RAISE CONTINGENCY FCAS – CONTRACT DESIGN AND PRICING

15 October 2010

Consultation Draft

Intelligent Energy Systems

Executive Summary

Reason for Review

On 24 July 2009, the Tasmanian Energy Regulator (Regulator) gave written notice of an intention to declare the supply of raise contingency frequency ancillary services (fast raise, slow raise and delayed raise) by Hydro Tasmania to meet the Tasmanian local requirement as declared electrical services. This was followed in December 2009 with the publication of its "Statement of Reasons". The Regulator considers that Hydro Tasmania has substantial market power in the supply of the defined services and the promotion of competition, efficiency and the public interest warrants the declaration of the defined services.

The Regulator has commenced, in accordance with the requirements of the Electricity Supply Industry (Price Control) Regulations 2003, the process for making a determination that regulates the prices that may be charged by, and specifies the price control mechanisms imposed on, Hydro Tasmania for raise contingency frequency control ancillary services (FCAS) to meet the Tasmanian local requirement. At the commencement of the process the Regulator decided to conduct the review in two stages.

Stage 1

As part of Stage 1 of the review, Intelligent Energy Systems (IES) was retained by the Regulator to analyse and advise on the reasonable options for price control mechanisms to regulate the prices for the FCAS services. IES recommended the regulation of Hydro Tasmania's provision and pricing of FCAS hedge contracts as the most appropriate price control mechanism to regulate the declared electrical services (being raise contingency frequency control ancillary services supplied by Hydro Tasmania to meet the Tasmanian local requirement). The Regulator adopted the IES recommendation.

Stage 2

As part of Stage 2 of the review, the Regulator has retained IES to design the terms and conditions, price methodology and parameters for a general FCAS hedge contract that will be offered by Hydro Tasmania to other Tasmanian generators for raise contingency FCAS (the three raise FCAS products) supplied by Hydro Tasmania to meet the Tasmanian local requirement. These FCAS hedge contracts will be regulated for a period of five years.

Scope of Stage 2

Under the scope of the Stage 2, IES is required to

- establish the terms and conditions, pricing methodology and parameters for a general FCAS hedge contract in which the price for the supply of the declared electrical services reflects the opportunity cost of provision of the services in terms of foregone revenue in the energy and Renewable Energy Certificate (REC) markets where:

  - the terms and conditions, pricing methodology, parameters and prices are to be reflected, where appropriate, in Hydro's existing template contract for hedges, being the International Swaps and Derivatives 2002 Master Agreement, Hydro Tasmania's Schedule to the 2002 Master Agreement, and "Confirmation" document; and
  - the values of the input parameters can, to the greatest extent possible, be objectively determined.
- take account of the Final Report prepared by IES, in so far as it is relevant to this consultancy;
- note the information provided by Hydro Tasmania in its submission to the IES Draft Report, entitled Hydro Tasmania Submission on IES Draft Report on Raise Contingency FCAS – Price Control Mechanism, which describes Hydro Tasmania's hedge pricing principles including its cost components, and subsequent presentation by Hydro Tasmania to the Regulator on 26 July 2010;
- detail all key assumptions affecting the pricing methodology, parameters, terms and conditions and the sensitivity of changes in these assumptions;
- advise on the principles and methodology for a six monthly adjustment of the pricing inputs, price parameters and/or price methodology in advance of their application in an FCAS hedge contract;
- consider the means by which rare events, such as Basslink and Gordon Power Station outages should be treated, if at all, in the pricing of the services (for example, should a risk premium be paid to Hydro Tasmania, over and above its opportunity costs, to limit its risk exposure, or should rare events be excluded from the general contract; and
- advise on the extent to which confidentiality should be attached to the pricing of each of the parameters; in doing so, the consultant is to advise whether disclosure of the price could affect Hydro Tasmania's competitive position in the Tasmanian market or the National Electricity Market or is considered to be commercially sensitive for some other reason.

Principal Findings

In accordance with its scope, IES has established the terms and conditions, pricing methodology and parameters for a general FCAS hedge contract in which the price for the supply of the declared electrical services reflects the opportunity cost of provision of the services in terms of foregone revenue in the energy and Renewable Energy Certificate (REC) markets. The general hedge contract has been designed as a "safety-net contract" with the aim of providing a high quality hedge not subject to any special conditions (other than those concerned with self provision and new sources of supply) or exclusions. A pricing methodology has been developed, along with pricing parameters and the basis for setting each parameter value. The pricing methodology aims to be transparent and the proposed basis for determining each parameter value is meant to be as objective as possible.

The Final Report by IES on the first stage of the investigation “Raise Contingency FCAS – Price Control Mechanism”, 28 July 2010, concluded that “the regulation of Hydro Tasmania’s provision and pricing of FCAS contracts should be the preferred price control mechanism”. IES also concluded that the Regulator should approve a general contract design and that pricing parameters be determined in advance on a periodic basis rather than set by Hydro Tasmania and subject to limited disclosure. IES recognised the opportunity cost of foregone generation as the proper basis for pricing and that this should be valued as “the sum of the foregone electricity value, based on an appropriate water value or proxy, and the expected foregone REC value”. The methodology developed by IES in stage 2 is consistent with these conclusions. IES also expressed the view in its stage 1 Final Report that the cost to Hydro Tasmania of providing system inertia (by running certain generator units in synchronous condenser mode) should not be included as a cost for the purpose of pricing FCAS hedge contracts. Accordingly, our proposed methodology does not provide for the inclusion of this cost.

IES has considered the information provided by Hydro Tasmania in its submissions and presentations to the Regulator in respect of stage 1 of the investigation. Our views on these submissions and presentations are set out in our stage 1 Final Report.

In this report we set out all key assumptions affecting the pricing methodology, parameters, terms and conditions and highlight the sensitivity of changes in these assumptions. We also indicate the basis for setting each parameter on a period basis in advance of their application in an FCAS hedge contract.

With respect to rare events which might take the form as exclusions in the contract, we have proposed that the safety-net contract not include such exclusions leaving counterparties to negotiate separately for their inclusion.

We do not consider that confidentiality should be attached to any of the pricing parameters or standing data we have specified or identified. We do not believe that Hydro Tasmania’s competitive position in the Tasmanian market or the National Electricity Market is likely to suffer any material detriment by disclosing any of these parameter values and identified standing data generally.

Summary Recommendations

IES recommends that

- the general hedge contract serve as a “safety-net” contract providing a high quality hedge with no exclusions, and that generators be encouraged (but not required) to negotiate price discounts in respect of any exclusions and special conditions they are willing to accept;
- the adoption of the pricing methodology set out in this report along with the identified parameters and proposed basis of setting parameter values;

- the methodology, current values of parameters, standing data and “safety-net” contract documentation be published on Hydro Tasmania’s website.

Table of Contents

List of Figures

List of Tables

Glossary

Term	Definition
AEMO	Australian Energy Market Operator
AER	Australian Energy Regulator
AETV	Aurora Energy Tamar Valley
AGC	Automatic Generation Control
FCAS	Frequency Control Ancillary Services
IES	Intelligent Energy Systems
LRAC	Long Run Average Cost
LRMC	Long Run Marginal Cost
NCAS	Network Control Ancillary Services
NEM	National Electricity Market
NEMDE	National Electricity Market Dispatch Engine
OTTER	Office of the Tasmanian Economic Regulator
REC	Renewable Energy Certificate
SRMC	Short Run Marginal Cost
WACC	Weighted Average Cost of Capital

1 Introduction and Scope

1.1 Reason for Review

On 24 July 2009, the Tasmanian Energy Regulator (Regulator) gave written notice of intention to declare the supply of raise contingency frequency ancillary services (fast raise, slow raise and delayed raise) by Hydro Tasmania to meet the Tasmanian local requirement as declared electrical services. This was followed in December 2009 with the publication of its “Statement of Reasons”. The Regulator considers that Hydro Tasmania has substantial market power in the supply of the defined services and the promotion of competition, efficiency and the public interest warrants the declaration of the defined services.

The Regulator has commenced, in accordance with the requirements of the Electricity Supply Industry (Price Control) Regulations 2003, the process for making a determination that regulates the prices that may be charged by, and specifies the price control mechanisms imposed on, Hydro Tasmania for raise contingency frequency control ancillary services (FCAS) to meet the Tasmanian local requirement.

1.2 Stage 1 and 2 of the Review

At the commencement of the process the Regulator decided to conduct the review in two stages.

Stage 1

As part of Stage 1 of the review, Intelligent Energy Systems (IES) was retained by the Regulator to analyse and advise on the reasonable options for price control mechanisms to regulate the prices for the FCAS services. IES recommended the regulation of Hydro Tasmania’s provision and pricing of FCAS hedge contracts as the most appropriate price control mechanism to regulate the declared electrical services (being raise contingency frequency control ancillary services supplied by Hydro Tasmania to meet the Tasmanian local requirement). The Regulator adopted the IES recommendation.

Stage 2

As part of Stage 2 of the review, the Regulator has retained IES to design the terms and conditions, price methodology and parameters for a general FCAS hedge contract that will be offered by Hydro Tasmania to other Tasmanian generators for raise contingency FCAS (the three raise FCAS products) supplied by Hydro Tasmania to meet the Tasmanian local requirement. These FCAS hedge contracts will be regulated for a period of five years.

1.3 Scope of Stage 2

Under the scope of the Stage 2, IES is required to

- establish the terms and conditions, pricing methodology and parameters for a general FCAS hedge contract in which the price for the supply of the declared electrical services reflects the opportunity cost of provision of the services in terms of foregone revenue in the energy and Renewable Energy Certificate (REC) markets where:
  - the terms and conditions, pricing methodology, parameters and prices are to be reflected, where appropriate, in Hydro's existing template contract for hedges, being the International Swaps and Derivatives 2002 Master Agreement, Hydro Tasmania's Schedule to the 2002 Master Agreement, and "Confirmation" document; and
  - the values of the input parameters can, to the greatest extent possible, be objectively determined.
- take account of the Final Report prepared by IES, in so far as it is relevant to this consultancy;
- note the information provided by Hydro Tasmania in its submission to the IES Draft Report, entitled Hydro Tasmania Submission on IES Draft Report on Raise Contingency FCAS – Price Control Mechanism, which describes Hydro Tasmania's hedge pricing principles including its cost components, and subsequent presentation by Hydro Tasmania to the Regulator on 26 July 2010;
- detail all key assumptions affecting the pricing methodology, parameters, terms and conditions and the sensitivity of changes in these assumptions;
- advise on the principles and methodology for a six monthly adjustment of the pricing inputs, price parameters and/or price methodology in advance of their application in an FCAS hedge contract;
- consider the means by which rare events, such as Basslink and Gordon Power Station outages should be treated, if at all, in the pricing of the services (for example, should a risk premium be paid to Hydro Tasmania, over and above its opportunity costs, to limit its risk exposure, or should rare events be excluded from the general contract; and

  advise on the extent to which confidentiality should be attached to the pricing of each of the parameters; in doing so, the consultant is to advise whether disclosure of the price could affect Hydro Tasmania's competitive position in the Tasmanian market or the National Electricity Market or is considered to be commercially sensitive for some other reason.

1.4 Principal Findings

In accordance with its scope, IES has established the terms and conditions, pricing methodology and parameters for a general FCAS hedge contract in which the price for the supply of the declared electrical services reflects the opportunity cost of provision of the services in terms of foregone revenue in the energy and Renewable Energy Certificate (REC) markets. The general hedge contract has been designed as a “safety-net contract” with the aim of providing a high quality hedge not subject to any special conditions or exclusions. A pricing methodology has been developed, along with pricing parameters and the basis for setting each parameter value. The pricing methodology aims to be transparent and the proposed basis for determining each parameter value is meant to be as objective as possible.

The Final Report by IES on the first stage of the investigation “Raise Contingency FCAS – Price Control Mechanism”, 28 July 2010, concluded that “the regulation of Hydro Tasmania’s provision and pricing of FCAS contracts should be the preferred price control mechanism”. IES also concluded that the Regulator should approve a general contract design and that pricing parameters be determined in advance on a periodic basis rather than set by Hydro Tasmania and subject to limited disclosure. IES recognised the opportunity cost of foregone generation as the proper basis for pricing and that this should be valued as “the sum of the foregone electricity value, based on an appropriate water value or proxy, and the expected foregone REC value”. The methodology developed by IES in stage 2 is consistent with these conclusions. IES also expressed the view in its stage 1 Final Report that the cost to Hydro Tasmania of providing system inertia (by running certain generator units in synchronous condenser mode) should not be included as a cost for the purpose of pricing FCAS hedge contracts. Accordingly, our proposed methodology does not provide for the inclusion of this cost.

IES has considered the information provided by Hydro Tasmania in its submissions and presentations to the Regulator in respect of stage 1 of the investigation. Our views on these submissions and presentations are set out in our stage 1 Final Report.

In this report we set out all key assumptions affecting the pricing methodology, parameters, terms and conditions and highlight the sensitivity of changes in these assumptions. We also indicate the basis for setting each parameter on a period basis in advance of their application in an FCAS hedge contract.

With respect to rare events which might take the form as exclusions in the contract, we have proposed that the safety-net contract not include such exclusions leaving counterparties to negotiate separately for their inclusion. However we do consider it appropriate to include conditions relating to self provision and new sources of supply.

We do not consider that confidentiality should be attached to the pricing of any of the parameters we have specified. We do not believe that Hydro Tasmania’s competitive position in the Tasmanian market or the National Electricity Market is likely to suffer by disclosing these parameter values generally.

1.5 Structure of Report

The report is structured as follows:

- Chapter 2 addresses the principal contract design features,

- Chapter 3 specifies the contract pricing methodology,
- Chapter 4 identifies the inputs required by the pricing methodology and proposes the basis for setting the value of each; and
- Chapter 5 provides summary recommendations.

2 Principal Contract Design Features

2.1 Introduction

The FCAS contract will be structured as a forward commodity contract (swap contract). Under such contracts, counterparties exchange fixed for floating price payments in respect of a defined notional quantity.

Relevant terms include the specification of fixed and floating prices, designation of the fixed and floating price payers, contract duration in terms of effective date and termination date, and any special conditions or exclusions.

2.2 “Safety Net” Contract

IES recognises that the number of possible standard contract designs is potentially large, and that in practice counterparties can be expected to have strong incentives to negotiate around particular terms and conditions. Clearly it will be impracticable to anticipate all the desirable contract variations and regulate the price in each case. Consequently, IES considers it appropriate to regulate the price of a single “safety net” contract. This particular design should

- serve as an effective hedge of FCAS exposure for the buyer of the contract, and
- should not be subject to any special conditions or exclusions.

In this way, the price control mechanism will provide a reference price for a high quality hedging product.

The “safety net” contract will be for all raise contingency products, although IES is of the view that the cost of Hydro Tasmania providing other than the 6s raise service is not significant. Further, IES considers that

- the pricing of the “safety net” contract should be highly transparent with a relatively simple underlying pricing methodology and relatively few pricing parameters and assumptions.

While the “safety net” contract will be a high quality hedging product, IES considers that its availability should not be an impediment to any possibility of achieving a more efficient risk transfer between counterparties. Accordingly, IES is of the view that the party seeking to hedge its FCAS exposure, should be encouraged (but not required) to negotiate with Hydro Tasmania in relation to particular additional terms, conditions and exclusions with a view to achieving a lower price for the service consistent with its risk preferences. Should the parties fail to negotiate a mutually satisfactory commercial contract, Hydro Tasmania will be required to offer the party the “safety net” contract.

2.3 Bundled Contract

The "safety net" contract will be for a bundle of 6s raise, 60s raise and 5 minute raise FCAS. This is because the provision of the 6s raise service by Hydro Tasmania results in the provision of the other services as well, due to the nature of Hydro Tasmania's generation plant.

In section 3.2, IES concludes that providing the 6s raise FCAS service dominates the costs of providing all of the three raise contingency services and that the 60s raise and 5 minute raise services can be delivered largely as by-products of Hydro Tasmania's dispatch for energy and 6s raise FCAS. Consequently, we recommend that the contract quantities be bundled quantities for all three raise contingency services.

2.4 Notional Quantity

The notional quantity could be defined potentially in various ways. It could be for example a specified fixed quantity for all periods or for each defined period. It could be a forecast quantity set at the beginning of a defined period with or without the facility for periodic renomination.

In our view, the notional quantity defined in the "safety net" contract ought to reflect the buyer's actual liability. In this way it serves as an effective hedge for the buyer, while avoiding the creation of an exposure which Hydro Tasmania, as the seller, may be unable to manage in the physical market. For the purpose of calculating the fixed price for a contract, the buyer will need to provide Hydro Tasmania with indicative requirements. In our opinion, this will reasonably include a maximum requirement or maximum requirements[1] which will serve to cap actual quantity. Pricing then will be based on indicative requirements communicated to Hydro Tasmania in good faith. Settlement will be based on actual requirements capped by the specified maximum requirement.

Since the "safety net" contract will be for a bundle of 6s raise, 60s raise and 5 minute raise FCAS the quantities for each of the services will be related. The ratio of the maximum requirement quantities for these services will be:

1.0 MW 6 second raise : 1.75 MW 60 second raise : 2.0 MW 5 minute raise.

The actual quantity determined in the hedge will be based on the actual liability based on the generator's output for the dispatch period. This being:

Hedge quantity for service = Minimum (Cap quantity for service, actual liability).

IES's recommendation that the contract quantities be bundled quantities for all three raise contingency services leads to several possibilities for the determination of the contract quantity for each dispatch interval. These are:

- Determine the contract quantity based on the 6s raise service MW liability;

[1] The maximum requirements could be by some time periods such as peak or off peak periods or quarters or both.

- Determine the contract quantity based on the average of the 6s raise liability, 60s raise liability / 1.75 and the 5 minute raise liability / 2.0; and
- Determine the contract quantity based on the maximum of the 6s raise liability, 60s raise liability / 1.75 and the 5 minute raise liability / 2.0.

The options above all assume that the actual liabilities are below the cap quantities for each of the services. IES recommends that the first option is used because the 6s raise service is the by far the most costly local service in Tasmania.

2.5 Self Provision

IES recognises that Hydro Tasmania's ability to support these contracts in practice will be subject to the existence and operations of other FCAS providers. Consistent with the safety-net contract functioning as an effective hedge for the buyer on one hand, and not creating unmanageable exposures for Hydro Tasmania on the other, there ought to be provision for the quantity specified in this contract to be reduced to the extent the buyer provides services of its own (self provision).

IES expects that this would be done based on the spot market quantities that the counterparty to Hydro Tasmania is dispatched for rather than a reduction in the cap quantity based on the counterparty's capability to provide the 6s raise service. Under this arrangement Hydro Tasmania is hedging the contracting party to the degree that they have an exposure to FCAS raise contingency costs subject to cap on quantities.

2.6 New Supplier

There are two main scenarios regarding a new supplier entering the market to providing contingency raise FCAS. These are:

1. The new supplier can provide some of the local Tasmanian requirements but is not sufficiently capable for OTTER to remove the declaration regarding the provision of FCAS by Hydro Tasmania; and
2. The new supplier is sufficiently capable for OTTER to remove the declaration regarding the provision of FCAS by Hydro Tasmania. This would occur if the new supplier could substantially remove the dependency on Hydro Tasmania to provide the service. For instance if a new supplier could provide 100 MW of 6s raise FCAS then they could meet all of Tasmania's requirements most of the time. The new supplier could be a new generator or an interruptible load which could be instantaneously tripped. In the case of the interruptible load it would only need to be 50 MW to be deemed to be providing 100 MW of 6s raise because of the way 6s raise capability is defined by AEMO[2].

[2] The amount of 6s raise that a source can provide is based on the average amount of additional power which can provided or the average amount of consumption which can be reduced multiplied by two. In the case of a generator whose output has to be ramped up then the average amount of power provided will be roughly half of the maximum amount of power provided. Hence, when multiplied by two will equal the maximum amount of additional power provided 6s after the contingency occurred. For a load that can be instantly tripped then the average will equal the maximum and the amount of 6s will be twice the reduction.

In the case of scenario 1, the contract design and pricing methodology would remain the same. In the case of scenario 2, OTTER would rescind the declaration and at this point the “safety net” contracts should terminate. However, there may be some short delay between when the new provider starts operating and when the declaration is rescinded. During this period the “safety net” contracts would remain in force and Hydro Tasmania would be expected to bid into the spot market in such a way so as to manage this risk.

2.7 Hydro Tasmania Production Efficiency Improvements

The last form of new supply is the case when Hydro Tasmania improves its own ability to deliver FCAS contingency services. This improvement could be the result of investment in existing generation plant. In this case nothing would change regarding existing or new contracts. The methodology would remain the same. In particular, the assumptions about lost power generation due to running at inefficient generation levels would remain the same. The reason for this approach is to give Hydro Tasmania the same incentives as any other provider to improve its efficiency in providing FCAS.

2.8 Contract Duration, Termination, and Repricing

Generators can expect that “safety net” contracts with a high degree of transparency around pricing principles will be available until the end of the five year determination period, or until the Regulator decides the supply of the relevant services is competitive and therefore the “safety net” contracts are no longer required.

While the determination period is five years, IES does not consider it necessary that the price of “safety net” contracts be fixed for the full period or for any period longer than a year. However IES does consider that the price should be fixed for six months and notes that transparency around methodology and assumptions will assist in informing interested parties as to the likely range of future “safety net” contract prices.

To provide this transparency, IES suggests that the methodology be published on the Hydro Tasmania website together with assumptions for the current and previous pricing periods.

The price of the “safety net” contract will be recalculated on a six monthly basis according to the published methodology and current published assumptions prior to the commencement of each six month period.

3 Contract Pricing Methodology

3.1 Introduction

IES's preferred method for estimating Hydro Tasmania's cost for providing an FCAS hedge is to determine Hydro Tasmania's costs of physically delivering to the spot market the amount of FCAS that is nominated in the hedge contract. In a sense this mimics the operation of a competitive market in the longer term in that the value of a swap contract should roughly correspond to the average spot price which in turn should roughly correspond to the costs of delivering that spot market service.

Determining a generator's costs of providing various FCAS raise contingency services is not as clear cut as it might seem. The FCAS services and energy are joint products from the same generator and hence the provision of one service affects the provision of the others. Thus to estimate the cost of providing a raise service requires an understanding of how providing this service affects the provision of energy and other FCAS and what are the associated opportunity costs.

3.2 FCAS Opportunity Costs

Determining the opportunity cost of being enabled to provide raise FCAS services is not always straight forward. There are three distinct situations which could result in different opportunity costs.

The first situation is when the unit's energy output is not altered by the amount of FCAS raise services for which it is enabled. In this case the unit's energy dispatched is not changed from what it would have been had no FCAS raise service been enabled. Thus the generator's energy output is not changed. In the case of a hydro-electric generation unit, its water use and any other variable costs have not changed. Consequently, in this case the opportunity cost of being enabled is zero. On the rare occasions that the contingency service is required, the generator may have an increased output but this should be largely compensated through the energy spot market.

The second situation is when the unit's energy output is altered by the amount of FCAS raise services for which it is enabled. In this case the unit's energy dispatched is changed from what it would have been had no FCAS raise service been enabled. Because the generator's energy output is changed, its water use and any other variable costs will have changed as well. Additionally, the unit may have its energy market dispatch reduced to provide raise FCAS.

The third situation is when the unit is dispatched primarily to provide FCAS and the energy output is really just a result of providing FCAS. In this case the unit's energy dispatched is changed from being zero and the unit being offline to a positive energy dispatch in order to provide the desired FCAS raise service. In this case the unit may suffer two opportunity costs. The first one is due to being dispatched to an inefficient energy target to provide the required service. The second one is the opportunity cost of being dispatched to a non zero value in the energy market when the generator did not want the unit to be dispatched in the energy market at all. For example if the generator had a fuel cost or marginal water value of $50/MWh and was dispatched in the energy market when the spot price was $30/MWh it would be losing $20/MWh in the energy market.

The opportunity costs of providing each of the raise contingency services: 6 second raise, 60 second raise and five minute raise are likely to be different for Hydro Tasmania. We will look at each service in turn.

3.2.1 5 minute raise service

For the 5 minute raise services the opportunity costs would be zero or very small because the services can be provided by units that are on line and operating around their optimal energy dispatch points[3]. The most efficient output for most units is somewhere between 80% and 90% of the unit's maximum output. Thus units operating at the most efficient points have the ability to provide additional output following a contingency. Any additional amounts of this service required would be provided by units which are being dispatched to provide the 6 second raise service. Thus given that Hydro Tasmania has to provide an amount of 6 second raise service there should be no additional cost to Hydro Tasmania of providing the 5 minute raise service.

3.2.2 60s raise service

Like the situation for the 5 minute raise service, the 60 second raise service would generally be provided by units on line and operating at their optimal energy dispatch points. Any additional amounts of this service required would be provided by units which are being dispatched to provide the 6 second raise service. Thus given that Hydro Tasmania has to provide an amount of 6 second raise service there should be no additional cost to Hydro Tasmania of providing the 60 second raise service.

3.2.3 6s raise service

The 6 second raise service is the most difficult for a hydro generator to supply. In most power systems this service is provided by steam based thermal generation. Many of Hydro Tasmania's units can supply little or no 6s FCAS and many of the others can only supply small amounts when they are significantly backed off and operating at significantly lower water use efficiencies. However the Gordon and John Butters power station units can supply significant amounts of 6 s FCAS relatively efficiently in the Tasmanian system.

[3] In other hydro systems with units that can start faster than Hydro Tasmania's some of the 5 minute service could be provided by units which are offline but armed to start with an under frequency event.

3.3 Hydro Tasmania's Opportunity Cost of Providing 6s Raise

3.3.1 Approach

IES's approach to determining the opportunity cost of providing the 6s raise service is to split the problem into two parts.

- The first part is concerned with determining the physical opportunity cost of providing the 6s raise service in terms of reduced generation efficiency and the consequential additional water consumption.
- The second part is concerned with valuing the additional water use associated with providing the 6s raise service.

3.3.2 Physical Opportunity Costs of Providing 6s FCAS

The two power stations which can provide substantial amounts of 6s raise service are John Butters and Gordon. Both of these power stations have units which can operate at relatively low outputs and provide substantial amounts of 6s raise. However, the operation at low output levels does come at the price of reduced efficiency with which water is converted from potential energy to electrical energy. Figure 1 and Figure 2 show the efficiency curves for John Butters and Gordon units. Note that at very low outputs the generation efficiencies of these units drop from around 90% at the most efficient points to 20% to 40% at very low outputs.

Figure 1 John Butters Unit Generation Efficiency Curve

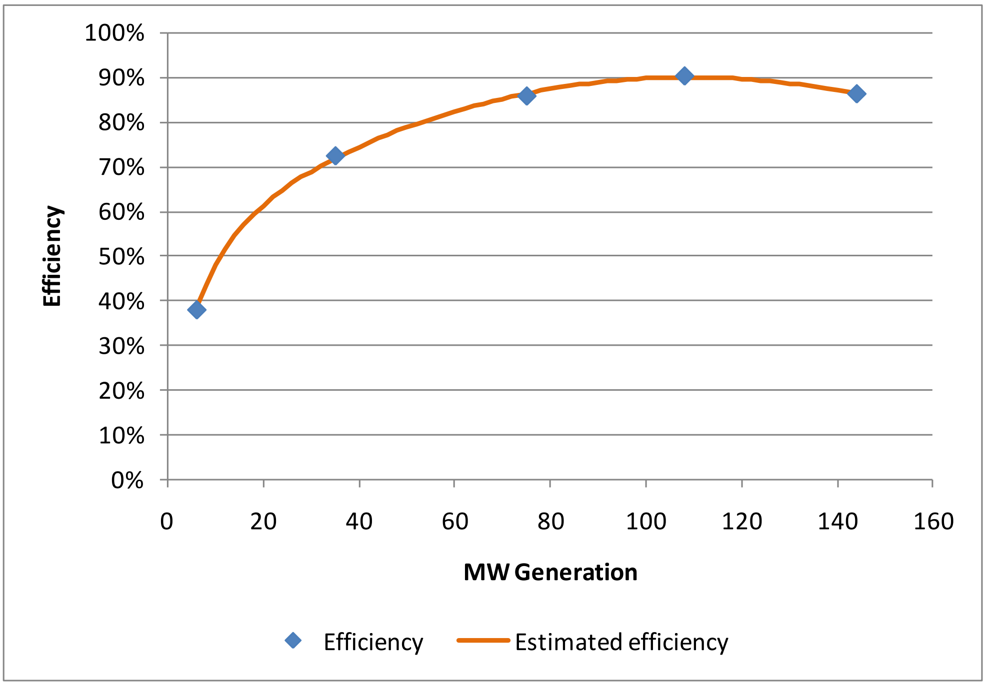


Figure 2 Gordon Units Generation Efficiency Curve

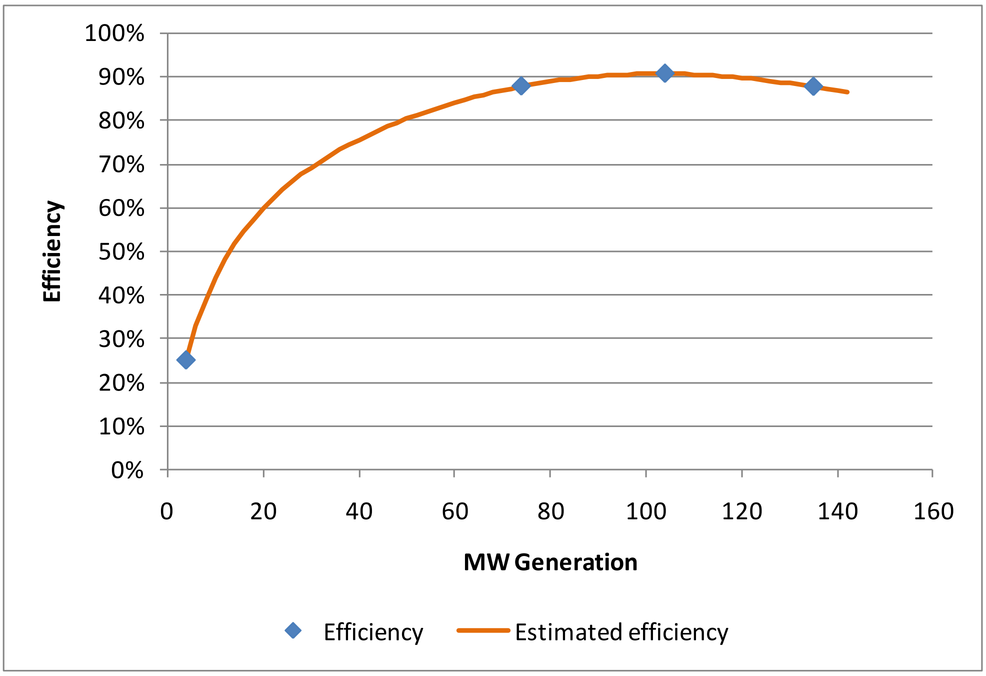


Figure 3 and Figure 4 show the maximum amounts of 6s raise that can be provided versus MW power output. The figures also show the opportunity costs in terms of water power losses incurred when operating away from the most efficient generation points. Please note that the Gordon information is for when just one unit is operating.

Figure 3 John Butters 6s Raise Capability and Water Power Losses Due to Operating Away from Maximum Efficiency Point

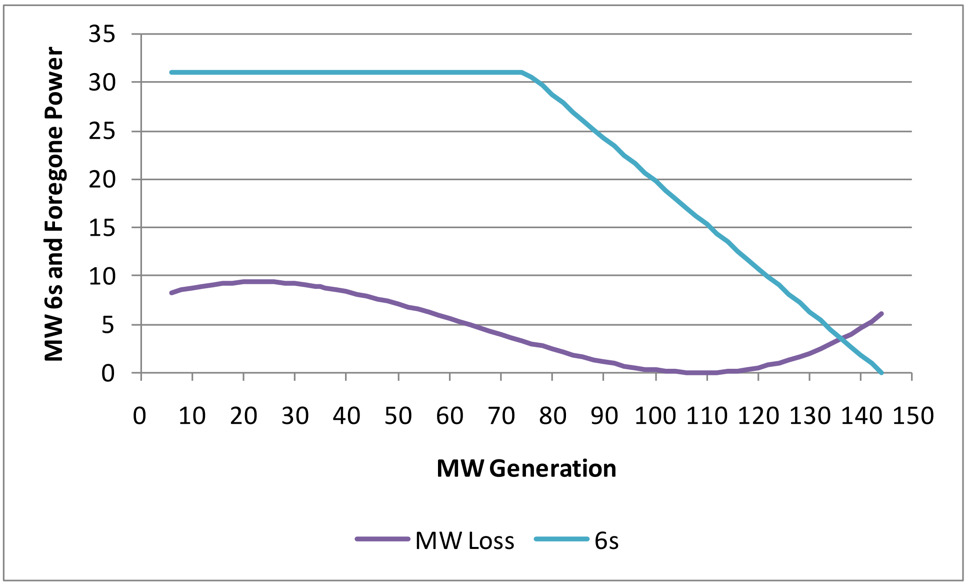
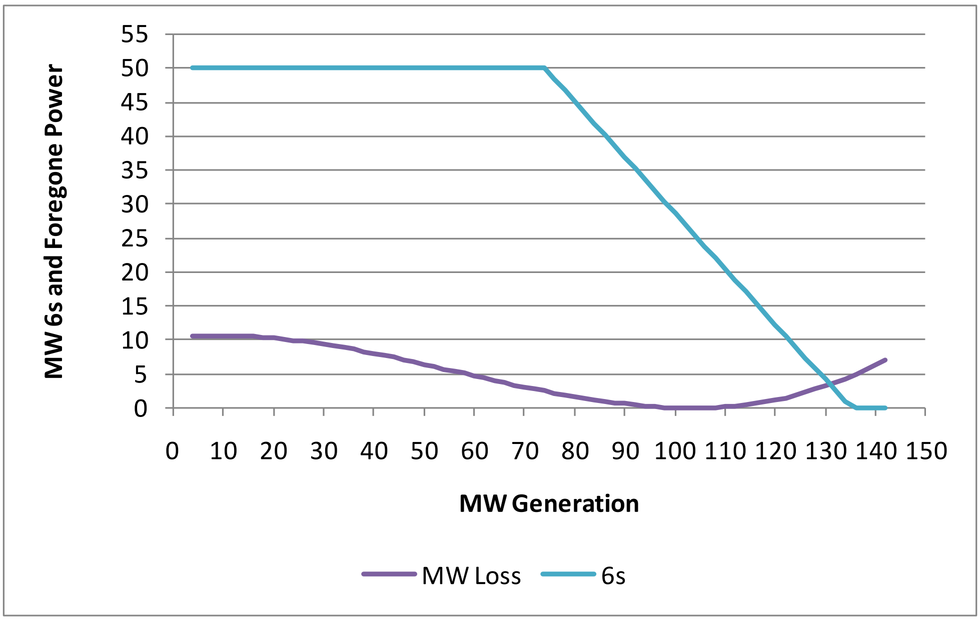


Figure 4 Gordon 6s Raise Capability and Water Power Losses Due to Operating Away from Maximum Efficiency Point



The amount of 6s raise that can be provided from Gordon power station does not increase linearly with the additional units operating. This is because the units share a common pipeline (penstock) which with increasing flows diminishes the speed with which the units can increase their outputs. The maximum amount of 6s raise that can be supplied from Gordon is as follows:

Number of units committed	Maximum MW 6s raise[4]
1 unit running	50 MW
2 units running	87 MW
3 units running	100 MW

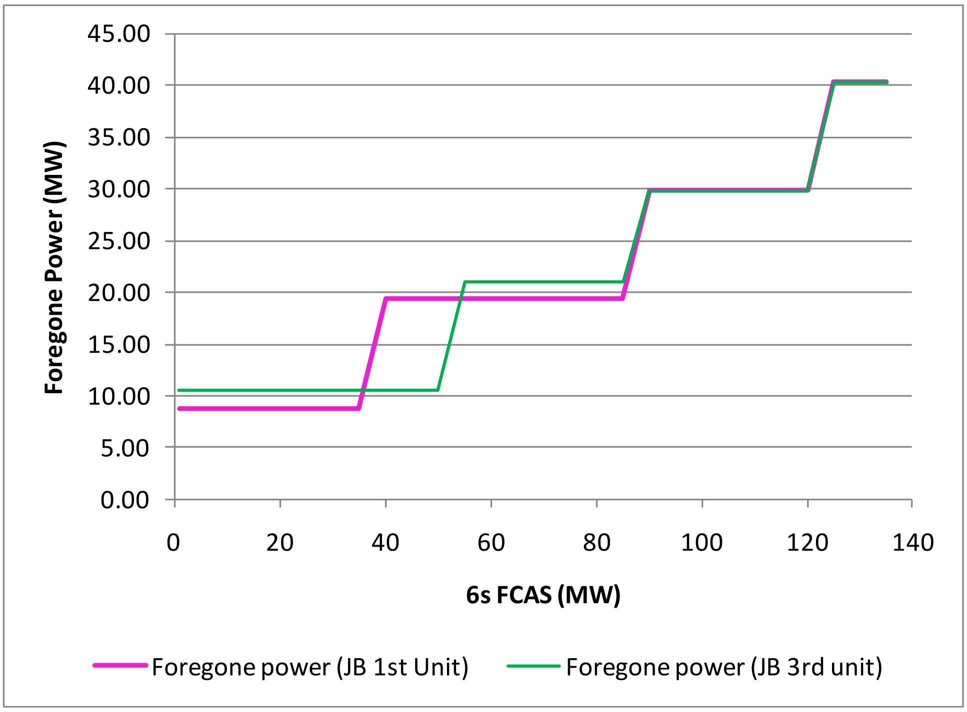
IES combined the information on the amount of 6s raise service and the water power opportunity costs versus power output to produce a supply curve for providing 6s raise. IES's model assumed the increasing amounts of 6s raise were being supplied by only John Butters and Gordon power stations.

Figure 5 shows a graph of the forgone power versus amount of 6s raise provided. There are two lines: the pink line is the FCAS supply curve when John Butters power station has the first unit committed to run to provide 6s FCAS and then additional units are committed from the Gordon power station to meet increasing amounts of 6s FCAS as required. The green line is for when units from Gordon power station are committed first. The staircase appearance of these lines is due to additional FCAS requiring additional units being committed and these units providing blocks of additional 6s raise at no additional cost once the unit has

[4] These figures are based on a mid range of operating heads

been committed. These supply curves have been constructed on the basis that the FCAS is being required at the time of Basslink imports and that the power generation and consequent water use at Gordon and John Butters is to be minimised at these times.

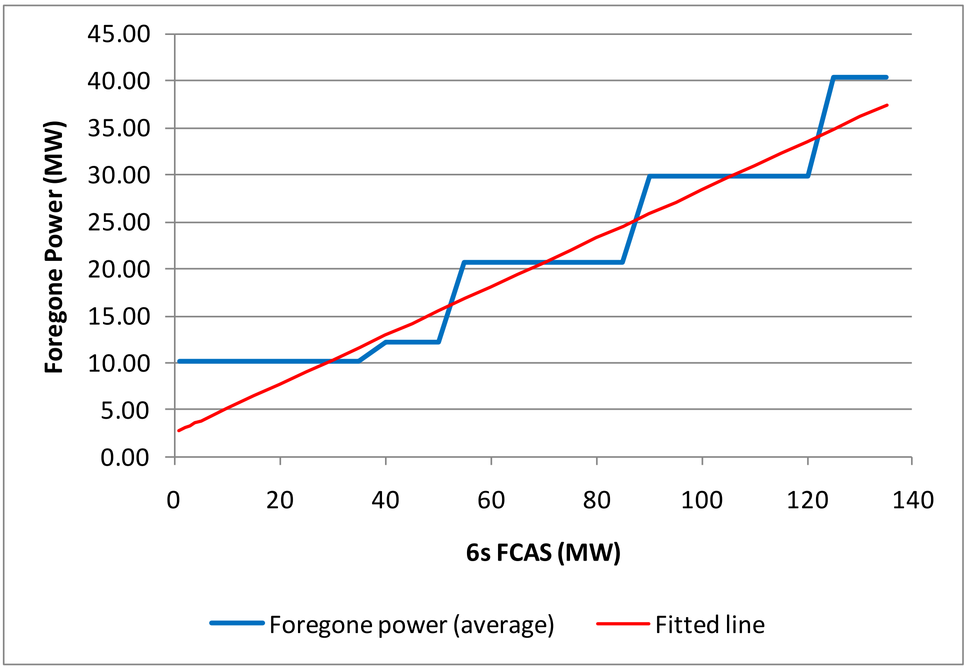
Figure 5 Supply Curves: Foregone Power versus 6s Raise



If we assume that for 20%[5] the time the John Butters unit is operating to provide 6s raise FCAS when there is a Tasmanian requirement for a local 6s raise service, then the expected opportunity cost for foregone power is the blue line in Figure 6. This line is just a weighted combination of the two lines in the previous graph. The red line is a fitted straight line which is based on the average amount of foregone power per MW of 6s raise for a 85 MW requirement. This is equivalent to 0.26 MW of foregone power per 1 MW of 6s raise supplied. This line has an intercept of 2.6 MW. This intercept can be interpreted as a fixed cost of providing 6s raise.

[5] The figure of 20% was supplied by Hydro Tasmania.

Figure 6 Average Supply Curve: Foregone Power versus 6s Raise



3.3.3 Calculation of the Value of Foregone Power Generation

Conceptually calculating the value of forgone power generation is simply a matter of determining the amount of forgone power and valuing this in terms of lost generation and REC sales. However there are a number of input values (parameters) to this calculation that need to be considered and sourced. These include:

- A price for the foregone generation;
- A price for the foregone RECs;
- A probability that the foregone water power output would have produced RECs;
- The relative proportion of the time that John Butters would be providing 6s raise FCAS and as a consequence expected foregone generation at John Butters and Gordon; and
- The proportion of the time water released from Gordon and John Butters respectively could be attributed to the need to meet environmental flow requirements.

3.3.4 Value of Lost Electricity Sales

The value of the lost electricity sales in the future could be approximated by a number of methods including the following:

- Using the Victorian prices for a one year flat swap or futures contract;

  - For example the average price of the d-cypha SFE Australian Electricity Futures market [6] base contract for the following twelve months at a predetermined date or at the time of the contract, for instance the prices on the last business day prior to the commencement of the contract.
- Using the Victorian prices for a one year peak period swap contract;
  - For example the average price of the d-cypha peak contract for the following twelve months at a predetermined date or at the time of the contract.
- The long run average cost of generation; and
- The long run marginal cost of generation.

IES favours using the price for a one year Victorian peak swap contract starting from the next quarter.

3.3.5 Value of Lost Renewable Energy Certificate Sales

The value of the lost renewable energy certificates in the future could be approximated by the futures price for RECs to be delivered in January the following year as reported by Next Generation Energy Solutions (Nextgen) in their Green Room publication at the time of the contract or at a predetermined date.

3.3.6 Probability of RECs

Because the baselines for pre 1997 hydro plant reflect their long term average outputs, one would expect that, due to the nature of the variability of inflows into hydro storages, that RECs should be produced in 50% of years over the long term. Depending on the state of storage levels, for some years the probability will be higher than 50% and in other years the probability will be lower than 50%.

3.3.7 John Butters Operation in Providing FCAS

Hydro Tasmania has suggested that the unit at John Butters would be providing 6s raise FCAS 20% of the time when there is a local Tasmania requirement. Such a number could be validated by historical NEM data.

The proportion of the time that John Butters is providing 6s raise does not affect the calculation greatly, never the less IES suggests that this proportion be determined based on the historical percentage using the last 12 months of operations. This information can be obtained from NEM published data.

3.3.8 Environmental Flows

If there are requirements for environmental flows and to satisfy these requirements necessitates units at Gordon or John Butters operating at low or inefficient outputs then it could be argued that the provision of 6s raise in these cases does not increase the amounts of water released and hence does not result in Hydro Tasmania incurring any additional opportunity costs.

[6] The electricity futures contract prices are available on d-cyphaTrade's website: http://d-cyphatrade.com.au/market_futures/vic#A

Hydro Tasmania has informed IES, that the operation of John Butters is not affected by environmental flows but Gordon is. In the case of Gordon there is a minimum flow required of 10 cubic metres per second (m^3/s or cumec) during the summer months and 20 cubic metres per second during the winter months.

A 10 cumec flow corresponds to a Gordon unit operating at 5 MW and providing 50 MW of 6s raise. A 20 cumec flow corresponds to a Gordon unit operating at 21 MW and providing 50 MW of 6s raise.

Thus during months of the summer period, none of the water passed through the turbines of a second unit could be attributable to environmental flows. Thus the marginal provision of FCAS from a second unit during this period would have no reduction in opportunity cost due to environmental flows.

For the winter months the situation is different. During these months a second unit could be run at 5 MW and this would satisfy the 20 cumec environmental flow requirement. The opportunity cost of running the second unit compared to just running one unit is 21 MW – 10 MW = 11 MW. Whereas if there had been no environmental flow requirement then the opportunity cost for running two units at 5 MW would have been 2 x 10.5 MW = 21 MW. Thus the requirement for environmental flows has reduced the lost opportunity by 10 MW which as a percentage is 10/21 = 48%. Consequently if we assume that there are 6 months of the summer regime and 6 months of the winter regime of environmental flows, this gives an estimate that 25% of the lost power due to providing FCAS at Gordon power station would have been required to satisfy environmental flows anyway.

3.3.9 Example Calculation of the Variable Opportunity Cost

The following is an example of a calculation of the opportunity cost to Hydro Tasmania of providing 6s raise FCAS. The calculation determines the amount of foregone generation per MW 6s raise provided. For this calculation IES has assumed that the total Tasmanian requirement for 6s raise is 80 MW and the assumed parameters for energy and REC prices etc are in Table 1. Some of the values, such as REC and energy prices, are for illustrative purposes and do not accurately represent the current values. John Butter's 36 MW capability is its registered value rather than its operating capability of around 31 MW.

Table 1 Model Input Parameters

	John Butters providing FCAS with Gordon	*Gordon alone providing FCAS*
Proportion of the time	20%	80%
Energy Price ($/MWh)	60	60
Proportion of lost water power needed for environmental flows anyway	0%	25%
REC price	40	40
Probability of RECs	50%	50%

In order to supply 80 MW of 6s raise FCAS, either John Butters (36 MW 6s raise) and one Gordon units (50 MW 6s raise) need to be operating or two Gordon units (87 MW 6s raise) need to be operating. If we assume that John Butters is only running for 20% of the time then to meet an FCAS requirement of 80 MW would require an average of 7.2 MW from John Butters and 72.8 MW from Gordon.

Table 2 Estimated Average MW Provision of 6s Raise FCAS

	John Butters	*Gordon*
John Butters Priority	36.0	44.0
Gordon Priority	0.0	80.0
Weighted average	7.2	72.8

Given the average provision of FCAS it is possible to determine the water power foregone per MW of FCAS service provided under the regimes of using John Butters and Gordon versus Gordon only, see Table 3. The average amount of power foregone to supply 1 MW of FCAS is 0.022 MW + 0.237 MW = 0.259 MW. That is, to supply 1 MW FCAS has an opportunity cost of about 0.26 MW of power.

Table 3 Estimated Foregone Generation (MW) per MW of FCAS Provided

	John Butters	*Gordon*
MW of foregone generation per MW 6s raise for each unit	0.24	0.26
MW of forgone generation on average for the portfolio of John Butters and Gordon combined	0.022	0.237

Under the assumptions presented in Table 1, including the estimate that 25% of the provision of 6s raise from Gordon does not incur any additional costs due to the requirements for environmental flows, the estimated opportunity cost for provision of 6s raise FCAS is about $16/MWh. How this figure is determined is outlined in Table 4.

Table 4 Opportunity Cost per MW FCAS ($/MW per hour)

	John Butters	*Gordon*	*Total*
MW foregone per MW FCAS once environmental flows are considered	0.022	0.178	0.199
Price per MWh foregone ($/MWh)	80	80	
Opportunity cost (price) per MW FCAS ($/MWh)	1.74	14.21	15.95

3.3.10 Allocation of Fixed Opportunity Cost

There is always some arbitrariness in allocating fixed costs but some attempt needs to be made otherwise Hydro Tasmania will be systematically under compensated if the linear approximation of FCAS opportunity costs is used. IES suggests that the fixed cost be allocated based on the maximum hedge quantity the generator wishes to contract for (the hedge quantity cap) and the expected total Tasmanian requirements at the times when the generator's liability is near its maximum.

The fixed cost (intercept of the straight line) is approximately 2.6 MW per hour comprising on average 0.5 MW of John Butters and 2.1 MW of Gordon based on the John Butters operating 20% of the time. When the impacts of environmental flows are considered and the assumptions in the earlier tables are used, this results in an hourly cost of approximately $165 ($164.80). This in turn gives an annual fixed cost of about $1,000,000 per annum ($1,010,551 per annum) assuming that Basslink is importing approximately 70% of the time. For more details see

Table 5 Fixed Opportunity Cost Calculation

	John Butters	*Gordon*	*Total*
MW foregone due to fixed losses once environmental flows are considered	0.48	1.58	2.06
Price per MWh foregone ($/MWh)	80	80	
Opportunity cost (price) for fixed losses ($/h)	38.68	126.11	164.80
Annual cost ($)	237,216	773,335	1,010,551

For a generator requiring a cap of X MW and the generator's maximum exposure occurring when the total Tasmanian liability is expected to be about Y MW, then the generator would pay a contribution to the fixed costs of:

(X / Y) x Total annual fixed cost

For a 30 MW cap and an expected Tasmanian requirement of 130 MW this would be approximately $233,000 per annum ($233,204 per annum).

3.3.11 Example Calculation of Variable and Fixed Cost Components of a Contract

Under the assumptions

- that a generator had an average liability of 10 MW for 6s raise over all time periods;
- that this generator needed to be hedged for up to 30MW at the time of Basslink imports; and
- Basslink imports occurred 70% of the time

then this would result in an approximate annual cost to the generator of

- fixed cost = $233,000 per annum ($233,204 per annum);
- variable cost = 10 MW x $15.95 / MWh x 8760 h = $1,397,049 per annum
- total cost = $1,630,253 per annum.

4 Settlements and Parameter Values

The key parameter values required to determine a contract price and settlements are presented in Table 6. This table also presents the suggested source or method of determining these parameter values.

Table 6 Parameter Values

Parameter	Purpose	Value
Generator turbine efficiencies	Calculation of foregone generation	Standing data provided by Hydro Tasmania
Generator FCAS capabilities	Calculation of FCAS provision and foregone generation	Standing data provided by Hydro Tasmania (can also be obtained from NEM FCAS standing data)
Proportion of the time John Butters is supplying FCAS for local Tasmanian requirement	Calculation of FCAS provision and foregone generation	Average of previous 12 months of historical data (can be obtained from NEM dispatch data)
Energy price	Used to value foregone generation	D-Cypha price for 1 year peak swap contract starting next quarter
REC price	Used to value foregone generation	Most recent REC spot price corresponding to an actual transaction reported by NextGen in their Green Room publication
Probability of power station generating RECs	Used to value foregone generation	Agreed to use 50% probability
Proportion of foregone generation required for environmental flows	Used to value foregone generation	By calculation with Hydro Tasmania supplying environmental flow requirements and water releases versus generation output curves

Parameter	Purpose	Value
Proportion of the time Tasmania is importing and has a local FCAS requirement Or Proportion of the time Tasmania has a local FCAS requirement	Used to allocate fixed cost component of opportunity costs	Average of previous 12 months of historical data (can be obtained from NEM dispatch data to determine which periods that Basslink exports were less than 50MW) Or Average proportion of time over the previous 12 months that Tasmania had a local requirement over, say, 5 MW
Maximum FCAS hedge quantity (cap)	Used for calculating contract price (fixed cost component)	Nominated by purchaser of contract
Actual FCAS liability for dispatch period used in hedging contract	Used for calculating settlement payments	Quantity determined by 6s liability and maximum hedge quantities for other services determined by scaling these amounts
FCAS quantity scalers	Used for calculating settlement payments	Hydro Tasmania has suggested a ratio of 1 MW 6s : 1.75 MW 60s : 2 MW 5 min
FCAS hedged quantity	Used for calculating settlement payments	• Minimum(cap, actual 6s liability – self provision) • Minimum(1.75 x cap, actual 60s liability – self provision) • Minimum(2 x cap, actual 5 min liability – self provision)
Self provision	Used for calculating settlement payments	Actual amounts enabled for contingency raise services in NEM dispatch

As discussed earlier, the “safety net” contract would be a bundled contract for all raise contingency services. As such there could be a number of ways that the bundled price could be split up between the individual services. However this is not really a problem. To illustrate how settlements can work assume that the amounts of FCAS that the generator has contracted for are in the ratio of 1.0 MW of 6s : 1.75 MW of 60s : 2.0 MW of 5 min. Assume that the generator has a cap of Qcap MW of 6s raise and an actual 6s liability of Q6s then the settlement for this 5 minute period would be such that the buyer pays Hydro Tasmania:

Fixed cost component per dispatch interval + Q6s x variable cost per MW FCAS

- Q6s x spot price 6s – Q60s x spot price 60s – Q5min x spot price 5min

If any of the quantities of the services exceeded the scaled cap amounts then the actual quantities would be reduced to the capped amounts.

5 Summary Recommendations

IES recommends that

- the general hedge contract serve as a "safety-net" contract providing a high quality hedge with no exclusions, and that generators be encouraged (but not required) to negotiate price discounts in respect of any exclusions and special conditions they are willing to accept;
- the adoption of the pricing methodology set out in this report along with the identified parameters and proposed basis of setting parameter values;
- the methodology, current values of parameters, standing data and "safety-net" contract documentation be published on Hydro Tasmania's website.