From: Sam Fleming
To: EA
Cc: Doug Watt; S9(2)(a)
Subject: RE: [EXTERNAL] RE: Meridian water value data
Date: Thursday, 15 April 2021 10 52:39 am
Attachments: image001.png
image002.png
image003.jpg
EPOC presentation.pdf

Hi S9(2)(a)

Works for me but I think it's probably cached from an earlier download as the rest of the EPOC site seems to be offline. Must be an issue at their end.

Here it is as an attachment.

Cheers
Sam

From: S9(2)(a)
Sent: Thursday, 15 April 2021 10:37 am
To: Sam Fleming S9(2)(a)
Cc: Doug Watt S9(2)(a) ; S9(2)(a)
Subject: [EXTERNAL] RE: Meridian water value data

Hey Sam,
The link you sent at the end of your email doesn't seem to work – can you please check it?
ta

From: Doug Watt S9(2)(a)
Sent: Wednesday, 14 April 2021 6:23 pm
To: S9(2)(a) ; S9(2)(a)
Subject: FW: Meridian water value data

From: Sam Fleming S9(2)(a)
Sent: Wednesday, 14 April 2021 5:46 pm
To: Doug Watt S9(2)(a)
Cc: S9(2)(a)
Subject: RE: Meridian water value data

Hi Doug

Sorry this took longer than expected. In response to your information request, please see attached two Excel spreadsheets:

- the first shows the minimum sell values from Perform reports;
- the second shows modelled generation volume guidance.

This data is from the start of the 2016 calendar year up to the week just been. It is in two documents because while the model runs weekly, Perform reports are less regular and the dates are not necessarily aligned. We understood this to be the data and date range you requested when we spoke but let us know if that's not correct. If you want a longer data set, please keep in mind that putting this together is a manual process and rather time consuming.

Obviously we do not fully understand the purpose of your information request or how you will use this information. However, we want to provide some context and comment to accompany the data and to add colour to our conversation on 31 March.

Minimum sell values from Perform

These values are agreed in Perform meetings and are informed by a range of different factors including:

- consent conditions;
- regulatory requirements;
- safe operation of plant;
- modelled generation volumes and prices;
- recent spot prices;
- the offer stack in market schedules;
- forward market prices; and
- recent contract sales prices.

S9(2)(b) and S9(2)(ba)(i)

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The minimum sell values in the attached Excel document are therefore a simplified view of the weekly trading guidance and do not convey the full range of

matters taken into account in trading decisions.

Water-values as a theoretical construct

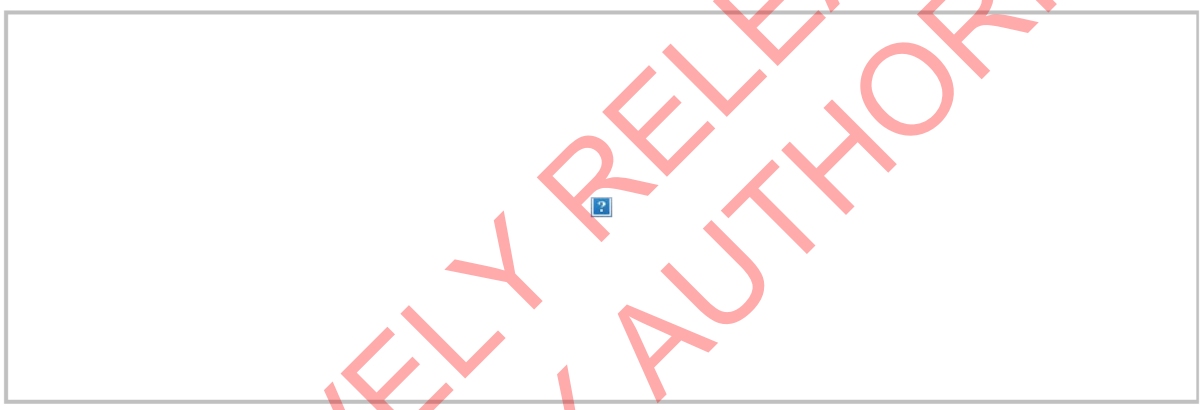
In traditional hydro-thermal analysis a 'water-value' is, at a point in time, an estimate of a future-facing, opportunity-value of energy that is stored as water in a long-term reservoir. The same general idea can be applied, not only to water in storage, but also to energy stored in other forms: be it a gas storage facility (Ahuroa), a coal stockpile (Huntly), or even chemical batteries.

An estimated water-value is stochastic in nature, and can be thought of as representing an option value for the cost of water today: one that reflects assumptions made about the future supply and demand of energy, both in terms of possible future costs, but also in terms of uncertainties in quantity or availability. Assumptions made about future hydro inflow uncertainty, lack of inflow predictability, and thermal station costs and availability are the most critical assumptions in the construction of a water-value. A water-value can be conceptualised as a mechanism that is used in power system economic analysis to balance excess hydro spill on the one hand, versus excess system shortage (interruption) and fuel burn on the other hand. The intent is to explicitly deliver a set of reservoir management guidelines that minimises costs to the power system (and consumers).

In theoretical hydro-thermal analysis, for a given set of power system assumptions, a hydro reservoir water-value and the hydro generation volumes that it implies are tightly bound: *lower* water-values are strongly associated with *higher* hydro generation volumes, whereas *higher* water-values strongly associated with *lower* hydro generation volumes. It is entirely possible and reasonable to resolve the same economic hydro-thermal problem using (primal) dispatch generation volumes rather than (dual) water-values, with the two approaches being broadly speaking, mathematically equivalent.

Finally, the water-value concept itself is best thought of as a matrix of possible values rather than as a single point estimate. A matrix of possibilities that is affected by the time of year, the level of storage in the reservoir, the level of storage in *other* reservoirs, and a myriad of other potential state-space variables. Most hydro-thermal methodologies including Meridian's naturally produce multi-dimensional water-value surfaces. It is by traversing points on these surfaces that future power system possibilities and outcomes can be forecast. This can be seen in the two charts below that describe:

1. the future water-value surface for Pūkaki (for a generic set of future assumptions); and
2. the future storage outcomes that can be forecast if we apply the water-value surface to a range of historical inflow outcomes.



Water-values as an input into real-world trading and reservoir management

In a real-world, competitive trading situation a reservoir owner like Meridian is attempting to derive an appropriate trading strategy for the wholesale market through time with the finite and uncertain resources that they have to hand, in this case water in storage. This requires balancing the needs of today versus the needs of the future. As outlined above, this is the methodological purpose of the water-value approach.

However, in the real-world, a reservoir owner does not have access to all the system information nor to the drivers of behaviour that influence other decision makers in the power system. These unknown variables have the potential to deliver real-world outcomes that deviate markedly from the internal set of future assumptions and the uncertainties that have been allowed for. Differences in outcomes can, at times, be significant, can last for some time (months), and can be difficult to reconcile with modelled guidance even as more information becomes available to the wider market over time.

The point of the water-value methodology described above is primarily to manage *physical* storage outcomes and to balance the current and future use of scarce hydro resources. Water-values in and of themselves are not intended to determine an objective 'truth' as to the value of water in storage. [redacted]

We recommend to the Authority that modelled generation guidance for the week along with the modelled water-value for the current storage levels is a *minimum* data set necessary to understand Meridian's real-word trading and reservoir management.

Assessing wholesale market performance

One way to assess wholesale market outcomes and the ability of analytical toolset to explain wholesale outcomes is to use hindcasting. In a hydro-thermal power system, hindcasting represents best-practice for examining wholesale outcomes in hindsight, and is an approach that appropriately acknowledges the pivotal role of hydro uncertainty in the New Zealand power system.

A public document describing the hindcast approach and the type of insights, questions, and uncertainties that it generates is available here: http://www.epoc.org.nz/workshops/ww2018/Telfar.pdf

Kind regards

Sam Fleming (he/him) – Manager Regulatory and Government Relations
Meridian Energy Limited
Level 2, 55 Lady Elizabeth Lane
PO Box 10840, Wellington 6143, New Zealand
M. S9(2)(a)

From: Doug Watt S9(2)(a)
Sent: Thursday, 8 April 2021 1:00 pm
To: Jason Woolley S9(2)(a)
Subject: [EXTERNAL] RE: Meridian water value data

Hi Jason
Thanks for making time last month to discuss water values and the material that you had.
I think that given that S9(2)(a) model gives a volume, and that the sell water value in the perform reports is the price that you expect to be able to clear that volume, then it is that series of prices that we would like please.
Happy to discuss.
Cheers
Doug

From: Doug Watt
Sent: Thursday, 25 March 2021 12:30 pm
To: S9(2)(a)
Subject: Meridian water value data

Hi Jason

As discussed we would like Meridian to provide the Authority with water value estimates. This email sets out the details of what we would like to obtain from you. This information will be kept in confidence and only used for the purposes of our market monitoring. If we publish any findings related to the data we will contact you before publishing, and redact any commercially sensitive information.

Please provide this information by 12 April 2021.

If you have any further questions about this request please don't hesitate to call or email me.

We would like:
-All water values that you estimate for reservoirs on your Waitaki chain (Ohau A, B, C, Aviemore, Benmore and Waitaki stations), and water values estimated for Manapouri.
-data back to the start of 2014 if possible, up to the most recent estimates, at the highest frequency available. If your estimates do not go back this far (or they are not readily accessible), please provide the data as far back as you can easily access.
-any supporting documentation for the estimated water values, including any assumptions, calculation steps, and equations.

Kind regards

Doug Watt

Doug Watt
Manager Market Monitoring
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