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1 Summary

Snowy Hydro has undertaken a number of critical activities to develop the business case for the Project. These include the ongoing procurement of the Main Works Contractors for the Project under an appropriate form of contract, development of a detailed capital and operating cost estimate and schedule, evaluation of tax and treasury effects of the Project, investigation and modelling of the National Electricity Market (NEM), sources of revenue for the Project, the assessment of risk and uncertainty in the future NEM, internal valuation of the Project and modelling of alternative market and corporate scenarios.

1.1 Outline

This chapter is one of four core chapters:

1. **Chapter One** - Health and Safety;
2. **Chapter Two** - Commercial business case (this chapter);
3. **Chapter Three** - Project execution; and
4. **Chapter Four** - Project and consolidated business operability.

This chapter has nine sections including the summary. Each section of this chapter has a corresponding supporting chapter of the same name with additional detail. The chapter numbers are given below:

1. Procurement (*Supporting Chapter Two*);
2. Contracts and legal (*Supporting Chapter Three*);
3. Schedule, cost estimate and contingency (*Supporting Chapter Four*);
4. Market modelling (*Supporting Chapter Five*);
5. Revenue sources and portfolio modelling (*Supporting Chapter Six*);
6. Drivers of revenue (*Supporting Chapter Seven*);
7. Valuation and selected business case (*Supporting Chapter Eight*); and
8. Scenario analysis (*Supporting Chapter Nine*).

1.2 Introduction

Snowy Hydro commenced its procurement process for the Project in early 2017. The process progressed through an Early Contractor Consultation (***ECC***) phase, an Expression of Interest (***EOI***) phase, progressive shortlisting, and issue of formal tenders. As at Final Investment Decision (***FID***) in December 2018, tenders have been received with binding bids and comprehensive evaluations undertaken. Subject to approval, further evaluation and negotiation will take place after FID, with the Main Works contracts intended to be executed by March 2019.

The Project will be executed under an Engineer-Procure-Construct (***EPC***) contracting strategy, based on a modified international standard form of EPC/Turnkey contract.[1] The key benefit of an EPC contract to Snowy Hydro is that the Contractor takes full responsibility for the cost of completion, the time for completion, the quality of the design, the works delivered under the Contract and the final performance of the Facilities, subject to the specific contractual risk allocation outlined below. Snowy Hydro obtains the advantage of world-leading expertise in the design and construction of these facilities. While a widely-used and recognised standard, the contract form has been customised to reflect Snowy Hydro's particular context and risk appetite, and the requirements of the Project.

Snowy Hydro and its consultants developed a Project Cost Estimate and Schedule. The Estimate and Schedule take into account the selected EPC strategy and have been validated against information provided by prospective Contractors through the procurement process. The Estimate includes a contingency provision, developed through a Quantitative Risk Analysis (***QRA***) process. This process takes into account material, quantifiable risks identified through the Pre-FID risk process. See *Supporting Chapter Seventeen* for further discussion of risk.

[1] The International Federation of Consulting Engineers (***FIDIC***) EPC/Turnkey Contract (***'Silver Book'***).

The Project has tax and treasury implications that need consideration. The Project is both complex and unique in the Australian tax environment, and there are several areas where additional clarity is required from relevant taxing authorities. The complexity of the laws means interpretation and negotiation play a part in the final assessment; however, a robust and defensible set of assumptions has been developed. The sheer volume of funds that will flow through the Project means the overall liquidity and short-term cash management will require additional attention.

Snowy Hydro and its consultants (particularly Marsden Jacob Associates (***MJA***)) investigated and analysed the international and domestic markets and modelled the potential for success of the Project in the NEM, both as an asset and an incorporated business model supported by potential energy diversification. There are multiple influences adding to the modelling approach and the outcomes and impact of the Project. MJA's findings are documented in a detailed report (the ***MJA Report***).[2]

The Project has a number of effects on the Snowy Hydro asset portfolio, including utilisation, risks and operations. These effects are evaluated in the context of MJA modelling results relevant to the business case of Snowy Hydro.

There is significant uncertainty and increasing risk to the NEM as the existing thermal fleet retires and is replaced by variable renewable energy (***VRE***), gas generation and, crucially, storage. The future evolution of the NEM and the dynamics of energy arbitrage mean the value arising from the Project is subject to and sensitive to many factors.

Snowy Hydro conducted an internal valuation of the Project and the underlying key assumptions. The valuation was primarily driven by the key findings within the MJA Report, and assessment of the future market state. The Project will add 2,000 MW of dispatchable capacity to Snowy Hydro's portfolio. 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 provide firming capacity for renewable projects sold direct to wholesale counterparties and indirectly through spot markets.

Snowy Hydro chose to base its core analysis and sensitivities on the economic base case modelling and underlying assumptions developed by MJA. The valuation approach utilises the Board-approved, industry-standard Discounted Cash Flow (***DCF***) methodology and economic assumptions.

Together, with a robust and defensible Base Case valuation scenario, a number of credible alternative scenarios were modelled for Snowy 2.0. These scenarios fell into two groups: NEM scenarios with a Project value focus, and Snowy Hydro Corporate scenarios with a debt-servicing focus. The value modelling found Snowy 2.0 provides substantial value under all plausible scenarios.

[2] 'Modelling Snowy 2.0 in the NEM' - Marsden Jacob Associates 2018

2 Procurement

2.1 Introduction

Snowy Hydro commenced its procurement process for the Project in early-2017. The process has progressed through an ECC phase, an EOI phase, progressive shortlisting, and issue of formal tenders. As at FID, tenders with binding bids have been received and comprehensive evaluations undertaken. The binding tender prices have been used in the FID business case. Subject to approval, further evaluation and negotiation will take place after FID to improve the cost and risk allocation inputs in the FID business case, with the target for Main Works contracts award being March 2019. The procurement process has been overseen by an independent third-party probity advisor who has provided confirmation that the process has been fair and equitable to all tenderers and that no breaches of probity standards were identified.

2.2 Activities undertaken

2.2.1 Overview

The key steps taken in the procurement process have been:

1. Strategy development and risk identification, assessment and management;
2. Market engagement (EOI);
3. ECC;
4. Civil shortlisting;
5. Testing of scale models of the proposed turbine designs;
6. Comprehensive due diligence of the bidders across safety, technical, quality, commercial and reference projects;
7. Civil and Electrical/Mechanical (***E&M***) tenders;
8. Exploratory Works - Roads (***EWR***) tender; and
9. Monitoring of probity standards.

There are five main areas of scope to be delivered for the Project:

1. EWR;
2. Exploratory tunnelling work (***Exploratory Works***);
3. Civil infrastructure and E&M works (***Main Works***);
4. Geotechnical investigation; and
5. Owner's advisors.

2.2.2 Exploratory Works and Main Works

The Exploratory Works and Main Works were managed as a single package for procurement. The procurement strategy was determined by the following key objectives:

1. Ensuring appropriate input from potential suppliers via a market sounding;
2. Packaging of scope to reflect contractor expertise;

3. Ensuring contractors engaged in the process are capable of delivering complex projects;
4. Ensuring that the overarching procurement process is fit-for-purpose;
5. Ensuring appropriate probity standards are met;
6. Leveraging contractors' knowledge throughout the procurement life cycle;
7. Maximising benefits from the competitive tension between contractors;
8. Ensuring that the contract and pricing models reflect Australian market norms; and
9. Building relationships for the execution phase.

Snowy Hydro decided to involve potential contractors at an early stage of the Feasibility study through its ECC process. The purpose of the ECC process was to draw on the construction experience and capabilities of contracting and manufacturing firms, which could then flow into the feasibility design and later into the definition of the Employer's Requirements. Snowy Hydro's primary goals in this process were to identify and reduce overall Project risks through contractor input to cost estimate, schedule, and constructability, and to reduce overall Project schedule.

More than 20 companies were approached to gauge interest in being involved in the ECC process. These companies were identified through a process involving internal subject matter experts and advice from external consultants. Snowy Hydro Senior Executives and SMEC Australia Pty Ltd (***SMEC***) (as Owner's Engineer) gave a market briefing presentation in early-2017 to companies who expressed interest and were willing to sign a confidentiality agreement.

EOI documentation was issued to companies that attended the market briefing. This documentation requested key information to allow selection of companies to proceed to the ECC phase. Submissions were evaluated by a cross-functional team against defined criteria. Respondents gave presentations to supplement their submissions.

The purpose of the ECC process was to seek input from contractors on the emerging design and create early awareness of the Project. Contract packages were presented back to the ECC participants for discussion. The parties worked collaboratively to facilitate submission of a Feasibility Study report to the Snowy Hydro Board in December 2017.

The ECC process also included reviewing design documentation with feedback loops from each contractor to capture issues, identify cost drivers and opportunities, value engineering and requests to the contractors on:

1. Geotechnical investigation planning;
2. Cost and Schedule;
3. Technical feedback on proposed solutions;
4. Proposed boundary limits; and
5. Identification of Early Works Packages to facilitate an accelerated program.

After the completion of the Feasibility Study, it was decided to reduce the shortlist of Civil contractors and Snowy Hydro issued a detailed Request for Information (***RFI***) to the three Civil contractors to enable a shortlisting decision.

The Civil contractors each submitted detailed, high-quality submissions, and the Project team undertook extensive due diligence including reference checks. Following this, Snowy Hydro shortlisted and invited the civil tenderers to proceed to the full tender stage.

In this period, Snowy Hydro undertook E&M technical due diligence focussed on machine capability specific to the Project duty and initiated a tender development phase with all participants.

Throughout the tender process, Snowy Hydro and the individual tenderers collaborated in confidential forums designed to clarify the Employers' Requirements (as documented in the tender package) and supplied information, shared knowledge, and expertise to improve the certainty of delivery. Detailed engagement also took place on the proposed contracting model and Project risk identification and allocation under the contracting model (see also *Supporting Chapter Three - Contracts and legal* and *Supporting Chapter Seventeen - Risk*).

Following this process, Snowy Hydro appointed Voith as the preferred E&M supplier for the project and received 'not to exceed' pricing for the E&M component. As at FID, work is continuing to achieve a 'contract wrap' between the Civil tenderers and Voith.

As at FID, the initial evaluation of the Civil tenders with binding bids including 'not to exceed' pricing was complete, and formal clarifications and negotiations with the tenderers are in progress. It is proposed that work with the tenderers continue into January and February to further leverage the competitive tension to improve the price and contractual outcome from the FID position.

An external probity consultant was appointed to provide a risk assessment and health check of the procurement process to date.

After a detailed review of the process and documentation, Snowy Hydro received an independent report confirming that the process has been fair and equitable to all tenderers and that no breaches of probity standards were identified.

2.2.3 Other procurement activities

A targeted geotechnical investigation was undertaken during the Feasibility study. Based on the findings, a decision was taken to expand the scope of the geotechnical work, and an extended Geotechnical Investigation Program (***GIP***) commenced in October 2017. The outcomes assisted with the refinement of the project design and enabled the development of the Geotechnical Baseline Report (***GBR***).

As noted in the Feasibility Study Report, Snowy Hydro identified an opportunity to de-risk the Project through undertaking some Exploratory Works (in addition to the geotechnical investigations underway) prior to award of the main EPC Contract(s). These works are primarily civil in nature, involving the development of

access roads and work areas, and would be limited to activities that can clearly be characterised as exploratory in nature.

Following the review of timelines, commencement of the Exploratory Works was scheduled for February 2019 .

A standalone procurement process has been conducted for an EWR scope design to improve the overall Project schedule. As at FID, the EWR bids have been fully evaluated and a recommendation for preferred tenderer approved.

Through the course of the Project, Snowy Hydro has sought out a range of advisors to help Snowy Hydro to develop the Project and discharge its responsibilities. Where appropriate and justified, Snowy Hydro has conducted a competitive bidding process for their engagement. Where a competitive process was precluded by the specialist nature of the services, sole-source justifications have been documented.

2.3 Procurement status as at FID

As at FID, Snowy Hydro retains the opportunity to further improve its outcomes from the tender processes by continuing to leverage the competitive tension between tenderers. This work will be carried out in early 2019 with final contracts targeted for completion by the end of March 2019. The 'not to exceed' cost and contract positions underpinning the business case at FID are binding and locked in with the tenderers and the continuing negotiation process will only improve Snowy Hydro's outcome from the FID position.

As at FID, the status of each scope procurement area is as follows:

1. **Exploratory Works:**
    a. **Access Roads** - A preferred bidder has been chosen and contract negotiations are being finalised. The work is planned to commence in February 2019 (see *Supporting Chapter Thirteen - Early and exploratory works* for scope description);
    b. **Balance of Works** - Snowy Hydro has received and is evaluating tenders for the balance of Exploratory Works (as part of the Main Works - Civil tender);
2. **Geotechnical investigation** - an investigation was initiated in Q1 2017 and has continued since. The current scope of work is expected to be completed by the end of 2018. Further drilling work will be considered on the basis of the expected incremental risk reduction to Snowy Hydro;
3. **Main Works:**
    a. **Civil works** - Tenders have been received and initial tender evaluations are complete. Binding price and contractual positions have been reached that underpin the FID business case. Work is continuing with the tenderers to further improve on Snowy Hydro's outcome from the tender submissions;
    b. **E&M Works** - Tenders have been received from the tenderers and fully evaluated. A preferred tenderer has been appointed and a Heads of Agreement executed. Discussions are in progress to achieve a contract wrap that brings together the Civil and E&M

scopes (E&M provider appointed as subcontractor to the Civil provider);

4. **Owner's advisors** - A number of Owner's advisors (including Owner's Engineer SMEC) have been progressively engaged since early 2017.

It is anticipated that negotiations on the Main Works packages will be complete and contracts will be ready for execution by the end of March 2019.

2.4 Regulatory considerations

The Project is subject to Commonwealth and NSW legislation applicable to construction projects. From a procurement and contracting perspective, the two main relevant Acts are the *Australian Jobs Act 2013 (Cth)* (***Jobs Act***) and NSW Security of Payment legislation as noted below.

The *Jobs Act* supports the creation of and retention of Australian jobs by requiring public and private major projects with a capital expenditure of $500 million or more to prepare and implement an Australian Industry Participation (***AIP***) Plan.

Snowy Hydro has complied with the requirements of the *Jobs Act*.

The security of payment legislation in NSW consists of two acts: the *Building and Construction Industry Security of Payment Act 1999* (NSW); and the *Contractors Debts Act 1997* (NSW) (largely superseded). The Acts generally affect payment terms.

The Acts' requirements will be reflected in the payment terms of the contracts and in contract administration procedures. See *Supporting Chapter Fourteen - Project controls* for payment processes.

In mid-2018, the Commonwealth acquired 100% of the shares in Snowy Hydro, and as a consequence Snowy Hydro became subject to the *Public Governance Performance and Accountability Act 2013* (**PGPA Act**). However, Snowy Hydro has not been prescribed to be an entity subject to the Commonwealth Procurement Rules under s105B of the PGPA Act and s30 of the PGPA Rules. Although Snowy Hydro is not required to comply with the Commonwealth Procurement Rules, the procurement process described in this chapter has been designed in accordance with best practice and high standards of probity.

2.5 Procurement and contract management

In the execution phase Snowy Hydro's Owner's Team will manage the Main Works Civil contracts (which will include the wrapped E&M provider).

Primary procurement and contract functions include:

1. **Sourcing (for Owner's contracts)** - While sourcing of the main contracts is largely concluded as at FID, there will be an ongoing need to contract with various specialist firms and Owner's advisors. The execution approach will be determined and documented in the Project's Procurement and Contracting Plan (***PCP***), as part of the overall Project Execution Plan (***PEP***);

2. **Contract implementation** - there will be an implementation period for the main contracts, to be documented in a contract implementation plan post-FID; and
3. **Contract management** - roles and responsibilities will be detailed in the PCP. Structured processes will be documented and adopted for contract management activities such as mobilisation, progress payments, cost management, claims management and change management.

3 Contracts and legal

3.1 Introduction

This section describes the contracts that Snowy Hydro proposes to enter into for the Civil, E&M and EWR Packages to execute the Project. In particular, this section sets out:

1. The rationale for selecting the forms on which those contracts are based, being:
    a. Engineer-Procure-Construct (***EPC***) Contracts for the Civil and E&M packages, based on the Silver Book template; and
    b. A Construct-Only Contract for the EWR package based on the AS 4000-1997 form of Contract;
2. The process followed to develop and adapt the forms into the contracts issued to the market, with expert advice and assistance from international construction law experts;
3. The commercial risk allocation set out in the contracts; and
4. The status of the contracts as at FID and actions to negotiate and finalise the contracts with the successful bidders.

3.1.1 Scope and exclusions

Contract administration and the overall contractor selection process is covered in the *Procurement* section above.

Contract pricing and contingencies for retained risk under the contractual risk allocation is covered in the *Schedule, cost estimate and contingency* section below.

The Approvals process is detailed in *Supporting Chapter Eleven*.

3.2 Activities undertaken

The strategy of splitting the Project into Civil and E&M Packages and using an EPC Contract for each package based on the Silver Book was determined during Feasibility. Snowy Hydro communicated this strategy to prospective contractors during the ECC phase (see *Procurement* section above for rationale and process). Following extensive review, including external advice, and interactions with the market post-Feasibility, Snowy Hydro elected to proceed to tenders with modified EPC Contracts for the Civil and E&M packages broadly consistent with the Feasibility position.

Key activities included:

1. Developing and issuing an initial term sheet to the Civil tenderers for feedback;
2. Refinement of contract terms (internally and with external legal advisors), primarily through a series of risk workshops;
3. Developing and issuing draft contract terms to the Civil and E&M tenderers for feedback;
4. Market feedback and refinement of commercial terms through the interactive tender process;
5. Refinement of key commercial terms with the engineering and commercial teams; and
6. Issue of final contracts to tenderers. The description of the contracts in this chapter is based on those issued to the market.

3.3 Contract introduction

In order to execute the Project, Snowy Hydro proposes to enter into three contracts for delivery of Project works in two phases: Exploratory Works and Main Works. In addition, Snowy Hydro entered and will enter into a number of supporting contracts for Owner's Team work such as geotechnical investigation, survey, environmental and other studies, and a range of contracts with various advisors and consultants to support the Owner's Team.

The three delivery contracts (which comprise the major portion of the scope of the Project) are:

1. EPC Contract for the Civil Works Package (***Civil EPC Contract***);
2. EPC Contract for the E&M Works Package (***E&M EPC Contract***); and
3. Construct-Only Contract for the EWR Package (***EWR Contract***).

The EPC Contracts issued to the market for tender contain a reasonable risk allocation, which is consistent with the market for major infrastructure works, under which the Contractors are responsible for delivering the Project safely, providing a fixed price (subject to the risks retained by Snowy Hydro as described in this Section) and delivering the Project by an agreed date for completion. The Contractors also take design risk to deliver a 'fit for purpose' design. Snowy Hydro takes the risks typically retained by an owner (eg tenure, site access and unforeseen delay events), along with risk under the Civil EPC Contract in relation to planning approval conditions and the geotechnical conditions encountered during tunnelling (see below).

Under the Civil EPC Contract and the E&M EPC Contract, the Project will be delivered by one of the civil contract consortia (***Civil Tenderers***) and one of the E&M Original Equipment Manufacturers (***OEM***) (***E&M Tenderers***) that have tendered to deliver the Project in accordance with the EPC Contracts through the procurement process described above.

As at FID, Snowy Hydro has received tenders and identified a preferred E&M Tenderer (with a reserve tenderer as back up).

Snowy Hydro intends to continue to negotiate with the preferred Tenderers and conclude those negotiations before March 2019. Snowy Hydro's strategy has been to maximise competitive tension between the Tenderers during the negotiation period to improve Project outcomes (design and pricing), while seeking to further mitigate key risks such as design, approvals, geotechnical, and interfaces. In particular, the further negotiation period will allow Civil Tenderers to negotiate directly with the preferred E&M Tenderer to improve the interface coordination and determine if a single EPC Contract for execution of the whole Project can be achieved.

The scope under each of those Contracts is divided into two stages: Exploratory Works and Main Works.

The Contracts represent the output of significant due diligence and procurement, and the risk allocation in the Contract is reasonable for the execution of the Project. This is supported by an external legal expert opinion in relation to the documents issued for tender.

3.4 Form of contract

In selecting the form of contract for delivering the Project, Snowy Hydro considered its recent experience in constructing large hydropower projects, accepted contracting practice for the delivery of large infrastructure projects both in Australia and internationally, the capability and resources available in the market, and generally understood commercial and contractual principles.

Snowy Hydro considered the range of contract delivery models available, and settled on an EPC Contract for the main works package. The primary driver behind the section of the EPC model is the allocation of design and execution risk. Under an EPC Contract, a single contractor takes responsibility for all elements of design, procurement, and construction, and is responsible for providing fully-equipped Facilities that are ready for operation (on a 'turnkey' basis). In addition, the other principal benefit to Snowy Hydro of an EPC contract is that the Contractor takes full responsibility for the cost of completion, the time for completion, the quality of the works delivered under the Contract and the final performance of the Facilities. Snowy Hydro gets the advantage of world-leading expertise in the design and construction of these facilities.

Given the international field of potential contractors, the preference was to base the Contract on a mature, internationally recognised standard for infrastructure development. FIDIC provided a market-preferred suite of Contracts (including the Silver Book) for EPC infrastructure works, and also included an appropriate base risk allocation. This is why Snowy Hydro elected to pursue a 'modified' EPC contracting strategy for the major packages based on the Silver Book.

3.6 EWR contract

Snowy Hydro identified a credible opportunity to accelerate the Project schedule by undertaking some civil access works early. Access roads to the Main Access Tunnel (***MAT***) portal and other early works areas were, therefore, carved-out from

the main Civil Works Package and tendered separately to local civil contractors on a construct-only basis.

The selected form of Contract is a modified AS 4000 Contract. This form of Contract has been used many times by Snowy Hydro for civil projects of a similar scale, and contains a reasonable and appropriate risk allocation for construct-only civil works.

4 Schedule, cost estimate and contingency

4.1 Introduction

4.1.1 Overview

An independent expert developed a Project Cost Estimate and Schedule under Snowy Hydro's direction. The Estimate and Schedule take into account the selected EPC strategy and have been validated against information provided by prospective Contractors through the procurement process. The Estimate includes a contingency provision, developed through a QRA process. This process takes into account material, quantifiable risks identified through the Pre-FID risk process managed by independent risk advisors. See *Supporting Chapter Seventeen* for more discussion of risk.

The Feasibility estimate has been progressively updated to support the decision-making process for the Employer's Requirements (see the *Facilities* section of *Chapter Three*) and will support the tender price evaluation to understand any potential pricing strategies in tender responses.

4.1.2 Key exclusions

The following items have been excluded from the independent cost and schedule estimating process:

1. Land and development costs;
2. Lease costs;
3. Foreign exchange fluctuations or hedging costs;
4. Funding or financing costs;
5. Operational ramp-up costs (recruitment and training of operational personnel and the like);
6. Operational spares; and
7. Goods and Services Tax (***GST***).

4.1.3 Estimate overview

The scope of work for each package is:

1. **Exploratory Works** - to undertake further investigation to confirm the final location and orientation of the cavern and to determine the geotechnical viability of the main project works. The outcome of the investigations will provide detailed information supporting a more refined project design; and

2. **Project Execution** - the full construction and commissioning of the Project following confirmation of the cavern location and orientation.

The Estimate will be summarised at Cost Breakdown Structure (CBS) level 2 as per Table 1.

Ref	Description
A	Civil Contractor Indirects
B	Exploratory drift/shaft
C	Power Waterway
D	Access Tunnels
E	Construction Access Tunnels & Construction Adits
F	Caverns
G	Enabling Works
H	Power Station
I	Switchyard/Cable yard
J	Testing & Commissioning
K	Completion Works

Table 1: Estimate at CBS level 2

4.2 Activities undertaken

The independent expert developed the Project Estimate and Schedule for the Feasibility Study then refined and validated them for FID by assessing the options, tender schedule and price, and estimate, with associated risks.

4.3 Approach and methodology

The general Estimate and Schedule development approach was to:

1. Update the Feasibility cost estimate;
2. Update the Feasibility schedule;
3. Develop a consolidated scenario and option model;
4. Prepare an input model for valuation; and
5. Prepare Work Breakdown Structure (***WBS***), and CBS.[3]

A common WBS was developed to organise the Project into manageable objectives and to align the valuation model and Schedule for consistency.

The independent expert used in-house cash flow models to develop cash flow forecasts. Forecasts were prepared by taking each activity in the Estimate and spreading the cost over time against the base case schedule. These cash flow forecasts will be validated against the tender responses.

[3] Note: The Organisation breakdown structure (***OBS***) and control account structure for Project controls during execution will be developed Post-FID (see *Chapter Three*).

The Estimate was priced based on a base date of Q4 2018. The independent expert's in-house construction economics advisory team developed escalation indices by assessing market conditions and making informed escalation provisions. Allowances for escalation in the tender responses were compared to the Project escalation model and the preferred design was used as the basis for the FID escalation amounts.

The independent expert's approach considers both Inherent Risk,[4] and Contingent Risk.[5] The output from the QRA together with the detailed capital cost estimates were modelled to generate a project range against which a P50 and P90 Project Estimate could be determined (ie the level where there is a 50% and 90% certainty of the Project Estimate not being exceeded). This output informed the process of assessing the Project contingency.

Each tender response will have a different risk profile and QRA will be developed for each response as part of the normalisation process. The Project-level QRA that will establish the contingency for execution will be completed Post-FID when the preferred contractors are selected.

4.4 Estimating and scheduling basis

The FID Estimate and Schedule have been based on the major procurement packages plus several contracts from the Owner's Team. They include battery limits, basis of design (taking tender submissions into account), treatment of approvals, long-lead items, access roads, exploratory works vs main works, key Project elements (intake structures, caverns etc), commissioning, resource pricing, allowances and provisional sums, indirects, overheads and profit.

The Estimate and Schedule will be based on the latest pricing schedule and analysis once contracts are awarded. The Control Budget will be developed from the Final Estimate and Schedule in Q2 2019. The Final Estimate and Schedule will be a combination of the EWR price, the Civil price, the E&M price and the Owner's Team cost and Contingency.

A manpower schedule has been developed for the Owner's Team and current market rates have been applied to determine the Estimate with an allowance for expenses.

Key interface milestones have been incorporated into the master Schedule.

4.5 Escalation and contingency

Escalation is based on assumed exchange rates, forecast real cash flow, development of escalation indices and an escalation model.

For contingency, QRA was used to combine the effects of identified uncertainties in the Estimate and discrete risk events on the Project objectives taking into account the correlation between discrete risk events from the risk register,

[4] The level of risk when no action has been taken to mitigate or reduce the risk, ie before any treatments or controls are applied. Inherent risks are certain to occur, though the consequences and impact may not be fully known.
[5] Risks attached to items outside the initial estimate that may occur but are not certain.

high-level schedule uncertainties and cost uncertainties, indicating the degree of overall risk faced by the Project.

All uncertainty and risks and generated inputs for the Project risk registers that might have a cost impact were assessed. The risks were then included in the QRA Model. Based on the likelihood and consequence evaluated in the registers, the change in percentage and cost impact were quantified.

The GBR contains the expected geological conditions and the pricing schedule details. A sensitivity model has been established to understand any potential changes in geological conditions and potential cost and time impacts.

4.6 Schedule

Key milestones were identified. The critical path runs broadly through:

1. Civil contract award;
2. Exploratory Works;
3. Construction adits;
4. Machine hall construction and fit-out; and
5. Commissioning.

The critical path will challenge the proposed construction methodology and productivities from the tender responses. Interfaces between contracts on the critical path will be highlighted for management action.

4.7 Due diligence

The consolidated Project Estimate will be compared to the working Estimate to understand any areas significantly different to expectation and warrant further investigation.

Input was sought from Civil and E&M Contractors involved in the ECC process.

Selected rates and prices were solicited from the Civil tenderers in the tender process described above. These rates and prices were used as a check when building up the working estimate.

5 Market modelling

5.1 Introduction

Third-party specialist economists MJA were commissioned to undertake an economic modelling exercise and deliver a confidential report: the MJA Report as noted above. The MJA Report presented the following:

1. The NEM's future market state and options to address the associated NEM price and reliability issues, and the benefits and comparative economics provided by the Project;
2. A multi-stage approach to the assessment of the economic and market benefits and potential value of the Project through a least-cost planning

simulation approach characterised by macro assumptions and policy that may influence this, including additional economic entry of intermittent generation;
3. Rationale for the Project, future NEM mix, the technologies available for generation; and energy storage and associated cost outlooks; and
4. An assessment of how these benefits would be shared and the resulting impact the Project would have to wholesale electricity energy prices and resulting customer prices.

5.2 Background

The NEM is moving towards a mix of renewable generation technologies that are increasingly intermittent, thus less predictable and reliable in nature. The reasons for this degree of intermittent penetration are, and will continue to be, environmental, political and economic. Examples include the uncertainty around energy policy, Australian commitment to international carbon emissions targets,[6] and the falling costs of producing renewable energy. Legislated or proposed energy policy by Federal and State governments, such as the proposed National Energy Guarantee (***NEG***), are attempts to address the resulting trilemma of affordable, reliable, and environmentally responsible production of electricity.

The economic evaluation of the Project has had to resolve the essentially unpredictable factors into a series of valuation cases. The analysis displayed, unsurprisingly, a very broad range of possible outcomes. However, it has also shown a high degree of convergence of likely future outcomes across the following inter-related factors:

1. Renewable penetration, at both grid and distributed levels, particularly relating to rooftop photovoltaic (***PV***) installations;
2. Domestic and commercial load growth, both average and peaking;
3. Smelter closures;
4. Coal plant closures; and
5. The penetration of Electric Vehicles (***EV***)

This work assisted Snowy Hydro's understanding of likely and boundary scenarios in the future NEM. As at FID, the position is consistent with that presented at Feasibility, that the likely scenarios are convergent.

5.3 Scope and exclusions

A number of due diligence activities were performed prior to FID. Areas of focus include:

1. Demand/supply modelling for the current and future market states of the NEM, including:
    a. Performing economic benefit analysis to the market modelling in order to identify the most economically rational sources of new generation;

[6] Australian Government, 2017. Australia's 2030 climate change target. Available at: http://www.environment.gov.au/system/files/resources/c42c11a8-4df7-4d4f-bf92-4f14735c9baa/files/factsheet-australias-2030-climate-change-target.pdf [Accessed November 23, 2017].

   b. Investigating the market potential for storage products; and
   c. Predicting the future NEM generation mix and market state under the 'with' and 'without' Project scenarios.
2. Assumptions review:
   a. Government policy-mandated decarbonisation targets;
   b. Cost curve trajectories of competing technologies of supply;
   c. Market bidding behaviours;
   d. Macroeconomic factors influencing the NEM;
   e. Capex; and
   f. Opex.

5.4 Activities undertaken

To assess the potential economic value of the Project, Snowy Hydro collaborated with independent third-parties to determine the viability of the Project. Market models were designed based on international and domestic market research and assessed:

1. **The Project in the NEM** - for the Feasibility study, MJA produced public and confidential market reports regarding the relationship between the NEM and the completed Project to discern the impacts on both the NEM and Snowy Hydro's business case. The reports and modelling have been leveraged to deliver improved and more detailed information to the stakeholders. The focus of these deliverables changed from benefits to the public to the Snowy Hydro business case;
2. **Energy supply-and-demand research** - a study tour to Europe raised questions over the additional flexibility offered by coal-fired power stations in the NEM. An independent expert was therefore engaged to determine the current and potential future plant operational flexibility of Australian plants on a least-cost basis. Deliverables included an assessment of current operational flexibility in comparison to comparable overseas coal fleets, and a report for each coal-fired station that owns optionality with respect to one or more potential upgrades or operational changes that would increase the flexibility of the station, and the associated capex and other costs.
   Another independent expert reviewed the East Coast gas market to understand the demand, supply and cost outlook and determine the potential of building an energy retail business. The Australian Energy Market Operator (***AEMO***)'s National Gas Forecasting Report (2016) advised for planning solutions that prioritise flexibility, innovation and options to defer investment until some certainty across the energy market are resolved.
   An independent expert was engaged to report on the dynamics of current and future Australian coal pricing assessing coal supply-and-demand and cost and risk-based consumer price forecasts by assessing the capacity of export and domestic demand to 2030 against production and distribution infrastructure;
3. **Climate trends** - Climate projections indicate the resultant scheme inflow will likely decline, with an increased frequency of drought events. A 'base

case' dataset (1999-2015) using long-term historic Water Utilisation Factors (***WUF***), modified to represent 2024-2040. Inflow data for the 1999-2015 period was selected as it includes frequent dry events and reduced average inflow, a pattern expected to continue in the future. See the *Hydrology* section of *Core Chapter Four* for further discussion of climate factors;

4. **Portfolio Diversification and transmission** - Snowy Hydro leveraged MJA's feasibility study work to determine the competitive viability of procuring intermittent energy. Snowy Hydro undertook a Renewable Energy Procurement Program (***REP-P***) in order to create a more diverse company portfolio, in turn potentially complementing the Project. It consisted of procuring 888 MW of wind and solar offtakes.
   The procurement of wind and of solar offtakes will diversify Snowy Hydro's portfolio, and complement the Project, utilising energy procured through the REP-P process for managing existing exposures and growth.
   AEMO's transmission development decisions impact the Project's viability and cost. Snowy Hydro and MJA analysed AEMO's Integrated System Plan (***ISP***) Report 2018, particularly the modelling used for the 'with' and 'without' cases of the Project. MJA separately assessed commercial drivers in the NEM, with or without the Project.
   Snowy Hydro and MJA assessed the impact of the Project on existing operations, examining the economic and market values of bidding, supply capacity, flexibility and portfolio constraints on existing operations.

The MJA FID Report is the most up to date version of modelling outcomes, and contains the following components:

1. Overview of the NEM, Large-scale Renewable Energy Target (***LRET***) and gas market;
2. Historical analysis of NEM prices and volatility;
3. The economics of new and existing dispatchable generation, renewable generation, batteries and interconnection;
4. How Snowy 2.0 would provide value to the NEM;
5. A description and results of market modelling undertaken over a range of scenarios;
6. Real option value provided by the development of Snowy 2.0 for a potential Snowy 3.0; and
7. How Snowy Hydro would operate and create value with and without Snowy 2.0, and under the various scenarios contemplated.

The MJA FID methodology was designed to:

1. Quantify how the NEM is expected to develop;
2. Quantify storage capacity and energy (in MWh) as the NEM develops;
3. Quantify the value Snowy 2.0 would provide to the NEM and the cost if Snowy 2.0 were not developed;
4. Model the Snowy 2.0 impact on total Snowy Hydro net revenues;
5. Identify key uncertainties and their impact on the Snowy 2.0 business case;
6. Determine the economics of Snowy 2.0 across a wide range of scenarios; and

7. Provide a transparent modelling approach.

The MJA study addressed:

1. Review of the transforming NEM;
2. Identification of key influences on Snowy Hydro spot market revenues and costs. Characterisation and operation of Snowy Hydro portfolio with and without Snowy 2.0;
3. The economics of Snowy 2.0;
4. The likely impact of Snowy 2.0 on carbon emissions in the NEM;
5. Development of a Base Scenario and modelling of that scenario;
6. Development and modelling of alternative scenarios; and
7. Modelling conclusions.

5.5 Logic underpinning the benefits of the Project

Increasing penetration of intermittent generation has implications for wholesale and retail electricity supply cost, reliability, and environmental outcomes.

Beneficially integrating increasing levels of intermittent generation with existing generation is a complex whole-of-supply-chain challenge:

1. **Generation** - increased penetration of intermittent generation (wind, solar) increases variability in residual demand for dispatchable generation (coal, gas and hydro). Absent storage, the economics of base load generation decrease, with consequent market instability and price impact;
2. **Retail products** - retail prices reflect the wholesale cost of energy borne by retailers. A portfolio including intermittent generation requires even more dispatchable generation, to follow changes in both the retail load and the intermittent generation so the retail load remains hedged;
3. **Storage** - energy storage provides the dispatchable capacity that intermittent generation cannot: ie together with generation capacity, it 'firms' the intermittent generation; and
4. **Project benefits** - Pumped-Hydro Energy Storage (***PHES***) has several benefits over batteries, including lower cost, higher capacity, firming capability, longer continuous generation, longer life, and contribution to network stability (inertia and interconnection).

Large-scale PHES will lower consumer prices, stabilise the power grid and enable deeper penetration of variable/intermittent renewable generation, directly addressing all three elements of the electricity trilemma:

1. **Affordability** - increased wholesale competition and reduced or stabilised spot prices;
2. **Security** - increased resilience of the NEM; and
3. **Environmental** - long-term enabler of additional least-cost renewable generation.

Given its context and constraints, the analysis concludes the Project is economically feasible and adds material value to the Snowy Hydro Group.

5.6 MJA market modelling

Snowy Hydro engaged MJA as long-standing specialists in modelling the NEM. MJA concluded, as the NEM generation fleet mix becomes increasingly intermittent and unreliable, the proposed Project is a material part of any solution to long-term stability in the NEM. The potential range of solutions includes future increases to PHES with the appropriate transmission system augmentation.

MJA's future base case market state estimation in the NEM was built upon:

1. The current and known regulatory framework;
2. State and Federal renewable targets;
3. AEMO forecast transmission upgrades (see the *Transmission* section of *Chapter Four* for details); and
4. Assumptions regarding current and forecast generation mix, storage, consumer demand, and fuel prices.

Key Findings

The key findings of this study relate to the Snowy 2.0 value proposition and the benefits Snowy 2.0 would provide to the NEM and to Snowy Hydro. These are summarised in turn below:

Variable, Dispatchable and Firm Capacity

While is it recognised that generation from VRE does not provide firm capacity, the study highlighted the need to make the further distinction between 'dispatchable capacity' and 'firm capacity':

1. **Dispatchable capacity** is that which is controllable (i.e. either up or down);
2. **Firm capacity** is capacity that is dispatchable and can be relied upon to be available. Dispatchable generation from storage with limited hours of storage also does not provide firm capacity as it may not be available to generate when needed. The study found that firm capacity requires at least 24 hours of storage.

Snowy 2.0 Quality and Value Provision

Snowy 2.0's qualities of capacity and storage size, central location, and ancillary service provision make it unique in the NEM. Snowy 2.0 would provide both dispatchable and firm capacity. These unique qualities provide for substantial value to the market, consumers, and Snowy Hydro. These quality and value relationships include:

1. Its **central location** that provides for maximum consumer access, NEM-wide balancing of VRE, and security against critical transmission outages;
2. Its **large quantity of storage** (175 hours at full load, assuming a full upper reservoir) provides for energy security and firming against extreme market conditions, both of which will become of increasing value to risk mitigation in the future. In the longer-term, storage value will move to be proportional to storage hours. (These are matters not capable of being managed by storage with less than about 24 hours of storage);
3. Its **flexible operating** nature provides for increased market stability and efficiency. This has its pumping demand (of up to 2,000 MW) operating in response to the changing availability of surplus coal and surplus VRE, and its generation operating in response to spot price signals and commercially and economically replacing gas plant and batteries that would have been developed and used. Such operation directly supports the development of new VRE and emissions reductions;
4. Its **economic value to be robust** against uncertain future outcomes;
5. Its ability to **transition smoothly** into operation.

While the transmission developments identified in the AEMO 2018 ISP between NSW-VIC-SA are considered to be needed regardless of Snowy 2.0 development (as they support the Renewable Energy Zones (***REZ***) and interregional transmission limits necessary to address the closing coal plants), Snowy 2.0 would provide additional value to this transmission. Snowy 2.0 could potentially reduce transmission asset costs due to its complementary operational nature to other types of assets.

Benefits to the NEM

Supports Trilemma

On a NEM-wide basis, the above relationships would provide for Snowy 2.0 to directly and substantially contribute to the trilemma issues of reliability, price, and emissions reduction as the existing coal fleet closes and replacement firm capacity and energy production is required.

Avoids Excess Supply

Snowy 2.0 would utilise otherwise unused low-cost generation (unused coal and VRE) and provide dispatchable and firm capacity that can operate for days if required, with the effect that the NEM would operate more efficiently and with lower emissions.

Benefits to Snowy Hydro

Snowy Hydro would capture a substantial amount of the value provided by Snowy 2.0. The modelling findings on the value Snowy 2.0 would provide to Snowy Hydro are as follows:

1. The central case (Base Scenario) has the NPV impact on Snowy Hydro net spot market revenues due to Snowy 2.0 at $3.643 billion (period 2018-19 to 2074-75).[7] This excluded contract sales revenues, which are very substantial;
2. From the nine scenarios modelled, the NPV impact on Snowy Hydro net spot market revenues due to Snowy 2.0 have seven scenarios in the range $3,398 billion to $3,740 billion. The outlier is a low carbon emissions scenario (45% by 2030, 80% by 2050) that had an NPV of $4,821 billion.
3. The multi-day storage provided by Snowy 2.0 will be of increasing value as VRE enters in the NEM and coal generators exit;
4. The impact of Snowy 2.0 on Snowy Hydro is complex, as the impact of Snowy 2.0 could result in Snowy 1.0 revenues being either lower or higher than they would have been otherwise, depending on market developments (excluding effects on contract revenue);
5. The sensitivity of spot price outcomes (and net spot market revenues to Snowy Hydro) to market changes will increase as the existing coal generators close;
6. The impact of reduced hydro water inflows was not significant to the value provided by Snowy 2.0. The impact of reduced hydro water inflows was not significant to the value provided by Snowy 2.0. This reflects that Snowy 2.0 operation is not reduced, it is the lowest value Snowy 1.0 generation that is reduced and reduced hydro inflows across all NEM would result in slightly higher spot prices.

MJA consulted a variety of sources in developing its modelling, including site visits, studies commissioned by Snowy Hydro, AEMO material and MJA's own internal market and cost data.

MJA undertook detailed modelling in a variety of formats, considering, eg, storage economics, emission reductions, operating rules, costs and prices, in multiple scenarios.

The economics of the Project were determined by Snowy Hydro as the differential between the spot market revenues Snowy Hydro would earn with the

[7] The impact of Snowy 2.0 on Snowy Hydro is given by the difference of Snowy Hydro net spot market revenues between the 'with Snowy 2.0' case and the 'without Snowy 2.0' case

Project and without the Project. The modelling considered four aspects of Snowy 2.0 economics:

1. Combined revenue (Snowy 1.0 plus Snowy 2.0);
2. Impact of Snowy 2.0 on net spot revenues under two scenarios: without Snowy 2.0 with no alternative investment ('Do Nothing'), and without Snowy 2.0 but an alternative investment is made;
3. Impact of Snowy 2.0 on NEM market benefits; and
4. Carbon emissions impact of Snowy 2.0.

To facilitate comparison, the operating parameters of the existing Scheme (Snowy 1.0) and the Project (Snowy 2.0) were precisely defined.

Though they are a very substantial component of market revenues, contract sales were excluded from the analysis because they are a product of Snowy Hydro modelling: modelling that leverages MJA modelling but is post hoc by Snowy Hydro.

The central Base Scenario (from which eight alternative scenarios were modelled), was based on increasing VRE supported by firming provided by existing dispatchable generation and new entry storage and gas generation. The Base Scenario:

1. Was consistent with current energy policy and announcements (eg AEMO Neutral Outlook and ISP);
2. Incorporated the most likely assessment of economic condition and costs; and
3. Was guided by rational economics.

Two models of the NEM were developed covering a 55-year period:

1. **2018-19 to 2046-47 (PROPHET modelling)** - detailing two cases: the Project is not developed ('without Snowy 2.0') and the Project commences operation 1 July 2025 ('with Snowy 2.0').[8] The PROPHET detailed simulation modelling stopped at 2047 as simulation past this date would be too uncertain; and
2. **2047-48 to 2074-75 (MJA Firming Analysis Model)** - fundamental analysis of firming needs under different levels of VRE and the associated value of storage to determine the annual value of the Project.[9]

The modelling produced a number of general conclusions:

1. **Risk** - the NEM will become increasingly uncertain and complex with increasing risks as the existing coal plant closes;
2. **Firming** - firming capacity availability will decrease as coal plant closes. As additional VRE is added, there will be an increasing need for new firming assets; and
3. **Emissions reduction** - as coal plants close and the amount of VRE increases, economics favour gas generation. This limits capacity for

[8] The PROPHET Simulation Model is an advanced simulation model of common clearing price electricity markets. It is used by many parties in Australia (portfolio generators and retailers) and in many major assignments in Australia and overseas.
[9] The MJA Firming Analysis Model is a proprietary model, built in-house, with its objective being to hypothesise the amount of firming required under various levels of VRE penetration in the NEM.

emissions abatement. Further emissions reduction would require a regulatory mechanism (eg the NEG), which would favour deep storage.

6 Revenue sources and portfolio modelling

6.1 Introduction

The Project has a number of effects on the Snowy Hydro asset portfolio including utilisation, risks and operations. These effects are evaluated in the context of MJA modelling results relevant to the business case of Snowy Hydro.

The Project will add 2,000 MW of dispatchable capacity to Snowy Hydro's asset portfolio, on top of the existing 5,262 MW (including gas and diesel). This increases scheme-wide 99% certain capacity by the full 2,000 MW due to portfolio diversification benefits.

The additional energy produced and capacity available from the Project will enable greater internal hedging of Snowy Hydro energy needs for mass market, C&I and wholesale customer loads. It will also provide ancillary services and firming capacity for potential renewable projects sold direct to wholesale counterparties and indirectly through spot markets.

Snowy Hydro engaged independent market experts MJA as a third-party specialist economic modelling firm with comprehensive experience in the NEM. Multiple stages of work have been undertaken for both the Feasibility Study and for FID. This section specifically explores the effects of MJA's *economic* evaluation of the Project in future market states but converted into *financial* cash flow terms.

6.2 Snowy Hydro portfolio effects and internal valuation

The Project will add 2,000 MW of dispatchable capacity to Snowy Hydro's existing 5,262 MW portfolio.

The additional energy produced and capacity available from the Project will enable greater internal hedging of Snowy Hydro energy needs. It will also provide ancillary services and provide firming capacity for the market.

The Snowy Hydro internal valuation approach provides a NPV utilising the DCF methodology and economic assumptions based on and consistent with the MJA Report.

MJA's modelling considers the economic value created by the Project as a standalone asset. The internal valuation explores the five key areas of financial value obtained from the Facilities:

1. **Storage value** - the ability to purchase energy at low prices for pumping, store the energy as potential energy of water, then sell generated energy when profitable;
2. **Capacity value** - the ability to sell and defend capacity 'hedge' (bespoke, very large, long-term and non-commoditised) products, providing network

reliability and security by supporting or firming the capacity of non-dispatchable or intermittent generation;
3. **Security value** - current participation in the regulation and five-minute Frequency Control Ancillary Services (***FCAS***) markets with respect to frequency control services, and future participation in other FCAS markets (pending upgrade of ***SCADA***);
4. **Drought protection** - the Project's ability to circulate very large quantities of energy around a closed loop, which does not require new water from inflows, increases the amount of energy and capacity that can be provided by the Scheme when inflows are at extreme lows; and
5. **Firming products** - the emerging market for storage-related products for balancing, firming, and shifting intermittent renewable output as VRE penetration increases.

Not developing the Project poses risk to Snowy Hydro:

1. **Transmission access** - Transmission will continue to be developed regardless of Snowy 2.0. Its development is required to leverage the temporal (time of day/seasonal and weather-related) diversity of geographically dispersed VRE resources, but without the Project, the transmission paths will ultimately bypass and crowd-out the existing scheme reducing future market access for Snowy Hydro. See *Chapter Three* for details.
2. **Supply-demand competition** - increasing demand for firming product may be offset by market over-supply of firming technology, causing competitive downward pressure on prices and potential decrease in market power.

A number of other factors were considered in internal valuation:

1. **Risk limits** - A review for a potential increase in risk limits will be required for Futures Cash Flow at Risk and Stress Test internal policy. Credit risk limits for individual counterparties may need to be increased as Snowy Hydro increases its contracting levels with them, and/or a wider spectrum of counterparties may arise.
2. **Large-Scale Generation Certificates (*LGC*)** - LGC benefit and liability was considered. Any potential benefit was excluded from modelling, and the likely additional liability arising from Snowy 2.0 was considered immaterial;
3. **Liquidity threshold** - future liquidity requirements will be quantified when TransGrid's long-term transmission plans are clear. Management, however, believe transmission redundancy will likely increase in the future and dispatch capability failure risk will reduce; and
4. **Hydraulic operations** - the Project can be operated as desired within the confines of the Snowy Water Licence and Snowy Hydro's operational risk tolerances. The Project can provide additional control over the consequences and to a lesser extent the frequency or duration of impact of extreme inflows through careful planning of operations.

7 Drivers of revenue

7.1 Introduction

There is significant uncertainty and increasing risk to the NEM as the existing thermal fleet retires and is replaced by VRE, gas generation and crucially, storage. These risks include the variability of energy production from VRE over both short and long-time scales, coal plant performance, availability of gas plant, and demand outlook. The future evolution of the NEM and the dynamics of energy arbitrage mean that the value arising from Snowy 2.0 is subject and sensitive to many factors. This section focuses on the macro assumptions underpinning those drivers of value and presents a qualitative overview of the transformation of the NEM over the next 50+ years.

7.2 Activities undertaken

This section focuses on the analyses undertaken by both Snowy Hydro and MJA that concern macro influences on Snowy Hydro revenue. The full MJA scope is explored in the *Market Modelling* section above.

7.3 Macro modelling assumptions

Snowy Hydro and MJA reviewed a number of information sources, including the NEM outlook, AEMO underlying assumptions, commissioned reports and State and Federal policy. A base set of assumptions was developed from this review.

The key macro assumptions are:

1. **Demand growth** - base case demand outlook was based on the more conservative AEMO's Electricity State of Opportunities 2017 (***ESOO*** 2017). There is potential for demand to be higher than projected;
2. **Coal generator closure profile** - profile is as presented in the AEMO ISP,[10] with all coal plant closing after 50 years of service except for Loy Yang A and Loy Yang B after 60 years of service. Notably, all existing coal plant would have closed by 2060;
3. **Existing coal generator performance** - ramp rates (as estimated within currently observed and bid parameters) and forced outage rates will increase in line with plant age. Observed mingen levels were used, with lower levels considered through sensitivity analysis;
4. **Transmission development** - The AEMO ISP (with an adjustment to bring forward the southern loop by ten years) was used as the basis for long-range development;
5. **Supply-side options and costs** - cost of conventional thermal plant not expected to decrease, solar and wind generation to continue to decrease, battery costs based on 4-hours storage;

[10] https://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Planning-and-forecasting/Integrated-System-Plan

6. **Gas and coal costs** - gas reserve outlook (AEMO, supported by analysis by EnergyQuest) is that substantial new reserves are required and will likely be at a higher cost;
7. **Behind-the-meter response and costs** - rooftop PV, behind-the-meter batteries, and demand-side management consistent with AEMO ISP, no storage contribution from EV;
8. **EV** - slow take-up until the mid-2020s, then accelerating take-up to saturation in 2055-60;
9. **Emissions and renewable energy policy** - the base case assumption is no emissions limits;
10. **Renewable energy schemes** - LGC prices are likely to collapse in the early 2020s, due to an increase in eligible generation. Victorian Renewable Energy Targets (***VRET***) and Queensland Renewable Energy Targets (***QRET***) are assumed to be met;
11. **Marginal Loss Factors (*MLF*)** - MLFs are substantially decreasing for new renewable generators, but the base case is based on current MLFs;[11] and
12. **Ancillary and other services** - FCAS prices are expected to reduce due to increased supply from batteries and the demand side. Energy adequacy (available reserve) may become a contracted service. The base case assumed Snowy 1.0 FCAS revenues would remain the same, Snowy 2.0 would access 50% more share of the 5-minute market, and there would be no revenue arising from an energy reserve service.

7.4 NEM energy market transformation

The NEM is undergoing a transformation, which is considered across three periods:

1. **2018 to 2025** - Pre-Snowy 2.0/Increasing VRE;
2. **2025 to 2047** - Post-Snowy 2.0/Transition to near-all VRE; and
3. **2048 to 2075** - Near-all VRE.

A summary of these periods is given in Table 2 below.

[11] MLFs are electrical transmission losses across the five regions in the NEM – Queensland, New South Wales (NSW), Victoria, South Australia, and Tasmania. AEMO publishes this information annually by 1 April as required by clause 3.6 of the National Electricity Rules (NER). The MLF for a connection point represents the marginal electrical transmission losses in electrical power flow between that connection point and the regional reference node (RRN) for the region in which the connection point is located.

Before Snowy 2.0	After Snowy 2.0 Enters	
2018 – 2025: Increasing VRE	**2025 – 2047: Transition to near all VRE**	**2048 to 2075: Near all VRE**
1. Increasing renewable generation in Vic and Qld 2. Liddell closes (in NSW) requiring (according to AEMO) 1000MW of replacement firm capacity into NSW. In 2022 this is provided by gas generation, battery, new VRE and increased interconnection to NSW 3. SA-NSW interconnector (Riverlink) developed in 2024 4. Gas market remains tight 5. Coal plant operation starting to change 6. Reduced retail margins and tighter wholesale energy purchase risk management.	1. Major transition upgrades in 2025 (Kerang link and Bannaby link) provide increased support between SA-Vic-NSW. SA/Vic/NSW have the characteristics of a single region. 2. LRET and VRET have been completed. QRET has continuing VRE development in Qld. 3. Vales Point projected to close in 2028. 4. Continuing large-scale VRE development reflects coal plant closures and a 2030 renewable or emissions policy. 5. All coal plant closes in NSW by 2044. 6. Post mid-2030's NEM energy surplus is reducing and firming capacity is increasingly required – storage and gas peaking 7. Increase in load following contracts	1. NEM moves to a system dominated by VRE and firming largely provided by storage and gas plant. 2. Value of storage increases due to the increasing amount if VRE required to be stored for later use. 3. Likely that the transmission interconnection will be further developed 4. Increasing periods of excess VRE result in spot prices reducing. 5. Price spread for S2.0 reflects low buy costs and gas-driven sell prices.

Table 2: NEM Development Periods

8 Valuation and selected business case

8.1 Introduction

Snowy Hydro has undertaken an internal valuation of the Project and the underlying key assumptions. The valuation was primarily driven by the key findings within the MJA Report, and assessment of the future market state.

As noted above, the Project will add 2,000 MW of dispatchable capacity to Snowy Hydro'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, C&I customers and wholesale customers. It will also provide ancillary services and provide firming capacity for renewable projects sold direct to wholesale counterparties and indirectly through spot markets.

Snowy Hydro chose to base its core analysis and sensitivities on the economic base case modelling and underlying assumptions developed by MJA. That is,

Snowy's base case is consistent with the parameters assumed by MJA and all sensitivity analyses reference this base case.

The valuation approach utilises the Board-approved DCF methodology and economic assumptions. The DCF valuation of the Project and its component parts are as at December 2018, unless otherwise stated.

Figure 1 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***).

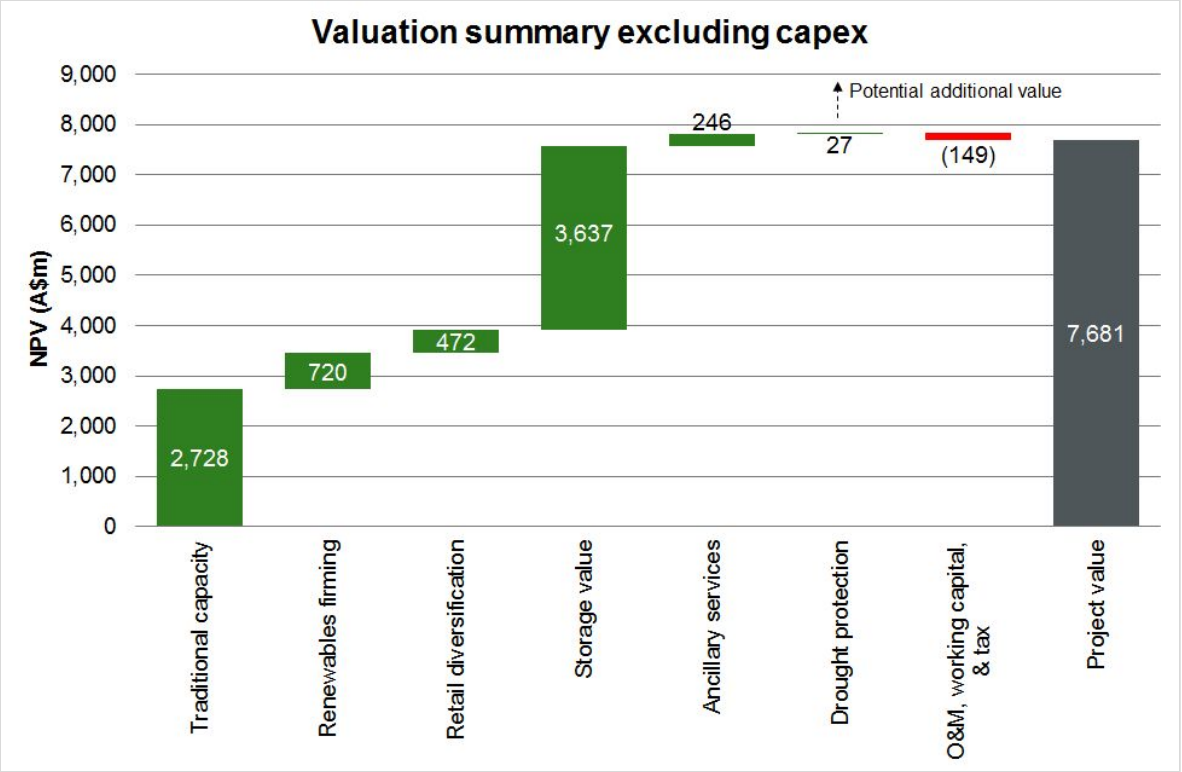

Figure 1: Valuation summary excluding capital cost

8.2 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) by transforming the intermittent supply into a firm, reliable supply;

4. **Retail diversification** - the portfolio value of non-coincident peak loads and the extent of imperfect correlation between sources of customer demand;
5. **System security** - increased capacity to participate in the five-minute 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 the *Scenario analysis* section below;
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.

9 Scenario analysis

9.1 Introduction

The range of valuation outcomes is infinite and thus is not exhaustive. However, the scenarios were selected to best demonstrate both the realistic, expected and the tail risk around the Base Case valuation.

9.2 Activities undertaken

The Snowy Hydro Commercial team compiled a series of scenario stress test outcomes to demonstrate the sensitivities around the Base Case value proposition. Specialist third-parties were engaged to maximise the assimilation of best available latest information into the assumption changes. MJA provided economic market modelling, Aurecon provided information on the flexibility of thermal plant and Macquarie Bank provided financing consultancy.

9.3 Valuation sensitivities and scenarios

The valuation scenarios were undertaken with two different approaches to fit two different strategic objectives:

1. **NEM scenarios** (Project value focus); and
2. **Snowy Hydro Corporate Scenarios** (debt-servicing focus).

The NEM scenarios highlight the uncertainty around market outcomes that primarily affect the Project value. The Snowy Hydro Corporate Scenarios were framed to satisfy the debt-servicing objectives of Standard & Poor's ***(S&P***) Rating Evaluation Service (***RES***).

A large number of scenarios were modelled to determine the robustness of the Snowy Hydro business case and whether to invest (or not) in the Project.

9.4 Modelling

9.4.1 'NEM' scenarios

Risks to Snowy Hydro (both Snowy 1.0 and Snowy 2.0) and the range of potential revenue streams that would be captured by Snowy 1.0 and Snowy 2.0 formed the basis of the scenarios developed.

The scenarios were a Base Scenario (considered most likely) and alternative scenarios that represented significant changes from the Base Scenario. The Base Scenario was:

1. Consistent with current energy policy and announcements;
2. Incorporated the most likely assessment of economic condition and costs; and
3. Developments and market operations were guided by rational economics.

The scenarios modelled were, briefly:

1. **Base Case** - current State government policy, NEG (26% reduction by 2030), announced and most likely closures and developments, economically rational entry and exit;
2. **Low Emissions** - stronger policy for emissions, high rooftop PV;
3. **Coal Early Closure** - all coal plant closed at 50 years;
4. **High Demand** - AEMO ESOO high-demand case;
5. **Hydrology Wet** - increased inflows due to wet climatic conditions;
6. **Hydrology Dry** - reduced inflows due to drought;
7. **High EV Penetration** - percent of EVs on the road (50% by 2030; 80% by 2040); and
8. **Cheap Battery** - accelerated cost depreciation and regulation requirement.

The Base Case was modelled over the period 2018-19 to 2074-75 on the basis that Snowy 2.0 does not enter, and on the basis that Snowy 2.0 enters 1 July 2025 (ie the 2025/26 year).

A key message from the modelling and results of these scenarios is that NEM market outcomes become increasingly complex and sensitive as the existing coal generators close. Increasingly, the 'layers' of generation with different Short Run Marginal Costs (***SRMC***) currently existing will be replaced with low marginal cost generation, gas generation and storage (which will likely have the opportunity value of sales at gas generation plus startup costs). This results in a price dynamic more sensitive to change.

Some of the existing coal power stations could close earlier than has been assumed in the Base Scenario. This could arise from policy changes or from economics associated with aging assets. The implications of coal closing earlier

are complex as it involves the response to replacing the firm capacity and the energy production foregone.

The modelling found Snowy 2.0 provides substantial value under all plausible scenarios. The Base Scenario sits near the middle of the range for the NPV impact on Snowy Hydro net spot market revenues due to Snowy 2.0.

9.4.2 'Snowy Hydro Corporate' scenarios

Five 'Snowy Hydro Corporate' scenarios were modelled with an emphasis on debt level constraints used in the S&P credit rating process:

1. **Base Case** - the difference between the value of Snowy Hydro with and without Snowy 2.0;
2. **NEM downside** - lower value of capacity and energy in the NEM;
3. **Hydrology Dry** - long-lasting reduced inflows to the Scheme;
4. **Severe downside capex** - overrun of $1.0 billion or 17%; and
5. **Consolidated downside** - NEM downside, capex overrun of $0.5 billion or 8%, and increased cost of funding.

10 Supporting information

There is no supporting information for this chapter.

11 Definitions and abbreviations

AEMO	Australian Energy Market Operator
AIP	Australian Industry Participation
CBS	Cost Breakdown Structure
DCF	Discounted Cash Flow
ECC	Early Contractor Consultation
EOI	Expression of Interest
EPC	Engineer-Procure-Construct
EV	Electric Vehicles
EWR	Exploratory Works - Roads
FCAS	Frequency Control Ancillary Services
FID	Final Investment Decision
GBR	Geotechnical Baseline Report
GIP	Geotechnical Investigation Program
GST	Goods and Services Tax
ISP	Integrated System Plan
LRET	Large-scale Renewable Energy Target
MAT	Main Access Tunnel
MJA	Marsden Jacob Associates
MLF	Marginal Loss Factors
NEG	National Energy Guarantee
NEM	National Electricity Market
PCP	Procurement and Contracting Plan

PHES	Pumped-Hydro Energy Storage
QRA	Quantitative Risk Analysis
QRET	Queensland Renewable Energy Targets
RES	Rating Evaluation Service
REZ	Renewable Energy Zones
RFI	Request for Information
S&P	Standard & Poor's
SRMC	Short Run Marginal Costs
VRE	Variable renewable energy
VRET	Victorian Renewable Energy Targets
WBS	Work Breakdown Structure
WUF	Water Utilisation Factors

12 Bibliography

There is no bibliography for this chapter.