environmental assessment requirements for the project within the next few months."

However, over 18 months later and 2½ years since the announcement of Snowy 2.0:

- only the first of four Environmental Impact Statements has been approved – the Stage 1 Exploratory Works. And even that EIS is now the subject of a modification application (26 June 2019) with another modification imminent
- the most important EIS, for the Main Works, has only just been exhibited (26 September

¹⁹ "Snowy Hydro 2.0 declared Critical State Significant Infrastructure" Minister for Planning 8 March 2018 <https://www.planning.nsw.gov.au/News/2018/Snowy-Hydro-declared-Critical-State-Significant-Infrastructure>

²⁰ "Snowy 2.0 put on development fast-track as environmental concerns rise". Sydney Morning Herald 9 March 2018 <https://www.smh.com.au/business/the-economy/snowy-2-0-put-on-development-fast-track-as-environmental-concerns-rise-20180309-p4z3l4.html>

2019)

- the EIS for the high-voltage transmission lines through Kosciuszko National Park is expected to be exhibited in December 2019, continuing the drip-feed release of information and the lack of a single overall assessment process

1.3.1. 'Exploratory Works' effectively mark the start of construction

The term 'Exploratory Works' is something of a misnomer as the scope involves far more than exploration. The stated purpose is *"to gain a greater understanding of the underground conditions at the proposed location of the power station cavern"*. The Works include establishment of a large construction and accommodation camp at Lob's Hole, boring a 2-3 km long, 8 m wide access tunnel to the location of the new underground power/ pumping station, dumping the associated 750,000 cubic metres of excavated rock, widening and upgrading 30 km of roads and building wharves.

The Exploratory Works are estimated to cost \$325 million and take 34 months. They effectively entail the initial phase of project construction.

The Exploratory Works will determine the final location of the cavern for the underground power/pumping station but have no bearing on whether the project proceeds or not. Completion at the end of 2021 will be well after commencement of the Main Works and transmission line route finalisation.

Snowy Hydro's recent application to modify the Exploratory Works EIS includes a new 330/33 kV substation and reticulation to the accommodation camp and works site, further belying the 'exploratory' terminology. A second modification proposes to increase camp accommodation by 70% and change the tunnel boring process.

1.3.2. Construction and Procurement is well underway before completion of the EIS process

Despite the lack of certainty about whether all stages would receive approval under the *Environmental Planning and Assessment Act*, Snowy Hydro has made its Final Investment Decision, the Government has approved the project and kicked in \$1.38 billion, the major works contract has been awarded and construction commenced in February 2019.

According to the Feasibility Study, procurement for the Main Works has already commenced, with civil equipment at the beginning of 2019, mechanical equipment in mid-2019 and electrical equipment at the beginning of 2020.

Also, Snowy Hydro²¹ are *"selling products off the back of Snowy 2.0 now"*.

In a recent article titled *"Behind Snowy's battery bet"*²², Mr Broad confirms that construction is proceeding apace, and major equipment is being ordered:

"For those naysayers who keep saying perhaps Snowy 2.0 isn't going to happen: sorry, it's started and for something not happening there sure is a lot of action happening. The diggers are digging, the financing is being lined up and the tunnel boring machines have been ordered. It's all on track."

²¹ "Snowy Hydro in the spotlight" Energy Insiders podcast. 10 August 2019

<https://soundcloud.com/reneweconomy-646697966/snowy-hydro-in-the-spotlight>

²² "Behind Snowy's battery bet" The Australian 14 September 2019

<https://www.theaustralian.com.au/business/mining-energy/snowy-20-glows-with-the-flow-as-volatility-soars/news-story/ee7717e4f238bbe846a8565593d1c862>

Unbelievably, construction of Snowy 2.0 is proceeding at full speed, before the Main Works and transmission EISs have been assessed or approved, totally disregarding the EIS process.

Now that the Exploratory Works and procurement are underway and represent a sunk cost, the fragmented environmental impact assessment process effectively builds momentum for the project irrespective of any major impediments that may arise through further investigations.

A further example of disregarding the EIS process is Snowy Hydro's lack of consultation with all stakeholders before submitting its recent modification for the Exploratory Works EIS.

This contempt for the EIS process is even more reprehensible for a project within a National Park.

And it carries a risk of refusal of the EIS or the imposition of conditions that render the project uneconomic.

1.4. Lack of robust Government review of the (partial) Business Case or alternatives

As noted in Section 1.1, the Government announced Snowy 2.0 within 2 weeks of being advised of the proposal, clearly with scant analysis of the project or alternatives.

2 years later, on 26 February 2019, Prime Minister Morrison stated that *"the Government has reviewed the project's business case and is satisfied that the project stacks up"*.

No detail was provided on how the Government conducted its review, which was completed in 2 months over the 2018-19 summer holiday period.

A project of this size, complexity, risk and cost requires a comprehensive and rigorous review, including obtaining expert independent advice on all relevant disciplines including hydro stations, tunnelling, transmission, financing, market analysis and environmental impacts. And such review should encompass the entire project, not just the hydro component.

It is understood that a financial advisory firm (Lazard Pty Ltd) was involved in the review, but independent advice was not sought on other relevant aspects.

By relying primarily on the advice of Snowy Hydro and its consultants, the Government could not have fulfilled its responsibilities as the sole shareholder in undertaking a rigorous review of the Business Case. This is even more relevant when a sizeable government subsidy (\$1.38 billion) is involved.

Further, before approving Snowy 2.0 it was incumbent on the Government to examine alternatives and determine a comprehensive approach to providing energy storage to the National Electricity Market over the coming decades.

1.5. Risk of premature approval already demonstrated

The risk of premature approval of Snowy 2.0 by the Commonwealth (26 February 2019) was demonstrated within 6 weeks when Snowy Hydro awarded a \$5.1 billion contract on 5 April 2019, significantly eclipsing the Business Case estimate of \$3.8 billion for the entire project.

Snowy Hydro must have known well before the Government's review of the Business Case was completed on 26 February 2019 that the contract price would exceed the Business Case estimate. Five weeks before Government approval, on 18 January 2019, Snowy Hydro announced²³ the

²³ "Snowy Hydro appoints preferred tenderers for Snowy 2.0" 18 January 2019

preferred tenderers, following an 18-month competitive tender process. It is most likely that contract prices would have been known well before then.

When Snowy Hydro announced²⁴ the awarding of contracts it did not mention the price – that was contained in a press release by the winning tenderer²⁵. The reluctance of Snowy Hydro to mention the value of the contract was mentioned in an article²⁶ “Snowy 2.0 construction costs blow out to more than \$5 billion”:

“The fact that Snowy Hydro chose not to mention the \$5.1 billion number reflects the sensitivities around the budgeted cost, which has already more than doubled once from the original \$2 billion price tag, and amid ongoing concern from many in the industry that it will struggle to make money and may not be the most efficient and cost effective choice”.

Even more concerning is a comment²⁷ by a Snowy Hydro spokesman in an article “Snowy Hydro costs, timeline blow out” that management had not sought approval from its Board:

“In documents released in February, when Mr Morrison announced a \$1.4 billion equity injection into Snowy Hydro to fund Snowy 2.0, the federal government-owned hydro power giant said the costs of the project were still “in line” with the range of \$3.8 billion to \$4.5 billion revealed with selected highlights of the initial feasibility study in December 2017. The spokesman said the government-owned company had decided to stick with the \$4.5 billion figure in “real” 2017 dollars to avoid confusion and the \$5.1 billion figure cited by Salini Impregilo was a contractual amount. “Snowy Hydro no longer has any CPI risk,” he said. He said there was no cost blowout and the management had not had to go back to the board to secure a further investment approval.”

The Snowy Hydro Board’s Final Investment Decision and the Government’s review of the Business Case would have been based on the \$3.8 billion estimate (upper bound of \$4.5 billion), which is now seen to be significantly understated. Snowy Hydro’s ‘explanation’ that \$3.8 billion or \$4.5 billion for the whole project is equivalent to \$5.1 billion for one contract is not plausible – see Section 2.2.3.

Clearly the cost of the project will be well above \$5 billion. This Paper suggests a figure of \$8 billion for the hydro component with a further \$2 billion for transmission (Section 2.4).

Both the Snowy Hydro Board’s Final Investment Decision and the Commonwealth’s approval of the Business Case were based on substantially flawed and deficient information.

The Commonwealth Shareholding Ministers should revoke approval of the Business Case. The sooner this action is taken, the less will be the sunk cost.

Snowy Hydro is a Government Corporation. Australian taxpayers will ultimately bear any loss.

<https://www.snowyhydro.com.au/news/snowy-hydro-appoints-preferred-tenderers-for-snowy-2-0/>

²⁴ “Local and global experts to build Snowy 2.0”. Snowy Hydro Press Release 5 April 2019

<https://www.snowyhydro.com.au/news/local-and-global-experts-to-build-snowy-2-0/>

²⁵ “Clough awarded the Civil and Electro-mechanical Works for the Snowy 2.0 Project” April 5, 2019

<https://www.clough.com.au/clough-awarded-the-civil-and-electro-mechanical-works-for-the-snowy-2-0-project/>

²⁶ “Snowy 2.0 construction costs blow out to more than \$5 billion” Renew Economy 9 April 2019

<https://reneweconomy.com.au/snowy-2-0-construction-costs-blow-out-to-more-than-5-billion-56320/>

²⁷ “Snowy Hydro costs, timeline blow out” Eutility’s news. 17 April 2019 <https://eutility.com.au/article/snowy-hydro-costs-timeline-blow-out/>

2. Optimistic estimates and understated costs

2.1. Completion time has more than doubled

When first announced on 15 March 2017, Snowy 2.0 was to take 4 years, with construction to start soon after a feasibility study, to be completed before the end of that year. That is, Snowy 2.0 was to be completed by the end of 2021.

Two months later, on 24 May 2017, Mr Broad acknowledged²⁸ that a 4-year timeframe was overly optimistic and that 5-6 years is more likely – i.e. a 150% increase.

“When Prime Minister Malcolm Turnbull announced the “supercharged” pumped-hydro scheme in March, he estimated it would take four years to dig 27 kilometres of tunnels and sink a turbine a kilometre below ground to make the project ready to plug in to the National Energy Market. But Snowy Hydro now believes that would take up to six years because of “challenging” geology. Prime Minister Malcolm Turnbull’s pet project to expand the Snowy Hydro scheme is going to cost more and take longer than expected.

Snowy Hydro chief executive Paul Broad told a Senate estimates hearing on Tuesday that the four-year aim was possible only if “everything went your way”, with five to six years being a more likely time frame for completion.”

The Feasibility Study estimated first power at the start of 2023 and completion in mid-2025.

A Snowy 2.0 Project Update²⁹ in July 2018 and the Final Investment Decision papers estimated first power in late 2024 and completion of the entire project by 2026 – i.e. 7 years from the Financial Investment Decision.

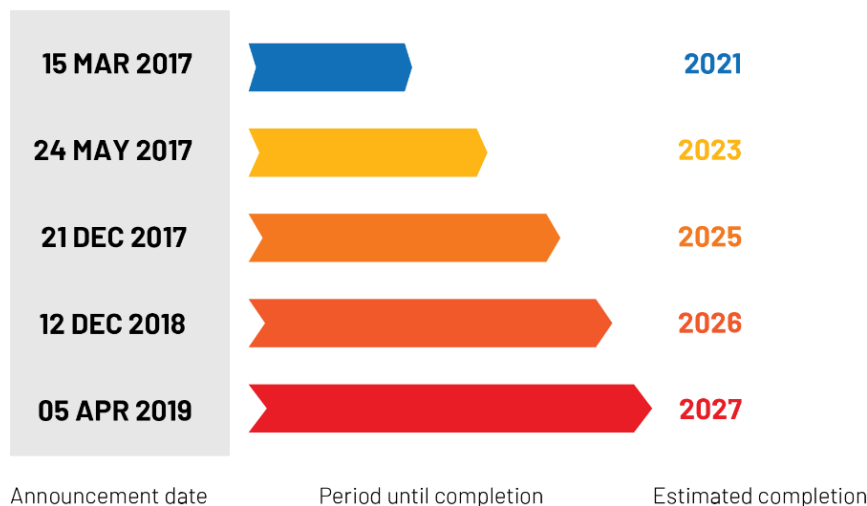


Figure 6. Stretching Completion Dates

However, the announcement on 5 April 2019 of the contract for the Civil and Electro-mechanical

²⁸ “Snowy Hydro expansion could cost double initial \$2 billion estimate”. Sydney Morning Herald 24 May 2017 <https://www.smh.com.au/politics/federal/snowy-hydro-expansion-could-cost-double-initial-2-billion-estimate-20170523-gwb0vy.html>

²⁹ “Snowy 2.0 Project Update July 2018 https://www.snowyhydro.com.au/wp-content/uploads/2018/07/SH1222_SQUARE-BOOKLET_Snowy-2-Project-Update_v10_web.pdf

Works stated that the project would take 8 years (i.e. 2027). The article³⁰ “Snowy 2.0 cost blows out to \$5.1b” referred to “eight years of the project” but Snowy Hydro noted that “the project was still on track to start producing power from the first of six generators by late 2024 and the extra year on the contract was largely to cover ‘remediation work’”. If the contract goes for 8 years (i.e. 2027) that would be an extra three years, not one year, after first power production in 2024.

The Main Works EIS indicates fit-out, testing & commissioning and final rehabilitation being completed at the very end of 2026.

So, instead of being completed in 2021, Snowy 2.0 is now expected to have the first of six units generating in late 2024 and be fully completed by 2027, more than double the initial estimate.

A new Business Case should provide an updated construction schedule and assess the financial implications of further time and (hence) cost overruns.

2.1.1. Exploratory Works schedule has also been extended

The “Preliminary Environmental Assessment for the Exploratory Works”, issued on 15 March 2018, stated that the “Exploratory Works are expected to be completed within 18 to 30 months”.

Four months later, the Exploratory Works EIS (issued on 23 July 2018) increased the estimate to 34 months, almost twice the initial lower estimate:

“Construction of the project is anticipated to commence at the end of 2018 with substantive works commencing in early 2019 and to continue for an estimated 34 months”.

2.2. Cost of pumped storage component has increased by 400%

When first announced on 15 March 2017, Snowy 2.0 was estimated to cost \$2 billion.

This was confirmed by Mr Broad two months later on 24 May 2017 at a Senate Estimates Hearing when, in answer to a question of “how feasible” the \$2 billion estimate was for the tunnelling and civil works needed, he replied³¹ “We believe that is a reasonable estimate at the moment.”

However, on 21 December 2017 the Feasibility Study included a cost estimate of \$3.8 - \$4.5 billion. Mr Broad elaborated³²:

“the costs have increased from the initial \$2 billion price tag (excluding transmission), to somewhere between \$3.8 and \$4.5 billion. The board is committed to doing \$60 million worth of work in the next six months to refine those costs and we expect [the cost] is at the lower end of the spectrum. It's expensive, but it stacks up economically. The price had increased due to the complexity of the engineering and building tunnels in the mountains, but he stressed the cost estimates were conservative.”

The estimate of “somewhere at the lower end of \$3.8 and \$4.5 billion” was double the original figure

³⁰ “Snowy 2.0 cost blows out to \$5.1b”. ABC News 9 April 2019 <https://www.abc.net.au/news/2019-04-09/snowy-hydro-2.0-cost-and-timeline-blows-out/10983998>

³¹ “Snowy Hydro expansion could cost double initial \$2 billion estimate” 24 May 2017. The Guardian <https://www.smh.com.au/politics/federal/snowy-hydro-expansion-could-cost-double-initial-2-billion-estimate-20170523-gwb0vy.html>

³² “Snowy Hydro 2.0 could actually cost as much as \$4.5b — more than double the initial price tag”. ABC News 21 Dec 2017 [https://www.abc.net.au/news/2017-12-20/snowy-hydro-2.0-could-actually-cost-as-much-as-\\$4.5b/9277368](https://www.abc.net.au/news/2017-12-20/snowy-hydro-2.0-could-actually-cost-as-much-as-$4.5b/9277368)

of \$2 billion. No information was provided on the break-up of the estimate.

However, it has become evident that this revised estimate did not cover all project costs.

2.2.1. “Excluded Costs” not in \$3.8 billion estimate

Delving into the Feasibility Study there is a brief mention in “Section 5.2 - Key assumptions and exclusions of the Estimate” that:

“The following items have been excluded from the estimate:

- 1. Land and development costs;*
- 2. Foreign exchange fluctuations or hedging costs;*
- 3. Funding or financing costs;*
- 4. Snowy Hydro Project Management and operational ramp-up costs;*
- 5. Validation of project uncertainty in association with risk profile;*
- 6. Operational spares; and*
- 7. GST”*

No reason is given for these exclusions, no cost estimate is provided, and no further comment or explanation as to why these costs have been excluded is made. Snowy Hydro has consistently quoted an estimated capital cost at the lower end of \$3.8 - \$4.5 billion without any mention of these excluded costs.

2.2.2. Capitalised interest not in \$3.8 billion estimate

One of the excluded costs is for “funding or financing”, which is usually termed capitalised interest³³, being *“the cost of the funds used to finance the construction of a long-term asset that an entity constructs for itself”*.

Snowy Hydro have commented:

“The contribution of debt financing is expected to be accomplished by a program of senior bank debt facilities, with tenures of between three and seven years, which may be bridged into longer-dated bonds or other facilities. The average, all-in cost of debt financing is projected to be 5.7% per annum, including the cost of fixed-rate hedging of between 80% and 90% of the total debt.”

In simple terms, if the project was to incur loans totalling \$8 billion in a linear fashion over 5 years the capitalised interest in each of the five years, assuming a borrowing rate of 5% p.a., would be \$80m, \$160m, \$240m, \$320m and \$400m, totalling \$1.2 billion. The actual figure will be higher due to the timing of capital spend being concentrated in the middle years (FID Valuation and Selected Business Case), a longer construction period than 5 years and a slightly higher interest rate (5.7%).

2.2.3. A single \$5.1billion contract exceeds the (understated) estimate for whole project

Clearly the \$3.8 billion project estimate was substantially understated, by not including “excluded costs”, capitalised interest and transmission.

However, it has become evident that the project estimate will need even further upward revision after the announcement of a \$5.1 billion contract for the Civil and Electro-mechanical Works

³³ “Capitalised Interest” CPE Accounting Tools. 8 January 2019
<https://www.accountingtools.com/articles/what-is-capitalized-interest.html>

component of the project on 9 April 2019. The article³⁴ "Snowy 2.0 cost blows out to \$5.1b" comments:

"The Federal Government's Snowy 2.0 project faces a significant cost blowout and delay from the original estimate detailed in a feasibility study a little over a year ago.

Major Perth-based construction and engineering firm Clough confirmed it had been awarded a \$5.1 billion contract with its Italian joint venture partner, Salini Impregilo, for the civil and electro-mechanical works for the Snowy 2.0 Project. "The value includes future escalation of prices through the eight years of the project," Clough said.

This is 35 per cent higher than the costliest outcome of \$4.5 billion tabled by the Snowy Hydro feasibility study in December 2017. It is also 60 per cent higher than the \$3.8 billion at the bottom end of expectations and more than 150 per cent higher than the original guesstimate of \$2 billion made by former prime minister Malcolm Turnbull in early 2017. However, unlike the feasibility study, the contract includes fixed, inflation-based escalation costs, which should in principle, provide a degree of certainty about the final cost.

Snowy Hydro said the higher cost reflected the difference between 2017 "real" dollars and 2019 "nominal" dollars. The company said the project was now in "a much better risk position" financially.

However, \$5.1 billion may be on the conservative side according to David Leitch, a veteran energy analyst and principal at consultancy ITK. "The final cost is more likely to be more than \$6 billion," Mr Leitch said. "These contracts generally include a 10 per cent contingency clause, which unsurprisingly get used and there'll be other costs for things like preliminary works."

The contract does not include the extra infrastructure spending required to upgrade the grid for the new Snowy generation."

Snowy Hydro's explanation that 2017 real dollars of \$3.8 - \$4.5 billion equates to \$5.1 billion in 2019 nominal dollars is not plausible, especially when Snowy Hydro had been indicating that it expected the final cost to be at the lower end of the range. The lower end \$3.8 billion estimate, made in December 2017, would equate to about \$3.9 billion 16 months later in April 2019, not \$5.1 billion. Even if the unrealistic approach is taken that the \$5.1 billion is in dollars of the day when paid, \$3.8 billion in 2017 equates to less than \$4.5 billion over the course of construction.

Furthermore, and most importantly, it is not an apples-vs-apples comparison. The \$3.8 - \$4.5 billion estimate is for the whole project (though significantly understated and not including the excluded costs and other costs mentioned earlier), whilst the \$5.1 billion figure is for only one (albeit the largest single) component of the project.

And it is almost inevitable that, with a project of this size and complexity, there will be contract variations and cost increases over the 8-year contract, even though Snowy Hydro consider this to be unlikely.

2.2.4. Latest cost estimate continues to exclude significant items

The recently-released Main Works EIS (Appendix E) refers to a 'Capital investment Value' of \$4.6

³⁴ "Snowy 2.0 cost blows out to \$5.1b". ABC News 9 April 2019 <https://www.abc.net.au/news/2019-04-09/snowy-hydro-2.0-cost-and-timeline-blows-out/10983998>

billion:

“The Main Works Capital Investment Value is made up of the following components:

1. *A ‘Lump Sum Fixed Price EPC Contract’ with a mechanism for adjustment of price associated with unforeseen geotechnical conditions (EPC deed) for the Project of AU\$4,609 million (excluding GST) (base dated December 2018) which comprises the following:*
 - a. *Electrical and mechanical equipment of \$790 million; and,*
 - b. *Civil excavation and construction of \$3,819 million*
2. *The Main Works Capital Investment Value excludes exploratory works, segment factory, SHL, advisors, funding, approvals, GST, land acquisition and escalation costs.”*

But as with the previous Feasibility Study estimate, this figure is meaningless as it excludes a raft of very significant project costs. This time there are even more excluded costs, and there is no mention of the cost of transmission lines to Maragle.

It is highly irregular for Snowy Hydro to again not provide a complete estimate of the total project.

2.2.5. Cost of pumped storage component estimated to be \$8 billion

Beginning with the known \$5.1 billion major contract and adding inevitable variations (10-20%), expenditure-to-date (some \$100s millions), other contracts (say ~\$0.5 billion), excluded costs (say ~\$0.5 billion), capitalised interest (>\$1 billion) and contingencies (5-15%), brings the cost for the pumped storage component of the project to approximately \$8 billion (without including the cost of transmission – outlined below).

Figure 9 provides a list of estimated costs.

2.3. Minimal allowance for transmission cost

Snowy 2.0 cannot operate without new transmission circuits.

Mr Broad stated³⁵:

“We have said right from day one that Snowy 2.0 will not work without transmission upgrades to get the electricity to customers north and south”.

The Feasibility Study notes:

“The Project will not be feasible without adequate and deep transmission augmentation to increase the capacity of the transmission lines between the Scheme and the load centres in NSW and Victoria. The Project requires this transmission augmentation so the benefits and products can be delivered both north and south.”

Snowy 2.0 will constitute both the largest single load ever added to the national grid and the largest generator to be added for 35 years.

2.3.1. Design and routes still being assessed

To date there has been no detailed information on the design, routes or cost of the electricity transmission line components – this is expected when the respective EISs are released.

³⁵ “Snowy Hydro News”. June 2017 https://www.snowyhydro.com.au/wp-content/uploads/2018/06/SHLNews_June2017_LR.pdf

Over the past year or so there has been considerable electricity industry discussion on development of the electricity grid to accommodate new solar and wind generators and to strengthen the connections between NSW, Victoria, Tasmania and South Australia. This has required changes in Snowy 2.0's proposed transmission extensions to align with the Australian Energy Market Operator's Integrated System Plan (ISP), which is still being developed.

At this stage it appears that there will be three circuits directly associated with Snowy 2.0:

- i. four 330 kV overhead transmission lines (two lines on each of two sets of towers) from the power/ pumping station (Lob's Hole) for 10 km to a new 500 kV/330 kV switchyard west of Talbingo Reservoir just outside Kosciuszko National Park in Maragle State Forest, called "Maragle Switchyard".
- ii. one 500 kV overhead transmission line from Maragle north to Bannaby (north of Marulan), 260 km long
- iii. one 500 kV overhead transmission line from Maragle to Bannaby via Wagga, 370 km long

The four 330 kV lines between the power/pumping station and the new Maragle Switchyard will need to traverse the Kosciuszko National Park and are likely to require an easement 120 m wide and 10 km long. The routes of the two 500 kV lines to Bannaby are unknown at this stage.

There may be other transmission augmentations required 'deeper' within the grid to accommodate the extra 2000 MW of capacity required for Snowy 2.0, particularly south to Melbourne.

2.3.2. Cost of transmission could be \$2+ billion

It was reported at a Senate Estimates Hearing³⁶ in May 2017 that the transmission lines will cost \$1 to \$2 billion "based on early works that TransGrid have started to do".

In June 2019 Transgrid issued a Project Specification Consultation Report³⁷ providing 12 options for reinforcing the NSW grid north from Snowy 2.0 to Sydney by an additional 2000 MW to 3100 MW, ranging in cost from \$0.8 to \$1.9 billion. Information on grid reinforcements south from Snowy to Melbourne are yet to come.

TransGrid's PSC Report lists four needs underpinning the proposed investment:

- i) *"The committed expansion of generation and storage capacity in the Snowy Mountains ('Snowy 2.0');*
- ii) *The strength of the renewable energy resources in southern NSW and western VIC;*
- iii) *The limitations on the existing NSW transmission network that would limit northwards flows from the Snowy Mountains to the major NSW load centres;*
- iv) *AEMO's ISP analysis that identified transmission augmentation of the shared network between the Snowy Mountains and Sydney as part of the optimal network development plan that would deliver net market benefits as dispatchable generation in NSW retires."*

The two extra 500 kV circuits from Maragle to Bannaby (see Section 2.3.1) constitute Option 3C,

³⁶ "Snowy Hydro expansion could cost double initial \$2 billion estimate" 24 May 2017. The Guardian <https://www.smh.com.au/politics/federal/snowy-hydro-expansion-could-cost-double-initial-2-billion-estimate-20170523-gwb0vy.html>

³⁷ "Project Specification Consultation Report: Reinforcing the New South Wales Southern Shared Network to increase transfer capacity to the state's demand centres" Transgrid 25 June 2019 https://www.transgrid.com.au/what-we-do/projects/regulatory-investment-tests/Documents/TransGrid%20PSCR_Reinforcing%20NSW%20Southern%20Shared%20Network.pdf

providing an additional 2500 MW firm capacity at an indicative capital cost of \$1.35 billion. Option 4C extends those two new 500 kV lines from Bannaby to Sydney, providing firm capacity of 3100 MW at an indicative cost of \$1.9 billion.

These indicative costs do not include the lines from Snowy 2.0 to Maragle or further required strengthening of the network from Wagga to Victoria to accommodate Snowy 2.0.

AEMO are yet to finalise the ISP, so it will be some time before the additional circuits are finalised and the cost determined. But it would appear that the total cost of transmission augmentations to both provide for Snowy 2.0 and strengthen the grid will be over \$2 billion.

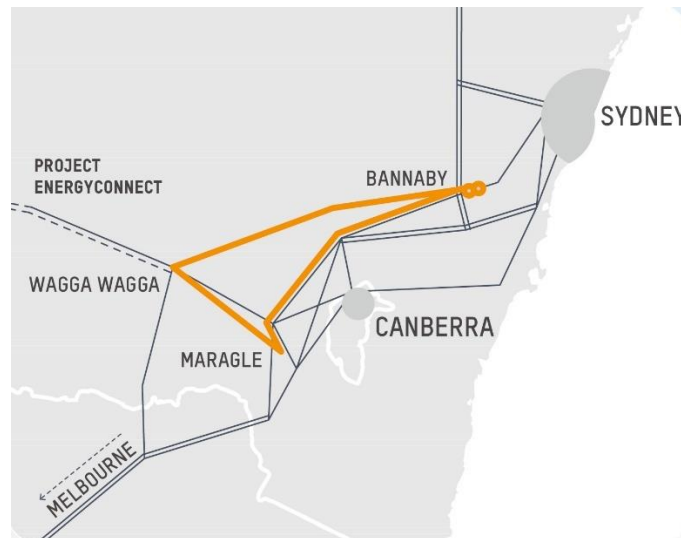


Figure 7. Option 3C in Transgrid PSC Report

Prime Minister Morrison stated³⁸ that “state governments have particular responsibilities” when it comes to transmission infrastructure required to ensure the proposed 2000 MW of new generation capacity is technically feasible. The Prime Minister seemed to be implying that the State Governments ought to be providing and paying for the extra transmission infrastructure, rather than Snowy Hydro. It is not clear how the NSW and Victorian Governments could do this, as the electricity transmission networks are privately owned (and actually overseen by Commonwealth Government regulators).

2.3.3. Snowy 2.0 proposes to pay for only 1.5% of grid augmentations

Mr Broad stated in an article³⁹ titled “Good business makes good business: The Case for Snowy 2.0” that it is misleading to suggest that Snowy Hydro does not propose to pay for the extra transmission:

“to suggest Snowy Hydro isn’t paying for transmission is misleading. The capital costs for Snowy 2.0 provide for the cost of the project’s transmission connection, that is, the lines connecting our assets to the wider shared network. The shared transmission network is common infrastructure used by all generators, with Snowy Hydro being only one and in fact the most infrequent user today, given we only generate at peak times. The transmission network was built decades ago

³⁸ “Snowy Hydro 2.0 poles and wires to be managed by states”. Scott Morrison, 26 February 2019 <https://www.theguardian.com/australia-news/2019/feb/26/snowy-hydro-20-poles-and-wires-to-be-managed-by-states-scott-morrison-says>

³⁹ “Good business makes good business: The Case for Snowy 2.0” 10 January 2018 Paul Broad <https://www.snowyhydro.com.au/news/good-business-makes-good-business-the-case-for-snowy-2-0/>

around coal, and the ideal zones for renewables are not in the same locations. The shared network needs a major upgrade to cater for renewables growth as new projects - again one of which is Snowy 2.0 - come online. The suggestion that Snowy Hydro pay for the entirety of these upgrades is misplaced.”

Mr Broad’s statement implies that Snowy Hydro intends to pay for the 10 km of 330 kV lines connecting the power/ pumping station to Maragle Switchyard and the Switchyard itself, as these lines and switchyard will be used exclusively by Snowy 2.0. His statement suggests that the cost of these lines was included in the estimate of \$3.8 billion.

However, Snowy Hydro does not intend to pay for the two 500 kV lines from Maragle to Bannaby, totalling 630 km in length and accounting for almost all the \$1 - \$2 billion cost of extra transmission to the north, or the augmentations required to the south, currently uncoded.

Capital Contribution Policy

A long-standing principle in the electricity industry is that whenever additional transmission or distribution is required to connect a new generator or load to the grid a capital contribution is determined that is commensurate with their relative use of the additional infrastructure compared to existing and potential customers. This principle ensures that each new load and generator pays its fair share of connection costs, thereby providing for economically efficient decision-making related to location and capacity needed.

This principle is contained within TransGrid’s Pricing Methodology⁴⁰, which states in Section 9.2 - Capital contribution or prepayment for a specific asset:

“Consistent with clause 6A.28.2 of the Rules, where TransGrid is required to construct or acquire specific assets to provide prescribed connection services or prescribed shared network services to a transmission network user, TransGrid may require that user to make a capital contribution or prepayment for all or part of the cost of the new assets installed. The treatment of such capital contributions or prepayments will be in accordance with the relevant provisions of the Rules and the revenue determination.”

AEMC Report proposes greater locational price signals

The Australian Energy Market Commission has just released its “Coordination of Generation and Transmission Investment (COGATI) Review⁴¹”. One of the key issues is ‘locational pricing’:

“Due to the current lack of locational price signals in the transmission framework, investors have located their generation or storage assets where the network has limited or no capacity for the additional capacity to be dispatched.

Better locational operational and investment decisions should result in a more efficient transmission network over the longer term, ultimately lowering costs for consumers.

⁴⁰ “TransGrid Pricing Methodology 2018/19 – 2022/23”. April 2018

<https://www.aer.gov.au/system/files/AER%20-%20TransGrid%202018%E2%80%932020-%20Transmission%20determination%20-%20Attachment%20B%20-%20Pricing%20Methodology%20-%20April%202018.pdf>

⁴¹ “Coordination of Generation and Transmission Investment (COGATI) Review”. AEMC 14 October 2019

<https://www.aemc.gov.au/news-centre/media-releases/managing-costs-and-risks-integrating-new-generation-power-system>

The proposals we are releasing today essentially do two things. They create better investment signals for generators to locate in more cost-effective places, and make it possible for them to use the transmission network more efficiently.”

The introduction of greater locational price signals will have implications for Snowy 2.0, being at a considerable distance from major load centres and generators, at least for the present.

Snowy Hydro disputes the need for Snowy 2.0 contributing to grid extensions

In the article titled “Behind Snowy’s battery bet⁴²”, Mr Broad states that Snowy Hydro should not be required to fund transmission as it is ‘for the common good’:

“The issue of whether Snowy should fund transmission for its own expansion touches a nerve. [Mr Broad responded] We’ve said this 150,000 times. Transmission is for the common good. Everyone benefits from it. We use it about 10 per cent of the time and the other 90 per cent it’s used by everybody else, particularly on the renewable side.”

The Maragle Switchyard and two 500 kV lines to Bannaby are essential for Snowy 2.0 to operate at full capacity. Whilst they will also strengthen the grid and provide other wider benefits, a prime, if not major, reason for their construction and timing is “to get the [Snowy 2.0] electricity to customers north and south”.

Also, to take issue with Mr Broad’s comment that Snowy 2.0 will only ‘use’ the extra transmission for 10% of the time. Whether Snowy 2.0 ‘uses’ the transmission for 1% of the time or 100%, it still requires that transmission capacity to be available continuously for whenever Snowy Hydro decides to pump or generate at Snowy 2.0. And the 10% figure is at odds with Snowy Hydro’s (overstated) claims for the use of Snowy 2.0 for 22 hours/day (i.e. 90% of the time) as depicted in Figure 14. Another relevant point is that the extra transmission will benefit the existing Snowy generators by enabling their full capacity to be transmitted to the Sydney and Melbourne load centres, especially in peak summer periods.

Snowy 2.0 is both a generator and a load (pumping). As such, Snowy 2.0 effectively obtains double the benefit of the grid extensions, compared to a stand-alone generator or a stand-alone load. Snowy Hydro should pay the majority of the capital contributions for the associated grid extensions – that cost should not be pooled and assigned to electricity consumers.

Snowy Hydro has not included any amount for the transmission extensions in its Business Case, except the 10 km of lines out of Kosciuszko National Park – i.e. just 1.5% of the 630 km of new lines required. Again, approval of the Business Case before resolution of this cost is a significant risk.

Irrespective of whether Snowy 2.0 is ultimately required to contribute to the remaining 98.5% of transmission, that cost is ultimately borne by electricity consumers and hence should be regarded as a cost that is partly attributable to the Snowy 2.0 project.

Also, as a government-owned entity, the Business Case should have provided a comprehensive economic/ environmental analysis of the transmission requirements, regardless of whether Snowy Hydro considered it should contribute to the cost.

⁴² “Behind Snowy’s battery bet” The Australian 14 September 2019
<https://www.theaustralian.com.au/business/mining-energy/snowy-20-glows-with-the-flow-as-volatility-soars/news-story/ee7717e4f238bbe846a8565593d1c862>

2.3.4. Timing of ISP transmission brought forward for Snowy 2.0

The Australian Energy Market Operator's Integrated System Plan (ISP), published in June 2018, presented a long-term transmission development plan based on the National Electricity Market (NEM) moving to Variable Renewable Energy (VRE) generation and storage as coal plant closes. The advent of Snowy 2.0 builds on this need for additional transmission.

As noted in Snowy 2.0's FID Drivers of Revenue, the original ISP had the Bannaby link and Kerang link being constructed by 2035. However, it would appear that the timing for both links has been brought forward 9 years to 2026 to accommodate Snowy 2.0, no doubt at considerable expense. Another reason for Snowy 2.0 to contribute to the cost of these transmission extensions.

2.3.5. Snowy Hydro is advocating changes to regulatory practices

An article⁴³ titled "Snowy Hydro says multibillion-dollar energy project doesn't need cost-benefit test", canvasses the related issue of the Regulatory Investment Test (RIT) and Snowy Hydro's view that the extra transmission lines should not be subject to the test. Selected extracts follow:

"Snowy Hydro says the transmission work will involve a link between Tumut, Wagga Wagga and Bannaby in NSW and a strengthened connection between NSW and Victoria.

The Australian Energy Market Operator assesses such projects through the so-called regulatory investment test - identifying which transmission option offers the greatest economic benefits to market players, including consumers.

In a submission to the Australian Energy Market Commission, Snowy Hydro says the transmission projects "should not be subject to the [test]". Instead, regulatory rules should be rewritten so that such "nationally significant and strategic" projects are approved differently - requiring only that a transmission network business "competitively source the most efficient means to deliver the project". Snowy Hydro said regulatory investment tests can take more than 18 months and risk being delayed through the disputes process.

Respected energy economist Bruce Mountain, a consultant who has advised government departments and regulators, said there was "just no way" Snowy 2.0 should be allowed to avoid the regulatory investment test. "We've been through a massive mistake in network investment over the last decade through taking this sort of view that it's all urgent, it has to be done, it always makes sense ... and we are now falling into the same trap," he said. Associate Professor Mountain said the test was a public process that considered alternative transmission, generation and storage options, and may reveal cheaper options to Snowy 2.0. "Snowy ought to be subject to exactly the same scrutiny as anyone else planning a major investment," he said.

Grattan Institute energy program director Tony Wood said the test took time to complete but was "there for good reason". "If such an exemption was to be granted [to Snowy 2.0], how does the consumer get protected?" he said, adding that should the expansion not prove as profitable as anticipated, "then the cost of it is worn by the consumer". Mr Wood said the government had not adequately assessed alternative options before announcing Snowy 2.0. If the project was made exempt from the investment test, full financial details of the project, including the transmission costs, should be released so the public could "decide whether that is justified or

⁴³ "Snowy Hydro says multibillion-dollar energy project doesn't need cost-benefit test". Sydney Morning Herald 13 November 2018 <https://www.smh.com.au/politics/federal/snowy-hydro-says-multibillion-dollar-energy-project-doesn-t-need-cost-benefit-test-20181112-p50fir.html>

not", he said."

Snowy Hydro contests the accuracy of this article. But it seems that, as well as expecting to make a limited financial contribution to transmission extensions, Snowy Hydro is also proposing limited scrutiny by the regulators.

Snowy Hydro has also proposed⁴⁴ that pumped hydro energy storage should not be required to pay for Transmission Use of Services (TUoS) for pumping, just generation.

"There is a strong case that can be made that pumped hydro energy storage is only temporarily storing the energy before it is transmitted to the final consumer, and therefore the TUoS charges should be applied only to the final consumer of the power and not 'double charging' for the same units of electricity. We advocate for redefining the purpose and allocation of TUoS charges from "those who are supplied electricity by means of the grid" to "those who end-consume the electricity provided by the grid."

It is noted that Snowy 2.0 pumps will actually 'end-consume 30% of the electricity provided by the grid', anyway. Snowy Hydro are attempting to assign the cost of transmitting electricity to its pumps to electricity customers.

A company is at liberty to advocate changes to regulatory arrangements to its advantage, but both proposals go against industry practice and basic user-pays principles.

If the Business Case assumes that TUoS charges apply only to generation, as proposed by Snowy Hydro, pumping costs would be understated.

2.3.6. Resolution of transmission has enormous implications

The Feasibility Study states that:

"successful and timely connection to the transmission network is a keystone in the viability of the Project. Failure to establish a clear path to connection will risk the FID timeline and possibly the Project itself. Known and normal risks exist in the transmission puzzle. These include the Project not achieving Development Approval in National Park areas, land acquisition delays being particularly drawn out, and failure to align with parallel transmission augmentation efforts and projects. Equally, fairly unique risks also exist such as a regulatory change specifically aimed at the Project, changes to AEMO generator performance standards that adversely impact costs and time, and regulatory uncertainty surrounding the Project transmission proposal that adversely impacts project timelines and/or costs."

Even if Snowy 2.0 were to proceed, there is a risk that the associated transmission lines are not approved or not constructed in time. For such a large and costly extension to the grid, one of the largest ever, the regulatory approval process would be expected to take two years, easements need to be finalised and construction could take four years. TransGrid's PSC Report states that for Option 3C:

"Construction is expected to take 3-4 years, with commissioning commencing in 2024, subject to obtaining necessary environmental and development approvals."

This means that the lines may not be completed before the 2024 target date for the first Snowy 2.0

⁴⁴ "Snowy Hydro submission to Australian Energy Market Commission 19 October 2018
<https://www.aemc.gov.au/sites/default/files/2018-10/Snowy%20Hydro.pdf>

unit to be commissioned.

Any delay in transmission availability adds to the capitalised interest cost and financial risk.

2.4. Total cost could be \$10 billion, 500% of the original estimate

When the cost of transmission is included, the total capital cost of Snowy 2.0 could soar as high as \$10 billion, a 500% increase on the initial estimate of \$2 billion.

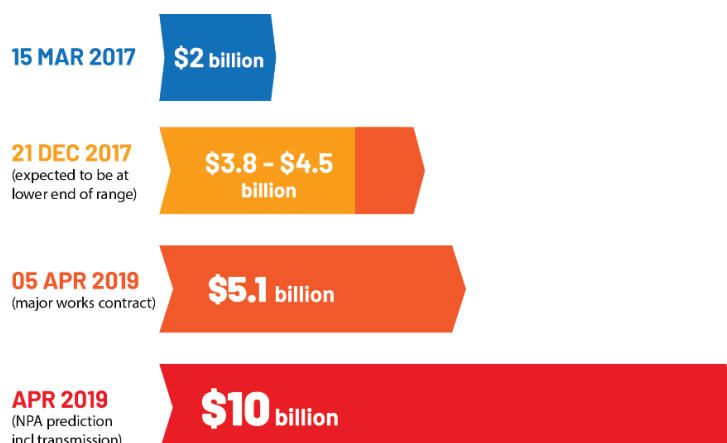


Figure 8. Ever-increasing Capital Cost Estimates

Figure 9 provides a preliminary list of components of the project, with 'ball-park' cost estimates.

| Component | \$million |
|---|------------------|
| Civil & Electro-mechanical Contract | \$5,100 |
| Contract variations (10-20%) | \$700 |
| Design | ? |
| Preliminaries (Feasibility Study, FID, EISs etc) | \$100 |
| Exploratory Works (portion not covered by main contract) | \$100 |
| 'Excluded Costs' (listed in Feasibility Study & Main Works EIS): land and development; foreign exchange fluctuations or hedging costs; project management and operational ramp-up costs; validation of project uncertainty in association with risk profile; segment factory, SHL, advisors, escalation costs, operational spares, GST | \$500 |
| Capitalised interest during construction | >\$1,000 |
| Transmission - Snowy 2.0 to Maragle | ? |
| Transmission - Maragle to Sydney (Note 1) | \$1,500 |
| Transmission - Maragle to Melbourne (Note 1) | ? |
| Contingencies (5-15%) | \$500 |
| TOTAL (indicative) | ~\$10,000 |

Note 1: Augmentation of the grid by this level of expenditure is needed to accommodate Snowy 2.0 but, as there are wider benefits, Snowy 2.0 would only be expected to contribute an equitable proportion.

Figure 9. Snowy 2.0 Capital Cost 'Ball-park' Estimate

Snowy Hydro should update its standing estimate of the cost of Snowy 2.0 of \$3.8 billion (upper limit \$4.5 billion), made in December 2017. Based on the latest information the cost of the project could well be of the order of \$8 billion for the pumped hydro component and \$10 billion when including

transmission.

To put these figures into context, the book equity value of the whole of Snowy Hydro is \$2.1 billion. They are also more than the fair market value of Snowy Hydro of \$7.8 billion⁴⁵, as agreed for the sale of the NSW and Victorian Government shares to the Commonwealth, but which of itself appears to be a premium price (see Section 3.2).

Snowy Hydro owns the existing Snowy Scheme, as well as other significant assets, and is many orders of magnitude larger and more valuable than Snowy 2.0 will be. The existing Scheme has 9 power stations (4100 MW), 16 major dams and reservoirs, 12 major tunnels (145 kms) and numerous aqueducts (80 kms), 2 pumping stations and other infrastructure. It includes the 1800 MW Tumut 3 pumped hydro station, which would be arguably of comparable value to Snowy 2.0.

A project cost for Snowy 2.0 that is more than a fraction of the value of Snowy Hydro seriously questions the economic viability of the project.

It is relevant to note that from the outset of the project a number of industry experts have been predicting a capital cost of similar magnitude to the \$8/\$10 billion estimates in Figure 9.

| Date | Expert | | Est. Cost \$ billion |
|------------------|-----------------------|--|---|
| 14 December 2017 | Dr Roger Dargaville | Senior Lecturer, Civil Engineering, Monash University | \$6-\$7b |
| 4 January 2018 | A/Prof Bruce Mountain | Director, Victoria Energy Policy Centre, Victoria University | >\$8b |
| 12 November 2018 | Paul Hyslop | Chief Executive Officer, ACIL Allen Consulting | \$5.2-\$6.3b (excl. financing, transmission) |
| 9 April 2019 | David Leitch | Principal, ITK Services | >\$6b (contract only) |

2.5. Even further time and cost increases should be allowed for

It does not bode well that both the estimated completion time and capital cost have blown out by over 200% and 500% respectively in just 2½ years, even before the Exploratory Works has progressed.

The Exploratory Works stage of the project is *“to gain a greater understanding of the rock conditions at the proposed location of the underground power station”*. In parallel with these works will be further assessment of the rock conditions along the 27 km route of the interconnecting tunnels. The rock conditions are unknown, as the power station and tunnels are in an area that was not assessed for the original Snowy Scheme. It would be most unusual for no difficulties (and extra costs) to emerge. (The proposed location of the underground power station has moved 3 times, necessitating additional bore holes and redesign of the tunnels).

Large complex infrastructure projects invariably run well over-budget and over-time. Snowy 2.0 is unlikely to be an exception, especially in light of substantial increases to date even before construction is well underway.

⁴⁵ “Snowy Hydro: NSW and Victoria to sell their stakes to federal government”. The Guardian 2 March 2018 <https://www.theguardian.com/environment/2018/mar/02/snowy-hydro-nsw-and-victoria-to-sell-their-stakes-to-federal-government>

In view of the recent further blow-out of costs, the Government should request Snowy Hydro to update its estimate, this time including all costs (contracts, project management, financing, hedging, capitalised interest, transmission etc) and a prudent amount for contingencies.

2.6. Cost comparison with ‘greenfield’ pumped hydro schemes

Researchers from the Australian National University (ANU) estimate⁴⁶ the capital cost for new off-river pumped hydro stations at roughly \$800/kW (power) and \$70/kWh (energy).

By comparison, the cost of Snowy 2.0 (excluding transmission) is of the order of \$4,000/kW (\$8b/2000 MW) and \$25/kWh (\$8b/350 GWh).

It is noted that the ANU estimates for new pumped hydro stations include the construction of reservoirs, whereas Snowy 2.0 would use existing reservoirs.

Despite this advantage, Snowy 2.0 is five times as expensive in supplying power (kW).

Conversely, Snowy 2.0 is two-thirds cheaper in supplying energy (kWh), reflecting the large capacity of Tantangara and Talbingo Reservoirs.

However, the actual practical storage capacity of Snowy 2.0 may be less than claimed (350 GWh) – see Section 5.4. Also, if Snowy 2.0 is rarely required to supply its maximum capacity, and usually cycles a much lower amount of energy, then the comparison should be based on that average amount of energy cycled. Applying these two adjustments would increase the Snowy 2.0 energy cost to a similar figure for typical new pumped hydro stations.

It is noted that the Main Works EIS includes a chart on lithium-ion battery costs, which are predicted to fall from \$2,000/kW in 2019 to \$1,000/kW in 2040.

⁴⁶ “100% Renewable Electricity in Australia” Blakers, Lu, Stocks 15 August 2017
<https://doi.org/10.1016/j.energy.2017.05.168>

3. Insupportable subsidies

3.1. Why are taxpayers providing a \$1.38 billion subsidy?

When first announced in March 2017, Snowy 2.0 was to be fully funded by Snowy Hydro.

In December 2017 Mr Broad repeated that intention in an article⁴⁷ “Snowy Hydro 2.0 could actually cost as much as \$4.5b - more than double the initial price tag”:

“It won't be a cost to taxpayers, we will be paying for this out of the balance sheet of Snowy Hydro.”

Again, in June 2018 Mr Broad stated⁴⁸:

“This is an economic project, this is a project that works. Some people say, 'Oh this is some sort of project that's going to be funded from the taxpayer', but it's not. It's funded off our balance sheet. We're doing it because we believe it works.”

However, on 26 February 2019 the Government announced that it:

“will commit up to \$1.38 billion in an equity investment for Snowy 2.0, with the remainder of the project to be financed by Snowy Hydro Limited.”

Finance Minister Cormann was quoted in an article⁴⁹ titled “We don't need Morrison's money, Snowy Hydro CEO declares” that the \$1.38 billion equity injection would “make this project happen”. This suggests that Snowy 2.0 would only proceed if the subsidy is provided.

However, Mr Broad was quoted in the same article as stating that Snowy Hydro had planned to raise its own debt without a taxpayer funded top-up:

“The government decided the way it wanted to balance out the funding. It wanted to sustain dividends. It wanted to support the project with equity. These things are part of negotiations that go on. We never asked for it. We never asked for anything.”

Also, Mr Broad commented⁵⁰ at the press conference:

“Thank you to you Prime Minister. Thank you to my two shareholding Minister's here. Let me tell you. Anyone thinks there's an easy touch on this thing, I can tell you now, meeting these two guys, it was bare knuckle brawling. And it was very tough. So it should be when you invest dollars of this nature. You'll want to be robust. Anyone that suggests anything else has totally got it wrong.”

These conflicting comments could be interpreted as either Snowy Hydro won the “bare knuckle

⁴⁷ “Snowy Hydro 2.0 could actually cost as much as \$4.5b — more than double the initial price tag”. ABC News 21 Dec 2017 [https://www.abc.net.au/news/2017-12-20/snowy-hydro-2.0-could-actually-cost-as-much-as-\\$4.5b/9277368](https://www.abc.net.au/news/2017-12-20/snowy-hydro-2.0-could-actually-cost-as-much-as-$4.5b/9277368)

⁴⁸ “Pumped hydro: How does it work and what's the fuss?” ABC News 9 Jun 2018 <https://www.abc.net.au/news/2018-06-07/how-does-pumped-hydro-power-work/9843804>

⁴⁹ “We don't need Morrison's money, Snowy Hydro CEO declares”. The Australian 27 February 2019 <https://www.theaustralian.com.au/national-affairs/we-dont-need-morrison-s-money-snowy-hydro-ceo-declares/news-story/5dd93ea77b7fb2ad6789275e4cfc09c7>

⁵⁰ “Transcript - Joint Press Conference - Snowy Hydro” 26 February 2019 <https://www.financeminister.gov.au/transcript/2019/02/26/joint-press-conference-snowy-hydro>

brawl” to get a subsidy/ equity injection from the Government to make the project viable or it lost the *“bare knuckle brawl”* to stop the Government insisting on providing a subsidy.

Mr Broad stated that *“we never asked for anything”*. However, it is understood that Snowy Hydro did ask for a ‘dividend holiday’ from the Government while Snowy 2.0 was being constructed. But apparently the Government wished to *“sustain dividends”*.

Could it be that the outcome of the *“bare knuckle brawl”* was the Government deciding to inject ‘equity’ into Snowy Hydro in order to maintain its dividend stream during Snowy 2.0’s construction?

The 2019-20 Budget Paper No. 1⁵¹ states that equity of up to \$1.38 billion will be paid over 6 years (making up 40% of the Climate Solutions Package):

“The Government will provide \$3.5 billion over 15 years from 2018-19 for a Climate Solutions Package to deliver on Australia’s 2030 climate commitments including up to \$1.38 billion in equity over six years from 2019-20, to support the delivery of the Snowy 2.0 project”.

\$1.38 billion of equity is a comparable amount to \$1.65 billion of dividends over six years, at the projected rate of \$275 million p.a.⁵⁵.

Is it intended that the six equity injections are to be returned to the Commonwealth almost immediately as dividend payments? If so, such recycling is at odds with assertions that the injections are *“making the project happen”*.

Either way, the \$1.38b subsidy raises several questions, including:

- what is the reason for the subsidy/equity injection?
- could dividends have been maintained during construction of Snowy 2.0 without the subsidy?
- does the Business Case stack up without the subsidy?
 - if so, why provide it?
 - if not, why proceed with Snowy 2.0?
- what is the benefit to the government and taxpayers?
- will other pumped hydro and energy storage projects also be subsidised?
 - if not, why give Snowy Hydro special treatment?
- how was the figure of \$1,380,000,000 determined?
- why is it described as “up to \$1.38 billion” rather than a firm amount?
- when will the final amount be determined, on what basis and by whom?

This enormous subsidy by Australian taxpayers provides an unfair advantage to Snowy 2.0 compared to its competitors in the National Electricity Market. If the Business Case for Snowy 2.0 stacks up there should be no need for a government subsidy.

3.2. Did the Commonwealth pay a premium for Snowy Hydro to facilitate Snowy 2.0?

Shareholdings in the Snowy Scheme Operating Company established in 1959 were apportioned to three governments, according to their respective entitlements to the energy produced:

- NSW Government 58%
- Victorian Government 29%

⁵¹ “Budget Measures 2019-20 — Part 2: Expense Measures” page 74 https://budget.gov.au/2019-20/content/bp2/download/bp2_expense.pdf

- Commonwealth Government 13%

Surprisingly, the announcement of Snowy 2.0 was made by the minor shareholder at the time (the Commonwealth), without any consultation with the two State Government shareholders (see Section 1.3).

It is understood Snowy Hydro recommended that ownership be consolidated to simplify the approval processes for Snowy 2.0. This objective was echoed by Prime Minister Turnbull when he announced⁹ on 2 March 2018 that the Commonwealth Government would become the sole owner of Snowy Hydro to “pave the way for the Snowy 2.0 pumped hydro project”:

“The Turnbull Government has reached an agreement with the New South Wales and Victorian Governments to take full ownership of Snowy Hydro Limited in a deal that will deliver more than \$6 billion in Commonwealth funds for investments in infrastructure across both states.

The historic agreement will generate more reliable energy, cheaper electricity, better infrastructure and more jobs for NSW and Victoria.

Initiated by the Federal Government and announced at the 2017 Federal Budget, the deal includes a broad commitment to invest the proceeds in productive infrastructure projects, with NSW set to receive \$4.154 billion and Victoria \$2.077 billion, reflecting their respective Snowy shareholdings.

The agreement also builds on the Turnbull Government’s substantive energy sector reforms to ensure reliable and affordable energy for businesses and households.

In a win for Australian energy consumers, the agreement will pave the way for the Snowy 2.0 pumped hydro project to proceed to a final investment decision by the independent Snowy board.”

The purchase was to be based on an agreed fair market value of Snowy Hydro, determined by the three governments to be \$7.8 billion.

Three of the ‘key terms reached as part of the purchase’ were:

- *“NSW will provide all reasonable assistance to Snowy Hydro in relation to its current and future operations (including planning and approvals process for Snowy 2.0)*
- *The Australian Government will provide an assurance that Snowy Hydro will continue to be a successful operation. Importantly, it will continue to be in public ownership, and employment levels and existing head office locations will not change*
- *There will be no change to current arrangements on water issues.”*

The first of the above terms is troubling, as it could be read to imply that, in return for receiving a premium price, the NSW Government has been compromised to assist Snowy 2.0 obtain planning and environmental approval.

The share transfer was completed in July 2018.

Was this a sound investment for the Commonwealth Government and Australian taxpayers, or was a premium price paid? If so, it represents another ‘subsidy’ to facilitate the construction of Snowy 2.0.

The Commonwealth’s investment in Snowy Hydro will increase to \$9.18 billion with the addition of the \$1.38 billion equity injection/ subsidy.

3.2.1. 2006 valuation of \$1.7 - \$3 billion

The value of Snowy Hydro was estimated in 2006 to be \$1.7 - \$3 billion⁵² during a privatisation process (that was terminated following public opposition):

“In December 2005, the NSW Government announced it would sell its 58% share in Snowy Hydro, expecting to yield A\$1 billion. The Federal and Victorian governments had followed suit, announcing by mid-February 2006 the intent to sell their 13% and 29% respectively, with A\$1.7 billion (ranging up to A\$3 billion) expectations through a public float. Pre-registration for shares in Snowy Hydro opened in mid-May and it was expected that the float would take place sometime in July. Over 200,000 people pre-registered to purchase shares in the company over two weeks.

On 2 June 2006, the Federal Government announced that it would no longer sell its 13% stake in the project, effectively forcing the hands of the New South Wales and Victorian governments to follow suit. The aborted sale followed strong opposition from the public, including government MPs and prominent Australians.”

The estimated value in 2006 translates to about \$2.2 - \$4 billion in 2018 (average annual inflation rate of 2.3%⁵³), less than half the 2018 agreed market value of \$7.8 billion. Additional assets purchased by Snowy Hydro in the intervening years (gas generators, retail companies) would not account for the \$4 billion difference between the two valuations.

As a side issue, whilst the 2006 privatisation was called off, the sale of Snowy Hydro continued to be raised. In 2012 the NSW government, which had recently sold the state-owned coal-fired power stations, again considered selling its shares in Snowy Hydro but decided against proceeding. In February 2014 the National Commission of Audit recommended⁵⁴ that the Commonwealth sell its interest in Snowy Hydro:

“Snowy Hydro operates in the highly contestable National Energy Market and is the third largest electricity generator by installed capacity. The public interest case for ongoing government ownership is not strong.”

It would appear that Snowy Hydro is unlikely to be privatised, at least for the time being, after the Commonwealth’s assurance that *“it will continue to be in public ownership”* (Section 3.2).

3.2.2. Dividend return of just 3.5%

Another measure to assess the value of Snowy Hydro is the dividend return on the equity invested.

Dividends are projected to average \$275 million⁵⁵ for the next 4 years (\$265 million in 2017-18):

“After the transfer of shares in July this year, all future dividends from Snowy Hydro Limited will go to the Australian Government, and therefore the forward estimates show the acquisition creating revenue for the Commonwealth of \$1.1 billion over four years from 2018–19.”

⁵² “Snowy Hydro Proposed Public Divestment” https://en.wikipedia.org/wiki/Snowy_Hydro

⁵³ “Reserve Bank of Australia Inflation Calculator” <https://www.rba.gov.au/calculator/annualDecimal.html>

⁵⁴ “Towards Responsible Government - Phase One Report” National Commission of Audit. February 2014 https://www.ncoa.gov.au/sites/g/files/net4136/f/phase_one_report.pdf

⁵⁵ “Budget Review 2018-19 Snowy Hydro Acquisition” Parliament of Australia. https://www.aph.gov.au/About_Parliament/Parliamentary_Departments/Parliamentary_Library/pubs/rp/BudgetReview201819/Energy

When the dividend is divided by the value of the shareholding (i.e. \$7.8 billion rising to \$9.18 billion), this gives a return of just 3.5 - 3.0%.

Such a low return suggests that a market value of \$7.8 billion is significantly overstated and that the Commonwealth paid NSW and Victoria a generous premium price for their shares.

3.2.3. ANAO Potential Audit

The Australian National Audit Office (ANAO) announced a 'potential audit' of the buyout of Snowy Hydro in 2018-19⁵⁶ to determine if it provided value for money:

"The audit would assess whether the Australian Government's purchase of state government shares of Snowy Hydro Limited provided value for money with public resources.

In March 2018, the Australian Government announced that it would purchase New South Wales and Victoria's combined shareholding of Snowy Hydro Limited (87 per cent). The purchase of Snowy Hydro Limited is a precursor to the planned implementation of Snowy Hydro 2.0, the expansion of the Snowy Mountains Scheme to facilitate pumped hydro for electricity generation.

The audit would include an assessment of the Department of Finance and the Treasury's assurance on whether value for money was achieved in the purchase."

Recent advice from the ANAO is that the potential audit was not commenced in 2018-19 and has not been rolled over. However, the ANAO advised that it will be considering Snowy Hydro's current risks, including capitalisation of Snowy 2.0 costs, during its 2019-20 financial statements audit process.

3.3. Minimal payment for commercial use of Kosciuszko National Park

The Feasibility Study states that Snowy 2.0 will be added to the existing Kosciuszko National Park lease:

"An extension to the existing Snowy park lease is required to include the area for the Project. To enable this, minor amendments to the SHC Act are needed so that the Minister for Environment can grant the lease extension".

3.3.1. Current Park Lease fee is a pittance

The existing Park Lease was negotiated in 2002 for a period of 75 years as part of the corporatisation of Snowy Hydro. It is understood that the initial fee was set at \$0.5 million per annum, subject to a CPI-based escalation. The current fee is understood to be approximately \$0.75 million p.a.

The fee covers the occupation and use of land and infrastructure within Kosciuszko National Park for 16 major dams and reservoirs, 12 major tunnels, numerous aqueducts, 9 power stations, 2 pumping stations and other related infrastructure.

It is arguable that it was appropriate to have applied a token fee when the Snowy Mountains Hydro-Electric Authority was a government-owned entity and when the NSW Government was the major shareholder. But it is definitely no longer appropriate.

A corporation with an exclusive right to operate a multi-billion-dollar business in a National Park,

⁵⁶ "Potential Audit of the Buyout of Snowy Hydro Limited". Australian National Audit Office 2018-19 Work Program <https://www.anao.gov.au/work-program/portfolio/finance>

should be making lease payments to the NSW Government of at least an order of magnitude greater than a mere \$0.75 million.

Other commercial interests in the Park, such as the private organisations that operate the four Kosciuszko resort areas (Perisher Range, Thredbo, Selwyn and Charlotte Pass Village) are subject to competitive tendering. Why shouldn't a commercial lease arrangement apply to Snowy Hydro?

No other electricity generation company (or business) in NSW is 'effectively gifted' use of land, roads, water etc, let alone in a National Park. If this situation prevails, Snowy Hydro will continue to be at a subsidised advantage compared with its competitors in the National Electricity Market.

3.3.2. Fee for Snowy 2.0 is higher, but still insufficient

It is understood an annual fee of \$1.6 million has been negotiated for Snowy 2.0.

This is double the fee for the existing Snowy Hydro assets, demonstrating the inadequacy of the existing fee, as it applies to substantially more assets than Snowy 2.0.

It is assumed that the Snowy 2.0 fee covers:

- exclusive use of significant areas of the Park during the 8-year construction phase, including the Lob's Hole area, associated road access (100 km), Marica, Talbingo and Tantangara work sites
- once completed, use of the Snowy 2.0 infrastructure in the Park
- on-going use of NPWS infrastructure and services

In the context of Snowy 2.0's cost, a lease fee of \$1.6 million is negligible. It is barely more than the rental for Snowy Hydro's Sydney office.

3.3.3. Time for a new commercial Lease with Snowy Hydro

The total Park Lease fee paid by Snowy Hydro, including Snowy 2.0, of \$2.35 million p.a. is less than 0.09% of Snowy Hydro's revenue (\$2.6 billion) or 1.1% of profit (\$210 million after-tax).

Whether or not Snowy 2.0 proceeds, this is an appropriate time for the existing Lease to be re-negotiated on proper commercial grounds.

Whilst Snowy Hydro is a Commonwealth Government Corporation, it is required to operate commercially and no differently to its privately-owned competitors within the NEM. (There is always the possibility that Snowy Hydro could be privatised, in which case it would be even more inappropriate for a private entity to have subsidised use of Kosciuszko National Park and its assets).

A more appropriate lease for Snowy Hydro would include:

- i. A base rent, covering NPWS costs; and
- ii. A variable amount based on a percentage of gross receipts over an agreed threshold

Snowy Hydro should no longer be subsidised and have preferential treatment compared to other commercial enterprises in the Park and, more importantly, to its competitors in the NEM, at the "expense" of NPWS.

3.4. No payment for water

It would appear that Snowy 2.0 does not intend to pay for the water it will use.

It is clear that no water should be 'lost' from the 'cyclic' operation of Snowy 2.0 and there should be

no impact on downstream obligations:

“There will be no change to the Scheme’s 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”.

However, Snowy 2.0 will be ‘borrowing’ the water used by its pumps and generators. It is not reasonable for a corporate body to be able to derive commercial gain from the use of such a ‘public asset’ for no fee.

For most periods, availability of sufficient water to ensure full operational capacity should not be an issue. But in time of drought, when storage volumes in the Snowy Scheme are depleted, there is no certainty of 239 GL (refer to Section 5.4) being available within the Tantangara/ Talbingo system for Snowy 2.0. So, it may be prudent for Snowy 2.0 to purchase a quantity of water to guarantee sufficient is always available to enable full operation of the pumping/ generation cycle.

4. Economically unviable

4.1. How could Snowy 2.0 cover its interest payments?

As noted earlier, the final capital cost for Snowy 2.0 could be as much as \$10 billion (including transmission) - it is unlikely to be much less and could be higher. How much of the cost will be debt financed is not known, but it is expected to be required for the majority of the capital cost. Even if the project had significant equity, there is still an opportunity-cost for using equity rather than debt.

Snowy Hydro, with the benefit of the Commonwealth Government as its shareholder, holds a BBB+ Standard & Poor's credit rating, so should have access to relatively low-interest financing. This is confirmed by the Snowy Hydro comment (noted earlier) that *"the average, all-in cost of debt financing is projected to be 5.7% per annum."* Of course any lender has the reassurance that Snowy Hydro is owned by the Commonwealth Government.

Applying a simplistic calculation, the annual interest bill on \$10 billion, at a rate of 5.7%, is \$570 million. Even if Snowy 2.0 does not have to contribute at all to the transmission augmentation, the interest bill on \$8 billion is still \$460 million.

How could Snowy 2.0 service a debt of this size and also make a profit?

To put such a figure into context, it is more than twice Snowy Hydro's profit of \$210 million (2017-18). (Underlying profit after tax was \$370 million). That profit includes the financial returns for Tumut 3 pumped hydro station, which is of a comparable size (1800 MW) to Snowy 2.0 and hence financial value. It also includes other non-hydro assets.

Without wishing to sound overly dramatic, on these figures Snowy 2.0 would jeopardise the financial viability of Snowy Hydro.

However, Mr Broad remains confident that the economics for Snowy 2.0 are compelling and worth betting the whole company on, as he stated in a recent article⁵⁷ "Renewable energy: Australia bets on a 'water battery'":

"We aren't doing this because we're zealots for renewables, we're doing it because it makes business sense – the economics are compelling ... you have to have that storage in place or you are dreaming and you will have lots of blackouts.

Snowy is the answer to that.

We are betting the whole company on it."

Snowy Hydro should provide its 'compelling' economic case for Snowy 2.0 and explain how it is a sure 'bet' – a \$10 billion bet (in total) that Snowy Hydro is taking on behalf of Australian taxpayers.

4.2. Market benefit is half its cost

In January 2018 Snowy Hydro released a Report by Marsden Jacob Associates⁵⁸ (MJA) that estimates

⁵⁷ "Renewable energy: Australia bets on a 'water battery'" Financial Times 29 May 2019

<https://on.ft.com/30LCjQD>

"The big bet on Snowy's 'water battery'" Australian Financial Review 29 May 2019

<https://www.afr.com/business/energy/solar-energy/the-big-bet-on-snowy-s-water-battery-20190529-p51sba>

⁵⁸ "NEM outlook and Snowy 2.0". Report prepared for Snowy Hydro Limited by Marsden Jacob Associates, 4 January 2018 <https://arena.gov.au/assets/2018/02/National-Electricity-Market-outlook-Snowy-2.0.pdf>

the market benefit of Snowy 2.0 to be between \$4.3 and \$6.6 billion, calculated over 50 years.

Various analysts have questioned the optimistic assumptions and rigour of that Report (e.g. see Appendix C).

Nevertheless, the latest revelations indicating a total project cost of \$10 billion mean that, even if the MJA estimate is accurate, the cost of Snowy 2.0 is approximately twice the market benefit.

4.3. Estimated Rate of Return is low, and now needs to be recalculated

Mr Broad has defended^{59/60} the economics of the project:

“The critics that say the economics of the project don't stack up are “wrong”, reiterating that the investment will yield a rate of return of 8 per cent”.

“The internal rate of return is 8.3 per cent. When you think about putting your money in the bank and get 1.5 per cent, you can put your money into Snowy and get 8.3 per cent and with gearing it could be about 11 per cent,” Broad says. “I mentioned at a Macquarie Bank function even Macquarie might put money into that.”

Even if this estimated Rate of Return (ROR) is correct, 8% is low for a project of this size, complexity and risk – it is not much higher than Snowy 2.0's interest rate of 5.7%.

Snowy Hydro has not provided information to substantiate its estimated ROR. If it is based on the (understated) project cost estimate of \$3.8 - \$4.5 billion, then it implies a profit from Snowy 2.0 of about \$300 million per year. If it is based solely on the equity invested by Snowy Hydro in the project, then this is a meaningless measure as it ignores the cost of debt financing.

4.4. How will Snowy 2.0 get sufficient spread between its buying and selling price?

Snowy 2.0 intends to offer 5 major 'products' (FID Valuation and Selected Business Case):

- Traditional capacity
- Renewable firming
- Retail diversification
- Storage
- Ancillary services

Over half of Snowy 2.0's revenue is projected to come from storage:

“The key principle of storage value is to purchase energy at low prices for pumping (generally during periods when available energy supply is greater than system demand), store the energy as potential energy of water at higher elevations, then sell the energy when supply-demand is constrained. In other words, the Project's storage value is analogous to a battery.”

As noted later (Section 5.6), Snowy 2.0 is expected to have a round-trip loss of approximately 40%, due to losses in the pumping/ power cycle (30%) and transmission (2.5 - 5% each-way). This means

⁵⁹ “Snowy 2.0 early works to start in December”. Australian Financial Review, 28 June 2018
<https://www.afr.com/business/energy/solar-energy/snowy-20-early-works-to-kick-off-in-december-20180627-h11yca>

⁶⁰ “Behind Snowy's battery bet” The Australian 14 September 2019
<https://www.theaustralian.com.au/business/mining-energy/snowy-20-glows-with-the-flow-as-volatility-soars/news-story/ee7717e4f238bbe846a8565593d1c862>

that Snowy 2.0 will need to sell generated electricity at a price approximately twice the purchase price of pumping electricity to make a financial gain.

Electricity futures prices, published by the Australian Energy Regulator⁶¹, show a gradual decline from \$100/MWh in 2019 (NSW & Victoria) to \$70/MWh in 2022. This would imply a lessening of the available spread of buying and selling prices, at least in the immediate future.

The MJA Report predicts the average peak-to-off/peak spread (all price periods) to be:

- 2025: \$85/MWh (off-peak \$50/MWh, peak \$135/MWh)
- 2030: \$30/MWh (off-peak \$75/MWh, peak \$105/MWh)

If this proves to be the case, by 2030 there is insufficient spread (of at least 1:2) for Snowy 2.0 to be able to operate commercially.

No information is provided on how Snowy2.0's projected revenues are derived.

4.5. Widespread scepticism of the viability of Snowy 2.0

In undertaking research for this Paper, it has been evident that there is widespread scepticism of Snowy 2.0 from the electricity industry, consultants, academics, press and environmentalists ever since the project was announced.

That scepticism encompasses the lack of detailed information covering the project in its entirety and its commercial justification; no analysis of alternatives; its substantial and ever-increasing cost and uncertain commercial viability; its complexity and challenging construction; its enormous size; the consequent swamping of the market for pumped hydro storage and hence dampening of competition; its \$1.38 billion taxpayer subsidy and preferential treatment by the Government; and the significant, permanent environmental damage to Kosciuszko National Park.

Many respected analysts have questioned the financial viability of Snowy 2.0 and its market value. Comments from three experts follow, which encapsulate that scepticism.

Associate Professor Bruce Mountain, Director Victoria Energy Policy Centre, Victoria University, stated in an article⁶² in January 2018 titled "Why Snowy 2.0 is a write-off from the start":

"So, in round numbers, a conservative estimate of the total capital outlay attributable to Snowy Hydro 2.0 will be at least \$8bn, four times more than the Prime Minister suggested when announcing this project. It would be surprising if the estimate at the time of the final investment decision is any lower than this, and the actual build cost will surely be yet higher, quite possibly significantly so.

It is inconceivable that Snowy 2.0 will produce revenues that are vaguely close to that needed to compensate its capital outlays. This is because the volume of electricity it can produce, valued at the difference between the price paid to pump water uphill and the price received when running the water back down the hill again, will be much too small.

Experience in other countries is also instructive. The Feasibility Study likens Snowy 2.0 to the

⁶¹ "Electricity base futures prices" Australian Energy Regulator <https://www.aer.gov.au/wholesale-markets/wholesale-statistics/quarterly-base-futures-prices>

⁶² "Why Snowy 2.0 is a write-off from the start". Australian Financial Review 4 January 2018 <https://www.afr.com/news/economy/why-snowy-20-is-a-writeoff-from-the-start-20180104-h0d9z4>

Dinorwig pumped hydro plant in Wales. Dinorwig along with the smaller Ffestiniog has comparable capacity to Snowy 2.0. In its most recent market transaction six months ago, the market value of Dinorwig and Ffestiniog was established at just \$236m, a small fraction of its initial build and subsequent refurbishment costs.

It is almost certainly the case in Australia that the market value of Snowy 2.0 will be a small fraction of its likely construction cost.”

Paul Hyslop, Chief Executive Officer of ACIL Allen Consulting, issued a paper⁶³ in November 2018 titled “Snowy 2.0 – is the reward worth the risk” on the project and the MJA Report. Mr Hyslop’s paper is contained in Appendix C - a few extracts follow:

“The federal government has already spent \$6 billion buying out the stake held by the NSW and Victoria governments, but the new \$1.4 billion cash injection into Snowy Hydro from federal taxpayers’ funds bodes ill. It suggests that Snowy Hydro is struggling to make the numbers for Snowy 2.0 add up.

The consultant’s analysis [Marsden Jacob Associates] appears very narrow and does not cover the expected range of scenarios and states of the world that would be typical for a market benefits assessment. It might even be argued that the consultant has assessed favourable scenarios and ignored less favourable scenarios.

Therefore, in a competitive market, Snowy Hydro returns would be expected to be a fraction of the estimated market benefits. Even using the low-end cost estimates provided by Snowy Hydro and assuming a competitive market environment, it would appear that Snowy Hydro would not recover the cost of the Snowy 2.0 investment, even where it is prepared to wait 50 years to do so.

Snowy Hydro appears to be moving with haste to commit to Snowy 2.0. Yet there is nothing in the outlook for the market that would justify this haste. If there is a market need for Snowy 2.0, it is likely to be from the mid-2030s when significant coal fired plant are expected to close.

Assuming a 50 per cent increase in tunnel construction costs to reflect more lining and grouting, would add between \$1.4 and \$1.75 billion to the cost of the project with the total cost rising to between \$5.2 and \$6.25 billion. Snowy Hydro redacted the detailed costs chapter from the public version of the feasibility study, so it is unclear how contingencies have been costed and handled in the overall analysis.

Its owners, the Commonwealth Government, have recently been extolling the virtue of intervening in the market to pressure participants to lower prices for consumers. Allowing a government-owned entity to establish such a dominance in the peak end of the market in both Victoria and New South Wales does not appear consistent with these recent statements and actions.

There is no doubt storage is needed in a high renewables grid, but neither the government nor Snowy Hydro have made the case that theirs is the best option, over competing pumped hydro and battery storage projects”.

Mary Hendriks, Industry Executive, Australian Energy Storage Alliance, provided her personal

⁶³ “Snowy 2.0 – Is the reward worth the risk?” Paul Hyslop, CEO ACIL Allen Consulting, 14 November 2018 <https://www.acilallen.com.au/insights/snowy2-is-the-reward-worth-the-risk>

observations in an article in May 2019 titled “Snowy Too Much⁶⁴”:

“There are many options for energy storage, from various forms and sizes of battery storage, to a range of both traditional and innovative energy storage technologies. Despite these options, the recent announcement of Snowy 2.0 took many in the industry by surprise, as there was little, if any, open consultation about the options available.

- *Too Much Time: Snowy 2.0 will take close to a decade to complete.*
- *Too Much Control: Snowy 2.0 goes against the concept of decentralised systems.*
- *Too Much Cost: Snowy 2.0 is an expensive option, with no return for many years. Importantly, why was this decision rushed with over \$5 billion in contracts apparently already awarded, with no clear figure for the final cost of this project?*

Overall, Snowy 2.0 has the potential to be an innovation killer, stifling systems that could be developed by private enterprise. It sets us on an expensive and lengthy path to end up with more central control of our energy resources.

Let’s rethink and review this project before it turns out to be Snowy Too Much.”

The only positive press, other than that by Snowy Hydro and the Government, has related to job creation during construction and nostalgic reminiscences harking back to the construction of the iconic Snowy Scheme, aptly expressed in an article⁶⁵ quoting the NSW Deputy Premier, who is also the local member:

“NSW Nationals leader John Barilarlo said “Snowy Hydro is an iconic, Australian success story, part of the fabric of our nation and of the community here in the Snowy Mountains. The communities in Monaro will reap the benefits associated with the extension of the existing scheme with 2000 jobs expected to be created during peak construction.

I’m thrilled the Federal Government has agreed to proceed with Snowy 2.0. This is a great win for the region.”

Prime Minister Turnbull indicated that:

“Snowy 2.0 will create thousands of jobs - there’ll be about 5000 jobs in the construction of it.”

The local sentiment is summed up by the following comment⁶⁶:

“In the nearby town of Cooma, locals are sharing in the early confidence. “I think everyone really believes the project will go ahead,” local publican Michael Sharkey said. “Everyone’s just been overjoyed, basically. There’s been a lot of bar talk about it, people are discussing property prices going up and just the amount of flow-on effect it’ll have on the town.”

⁶⁴ “Snowy Too Much”. Mary Hendriks, Industry Executive, Australian Energy Storage Alliance. 16 May 2019
<https://www.linkedin.com/pulse/snowy-too-much-mary-hendriks/>

⁶⁵ “A \$1.38bn cash injection to get Snowy 2.0 scheme running” The Land. 26 February 2019
<https://www.theland.com.au/story/5924082/giant-4bn-snowy-20-scheme-approved-by-federal-government/>

⁶⁶ “Pumped hydro: How does it work and what’s the fuss?” ABC News 9 Jun 2018
<https://www.abc.net.au/news/2018-06-07/how-does-pumped-hydro-power-work/9843804>

5. Overstated benefits

5.1. Lack of analysis of claimed improvements to prices and reliability

Prime Minister Turnbull stated on 20 December 2017:

"Snowy Hydro 2.0 is a nation-building project. It will not only deliver a more affordable and reliable energy system but will also generate jobs and grow our economy".

No analysis has been provided to support the contention that Snowy 2.0 will result in cheaper electricity or by how much.

The Marsden Jacob Associates Report's estimate of the market benefit of Snowy 2.0 of \$4.3-6.6 billion includes estimated energy spot price reductions of 5.7% in NSW and 3.2% in Victoria.

However, even if the MJA Report is accurate, which is dubious according to industry experts, spot price reductions do not necessarily carry over directly to retail price cuts. Also, the Report ignores the cost of the additional transmission circuits, which have yet to be revealed. It is possible that the consequent increase in transmission charges will exceed the estimated spot price reductions, resulting in a net increase in electricity prices rather than a decrease.

Whether there is an increase or decrease in electricity prices, it is also relevant to note that wholesale generation costs account for approximately 30% of the retail price. Hence, the ultimate price change to consumers is likely to be marginal either way.

With respect to reliability, any added generation will increase the overall system reliability. But that needs to be considered in light of the cost. Obviously, there is a tipping point where the cost of additional generation does not justify the incremental increase in reliability.

For example, the average 'Customer Minutes off Supply' in city areas is typically less than 2 hours/year. Is the community prepared to pay for additional generation to decrease that figure to say less than 1 hour/year? Also, it is noted that most supply losses are due to distribution and transmission outages, rather than insufficient generation capacity, so it is usually more productive to invest in wires than power stations to improve reliability.

Snowy Hydro should release its analysis to validate its claim that Snowy 2.0 will reduce electricity prices and increase reliability.

5.2. Snowy 2.0 is markedly different to other pumped hydro schemes

Snowy 2.0 is a massive project and, if constructed, will become the fifth largest pumped hydro scheme in the world (Tumut 3 is currently ranked seventh).

Technically it is a challenging project, as described in the FID Facilities Report:

"The Project hydraulic design is extremely challenging, due to the power output, high head and long tunnels. The Contractors have limited prototype experience with such a challenging hydraulic design and are pushing the boundaries of their present operational experience."

Snowy 2.0 is markedly different to other large pumped storage schemes worldwide in two respects (see Appendix A) - the first difference is a major negative and the second a positive (though overstated).

5.2.1. Long distance between reservoirs

The distance between the upper and lower reservoirs (Tantangara and Talbingo) is 27km, far longer than any other large pumped hydro scheme.

Ideally the two reservoirs should be as close as possible, to reduce costs and maximise efficiencies. Appendix A shows that the distance between reservoirs is usually less than 3 km. For Tumut 3 the distance between Talbingo Reservoir and Jounama Pondage is 0.6 km. Despite an extensive search, no pumped hydro scheme in the world could be found with a distance between reservoirs of anywhere near 27 km.

An industry ‘rule-of-thumb’ is that for a pumped storage scheme to be economic, its reservoirs should be located within 5 times the difference in head. For Snowy 2.0, with a head of 680 m, this equates to about 3.5 km. Snowy 2.0 has the advantage of using two existing reservoirs, but that saving is unlikely to equate to the cost of an extra 23.5 km of tunnelling.

The substantial length of tunnel is a major factor against Snowy 2.0, due to both its engineering challenge, enormous cost and the consequential environmental impact of disposing of 14,000,000 cubic metres of excavated rock.

Also, the 18 km length of the headrace tunnel from Tantangara to the power/ pumping station means that Snowy 2.0 will be less efficient than other equivalently configured pumped hydro storage schemes due to higher frictional losses.

5.2.2. Large reservoirs

Snowy 2.0 has a far greater reservoir capacity and hence ‘electricity storage’ capacity (claimed to be 350 GWh – 175 hours at 2000 MW) than other schemes.

Most pumped hydro schemes have the capacity to generate for a few hours or up to a day. For example, Tumut 3 has the capacity to generate 1800 MW for 6 hours without spilling Jounama Pondage (assuming it was empty), or 33 hours if Talbingo is discharged from full and excess water is discharged into Blowering Reservoir.

It is clear that the availability of two existing large reservoirs, at a major head differential, was the reason for choosing Snowy 2.0. However, the benefit of using existing reservoirs is more than offset by the cost of the exceedingly long interconnecting tunnel.

5.3. How often will Snowy 2.0 be needed to supply 350 GWh?

It has not been demonstrated how often a situation might arise in the National Electricity Market where Snowy 2.0 would be called upon to generate continuously at full capacity for 175 hours.

The Feasibility Study indicates that prior to 2040 Snowy 2.0 will operate at full capacity for less than 87 hours per year.

Further, as noted below, once expended it would take many months to be replenished.

5.4. Cycling energy storage capacity (350 GWh) is considerably overstated

Snowy 2.0 is claimed to have 350 GWh of energy storage capacity, enabling it to generate 2000 MW continuously for 175 hours (7.3 days). The impression given is that Snowy 2.0 is a ‘water battery’, able to regularly cycle 350 GWh back-and-forth.

As stated in the Main Works EIS (and practically every Snowy 2.0 document):

“Snowy 2.0 will increase the generation capacity of the Snowy Scheme by almost 50%, providing an additional 2,000 megawatts generating capacity, and making approximately 350,000 megawatt hours (175 hours of energy storage) available to the National Electricity Market.”

But there are a number of mitigating practical considerations and the claimed recyclable capacity is overstated.

5.4.1. 350 GWh will rarely be on-tap

No details have been provided on how the 350 GWh has been calculated, though it would appear to be based on the active storage capacity of the upper reservoir (Tantangara):

“The period of full and continuous operation when headwater reservoir is full is 175 hrs (which equates to 7.3 days).” (FID Market Modelling)

However, independent analysis suggests that Tantangara may only need to be at about 90% of active water storage capacity for 350 GWh to be deliverable. Though this may be offset by lost capacity from sedimentation over the 60-year life of the dam and the dumping of over 4,000,000 m³ of excavated spoil from the tunnel.

Either way, the full 350 GWh will only ever be available when Tantangara is close to full supply level.

If for example Tantangara is half full, only 175 GWh could be delivered, and when it is at minimum operating level Snowy 2.0 couldn't generate at all.

If Snowy 2.0 were ever called upon to generate continuously for 7 days till Tantangara was emptied, it would likely be at a time of major problems in the National Electricity Market. At such times Snowy 2.0 is likely to have been called upon to generate beforehand, thereby reducing water levels in Tantangara. It would be most unlikely for 7 days of continuous generation to follow a period of no generation.

What is the likelihood of Tantangara being full (and Talbingo being empty) when there is a need to generate continuously for a week?

5.4.2. Will Tantangara levels continue to be reduced to avoid spilling, thereby reducing the maximum energy storage capacity of Snowy 2.0?

“Snowy 1.0 and Tantangara are operated such that ponds are low entering the winter period in order to address the risk of 1-in-10-year extreme inflows” (FID Drivers of Revenue).

If this practice is maintained then Snowy 2.0 will never be 'fully charged', at least in winter and early spring. Also, at other times of the year will Tantangara be kept below full supply level to avoid spilling from unexpected flood events?

If so the maximum available energy storage capacity of Snowy 2.0 will be reduced accordingly.

Of course, Snowy 2.0 generation could assist in the management of extreme inflows, provided there was space in Talbingo and Blowering, though such generation may have to occur regardless of the prevailing electricity market price.

5.4.3. If Tantangara were emptied, it will involve 'losing' at least one-third of the water from the Snowy 2.0 Scheme (to Blowering)

“Tantangara Reservoir has an active storage volume of 239 gigalitres (GL) and Talbingo has an active storage volume of 160 GL.” (Feasibility Study)

Hence, Tantangara’s active storage volume can’t be fully ‘accommodated’ within Talbingo, as Talbingo is only two-thirds the volume (see Figure 10). As an aside, the total storage volumes of the two reservoirs are the ‘other way round’, with Tantangara being smaller at 254 GL versus Talbingo at 920 GL.

So, if Tantangara happened to be full and Snowy 2.0 was run until Tantangara was emptied, about 33% of the water from Tantangara (79/239) couldn’t be accommodated within Talbingo, assuming the best of situations with Talbingo starting at its minimum operating level.

However, it would be unlikely for Talbingo to ever be at its minimum operating level as it is both the lower reservoir for Tumut 2 hydro power station and the upper reservoir for Tumut 3 pumped hydro station. If Talbingo was at minimum operating level this would preclude operation of the Tumut 3 generators.

As the Tumut 3 generators operate as a first response for system faults and emergencies, some of the 160 GL of active volume in Talbingo is ‘set aside’. A typical ‘set aside’ amount would be equivalent to the active storage capacity of Tumut 3’s lower reservoir – Jounama Pondage (28 GL).

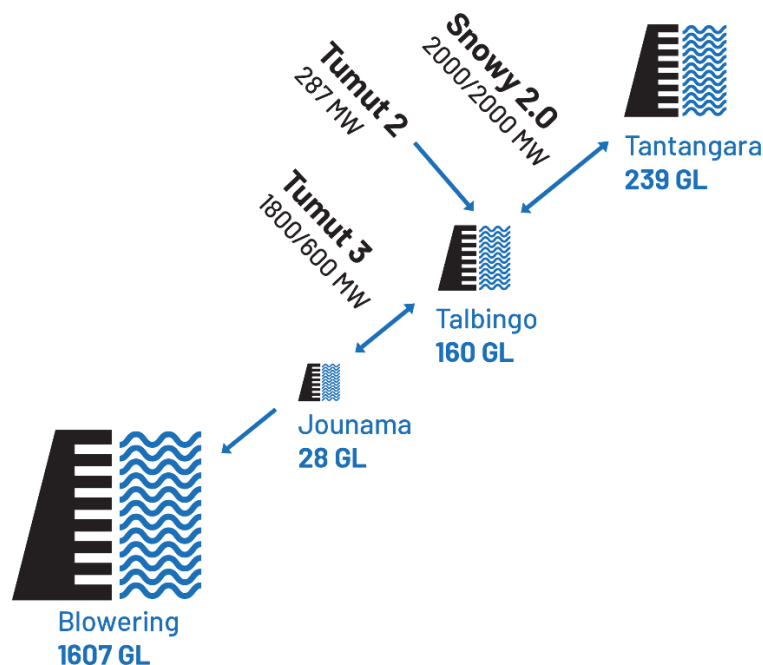


Figure 10. Schematic of Tumut and Snowy 2.0 Reservoirs

When Talbingo is half full, 67% of Tantangara water (159 GL) cannot be accommodated. When Talbingo is full, no water from Tantangara could be accommodated.

Water that cannot be accommodated in Talbingo would be discharged into Jounama Pondage (the lower reservoir for Tumut 3). The small volume of Jounama Pondage (28 GL) means that most of the excess water from Tantangara would end up in Blowering Reservoir, where it is ‘lost’ to the Snowy Scheme as there are no pumps to return it back up to Jounama and thence to Talbingo via the Tumut 3 pumps.

Of course, Blowering Reservoir itself would need to have spare capacity to hold the excess water. With a total storage of 1,607 GL that would usually be the case, except in wet years when Blowering is full, and the Tumut Scheme (and Snowy 2.0) is bottled up with limited capacity to generate.

To conclude, if Tantangara happened to be full and Snowy 2.0 was called upon to generate till Tantangara was emptied, then at least one-third of the water from Tantangara would be 'lost' from the Snowy 2.0 cycle. If Talbingo were not empty even more water would be lost from the Snowy 2.0 cycle.

5.4.4. Snowy 2.0 may curtail up to 2517 MW from existing Tumut generators

During a 175-hour continuous generating period or any extended generation by Snowy 2.0, the operation of the three existing Tumut power stations may have to be curtailed if discharging into Blowering is to be avoided:

- Tumut 3 (1800 MW) would not pump whilst Snowy 2.0 is generating. Hence its generation would be limited to the spare capacity in Jounama
- Operation of Tumut 2 power station (287 MW) and Tumut 1 (330 MW) may also have to be curtailed to stop water discharging from Tumut 2 into Talbingo Reservoir and limiting the space for Tantangara water

As the combined output of the three Tumut power stations is 2517 MW, any curtailment would significantly detract from the 2000 MW generation capacity of Snowy 2.0.

5.4.5. 'Closed-circuit' energy storage capacity of Snowy 2.0 is significantly less than 350 GWh

The Main Works EIS stated that Snowy 2.0 is a closed system where the same water is recycled between its two water reservoirs:

*“Snowy 2.0, being a closed system, can move water between reservoirs and not rely on natural inflows that may vary seasonally, offering valuable seasonal storage and insurance against drought risk. This is because Snowy 2.0’s pumping capabilities work in a ‘closed’ system - **water is recycled between the two dams so the same water can be used to generate power more than once, making the most of available water (emphasis added).**”*

This reflects the usual determination of the energy storage capacity of a pumped storage scheme⁶⁷ being set by the fixed volume of water that can be recycled between the two reservoirs – i.e. the volume of the lesser reservoir:

“the energy generating capacity of a pumped storage scheme is set by the water storage capacity of the lesser of the two water storage volumes”.

Hence, the nominal energy capacity of Snowy 2.0 should be based on the active storage volume of Talbingo (160 GL), the lesser reservoir. But the claimed 350 GWh of capacity has been determined by the volume of the larger reservoir – Tantangara (239 GL).

Using the standard definition, the closed-circuit recycling capacity, based on the storage volume of Talbingo, would be approximately two-thirds the claimed amount of 350 GWh – i.e. 230 GWh, providing 2000 MW continuously for 115 hours (not 175 hours).

However, Snowy 2.0 is more complex as, contrary to the Main Works EIS quote above, Snowy 2.0 is not a 'closed system' with exclusive use of its two reservoirs.

Snowy 2.0 will need to be integrated into the existing Tumut Scheme (Tumut 1, Tumut 2 & Tumut 3).

⁶⁷ “ROAM report on Pumped Storage modelling for AEMO 100% Renewables project” 24 September 2012 <http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.434.9204&rep=rep1&type=pdf>

Talbingo is the lower reservoir of Tumut 2 hydro power station and the upper reservoir of Tumut 3 pumped hydro station (which has 1,800 MW of generation and 600 MW of pumping).

Historically, levels in Talbingo Reservoir have been kept as high as possible to optimise the operation of Tumut 3. The higher the level of Talbingo the greater amount of energy is stored and the higher is the efficiency of generation. As stated in the Main Works EIS:

“Water levels [in Talbingo] are typically maintained at the dam crest level for around six months of the year and lower water levels tend to occur in late winter or spring, although this pattern shifts from year to year.”

Therefore, the practical recycling capacity would be even less if Talbingo is kept relatively full and operation of Snowy 2.0 is to avoid discharges into Blowering.

Snowy Hydro needs to provide information on the integration of Snowy 2.0 into the Tumut Scheme and the future operating regime, together with the practical energy storage capacity of Snowy 2.0 based on the fixed volume of water that can be recycled between its two reservoirs.

5.4.6. Might there be limitations on Tantangara drawdown rates?

Rapid lowering of levels can cause slumping of the sides of a reservoir. Apparently this occurred at Geehi Reservoir, necessitating procedures to limit the drawdown rate over a weekly cycle.

Might this be an issue for Tantangara Reservoir, where levels will drop up to 5 metres over 24 hours? If so, it will limit generation from Snowy 2.0.

5.4.7. Actual active storage capacity of Tantangara is likely to be less than 239 GL

Ex-Snowy engineers have recommended that the claimed 239 GL of active storage in Tantangara should be surveyed, as siltation by erosion of the catchment will have occurred since the dam was completed in 1960.

Much of the Scheme infrastructure was based on design principles of the US Bureau of Reclamation where, in the case of reservoirs, the minimum operating levels were based on design lives of 100 years and the vegetation condition of the catchment. For Tantangara the 100 years of estimated sedimentation amounted to 15 GL (i.e. the difference between the total storage of 254 GL and active storage of 239 GL).

As Tantangara Reservoir is 60 years old, theoretically 60 percent of the dead storage should have been depleted by now (i.e. 9 GL). Though in practice not all sediment finds its way into dead storage but impinges as an alluvial fan into the active storage. It is likely that sedimentation into Tantangara has occurred at an accelerated extent because of the ever-increasing numbers of feral horses trampling the watercourses and destroying catchment vegetation.

So, it is likely that the active storage is less than 239 GL, by at least 9 GL (4%). Tantangara will suffer a further loss of 3 GL with the dumping of over 4,000,000 m³ of excavated spoil.

In a project costing many \$billions it is considered that the current volume of Tantangara and Talbingo should have been surveyed and an assessment provided of further reductions in storage volumes over the 100-year life of Snowy 2.0.

5.4.8. 350 GWh overstates Snowy 2.0's recyclable capacity

To summarise, it would appear that the full 350 GWh of energy capacity is a theoretical figure that will in practice rarely be needed or available.

As an initial point, the current storage volume of Tantangara (and Talbingo reservoirs) should be determined, as sedimentation will have reduced the initial active capacity of 239 GL, possibly by 4% or more. Also, an assessment should be made of the sedimentation rate for the next 100 years, particularly due to the impact of feral horses on the Tantangara catchment.

That aside, if 350 GWh happened to be available (i.e. Tantangara Reservoir was full) and was fully depleted it would involve the loss of at least one-third of Tantangara's water from the Snowy 2.0 system (into Blowering).

The nominal energy capacity of Snowy 2.0, based on the amount of water that can be cycled between the two reservoirs in a closed-circuit operation (160 GL), is approximately two-thirds the claimed 350 GWh – i.e. 230 GWh (5 days at 2000 MW). And this ignores possible impingement on the output of Tumut 1, 2 and 3 stations.

Therefore, the practical recycling capacity would be even less if Talbingo is kept relatively full and operation of Snowy 2.0 is to avoid discharges into Blowering.

Snowy Hydro should provide information on the integration of Snowy 2.0 into the Tumut Scheme and the future operating regime, together with the practical energy storage capacity of Snowy 2.0 based on the fixed volume of water that can be recycled between its two reservoirs.

5.5. It will take months to replenish Tantangara

A further major constraint is that whenever Tantangara Reservoir is at or near minimum operating level it will take a considerable time to be refilled.

In theory, if Snowy 2.0 pumps were run at 2000 MW, Tantangara could be refilled in about 11 days of continuous pumping (allowing for the 30% loss factor). But this is not possible as there is insufficient water in Talbingo, being two-thirds the capacity of Tantangara (and it would not be economic to run Tumut 1 & 2 to refill Talbingo at the same time as Snowy 2.0 was pumping).

Usually it would not be financially viable to run Snowy 2.0 pumps for more than 5-8 hours/day at 2000 MW (i.e. when the wholesale price is 'cheap'). It could well be less hours/day, as if Tantangara were emptied it is likely to be during a period when wholesale prices were high due to stresses within the National Electricity Market that triggered extended Snowy 2.0 generation in the first place.

So, the quickest conceivable time that Tantangara could be refilled would be about 45 days, pumping at 2000 MW for 6 hours/day. But this assumes no Snowy 2.0 generation during that time - an unlikely scenario. (Also, Tumut 2 would have needed to discharge 79 GL into Talbingo for pumping by Snowy 2.0 up to Tantangara – this should be possible, given that 12 hours/day of Tumut 1 and 2 generation would discharge about 5 GL/day.)

During such periods it is likely to be profitable to run Snowy 2.0's generators whenever there was water in Tantangara, thereby depleting water pumped back to Tantangara. Any period of generation requires 1.4 times that period for pumping at the same MW rate, to replenish the water used. The net amount of water pumped back up to Tantangara would be determined by the prevailing electricity price spreads.

So, it appears that in practice it would take many months to refill Tantangara and for Snowy 2.0's full capacity to be 'available' again, belying the claim of Snowy 2.0 being a 'water battery', able to regularly cycle 350 GWh back-and-forth.

In reality if Tantangara were ever emptied it is a once-a-season shot. And it will require 500 GWh of pumping energy to re-fill – see next Section.

5.6. Snowy 2.0 is a net consumer of electricity

All means of storing electricity (pumped hydro, batteries etc) involve losses. Less energy is extracted than injected. The ‘round-trip’ efficiency for pumped hydro storage schemes is typically 70%–80%.

Prime Minister Morrison stated⁶⁸:

"It's absolutely fair dinkum power, it doesn't get more fair dinkum than this".

However, whilst Snowy 2.0 will generate up to 2000 MW, it is a net consumer of electricity, not a net generator.

The round-trip efficiency of Snowy 2.0's pumping/ generation cycle is estimated to be 67% at 2000 MW and 75.5% at 1000 MW, dropping to 63% and 74.5% over the design life (FID Facilities Report).

For every 100 units of electricity used to pumped water up to Tantangara Reservoir, only about 70 units will be recovered when that water flows back down through the turbine generators to Talbingo Reservoir – 30 units are consumed/lost.

Every hour that Snowy generates 2000 MW will require nearly 1½ hours of pumping to replenish the water used. Putting it another way, if Snowy 2.0 ever generated its claimed 350 GWh of energy, it would take 500 GWh of pumping to be re-charged, incurring 150 GWh of consumed/lost energy.

5.7. Snowy 2.0 is only 60% efficient overall

As well as having a ‘round-trip’ loss of 30% within the pumping/power cycle, there are also losses in transmitting electricity to and from Snowy 2.0. No information has been published on transmission losses.

As summarised by the Australian Energy Market Operator (AEMO)⁶⁹,

"As electricity flows through the transmission and distribution networks, energy is lost due to electrical resistance and the heating of conductors. The losses are equivalent to approximately 10% of the total electricity transported between power stations and market customers".

Energy losses on the network must be factored in at all stages of electricity production and transport, to ensure the delivery of adequate supply to meet prevailing demand and maintain the power system in balance. In practical terms, this means more electricity must be generated than indicated in simple demand forecasts to allow for this loss during transportation".

Snowy 2.0 will incur transmission losses each way:

- to Snowy 2.0 pumps from the major generators, currently concentrated in the Hunter Valley north of Sydney and in the Latrobe Valley east of Melbourne, and
- from Snowy 2.0 generators to the major load centres of Sydney and Melbourne

⁶⁸ "Snowy 2.0 project given funds and approval for early work phase by Federal Government". ABC News. 26 Feb 2019 <https://www.abc.net.au/news/2019-02-26/snowy-2.0-project-approved-for-early-works-stage/10848412>

⁶⁹ "Loss Factors and Regional Boundaries". Australian Energy Market Operator <https://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Security-and-reliability/Loss-factor-and-regional-boundaries>

The Australian Energy Market Operator determines Marginal Loss Factors (MLF) in the NEM⁷⁰:

“to adjust electricity prices to reflect the energy lost in transporting electricity across networks. In a power system electrical losses are a function of the load, network and generation mix which is constantly changing. Another feature of electrical losses is that they increase quadratically to the electrical power transmitted. These variables mean that a single MLF for each connection point is necessarily an approximation.”

To get some indication as to what Snowy 2.0 transmission losses might be, the Lower Tumut MLF's for 2019-20 provide a reasonable approximation:

- Generation – dual MLF: 0.9304 (compared with 0.9954 for the previous year)
- Pumps – dual MLF: 1.0012 (compared with 1.0545 for the previous year)

The difference between the Lower Tumut MLFs in generating and pumping modes gives an indication of round-trip transmission losses assuming the energy is sourced from and returned to the Regional Reference Node. From these figures, a loss of about 5-10% might be indicative for Snowy 2.0, noting that future generation and transmission investment, especially at 500 kV, could lead to a significantly different result.

In simple terms, for every 100 units of electricity purchased by Snowy 2.0 for pumping, it will only generate and deliver about 60-65 units to the major load centres of Sydney and Melbourne. Or putting it the other way around, it will take approximately 170 units of pumping energy to deliver 100 units of electricity to the load centres.

By comparison, a battery installed on a customer's premises or on the local distribution network can be expected to supply over 85 units of each 100 units generated. It is also relevant to note that Snowy Hydro's competitor generators are located closer to the city load centres and only transmit electricity one-way, hence incurring lower losses (and hence Transmission Use of Services charges to consumers).

Being only 60% efficient overall means that Snowy 2.0 will need to sell generated electricity at a price approximately twice the purchase price of pumping electricity to avoid making a financial loss.

Predicted transmission loss figures for Snowy 2.0 should have been provided, as they impact the operation of Snowy 2.0 and its financial returns.

5.8. Most pumping electricity will come from coal-fired generators initially

Snowy 2.0 has been touted as a giant storage for intermittent renewable generation (solar and wind) – a 'green battery'.

On 1 November 2018 Snowy Hydro announced⁷¹:

“the signing of eight wind and solar contracts ... totalling 888 megawatts (MW), located across NSW and Victoria, expected to generate about 2.8 TWh annually. All eight winning projects are

⁷⁰ “Forward-looking Transmission loss factors” Australian Energy Market Operator. 8 February 2017
https://www.aemo.com.au/-/media/Files/Electricity/NEM/Security_and_Reliability/Loss_Factors_and_Regional_Boundaries/2017/Forward-Looking-Loss-Factor-Methodology-v70.pdf

⁷¹ “Snowy Hydro signs game-changing deals” 1 November 2018
https://www.snowyhydro.com.au/news/shl_deals/

expected to come online within the next two years”.

No doubt further contracts will be established as renewable generation replaces coal. Though it is rumoured that two of the projects have been unable to secure finance at the contracted electricity price.

However, this is not the complete story.

Pumped hydro operators purchase electricity when it is cheap (during periods of high generation/ low demand) to pump water uphill and then generate when prices are higher (during periods of peak demand). There is no distinction between whether that cheap pumping electricity is generated by renewable or non-renewable generators. To use a commonly used terminology, pumped hydro operators are agnostic on the source of purchased electricity.

Currently electricity is at its cheapest when demand is low, typically in the off-peak late evening/ early morning hours of working weekdays and at weekends. However, at these times most of the electricity is generated from base load coal-fired generators. This situation is likely to apply until the majority of coal-fired generators are retired and replaced by gas and renewable generators. The FID Drivers of Revenue Report forecasts that:

- by 2035 55% of coal plant would have closed
- by 2045 75% of coal plant would have closed
- by 2060 all existing coal plant would have closed

A CSIRO/ Energy Networks Australia Report⁷² predicts a faster transition to renewable power, as depicted in Figure 11, though coal continues to have a significant role till the late 2030's.

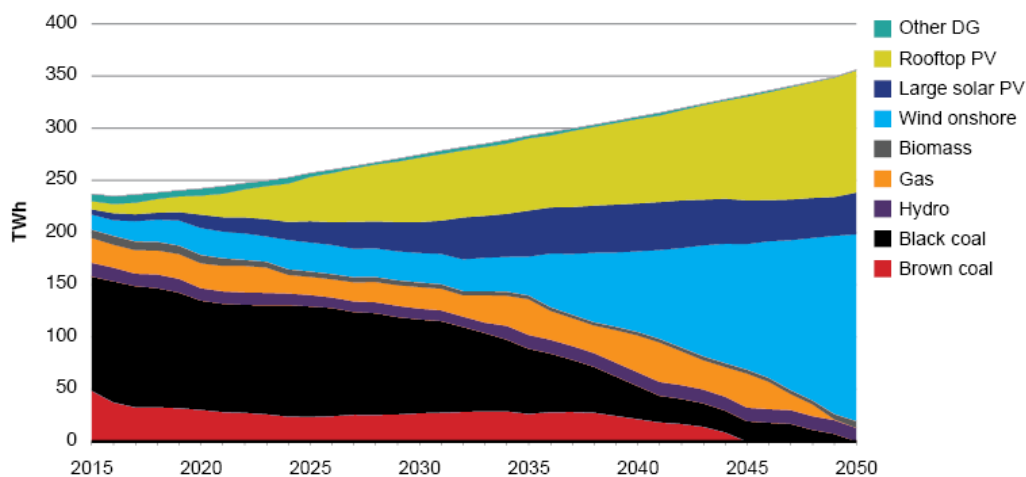


Figure 11. Electricity Generation Type 2015-50 (CSIRO/ENA)

So, for the next decade or so the majority of electricity used to power the Snowy 2.0 pumps is expected to come from fossil fuelled generators (coal and gas).

This situation is exacerbated for Snowy 2.0 when the presence of the two existing pumped hydro

⁷² “Electricity Network Transformation Roadmap”. CSIRO/ Energy Networks Australia April 2017
https://www.energynetworks.com.au/sites/default/files/entr_final_report_april_2017.pdf

stations is taken into account - Tumut 3 (1800 MW) and the Shoalhaven Scheme (240 MW expanding to 475MW). These two stations can be viewed as 'competitors' to Snowy 2.0 in terms of purchasing electricity (even though Snowy Hydro owns Tumut 3). The introduction of Snowy 2.0 into the market will increase competition for cheap pumping power and hence coal-fired generation.

Some commentators have suggested that Snowy 2.0 will provide a new market for coal-fired generation, help extend the economic life of the oldest thermal power stations, and so increase rather than reduce greenhouse gas emissions. Independent modelling should be undertaken to clarify this issue.

As reported in the article⁷³ "Costs blow out for Turnbull's Snowy dream to push coal power uphill":

"Chris Dunstan, from the Institute of Sustainable Futures, says the feasibility report's claim that Snowy 2.0 can enable new wind and solar "in a manner not otherwise economically achievable" is simply not true. Demand Response and time varying prices would be much more economically achievable, in the same way as they would for replacing the Liddell coal generator.

Snowy is likely to increase the carbon intensity of the energy market, at least in the short to medium term as Snowy 2.0 will most likely be powered by coal not renewable energy.

In summary, there may be a case for Snowy 2.0 when we reach say greater than 50 per cent renewables share of generation, and we have used other cheaper flexible resources first. But this is not so now and is unlikely to occur before 2030".

It is important to put into proper context the promotion of Snowy 2.0 as being a 'green battery' for renewable energy. At least for the next decade or so Snowy 2.0 will result in more coal-fired generation and emission of greenhouse gases.

Of course, this situation will change as renewable generation replaces coal-fired generation.

5.9. Limited past operation of Tumut 3 pumped hydro station is cause for concern

Tumut 3 pumped hydro station has been in operation for nearly 50 years (opened in 1973) and, with 1800 MW of generation and 600 MW of pumping capacity, is of a comparable size to Snowy 2.0.

A paper⁷⁴ entitled "Does Snowy Hydro 2.0 Stack Up?" provides some salutary data on the limited operation of Tumut 3 over the 15-year period 2002-2016. Figure 12 shows the average daily operating profile of Tumut 3. When pumping occurred it was typically from 11pm to 6am, when wholesale prices were cheap, and generation was from 8am to 9pm, when wholesale prices were expensive.

It should be noted that the generation profile (blue line) is 'amplified', as Tumut 3 mainly generates from water from Tumut 2 destined for Blowering, rather than re-cycled water pumped up from Jounama Pondage. If the generation profile were to only depict generation derived from pumped water, it would be very much lower (enclosing an area approximately 70% of the area under the pumping profile (orange line)).

In that case the average generation profile for pumped water would peak at about 40 MW,

⁷³ "Costs blow out for Turnbull's Snowy dream to push coal power uphill". Renew Economy. 21 December 2017 <https://reneweconomy.com.au/costs-blow-out-for-turnbulls-snowy-dream-to-push-coal-power-uphill-68730/>

⁷⁴ "Does Snowy Hydro 2.0 Stack Up?" IES. 28 April 2017 <http://iesys.com/assets/news/attachments/Insider-028.pdf>

demonstrating the very limited usage of Tumut 3 for pumped hydro.

The paper also notes that:

- for 6 of the 15 years, pumping occurred on less than 10 days in the year
- over the 15 years the average pumping price paid was \$25/MWh and the average generating price received was \$141/MWh, giving an average spread of \$116/MWh
- since 2012 the spread between pumping and generating prices was only \$70/MWh
- since 2012 the pumps ran on average for only 20 days/year
- in 2013 the pumps didn't pump at all
- 2007 and 2008 were exceptions, when the pumps ran almost every day due to low levels in Lake Eucumbene.

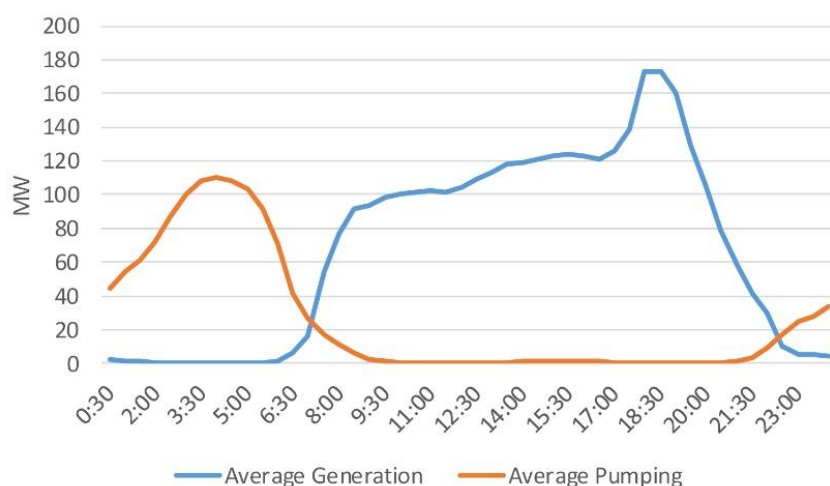


Figure 12. Tumut 3 Average Generation and Pumping Profile 2002-16 (IES)

Similar information is provided in another report⁷⁵ that analysed NEM data between 2009 and 2018. As shown in Figure 13, Tumut 3 pumps operated on average for 281 hours per year (12 days/year) over that 10-year period, ranging between 0 and 716 hours per year (there are 8,760 hours in a year). The pumping capacity factor for the 10 years was just 1.6%.

Clearly, Tumut 3 pumps have had very limited operation and have significant spare capacity (over 95%, allowing for outages and transmission constraints).

For this situation to reverse, the wholesale price spread will need to be much greater (the average for 2002-2016 was \$116/MWh). This would need to apply if Snowy 2.0 is to operate anywhere near its capacity. And it will be still be 'competing' with Tumut 3 (and Shoalhaven) for this business. It will also be 'competing' with the other 2300 MW of Snowy generators, and gas generators, in chasing peak prices.

Historical operation is not directly translatable to the future, especially as renewable generation becomes more prominent. But at least for the next decade the wholesale market is unlikely to be significantly dissimilar and Snowy 2.0 seems unlikely to operate to capacity.

⁷⁵ "Generator Report Card 2018". WattClarity. 31 May 2019 <http://www.wattclarity.com.au/other-resources/detailed-analysis-and-reports/generator-report-card-2018/>

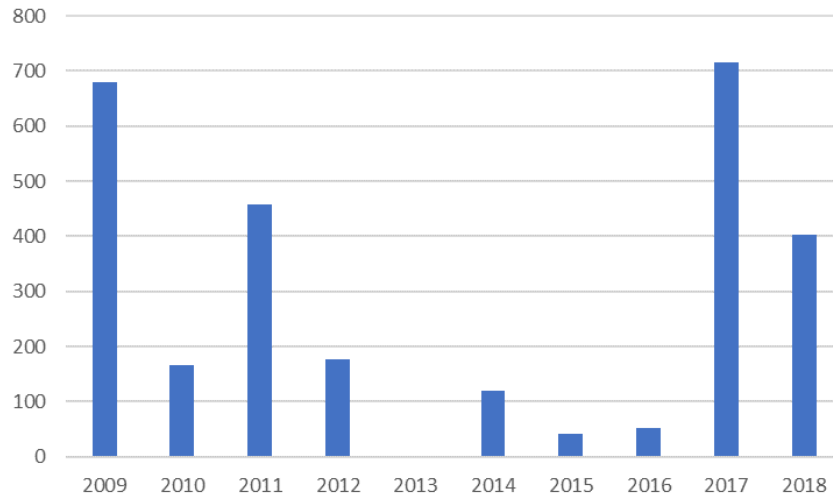


Figure 13. Tumut 3 Pumping Hours/Year 2009-18 (WattClarity)

In any event, Snowy 2.0 should be assessed on the basis that it will only operate when Tumut 3 is fully utilised. Otherwise, Snowy 2.0 will be supplanting the usage of an existing asset that has been fully depreciated.

5.10. Differing representations of Snowy 2.0 operation

There are inconsistencies in the information provided on how Snowy 2.0 will operate.

Figure 14 is a Snowy Hydro diagram⁷⁶ showing “a typical day when Snowy 2.0 initially enters the market”. It depicts Snowy 2.0 purchasing up to 2000 MW from solar and wind generators for pumping during about 8 daylight hours and then using the water stored in Tantangara for generating up to 2000 MW for about 13 hours at night.

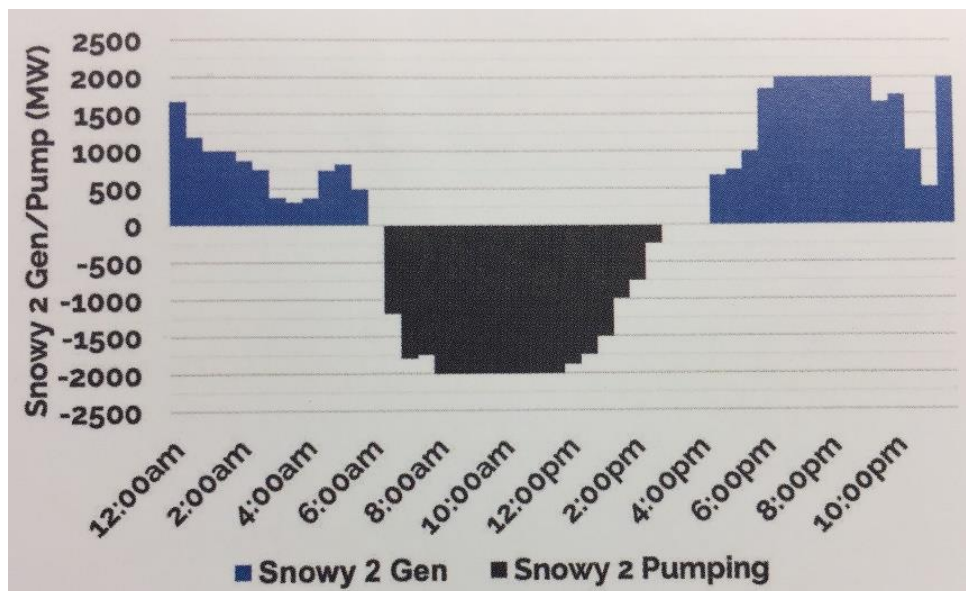


Figure 14. Snowy 2.0 Typical Daily Operation in 2024/5 (Snowy Hydro)

⁷⁶ “Snowy 2.0 Project and business case overview” Snowy Hydro May 2019. https://www.snowyhydro.com.au/wp-content/uploads/2019/03/Snowy2_OverviewFeb19.pdf

Will this really represent a typical day's operation in 2024/5?

- the MJA Report estimates the Generating Capacity Factor to be (an optimistic) 17% - i.e. Snowy 2.0 will generate for 6 hrs/working weekdays on average, not 13 hours as shown in Figure 14 (twice the MJA estimate). As an aside, if the Generating Capacity Factor is 17%, the Pumping Capacity Factor would be 25% (to allow for 'round-trip' losses), which seems unrealistically high
- Figure 14 is inconsistent with the very limited operation of Tumut 3 in past years, with a Pumping Capacity Factor of just 1.6% (see Section 5.9)
- Figure 14 implies that Snowy 2.0 will be purchasing electricity for pumping when prices are usually high and generating electricity when prices are usually cheap
- Figure 14 indicates less pumping than generation, whereas pumping will need to exceed generation by 1.4 times to account for round-trip losses

Figure 14 may represent a scenario when most coal-fired power stations have been replaced by renewable generation, but that is some decades into the future - not in 2024/5.

As a comparison, the current profile of pumped storage in the NEM for the first quarter of 2019⁷⁷ (Figure 15) shows the majority of pumping between 10pm and 5am, with minor pumping during daylight hours. Generation was concentrated over the evening peak from 6pm to 9pm.

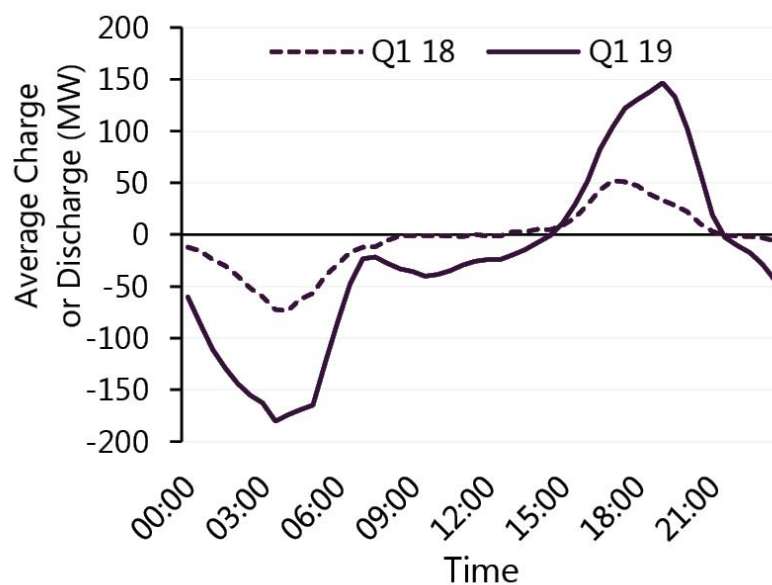


Figure 15. Pumped Hydro Intraday Dispatch – Q1 2018 and 2019 (AEMO)

It is interesting to note the losses from pumped storage, by comparing the larger volume of energy for pumping (below the zero horizontal axis) to energy for generation (above the axis).

Not only is the Snowy 2.0 scenario depicted in Figure 14 inconsistent with current and near-future market conditions (and Tumut 3's operation), it is inconsistent with a number of Snowy 2.0 engineering design factors:

- the FID Facilities Report (page 21) indicates that the pumps and generators have each been

⁷⁷ "Quarterly Energy Dynamics Q1 2019". AEMO https://aemo.com.au/-media/Files/Media_Centre/2019/QED-Q1-2019.pdf

designed to operate for 5 hours/day, not 8 and 13 hours/day as depicted in Figure 14:

“The numbers outlined below are key inputs into duty cycle performance, as well as design life. It should be noted though that as at FID these numbers are still being negotiated with the E&M suppliers and are subject to change:

- *Five hours generation*
- *Five hours pumping”*
- the Feasibility Study (page 16 of Summary) indicates that, prior to 2040, Snowy 2.0 will operate at full capacity for less than 87 hours per year. Figure 14 depicts operation at or near 2000 MW for 7 hours/day (4 pumping and 3 generation), totalling over 2,500 hours/year):

“A key consideration for the power waterway diameter selection was the average permissible velocity in a concrete lined tunnel (generally accepted to be 6m/s). Prolonged operation at such high velocities may lead to a deterioration by scouring of the power waterway’s concrete surfaces due to high local turbulence at surface irregularities. This analysis consequentially must be matched to the independent market expert’s modelling of the Project’s operation profile, which shows that in any given year prior to 2040, the Project will be operated at full capacity for less than 87 hours per year. At this stage of the Project’s due diligence efforts, this is deemed acceptable.”

It seems almost unbelievable that Snowy 2.0 would have been approved at this time if it will operate at 2000 MW for less than 4 days a year prior to 2040. This suggests that Snowy 2.0 is massively oversized and being constructed decades before it is needed.

(A relevant side issue is whether the sizing of the tunnel diameter will place a limit on operation at 2000 MW post 2040. Possibly the increase in diameter from 9 m in the Feasibility Study to 10 m in the Final Investment Decision was to address this issue. It is also relevant to note that the 1 m increase in diameter will increase the excavated spoil by almost 25%, adding a significant cost and environmental impact.)

5.10.1. Latest depiction of Snowy 2.0 operation contradicts earlier information

To add further contradictions to Snowy Hydro’s depictions of how Snowy 2.0 is expected to operate, the recently released Main Works EIS contains a chart “Snowy 2.0 daily power demand and generation”, copied here as Figure 16. This chart shows:

- pumping from 12 am to 6 am – *“when demand is low, water is pumped into the upper reservoir using cheaper energy and stored”*
- generation from 5 pm to 8 pm – *“when demand is high, water is released from the upper reservoir, generating energy”*

This portrayal is totally at odds with Figure 14. Also, to be pedantic, pumping will occur when prices are cheap, not necessarily when demand is low, and generation will occur when prices are expensive, again not necessarily when demand is high.

But this latest depiction is consistent with this Paper’s expectations, as outlined in earlier sections, of pumping mainly during the night-time off-peak hours when prices are cheap and most generation is from coal-fired plant, at least for the next decade or so. Though, over coming years more pumping is likely to occur increasingly during high solar generation periods.

Realistic and consistent information should be provided on the expected operation of Snowy 2.0, as

this is fundamental to the economics of the project.

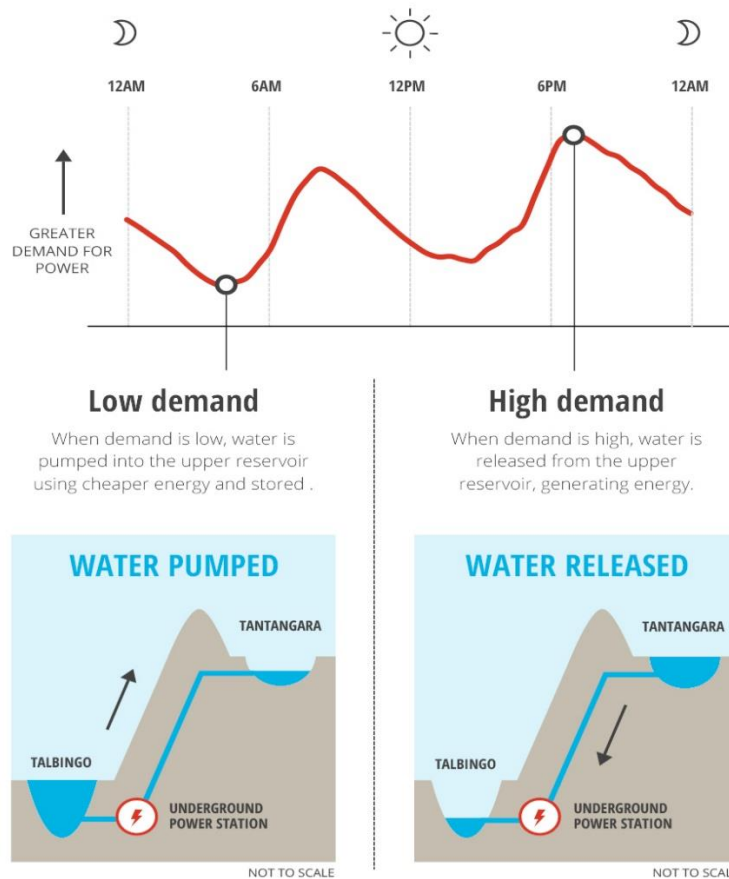


Figure 16. Snowy 2.0 daily power demand and generation (Snowy 2.0 EIS)

5.11. Snowy 2.0 is additional to existing plant, forestalling its full utilisation

Market and physical co-ordination with existing plant would impose constraints on how Snowy 2.0 operates and limit its financial return to some extent.

Snowy Hydro currently generates about 5000 GWh annually, with substantial capability to load-shift over minutes to months due to the flexibility in releasing water to the major storages (Blowering and Hume) for both the Tumut and Murray Schemes. Snowy 2.0's capacity ('recyclable [350] GWh') would be additional to this existing capability.

The extent to which Snowy 2.0 would actually be utilised on top of Snowy Hydro's existing capability is the key issue, not just Snowy 2.0's capability in isolation.

Of most relevance is Snowy 2.0's integration with Tumut 3 pumped hydro station.

For example, Figure 14 depicts Snowy 2.0 as being fully utilised for a considerable proportion of every day from 2024/5. This must presuppose that Tumut 3 is also fully utilised, otherwise Snowy 2.0 would be cannibalising the usage of Tumut 3. In this case, it seems implausible that the combined capacity of the two stations, 3800 MW generation and 2600 MW pumping, will be used from 2024/5. Any time that Snowy 2.0 is utilised will likely mean that Tumut 3 is backed off and vice versa.

Also, as Tumut 3's upper reservoir (Talbingo) is both Snowy 2.0's and Tumut 2's lower reservoir, all four power stations - Tumut 1, Tumut 2, Tumut 3 and Snowy 2.0 - would need to operate in tandem to gain maximum value (see Section 5.4).

Limited references to such operating constraints/ considerations are included in Snowy 2.0 documentation.

The other pertinent fact is that the total generation capacity of Snowy Hydro is 4100 MW, which would increase to 6100 MW with the addition of Snowy 2.0. Whenever it is economic for Snowy Hydro to generate, Snowy 2.0 would not necessarily be the first of Snowy Hydro's 9 power stations to be despatched, especially as the other power stations need to fulfil water licence requirements for downstream use.

In fact, from a financial assessment perspective in justifying Snowy 2.0 it should be the last to be despatched, as all other Snowy Hydro power stations are existing (and fully depreciated).

5.12. Snowy 2.0 may dampen commercial opportunities for other storage

A concern expressed by industry analysts is that if Snowy 2.0 is constructed it will enable Snowy Hydro to corner the pumped hydro market, with its combined 3800/2600 MW of generation/ pumping capacity, and substantially reduce commercial opportunities for new storage entrants.

Mr Broad refutes that concern⁷⁸:

"There's no crowding of the marketplace here, let me tell you. The federal government doesn't have any control over the market. If you're suggesting that will come through us and 2.0 that is just blatantly wrong," Broad says. "I can only rationalise that someone is trying to undermine my business. That's the only rational argument I can put."

However, the Australian Energy Market Operator has stated⁷⁹ that:

"With Snowy 2.0 committed, and existing hydro generators already storing potential energy in deep reservoirs, market signals for an additional suite of complementary pumped hydro energy storage (PHES) are subdued until further significant coal-fired generation closures occur (currently expected to be from the late 2020s to mid-2030s)."

Mr Hyslop commented on the dominant market power that will result if Snowy Hydro controls both Snowy 2.0 and Tumut 3:

"Its owners, the Commonwealth Government, have recently been extolling the virtue of intervening in the market to pressure participants to lower prices for consumers. Allowing a government-owned entity to establish such a dominance in the peak end of the market in both Victoria and New South Wales does not appear consistent with these recent statements and actions."

⁷⁸ "Behind Snowy's battery bet" The Australian 14 September 2019

<https://www.theaustralian.com.au/business/mining-energy/snowy-20-glows-with-the-flow-as-volatility-soars/news-story/ee7717e4f238bbe846a8565593d1c862>

⁷⁹ "Building power system resilience with pumped hydro energy storage" July 2019 http://aemo.com.au/-/media/Files/Electricity/NEM/Planning_and_Forecasting/ISP/2019/ISP-Insights---Building-power-system-resilience-with-pumped-hydro-energy-storage.pdf

6. Other, better alternatives not analysed

6.1. Snowy Hydro should reveal why Snowy 2.0 is the best option

Right from the initial announcement in March 2017, Snowy Hydro has focused on the 'Snowy 2.0' Tantangara/ Talbingo project. No information was provided then or since on why this is the best option at this point in time.

It would seem that Snowy Hydro was fixated by the relatively large capacity of Snowy 2.0 of 350 GWh. No doubt such capacity (if achievable – see Section 5.4) would give Snowy 2.0 a significant advantage over other potential pumped hydro schemes, but at an enormous (and unsustainable) cost and environmental impact.

Alternatives do exist, both within the Snowy Scheme and outside Kosciuszko National Park. These should have been disclosed and assessed before Snowy 2.0 was approved.

When announcing Snowy 2.0 Prime Minister Turnbull stated⁸⁰

“The Government, through the Australian Renewable Energy Agency (ARENA), will examine several sites, which could support large scale pumped hydroelectric energy storage in the precinct. These sites would involve new tunnels and power stations, connecting existing storages”.

However, it appears that no sites beyond the Tantangara/ Talbingo option were examined.

In the article⁸¹ “Snowy Hydro expansion won't be 'magical' solution to power problems, experts say”:

“Max Talbot, the former executive officer of Strategic Engineering at the Snowy Hydro Scheme, told ABC Local Radio previous expansion plans had proved too expensive. “We did look at that prospect briefly, expanding the scheme goes back nearly 20 years ago,” he said. “If he's [Malcolm Turnbull] talking about what I think he's talking about, then that was considered feasible but far too expensive at the time.”

As noted later (in Section 6.3):

“augmentation studies of pumped storage schemes were first considered in 1966 during the design and construction phase of the Snowy Mountains Hydroelectric Scheme. Further studies were undertaken from 1980-1986 and in 1991”.

Snowy Hydro has declined requests for copies of these studies on the grounds they are commercially sensitive. This seems incongruous as no other competitor could gazump Snowy Hydro and build a hydro power station within the Snowy Scheme.

Mr Broad has mooted⁸² Snowy 3.0 and 4.0:

⁸⁰ “Massive expansion for Snowy Hydro”. Engineers Australia 15 March 2017
<https://www.engineersaustralia.org.au/News/massive-expansion-snowy-hydro>

⁸¹ “Snowy Hydro expansion won't be 'magical' solution to power problems, experts say” ABC News 16 March 2017 <https://www.abc.net.au/news/2017-03-16/snowy-hydro-expansion-wont-be-magical-solution-to-power-problems/8360320>

⁸² Snowy 2.0 needs to double or triple in size, hydro chief says”. CEDA Conference 29 June 2018
<https://www.smh.com.au/business/the-economy/snowy-2-0-needs-to-double-or-triple-in-size-hydro-chief-says-20180628-p4zodi.html>

“we see a world where we can duplicate Snowy 2.0 and get another 2.0 right alongside it, and possibly a 4.0 where you can have 4000 megawatts. You could even get 6000 megawatts out of this”.

All other Snowy X.0's should be examined now before Snowy 2.0 proceeds any further.

As noted in Section 6.3, it is incumbent on Snowy Hydro to disclose and analyse alternatives in order to comply with the Environmental Planning and Assessment Regulation 2000.

6.1.1. Possible alternatives

It is difficult to postulate alternatives without access to detailed Snowy Hydro information. And it is incumbent on Snowy Hydro to undertake such analysis and publish the results. Nonetheless, a few potential alternatives within the Snowy Scheme are listed below to start a discussion.

None are as large as Snowy 2.0, but all involve less construction, cost and risk, are more modular and manageable, and have significantly lower or minimal environmental impacts. Also, most are already connected to the transmission grid and do not involve the same extent of transmission augmentation as Snowy 2.0, especially through Kosciuszko National Park.

More than one alternative or a combination could be adopted, providing flexibility for introducing additional pumped hydro in smaller increments, rather than in one enormous project. No doubt there are other alternatives.

- i. Tumut 3 Pumped Hydro Station augmentations:
 - install a Pumping Station at Blowering Reservoir to pump up to Jounama Pondage
 - install a Pumping Station at Blowering Reservoir to pump up to Talbingo Reservoir
 - increase the pumping capacity of Tumut 3 (currently 600 MW)
- ii. Install a power/ pumping station at Blowering and tunnel to Talbingo Reservoir
- iii. Install a new Tumut 3B pumped hydro station. Possibly it could use a lower intake structure at Talbingo Reservoir to utilise some of the 'dead storage'. Of Talbingo's total storage volume of 920 GL, only 160 GL (17%) is active storage for Tumut 3.
- iv. Install a 'turkey-nest' storage (or storages) above Jindabyne Reservoir and a pumped hydro station
- v. Install a tunnel between Eucumbene and Jindabyne Reservoirs, and a pumped hydro station at Jindabyne
- vi. Use Tooma Reservoir as an upper storage connected to a new reservoir lower down the Tooma River via a pumped hydro station (though the lower reservoir would need to be outside Kosciuszko National Park)

Also, possible variations to the Snowy 2.0 concept that involve less environmental impacts, though probably still uneconomic and unacceptable, might include:

- vii. Moving the Snowy 2.0 underground Power/Pumping Station to the southern end of Talbingo Reservoir. On the negative side it may involve a longer tunnel to Tantangara Reservoir, possibly a new access road to the power station and a surge tank; on the positive side the excavated rock at the Talbingo end is much closer for transport off-Park, the works accommodation area could be located at Talbingo township, it might enable a ground-level Power Station (or at least one less than 2-3km underground from the access portal), and would significantly reduce the length of the transmission lines through Kosciuszko National Park to the new Maragle Switchyard.
- viii. Move the Snowy 2.0 underground Power/Pumping Station to the shores of Blowering

Reservoir, making it the lower reservoir, rather than Talbingo. The same negatives and positives apply except it would involve an even longer tunnel to Tantangara Reservoir (maybe prohibitively so) but would provide an extra 200 metres of head.

- ix. A smaller Snowy 2.0, more in line with earlier SMHEA proposals, linking with the existing Upper Tumut to Yass 330 kV transmission line that traverses Lob’s Hole (see Section 6.2).

6.1.2. Cursory analysis of the Blowering to Jounama Pumping Station Option

To take this discussion a step further, the first option mentioned above is cursorily examined and compared with Snowy 2.0 against the three key factors of environmental impact, additional power/energy benefits and economics.

| Factor | Snowy 2.0 | Blowering Pumping Station |
|--|---|---|
| Environmental Impact (see Section 7) | Substantial impact on Kosciuszko NP: <ul style="list-style-type: none"> • 100 km² of KNP impacted, 1,000 ha destroyed • 14M m³ excavated spoil dumped in KNP • 10 km transmission lines (2 sets of towers) in KNP • 100 km of road upgrading in KNP, in sensitive areas • accommodation camps in KNP • pest species transported to Tantangara and downstream • depressed groundwater | Minimal impact on Kosciuszko NP: <ul style="list-style-type: none"> • ~ 0.5 M cubic metres excavated spoil transported outside KNP • much less transmission lines in KNP, preferably underground • no extra roadworks in KNP • no camp in KNP (use Talbingo) • no transport of pest species • no groundwater issues • Jounama Pondage designed for frequent fluctuations |
| Additional Power/Energy | Substantial power and energy: <ul style="list-style-type: none"> • 2000 MW generation • 2000 MW pumping • 350 GWh (overstated) | Significant energy: <ul style="list-style-type: none"> • 50+ MW generation at Jounama (T3B &/or Blowering generators?) • 250+ MW pumping • 500% increase in Tumut 3 cyclic energy capacity |
| Economics | Substantially uneconomic: <ul style="list-style-type: none"> • ~\$8 B hydro component • 27 km tunnel • power/ pumping station (2-3 km underground from access portal) • remote location, difficult accessibility • temporary construction camps • access roads • ~\$2 B major transmission | To be determined: <ul style="list-style-type: none"> • substantially less than S2.0 • ~7 km tunnel • pumping station at ground level • readily accessible, adjacent to Snowy Mountains Highway • accommodation at Talbingo Town • no roads, wharves etc • substantially less transmission than S2.0 |

Shading - positive middling negative

Figure 16. Rough Comparison of Snowy 2.0 with Blowering Pumping Station Option

This Blowering to Jounama Pumping Station option is much smaller and cheaper than Snowy 2.0.

It involves construction of a pumping station on the shore of Blowering Reservoir and a tunnel (~7

km) up to Jounama Pondage. From Jounama Pondage water can be pumped by Tumut 3 back up to Talbingo Reservoir, enabling the full 160 GL of active storage capacity of Talbingo to be recycled, rather than just the 28 GL capacity of Jounama (refer to Figure 10). This increases the flexibility and cyclic energy storage capacity of Tumut 3 by 500%.

Additionally, a small hydro power station could be added to the existing 14 MW station at Jounama to ensure all water discharged from Jounama to Blowering is utilised for power generation. Also, this option could be further augmented with a Tumut 3B pumped hydro station and/or a power station at Blowering.

As depicted in Figure 16, compared to Snowy 2.0 the Blowering Pumping Station option:

- has minimal environmental impact on Kosciuszko National Park
- provides less energy capacity, though still significant
- is substantially less costly overall and per/MW, but still may not be economic

This notional comparison demonstrates the need to comprehensively evaluate all feasible alternatives, environmentally, technically and economically, before committing to Snowy 2.0.

6.2. Why is 2000 MW the optimal size?

A related issue to alternatives is a lack of justification for the output of Snowy 2.0 being set at 2000 MW for both generation and pumping.

For example, less than 2000 MW would involve smaller diameter tunnels and smaller generation/pumping equipment, at a lower cost, less transmission and less environmental impact. Conversely, greater than 2000 MW would have a higher cost and environmental impact but provide more power.

A lower output would seem to have some merit, especially as Snowy 2.0 is forecast to operate at 2000 MW for less than 87 hours/year prior to 2040.

Also, a lower output would be more in line with studies by the Snowy Mountains Hydro-electric Authority of some decades ago based on a 990 MW Tantangara/ Talbingo Yarrangobilly pumped hydro option. A pumped hydro station of this size could run at full output for twice the time of Snowy 2.0.

It is understood that the Upper Tumut to Yass 330 kV transmission line was routed past Lob's Hole as a potential link to a future power station in the vicinity. Could a smaller Snowy 2.0 utilise the existing transmission system, possibly uprated, rather than requiring a massive transmission extension from Snowy 2.0 to a new Maragle Switchyard and thence to Wagga and Bannaby?

Clearly a smaller sized Snowy 2.0 would have significantly less environmental impact, especially for transmission. Its cost/MW may be similar to a 2000 MW station, especially with less transmission, but it would be more fully utilised and hence the overall cost/GWh may well be less.

What analysis was undertaken to determine the optimal size to be 2000 MW for generation and pumping, both in terms of the cost and environmental impacts?

6.3. Snowy Hydro hasn't complied with the regulation requiring analysis of alternatives

Consideration of alternatives is a requirement of Clause 7(1)(c) of Schedule 2 of the Environmental

Planning and Assessment Regulation 2000⁸³ for an environmental impact statement to include:

“an analysis of any feasible alternatives to the carrying out of the development, activity or infrastructure, having regard to its objectives, including the consequences of not carrying out the development, activity or infrastructure.”

The Exploratory Works EIS provided no such analysis of alternative pumped-storage schemes, as is required, particularly alternatives with less environmental impact.

In its response to NPA’s submission on the Exploratory Works EIS requesting information and analysis of alternatives, Snowy Hydro evaded the issue:

“The development of pumped hydro-electric storage requires significant lead time for planning, engineering and design. Snowy 2.0 utilises existing assets under the control of Snowy Hydro. A feasibility study for Snowy 2.0 was completed in 2017, and the connection of Talbingo and Tantangara reservoirs to deliver pumped hydro-electric capability has been considered at a conceptual level since the original construction of the Snowy Scheme.

The Feasibility Study (Snowy Hydro 2017) identified that a key study regarding the connection of the two reservoirs was a study completed in 1991, titled Snowy Mountains Scheme Augmentation Ranking Study (Dunn 1991), which included a summary of studies undertaken before 1991, and stated that augmentation studies of pumped storage schemes were first considered in 1966 during the design and construction phase of the Snowy Mountains Hydroelectric Scheme. Further studies concerned with energy reserve capability and mostly of pumped storage schemes were undertaken from 1980-1986 and a study of a mini hydro development at Khancoban Dam was completed in 1990.”

A follow-up request for such information was made by NPA on 13 December 2018, to no avail:

“NPA has been considering the response from Snowy Hydro that the Snowy Mountains Scheme Augmentation Ranking Study (Dunn 1991) will not be released as it ‘contains commercially sensitive, proprietary information’.

Such reasoning seems problematic to us. The Study is over a quarter of a century old and Snowy Hydro has no commercial competitor when it comes to further exploitation of the Snowy Scheme. Can SHL please re-consider its refusal and if it is to be maintained explain how release of this 25+ year-old study might detrimentally affect SHL.”

A key question is why Snowy Hydro was not required to comply with the EP&A Regulation to analyse ‘any feasible alternatives’?

The Main Works EIS provides a very cursory reference to the 1991 study.

6.4. The Government should have reviewed alternatives, including outside Kosciuszko

In September 2017, the Australian National University (ANU) completed an audit⁸⁴ of potential pumped hydro-energy storage sites across Australia, funded by ARENA. The audit identified 22,000

⁸³ “Environmental Planning and Assessment Regulation 2000”

<https://www.legislation.nsw.gov.au/#/view/regulation/2000/557>

⁸⁴“ANU finds 22,000 potential pumped hydro sites in Australia”. 21 September 2017

<http://www.anu.edu.au/news/all-news/anu-finds-22000-potential-pumped-hydro-sites-in-australia>

potential sites across Australia. The 8,600 sites identified in NSW/ACT have a combined storage capacity of approximately 29,000 GWh, compared to (a questionable) 350 GWh for Snowy 2.0.

Subsequently, in December 2018 the NSW Government published a “Handbook for large-scale hydro energy projects” and a “NSW Pumped Hydro Roadmap”. The Roadmap⁸⁵ states:

“The NSW Government has worked with the Australian National University (ANU) to uncover opportunities for pumped hydro across the State. This analysis found an incredible 20,000 reservoirs in the natural landscape that could be used as storages for pumped hydro energy. These could be paired-up in different ways to create 98,000 potential off-river pumped hydro sites—representing over 50 terawatts (TW) of firm generation capacity. In 2018, AEMO has projected that NSW will need investment in 9,000 MW of utility-scale energy storage by 2040, which is less than 1 per cent of the opportunities mapped”.

No doubt most of these options will not be viable, but some are likely to be commercially and environmentally suitable.

It was not incumbent on Snowy Hydro to examine pumped hydro alternatives ‘beyond’ the Snowy Scheme, but the Government ought to have done so before approving Snowy 2.0 and committing \$1.38 billion.

The Government should also have assessed other storage alternatives (and ‘competitors’ to Snowy 2.0) beyond pumped hydro, including:

- Batteries - large and small-scale battery banks have the advantage of being more efficient (90+% versus 70% for pumped hydro), can be installed in much smaller increments than 2000 MW, can be installed in a matter of months, have no risk of cost escalation, and can be located at load centres, thereby minimising the need for extra transmission circuits and losses. Also, there have been and will continue to be rapid reductions in cost. On the negative, they have a limited life of typically 10 years and less capacity.
- Demand response enabled electrical appliances – appliances such as water heaters, air-conditioners, electric vehicle chargers etc, which can be turned off and on by aggregators, depending on the available generation (particularly solar and wind).

It is noted that the NSW Government has established a \$75 million Emerging Energy Program:

“to support the development of innovative, large-scale electricity and storage projects in NSW. The program will help reduce barriers to investing in emerging technologies, supporting affordable, reliable and clean energy across the state.”

Grants were recently awarded⁸⁶ for 10 pre-investment studies, representing 2,150 MW of on-demand electricity for projects covering compressed air storage, batteries and pumped hydro. Also, 21 projects were shortlisted for 700 megawatts of pumped hydro, gas, biogas, solar thermal, virtual power plants and batteries.

So there is no question that there are numerous alternatives to Snowy 2.0 and many could easily be installed before Snowy 2.0.

⁸⁵ “NSW Pumped Hydro Roadmap”. December 2018 <https://energy.nsw.gov.au/media/1546/download>

⁸⁶ “NSW Government delivering an affordable, reliable and clean energy future” Minister for Energy 30 September 2019 <https://energy.nsw.gov.au/nsw-government-delivering-affordable-reliable-and-clean-energy-future> and <https://energy.nsw.gov.au/renewables/clean-energy-initiatives/emerging-energy-program>

As one commentator opined:

"Snowy 2.0 does seem a myopic approach of the grand engineering project rather classically proposed and pushed by empire building bureaucrats and accepted by "nation building" politicians! At the very least they need to be held to account for a proper evaluation".

Prime Minister Turnbull stated⁸⁷:

"I am a nation-building Prime Minister and this is a nation-building project," he said through a broad grin. "This is the next step in a great story of engineering in the Snowy Mountains and the courageous men and women who are confident and committed to Australia's future."

The prescient video clip from the TV series Utopia⁸⁸ screened in 2014, is provided as a bit of light relief for those who have persevered to reach almost the end of this lengthy and dense Paper.



There are many alternatives to Snowy 2.0 and there is no need to hastily proceed on the pretext it is urgently required and the only option for electricity storage.

⁸⁷ "Snowy Hydro 2.0: a breakthrough, a distraction or both?" Bega District News. 19 March 2017
<https://www.begadistrictnews.com.au/story/4539167/everything-you-need-to-know-about-snowy-20/>

⁸⁸ "Utopia: Snowy Mountains Scheme" ABCTV 28 August 2014
<https://www.youtube.com/watch?v=n1TMpXhwcQw&feature=youtu.be>

7. Unacceptable environmental impacts

7.1. A project of this size and impact should not even be contemplated in a National Park

Snowy 2.0 and its interconnecting transmission lines are located within Kosciuszko National Park. It is totally inappropriate and incompatible for infrastructure of such magnitude and environmental consequences to be permitted within the delicate alpine and sub-alpine environments of the Park.

NPA is not aware of an infrastructure project ever being constructed within a National Park in NSW or elsewhere in eastern Australia, let alone a project as huge and with such devastating environmental impacts as Snowy 2.0.

It is noted that the existing Snowy Hydro-electric Scheme was initiated and largely constructed (1949-74) before Kosciuszko National Park was declared in 1967.

Snowy 2.0 should not even be contemplated due to its location within one of Australia's premier natural areas with its outstandingly unique, breathtakingly beautiful and fragile environment that must be preserved in perpetuity.

The National Parks Association of NSW stated in its submission⁸⁹ on the Exploratory Works EIS:

“As a matter of principle, no significant infrastructure, such as Snowy 2.0, should be permitted within a National Park. Less than 10% of NSW is protected from man-made encroachment and development for future generations.

While NPA supports hydro-electric pumped-storage in principle where it is integrated with renewable generation and not used to maintain coal-fired power generation, it does not support the construction of major infrastructure for this purpose within National Parks. National Parks and other protected areas are the primary means of safeguarding our biodiversity for future generations. Kosciuszko is one of Australia's premier National Parks, being the largest in NSW and part of the national heritage listed Australian Alps with its unique alpine environment.”

At its Annual Conference on 20 October 2018 the Nature Conservation Council of NSW carried Motion 2018/L2⁹⁰. Extracts include:

“NCC believes that the adverse long-term impacts of Snowy 2.0 outweigh the benefits of the scheme as it is being proposed. The environmental impacts that can already be identified from the Snowy 2.0 proposal are so numerous and extensive, and irreversible, that this project cannot be regarded as a “clean energy” contribution simply because it is hydro-based, and not based on fossil fuel.

In evaluating the Snowy 2.0 pumped hydro proposal NCC is guided by two basic principles:

- upholding the integrity of natural landscapes, including most particularly those protected areas reserved as national parks and nature reserves; and*
- the urgent need to reduce climate change emissions, including those produced by*

⁸⁹ “Submission on Snowy Hydro 2.0 Exploratory Works Environmental Impact Statement”. National Parks Association of NSW 20 August 2018
<https://majorprojects.planningportal.nsw.gov.au/prweb/PRRestService/mp/01/getContent?AttachRef=EXH-12%2120190224T014047.598%20GMT>

⁹⁰ Nature Conservation Council of NSW Annual Conference Minutes. 20 October 2018
<https://www.nature.org.au/media/355854/2018-final-ac-minutes.pdf>

enhanced renewable energy, while decreasing reliance on fossil fuels.

We:

- *Recognise that pumped hydro projects can increase energy storage capacity in NSW, reducing our reliance on fossil fuels and helping us transition to 100% renewable energy and reduce carbon missions.*
- *Do not support infrastructure projects that will have significant, detrimental impacts on National Parks, and hence do not support Snowy 2.0, as proposed.*
- *Also, we are concerned that Snowy 2.0:*
 - *Has been announced without any assessment of alternative options for the generation and storage of power within the Snowy Scheme, as well as options in other areas of the State, with potentially less impact on the environment and natural heritage.*
 - *Will have significant permanent detrimental impacts on the Kosciuszko National Park and its fragile alpine ecosystems, including impacts on biodiversity (including native vegetation and threatened species) and the national heritage values of the National Park.*
 - *Will involve five separate stages of assessment and determination, avoiding a single, comprehensive assessment and understanding of the overall impacts of the entire Snowy 2.0 proposal.”*

7.2. A 1½ year EIS process

Setting aside the fundamental principle of National Parks being inappropriate locations for major infrastructure and the major questions on its economic viability and deliverability of claimed benefits, Snowy 2.0 will have devastating environmental impacts on the national-heritage listed Kosciuszko National Park.

Some of these were revealed in the Exploratory Works EIS (July 2018). A much fuller extent of impacts has now become evident with the release of the Main Works EIS (26 September 2019). The EIS for the four transmission lines through the Park will complete the package when released, expected in December 2019. The EIS process is going to take 1½ years before the full extent of environmental impacts are revealed.

It is considered to be highly inappropriate for Snowy 2.0 to be approved and construction commenced before these impacts are identified and assessed. Also, some impacts may result in approval conditions that significantly affect the engineering and costs of the project.

As a further example of the irresponsibility of commencing construction before the environmental assessment process has been completed, an application by Snowy Hydro to extensively modify the Exploratory Works EIS was exhibited on 26 June 2019 (see Section 7.13). Also, a further application for modifications has been flagged.

7.3. The Main Works EIS has finally revealed the enormity of impacts on the Park

Whilst previous Snowy 2.0 documents gave some indication of the scope of the project, the extent of environmental impacts on the Park only became evident with the release of the Main Works EIS. in summary:

1. Snowy 2.0's 'project area' covers 250,000 hectares (2,500 square kms⁹¹) – one-third of Kosciuszko National Park
2. 100 km² of KNP will be significantly and permanently impacted (25 times the size of Lane Cove National Park), not including the visual blight over vast areas of the Park
3. 1,053 ha of native vegetation will be totally destroyed:
 - includes 992 ha of habitat for 14 threatened species
 - in some cases significant proportions of the species in KNP will be wiped out
4. 14,000,000 cubic metres of excavated rock will be dumped in the Park:
 - some has naturally occurring asbestos and/or is acidic
 - unbelievably, over 8,000,000 m³ is to be dumped in Talbingo and Tantangara Reservoirs, decreasing their storage capacities
 - 6,000,000 m³ is to be dumped on Park land (minor amount for roadworks)
5. major infrastructure is to be constructed at various locations, creating permanent environmental damage and a blight on the natural landscape:
 - Lob's Hole - clearing and 're-forming' 400 ha along 8 km of the Yarrangobilly River for an accommodation camp (1,650 workers), rock dump, substation, multiple works areas and permanent infrastructure
 - Marica - accommodation camp (100), works areas and permanent infrastructure
 - Tantangara Reservoir
 - accommodation camp (500), works areas, rock dump and permanent infrastructure
 - water level will fluctuate by up to 5 metres a day, resulting in shoreline movements of hundreds of metres, dramatically affecting the aquatic ecology and public amenity
 - infested by pest species transported up from Talbingo
 - Tantangara will become nothing more than a holding tank and an eyesore
 - Talbingo Reservoir - works areas, rock dump and permanent infrastructure
6. 100 km of roads and tracks built/upgraded/widened throughout the project, some through sensitive environmental and geological significant areas:
 - includes a two-lane, sealed, heavy-duty road down the precipitous mountainside to Lob's Hole, requiring extensive cutting and banking
7. two side-by-side high voltage transmission lines traversing 10 km of the Park, with a 120 m easement swathe and associated access tracks
8. power and communication cables throughout the project area
9. the water table in the vicinity of the 27 km tunnel will be depressed:
 - in some sections by over 50 m and by 0.5 m up to 2 km either side
 - drying up streams and bogs, killing off habitat and native species (some threatened)
 - reducing inflows to Snowy reservoirs and downstream rivers

⁹¹ 1 km² = 100 ha = 1,000,000 m²; 1 ha = 10,000 m² (100m x 100m)

10. pests spread throughout the Snowy Scheme and downstream:
 - pest fish (including a Class 1 Noxious Fish), fish diseases and aquatic weed transported from Talbingo Reservoir up to Tantangara (pest-free) and the Upper Murrumbidgee catchment, then to Eucumbene and throughout the Snowy Scheme and downstream rivers (despite the preventative filtration systems proposed)
 - major impacts on fish in Tantangara and downstream
11. substantial amenity impacts, totally inconsistent with the natural landscape of a National Park:
 - visual blight on the pristine Park landscape from vantage points over thousands of km²
12. a flawed, totally inappropriate offsets strategy, inadequately attempting to compensate for the environmental damage

Any one of the above impacts would be more than enough to stop a proposed development anywhere, let alone in Kosciuszko National Park.

It is contemptable that the Main Works EIS concludes there aren't "*any significant long-term impacts on the local environment*":

"Through the implementation of proposed mitigation, management and offsetting measures, this EIS demonstrates that Snowy 2.0 Main Works could be undertaken without any significant long term impacts on the local environment.

As such, Snowy 2.0 is considered to be in the public interest."

Detail on some of these environmental impacts are addressed in the following sections.

7.4. Enormous Project footprint

The EIS refers to the 'Project Area'⁹² covering approximately 50 km x 50 km, an area of 2,500 square kms (250,000 ha). The Project Area encompasses a third of Kosciuszko National Park (690,000 ha) - an area twice the size of Greater Sydney.

It is totally disingenuous to try to pass off the enormous size of the project by stating that "*the total disturbance footprint of the project is very small at less than 0.25% of the total park size*".

The EIS also refers to a 'Disturbance Footprint' of 1,680 ha, narrowly defined as the areas of physical disturbance. Also, 1,053 ha of native vegetation is to be lost, including 992 ha of habitat for 14 threatened species.

A far more relevant measure would be the area permanently impacted by the project. NPA's estimate of such an 'Impact Footprint' is approximately 10,000 ha (100 km²):

⁹² "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*". Summary page 12.

| | |
|---|---------------|
| Construction sites - Tantangara, Marica, Lob's Hole, Talbingo | 650 |
| Tantangara Reservoir | 2,117 |
| Talbingo Reservoir/Jounama Pondage | 2,317 |
| Land above tunnel (water table drawdown) | 5,000 |
| Roads and tracks | 100 |
| Transmission lines and access tracks | 125 |
| Total | 10,309 |

This footprint does not include:

- rivers, dams, waterways downstream of Tantangara Reservoir that will be infested by pest species transported up from Talbingo – Murrumbidgee River, Eucumbene Dam, all of the Snowy Scheme, Snowy and Murray Rivers (noting that some waterways already are infested with some of the pest species).
- the visual blight on a pristine natural environment over 100's km2 of KNP, including:
 - engineering structures
 - transmission towers and lines
 - rock dumps
 - major road construction works, particularly down steep mountainsides
 - surge tank, ventilation shaft

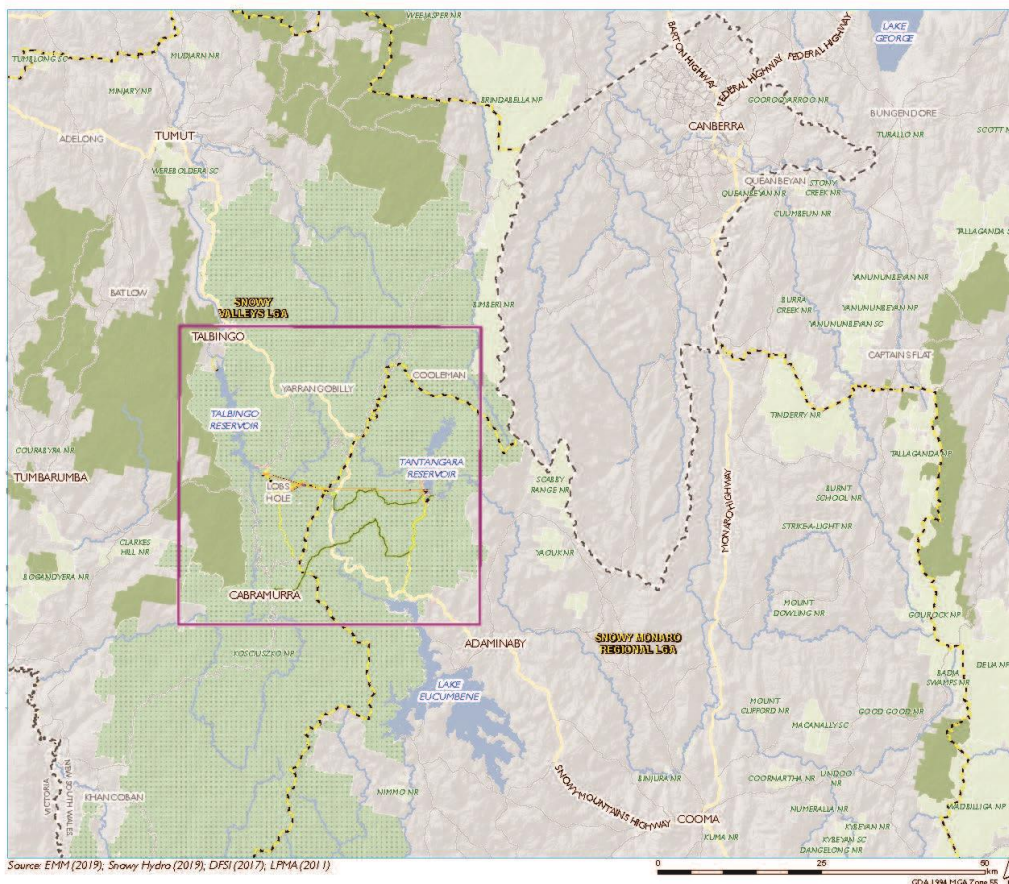


Figure 17 – 250,000 ha Project Area (EIS Figure 4)

7.5. Destruction of threatened species habitat

The Main Works EIS provides a list of lost habitats for threatened species, summarised below:

Native vegetation and threatened ecological communities

- 17.51 ha of threatened species (Alpine Sphagnum Bogs and Associated Fens)

Threatened species and their habitat

“Removal of native vegetation and threatened species habitat has the potential to result in fragmentation of fauna habitat, with resultant effects on fauna species movement, reproduction and gene flow. Habitat loss is expected for several threatened species:

- 2.01 ha of habitat for Clover Glycine;
- 1.67 ha of habitat for the Kiandra Leek Orchid;
- 17 individuals of the Leafy Anchor Plant;
- 16.55 ha of habitat for the Mauve Burr-daisy;
- 0.38 ha of habitat for the Raleigh Sedge;
- 0.18 ha of habitat for the Slender Greenhood;
- 0.04 ha of habitat for *Thelymitra alpicola*;
- 5.42 ha of breeding habitat for the Gang-gang Cockatoo;
- 30.23 ha of habitat for the Broad-toothed rat;
- 552.94 ha of habitat for the Eastern Pygmy-possum;
- 174.39 ha of habitat for the Smoky Mouse;
- 9.85 ha of habitat for the Booroolong Frog;
- 48.87 ha of habitat for the Alpine Tree Frog; and
- 133.83 ha of habitat for the Alpine She-oak Skink.”

Migratory species habitat impacted

- Satin Flycatcher
- Latham’s Snipe

Groundwater dependent ecosystems

- PCT 637 - Alpine and sub-alpine peatlands, damp herbfields and fens, South Eastern Highlands Bioregion and Australian Alps Bioregion;
- PCT 765 - *Carex* - *Juncus* sedgeland/wet grassland of the South Eastern Highlands Bioregion; and
- PCT 1225 - Sub-alpine grasslands of valley floors, southern South Eastern Highlands Bioregion and Australian Alps Bioregion.

Combined threatened species losses of this magnitude are overwhelming and unprecedented. The EIS concludes that:

“Removal of native vegetation and threatened species habitat has the potential to result in fragmentation of fauna habitat, with resultant effects on fauna species movement, reproduction and gene flow. Habitat loss is expected for several threatened species.

Residual impacts will be offset.”

If Snowy 2.0 proceeds there is nothing that can be done to avoid this enormous and tragic loss. ‘Offsetting’ is entirely inadequate.

7.6. Dumping 14,000,000 m³ of waste rock spoil in the Park

The Feasibility Study estimated 6,000,000 cubic metres (m³) of rock (net of bulking factor) to be

excavated from the tunnels, power station cavern, access road etc, proposing it be dumped in the 'dead-storage' of Talbingo and Tantangara reservoirs:

“In considering the basic options for disposal, disposal to land within KNP has been assumed to be non-viable due to the potential impact on large areas of relatively high conservation value. Similarly, disposal to land outside KNP has also been considered non-viable due to the large transport distances leading to an economically prohibitive cost.

The only remaining viable option to consider then is in-lake disposal in Talbingo and Tantangara reservoirs. While a number of investigations to confirm suitable geochemistry and likely grading of the material are required, spoil disposal operations into lakes at depth have been successfully undertaken in projects around the world, with appropriate controls for local sensitive habitat avoidance and turbidity controls such as silt curtains. There is significant 'dead' storage available in the reservoirs, particularly in Talbingo, to easily accommodate the excavated volumes of material.”

However, this situation has changed completely. The Main Works EIS estimates there to be 9,000,000 m3 of spoil (50% increase) and for the spoil to now be dumped in the active storage areas of the reservoirs and elsewhere on ground.

| Area | Total estimate | In-reservoir placement | Permanent structures (1) | Shaped landform |
|-----------------------|----------------|------------------------|--------------------------|-----------------|
| Talbingo & Lob's Hole | 4,974,784 m3 | 2,834,212 m3 | 1,140,573 m3 | 1,000,000 m3 |
| Tantangara | 3,627,419 m3 | 2,800,677 m3 | 826,742 m3 | Not applicable |

(1) roads, operational pads, portals

Figure 18 - Estimated excavated material volumes reused or permanently placed (EIS Table 2.15)

All of the EIS narrative and tables refer to 9,000,000 m3 of excavated spoil, except in Appendix F, where it is revealed that the actual volumetric amount of extracted rock to be dumped is between 12,900,000 m3 and 14,600,000 m3:

“It is estimated that approximately 9,000,000 m3 banked volume (between 12,900,000 m3 and 14,600,000 m3 bulked volume) of rock and soil will be excavated associated with the construction of the tunnel excavations, power station complex caverns and intakes.”

It is highly misleading to have based all the EIS documentation referring to the (bulked) volume of rock (i.e. the volume in-situ), when the actual volumes to be dumped are 33% to 60% more.

Deliberately dumping over 8 million m3 of spoil (unbulked) in Tantangara and Talbingo Reservoirs seems totally incongruous, as usually every effort is taken to minimise sedimentary runoff into dams to forestall their inevitable infilling.

And dumping on Park land runs counter to previous intentions.

Frankly, whether the spoil is dumped on land or in reservoirs it is all still within Kosciuszko National Park, with consequent impacts on land and aquatic habitats.

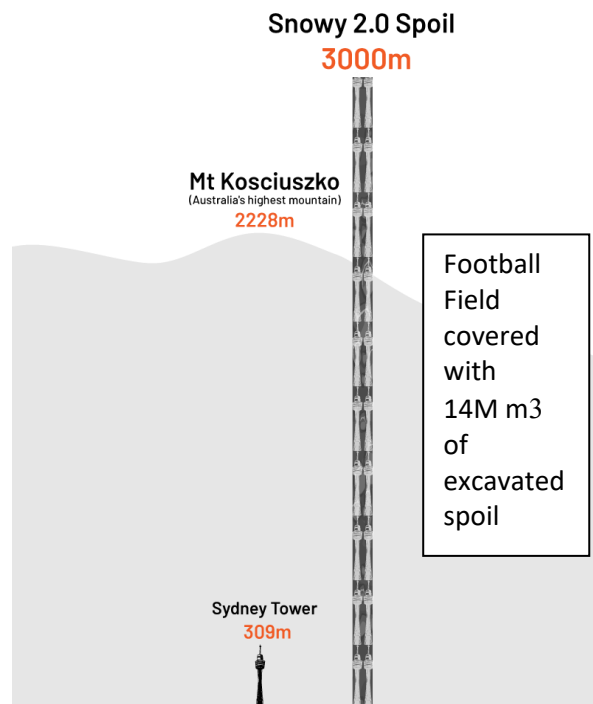
The EIS also reveals that some excavated rock is contaminated or has naturally occurring asbestos (NOA) or is potentially acid forming (PAF):

“Based on the findings of this contamination assessment, there is the potential for localised areas of soil, mine waste and surface water contamination associated with historically contaminating land uses to be encountered during construction, and further assessment is warranted in some instances.

NOA and PAF rock are also likely to be encountered during tunnelling and associated construction activities that will require management to minimise potential risks to human health and the environment.”

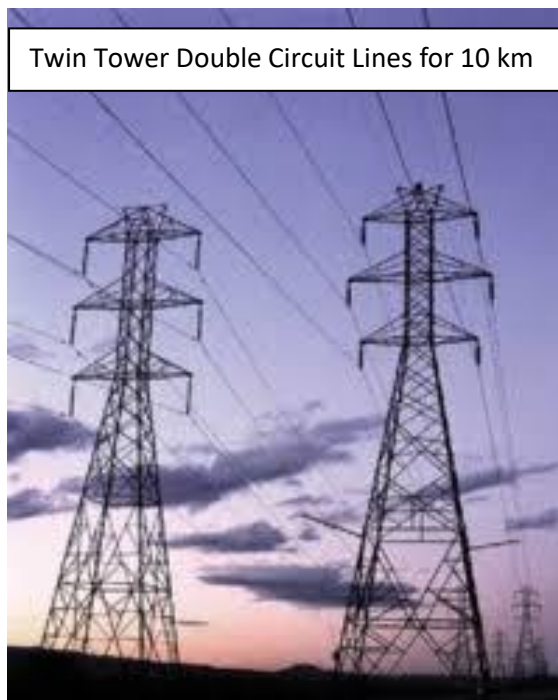
The EIS is circumspect on how this contaminated rock is to be classified and ‘managed’.

If anyone proposed dumping 14,000,000 m³ of waste material, some contaminated, in a National Park they would be dismissively rebuffed, rightly so.



7.7. Twin high voltage transmission towers and lines through Kosciuszko National Park

Details of the overhead transmission lines from the Snowy 2.0 switchyard at Lob’s Hole to a new switchyard to the west of Talbingo Reservoir (just outside Kosciuszko National Park) have yet to be released.



It is expected that four 330 kV transmission circuits (consisting of three conductors each) will be carried on two sets of side-by-side towers, similar to the adjacent photograph.

The towers will vary in height depending on the terrain, but will be typically 40 m high and located on high points. Some towers, particularly where the lines cross the existing 330 kV transmission line through Lob’s Hole and on the top of the ranges each side of Talbingo Reservoir, would be higher.

The lines will traverse protected native vegetation through Kosciuszko National Park for 10 km. A 120 m-wide easement swathe will be cleared of vegetation above a few metres from ground level, except in areas where the conductor clearance is greater due to the elevated height of adjacent towers. The easement will cover an area of over a

square kilometre.

A network of access tracks to the towers along the 10 kilometres will be required.

Kosciuszko National Park is already traversed by several single tower 330 kV transmission lines and access tracks, but the environmental and visual impact of this double set of towers and lines will be even more of a blight.

The towers, conductors, easement and access tracks will dominate the landscape and be visible from an area of some hundreds of square kilometres.

The intrusion of such infrastructure on the natural environment of the Park will be overwhelming and reason alone to scrap Snowy 2.0.

7.8. Permanent damage to Lob's Hole area

Lob's Hole is to be the major works area for the project, being the entrance to the underground power station. The disturbed area covers about 400 ha along an 8 km stretch of the Yarrangobilly River. 100 ha of native vegetation is to be cleared and 75 ha of threatened native species habitat will be destroyed.

Works include a serviced accommodation camp catering for a construction workforce of 1,650 personnel, two large rock dumps, services infrastructure (diesel-generated power, water, wastewater, sewage treatment plant, communication towers and cabling), a 330/33 kV substation and connecting transmission and distribution lines, concrete batching plant, fuel storage, vehicle storage and maintenance, materials stockpiles.

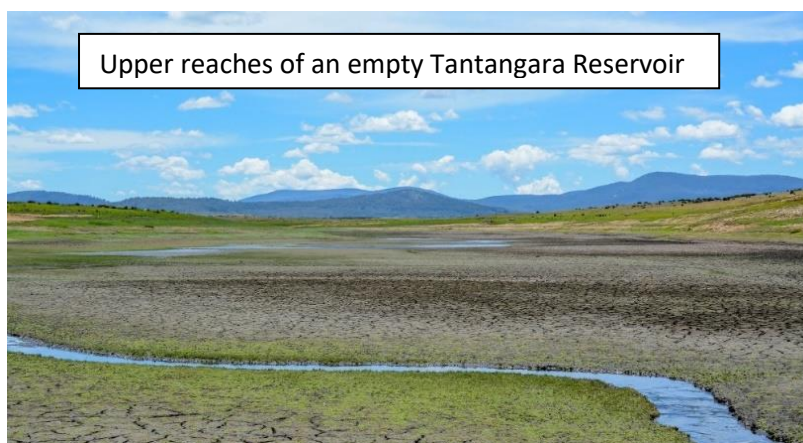
Approximately 1,500,000 m³ of excavated material will remain in Lobs Hole following construction and used for 'land-forming'.

7.9. Tantangara will become a holding tank, occasionally empty and an eyesore

Currently the water levels in Tantangara are relatively stable and fluctuate largely on a seasonal basis.

However, if Snowy 2.0 proceeds, Tantangara levels will vary on an hourly basis. Whenever Snowy 2.0 operates at full capacity, Tantangara will rise and fall as much as 5 metres in 24 hours at full generation or 3 metres at full pumping. Potentially Tantangara could drop from full to empty in a week.

The reservoir's flat topography means that every 1 m change in level will result in a significant movement in the shoreline – possibly up to 50 m.



Rapid fluctuations in water volumes and occasional emptying will have a devastating impact on the aquatic environment and the reservoir's general attractiveness. What fish kill will occur when the reservoir is emptied?

Whenever Tantangara is near minimum operating level (i.e. only 6% full) it will look like a large puddle surrounded by an extensive mud/ dirt shoreline.

No doubt the large cyclic water level changes will exacerbate sedimentation.

The Reservoir will also be impacted by the large intake works for the tunnel and a rock dump of over 4,000,000 m³ in a prominent position.

Tantangara will often be an eyesore and no more than a holding tank.

7.10. Groundwater levels depressed

According to the Main Works EIS, groundwater levels along sections of the 27 km tunnel will drop during construction and continue to be depressed thereafter.

“The groundwater inflow to underground excavations during construction and operation is predicted to create depressurisation and drawdown of the watertable.

The numerical groundwater model predicts that total inflow to excavations is expected to increase throughout the construction period as tunnelling progresses, with a peak at 160 L/s (5 GL/year) in the final year of construction.

During operation, the tunnel will become a throughflow system, and will continue to draw water into it (e.g. primarily act as a ‘sink’), with a very minor volume of groundwater re-entering the groundwater system. Tunnel inflows will taper following construction as the tunnel floods and enters the operational stage. Inflow during operations is predicted to reduce to approximately 85 L/s (2.7 GL/year).

The volumetric impacts to surface water systems are largely a result of decreased groundwater levels which decrease the available groundwater baseflow to streams.”

The level of drawdown varies according to the characteristics of the rock, but will be in excess of 50 m in some sections and extend 2 km either side of the tunnel:

“Watertable drawdown is predicted to be in excess of 50 m directly above the tunnel alignment in areas of high vertical hydraulic conductivity (Gooandra Volcanics). At a distance of approximately 2 km either side of the tunnel alignment the drawdown reduces to 0.5 m in the western plateau.”

The area impacted is approximately 50 square kilometres (5,000 ha). The EIS provides information on the areas of impact for Gooandra Creek and Eucumbene River:

- *“Gooandra Creek*
 - *the long-term baseflow is conservatively predicted to decline by 28.8%*
 - *likely to change from a perennial streamflow regime to ephemeral (days with ‘no flow’ increase from 0% to 9%)*
 - *days with no flows and very low flows increase, particularly in summer and autumn and the number of days with low, medium and high flows decrease correspondingly*
- *Eucumbene River*
 - *the long-term baseflow is conservatively predicted to decline by 12.5% in the upper reaches*
 - *the streamflow regime could change from perennial to ephemeral (days with ‘no flow’ increase from 0% to approximately 20-25%).”*

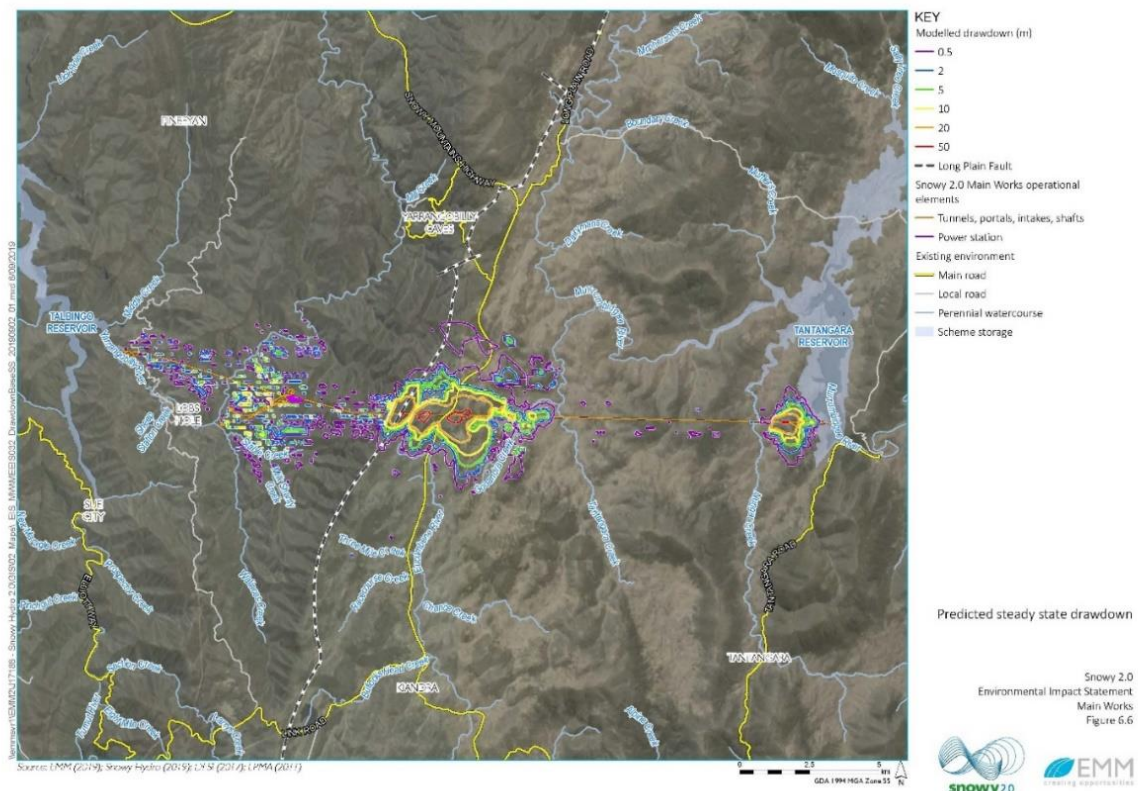


Figure 19 - Permanent Drawdown of Water Table (Snowy 2.0 EIS)

The environmental impact of the drawdown of the watertable is acknowledged briefly, but it appears that nothing can be done to avoid damage to several ecosystems:

“As terrestrial vegetation communities are composed of a range of vegetation types, with a range of rooting depths and strategies, there is a relationship between groundwater depth and the types and composition of the vegetation that can access it (Serov 2013). Analysis of the distribution of Plant Community Types (PCTs) in relation to the simulated regional groundwater levels carried out for the project indicated several PCTs are strongly associated with shallow groundwater.

The majority of entirely/obligate dependent ecosystems occur across the high plains of the Plateau and Tantangara.”

“17.51 ha of threatened species (Alpine Sphagnum Bogs and Associated Fens) is within the groundwater drawdown area and may be subject to impacts arising from changes in hydrology. The scale and extent of these impacts are unknown and will be subject to ongoing monitoring.”

Nevertheless, the EIS assures that *“the regional effects on the catchment surface water flows are considered insignificant.”*

7.11. Transfer of pest species throughout the Snowy and downstream

The Feasibility Study referred to the presence of Redfin Perch, a Class 1 Noxious Pest, in Talbingo and the possibility of transportation to Tantangara Reservoir, which is Redfin-free:

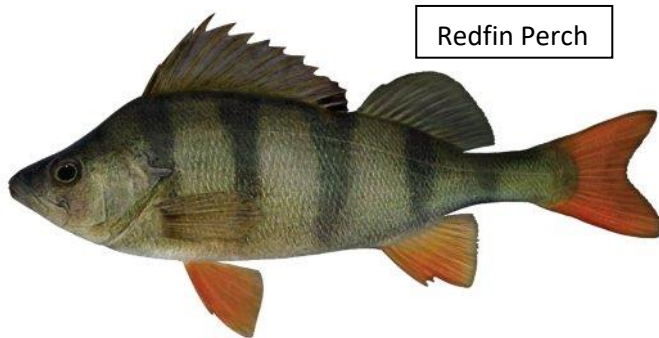
“The presence of Redfin has been confirmed in Talbingo reservoir. This species is considered a

pest particularly in the context of a recreational trout fishery, for which the lakes and rivers of the Snowy Mountains are famous. There have been no identified catches of Redfin to date in Tantangara. As such, the potential translocation of the pest species from Talbingo to Tantangara during pumping operations is considered to be a risk.

The pressure effects and mechanical impacts of passing through the pump turbines is likely to result in significant mortality of mature individuals but there may not be 100% mortality for early life stages. The ability for a viable population of Redfin to fully establish in Tantangara is still being assessed. Until proven otherwise, it is being assumed that it is possible so additional management controls will be considered for both the Talbingo and Tantangara intake works in the detailed design phase. These are likely to include physical barriers, deterrents and mortality strategies. In addition, supplementing existing trout stocking programs could be considered to ensure the long term maintenance of the recreational trout fishery in Tantangara.”

The NSW Department of Primary Industries website states⁹³:

“Redfin Perch, also known as English Perch, was listed as a Class 1 noxious fish in NSW in December 2010.



Redfin are voracious predators of other fish and invertebrates, can destroy recreational fisheries in enclosed waters by building up large numbers of stunted fish and eliminating other species, and can devastate native fish populations by carrying the epizootic haematopoietic necrosis (EHN) virus”.

Don’t transfer redfin between waterways or introduce them into farm dams - it's illegal!”

A Murray-Darling Basin Authority Fact Sheet⁹⁴ outlines the devastating impact of Redfin:

“The species is occasionally moved illegally by anglers and, once established, can increase rapidly in numbers. In Lake Burley Griffin, Canberra, within six years of establishing it formed 58% of the total catch. However, these numbers declined dramatically after an outbreak of EHN in the early to mid 1990s, and the species now comprises around 10–15% of the catch.”

The Main Works EIS has revealed that the issue is far more dire, with several noxious species (fish, fish disease and weeds) in Talbingo Reservoir, which if spread would have devastating impacts on native species:

“The noxious weed Elodea is widespread in Talbingo Reservoir and plant fragments could inadvertently be transferred to other waterways.

Similarly, eggs of non-native pest species, such as redfin perch, eastern gambusia and wild goldfish could be transferred between waterways.

⁹³ NSW Department of Primary Industries Pests <https://www.dpi.nsw.gov.au/fishing/pests-diseases/freshwater-pests/species/redfin-perch>

⁹⁴ “Fish Factsheet Redfin Perch” Murray-Darling Basin Authority. January 2009. <https://www.feralscan.org.au/docs/MDBA-A4-Fact-Sheet-50-Redfin-perch.pdf>

The risk of Redfin perch spreading from Talbingo Reservoir and its tributaries to Tantangara Reservoir and tributaries where it does not currently occur is of concern.

Eastern gambusia and Wild goldfish are also not currently found in Tantangara Reservoir, the Upper Tantangara or Upper Murrumbidgee catchments.

The introduction of pests to these catchments could impact on native species.”

Even more alarming is Snowy Hydro’s acceptance that when Snowy 2.0 is operational it is inevitable that noxious species in Talbingo Reservoir will be transferred to Tantangara Reservoir. This in itself is a travesty.

“Ning et al. (2019) were commissioned by Snowy Hydro to investigate the potential survival of various life-history stages of redfin perch and of adult eastern gambusia through the proposed pumped hydro system. Overall, they concluded that based on the results of their experiments and modelling, if entrained into the intake at Talbingo Reservoir, a proportion of redfin perch or eastern gambusia could survive the shear, blade strike and pressure impacts expected to occur within the pumped hydro system.”

“In response to key matters raised by stakeholders regarding the potential transfer/movement of fish between the reservoirs, Snowy Hydro carried out detailed design investigations for fish barrier controls.

The approach included investigations of the feasibility and effectiveness of controls that could be incorporated at the intake structures in Tantangara and Talbingo reservoirs (primary controls) to prevent live fish transfer to Tantangara Reservoir. However, due to the complex nature of the proposed structures and their operation, no feasible primary control measures were identified to prevent the transfer of fish, larvae and/or eggs between the reservoirs.”

No information is provided on the expected impact of these pest species into Tantangara. One would conjecture that the impact on local species will be catastrophic.

Having accepted that pest species will transfer to Tantangara, Snowy Hydro are proposing to contain the pests within Tantangara by physical barriers:

“Consequently, the objective of the barrier control measures is to contain any fish potentially transferred and restrict them to within Tantangara Reservoir and out of any catchments known to contain threatened species. These investigations identified secondary design controls which form part of Snowy 2.0 Main Works. These are:

- *In Tantangara Creek just upstream of the waterfall upstream of Alpine Creek Trail ... to prevent movement of Climbing galaxias into the 4 km upstream section of Tantangara Creek where stocky galaxias are found;*
- *At Tantangara Reservoir dam wall, ... to prevent transfer ... to the Mid and Lower Murrumbidgee River catchments; and*
- *At the entrance to the Murrumbidgee-Eucumbene tunnel that transfers water from Tantangara Reservoir to Lake Eucumbene ... to prevent fish transfer to the Snowy River, Upper Tumut River and Murray River catchments.*

These barriers are a result of considerable volumes of research and design development initiated by Snowy Hydro aimed to eliminate the potential risk to pre-existing fish populations and other components of aquatic ecology at risk from fish transfer.”

What guarantee can Snowy Hydro give that these barriers will be effective?

Snowy Hydro's previous assurances that the pest species could be contained in Talbingo Reservoir, together with these latest assurances that they can be contained in Tantangara Reservoir, are highly dubious.

If Snowy 2.0 proceeds, it appears inevitable that pest species will be transferred from Talbingo to Tantangara, and thence throughout the Snowy Scheme and downstream rivers. (It is noted that Redfin already inhabit some of these downstream rivers).

The transfer of Redfin between waterways is illegal in NSW.

7.12. Risible biodiversity offset payment so far

Snowy Hydro acknowledges that there will be unavoidable environmental impacts. For the Exploratory Works a Biodiversity Offset Strategy (BOS) was developed in consultation with the NSW Office of Environment and Heritage and the NSW Department of Planning and the Environment.

Simplistically, the BOS puts a dollar value on the residual impacts and determines a compensatory payment towards conservation actions within Kosciuszko National Park. The compensation for the damage caused by the Exploratory Works Stage has been set at a risible \$10.5 million in the Minister's Notice of Decision, in accordance with the recommendation in the Department of Planning and Environment's Assessment Report¹¹.

The offset strategy is a problematic and totally inadequate attempt to "pay back" the permanent environmental damage to be caused by Snowy 2.0.

No appropriate offsets for the habitats that would be damaged or destroyed by Snowy 2.0 could be provided, given that all of the comparable alpine and subalpine areas of NSW are already included in Kosciuszko National Park.

7.13. Substantial modifications proposed for the Exploratory Works EIS, lack of consultation

Within 5 months of the Exploratory Works EIS being approved on 7 February 2019, modifications were exhibited on 26 June 2019¹⁴ involving changes to most aspects of the initial EIS and extensive additional environmental impacts on Kosciuszko National Park, including:

- construction of a 330/33 kV substation, 50m high steel lattice tower and overhead lines
- electricity reticulation (overhead or underground) to the accommodation camp
- clearing an additional 14 ha of native vegetation
- impacts to 11 ha of threatened species habitat
- expansion of the construction footprint into the buffer area along the Yarrangobilly River
- further widening and upgrading of roads and removal of an additional 91 trees
- 300% increase in peak hour heavy vehicle movements
- 12 additional borehole sites (900 square metres each)
- 70 additional workers

The need for these extensive modifications so soon after the initial proposals again demonstrates the injudiciousness of a piece-meal approach and lack of a whole-of-project plan.

Snowy Hydro consulted with 10 government agencies and Transgrid regarding the proposed modification, but did not consult with any community stakeholders, stating that "*The proposed modification is expected to have no impacts on the community beyond those anticipated for the*

Exploratory Works. The stakeholder engagement for Modification 1 has therefore focused on consultation with key agency stakeholders.”

Contrary to Snowy Hydro’s assertion, the proposed modifications will have extensive additional impacts on the Park and the community. As well as not consulting with all stakeholders beforehand, a 14-day exhibition period was insufficient for a proposal of this scale and impact. The documentation alone was over 550 pages.

The failure to consult with key stakeholders compromises the integrity of the environmental impact assessment process. Snowy Hydro should be required to fully consult and then provide adequate time for all stakeholders to assess the modification application and make submissions. Or better still, wait and include these modifications in the forthcoming Main Works EIS.

Snowy Hydro’s response⁹⁵ to submissions has recently been published.

It is understood that a second modification to the Snowy 2.0 Exploratory Works is to be submitted to:

- increase accommodation from 150 to 250 beds
- change the tunnelling method for the exploratory tunnel from drill and blast to TBM

Another demonstration of the piece-meal approach and lack of a whole-of-project plan.

7.14. Absence of life-cycle assessment of environmental impact

Snowy 2.0 is a massive project involving substantial energy and materials in its construction, such as energy to bore a 10+ m diameter tunnel for 27 km and carbon emissions to produce the concrete segments to line the tunnel. Then, once constructed the Snowy 2.0 pumps will consume electricity for the first decade or so that will come predominantly from coal-fired generators.

For a project of this magnitude, especially one that purports to replace fossil-fuel generation with renewable generation, a lifecycle and greenhouse gas emissions assessment should be mandatory.

It would be multiple decades into the future before the fossil-fuels used to construct Snowy 2.0 and power its pumps in the initial years are exceeded by the renewable generation that is stored.

Also, this is a highly relevant issue when considering the respective environmental impacts of alternative pumped hydro schemes.

⁹⁵ “Snowy 2.0 - Exploratory Works MOD 1 - Substation and further geotechnical investigations” 2 September 2019 <https://www.planningportal.nsw.gov.au/major-projects/project/13601>

8. The Business Case should be revoked

8.1. Why was the Business Case commercially sensitive?

Snowy Hydro hasn't released its (partial) Business Case, claiming it contains commercially sensitive information. Nor has any financial information been provided.

It was incumbent on Snowy Hydro to release the Business Case and sufficient financial information in the interests of transparency and accountability, and to address the widespread scepticism of the project:

- Snowy Hydro is a Government Corporation and hence “owned” by all Australians, who bear the risks of the Corporation
- Ultimately, Snowy 2.0 will be paid for by electricity consumers and taxpayers, who need to be satisfied that the project is economically viable and environmentally acceptable
- No rival can gain access to Snowy Hydro's facilities or build a pumped hydro station within Kosciuszko National Park
- Any market information or projections made in 2018 are most unlikely to be of any commercial relevance for competitors when Snowy 2.0 commences operation in 2024/5

Like most stakeholders, the Federal Opposition is supportive of pumped hydro projects, but also wishes to see the Business Case⁹⁶:

“The shadow climate change minister, Mark Butler, said the government should release the full business case so the opposition and other stakeholders could ensure the project stacked up.

He noted the government had already spent \$6bn on the project, buying stakes previously controlled by NSW and Victoria, and now the Commonwealth was kicking in another \$1.38bn.

“We have said, since Malcolm Turnbull made this announcement, that we support these pumped hydro projects in principle, subject only to being able to see the full business case, which still hasn't been released publicly,” Butler told the ABC. “I mean, today's announcement takes the spend by this government on Snowy to about \$7.5bn, but they still won't show people the full business case.”

“We do want to be able to kick the tyres on this thing”.

8.2. The flawed Business Case should be revoked and the EIS refused

It has become clear that the Government's approval of Snowy 2.0 was based on a flawed and totally deficient Business Case.

The Commonwealth Shareholding Ministers should revoke approval of the Business Case on the grounds of inadequate estimation of the costs and projected returns to the Australian public.

The NSW Minister for Planning should refuse approval of the Main Works EIS on the grounds of inconsistency between the enormous scale of the project and the National Park status of the proposed development site.

⁹⁶ “Snowy Hydro 2.0 poles and wires to be managed by states, Scott Morrison says”. 26 February 2019. The Guardian. https://www.theguardian.com/australia-news/2019/feb/26/snowy-hydro-20-poles-and-wires-to-be-managed-by-states-scott-morrison-says?CMP=Share_iOSApp_Other

CONCLUDING COMMENTS

Snowy 2.0 has been approved by the Snowy Hydro Board and the Commonwealth Government, the major works contract has been awarded and construction has commenced well before all critical issues and costs were identified and addressed, including results from the Exploratory Works. It has been approved before the EISs for the Main Works and transmission lines were exhibited and assessed.

Snowy 2.0 is being subsidised by taxpayers and Kosciuszko National Park. No other competitor in the National Electricity Market receives such subsidies. The Business Case for Snowy 2.0 should have stacked up without any subsidy.

The capital cost for Snowy 2.0, which must include transmission as it is an essential component of the project, is now estimated to be of the order of \$10 billion. This is five times the original estimate and could be higher. At this cost Snowy 2.0 is totally uneconomic – a \$0.5 billion per annum interest bill could never be paid.

Snowy 2.0 will inevitably post substantial losses and ultimately have to be bailed out by the Commonwealth Government, a result that would adversely impact Australian taxpayers, the ultimate owners and risk-bearers.

Snowy 2.0 will cause substantial, permanent environmental damage to extensive areas of Kosciuszko National Park. An infrastructure project of this magnitude is totally inappropriate and incompatible with a National Park.

Viable alternatives have not been assessed, as is required under the EP&A Regulation. A review of alternatives is likely to produce proposals that have far less environmental impacts, are cheaper and more flexible, offer lower risk and have a positive financial return.

The (partial) 'Business Case' should have been released so that those paying for Snowy 2.0 – taxpayers and electricity consumers – could assess its merit.

More importantly, it is now clear that the Business Case was deficient and flawed, especially due to its considerably understated cost estimate.

On the basis of the information on the project now at hand, particularly the recently released Main Works EIS, it is time to stop this project before any more money is wasted and environmental damage is done.

Snowy 2.0 doesn't stack up economically or environmentally and its claimed benefits are overstated – there are better alternatives.

Snowy 2.0 is the wrong project in the wrong place.

APPENDIX A – Characteristics of the World’s Largest Pumped Hydro Storage Schemes

| Rank | Pumped Storage Power Station | Location | Generation Capacity (MW) | Storage Capacity (GWh) | Completion | Distance between Upper & Lower Reservoirs (km) | Efficiency (%) | Storage Capacity (hours) | Head (m) |
|------|-------------------------------------|--|--------------------------|------------------------|-------------|--|--------------------------|--------------------------|----------|
| 1 | Bath County USA | 38°12'32"N 79°48'00"W | 3,030 | 24 | 1985 | 2 | 79% | 11 | 380 |
| 2 | Huizhou China | 23°16'07"N 114°18'50"E | 2,448 | | 2011 | 4 | | | 420 |
| 3 | Guangdong China | 23°45'52"N 113°57'12"E | 2,400 | | 1994, 2000 | 2.5 | | | 535 |
| 4 | Okutataragi Japan | 35°14'12"N 134°51'23"E | 1,932 | | 1974 | 2.5 | | | |
| 5[4] | Ludington USA | 43°53'37"N 86°26'43"W | 1,872/[2172] | 20 | 1973/[2019] | 0.3 | 70%/[75%] | | 111 |
| 6 | Tianhuangping China | 30°28'13"N 119°36'21"E | 1,836 | | 2004 | 0.5 | | | 882 |
| 7 | Tumut-3 Australia | 35°36'42"S 148°17'29"E | 1,800 | | 1973 | 0.6 | | 6/33 | 155 |
| [5] | Snowy 2.0 Australia | | 2,000 | [350] | [2027] | 27 | 67%@2000MW 75%@1000MW | [175] | 680 |

Data sourced from Wikipedia https://en.wikipedia.org/wiki/Pumped-storage_hydroelectricity.

Opening the “Location” column hyperlink gives a Google Earth view of the site, from which the distance between the upper and lower reservoirs has been estimated. The estimated distances will not be entirely accurate but are considered to be sufficiently so to highlight the relatively long distance between the Snowy 2.0 reservoirs.

This Paper questions the claimed Snowy 2.0 Storage Capacity (350 GWh and 175 hours) - see Section 5.4.

APPENDIX B –Selected quotes from the Paper

B.1. External Experts

| Quote | By | When |
|--|--|--------------------|
| <p><i>“So, in round numbers, a conservative estimate of the total capital outlay attributable to Snowy Hydro 2.0 will be at least \$8bn.</i></p> <p><i>It is inconceivable that Snowy 2.0 will produce revenues that are vaguely close to that needed to compensate its capital outlays.</i></p> <p><i>It is almost certainly the case that the market value of Snowy 2.0 will be a small fraction of its likely construction cost.”</i></p> | <p>Assoc Professor Bruce Mountain, Director Victoria Energy Policy Centre, Victoria University</p> | <p>4 Jan 2018</p> |
| <p><i>“The new \$1.4 billion cash injection into Snowy Hydro from federal taxpayers’ funds bodes ill. It suggests that Snowy Hydro is struggling to make the numbers for Snowy 2.0 add up.</i></p> <p><i>In a competitive market, Snowy Hydro returns would be expected to be a fraction of the estimated market benefits. Snowy Hydro would not recover the cost of the Snowy 2.0 investment, even where it is prepared to wait 50 years to do so.</i></p> <p><i>If there is a market need for Snowy 2.0, it is likely to be from the mid-2030s when significant coal fired plant are expected to close.</i></p> <p><i>Its owners, the Commonwealth Government, have recently been extolling the virtue of intervening in the market to pressure participants to lower prices for consumers.</i></p> <p><i>Allowing a government-owned entity to establish such a dominance in the peak end of the market in both Victoria and New South Wales does not appear consistent with these recent statements and actions.</i></p> <p><i>There is no doubt storage is needed in a high renewables grid, but neither the government nor Snowy Hydro have made the case that theirs is the best option, over competing pumped hydro and battery storage projects.”</i></p> | <p>Paul Hyslop, Chief Executive Officer, ACIL Allen Consulting</p> | <p>14 Nov 2018</p> |
| <p><i>“The final cost [of the \$5.1 billion contract] is more likely to be more than \$6 billion. These contracts generally include a 10 per cent contingency clause, which unsurprisingly get used and there'll be other costs for things like preliminary works.”</i></p> | <p>David Leitch, Energy Analyst and Principal, ITK</p> | <p>2 Apr 2019</p> |
| <p><i>“The government had not adequately assessed alternative options before announcing Snowy 2.0.”</i></p> | <p>Tony Wood, Energy Program Director, Grattan Institute</p> | <p>13 Nov 2018</p> |
| <p><i>“There was little, if any, open consultation about the options available.</i></p> <ul style="list-style-type: none"> <i>• Too Much Time: Snowy 2.0 will take close to a decade</i> | <p>Mary Hendriks, Industry Executive,</p> | <p>16 May 2019</p> |

| | | |
|---|--|-------------|
| <p>to complete.</p> <ul style="list-style-type: none"> • <i>Too Much Control: Snowy 2.0 goes against the concept of decentralised systems.</i> • <i>Too Much Cost: Snowy 2.0 is an expensive option, with no return for many years.</i> <p><i>Snowy 2.0 has the potential to be an innovation killer, stifling systems that could be developed by private enterprise. Let's rethink and review this project before it turns out to be Snowy Too Much."</i></p> | Australian Energy Storage Alliance (personal observations) | |
| <p><i>"The feasibility report's claim that Snowy 2.0 can enable new wind and solar "in a manner not otherwise economically achievable" is simply not true. Snowy is likely to increase the carbon intensity of the energy market, at least in the short to medium term as Snowy 2.0 will most likely be powered by coal not renewable energy. There may be a case for Snowy 2.0 when we reach say greater than 50 per cent renewables share of generation, and we have used other cheaper flexible resources first. But this is not so now and is unlikely to occur before 2030."</i></p> | Chris Dunstan, Institute of Sustainable Futures | 21 Dec 2017 |
| <p><i>"As a matter of principle, no significant infrastructure, such as Snowy 2.0, should be permitted within a National Park. Less than 10% of NSW is protected from man-made encroachment and development for future generations."</i></p> | National Parks Association of NSW | 20 Aug 2018 |
| <p><i>"The adverse long-term impacts of Snowy 2.0 outweigh the benefits of the scheme as it is being proposed. The environmental impacts that can already be identified from the Snowy 2.0 proposal are so numerous and extensive, and irreversible, that this project cannot be regarded as a "clean energy" contribution simply because it is hydro-based, and not based on fossil fuel."</i></p> | Nature Conservation Council of NSW | 20 Oct 2018 |

B.2. Government/Snowy Hydro

| Quote | By | When |
|---|-------------------------|----------------|
| <i>"I gave a speech in February [2017] at the Press Club and got in touch with Snowy Hydro to talk about pumped storage opportunities. The Chief Executive, Paul Broad's response was 'have I got a scheme for you'."</i> | Prime Minister Turnbull | 27 August 2017 |
| <i>"The Turnbull Government will start work on an electricity game-changer: the plan for the Snowy Mountains Scheme 2.0."</i> | Prime Minister Turnbull | 15 March 2017 |
| <i>"I am a nation-building Prime Minister and this is a nation-building project. This is the next step in a great story of engineering in the Snowy Mountains and the courageous</i> | Prime Minister Turnbull | 19 Mar 2017 |

| | | |
|--|--|----------------------|
| <i>men and women who are confident and committed to Australia's future."</i> | | |
| <i>"The costs have increased from the initial \$2 billion price tag, to somewhere between \$3.8 and \$4.5 billion. We expect [the cost] is at the lower end of the spectrum. It's expensive, but it stacks up economically. The cost estimates were conservative."</i> | Paul Broad Managing Director, Snowy Hydro Limited | 21 Dec 2017 |
| <i>"The higher cost [of the \$5.1B contract] reflected the difference between 2017 "real" dollars [\$3.8 - \$4.5B] and 2019 "nominal" dollars. The project is now in "a much better risk position" financially."</i> | Snowy Hydro | 9 Apr 2019 |
| <i>"It won't be a cost to taxpayers, we will be paying for this out of the balance sheet of Snowy Hydro."</i> | Paul Broad | 21 Dec 2017 |
| <i>"This is an economic project, this is a project that works. Some people say, 'Oh this is some sort of project that's going to be funded from the taxpayer', but it's not. It's funded off our balance sheet. We're doing it because we believe it works."</i> | Paul Broad | 9 June 2018 |
| <i>"Following Snowy Hydro Board's final investment decision on 12 December 2018, the Government has reviewed the project's business case and is satisfied that the project stacks up. The Government will commit up to \$1.38 billion in an equity investment for Snowy 2.0."</i> | Prime Minister, Minister for Energy, Minister for Finance & the Public Service | 26 February 2019 |
| <i>"[the \$1.38 billion funding would] make this project happen."</i> | Finance Minister Cormann | 27 Feb 2019 |
| <i>"The government decided the way it wanted to balance out the funding. It wanted to sustain dividends. It wanted to support the project with equity. These things are part of negotiations that go on. We never asked for it [\$1.38B Commonwealth funding]. We never asked for anything."</i> | Paul Broad | 27 Feb 2019 |
| <i>"[the four-year aim for construction was possible only if] everything went your way, with five to six years being a more likely time frame for completion."</i> | Paul Broad | 24 May 2017 |
| <i>"To suggest Snowy Hydro isn't paying for transmission is misleading."</i> | Paul Broad | 10 Jan 2018 |
| <i>"There's no crowding of the marketplace here, let me tell you. The federal government doesn't have any control over the market. If you're suggesting that will come through us and 2.0 that is just blatantly wrong," Broad says. "I can only rationalise that someone is trying to undermine my business. That's the only rational argument I can put."</i> | Paul Broad | 14 September 2019 |

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|--|-------------------------|-------------------|
| | | |
| <i>"We see a world where we can duplicate Snowy 2.0 and get another 2.0 right alongside it, and possibly a 4.0 where you can have 4000 megawatts. You could even get 6000 megawatts out of this."</i> | Paul Broad | 29 June 2018 |
| <i>"It's absolutely fair dinkum power, it doesn't get more fair dinkum than this."</i> | Prime Minister Morrison | 26 Feb 2019 |
| <i>"For those naysayers who keep saying perhaps Snowy 2.0 isn't going to happen: sorry, it's started and for something not happening there sure is a lot of action happening. The diggers are digging, the financing is being lined up and the tunnel boring machines have been ordered. It's all on track."</i> | Paul Broad | 14 September 2019 |
| <i>"We aren't doing this because we're zealots for renewables, we're doing it because it makes business sense – the economics are compelling ... you have to have that storage in place or you are dreaming and you will have lots of blackouts. Snowy is the answer to that. We are betting the whole company on it."</i> | Paul Broad | 29 May 2019 |

APPENDIX C “Snowy 2.0 – Is the reward worth the risk?”

Paul Hyslop, Chief Executive Officer ACIL Allen Consulting, 12 November 2018

“Quicquid id est, timeo Danaos et dona ferentis” (Virgil, The Aeneid)

Overview

Snowy Hydro Limited (Snowy Hydro) has proposed and is currently developing Snowy 2.0; a plan to add 2,000MW of pumped hydro to the existing Snowy Mountains Hydro-Electric Scheme. This involves constructing 27km of tunnels between the Lake Tantangara and Lake Talbingo storages and a power station inside a cavern deep inside a mountain between the two lakes.

There are large questions over the estimated costs of the proposed scheme when benchmarked against other equivalent projects. The largest cost item appears to be tunnelling for which there appears significant risk.

The CEO of Snowy Hydro has admitted that there will need to be a “massive amount of reinforcing of the tunnels” (Broad, 2017) because of the poor and weak structure of the rock that they will be tunnelling through.

Understandably, Snowy Hydro has not released its commercial business case. However, and somewhat unusually, it contracted a consultant to calculate the market benefits of the project which were estimated to be between \$4.2 and \$6.8 billion, depending on the scenario assumed.

The market benefits were estimated over a rather heroic 56-year study period (50 years of Snowy 2.0 operation).

However, the consultant’s analysis appears very narrow and does not cover the expected range of scenarios and states of the world that would be typical for a market benefits assessment. It might even be argued that the consultant has assessed favourable scenarios and ignored less favourable scenarios.

For example, there are several competing projects that do not appear to have been considered. And the costs of competing technologies appear unusually high, which when displaced by Snowy 2.0 in the analysis, produce more benefits than would otherwise be expected.

Market benefits is a regulatory concept used to assess the benefits of regulated investments in the NEM. It estimates the increase in consumer/producer surplus where the market is competitive.

The estimated market benefits are not relevant to the likely returns to Snowy Hydro, except that in a competitive market environment, they represent the maximum that Snowy Hydro could extract in returns; but this assumes that there would be no free riders and that Snowy would not have to share any of the benefits with other market participants.

Practically, this would never be the case.

Therefore, in a competitive market, Snowy Hydro returns would be expected to be a fraction of the estimated market benefits. Even using the low-end cost estimates provided by Snowy Hydro and assuming a competitive market environment, it would appear that Snowy Hydro would not recover the cost of the Snowy 2.0 investment, even where it is prepared to wait 50 years to do so.

An even bigger threat to Snowy 2.0 returns comes from alternative modular technologies, especially

battery energy storage systems (BESS). Snowy 2.0 is a large capital and irreversible investment – once committed it cannot be unbuilt. Alternative technologies, especially BESS are modular and have little economies of scale.

They can be committed in small quantities at many locations and can be expanded to adapt to the market over time. Snowy Hydro investing in Snowy 2.0 has none of this luxury and rather must hope that it can pick the market for up to 50 years into the future.

Snowy Hydro appears to be moving with haste to commit to Snowy 2.0. Yet there is nothing in the outlook for the market that would justify this haste. If there is a market need for Snowy 2.0, it is likely to be from the mid-2030s when significant coal fired plant are expected to close.

In working through the costs and risks associated with the proposed Snowy 2.0 project, it has been difficult to understand how the rewards as we understand them justify moving quickly to FID. It appears to be a textbook case where a rational investor would wait and use the period of waiting to gather better information.

The proposal

Snowy Hydro has put forward a plan to develop a 2,000 MW pumped hydro storage scheme as an adjunct to the existing 4,100 MW hydroelectric scheme. Possibly to give it an entirely modern flavour, it has been branded Snowy 2.0. The proposed scheme would establish a network of headrace and tailrace tunnels of around 26 km in length.

The new power station is proposed to be located several hundred metres underground by constructing a 600-700 metre vertical shaft and a cavern at the bottom to house the power station. The conceptual design of the Snowy 2.0 scheme is shown in Figure 1.



Source: <https://www.snowyhydro.com.au/our-scheme/snowy20/about-snowy-2-0-2/>

Figure 1 Conceptual design for Snowy 2.0 Source: Source: Snowy Hydro

Electricity from Snowy 2.0 will be produced from water released from Lake Tantangara to the Snowy 2.0 headrace tunnel. The water will flow along the tunnel and then drop down through the vertical shaft and pass through the Snowy 2.0 hydro-electric turbines to produce electricity.

The water will then flow through the tailrace tunnel to Lake Talbingo, the headwater storage for the existing 1,800 MW Tumut 3 power station.

Lake Tantangara will be resupplied by pumping water from Lake Talbingo using pumps installed at the Snowy 2.0 power station. Utilising the Lake Tantangara and Lake Talbingo storages in this manner should have no net effect on the water yield and electricity generated from the existing Snowy scheme.

The preliminary cost estimate of the project (Snowy Hydro, 2017) is \$3.8 to \$4.5 billion (\$1,900 to \$2,250 per kW). However, this does not include \$1 to \$2 billion (TransGrid, 2017) for additional transmission capacity to transport electricity to New South Wales and Victoria at peak times (when Snowy 2.0 is most likely to be generating).

This would take the total cost of the project to \$4.8 to \$6.5 billion (\$2,400 to \$3,250 per kW). Snowy Hydro's decision to exclude transmission costs appears to be based on a view that transmission network service providers will upgrade the connections to New South Wales and Victoria at the electricity consumers' cost (Broad, 2017).

Allowing a broad estimate of say \$1 billion for the cost of constructing the power station cavern and power station [1] leaves \$2.8 to \$3.5 billion for the 27 km of headrace and tailrace tunnels – approximately \$110k to 135k per metre. This tunnelling cost appears in line with global experience [2] for large-scale unlined hydroelectric tunnels.

However, these costs are highly dependent on the nature of the geology which the tunnels traverse. Some types of rocks are well suited to hydroelectric tunnels with limited leakage. Other types are subject to high amounts of water leakage.

The CEO of Snowy Hydro, in an interview with Michael McLaren on 2GB in December 2017, stated that investigation of the tunnel route “found the rock in pretty poor shape”, pretty weak”. He then went on to note “so we've got to do a massive amount of reinforcing of the tunnels” and “you got to reinforce it, you got to put lining in these things” (Broad, 2017).

As stated by Broad, leaky tunnel structures would need to be lined or grouted with cement to overcome the leakage, which would significantly increase the cost of constructing the tunnels.

Assuming a 50 per cent increase in tunnel construction costs to reflect more lining and grouting, would add between \$1.4 and \$1.75 billion to the cost of the project with the total cost rising to between \$5.2 and \$6.25 billion.

Snowy Hydro redacted the detailed costs chapter from the public version of the feasibility study, so it is unclear how contingencies have been costed and handled in the overall analysis.

Estimating market benefits

Understandably the public version of the feasibility study released by Snowy Hydro excluded the chapter covering the business analysis and market modelling of Snowy 2.0. Instead Snowy Hydro released a report covering the purported market benefits of the proposed Snowy 2.0.

Market benefits is a concept used within the National Electricity Market (NEM) in relation to regulated network investments.

The market benefits test derives from benefit-cost analysis where the benefits and costs to society are tallied up to determine whether projects have a net benefit to society. In the case of the electricity market, society consists of electricity consumers and producers.

The market benefit is the sum of the net change in both producer and consumer surplus associated with a proposed investment compared with the counterfactual, which is usually 'not to build the

asset in question’.

Therefore, the market benefit includes the savings in producer costs and may include an increase or decrease in production/consumption where changes in prices lead to changes in consumer and producer incentives.

The market benefits test assumes that the market is competitive. In a real sense this represents the maximum benefit that a project could capture from all other participants in the electricity market, where the market is competitive.

In a competitive market, the proposed investment would expect to capture only a fraction of the market benefits. The remainder would go to electricity consumers and some producers.

Therefore, assuming the NEM is a competitive environment, the returns to Snowy would be expected to be much less than the estimated increase in benefits to all electricity producers and consumers in the report provided by Snowy Hydro’s consultant.

Snowy Hydro’s consultants estimated market benefits (largely consisting of capital and operating cost savings) for two scenarios compared with the counterfactual of Snowy 2.0 not proceeding.

The range of these benefits were \$4.2 – \$4.9 billion for the so-called LRET and VRET scenario and \$6.1 – \$6.8 billion for the so-called LT commitment scenario (which appears to be the LRET and VRET scenario plus additional renewable generation investment to meet a target of 60% of NEM generation by 2040 – including embedded rooftop generation). These benefits were estimated over the period 2018 to 2074 (50 years of operating life).

Where the market is competitive, Snowy might be expected to capture 50 per cent of these benefits as returns against the investment (between \$2.1 and \$3.4 billion to 2074). This would mean Snowy Hydro would not be able to fully recover the cost of its investment by 2074, even when using the apparently optimistic costs estimated in the feasibility study.

While the consultant’s market benefits report extends to 150 pages, there is limited detail about the assumptions behind each of the scenarios considered. While several factors affect these market benefits, the critical assumptions in any analysis of Snowy 2.0 are the assumed costs of competing technologies which, in the case of Snowy 2.0, are:

- Other pumped hydro storage projects [3] as complete competitors in energy arbitrage and dispatch firming;
- BESS as complete competitors in both energy arbitrage and dispatch firming;
- Dispatchable capacity entry (which is open cycle and combined cycle gas-fired turbines in the consultant’s analysis).

The consultant’s report provides limited information about assumed competing technology costs and how those costs are assumed to change over time.

However, from the data that is provided and when compared with ACIL Allen’s understanding of generation capital costs and learning curves, capital and operating costs are overstated for gas turbines [4], BESS capital costs are overstated, and BESS learning curves are understated [5].

This has the effect of overstating benefits (savings in capital and operating costs) where gas turbine generation plant and BESS are displaced by Snowy 2.0.

This differential in capital and operating cost estimates results in a reduction in the present value of

estimated market benefits of Snowy 2.0 of around \$0.6 billion to 2040 and around \$1.2 billion to 2074 for the LRET/VRET scenario using the discount rate assumed by Snowy's consultant.

For the LT commitment scenario, the estimated market benefits are lower by around \$0.5 billion to 2040 and \$1.1 billion to 2074. Making these adjustments to the total estimated market benefits (to 2074) gives:

- \$3 billion to \$3.7 billion for the LRET/VRET scenario;
- \$5 billion to \$5.7 billion for the LT commitment scenario.

This compares with Snowy Hydro's cost estimates of \$3.8 to \$4.5 billion for the project and \$5.2 billion to \$6.25 billion where assumed tunnelling costs increase by 50%.

This is not to say that these revised market benefits and potentially higher costs are more accurate than those provided by Snowy Hydro and its consultant, but rather to highlight that the market benefits and costs have a great deal of uncertainty.

In highlighting this uncertainty, it is noted that the Australian Energy Regulator's guide to assessing market benefits requires the proponent to consider all credible options and all states of the world for each credible option (AER, 2017, pp. 14-15).

Snowy Hydro's consultants provided two scenarios based on different emissions reduction policies. But it did not consider other credible options or comprehensively incorporate all states of the world.

For example, Hydro Tasmania's proposed Battery of the Nation project could be considered a credible alternative option, or it could represent one of the states of the world to be considered in each credible option considered. The timing of Snowy 2.0 may also form several credible alternatives.

The option proposed appears to be the earliest possible timing but not necessarily the optimal timing. Delaying for 5, 10, 15 years is likely to be more optimal where the market need for additional dispatchable capacity, such as Snowy 2.0, is later following the closure of more coal-fired plant.

Other pumped hydro projects might also represent credible alternative options or at least be represented in different states of the world.

The presence or absence of the proposed interconnector between New South Wales and South Australia should probably have been included as different states of the world through scenarios. [6]

And as costs of competing technologies are highly uncertain, especially over the rather heroic 56-year study period [7], variations in these costs should also have been considered.

Therefore, as an exercise in assessing the project's market benefits, the consultant's estimates appear to be inadequate, in that the exercise appears to be incomplete.

It might even be argued that the scenarios and states of the world that have been considered are highly favourable to the project whereas other credible options and states of the world that are less favourable have not been considered.

Real options

Of course, as a basis for investment, the market benefits study is irrelevant except that it provides a theoretical upper limit on the benefits that Snowy Hydro might capture in a fully competitive market

environment, where there are no free riders and Snowy Hydro does not have to share any of the benefits with other market participants.

However, electricity markets are at best workably competitive and at times exhibit oligopolistic characteristics, especially in the so-called peak end of the market. The peak end of the market are those periods where extreme demand conditions require most, if not all available supply, to meet demand; i.e., no involuntary load shedding.

At such times, a relatively small number of peaking plants mixed with small amounts of voluntary load shedding have pricing power to set the price at, or close to, the market price cap. The fewer the number of independent peaking plant providers, the greater their pricing power.

Storage (BESS, pumped hydro and potentially other technologies) will potentially play a key role in satisfying extreme peak demand as environmental constraints lead to coal-fired power station closures and more non-firm renewable generation. BESS are modular, have almost no economies of scale and can be deployed over short periods of time and in multiple locations throughout the market.

BESS can be deployed in small or large volumes with the unit price for capacity (per kW) and energy storage (per kWh) being largely constant.

This means that BESS can be deployed in small quantities initially and grown as the market grows and adapts. Equally importantly, growth plans can be deferred or abandoned where the market environment changes and the additional investment is no longer warranted.

And BESS can be easily redeployed to other regions where there is no ongoing need at the current deployment location. Unlike Snowy 2.0, BESS can be deployed close to load centres to maximise benefits to consumers and minimise power system losses and the need to expand networks.

These characteristics of BESS suggest that it is likely to be deployed by many parties in smaller quantities to firm up intermittent renewable capacity and to arbitrage energy prices intraday and within weeks. In this case, it would be expected that there would be a much greater degree of competition to supply capacity during peak periods of the day, which is especially important during days with extreme peak demands.

Greater competition will limit oligopolistic behaviour during such periods and it is therefore more likely that prices paid by consumers would be efficient.

The characteristics of Snowy 2.0 are opposite those of BESS. Snowy 2.0 is a large and irreversible capital investment with a long lead time. There are large economies of scale in developing it in large tranches (tunnels, caverns etc.).

Planning to develop the project as a 2 000 MW pumped hydro project reduces the average capital cost per MW of pumped hydro installed (economies of scale), but the marginal value of much of the planned capacity in the early years following its commissioning is expected to be small or even zero.

Some of the additional capacity to be supplied by Snowy 2.0 may be required to meet demand reliably from 2025, but it will take the market many years, possibly decades, to absorb all the planned capacity.

There are credible futures where it will never be fully absorbed; e.g., where alternative technologies are developed and make Snowy 2.0 obsolete. In very simple terms, Snowy 2.0 is not modular and is not able to be adapted and redeployed as the future unfolds and as market environment and

circumstances change (unless 2 000 MW is considered modular).

It requires a very large upfront commitment to an irreversible investment at a time when the future of energy markets including the policy outlook, technology, consumer preferences (use and investment in own embedded supply) and types of consumption are all highly uncertain.

In their landmark work, *Investment and Uncertainty*, Dixit and Pindyck (1994) developed what is now known as real-options theory. Dixit and Pindyck argued that when considering making large irreversible investments in an environment of uncertainty, that it is better to wait rather than jump in and make an investment decision and use the period of waiting to gain better (not necessarily complete) information about the future and hence reduce uncertainty.

Snowy Hydro's CEO has stated on several occasions that Snowy 2.0 FID would be taken in December 2018. If this is the case, the FID will be taken in an environment of great uncertainty with respect to several factors including:

- Commonwealth and state environmental and energy policy;
- Technology, especially the development path of BESS;
- Consumer preferences in relation to electricity demand and the use of embedded generation;
- Transmission upgrades that are required to support the additional flows from Snowy 2.0 to the main centres of demand in New South Wales and Victoria.

Faced with these uncertainties, it is surprising that the Board of Snowy Hydro would be willing to make such a large irreversible capital investment rather than wait for more and better information.

Market concentration

Snowy Hydro is a unique business in the NEM and dominates the peak end of the market in Victoria and New South Wales with around 4,100MW of hydro capacity with an average capacity factor of around 12.5 per cent (characteristically peaking plant).

In addition, it owns and controls around 1 300 MW of gas peaking capacity (620 MW installed in Victoria and 687 MW in New South Wales). It owns and controls around 5,400 MW of peaking capacity and has considerable pricing power during peak periods, especially extreme peak periods.

Therefore, it appears to have a strong interest in maintaining value in the peak end of the market – higher overall prices. A proliferation of small and independent BESS provides a real and credible threat to Snowy Hydro's peak end pricing power.

However, the reverse is also true, so with the benefit of first mover advantage, Snowy 2.0 might be considered a 'knock-out' blow to prospective BESS in order to protect Snowy Hydro's position and pricing power in the market. Snowy 2.0 would allow Snowy Hydro to increase its dominance of the peak end of the market in Victoria and New South Wales by controlling 7 400 MW of peaking capacity across the two NEM regions.

There is no apparent restriction on preventing Snowy Hydro from increasing its dominance of this part of the market through the development of Snowy 2.0.

However, its owners, the Commonwealth Government, have recently been extolling the virtue of intervening in the market to pressure participants to lower prices for consumers. Allowing a government-owned entity to establish such a dominance in the peak end of the market in both Victoria and New South Wales does not appear consistent with these recent statements and actions.

A solution to the problem of concentration might be to establish Snowy 2.0 as a separate pumped hydro business operated independently from Snowy Hydro with its own board and management team.

As Snowy 2.0 is expected to use no net water from the remainder of the Snowy Scheme, there would appear to be no loss of operational efficiency in operating them separately. Coordinating and managing water use from the shared storages of Lake Tantangara and Lake Talbingo is very straightforward regardless.

An example of how an independent pumped hydro business could be operated viably is given by the UK pumped hydro business based on the Dnorwig and Ffestiniog pumped hydro power stations (around 2 100 MW of capacity).

They operate as an independent business under the ownership of the First Hydro Company, a subsidiary of Engie Energy International. It provides an excellent example of how a separated Snowy 2.0 could operate viably where the overall investment is warranted; i.e. would be expected to provide a return on investment without relying on increased pricing power.

A good test of Snowy Hydro's intentions with respect to Snowy 2.0 and the increased pricing power it will achieve would be to inform Snowy Hydro that, once Snowy 2.0 is commissioned, it would be moved to a fully independent company/market participant, controlled and operated by a board and management team that is fully separate and independent from Snowy Hydro.

It would be interesting to see under such circumstances whether Snowy Hydro would continue to develop Snowy 2.0 with such haste.

Endnotes

[1] Power station includes turbines, generators, control systems, electrical connections, access tunnels and surge tanks. Transmission upgrades to New South Wales and Victoria to facilitate the flows from the additional capacity to be provided by Snowy 2.0 have not been included by Snowy Hydro in the cost estimates.

[2] For example, the Niagara project tunnel of around 10 km with a diameter of 12.7 metres and a capacity of 500 m³/s, cost around \$150k per metre. The Snowy headrace and tailrace tunnels are expected to be around 9 metres in diameter with a maximum flow of around 420 m³/s.

[3] A recent ANU report identified 22,000 pumped hydro storage sites with 67 TWh of storage in Australia including around 17,000 sites with 43.5 TWh of storage across the NEM (refer <http://www.anu.edu.au/news/all-news/anu-finds-22000-potential-pumped-hydro-sites-in-australia>)

[4] OCGT overstated capital by around 50%, CCGT overstated capital by around 33% – FOM around 100% higher for both OCGT and CCGT and VOM around 25% higher for both (compared with ACIL Allen's understanding of costs).

[5] Batteries 10% overstated capital costs in 2018 and learning curve falls around 33% in real terms to 2040 compared with around 65% fall for ACIL Allen's outlook for BESS.

[6] The proposed interconnector could substantially affect Snowy Hydro's ability to export the additional capacity from Snowy 2.0 to New South Wales.

[7] The degree of uncertainty associated with looking forward 56 years can only be described as huge.

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