Attachment A
Alternatives to Snowy 2.0

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 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 stated[1]

> *"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 article[2] "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:

> "*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 mooted[3] Snowy 3.0 and 4.0:

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[1] "Massive expansion for Snowy Hydro". Engineers Australia 15 March 2017 https://www.engineersaustralia.org.au/News/massive-expansion-snowy-hydro

[2] "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

[3] 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 5, it is incumbent on Snowy Hydro to disclose and analyse alternatives in order to comply with the Environmental Planning and Assessment Regulation 2000.

2. 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 4).

3. 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: • 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: • ~ 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: • 2000 MW generation • 2000 MW pumping • 350 GWh (overstated)	Significant energy: • 50+ MW generation at Jounama (T3B &/or Blowering generators?) • 250+ MW pumping • 500% increase in Tumut 3 cyclic energy capacity
Economics	Substantially uneconomic: • ~$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: • 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 1. 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. 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 1, 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.

4. 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?

5. 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 2000[4] 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, covered in just a couple of pages of the EIS plus a diagram:

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[4] "Environmental Planning and Assessment Regulation 2000"
https://www.legislation.nsw.gov.au/#/view/regulation/2000/557

"A comprehensive assessment of options for the augmentation of the Snowy Scheme was prepared for the Snowy Mountains Scheme Augmentation Ranking Study (SMA 1991). This involved detailed consideration of 10 conventional hydro power alternatives and four pumped storage alternatives.

This study included consideration of a pumped hydro connection between Talbingo and Tantangara reservoirs similar to the Snowy 2.0 alignment, called the Yarrangobilly Pumped Storage Scheme. This option was found to be the lowest cost alternative for large scale pumped hydro energy storage of 18 gigawatt hours (GWh) for 10 day capability. This option was not considered economic at the time in 1991 largely due to the comparative cost of gas turbines.

The Yarrangobilly Pumped Storage Scheme was investigated further in early 2017 in the Snowy 2.0 Feasibility Study as it was identified that the economic viability of large scale pumped hydro energy storage had improved significantly, reflecting the change being seen in the energy market with more renewables entering the system and thermal coal progressively retiring. It is this scheme which has been developed into Snowy 2.0."

This hardly constitutes a comprehensive analysis:

- based on a study nearly 20 years old
- only 4 four pumped hydro schemes were considered
- the Yarrangobilly option selected was for a 990 MW pumped hydro station, half the size of Snowy 2.0

There are far more than four pumped hydro options within the Snowy Scheme (see Attachment E).

6. The Government should have reviewed alternatives, including outside Kosciuszko

In September 2017, the Australian National University (ANU) completed an audit[5] of potential pumped hydro-energy storage sites across Australia, funded by ARENA. The audit identified 22,000 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 Roadmap[6] 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

[5] "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

[6] "NSW Pumped Hydro Roadmap". December 2018 https://energy.nsw.gov.au/media/1546/download

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 awarded[7] 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.

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 stated[8]:

> *"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 Utopia[9] screened in 2014, is provided as light relief.

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[7] "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

[8] "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/

[9] "Utopia: Snowy Mountains Scheme" ABCTV 28 August 2014 https://www.youtube.com/watch?v=n1TMpXhwcQw&feature=youtu.be

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.