Hydropower asset improvement at Gordon Power Station

Feasibility study

Knowledge sharing report

January 2018

Contents

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1.0 Executive summary

The purpose of Hydro Tasmania's *Battery of the Nation* (BotN) strategic initiative is to investigate and map out future development opportunities for Tasmania to make a bigger contribution to a future National Electricity Market (NEM).

Gordon Power Station in south-western Tasmania must maintain a minimum environmental flow release of 10 m^3/s from December to May (summer-autumn) and 20 m^3/s from June to November (winter-spring). This flow is mandatory under Hydro Tasmania's water license to ensure minimal impact on the ecology of the Gordon River.

When the station is not required for generation, environmental flows must still be maintained by running one of the station's large 144 MW units in a very low load range of 15-30 MW. This mode of operation historically occurs for around 30% of the time in summer-autumn and 50% of the time in winter-spring.

This means of providing the environmental flow is inefficient due to the poor efficiency of large Francis type hydro turbines in this low load range. A new smaller generator, sized appropriately for these flows, would be much more efficient and produce approximately double the energy output for the same flow (refer Figure 1).

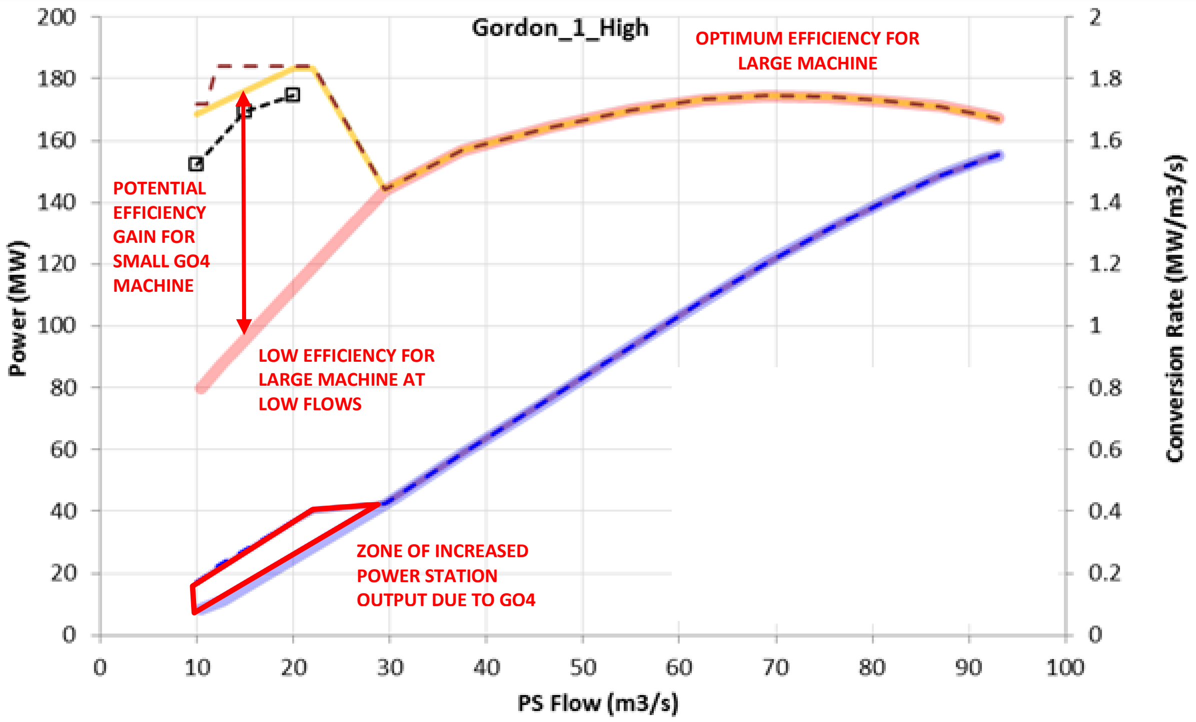


Figure 1: Example hydro turbine efficiency curves

As a result, a feasibility study into installing a separate environmental flow unit (referred to as Gordon 4 or GO4) in the Gordon Power Station has been completed. The study has included equipment design, supply and installation proposals from suppliers of the major new equipment and detailed civil construction estimates.

The study demonstrated that the GO4 project is technically and commercially feasible. The project has the following key benefits:

- Improved energy security in Tasmania through an increased annual generation of ~45 GWh.
- Prolonged asset life of the existing large machines as they no longer need to be operated for extended periods at low loads, which damages the turbines over extended periods.
- Minimal project approvals are required.

The estimated capital cost of the project is $25.4 million (-5%/+15%). The financial analyses show that the project would generate a viable IRR and NPV; however, cessation of the Renewable Energy Target (RET) scheme at the end of 2020 would mean that LGCs have no further value, reducing the IRR by about 1% and the NPV by about $2 million.

It is noted that under future market scenarios where capacity is more valued (such as those modelled by Hydro Tasmania's separate future NEM study), a changed operating regime for Gordon Power Station is likely to result in the new GO4 unit being run more often than under current projections. This would increase the annual energy gain and further strengthen the business case.

The study concluded that while considered a positive business case, the investment of capital against this project must be considered against Hydro Tasmania's other capital priorities. As such, the study recommended that:

- Hydro Tasmania does not immediately progress to implementation,
- the project be included for consideration in Hydro Tasmania's normal annual capital planning and prioritisation process, and
- any material change in future market price signals, in particular a relative shift in value from energy to capacity, triggers a review of the business case for possible implementation.

2.0 Introduction

2.1 Background and context

Gordon Power Station was originally constructed with provision for five units. Two units were initially installed in the 1970s and a third unit added in the 1980s, leaving two spare bays. These three large vertical-axis Francis units each have a design flow of ~85 m^3/s and an installed capacity of ~144 MW. Photos of the station are provided in **Figure 2** and **Figure 3**.

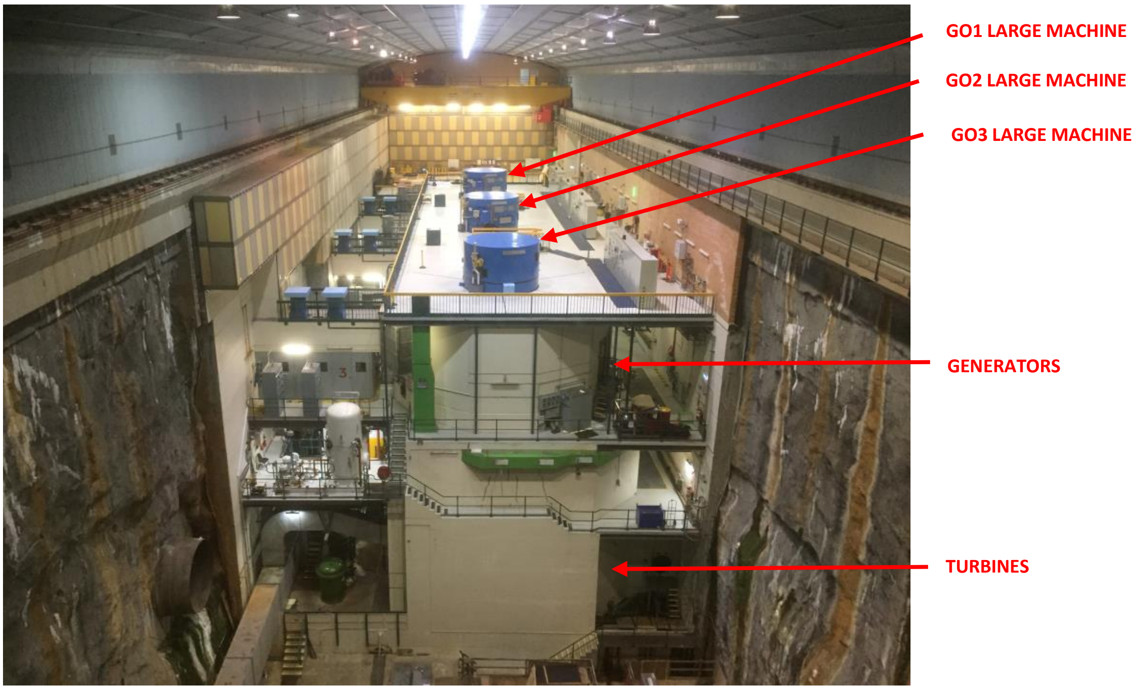
When Basslink was commissioned in 2006, the operating regime of Gordon Power Station changed due to new market drivers in the NEM. To mitigate the potential environmental impact of changed operations on the Gordon River downstream of the station, a regime of minimum environmental flow in the Gordon River was introduced, requiring minimums of 10 m^3/s in summer and autumn (December-May) and 20 m^3/s in winter and spring (June-November).

When the station is not required for generation, environmental flows must still be maintained by running one of the station's large 144 MW units in a very low load range of 15-30 MW.

Historically, the station discharges these environmental flows for 30% of the time in summer and autumn and 50% of the time in winter and spring. The three large Gordon units (GO1, GO2 and GO3) were not designed to run regularly at such low flows. As a result, the turbine efficiency is low and rough running is causing accelerated deterioration of the turbine runners.

Two spare bays of the five originally constructed remain within the Gordon Power Station underground cavern, with ample space for additional equipment without the need for costly additional excavation works. In recent years, Hydro Tasmania has been considering the use of one (or both) of these bays to install a new, smaller unit sized to discharge the environmental flows at much higher turbine efficiency, thereby increasing annual energy generation. This new unit is now referred to as GO4.

Hydro Tasmania undertook a pre-feasibility study in 2017 which concluded that the project is likely to be both technically and commercially feasible and recommended that a full feasibility study be commissioned.



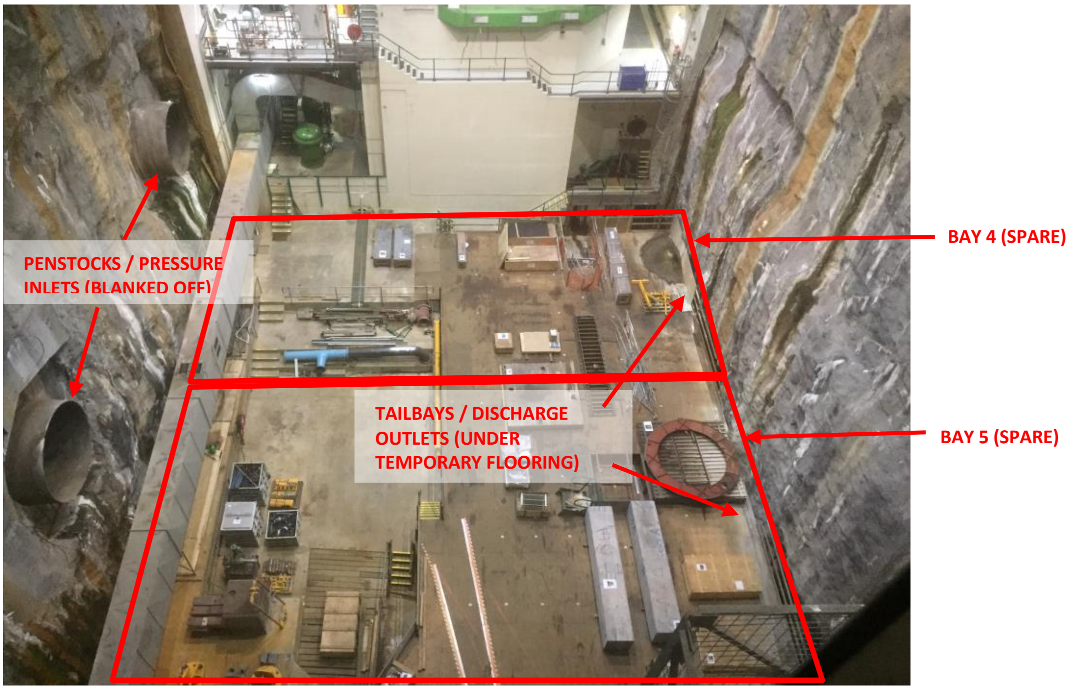


Figure 2: Gordon Power Station cavern

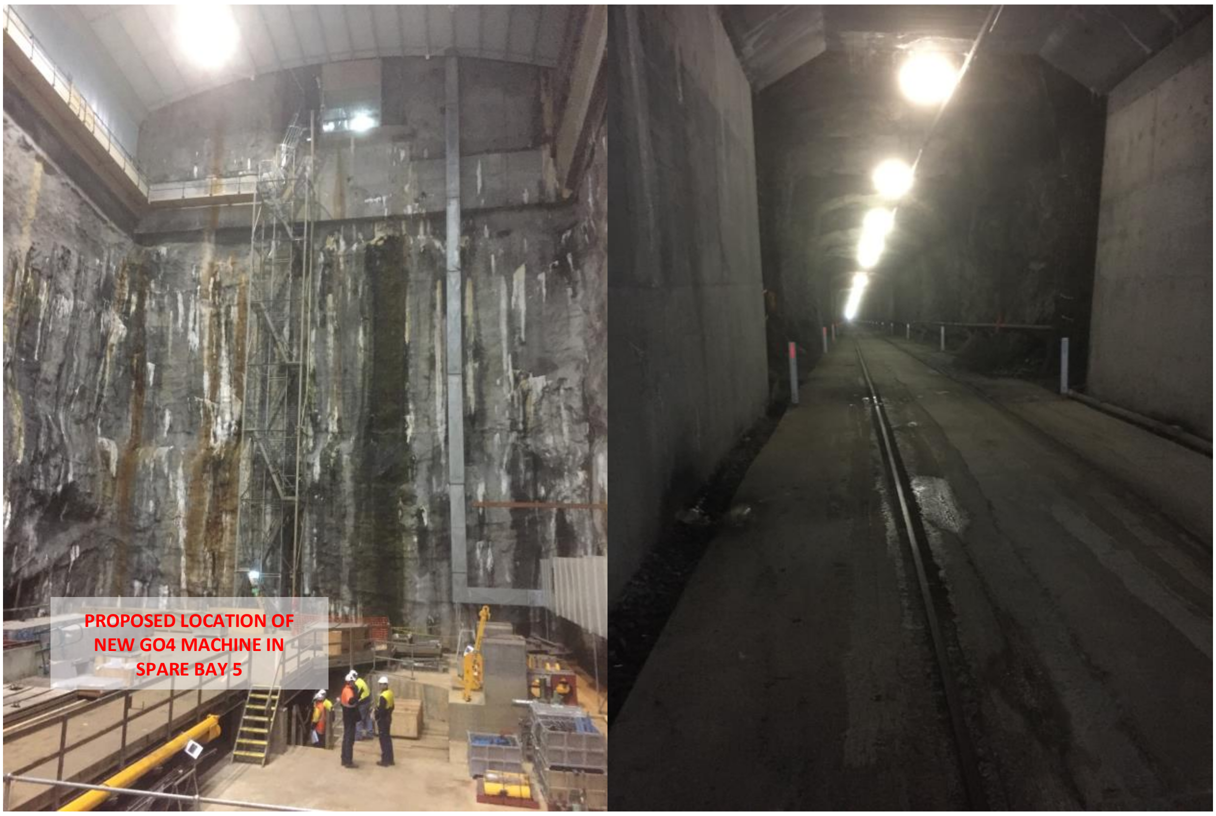


Figure 3: Gordon Power Station cavern and access

2.2 Study approach

The objective of the feasibility study was to assess the technical and commercial feasibility of installing an environmental flow unit at Gordon Power Station and, if the project is proven to be highly feasible, to develop a business case for implementation.

The main feasibility study scope items were as follows:

- *Technical feasibility*: Electrical and mechanical (E&M), civil works and primary electrical connection.
- *Commercial feasibility*: Project cost, energy modelling, energy revenue and financial modelling.
- *Project issues and risks*: Operational considerations and project approvals.

Project feasibility is dominated by the technical and commercial aspects of E&M supply and installation. As part of the scope of this study, Hydro Tasmania obtained from the market fully-costed E&M design, supply and installation proposals to meet the project objectives in the most optimal way.

The feasibility study was implemented through Hydro Tasmania's *Battery of the Nation* program and received a funding contribution from ARENA as part of ARENA's Advancing Renewables Program.

3.0 On river hydro

3.1 Description of asset class

Hydropower assets are a flexible and synchronous source of renewable energy generation with a long lifespan. These characteristics are conducive to addressing the issues of affordability, system security and emissions reduction in the energy sector.

On river hydropower involves raising the water level of a river or diverting water to another location so that it can be discharged through a turbine under pressure to generate electricity. Depending on the water source and scheme configuration, hydropower schemes can be classified as ‘run of river’ or ‘conventional’.

A ‘run of river’ scheme has limited storage and generates electricity continuously from effectively uncontrolled river flows, whereas a ‘conventional’ scheme can store water to generate when it is required.

The Gordon hydropower scheme is a conventional scheme with the ability to store large volumes of water (energy) and release it for generation when required, with the only caveat being that the station also operates to maintain minimum environmental flows in the Gordon River downstream of the power station. An important component of this is ensuring that environmental flows are maintained when the station would otherwise not be operated for electricity market purposes.

The proposed new environmental flow unit (GO4) will enable maximum energy efficiency and generation from the environmental flow releases from Gordon Power Station.

3.2 Applicable market, regulatory and system development issues

The NEM is facing a period of significant change. The aging coal infrastructure fleet is expected to progressively retire due to age-related deterioration (and possibly market pressures) and be replaced by new energy sources. The future NEM is expected to be vastly different to today, characterised by low-cost variable renewable energy sources being firmed by dispatchable (i.e. controllable) storage and generation.

Disruptions to electricity supply in the recent past have made Australia’s electricity supply a hot topic. The debate has been driven by incidences of high prices, and a shortage of reliable generation causing (or at least threatening) black-outs and brown-outs (i.e. restrictions in available electric power).

These changes in the physical power system will also prompt a change in the markets. Energy services that help manage the reliability and security of the system will become more valued by the market. New services that can shift bulk energy from times of energy surplus to times of relative energy scarcity will become critical. In order to meet the physical requirements of the system, new system services will be required that work alongside the low-cost variable energy sources. These services will help manage the variability of the future renewable generation sources and the magnitude and type of those services will depend on the characteristics of each region, particularly with reference to the need for short-term versus longer-term firming capability.

These changes are expected to drive a different future operating regime for existing hydropower stations such as Gordon, focussed more on energy storage, shorter-term capacity and provision of market support services as required. In turn, these expected changes in operating regime will drive increases in the time that Gordon would be operating primarily for environmental flow release purposes, reducing its overall efficiency further and enabling even greater benefits to be derived from a purpose designed environmental flow release unit.

The markets will also need to evolve to recognise and value these new services (such as inertia and fast rate of change) to provide the financial incentives to respond to the physical market needs. The current market price arbitrage mechanism for valuing storage and flexible, dispatchable capacity is not conducive to new investment and does not recognise the full value of services that it brings to the market.

3.3 Social license considerations

The Gordon hydropower scheme is located in a remote area of south-west Tasmania. The project involves installing a new hydropower machine in an existing underground station to release the same water through a more efficient machine, thereby producing more electricity. It will not have any impact outside of the station other than during construction. The project is not expected to have any significant social impacts or risks.

3.4 Role of Basslink to new on-river hydro investments

Basslink has been in service since 2006. Given its limited import/export capacity, there are currently few drivers for new, on-river hydropower investments in Tasmania.

Hydro Tasmania's system currently provides the majority of electricity to the Tasmanian market (base load and peaking). The objective of Basslink is to import base load power when prices are low in Victoria and to export peaking power when prices are high.

Future interconnection will reduce the constraint of import/export capacity and is expected to unlock Tasmania's potential to provide dispatchable renewable energy to the Australian mainland – the *Battery of the Nation*.

While this is not expected to encourage new on-river hydro development, it is expected to encourage investment in a whole range of renewable energy technologies including improving the flexibility of existing hydropower schemes (such as Gordon), pumped hydro energy storage and private wind farms.

Maximum value will be achieved by those schemes which can provide flexible capacity in a market with increasing penetration of non-dispatchable wind and solar generation sources.

4.0 Technical

4.1 Design characteristics

4.1.1 Feasibility design – turbine and generator

A functional requirements specification for the E&M supply was developed and proposals obtained from the market for fully-costed E&M design, supply and installation proposals to meet the project objectives in the most optimal way. This has provided a high level of confidence in the technical feasibility and cost of the main turbine and generator plant required for the project, which is reflected in the other elements of the feasibility study.

It was found that a horizontal shaft (rather than vertically mounted) turbine/generator arrangement is likely to be the most economic arrangement. Despite potentially slightly lower efficiency from this arrangement, it offers considerably lower civil construction complexity and cost.

4.1.2 Feasibility design – civil works

The scope of the civil works includes the following main items:

- Site mobilisation and demobilisation including the provision of a concrete batch plant.
- Site supervision, security and worker accommodation.
- Power station cavern establishment works including access, safety and protective works.
- Clearing, stripping and foundation preparation of the bay 5 area.
- Concrete works for the main operating floor slab and the main inlet valve (MIV), turbine and generator foundations.
- Perimeter walls and cavern wall stabilisation works.
- Connection works from the existing penstock to the new MIV.
- Concrete works for draft tube connection to tailbay and for draft tube gate.
- Miscellaneous concrete works and access stairways and platforms.

The civil works feasibility design was based on a selected manufacturer's design proposal in bay 5. A three-dimensional laser scan was performed of Gordon Power Station bays 4 and 5 to produce a high-resolution survey model of the existing surfaces.

The new turbine/generator unit was then inserted into the model including the connections with all relevant interface points including the existing penstock, main inlet valve, draft tube and draft tube gate and connection with the tailbay. The survey model and the locations of the new works enabled the civil works (in particular the concrete volumes) to be estimated to a high level of accuracy. A drawing, models and photos of the design are provided in appendix A.

4.1.3 Feasibility design – primary electrical connection

The primary electrical connection was considered in detail as part of the feasibility study. This is because Gordon Power Station is underground and has non-standard 18 kV generators and primary electrical equipment. Two connection options for the new generating plant were considered:

- Connection of GO4 to one of the existing 144 MW units (GO1, GO2 and GO3) with new busbars and switchgear within the station. This would require an 18 kV generator or an 11 kV-18 kV dry-type transformer.

- Independent unitised connection of GO4 to the existing surface switchyard. This would enable use of a standard 11 kV generator but requires more comprehensive electrical connection arrangements including running new 11kV busbars/cable up the existing shaft (~200 m length) to the switchyard, where a new 11 kV-220 kV transformer would be installed.

A detailed assessment of the pros and cons of both options was undertaken.

- Option 1 was found to be technically challenging, with significant cost uncertainty and high operational risk due to its potential to impact the security and reliability of the larger main unit that would be part of the connection. Despite being the cheaper of the two options, it is not preferred.
- Option 2, which is more expensive, is more standardised, provides greater operational flexibility and redundancy and has considerably lower operational risks.

4.1.4 Proposed operating regimes

Potential operating regimes of GO4 were developed with extensive input from Hydro Tasmania's Spot Market Operations team. The three potential regimes are presented in Table 1. The preferred operating regime modelled for this study was regime B, however, this could change in future with changed market drivers.

Description	Regime A	Regime B	Regime C
Isolated operation to provide environmental flow	✓	✓	✓
Parallel operation with one or more other units when directed by AEMO (e.g. for provision of FCAS)	✓	✓	✓
Parallel operation with one or more other units as required by HT within existing operating bands	✗	✓	✓
Parallel operation with one or more other units as required HT up to 20 m^3/s or 35 MW beyond existing operating bands	✗	✗	✓

Table 1: Proposed operating regimes of GO4

4.1.5 Feasibility design summary

The feasibility design is summarised as follows:

- 35 MW horizontal axis Francis turbine.
- Single runner optimised for 20 m^3/s flow.
- E&M works configured to minimise civil works.
- GO4 installed in bay 5, leaving bay 4 for storage.
- 11 kV generator.
- Direct electrical connection to switchyard up existing shaft (~200 m length).
- 11 kV / 220 kV transformer in existing switchyard.

4.2 Key challenges in delivering solutions

4.2.1 Technical challenges

There are many technical challenges associated with retrofitting a new turbine in an existing power station. These challenges are exacerbated at Gordon Power Station, which is an underground station in a remote area of Tasmania.

Key technical challenges are summarised below:

- *Transport to site*: The large size and weight of some of the electrical and mechanical (E&M) equipment exceeds some Tasmanian bridge limits. Selected equipment may need to be transported in components and assembled on site.
- *Access to the underground cavern*: Access is via a steep decline (tunnel) with concrete invert and unlined walls and roof. The size and stability of the tunnel needs to be considered as part of the construction planning.
- *Ventilation*: Intensive construction activity may exceed the capacity of the existing ventilation system. Additional ventilation may need to be installed and petrol engines will not be permitted due to carbon monoxide emissions.
- *Working around existing machines*: The three large machines will be in operation during the construction works. All equipment will need to be lifted over the existing machines with the station crane. Protective ‘catch’ netting will be installed over exposed parts of the machines to avoid impact damage.
- *Impact on station auxiliary systems*: The new GO4 machine will impact on several existing auxiliary systems such as power supply and emergency dewatering. A substantial allowance has been made in the feasibility study for system integration works.
- *Outage management*: Installation of GO4 will require full station outages for interconnection of the new machine with the existing penstocks (pressure inlet) and the tailbays (discharge outlets). The outages will need to be very carefully planned and managed to minimise impact on system security or market opportunities.
- *Installation of busbars up the vertical shaft*: A direct electrical connection between GO4 and the surface switchyard requires the installation of a new busbar up the existing busbar shaft (~200 m length). In order to safely install the busbar while the station is operating, careful management of exposure to electromagnetic fields (EMF) from the operating machine busbars will be required.
- *Electrical and mechanical (E&M) equipment configuration*: Project costs are dominated by procurement and installation of E&M equipment and civil works costs. These items need to be optimised together as a potentially cheaper E&M configuration may involve significantly greater civil works costs. The feasibility study found that a single, horizontal axis Francis turbine set as low as possible in the power station cavern is likely to have the lowest total project cost and shortest installation time.
- *E&M equipment customisation*: Due to the sensitivity of project feasibility to project cost, Hydro Tasmania invited E&M manufacturers to propose ‘off the shelf’ solutions with minimal customisation. The lower procurement cost of an ‘off the shelf’ solution needs to be considered against potentially higher integration and operational costs.

The challenges associated with the design, installation and commissioning/integration of GO4 were assessed in the early stages of the feasibility study through a HazOpS (hazard and operability study). The HazOpS included representatives from key experts with a wide range of technical expertise and construction and operational experience.

The study was undertaken prior to the development of E&M design, supply, install proposals and the results made available to the E&M proposal developers. HazOpS is an ongoing process and will be reviewed should the project proceed to implementation.

4.2.2 Operational considerations

Detailed consideration of the operational impacts of GO4 and identified the following:

- *Primary electrical connection of GO4 to an existing unit (GO1, GO2 or GO3) poses a number of operational risks and limitations, including the ability to use one of the machines to provide ancillary services. For these and other reasons, an independent, unitised connection of GO4 to the switchyard is proposed.*
- *It is highly desirable to have the operational flexibility to operate GO4 in conjunction with one or more of the existing large units. Otherwise more frequent start-stop operation of GO4 would be required which increases machine operation and maintenance costs, and the start/stop time responsiveness of the main Gordon units would be reduced which introduces both station operational risks and market opportunity risks.*
- *In order to achieve the modelled energy gain, GO4 needs to operate at least 72% of the time in winter-spring (20 m3/s) and 35% of the time in summer-autumn (10 m3/s). This would require specific operational management to ensure business benefits are realised.*

4.3 Review of current turbine market

A shortlist of three international hydro generating equipment manufacturers was selected and a formal request for proposal (RFP) process conducted to assess the market as part of this study. Hydro Tasmania self-funded this process outside the scope requirements of the funding agreement with ARENA.

A functional requirements specification for E&M design, supply and installation specific to the GO4 project was developed. The specification included the full range of expected power station functional requirements, with the exception of ancillary services, which are already provided by the existing large Gordon units.

The specification was deliberately open-ended to allow maximum flexibility to propose solutions to balance maximum efficiency (i.e. energy output) and least supply and installation cost (including associated civil construction costs). Emphasis was given to the need to provide largely ‘off the shelf’ equipment with a configuration which minimises civil works costs.

The selected manufacturers provided a range of technical solutions. Two manufacturers proposed horizontal axis machines and the third proposed vertical axis machines. Horizontal axis machines are preferred as they require less civil works and are quicker to install, however are understood to be at the ‘upper end’ of the technical limitations for horizontal axis Francis type hydro machines.

Two manufacturers proposed ‘change-over’ runners to maximise turbine efficiency: i.e. a runner optimised for the summer-autumn flow of 10 m^3/s and another runner optimised for the winter-spring flow of 20 m^3/s. While this is an innovative consideration, the energy modelling found the energy gain benefits of change-over runners to be largely offset by the energy lost during the changeover (outage) time.

Overall, the assessment confirmed that typically available hydro generating equipment would be suitable for the objectives of the project.

5.0 Capital cost

5.1 Project cost estimate

A detailed cost estimate was developed as part of the study and is summarised in Table 2. The detailed estimate, which includes information contained within the commercial offers submitted by the electrical and mechanical manufacturers, is considered confidential and is not included in this knowledge sharing report.

Costs were separated into direct costs and indirect costs. Direct costs include the civil works contract, E&M supply and installation contract and electrical works contract. Indirect costs include civil and electrical detailed design, contract management, project management, site supervision, outages and Hydro Tasmania integration and adaptation costs.

Item	Cost ($M incl. contingency)	Reference
DIRECT COSTS	**22.8**	
Civil works	3.8	Scope and quantities by Entura Unit rates by specialist civil works estimator in collaboration with industry
Main E&M supply & install	17.0	E&M supplier commercial offers (incl. generating plant, control & protection, HV electrical equipment) Draft tube gate estimate by Entura. Minor additional items to suit O&M requirements
HV Electrical installation	2.0	Estimate developed by Entura with industry budget pricing
INDIRECT COSTS	**2.6**	Detailed design estimates by Entura Outage cost estimates by HT Integration and adaptation costs by HT
TOTAL PROJECT COST ESTIMATE	**25.4**	Accuracy -5% ($24.1M) to +15% ($29.2M) Includes $1.4M (6%) contingency

Table 2: GO4 project cost estimate

5.2 Procurement approach

The following procurement approach was recommended by the feasibility study. The project is similar in scale and nature to many of the major refurbishment and upgrade projects being undertaken by Hydro Tasmania over many years as part of its long-term asset management. The procurement approach leverages this experience in packaging projects for procurement to achieve the most effective outcomes and manage the risks associated with major works in operating power stations.

- *Detailed design*: The civil and HV electrical works detailed design is specialised in nature and requires considerable knowledge of the existing power station as well as interfaces with the E&M manufacturer. Due to the need to manage the work within an existing operating power station, it was determined the risks associated with the work are best managed by HT as the asset owner, with the work undertaken by HT's consulting group, Entura.

- *Civil works contract*: Includes site management and supervision, preliminaries (including concrete batch plant) and civil works associated with a single horizontal axis Francis machine. The contract is proposed to be competitively tendered and provide opportunities to local contractors.
- *Electrical and mechanical (E&M) supply and installation contract*: Includes E&M design, manufacture, supply, installation and commissioning. Components include: turbine, generator, primary electrical (including transformer), secondary systems and draft tube gate.
- *Electrical works contract*: Includes supply and installation of bus work in the bus shaft and civil and electrical works in the switchyard (including supply of civil and miscellaneous electrical equipment for the switchyard). The contract is proposed to be competitively tendered and provide opportunities to local contractors.

6.0 Revenue model

6.1 Energy modelling

Energy modelling was undertaken to estimate the annual energy gain from operation of Gordon Power Station with three large units + GO4 over its existing configuration. The model itself (a comprehensive system energy and water optimisation model), the modelling inputs and assumptions are commercially sensitive and not included in this knowledge sharing report. The key model outputs are summarised below.

The modelling found that GO4 would operate 72% of the time in winter-spring (20 m^3/s) and 35% of the time in summer-autumn (10 m^3/s). Hence, most of the benefits of GO4 will be accrued during the winter-spring period.

The modelling estimated an annual energy gain of 45 GWh (‘at node’ including station losses and the marginal loss factor [MLF]) and around 10 GWh in large generation certificates (LGCs). The energy gain is due to the increased efficiency of GO4 turbine in comparison with the existing large units as shown in Table 3.

Season	Energy conversion rate at SL 284.8 m Existing large units (MW/m^3/s)	Energy conversion rate at SL 284.8 m GO4 unit (MW/m^3/s)
Summer-autumn	0.67	1.52 (+127%)
Winter-spring	1.14	1.65 (+45%)

Table 3: Energy conversion rates of existing large units vs new GO4 unit

6.2 Financial analyses

Financial analyses were undertaken with revenue assumptions based on Hydro Tasmania’s Board-approved projections for energy and large generation certificates (LGCs) values and are therefore confidential. As the objective of the project is to increase the overall annual energy generation from the station, the modelling did not include any additional benefit from non-energy services such as ancillary services.

Other key assumptions are summarised below:

- Analysis period 61 years (1 year construction and 60 years operation).
- Annual operations and maintenance costs of $100k and mid-life refurbishment costs of $6M (refer7.0 Operational cost).

Table 4 summarises the relative results of the financial analyses interpolated for the project estimated capital cost of $25.4M with a sensitivity analysis of -5% / +15%. The financial analyses show that the project would generate a viable IRR and NPV; however, cessation of the Renewable Energy Target (RET) scheme at the end of 2020 would mean that LGCs have no further value, reducing the IRR by about 1% and the NPV by about $2million.

Project cost	$24.1M (-5%)	$25.4M (most likely)	$29.2M (+15%)
IRR (%)	+0.6%	**Base case**	-1.4%
NPV ($M)	+1.2M	**Base case**	-$3.6M

Table 4: Results of financial cost sensitivity analyses for GO4 project

7.0 Operational cost

Operation and maintenance (O&M) costs include two main components: (1) annual O&M costs and (2) mid-life refurbishment costs.

Gordon Power Station was commissioned in the late 1970s; hence Hydro Tasmania has considerable experience in O&M management at this site and with other machines of similar size to the G04 proposed machine. Based on this experience, an annual cost of $100k is a reasonable allowance for additional maintenance associated with the O&M of a new machine of this size.

While the overall project will have a design operational life of 60 years, in Hydro Tasmania's experience the electrical and mechanical equipment will require a substantial mid-life refurbishment around 30 plus years. A mid-life refurbishment typically includes the following items and for a machine the size of G04 has been estimated to cost approximately $6M in today's terms:

- HV Transformer mid-life refurbishment.
- Turbine dismantling and refurbishment (including labour associated with the outage).
- Generator refurbishment and circuit breaker replacement.
- Balance of plant major maintenance/replacement (coolers, brakes, bushes, etc.).
- Main inlet valve removal and refurbishment.

8.0 Financing

The most likely capital cost of the project is estimated to be $25.4M. This would be managed off the Hydro Tasmania balance sheet.

Pending a project investment decision, the following indicators are being monitored which could signal a change in the project business benefits and a move up the capital expenditure priority stack for the project:

- Change in the operating regime of Gordon Power Station.
- Change in weighted average cost of capital (WACC).
- Sustained market price volatility.
- Sustained high spot and/or swap prices.
- Increase in the long-term price benchmark.
- Closure of any major generator in the NEM.

9.0 Land acquisitions, connection and environment

9.1 Land acquisition

No land acquisition is required as part of the project as the new GO4 unit will be installed in the existing Gordon Power Station underground cavern.

9.2 Approach to network connection

The new GO4 is proposed to have a direct/unitised connection to the existing Gordon Power Station switchyard where a new 11 kV-220 kV transformer will be installed. Constraints along the transmission line linking Gordon Power Station with the Tasmanian network are rarely an issue as there are two lines and either line can handle full station load except on the hottest days.

9.3 Project approvals

The project planning and environmental approval requirements have been determined to fall under the Commonwealth *Environmental Protection and Biodiversity Conservation Act 1999* (EPBCA) and State legislation.

Requirements under State legislation:

- Planning approval is not required for the installation and operation of the project under s.60(92)(a) of the Land Use Planning and Approvals Act 1993.
- There is no requirement for consent or other restriction on the project under the Hydro-Electric Corporation Act 1995.
- A building permit from the West Coast Council is the only planning/environmental approval that may be required for the project under State legislation.

Requirements under Commonwealth legislation (operating regime B – refer **Table 1**):

- If GO4 is operated under the proposed regime, there is exposure to the project falling outside the existing use right protections of the EPBCA. The reason being that it will necessarily change (albeit marginally) the flow release patterns from the station. Accordingly, it may be regarded as an 'intensification of the use' or a 'change in the nature of the activity comprising the use'.
- In order to pursue this option, Hydro Tasmania would need to undertake an internal environmental analysis to determine if there were any possible environmental impacts associated with the likely flow release changes.
- Early engagement with the Commonwealth Department of Environment and Energy (DEE) and the Tasmanian Department of Primary Industries, Parks, Water and Environment (DPIPWE) would be prudent; a low risk option may be to refer the project to the Commonwealth Minister for Environment (CEM) on the basis that it is determined to be either:
    - a non-controlled action (assessment and approval not required); or
    - a particular manner decision under section 77A of the EPBCA. That is, provided HT operates GO4 as described in the referral documentation (i.e. operating rules that limit parallel operation to water discharges within existing operating bands), an approval is not required.

10.0 Conclusion and next steps

10.1 Project duration and next steps

The critical path for the project schedule is the design, manufacture, transport, installation and commissioning of the electrical and mechanical (E&M) equipment. The civil works feasibility design included detailed scoping of the civil works tasks and identification of the necessary interaction points with the E&M manufacturer. It also assessed station outage durations associated with interconnection of the new main inlet valve (MIV) to the existing penstock and the new draft tube to the existing tailbay.

The project duration is estimated to be 20 months from award of the electrical & mechanical contract. However, the project is not immediately progressing to implementation, and will be included for consideration in Hydro Tasmania's normal annual capital prioritisation process.

10.2 Conclusions

The study demonstrated that the GO4 project is technically and commercially feasible. The project has the following key benefits:

- Improved energy security in Tasmania through an increased annual generation of ~45 GWh.
- Prolonged asset life of the existing large machines as they no longer need to be operated for extended periods at low loads, which damages the turbines over extended periods.
- Minimal project approvals are required.

The estimated capital cost of the project is $25.4 million (-5%/+15%). The financial analyses show that the project would generate a viable IRR and NPV; however, cessation of the Renewable Energy Target (RET) scheme at the end of 2020 would mean that LGCs have no further value, reducing the IRR by about 1% and the NPV by about $2million.

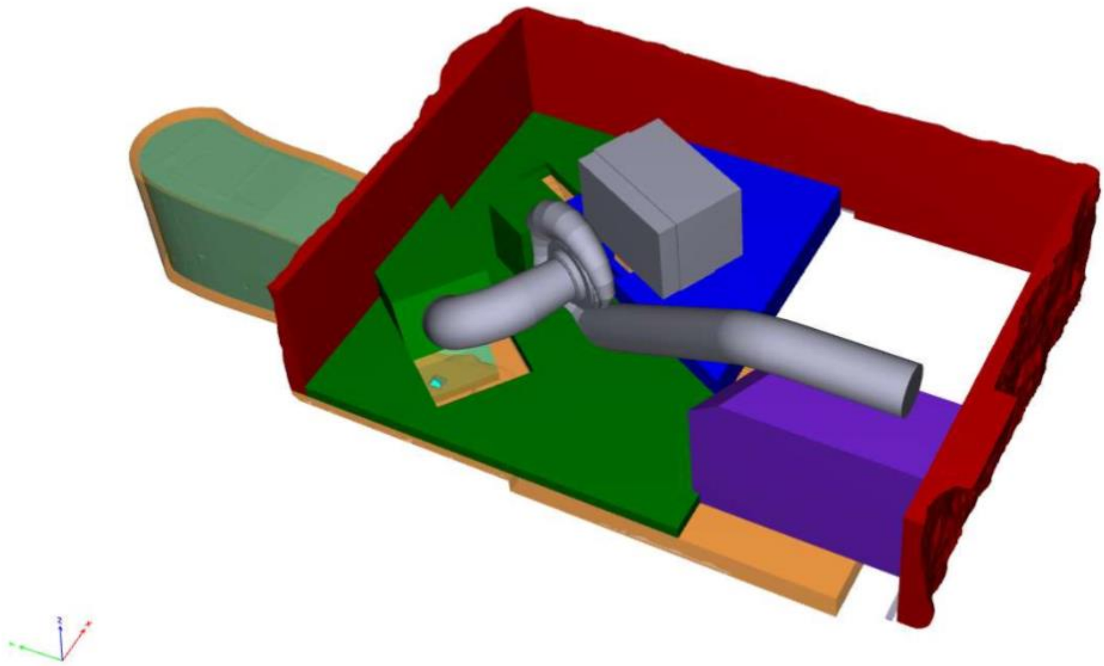
It is noted that under future market scenarios where capacity is more valued (such as those modelled by Hydro Tasmania's separate future NEM study), a changed operating regime for Gordon Power Station is likely to result in the new GO4 unit being run more often than under current projections. This would increase the annual energy gain and further strengthen the business case.

The study concluded that while considered a positive business case, the investment of capital against this project must be considered against Hydro Tasmania's other capital priorities. As such, the study recommended that:

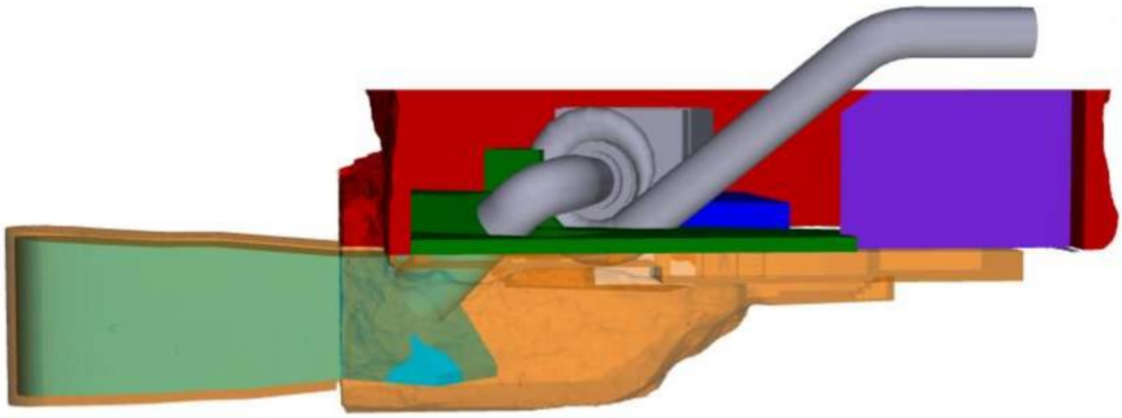
- Hydro Tasmania does not immediately progress to implementation,
- the project be included for consideration in normal annual capital planning and prioritisation process, and
- any material change in future market price signals, in particular a relative shift in value from energy to capacity, triggers a review of the business case for possible implementation.

11.0 Appendices

Appendix A – Design models and photos



Appendix Figure: Gordon Power Station environmental flow unit (GO4) – isometric view of horizontal axis Francis machine in bay 5



Appendix Figure: Gordon Power Station environmental flow unit (GO4) – elevation view of horizontal axis Francis machine in bay 5

Appendix Figure: Photos of an example installation of similar horizontal Francis units

Links to GIS animated fly-through

- Cavern with empty bays 4 and 5
- Cavern with new GO4 unit installed in bay 5