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1 Summary

This chapter addresses and presents the results of an internal Snowy Hydro valuation of the Project and underlying key assumptions, primarily driven by the key findings within the Marsden Jacob Associates (***MJA***) Report and assessment of the future market state.

1.1 Introduction

Snowy Hydro has undertaken an internal valuation of the Project and underlying key assumptions. The valuation was primarily driven by the key findings within Modelling Snowy 2.0 in the NEM Report (MJA) (MJA Report) and assessment of the future market state. The value of the Project is expressed in two forms:

1. The incremental Enterprise Value that arises purely from the Project; and
2. The overall incremental Group Enterprise Value with respect to the next best option and resulting market environment should Snowy 2.0 not proceed.

The Project will add 2,000 megawatts (***MW***) of dispatchable capacity to Snowy's portfolio, on top of the existing 5,262 MW, increasing scheme-wide certain capacity by 2,000 MW. The additional energy produced and capacity available from the Project will enable greater internal hedging of Snowy Hydro energy needs for mass market load, Commercial and Industrial (***C&I***) customers and wholesale customers. It will also provide ancillary services and firming capacity for renewable projects sold direct to wholesale counterparties and indirectly through spot markets.

Snowy Hydro has chosen to base its core analysis and sensitivities on the economic base case modelling and underlying assumptions developed by MJA. The Snowy 2.0 base case is consistent with the parameters assumed by MJA and all sensitivity analyses reference this base case. The assumptions underpinning the base case analysis are described in more detail in *Supporting Chapter Six - Market modelling*.

The valuation approach utilises the Board-approved, industry standard Discounted Cash Flow (***DCF***) methodology and economic assumptions.

1.2 Value concepts

This Valuation considers the following core value concepts:

1. **Storage** - the ability to purchase energy at low prices, store as potential energy, and sell the energy when supply-demand is constrained;
2. **Traditional capacity** - the ability to sell and defend $300 cap products;
3. **Renewable firming** - the ability to match intermittent solar or wind (supply) with a load (demand);
4. **Retail diversification** - being able to improve the alignment of peak capacity with peak demand;
5. **System security** - increased capacity to participate in the five-minute Frequency Control Ancillary Services (***FCAS***) market; and
6. **Drought and real option value** - increased capacity to operate without requiring water from inflows.

And non-core value concepts:

1. **Scenario value** - these are addressed in more detail in *Supporting Chapter Eleven - Scenario analysis*;
2. **Qualitative value** - various improvements: capacity, transmission access, and water management during extreme inflow events;
3. **Snowy Hydro opportunity costs** - the negative value impact on Snowy 1.0 as a consequence of the Project; and
4. **Terminal value** - residual value beyond the life of the generation plant.

1.3 Valuation outcome - Base Case

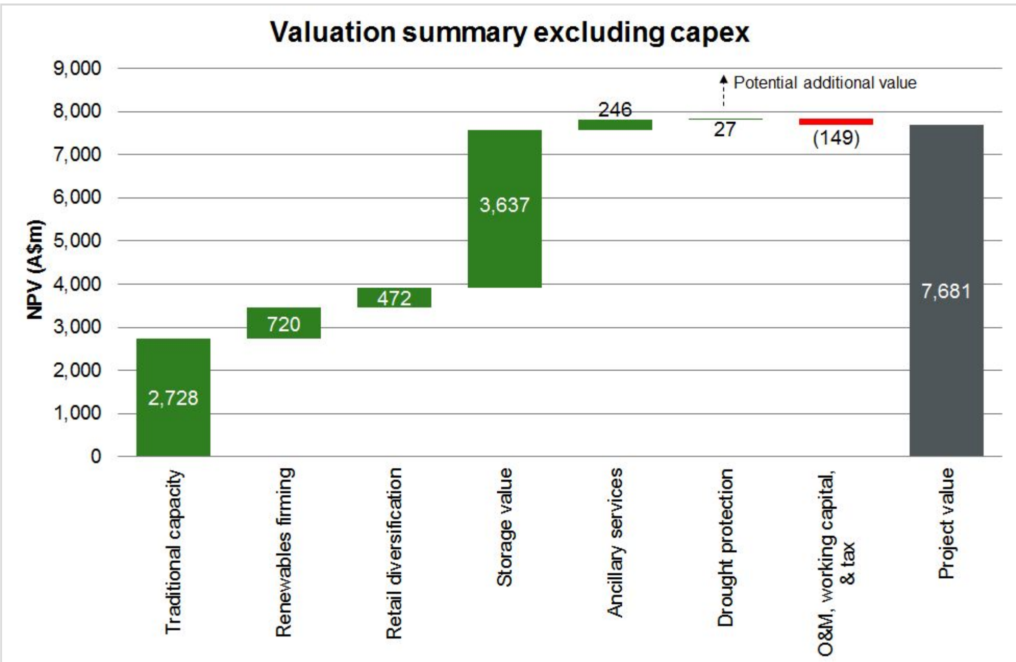

Figure 1: Valuation summary including capital cost

The Snowy Hydro base case internal valuation concludes the Project's sources of core value have a total present value of $7.7 billion excluding capital expenditure.

In order to determine the Net Present Value (***NPV***) of the Project, the capital program is discounted by the Weighted-Average Cost of Capital (***WACC***) with respect to the projected capital expense during the construction period and cash outflow timing. This results in an equity Internal Rate of Return (***IRR***) in excess of 8.0%.

The Project will provide traditional and firming capacity in the form of a suite of products. Valued at the New Entrant Price (***NEP***), the value contribution from Traditional Capacity and Renewables Firming is $2.7 billion and $720 million, respectively.

Retail diversification benefit occurs at a time after the Project reaches full operating capacity in 2029. The contribution from Retail Diversification value is $472 million.

Greater storage capability from the Project will allow Snowy Hydro to better manage and displace energy across time periods, thus leveraging intertemporal pricing. The contribution from Storage value is $3.6 billion.

The contribution to value from FCAS services from the Project was assessed to be $246 million.

The drought protection value has been conservatively assessed at $27 million, noting that there is no downside or, restated, the floor is zero.

2 Valuation - methodology, assumptions and outcome

2.1 Overview

Determining the structure and quantification of appropriate cash flows that underpin the value of the Project not only requires robust and materially accurate valuation parameters, but a framework that transparently and informatively provides key stakeholders with the information that facilitates auditable and sound decision support.

The valuation approach utilises the Board-approved, industry standard DCF methodology and economic assumptions.

2.2 Value concepts

This valuation considers the following core value concepts:

1. Storage;
2. Traditional capacity;
3. Renewable firming;
4. Retail diversification;
5. System security; and
6. Drought and real option value.

And non-core value concepts:

1. Sensitivity value;

2. Qualitative value;
3. Snowy Hydro opportunity costs; and
4. Terminal value.

2.2.1 Storage - core value concept

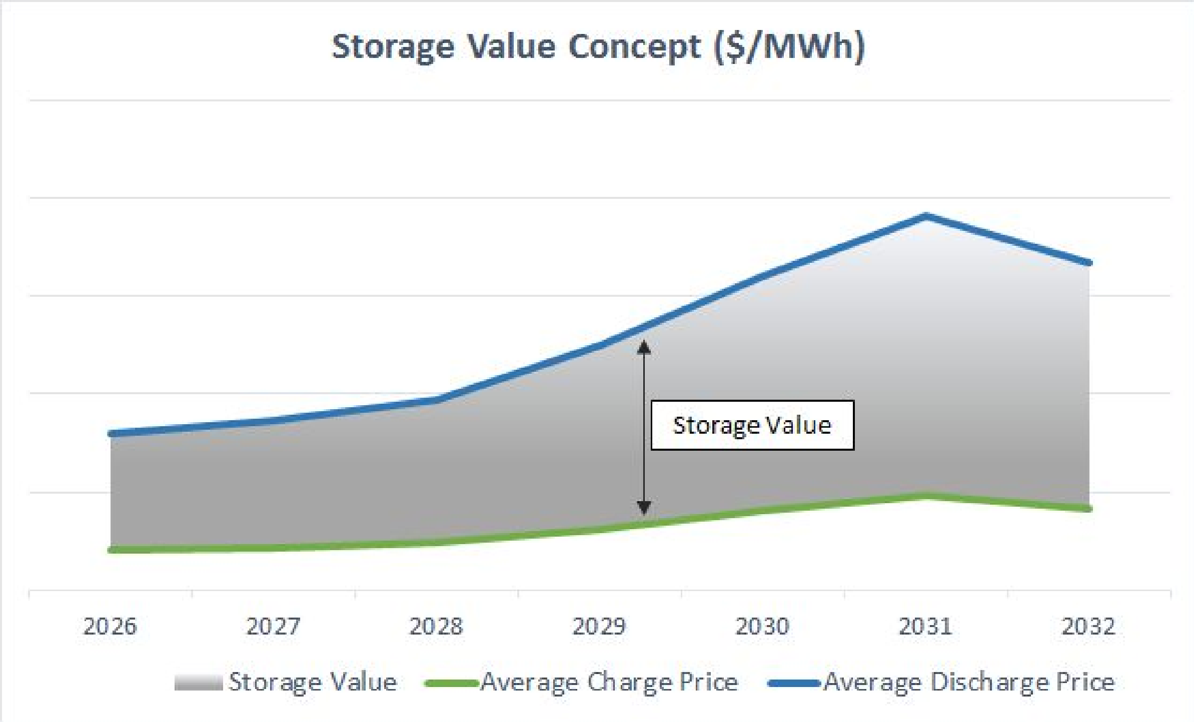

Figure 2: Storage value concept

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.

The storage value is derived from the projected volume of energy output multiplied by the weighted discharge/charge differential inclusive of round-trip efficiency (***RTE***) losses.

2.2.2 Traditional Capacity - core value concept

The basis for Project capacity value is equivalent to that of Snowy 1.0 capacity value. Value is derived from the ability to sell and defend $300 cap products where the value is a function of supply/demand capacity balance, expected price volatility and new entrant pricing, as well as the capability to defend with fast-start physical generation assets, such as the Project.

The Project's capacity value is assessed from the projected volume of traditional capacity required by the market under the base case scenario multiplied by the Least-Cost of Energy (***LCOE***) or shadow price for the next least-cost plant that delivers a similar capability, such as Open-Cycle Gas Turbine (***OCGT***). The next new entrant is thought to be either OCGT risk-adjusted for the introduction of the five-minute settlement market or reciprocating gas engines that have a faster start capability than OCGT but are of higher cost. The core valuation includes the positive effect from the introduction of a five-minute settlement market, as calculated by MJA.

2.2.3 Renewable firming - core value concept

'Firming' matches intermittent solar or wind (supply) with a load (demand). The difference between demand (load) and the supply of energy from wind and solar is a supply deficit. Firming acts to cover this deficit. Hydro is an excellent source for firming wind and solar; equally so is OCGT but at a higher cost.

Figure 3 below provides a heat map of wind and solar output in NSW during the warm and cold seasons, respectively. The dark areas represent a concentration of observations of a particular wind and solar output combination. The red line illustrates a level of negative correlation between wind and solar output.

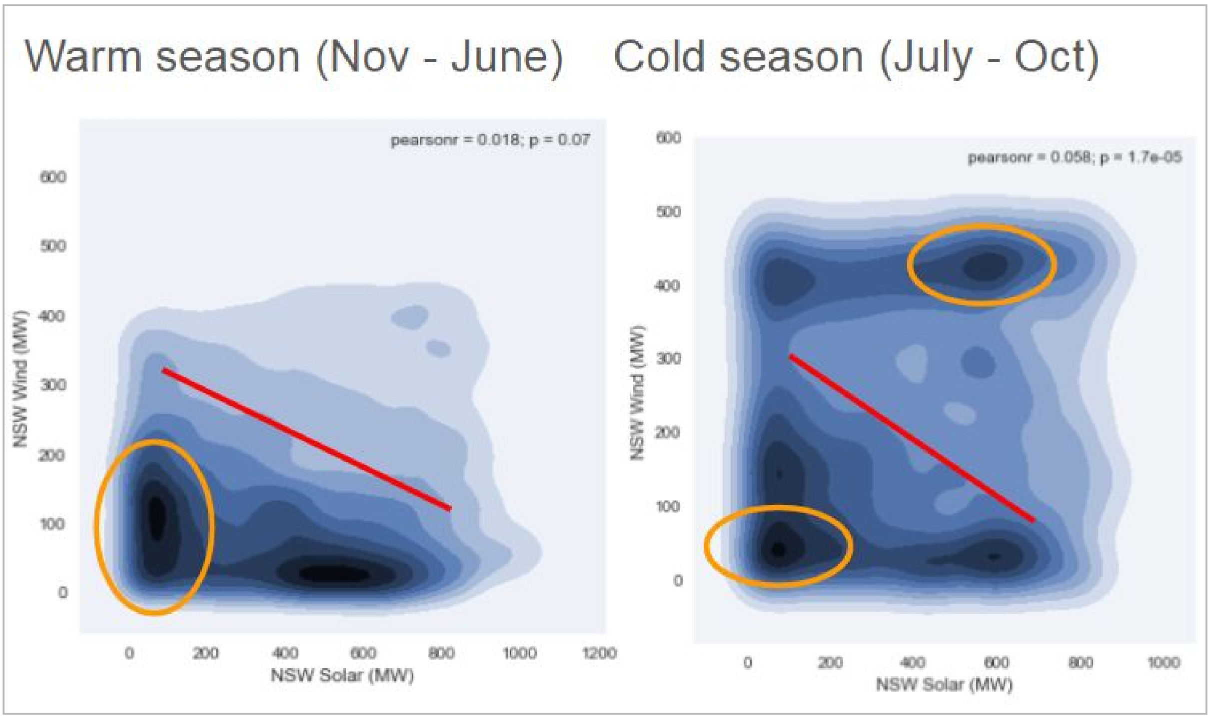

Figure 3: Wind and Solar Correlation Analysis

The negative correlation, or complementary coverage of wind and solar across the year, as shown in Figure 3 above, is key to maximising interseasonal output and reducing intermittency when combined into a portfolio. Similarly, the intraday profile of wind and solar is also complementary and has the same positive effect.

The characteristics described above arising from a carefully selected, geographically diverse portfolio of wind and solar will significantly reduce firming costs compared to firming an individual development or technology in isolation.

Firming for Snowy Hydro means buying a diversified portfolio of intermittent energy, using existing dispatchable assets to 'firm' that energy and selling that as bespoke, reliable energy products. Similarly, firming also means selling products that support the firming of many individual intermittent energy developments that enables these asset to resell the energy as firm energy. In both cases, a geographically well-diversified and balanced portfolio of wind and solar will enable Snowy Hydro to offer the most cost-competitive and efficient fully renewable firming and sustainable hybrid products. Without the provision of firming products, variable renewable energy (***VRE***) is of limited use in hedging wholesale energy purchases.

Firming product customers include:

1. C&I customers - both those that are seeking green credentials and those who are not;
2. Gentailers who have the ability to firm up renewables, but not as efficiently as Snowy Hydro. This allows them to concentrate on selling base load elsewhere;
3. Retailers without sufficient physical hedge; and
4. Merchant power developers seeking to firm up their energy to make it more attractive to their own customers (this could be regulatorily driven).

In Figure 4 below:

1. **Traditional Capacity Requirement (A1)** - Snowy 2.0 receives an option fee from selling traditional capacity products; and
2. **Renewable Firming Requirement (A2)** - Snowy 2.0 receives additional capacity value by firming intermittent energy to retail load or flat swap.

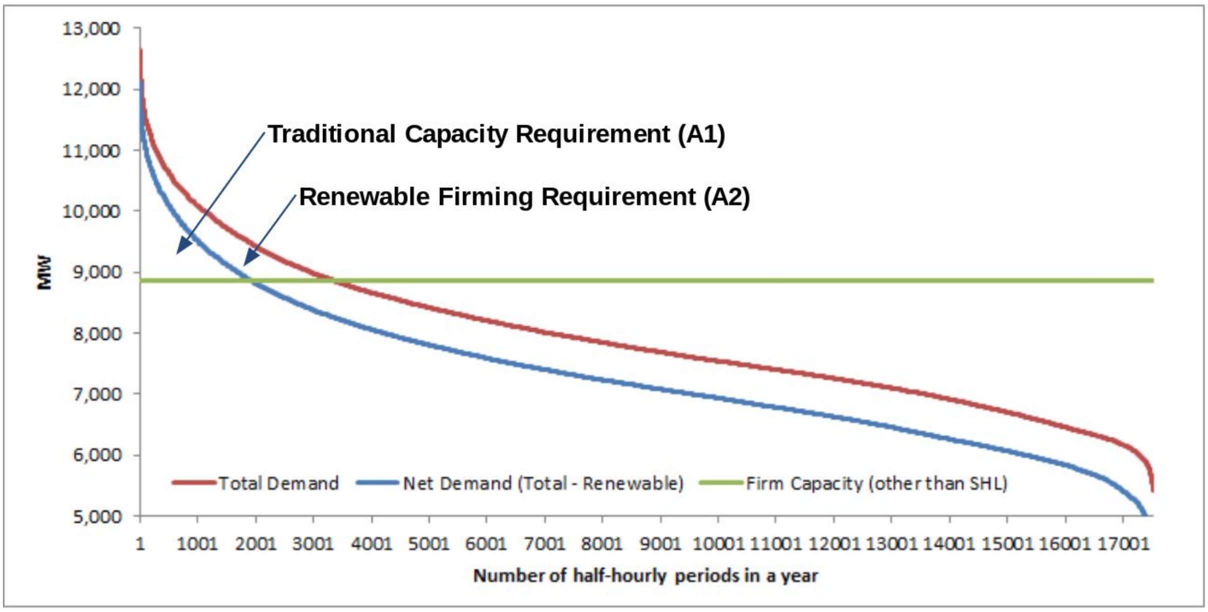

Figure 4: Firming Capacity Concept

2.2.4 Retail diversification - core value concept

Due to different consumption characteristics and varying demand sensitivities associated with temperature, residential and C&I customers experience non-coincident maximum demand or peak capacity requirements. Optimising the degree of non-coincident peak demand reduces the hedge requirement by a factor that can be materially below the sum of the individual customer's maximum capacity requirement. This strategic portfolio diversification effect enables more capacity to be sold than is otherwise would be available under acceptable risk limits.

2.2.5 System security - core value concept

In assessing the value of system security, the Project valuation must consider the current and future capability of the existing Snowy Hydro fleet with respect to Ancillary Services. The Supervisory control and data acquisition (***SCADA***) system restricts Snowy Hydro participation to the five-minute FCAS market with respect to frequency control services. However, the current SCADA upgrade will enable Snowy 1.0 to participate across all eight FCAS markets, as will the Project. For this reason, the extent of FCAS value attributed to the Project is subject to full utilisation of Snowy 1.0 for these services.

Ancillary Service Provision:

1. **FCAS** - The regulation frequency control services are provided by generators and controlled by the Australian Energy Market Operator (***AEMO***). AEMO continually monitors the system frequency and sends control signals out to generators providing regulation so that the frequency is maintained within the normal operating band of 49.85 Hz to 50.15 Hz. Forecast trends in the supply of this service suggest longer-term intense competition. The value ascribed to the provision of this service by the Project is assessed as being incremental to this service being fulfilled by Snowy 1.0 and in consideration of market competition and demand in excess of Snowy 1.0 capability and opportunity cost.
2. **System Restart Ancillary Service or Black Start** - Allows parts of the power system to be re-energised by Black Start-equipped generation capacity following a full (or partial) black-out. There is currently no market for Black Start as this is procured by AEMO. For the Project no incremental value can be ascribed as this can be sufficiently covered by Snowy 1.0 as the market demands and opportunity cost is exceeded.

2.2.6 Drought and real option value - value concept

The Project would also provide additional 'strategic' benefits that relate to drought protection and real option value associated with expansion of the Project in the future.

Drought protection arises from the Project's capacity to operate without requiring water from inflows. Today, the Company is more diversified in terms of fuel resource risk with a larger proportion of gas generation compared to the time of the ten-year-dry inflow sequence that occurred up to 2010 and the one-in-a-thousand-year-low inflow of 2007. Despite this, the Project would provide value by a significant increase in the amount of capacity that can be provided by the Scheme when inflows are at extremes.

The future of the National Electricity Market (***NEM***) is unknown and many scenarios are possible, including significantly more renewables development brought about by more urgent action on climate change, coal-fired power station closures due to asset age or damage, and increases in demand. Contingency measures are required to ensure options are available to address such issues. The development of the Project would provide the infrastructure for additional and quick development of new capacity through additional pumped storage within the Snowy Hydro fleet. This can be viewed as the provision of a real option (a physical option) that addresses the NEM's demand for insurance against such contingent events.

Real option value and flexibility for the NEM to respond to unforeseen (and foreseen) changes will become increasingly more valuable in the future.

2.2.7 Non-core sensitivity value

In addition to the MJA Report, MJA has modelled various sensitivities under the direction of Management. The value contribution of each sensitivity is presented in 2018 terms later in the *Sensitivities* section. Importantly, the sensitivities are not necessarily mutually exclusive: there will exist some interdependency. Therefore, as a group they are not additive as some overlap of value may exist.

2.2.8 Non-core qualitative value

Other considerations outside of core value concepts are:

1. The improvement in tradeable capacity of Snowy 1.0 and associated capacity value;
2. The improvement in transmission access and connection point risk mitigation for Snowy 1.0; and
3. Improvement with Snowy 1.0 water management specifically during extreme inflow events where spill risks options enable better management and greater drought protection.

2.2.9 Snowy Hydro opportunity costs

The MJA economic modelling provides net revenue projections for Snowy 1.0 for both the 'with Snowy 2.0' and 'without Snowy 2.0' cases. The Snowy Hydro internal valuation approach explicitly derives this value by including the net revenue difference of Snowy 1.0 between these two cases in order to transparently illustrate the negative value impact on Snowy 1.0 as a consequence of the Project.

2.2.10 Terminal value

Terminal value is a present value that represents the value of all future cash flows beyond the modelling time horizon or asset life.

The limiting factor with the terminal value calculation is generally linked to the key asset with the shortest life, notably the generation plant. Importantly, the balance of plant, specifically the water delivery infrastructure, does contain residual value well beyond the life of the generation plant. While there is value beyond the life of the generation plant, for example by replacing or refurbishing generators, the approach to modelling utilises a 50-year time horizon that is more than sufficient to transparently demonstrate returns and illustrate break-even timing in both terms of nominal and present value of cash flows. For this reason, a terminal value has been excluded from the valuation.

2.3 Key Project and financial assumptions - Base Case

This section is restricted to presenting the key Project and financial assumptions that underpin the Base Case internal valuation. All other assumptions related to economic modelling of the Project are detailed in *Supporting Chapter Five* and key macro assumptions are detailed in *Supporting Chapter Seven Drivers of revenue.*

2.3.1 The Project operating assumptions

Table 1 lists the key features and operating assumptions for the base case scenario of the Project.

	Key features and operating assumptions
1	A period that is consistent with the base case operating life and construction period of the Project.
2	An additional 2,000 MW dispatchable nominal capacity within the NEM, that is consistent with nameplate capacity adjusted for RTE.
3	An operation profile that has been independently determined by MJA's base case economic modelling approach that optimises the balance between pumping and generation as a means to maximise economic value.
4	24 hours/day maximum generation.
5	Cost of goods sold: 1. Fuel - Pumping is considered unconstrained given the large volume of active storage versus the generation required. Therefore, across an average week pump scheduling has been assumed to be unconstrained. See *Supporting Chapter Five* 'Guide Curve'; 2. Long-run 80 hours of operational active storage for the Project is significantly less constrained than current lithium-ion solutions that might provide up to four hours of storage. This provides the Project with a competitive advantage for minimising pumping costs over at least a week compared to overnight.
6	A RTE range from 72% to 78% for pumped-hydro that is a function of electro-mechanical and hydraulic efficiency.
7	Capacity Value and Retail Diversification: 1. **Capacity Value** - Determined by the new entrant price, equivalent to the capital investment of that capacity inclusive of the opportunity cost of capital. The base case includes the effect of the proposed five-minute settlement and the associated risk. 2. **Retail Diversification** - This is linked to the capacity demand profile as determined by the MJA base case modelling. The valuation includes a retail diversification benefit volume in excess of full operating capacity of Snowy 2.0 that occurs from 2029 onward.
8	Storage value (buy low, store, sell high). This is inextricably linked to the operational profile as determined by the MJA New Entrant modelling economic approach. The key outputs being: 1. **Energy volume** - This is an output of the MJA modelling that projects the annual energy output across the life of the Project inclusive of seasonal variation and demand; 2. **Discharge/charge price** - An output of the MJA modelling, this is the dispatch-weighted price of energy sold and the cost of pumping; and 3. **Pumping volume** - An output of the MJA model that projects the pumping volumes required across the life of the Project, adjusted for round-trip efficiencies. See the *Storage value and pumping cost* section for outcomes.

9	Security value - FCAS and inertia services: 1. As previously mentioned, forecast trends in the supply of this service suggest limited longer-term incremental revenue upside for the Project than has traditionally been the case in the past, ie revenue in excess of Snowy 1.0 (Snowy Hydro NEM Transmission, 2017) and is thus reflected in the valuation outcome for the Project. Management have assessed an incremental annual benefit equivalent to approximately $16 million (December 2018, real). This is consistent with projected competition and independent advice from MJA that pricing of the five-minute service alone would be in the order of $2.00/MWh, noting that the Project as well as Snowy 1.0 will in the future be capable of participating across all eight FCAS markets.
10	Fixed Operations and Maintenance (***O&M***): 1. This has been assessed at annual cost of approximately $5 million (December 2018, real) using Tumut 3 as a reference. Although the Project is larger and more complex, it is also newer, and should require less maintenance, therefore Tumut 3 is a reasonable comparison.
11	Variable O&M (non-fuel): 1. $0.72/MWh (Dec 18, real) is used for the three synchronous machines, however, this is slightly higher for the the variable speed units, due primarily to the size, quantity, and replacement frequency of the brush-gear. Therefore, $0.77/MWh (Dec 18, real) is used for the three variable speed machines.[1]
12	Capital program: 1. Consistent with best practice, Snowy Hydro engaged a team from a tier one expert, to provide the Project with a fully integrated cost estimate and project schedule (See *Supporting Chapter Four*). The scope of this engagement was to provide a capital cost estimate (the Estimate) for the complete Project to Snowy Hydro as well as identification of risks and contingency modelling. The outcome of the capital program modelling is addressed in the Valuation Outcome section.
13	Transmission proposal: 1. The base case valuation assumes that transmission is unconstrained to the regional load centres. See *Supporting Chapter Sixteen - Transmission*.

Table 1: The Project operating assumptions

2.3.2 Financial assumptions

The annual baseline review for valuation analysis was presented to the Board in June 2018.

2.4 Valuation outcome - Base Case

The Base Case valuation utilises the valuation methodology, value concepts and key operating and financial assumptions discussed above. The DCF valuation of the Project and its component parts are as at December 2018, unless otherwise stated.

Figure 5 illustrates the internal assessment of present value in terms of Snowy Hydro's key ground-up components of value: traditional capacity, renewables firming, retail diversification, storage and ancillary services. The Snowy Hydro Base Case internal valuation concludes the Project's sources of core value have a total present value of $7.7 billion excluding capital expenditure. Figure 5 illustrates the quantum of each value contributor, as described in the Value Concepts section, and additionally includes the cost of Operations and Maintenance (***O&M***).

[1] See Chapter Twelve - Facilities for more detail of the machines.

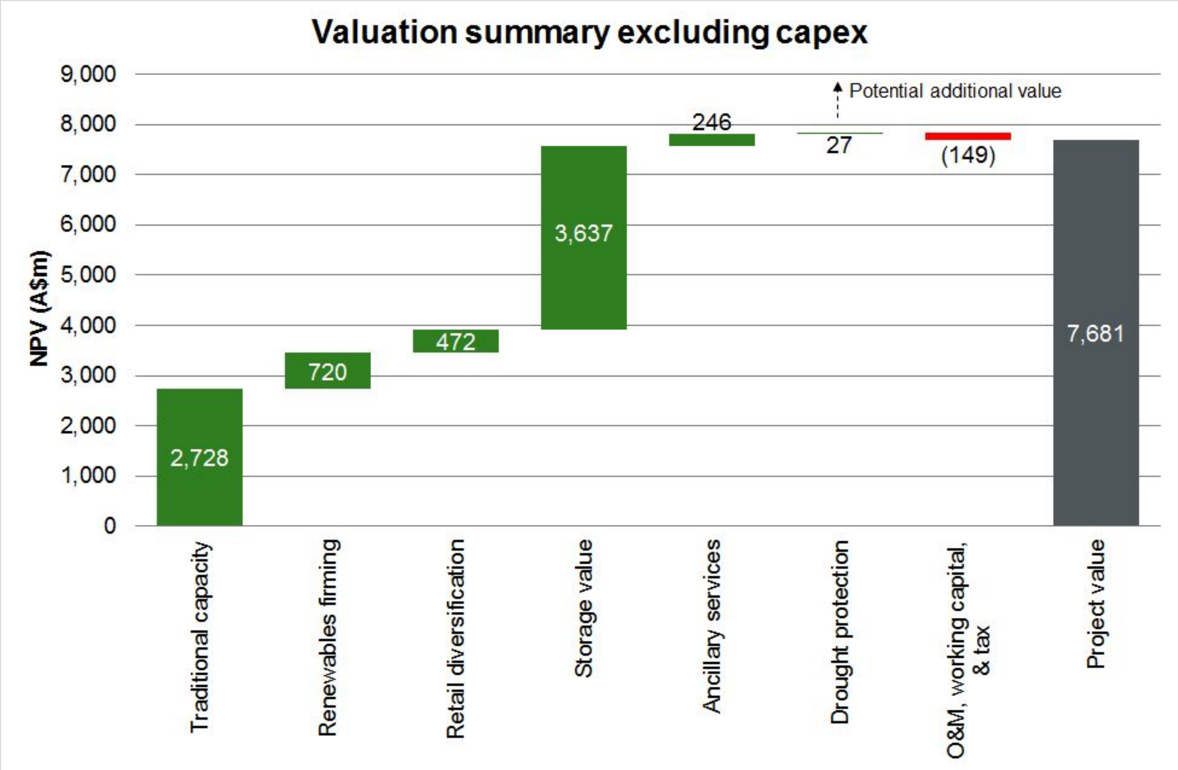

Figure 5: Valuation summary excluding capital cost

2.4.1 Traditional and renewables firming capacity

The Project will provide traditional and firming capacity in the form of a suite of products, The products will range from smaller, short-term to large long-term bilateral and firming products at a value that is benchmarked to the NEP. This is appropriate as the combined capacity volume trajectory of both traditional and firming products is consistent with the demand projection outcome from MJA and would therefore be sold at a shadow price that is the equivalent of the Long-Run Marginal Cost (***LRMC***) of the next lowest-cost technology.

The next new entrant is thought to be either OCGT risk-adjusted for the introduction of the five-minute settlement market or Reciprocating Gas Engines (***RGE***) that have a faster start capability than OCGT but are of higher cost. The core valuation includes the positive effect from the introduction of a five-minute settlement market.

The NEP has been derived on the basis of the next new entrant being a brownfield OCGT plant risk-adjusted for five-minute settlement.

MJA's modelling has shown that not all of the Project's capacity and storage would be fully utilised during the first three years, the key factors being the timing of thermal plant retirement and the persistent forecast of flat NEM operational energy and capacity demand.

The value contribution from Traditional Capacity and Renewables Firming is $2.7 billion and $720 million, respectively.

2.4.2 Retail diversification value

As described in the core value concepts section, the retail diversification value arises through the optimisation of non-coincident peak demand load profiles and reduces the hedge requirement compared to the sum of the individual customers' maximum capacity requirement. The value attributed to retail diversification is $472 million.

Importantly, the firming capacity and retail diversification benefit obtained under the Project is in excess of capacity that would otherwise be sold by Snowy Hydro's existing facilities.

2.4.3 Storage value and pumping cost

Figure 6 illustrates the volume of energy sold into the spot market at the corresponding dispatch-weighted price across the life of the Project. The volume projection and price are outputs of the MJA base case modelling. Noteworthy is the lower than potential energy output during the early years post-commissioning that is consistent with MJA's economic modelling.

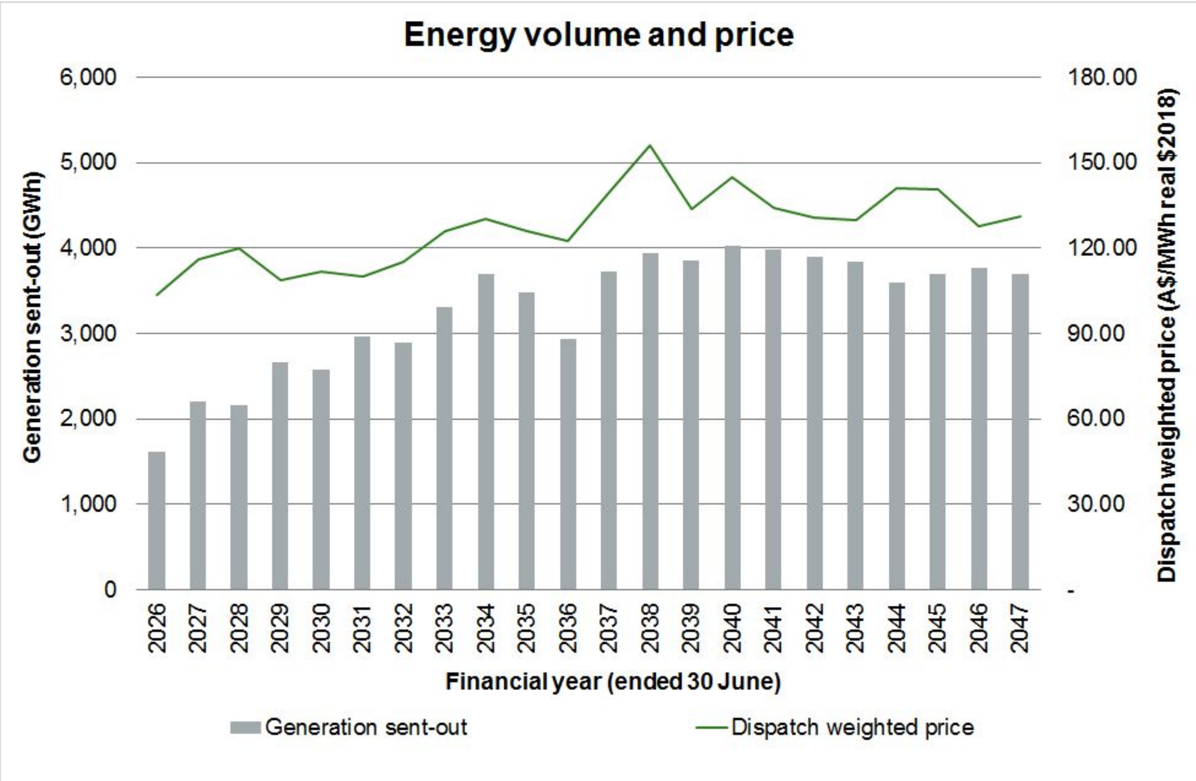

Figure 6: Energy volume and price outcome for the confidential base case

Storage value is derived from the projected volume of energy required by the market under the base case scenario multiplied by the dispatch-weighted price net of pumping costs. Figure 7 illustrates the associated charging or pumping volume and pumping-weighted price required to provide the energy or generation sent out. Of significance is the larger forecast average pumping volumes at approximately 4.8 TWh compared to the average energy sent out at approximately 3.5 TWh. This differential accounts for RTE losses.

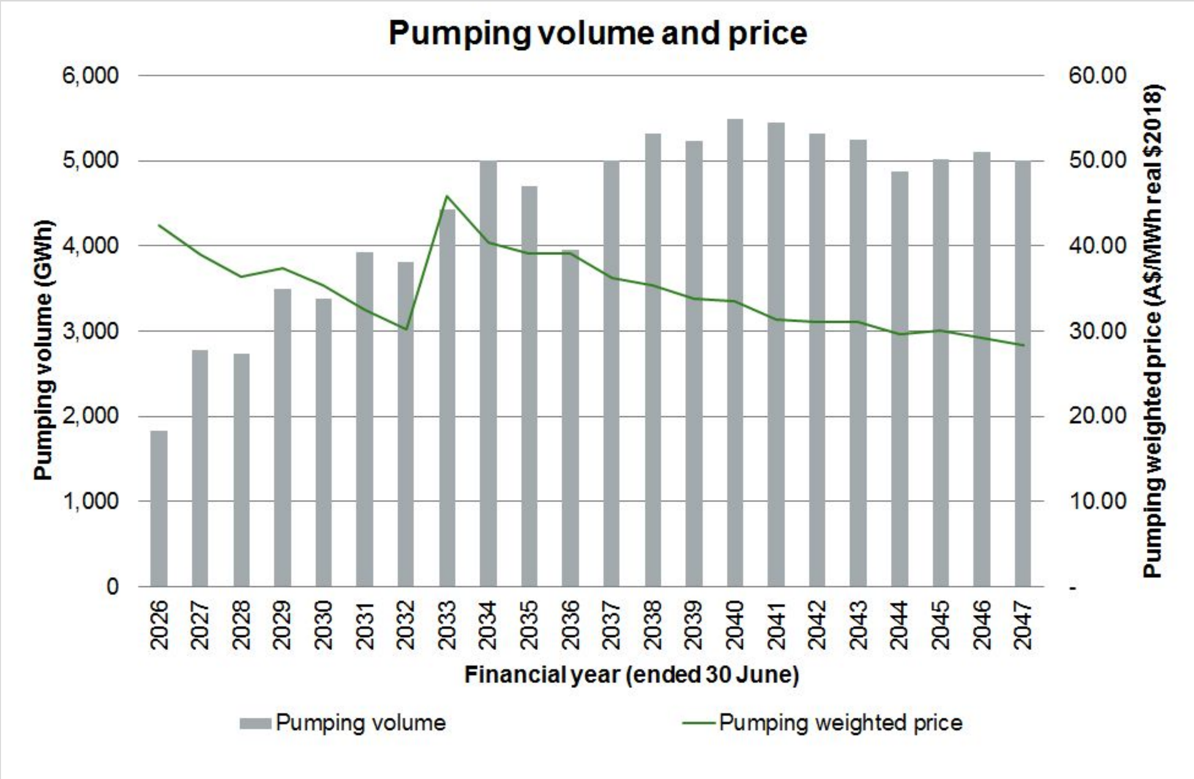

Figure 7: Pumping volume and price outcome for the confidential base case

Greater storage capability from the Project will allow Snowy Hydro to better manage and displace energy across time periods, thus leveraging intertemporal pricing. As illustrated in the valuation summary graph above, the contribution from storage value is $3.6 billion.

2.4.4 System security value

As previously mentioned, the Project valuation considers the current and future capability of the existing Snowy Hydro fleet with respect to security services, specifically FCAS. For this reason, the extent of FCAS value attributed to the Project is subject to full utilisation of Snowy 1.0 for these services. The contribution to value for these services from the Project was assessed to be $246 million.

2.4.5 Drought value

As discussed in the Value concepts section, in addition to benefits that accrue each year, the Project would provide value through providing for increased generation when required during drought conditions.

The drought protection value has been conservatively assessed at $27 million, noting that there is no downside or, restated, the floor is zero. In contrast, if conditions similar to the extremely low inflow year of 2007 and the preceding ten-year-dry inflow sequence were to recur, the upside would be well in excess of the modelled value.

2.4.6 Capital program

Figure 8 illustrates the expected capital program and timing of nominal capital spend for key Project components across the duration of the construction period from 2019 to 2026 commissioning.

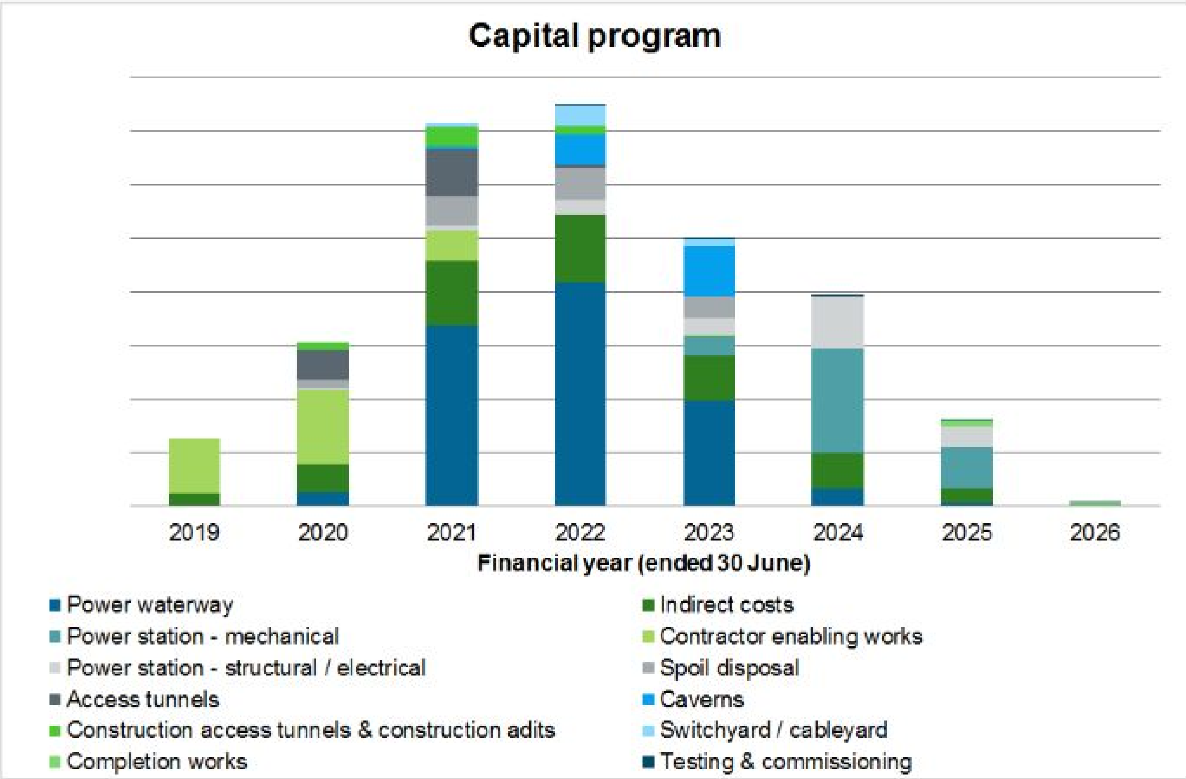

Figure 8: Capital program

2.5 Sensitivities

In addition to the MJA Report, MJA has modelled various sensitivities under the direction of Management. The value contribution of each sensitivity is relative to the Snowy Hydro base case scenario modelled by MJA and is presented and more fully described in Supporting Chapter Nine - Scenario analysis.

3 Definitions and abbreviations

AEMO	Australian Energy Market Operator
C&I	Commercial and Industrial
DCF	Discounted Cash Flow
FCAS	Frequency Control Ancillary Services
IRR	Internal Rate of Return
LCOE	Least-Cost of Energy
LRMC	Long-Run Marginal Cost

MJA	Marsden Jacob Associates
NEM	National Electricity Market
NEP	New Entrant Price
NPV	Net Present Value
O&M	Operations and Maintenance
OCGT	Open-Cycle Gas Turbine
RGE	Reciprocating Gas Engines
RTE	Round-trip efficiency
SCADA	Supervisory control and data acquisition
VRE	Variable renewable energy
WACC	Weighted-Average Cost of Capital

4 Bibliography

There is no bibliography for this chapter.