IES INSIDER

ISSUE 28 April 2017

Does Snowy Hydro 2.0 Stack Up?

Bill Nixey, Lead Consultant, IES Advisory Services

The Federal Government recently announced a proposed expansion of Snowy Hydro's electricity generating capacity by 2,000 MW at a cost of $2 billion. This edition of IES Insiders considers the economic viability of this proposal by making a comparison to the existing Snowy pumped hydro scheme, known as Tumut 3.

A feasibility study of the proposed scheme will be carried out later this year by Snowy Hydro and ARENA. The assumptions and method outlined in this article were prepared independently and without the assistance of these organisations.

1 What is Snowy Hydro 2.0?

The details of the proposed expansion remain scarce but the Federal Government's March 16th announcement describes a 27 kilometre pipeline linking existing water reservoirs. The new pipeline will connect the lower Talbingo Reservoir with either the upper Tantangara Reservoir, or Lake Eucumbene[1]. These two upper reservoirs are located about 600 metres above Talbingo. The proposal involves 2,000 MW of new hydroelectric generating capacity operating as pumped storage. This involves pumping water uphill during off-peak periods and running generators in peak times. It will be seven years before the new power station is commissioned and the Federal Government hasn't confirmed if it would fund all or part of the estimated $2 billion cost for the scheme.

[1] ABC News 16th March 2017

2 Assessing the Project

There are a number of considerations that will impact the feasibility of the Snowy expansion project:

1. The efficiency of the generators and pumps. How much energy is lost when pumping and generating electricity from water?
2. The electricity generation and water pumping operating regime. At what times will it run?
3. Wholesale electricity prices. What is the difference between the price received for generating and the price paid for water pumping?
4. How much new water is available for running the generators to reduce the cost of water pumping?

To determine reasonable estimates of these factors, a good starting point is to consider the existing Snowy pumped hydro operation at Tumut 3 (T3). It was built in 1973 and has 1,800 MW of generation capacity and 600 MW of pumping capacity. T3 underwent a major upgrade in 2012 when its generating capacity was expanded from 1,500 MW to 1,800 MW.

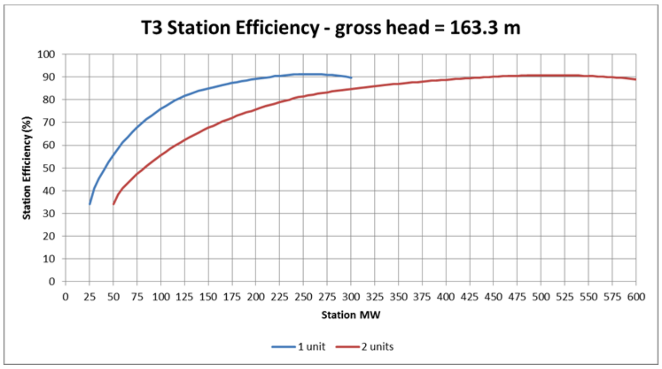
3 Pumped Hydro Efficiency

Pumped hydro projects move water uphill before releasing it and relying on gravity to drive a generator. There are efficiency losses both in pumping water uphill and in converting downhill flowing water into electricity. Using a known equipment capacity, water flowrate[2], and pressure drop it is possible to calculate these efficiency values. When running at full capacity T3 pumps have a 75% efficiency and

[2] The pumps have a maximum flowrate of 297 m^3/sec and generators 1133 m^3/sec (with a head of 155.1 meters).

the generators achieve 91%. This means that for every litre of water used to generate electricity, 1.1 litres must be pumped uphill (assuming no free water is available from the upper reservoir). It also means that for every MWh of electricity generated, almost 1.5 MWh of electricity is needed to operate the pumps. If the water flowing through the T3 generators is less than full capacity then the efficiency achieved will be less than the maximum of 91%. The following figure shows these effects for two of the T3 generating units. Multiple generators in the same facility should allow operational efficiencies to be optimised.

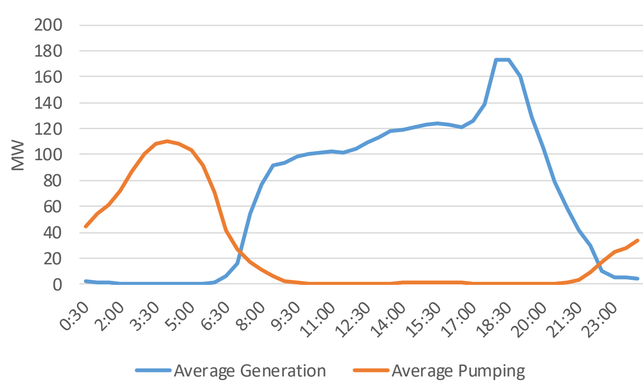
Figure 1 Tumut 3 Generating Efficiency for Two 300 MW Units[3]



4 Operating Profile

Pumped storage power stations pump water uphill when electricity prices are cheaper and run generators when prices are more expensive. Obviously the operating regime should maximise the difference between cheaper off peak prices and peak time prices. The following chart shows the average operating profile for T3 over the last 15 years.

Figure 2 Average half-hourly generation and pumping (T3)

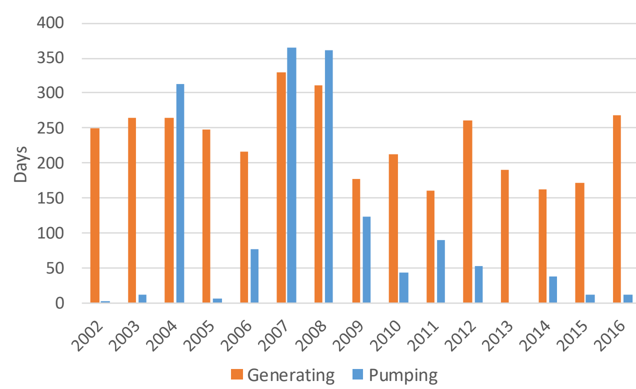


The pumping typically occurs in the early hours of the morning and stops during the middle of the day. The generating profile is similar to the day time system demand in NSW. Generation starts at about 7am in the morning and increases steadily throughout the day. It peaks at around 6:30pm and falls to zero by late evening.

These profiles will vary on different days of the week and throughout the year. More generation occurs in summer and winter to reflect the higher demand and wholesale prices. More pumping occurs on weekends when wholesale prices (and demand) are lower. T3 typically pumps more water in summer than in winter.

The average megawatts (MW) shown above are considerably lower than the installed capacity of the equipment at T3. This is because the plant doesn't run every day. The following figure shows the number of days that T3 has run since 2002. The main observation is that in most years the T3 generators run more often than the pumps. It shows that large quantities of new water (ie. water that isn't pumped) is regularly used to run the generating turbines.

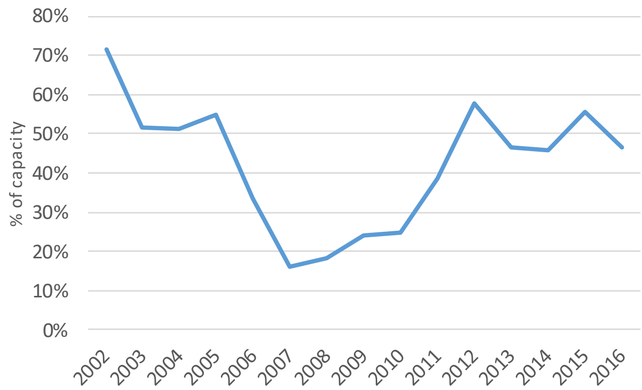
Figure 3 Number of Operating Days (T3)



The exception was in 2007 and 2008 when the pumps at Tumut 3 ran almost every day. This can be explained by the low levels of Lake Eucumbene, which is the source reservoir for the T3 hydro plant. When the water levels were low in 2007-8 following a period of drought, significantly more water was pumped at T3.

3 Snowy Hydro Letter to AEMC 13th October 2015

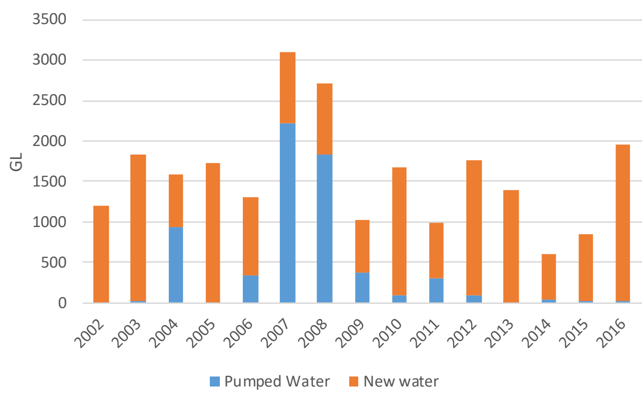
Figure 4 Lake Eucumbene Average Water Levels[4]



Since 2012 the T3 pumps have hardly run and in 2013 they didn't run at all. As the lake levels improved from 2010 onwards, T3 was able to run more new water through the turbines and avoid the electricity cost incurred with water pumping. The capacity upgrade in 2012 may also have influenced operating patterns.

Using the equipment efficiencies described earlier it is possible to calculate the amount of water run through the T3 scheme. It is also possible to estimate how much water was recovered by pumping and how much was from fresh catchment runoff. Figure 5 shows this for the last 15 calendar years. In the last five years most of the water was new runoff which isn't surprising given that the pumps were not running regularly.

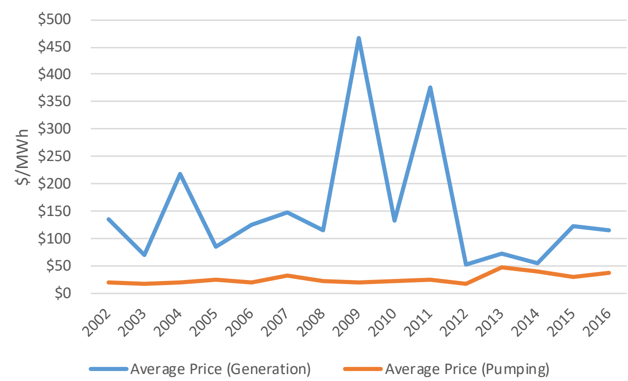
Figure 5 Estimated Water for Generation (T3)



5 Wholesale Prices

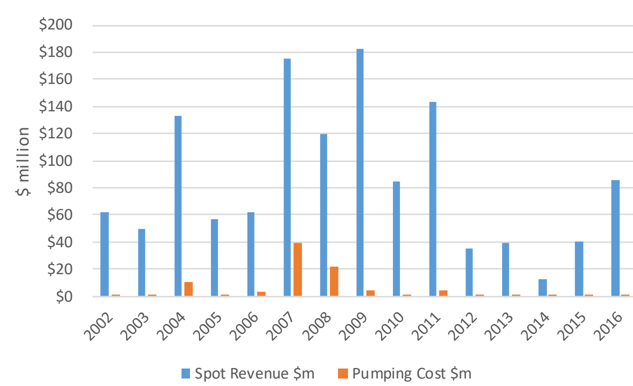
An analysis of the average wholesale prices T3 received for generating and paid for pumping is shown in the following figure. These are weighted averages based on the amount of generation and pumping occurring at each 30 minute trading interval over the last 15 years[5]. The average generating price received by T3 was $141 /MWh while for pumping the average price paid was $25 /MWh. This demonstrates the much higher prices obtained for generation as compared to the prices for electricity used to run the pumped system.

Figure 6 Weighted Average Spot Prices (T3)



The next chart shows the annual spot revenues and electricity purchase costs (for pumping) derived from the historical data. Total spot revenues significantly exceed the pumping costs in all years. As these are spot revenues they don't necessarily reflect any wholesale hedging contracts that may have been in place during the period shown.

Figure 7 Spot Revenue and Pumping Purchase Costs (T3)



4 Snowy Hydro website www.snowyhydro.com.au

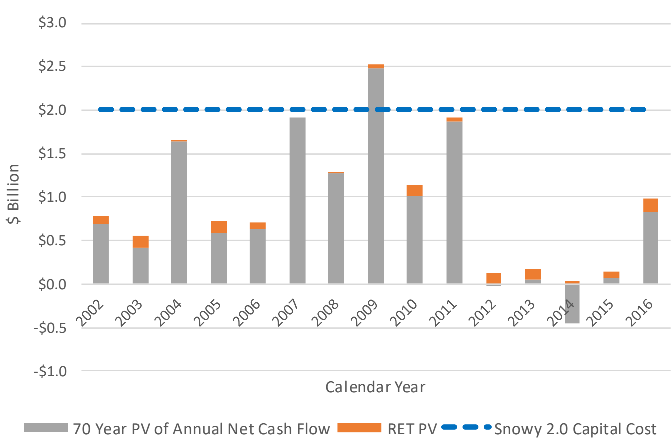
5 The Snowy wholesale pricing region was abolished at the end of June 2008. Since then the Snowy Hydro scheme has received the NSW regional price.

6 Can Snowy 2.0 breakeven?

This article has examined the operating history of the existing T3 pumped hydro operation. However Snowy 2.0 is proposed to have 2,000 MW of generating capacity, making it 11% larger than T3. To carry out a breakeven analysis for the proposed expansion, the T3 generation data was scaled up to reflect the 2,000 MW of new capacity for Snowy 2.0. For the pumping, 667 MW of capacity is assumed to be installed and this adheres to the same ratio of generation to pump capacity as installed at T3.

Separate ungeared[6] project cash flows were calculated for each year of the scaled up T3 historical data from 2002 to 2016. These cash flows included wholesale market revenues, pumping costs, and an allowance for overheads and company tax. The new scheme is assumed to have a 70 year project life and a cost of capital of 6%. Present values of the cash flows were calculated for each of the 15 historical years and the results appear below. Benefits from certificates generated under the Renewable Energy Target were added as shown.

Figure 8 Present Values of Annual Net Cash Flows



Only one year out of 15 manages to breakeven and could justify the proposed $2 billion proposed expansion. In 2009 (the best year) the average price for generation was a very high $463 /MWh and almost two thirds of the water used to produce electricity was new. The worst year was 2014 when the average dispatched price was only $55 /MWh. This was despite 93% of the water used in generation being new.

6 Excludes financing costs

7 Conclusion

This analysis has considered the cash flows a pumped hydro scheme could receive from a range of operating conditions including different wholesale prices and water availability. One of the problems with the proposed scheme is that it will not have access to new reservoirs. Lake Eucumbene and Tantangara already provide water to existing Snowy generators. This limits the ability of the proposed scheme to access new water which is an important part of the economics (as demonstrated by the T3 historical data). If the existing and proposed assets have to share supplies of new water then the overall utilisation of the Snowy generation capacity will fall.

But past wholesale prices and rainfall are not necessarily a definitive sign of what will occur in future. In 2017 wholesale prices reached levels never seen before in the history of the NEM. As gas fuelled electricity generation becomes increasingly expensive alternatives are needed to provide electricity supply when intermittent sources aren't available. A supply side response in the form of new generation capacity is required. Many investment decisions will depend on whether the Snowy expansion goes ahead. The result of the joint Snowy Hydro and ARENA feasibility study is eagerly awaited.

CONTACTS

Bill Nixey

+61 (0)2 8622 2224 +61 (0)2 9436 2555

bnixey@iesys.com www.iesys.com