MINISTRY OF BUSINESS, INNOVATION & EMPLOYMENT
HĪKINA WHAKATUTUKI

BRIEFING

Joint Ministers meeting on the New Zealand Battery Project

Date:	7 April 2022	**Priority:**	Medium
Security classification:	In Confidence	**Tracking number:**	2122-2339

Action sought		
	Action sought	**Deadline**
Hon Dr Megan Woods **Minister of Energy and Resources**	**Forward** to the Minister of Finance and Infrastructure, the Minister for the Environment and Minister of Conservation **Read** ahead of the joint Ministers meeting on 11 April 2022	8 April 2022
Hon Grant Robertson **Minister of Finance** **Minister for Infrastructure**	**Note** the contents of this briefing.	11 April 2022
Hon David Parker **Minister for the Environment**	**Read** ahead of the joint Ministers meeting on 11 April 2022	11 April 2022
Hon Kiri Allan **Minister of Conservation**		

Contact for telephone discussion (if required)				
Name	**Position**	**Telephone**		**1st contact**
Andrew Millar	Manager, Energy Projects and Programmes	Privacy of natural	Privacy of natural persons	✓
Daniel Wright	Senior Policy Adviser	Privacy of natural persons		

The following departments/agencies have been consulted
The Treasury, Ministry for the Environment, Department of Conservation

Minister's office to complete:

☐ Approved ☐ Declined
☐ Noted ☐ Needs change
☐ Seen ☐ Overtaken by Events
☐ See Minister's Notes ☐ Withdrawn

Comment

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Purpose

The purpose of this briefing is to provide you with:

- an update on the progress of the New Zealand Battery Project (NZ Battery Project),
- early and emerging findings from the work to date, and
- an overview of upcoming milestones and decisions in 2022.

The briefing is also intended to support a joint Ministers meeting on 11 April 2022 to discuss NZ Battery Project and its cross-portfolio interactions.

Executive summary

Cabinet asked officials to investigate options to address the dry year problem and support the transition to 100 per cent renewable electricity, with a focus on pumped hydro at Lake Onslow

Currently, hydro dams generate about 55-60 per cent of New Zealand's electricity, with another 20-25 per cent coming from other renewable sources, and about 20 per cent coming from combustion of gas, coal and diesel (known as thermal plants). The hydro dams are susceptible to variations in rainfall within their catchment, which can vary how much electricity they can generate year-to-year. Thermal plants currently cover the deficit arising from years with lower rainfall, with Huntly being a major asset. This is commonly known as the 'dry year problem', for which the most economical solution, to date, has been to rely on fossil fuels that are readily stored or have a flexible supply source. A renewable solution to this problem could support the Government's targets to achieve net zero emissions by 2050, and 100 per cent renewable electricity generation.

New Zealand needs about 3-5 TWh energy storage to resolve the dry year problem

The size of the dry year problem is approximately 3 to 5 terawatt hours (TWh), based on a review of the last 89 years of data on water inflows into the South Island hydro lakes. For comparison, New Zealand has recently been consuming about 38 TWh per year.

Wind and solar generation will increase in New Zealand over time to meet increasing demand from further electrification of the economy, and displace some of the coal, gas and diesel plants. As a higher percentage of generating capacity moves to wind and solar, hydro will make up a smaller percentage of total generation. This will lower the electricity generation risks from lower rainfall but introduces a gradually increasing risk of intermittency in solar and wind generation from calm and/or cloudy weather. Fortunately, these calm and/or cloudy conditions tend only to last a few days, to a week, in New Zealand.

The problem therefore evolves from being a primarily year-to-year issue (the dry year problem that we face now), to being a mixture of year-to-year, and a shorter-term intermittent supply issue (calm, cloudy, and dry).

Cabinet initiated the NZ Battery Project to identify the best long-term, large-scale renewable energy storage options, with a focus on pumped hydro at Lake Onslow, to help resolve the dry year problem and support a transition to 100 per cent renewable generation. The NZ Battery Project is a multi-year, multi-phase project.

Early and emerging findings indicate that a pumped hydro scheme at Lake Onslow is technically feasible and could solve the dry year problem…

A detailed engineering, geotechnical and environmental investigation into the feasibility of a pumped hydro scheme at Lake Onslow is currently underway. The investigation is initially focussing on Lake Onslow and its surrounds before moving into the Teviot Valley.

Early and emerging findings from predominantly desktop level engineering analysis indicate that a pumped hydro scheme at Lake Onslow is technically feasible and could provide significant additional hydro storage to address the dry-year problem at between 3 to 5 TWh. A larger scheme, while technically feasible, is unlikely to be required at this time.

Such a scheme would require an underground tunnel between Lake Onslow and the Clutha River/ Mata-Au—either upstream of the existing Roxburgh hydro dam, or downstream in the Clutha Valley. The existing Roxburgh hydro dam (owned and operated by Contact Energy) has implications for access and control of water for the effective operation of a pumped hydro scheme at Lake Onslow.

This makes tunnel route and intake location a key design decision, and could necessitate some form off river storage, like a reservoir.

… but it comes with environmental, social and cultural costs…

Any pumped hydro scheme will require the level of Lake Onslow to be raised substantially.

There are some Resource Management Act, and Conservation Act considerations to manage

Pumped hydro at Lake Onslow would likely spread aquatic weeds from one body of water to another, which is prohibited under the current Otago Regional Water Plan. Furthermore, a small part of the Manorburn Conservation area would be flooded, which would likely be a violation of the Conservation Act’s protections for wetland areas.

Endangered species live around the lake and there are high value wetlands that would be flooded

The Department of Conservation (DoC) has identified some biodiversity risks with raising the lake level at Lake Onslow, some of which may not be able to be fully mitigated. For example, the Teviot flathead galaxias is a freshwater native fish that is critically nationally endangered and has a substantial amount of its total known habitat within the inundation zone.

The existing lake is an important social asset for some people

Lake Onslow is a highly regarded location for local anglers, with notably high stocks of brown trout. Raising and varying the lake level, may deteriorate the angling asset.

There are some culturally significant sites for mana whenua nearby

Officials commissioned a cultural values assessment that found that there are ancestral, historical tool making, and food gathering sites around Lake Onslow, and that the site had been subject to historic degradation.

The implications for the project under the proposed Natural and Built Environment Act are not clear

The Government has committed to reforming the resource management system in this parliamentary term. Natural and Built Environments Act (NBA) will be the primary replacement for the Resource Management Act 1991 and will provide a greater focus on positive outcomes for both natural and built environments. It will ensure that the use, development and protection of resources only occurs within prescribed environmental limits.

The Ministry for the Environment advises that at this time, it is unclear as to whether the positive outcomes of a pumped hydro scheme will be able to be achieved within prescribed environmental limits, even once adverse effects have been avoided, minimised, remedied and offset.

… and it will likely cost more than early estimates of $4 billion…

By the proposed Cabinet report back in May, we expect to have revised cost and construction timing information for two to three different design options for a pumped hydro scheme at Lake Onslow.

While these costs are still being calculated, it is likely that the potential cost of a pumped hydro scheme at Lake Onslow will exceed the early estimate of $4 billion. This earlier estimate was based on very preliminary engineering analysis and did not include additional transmission and land acquisition costs, or escalation.

We are working to provide the most accurate cost information possible as part of final feasibility decisions in December 2022. The result of geotechnical work will be critical to provide an accurate cost estimate on which to base future decisions.

… it will, however, provide security of supply, gross economic benefits, and a positive cash flow.

Our findings to date indicate that pumped hydro schemes of various sizes at Lake Onslow would create gross benefits to the energy system, primarily through reducing the required overbuild of intermittent renewable generation to maintain security of supply in a 100 per cent renewable future.

Similarly, modelling suggests that if Lake Onslow operated on a competitive basis in the electricity market it would be broadly revenue positive; however, there could be significant variability between wet years where it would likely be a net purchaser of electricity, and dry years where it would a net seller of electricity.

We have not determined whether a pumped hydro scheme at Lake Onslow would be able to recover its capital costs by trading in the wholesale market, but at this stage we think it is unlikely. Further work on its potential commercial feasibility is in progress.

Cabinet also asked officials to investigate other hydro storage options…

At this stage in the NZ Battery Project, we have not identified a clearly superior option to a pumped hydro scheme at Lake Onslow address the dry year problem in a 100 per cent renewable electricity system.

We have been looking at other alternative options to build a pumped hydro scheme elsewhere, or to modify existing hydro assets. A national level scan by NIWA identified two potential North Island sites with technical potential for pumped hydro (Lake Moawhango and the Taruarau River). We also identified potential modifications to Lake Pukaki (current Meridian hydro dam) as an alternative option to meaningfully increase hydro storage.

A desktop level engineering and environmental assessment of these sites has identified that while these alternative hydro options may be technically feasible, none of the options present a clear alternative to Lake Onslow. Each come with significant environmental and social impacts, and early assessments of their costs suggest that they would be broadly comparable to a pumped hydro scheme at Lake Onslow.

… and non-hydro alternatives

We have also identified a short-list of non-hydro options that could help to address the dry year problem, including increasing flexible geothermal generation, biomass and hydrogen production or similar. At this stage, our investigation into these options is high-level. However, it suggests that each of these options would struggle to solve the full dry year problem on its own and come with its own risks and challenges. A portfolio approach may be plausible, and it may improve risk and resilience by spreading development of assets across technologies and locations. This is a fruitful area of further investigation.

Furthermore, electricity industry participants are themselves investigating these technologies, such as Genesis exploring the use of biomass at the Huntly Power Station, and Meridian and Contact's Southern Green Hydrogen proposal. This suggests that the electricity industry may go some way to implementing solutions to the dry year problem.

Even if this is the case, a benefit of Government investigation into a wide range of alternatives is that we can determine the collective effect of proposals being considered, what more might be needed, and whether further government action (whether through incentives, investment, or regulation for example) is needed to fully solve the dry year problem.

The way that Lake Onslow or another NZ Battery option is operated is of keen interest to the market

Any of the "battery" options could substantially modify the way that the New Zealand electricity market functions. The generators are naturally very interested in this market disruption. Signalling the development of a project like Lake Onslow will factor into the generators' future investment decisions.

There are key stage gates for the NZ Battery Project later this year, in May and December

The NZ Battery Project is currently scheduled to report to Cabinet in May and December 2022. A paper in May provides an opportunity to update Cabinet on the emerging findings of the NZ Battery Project. In May, we anticipate Cabinet will be able to consider:

1. an updated assessment of the feasibility of a pumped hydro scheme at Lake Onslow, including 2 to 3 scheme design options, updated information on cost and construction timing, and environmental and cultural impact information,
2. results of desktop level environmental and engineering analysis into three alternative hydro options, based on existing legislative settings,
3. results of engineering analysis into non-hydro options, and
4. updated information on the costs and benefits of different options.

This information will enable Cabinet to make decisions on the remainder of the feasibility stage of the NZ Battery Project, including next steps for the Lake Onslow workstream and whether further work is required on alternative options.

At this stage we consider that further work should continue on the Lake Onslow option in order to fully assess the feasibility, costs, benefits and impacts of a pumped hydro scheme by the end of the year. We also see further benefits in continuing to focus on the portfolio of non-hydro options after May. In contrast, we see limited benefit in doing further work on other hydro expansion options.

In December, Cabinet will be able to make a further and final consideration of the feasibility of a pumped hydro scheme at Lake Onslow, based on a preferred scheme design or design and the results of detailed geotechnical investigations, as well as alternative options.

This information will enable a decision about which option or options (if any) should proceed to the detailed business case stage of the NZ Battery Project.

Recommended action

The Ministry of Business, Innovation and Employment recommends that you:

a **Note** following Cabinet's request [CBC-20-MIN-0090 refers], officials have investigated the scale of the dry year problem and have found that it is in the magnitude of 3-5 terawatt-hours (TWh) of energy storage or flexibility.

Noted

b **Note** emerging findings suggest that a pumped hydro scheme at Lake Onslow is technically feasible, could solve the dry year problem and make significant contributions to addressing the emerging future calm, cloudy problem.

Noted

c **Note** that there are cross-portfolio implications for developing a pumped hydro scheme at Lake Onslow.

Noted

d **Note** the NZ Battery Project has an upcoming report back to Cabinet in May 2022 on emerging findings from the feasibility study of renewable options for addressing the dry year problem in the electricity system.

Noted

e **Forward** this briefing to the Minister of Finance and Infrastructure, Minister for the Environment and the Minister of Conservation.

Agree / Disagree

Andrew Millar
Manager, Energy Projects and Programmes
Building, Resources and Markets, MBIE

07 / 04 / 2022

Hon Dr Megan Woods
Minister of Energy and Resources

..... / ...... / ......

Background

1. In 2019, the Interim Climate Change Committee (ICCC) recommended that the Government explore pumped hydro as an option to address the dry year problem in the electricity system.[1] The dry year problem arises from extended periods where inflows into hydro catchments are lower than normal and lake levels decline. Currently, when lakes are low, fossil fuelled generation increases to maintain the supply of electricity.

2. The Government has a manifesto commitment to investigate dry year storage to help New Zealand move towards 100 per cent renewable electricity generation. In 2020, Cabinet set up the NZ Battery Project to assess renewable storage options to address the dry year problem. Cabinet agreed the NZ Battery Project should examine the viability of pumped hydro, particularly at Lake Onslow, and consider this solution against alternative technologies [CBC-20-MIN-0090 refers].

3. In December 2020 Cabinet agreed that the objective of the NZ Battery Project was "*to manage or mitigate dry year risk in the electricity system*", and set the following criteria for proposals to be assessed against:

    - *"provide at least [5,000 GWh] of energy storage or equivalent energy supply flexibility*
    - *provide significant levels of employment for post COVID-19 recovery*
    - *reduce emissions either directly or indirectly through facilitation decarbonisation*
    - *maximise renewable electricity in order to provide a pathway to achieve the goal of 100 per cent renewable electricity*
    - *lower wholesale electricity prices, and*
    - *be practical and feasible."*

    and noted "*that the assessment of any option will take into account wider social, cultural and environmental factors…".*

4. In December 2020 Cabinet also agreed to a multi-stage, multi-year approach to the NZ Battery Project. This approach includes a feasibility study phase (Phase 1), followed by a detailed business case phase, leading to a final investment decision (Phase 2), and then an implementation phase (Phase 3).

5. We are currently in the feasibility study phase of the NZ Battery Project, which we expect will conclude at the end of 2022. We are scheduled to report to Cabinet in May and December 2022.

6. Since its establishment, the NZ Battery Project team has conducted a significant amount of analysis on the feasibility of a pumped hydro scheme at Lake Onslow, as well as on alternative options, including other sites for pumped hydro, and other non-hydro technologies.

7. To support discussion at the joint Ministers meeting, this briefing provides an update on the NZ Battery Project and outlines the emerging findings, particularly as they relate across portfolios. It also provides an overview of the milestones and decision points for the project in 2022.

[1] Interim Climate Change Committee (2019). Accelerated Electrification.

Emerging findings

We have an improved understanding of the dry year problem

8. New Zealand consumes around 38 TWh[2] of electricity annually. On average, over the last five years, between 81 and 84 per cent of this electricity is generated from renewable sources (the average varies by around two percentage points year-to-year). Some renewable fuels are intermittent (eg hydro, wind, solar) and fluctuate a lot depending on the weather. To balance this variation and make sure supply continuously matches demand, some controlled generation is required. Controlled generation draws on stored fuel (eg water stored in hydro lakes, or combustible materials like coal or gas) to respond to demand changes.

9. Despite having hydro-dominated generation, the hydro storage lakes in New Zealand are relatively small, storing weeks to months of energy when combined – 4.5 TWh of storage capacity compared to around 25 TWh of average annual inflows. Hydro storage relies on inflows to continually top up the lakes. However, inflows vary year to year, as shown in Figure 1 below.

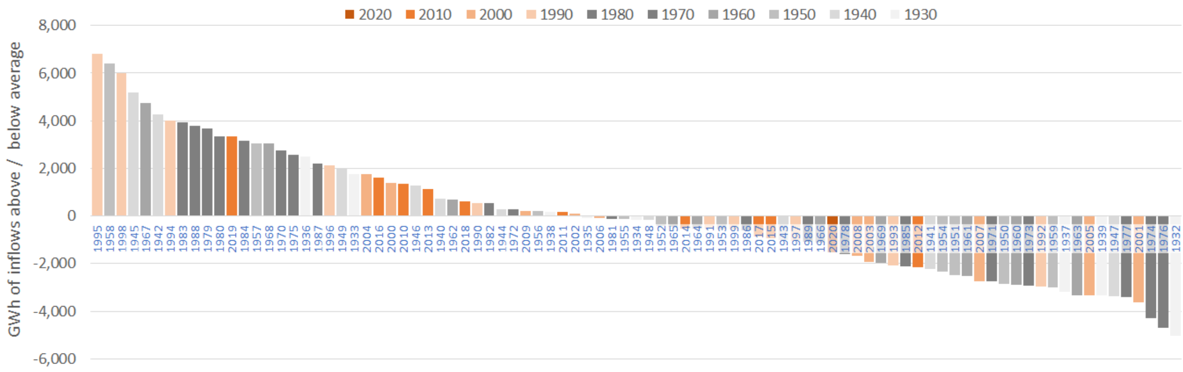

Figure 1: Inflow years, wettest to driest

10. At its worst, the shortfall of annual inflows has been 5 TWh lower than the historical average, however, a more typical dry year is around 3 TWh.

11. Future patterns of electricity supply, demand, and individual weather events carry a high degree of uncertainty, in aggregate. However, our analysis suggests that the energy storage required to mitigate intermittent supply from renewables will remain in the range of 3-5 TWh until around the 2040s. From there, storage needs could decrease, but remain significant, before rising again to 3-5 TWh after 2050, as more renewables are built.

12. Large-scale, long-term renewable energy storage like a pumped hydro scheme at Lake Onslow or similar could play a greater role in managing shorter-term intermittent supply risk from wind and solar (calm or cloudy periods of several days), while maintaining its role in managing inter-year intermittent supply of hydro (dry years).

13. In the future, New Zealand will have competing forces that will both exacerbate, and mitigate the dry year risk:

- Further electrification of the economy will increase electricity demand.
- A future profile of electricity production will become increasingly reliant on weather patterns, as more renewable generation sources are built and displace thermal plants.
- Mass deployment of renewable electricity generation like wind and solar, will result in surplus energy at times.

[2] 1TW = 1,000 Gigawatts (or 10^{12} watts)

- Climate change will alter the hydro catchment inflow patterns.

14. We have sought to understand the effects of climate change on renewable electricity generation and how it will affect future inflows of hydro, wind and solar. We have accounted for the latest evidence on impacts of climate change in our models on hydro inflow, wind patterns, and electricity demand.

15. While referred to as dry ‘years’, the system may be stressed by a dry period that only lasts a few months, especially if it overlaps with winter. Although all dry years end when inflows increase, either from rainfall or snowmelt, each dry year has different characteristics and are often difficult to recognise at the time. Whenever dry years threaten, market participants will try to conserve their water by pricing it higher, reflecting its scarcity and the need for higher cost fossil fuel generation to avoid potential electricity shortages. This puts upwards pressure on wholesale electricity prices.

16. Following changes to the Electricity Industry Participant Code 2010, the market has managed the risk of dry years successfully and the electricity has not had to run a public awareness campaign on electricity conservation since 2008.

Currently, we manage the risk of dry years using fossil-fuel generation

17. Hydro electricity generators are constantly managing their storage reservoirs (within resource consent limits, which require minimum river flows) to balance today’s demand for electricity with their expectations of future inflows and demand, to avoid the risk of running out of water.

18. It is impossible to perfectly forecast inflows or demand. Hydro electricity generators make decisions based on incomplete information and unpredictable weather. Sometimes, they may hold back water expecting it to be a dry year only to have it rain continuously for a week. With hindsight it is clear it was not a dry year, but that is not known in real time.

19. Low inflows can be compounded by several factors that make managing a dry period more challenging, including:

    a. high demand, eg heating in winter,
    b. other generation being unavailable eg a maintenance outage or constrained fuel supplies,
    c. uncertainty over whether industrial consumers with high electricity usage will reduce demand, and
    d. transmission constraints.

20. These other factors can put additional stress on the electricity system and may be unrelated to rainfall.

21. When hydro inflows and/or storage levels are low enough to make hydro generators want to conserve water, they indicate this by raising the price they offer generation to the wholesale market. Consequently, wholesale electricity prices rise to reflect the scarce resource. Higher prices incentivise fossil fuelled generators (who have a higher operating cost) to generate more to cover the shortfall, draw down their storage of fuel, and if prolonged, purchase additional fuel. This allows lake levels to be kept higher throughout the year.

22. In summary, dry years have the following features:

    a. lower than average inflows (3-5 TWh shortfall),
    b. an overlap with periods of higher demand (eg winter),
    c. security of supply being threatened,
    d. higher prices, and
    e. increased fossil-fuelled generation.

23. In the future, electricity system modelling indicates that calm and/or cloudy periods will place additional short-term stress on the electricity market, as solar and wind generation plays an increasingly important role. With New Zealand's weather patterns, these events can last a few days to a week.

24. Solutions to the dry year problem, therefore, require significant amount of stored energy that can be released over a few weeks or months when the electricity market is stressed. This reaffirms the focus of the New Zealand Battery Project, on finding a long-term, large scale energy storage scheme.

But there are other ways of managing the risk

25. In a 100 per cent renewable electricity system, the dry-year problem can be addressed by building sufficient spare renewable generation capacity (most likely wind and solar) to reliably fill the energy gap when hydro inflows are very low. This so-called 'renewable overbuild' approach could risk upward pressure on electricity prices, as was identified by the Climate Change Commission and the Interim Climate Change Committee.

26. It is likely that demand response measures (eg temporarily scaling down energy-intensive industries) will play some role in balancing supply and demand in the future, which can also help to manage periods where intermittent generation sources are not producing.

Government has a role to play in finding a renewable solution

27. The market is unlikely to completely resolve the dry year problem with renewable generation on its own. The dry year problem necessitates an asset that stores energy for a longer period of time (multiple years) than is generally commercially viable. An investor must be willing and able to manage correspondingly infrequent and uncertain revenue flows.

28. Thermal fossil fuel plants, like natural gas, are relatively cheap to build, but have higher operating costs in the form of fuel. Given the low upfront capital at risk, they have to date been favoured for managing the dry year risk.

29. In comparison, renewable technologies are less likely to have controllable output, and more likely to have a large proportion of their costs come up-front to build them. They are also more likely to be immature technologies or still in development (hydro generation with storage being the exception). Renewable solutions to the dry year problem are hence high risk, which makes them less attractive to private investment.

30. There is a role for Government in resolving the dry year problem with renewable sources, either through investment in a project like pumped hydro, or through other market-guiding levers.

A pumped hydro scheme at Lake Onslow can technically address the dry year problem and periods of low generation from intermittent renewables

31. A key focus of the NZ Battery Project is investigating the feasibility of a pumped hydro scheme at Lake Onslow.

32. A pumped hydro scheme at Lake Onslow would be the biggest hydro infrastructure project New Zealand has undertaken since Clyde Dam in the 1980s. MBIE has engaged Te Rōpū Matatau (a consortium led by Mott MacDonald New Zealand Limited with GHD Limited and Boffa Miskell Limited as key sub-consultants) to conduct an engineering, geotechnical and environmental investigation of a pumped hydro scheme at Lake Onslow.

33. The investigation consists of two broad parts which overlap:

    a. Part A - a predominantly desktop-based technical study to select the optimal design configuration(s) of the pumped hydro scheme, and initial geotechnical and environmental fieldwork.

b. Part B - more detailed design study based on Part A and detailed geotechnical investigations.

34. Alongside the investigation by Te Rōpū Matatau, MBIE has engaged other specialists to:

a. assess what upgrades, if any, may be required for the transmission system (see paragraph 45),
b. conduct assessments of the cultural values, environmental values, and social impact of the potential scheme (see paragraph 48), and
c. model how a pumped hydro scheme at Lake Onslow might integrate into the electricity market, and its economic benefits to the electricity system (see paragraph 73).

35. Early and emerging analysis from Part A of Te Rōpū Matatau engineering and geotechnical investigation indicates that a pumped hydro scheme at Lake Onslow is technically feasible and could substantially resolve the dry year problem. Note these are provisional findings only.

36. Additionally, pumped hydro technology is well suited to addressing the challenges posed by intermittent renewable generation, as it can store energy when there is a surplus of supply (like when the wind is consistently blowing), and use that energy when there is less supply (like when the weather is calm).

37. Te Rōpū Matatau has identified several design considerations for a pumped hydro scheme at Lake Onslow, and is in the process of analysing which combinations of design elements are most feasible (eg tunnel route, dam size and type). Early and emerging findings suggest the following:

a. A pumped hydro scheme of 3 to 5 TWh would be suitable for Lake Onslow.
b. A concrete dam would be cheaper, carry lower construction risk, and could more easily be scaled up later if desired, but the concrete creates carbon emissions. Alternatively, a rockfill dam would avoid a lot of those emissions but would be more expensive and difficult to construct.
c. There are three prospective intake structure locations: one upstream and two downstream of the Roxburgh hydro dam, each with their own practical and geological risks to manage (see paragraph 39).
d. Taking water from a point downstream of the Roxburgh dam would likely require a way to pool some water off-river to create storage that can decouple the operation of a pumped hydro scheme from Contact Energy's operation of the Roxburgh dam (see paragraph 39). It would require flooding a small area at the tunnel mouth.

38. Further refinement of this early analysis will be ready for Cabinet in May, alongside additional supporting desktop analysis on indicative revised cost and construction timing. Further milestones and decisions for the NZ Battery Project are discussed in paragraph 76.

39. Te Rōpū Matatau has presented three leading design options for the lower intake as reflected in Annex One:

a. "Lake Roxburgh" – upstream of the Roxburgh dam.
b. "Dumbarton rock" – downstream of Roxburgh dam.
c. "Craig flat" – downstream of Roxburgh dam.

40. Confidential information entrusted to the Government

41. Any intake upstream of the Roxburgh dam, will require careful handling and commercial arrangements with Contact Energy as it could potentially affect their commercial operations. The other two options downstream of the dam, with off-river storage, will have less of an impact on Contact's commercial operations.

42. These findings are provisional and further engineering work, alongside detailed geotechnical investigations of the Lake Onslow area and potential tunnel routes, will be required to provide a more accurate cost estimate and geotechnical risk assessment. *Annex One: Maps for reference* shows the possible inundation zones for Lake Onslow, and the proximity to the Roxburgh Dam (Contact Energy asset).

43. This detailed geotechnical programme commencing in April will be ongoing throughout 2022 to feed into final feasibility decisions planned for the end of 2022.

44. Geotechnical investigations and engineering work are required to provide further assurance of feasibility, costs, and timeframes. Note that should Cabinet agree to proceed pumped hydro at Lake Onslow to Phase Two (detailed business case) in December, significant additional geotechnical work would be required to support a final investment decision.

Transmission grid upgrades will be required to support the delivery of electricity from Lake Onslow

45. MBIE has engaged Transpower to work through the transmission and overall grid resilience implications of a pumped hydro scheme at Lake Onslow. Transpower is providing advice on any potential transmission grid stability issues and necessary upgrades should we progress with Lake Onslow. Early indications are that some upgrades will likely be required in order to integrate a pumped hydro scheme at Lake Onslow into the transmission network, though these specific details are being worked through currently.

The total costs are likely to exceed the early estimates of $4 billion

46. We are in the early stages of preparing cost estimates for different pumped hydro scheme design options at Lake Onslow. After accounting for things like transmission grid upgrades and cost escalation, preliminary estimates suggest that the total cost will likely be higher than the approximately $4 billion estimate previously provided.

47. While we are unable to provide you with an indication of these costs now, we will have revised estimates prepared for the Cabinet discussion in May. Note that these estimates will still be subject to the results of geotechnical programme, appropriate benchmarking and peer review, which will occur throughout 2022.

There are environmental, social, and cultural costs for Ministers to consider

48. While constructing a pumped hydro scheme at Lake Onslow could address the dry year problem, and hence enable a 100 per cent renewable electricity system, it would likely affect some significant environmental and cultural values. Some, but not all, of these effects could be mitigated or managed.

49. Inundation of land around Lake Onslow would inevitably result in the loss of some high environmental values. Desktop analysis and fieldwork undertaken by DoC, as part of their assessment of conservational values to date, have revealed several emerging findings:

    a. Teviot flathead galaxias (critically threatened freshwater fish species) populations are limited to eleven sections of waterway in the Lake Onslow tributaries – two of which would be destroyed by raising the lake levels, and more placed at risk.

    b. Burgan skinks (nationally endangered), as well as Southern grass skink and korero skink, have been found in the Lake Onslow area.

c. Indigenous birds, including black fronted tern (nationally endangered), grey duck and eastern/New Zealand falcon (nationally vulnerable), as well as other at-risk species, reside around Lake Onslow.

d. There are nationally significant wetland areas, including the Fortification Creek Wetland, in the project area and surrounding landscape that cannot be recreated.

50. DoC's fieldwork has covered approximately 53 per cent of the affected land. The remaining area is split across two landowners. To date we have not been able to access properties for fieldwork. DoC has supplemented this fieldwork gap with desktop analysis of the wider area.

51. In addition, there are some early indications of regulatory barriers to developing a pumped hydro scheme at Lake Onslow, including provisions of the Otago Regional Water Plan, which prohibit the spread of aquatic weeds, and the inundation of the Manorburn Conversation Area.

52. Both a full assessment of the consenting pathways for pumped hydro scheme at Lake Onslow and a formal assessment of environmental effects is in development and will be available for decisions at the end of the year.

53. In addition, there are current regulatory settings that will change during our detailed work on Lake Onslow. The Otago Regional Water Plan is currently under review, and the government is working on the Natural and Built Environments Bill. Officials will continue engagement through these changes and advise of any interlinkages with Lake Onslow.

54. *Annex Two: Conservation, environmental, cultural, and social implications of a pumped hydro scheme at Lake Onslow* contains further detail on these findings.

Other options are only partial/portfolio solutions

55. Alongside investigating the feasibility of a pumped hydro scheme at Lake Onslow, the NZ Battery Project has also been exploring other potential hydro and non-hydro alternatives.

Alternative hydro developments are at least as challenging as Lake Onslow

56. A national level scan by NIWA identified two potential North Island sites with technical potential for pumped hydro. North Island options are conceptually appealing for pumped hydro development as they are closer to demand centres and the likely location of a lot of future wind and solar investment. We also identified potential modifications to Lake Pukaki as alternative options to meaningfully increase hydro storage.

57. These sites are:

a. Up to 2.7 TWh pumped hydro at Upper Moawhango catchment in the Central North Island (existing hydro asset).

b. Up to 1.1 TWh pumped hydro at Taruarau River near Hawke's Bay (new hydro development).

c. Up to 5 TWh extension to Lake Pukaki on the Waitaki River in the South Island (existing hydro asset).

58. A draft desktop-level engineering and environmental assessment of these sites has identified that while these alternative hydro options may be technically feasible, none of the options present a clear alternative to Lake Onslow.

59. Early cost estimates for the three alternative sites are broadly comparable to pumped hydro at Lake Onslow, and either do not provide the same level of storage or flexibility. These sites also include significant environmental, cultural and social values which could be significantly impacted. *Annex Three: Other hydro options* contains further information.

60. Note to date we have not sought views from iwi or other stakeholders on these potential options. To date, we have focused our efforts on determining their fundamental feasibility. Engagement will be required if these other hydro options are explored further. That could have both resourcing and timing implications for the NZ Battery Project.

61. Additionally, if we pursued any of these options any further, the Government would need to consider interactions with existing assets and managing risks of exacerbating market power.

62. Given the emerging feasibility information about a pumped hydro scheme at Lake Onslow, it is unlikely that further development of these options is necessary at this stage of the NZ Battery Project, and the final results of our existing work can feed into the final feasibility decisions at the end of the year.

Non-hydro options are more prospective, but present their own challenges

63. We have identified a short-list of non-hydro options that could help to address the dry year problem by 2030. External engineering assessments are supporting our investigation into these options.

64. Currently, increasing flexible geothermal generation, biomass and hydrogen are the most prospective non-hydro options. It would be difficult to solve the dry year problem with just one of these options on its own, given logistical and commercial challenges—for example, whether New Zealand or international industries will produce biomass at rates sufficiently competitive to be cost effective as an electricity generation source. Each option would have its own balance of costs and benefits to consider. A portfolio of smaller options may be possible and may improve risk and resilience of the electricity sector, as well as being quicker to develop than a pumped hydro scheme.

65. These alternative options may be better suited to a portfolio solution (eg each provide around 1 TWh). While there are likely resilience benefits to having a diversified solution, further work is required to understand the practicalities of whether, how and where these technologies would operate in the New Zealand context.

Demand response may play a larger role in balancing the market, in the future

66. We are also considering the potential role that large scale interruptible demand could play in solving the dry year problem. Large industrial consumers have historically shown some willingness to reduce their load during dry periods, and new industries such as datacentres and hydrogen production may be willing and able to provide a helpful response in future.

67. However, it is unlikely that large consumers could meet the full large-scale, long-term response that the dry year problem requires, given the impact that a sustained period of load reduction would have on their businesses. It is unlikely that the specific requirements of a dry year response and the independent drivers of a business' operations would always align. It is hence realistically only a partial solution.

Industry is investigating a range of these non-hydro options

68. Since the Government announced the NZ Battery Project, market participants have also been looking at options to address the dry year problem.

69. Industry is actively exploring similar energy storage technologies to us. Genesis Energy is planning a two-day test burn of steam exploded biomass pellets at Huntly Power Station in June.

70. Contact Energy and Meridian Energy are exploring options for a hydrogen plant in the South Island, as a source of demand response, along with datacentres. Contact Energy has suggested that it is also considering a small pumped hydro scheme between its assets on the Clutha River/Mata Au.

71. The NZ Battery Project team is keeping abreast of these different projects and their progress.

72. Market participants have indicated they would not invest significant capital in these projects until the outcomes of the NZ Battery Project are clear, including how a solution like a pumped hydro scheme at Lake Onslow would operate in the market. They would also likely seek government support in progressing those options in any case.

Large scale, long-term storage like pumped hydro could change the way the electricity market works

73. Alongside assessing the physical feasibility of the different solutions, we have also been analysing the economic benefit different options to the electricity system and how they might integrate into the electricity market.

74. To date our analysis has focused primarily on pumped hydro at Lake Onslow. Early findings indicate the following:

    a. A pumped hydro scheme at Lake Onslow, with a storage capacity in the order of 3-5 TWh could create significant benefits for the New Zealand electricity system - for example, by reducing the amount of construction of other renewable generation, necessary to reach the 100 per cent renewable target.[3]

    b. If a pumped hydro scheme at Lake Onslow operated in a way to maximise its profit, then it would likely generate a net positive revenue, as it would pump water when prices are low, and generate when prices are high. However, there would be significant volatility in revenue, within years and between years, depending on whether it was pumping (buying electricity, but accumulating an asset), or generating (selling electricity, and drawing down the asset).

    c. The storage and generating capacity that we are investigating (3-5 TWh storage, 1,000 MW capacity) is significant in the context of current electricity generation in New Zealand. For comparison, we estimate that the total current hydro storage in New Zealand is 4.5 TWh, and Lake Manapōuri is the largest hydro power station, with 850 MW of installed capacity. Officials are developing ways to make best use of an asset this large, and to mitigate market power risks.

    d. There are hydrological interactions with Contact Energy’s hydro generation assets on the Clutha River, especially the Roxburgh Dam, which, depending on the design of Lake Onslow, may have commercial ramifications.

75. *Annex Four: Electricity market interactions* includes more information on our current level of understanding of market effects of an asset like a pumped hydro scheme at Lake Onslow. We expect to be able to provide further information and analysis in the May Cabinet update.

Decisions and stage gates for the NZ Battery Project in 2022

A Cabinet report back in May provides an opportunity to share early findings and direct the remainder of the feasibility work

76. May provides an opportunity to update Cabinet on the emerging findings of the NZ Battery Project and help shape the focus for the reminder of phase 1 of the project. In May, we anticipate Cabinet will be able to consider the following:

[3] This is against a counterfactual scenario where New Zealand achieves 100% renewable electricity by “over building” intermittent renewable generation like wind and solar.

Findings	**Potential decisions**
Lake Onslow pumped hydro An updated assessment of the feasibility of a pumped hydro scheme at Lake Onslow, including: • two to three scheme design options (eg tunnel routes, dam location and type) • updated information on cost, constructability and construction timeframe • environmental and cultural impact information.	Interim decision to continue feasibility work with a pumped hydro scheme at Lake Onslow. Interim decision to focus on one or two preferred scheme design options for further development. Interim decision on specific scheme design elements for further refinement, including dam size, generating capacity and lower intake location.
Other hydro options Results of desktop level environmental and engineering analysis into three alternative hydro-based options	Decision on whether to undertake any additional feasibility assessment into these options before the end of 2022.
Non-hydro options Results of engineering analysis into non-hydro options, including:	Decision on whether to undertake any additional feasibility assessment non-hydro storage options, either individually or as part of a portfolio solution.
Market integration Updated information on the costs and benefits of other, non-hydro energy storage options. Examples of different potential operational models, and their relative costs and benefits.	Express a preference for a preferred operational model.

77. By May we will have undertaken further analysis of these early and emerging results and will be able to provide you with a more complete set of potential decisions for this Cabinet update and can work these through with your office.

78. In December 2021 we previously described these decisions in May an ‘in-principle decisions’, that would be subject to confirmation as part of final feasibility decisions. Given how this phase of the NZ Battery Project is developing, we now consider it more appropriate to class any May Cabinet decisions as interim decisions. This would allow for more flexibility while the project continues it work to the end of 2022.

By the end of 2022, we expect there to be sufficient information to make a complete feasibility assessment of a pumped hydro scheme at Lake Onslow and other options

79. By December, Cabinet will be able to make a further and final consideration of the feasibility of a pumped hydro scheme at Lake Onslow based on a preferred scheme design and the results of detailed geotechnical investigations, as well as alterative options. Officials intend to provide an indicative business case to support Cabinet’s decision making.

80. This information will enable a decision about which option or options (if any) should proceed to the detailed business case stage of the NZ Battery Project. At this stage, a detailed business case is likely to take 18 months to two years depending on the option selected, at which point a final investment decision could be made.

81. There may also be a range of non-infrastructure related initiatives that could be progressed as part of – or separately to – the NZ Battery Project, such as supporting a local New Zealand biomass industry.

82. If Cabinet decides in December 2022 to progress more than one option to Phase 2 of the project, this will have implications for the scope and scale of the project. It may also have associated implications for timeframes, depending on available resource.

Next steps

83. On 11 April, the Ministers of Energy and Resources, Environment and Conservation will meet to discuss the matters outlined in this briefing. Consideration of these early findings will help to assess whether further or additional work is required.

84. In early May you will receive a draft Cabinet paper providing the latest update on the NZ Battery Project and seeking some high-level decisions.

Annex One: Maps for reference

Inundation

1. Figure 2 below illustrates the various inundation scenarios at Lake Onslow. T2 illustrates how the inundation levels translate to energy storage options. The lake is in a basin, so small increases in the lake level will inundate a wide land area, but relatively little further inundation thereafter.

Table 1: Translation of inundation options, to estimations of stored energy at Lake Onslow.

Inundation (m above sea level)	Estimated stored energy
740m	3 TWh
760m	5 TWh
780m	7 TWh
800m	9 TWh

Commercial Information

Lower reservoir intake location options

2. Figure 3 below shows the tunnel alignment and lower reservoir intake locations that we are considering.

Commercial Information

Annex Two: Conservation, environmental, cultural, and social implications of a pumped hydro scheme at Lake Onslow

Conservation implications

Inundation would threaten some endangered species and their habitat

1. While the Lake Onslow basin is not a pristine natural landscape, parts of it still have high environmental values. It has been modified historically to support pastoral farming and hydro electricity generation. The area is home to several different endangered species.

2. The proposed inundation area encapsulates habitat used by nationally endangered freshwater fish- the Teviot flathead galaxias and dusky galaxias. The known Teviot flathead galaxias populations are limited to eleven sections of waterway in the Lake Onslow tributaries, two of which are in the inundation zone. These indigenous fish have not been found anywhere else in the country. The lake also has known populations of freshwater crayfish (kōura), which are at risk.

3. There are also endangered lizards in the area. Burgan skinks, which are nationally endangered, were found in the area, as well as the Southern grass skink and korero gecko, which are at risk.

4. Lake Onslow also supports a large number of indigenous birds, including the nationally endangered black fronted tern, the nationally vulnerable grey duck and eastern/New Zealand falcon, as well as several other at-risk species.

5. Many types of wetlands are abundant (1,335 hectares) within the project area and surrounding landscape. Wetland types identified include bog wetlands, comb sedge bog, marshes, swamps, ephemeral wetlands and seepages. Throughout these wetlands, the vegetation communities are relatively intact, containing primarily indigenous wetlands species. The Fortification Creek Wetland is nationally significant as it contains ephemeral wetlands, which are rare, and it also likely home to several threatened and at-risk plant species.

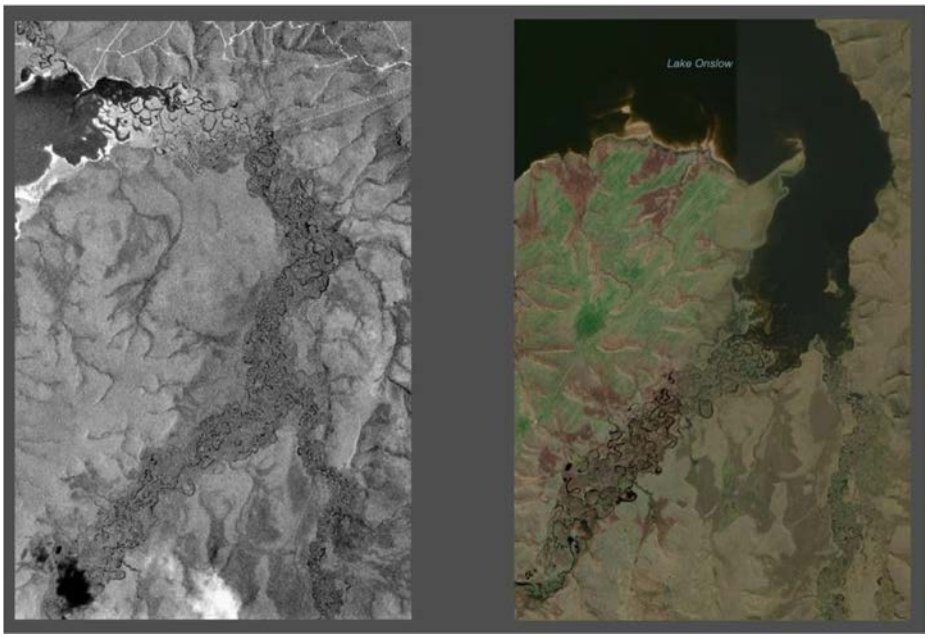

Figure 4: Fortification Creek Wetland 1975 (left) before the 1982 dam raise, and 2021.[4]

[4] Retrolens, 2021 (detail); Google, 2021 (detail).

6. Note a significant portion of the historic wetlands have already been flooded by previous damming efforts at the lake, as Figure 4 illustrates above.

Environmental/consenting implications

7. MBIE is also working with Te Rōpū Matatau on the potential consenting pathway for Lake Onslow under the Resource Management Act 1991 (RMA). This process has identified some potential legislative impediments to the Lake Onslow option that would need to be worked through, should it be the preferred option.

8. Note that the proposed Natural and Built Environments Act would likely be enacted before the project is at the consenting stage, and as such the legislative framework for the consideration of environmental, cultural and social effects will be different. The implications set out below relate to existing legislative and regulatory settings under the RMA.

9. The impediments identified to date include the following:

    a. The current Otago Regional Water Plan includes a prohibition on introducing aquatic weeds, such as didymo and lagarisyphon, from one body of water to another. Lagarisyphon and didymo are both found in the Clutha catchment, but not Lake Onslow. As pumping between the Clutha River and Lake Onslow would introduce these into the Lake, we would be unable to apply for a resource consent given the Water Plan's current form.

    b. All inundation options for Lake Onslow currently include flooding into part of the Manorburn Conservation Area (stewardship land), as well as marginal strips. While there are some prohibitions on flooding parts of the conservation estate, there are also options under the Conservation Act 1987 to allow for land swaps where there are no or very low conservation values. It would, however, be very difficult to argue that the relevant section of the Manorburn Conservation Area meets the test of "no, or very low conservation values", given the known historic heritage of the area.

10. The National Policy Statement for Freshwater Management 2020 and Resource Management (National Environmental Standards for Freshwater) Regulations 2020 include a range of constraints to development within or near wetlands, and which lead to loss of river extent. Some, but not all of these constraints, are subject to potential exemptions and mean Lake Onslow could have a consenting pathway under the RMA.

Cultural implications

11. There are three papatipu rūnanga located in Otago that hold shared authority and mana whenua status in the area surrounding Lake Onslow, including the Mata-au/Clutha River, Te Rūnanga o Ōtākou, Hokonui Rūnanga and Kāti Huirapa Rūnaka ki Puketeraki. For the purposes of this briefing, they are collectively referred to as Ngā Rūnanga.

12. Note one of the members of the Technical Reference Group for the NZ Battery Project is from Te Rūnanga o Ōtākou.

13. At the recommendation of Te Rūnanga o Ōtākou, MBIE engaged Aukaha (a rūnanga-based consultancy) to conduct a cultural values assessment, including archaeological and heritage assessments. Aukaha's report identified several areas of cultural value in relation to Lake Onslow.

14. It highlighted the significance of wai (water) to Ngāi Tahu both as an early ancestor and as taonga. The mauri (lifeforce) of wai binds all things and connects the environment. Mauri is a critical element in the relationship of Ngā Rūnanga with all waterways, including the Mata-au, Te Awa Makarara/Teviot River, and Lake Onslow.

15. The report set out the historic degradation of the waterways resulting from colonisation. The waterways have been altered by activities including the introduction of exotic species (eg trout) in 1863, the damming of 'Dismal Swamp' in 1888 to enable gold mining and use of the waterways for irrigation and power generation from the early 1920s until today, as well as pastoral farming. As a result, Lake Onslow now has medium levels of nutrients, a well-established exotic trout population, threatened native flora and fauna species, invasive exotic grass types, and reduced wetland area.

16. Aukaha's report found that there wāhi tūpuna (ancestral sites), wāhi taoka (historical tool making sites) and wāhi mahika kai (food gathering sites) in the affected area. These sites have significant value to mana whenua to support the rekindling of connection across generations.

17. Finally, the report outlined that each waterway has its own mana and mauri, providing specific ecological services. It also pointed to the principles set out in the National Policy Statement for Freshwater Management 2020 (NPS-FM) that identifies Te Mana o te Wai as the fundamental concept in the management of freshwater in Aotearoa. The first priority is identified as the health and well-being of the waterway and freshwater ecosystems, with human health, and social, economic, and cultural well-being prioritised second and third respectively. The NPS-FM also outlines the key role of mana whenua in defining Te Mana o te Wai.

18. Note that the protection of wetland complexes and the indigenous biodiversity they support is a priority of great significance for Ngā Rūnanga. However, so is responding to climate change.

Social implications

19. The Lake Onslow area provides recreation opportunities for mountain biking, tramping, hunting, backcountry skiing, fishing and horse trekking. Angling is the primary recreational activity at Lake Onslow. There is a very healthy population of brown trout that allows for Lake Onslow to have the highest bag limit in the South Island (10 fish).

20. The Teviot Anglers Club has between 150 and 200 members and there are 17 private or club-owned angling huts surrounding the Lake. These huts are well utilised and the heart of the angling community. Use is consistently high, and the Club's huts are booked almost every weekend over the season. Figure 5 below illustrates the proximity of the club huts to the existing shore of Lake Onslow.

Figure 5: Fishing huts at Lake Onslow will be inundated by the proposed increase in lake levels.[5]

21. These huts, along with the boat ramp, would be inundated were the pumped hydro scheme at Lake Onslow option to proceed without mitigation. However, there could be options to relocate the huts. The full effects on the trout habitat have not yet been assessed and would be part of further fieldwork in later stages.

5 Source: https://tikitouringnz.blogspot.com/2014/05/the-dismal-swamp-lake-onslow.html

Annex Three: Other hydro options

1. In 2021, we asked NIWA to undertake a scan of the country using an algorithm to identify the full range of locations that have the geographical features necessary to support a large, pumped hydro development—as described by certain search parameters. It sought purely to identify sites with the right potential characteristic for pumped hydro.

2. The topography of Lake Onslow makes it a standout option for a large pumped-hydro dam with maximum storage potential of approximately 8 TWh. However, after screening the NIWA results, we identify two sites which could be suitable for pumped hydro.

3. Separately, we also considered whether existing hydro assets could be modified to increase storage and found one existing hydro asset that could be extended.

4. The three sites are listed below, and Figure 6 illustrates their approximate location:

    a. Up to 2.7 TWh pumped hydro at Upper Moawhango catchment in the Central North Island (existing hydro asset).

    b. Up to 1.1 TWh pumped hydro at Taruarau River near Hawke's Bay (new hydro development).

    c. Up to 5 TWh extension to Lake Pukaki on the Waitaki River in the South Island (existing hydro asset).

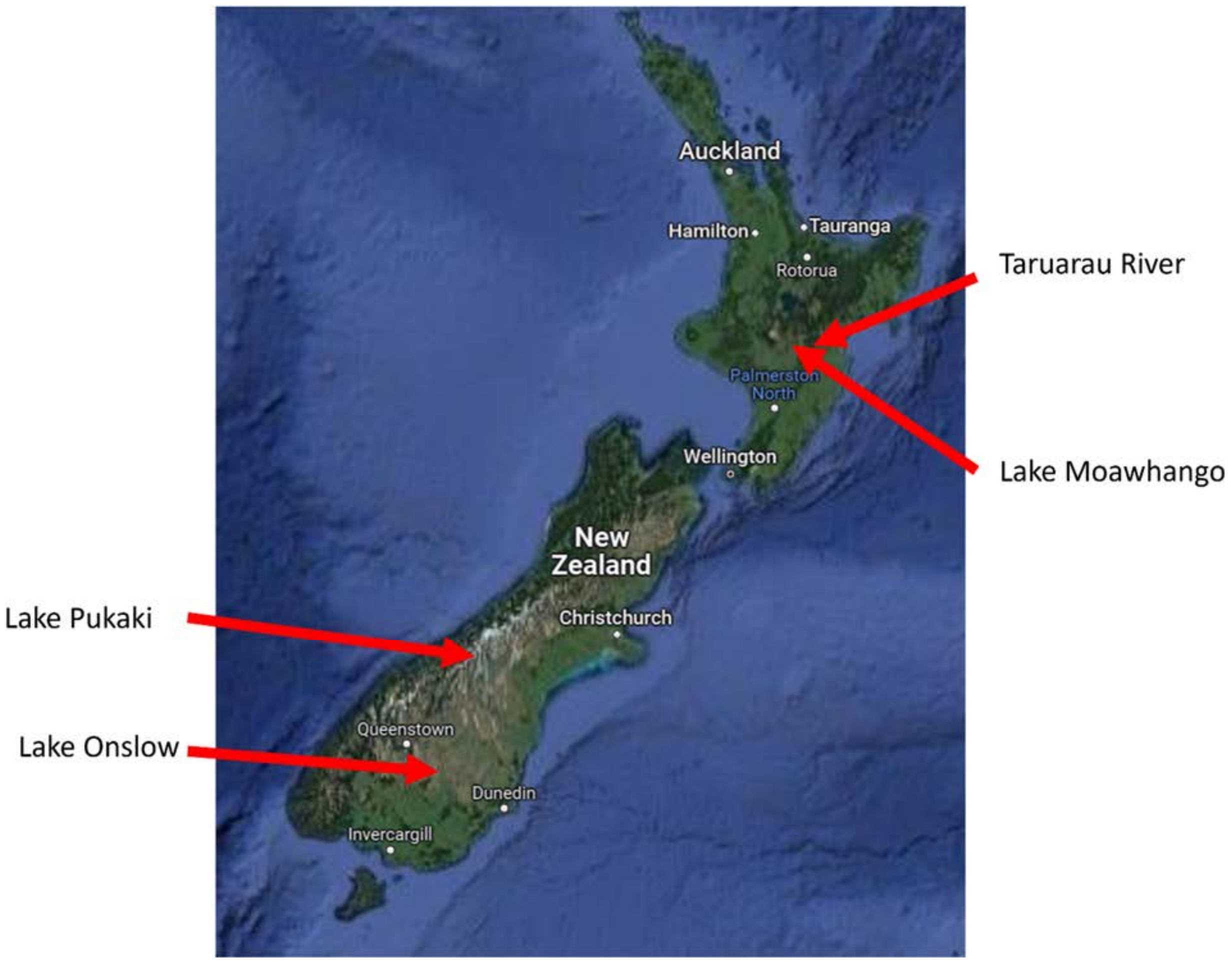

Figure 6: Approximate locations of new or expanded potential hydro options.

5. It is important to note that these sites were identified based purely on their technical potential, which some limited assessment of environmental and other values. In order to

understand whether the technical potential of any of these sites translated into a feasible option, an engineering and environmental assessment was required.

6. MBIE has engaged engineering firm Stantec NZ to conduct an initial high-level desktop engineering and environmental assessment of these three sites. The results of this assessment are still being finalised, but early cost estimate of these three alternative sites are broadly comparable to a pumped hydro scheme at Lake Onslow, although the range varies.

7. Furthermore, each of the sites contain their own profile of environmental and cultural values, which would need careful consideration and engagement (particularly with mana whenua) before further work is undertaken. The Taruarau River option in particular has many challenges.

8. No engagement has been undertaken to date with iwi or stakeholders related to these potential alternative hydro sites. If any of these options were to be considered further, then engagement with appropriate mana whenua and stakeholder would be required.

9. At this stage, we consider it is unlikely that further investigations on these alternative hydro options is required until the feasibility of pumped hydro at Lake Onslow is fully investigated and considered. We will provide further information on these options in May.

Annex Four: Electricity market interactions

Once commissioned, the NZ Battery will deliver economic benefits to the electricity sector

1. Economic modelling carried out to date indicates that a NZ Battery, such as pumped hydro at Lake Onslow, once operational will provide significant benefits for the electricity system. The principal benefit is in reducing the need for demand curtailment to balance the system, and in reducing the amount of additional new renewable generation (wind, solar and geothermal) that would otherwise be required to ensure security of supply in a 100 per cent renewable electricity system.

2. For example, modelling indicates that by 2050, a 1,000 MW and 5 TWh[6] sized pumped hydro scheme at Lake Onslow would have significantly reduced the need for demand curtailment and displaced the need for over 1,200 MW of wind and solar generation, plus some geothermal generation. This represents a significant benefit in meeting consumer expectations and avoided market capital expenditure. The larger the capacity and size, the more demand is met, the more generation is displaced and the greater the potential benefits (though with diminishing marginal returns, and within capacity constraints of the transmission system). This will need to be balanced with its cost implications, as well as cultural and environmental impacts.

There is a risk that the NZ Battery would disrupt private investment

3. Market participants have signalled that the NZ Battery Project is a source of investment uncertainty. Delays to investment in new renewable generation could slow decarbonisation efforts.

4. Part of this is due to scale. The Lake Onslow option dwarfs existing market participants in terms of storage. Currently New Zealand’s total hydro storage is 4.5 TWh, with Meridian Energy owning 2.7 TWh of that, and others under 1 TWh each. The pumped hydro scheme at Lake Onslow option could be up to 8 TWh. Other NZ Battery Project options would still have notable effects, adding between 1-5 TWh to the total storage available.

5. The Lake Onslow option could also have substantial (~1000 MW) generation/pumping capacity. For reference, Manapōuri is the next biggest renewable source of generation at 850 MW, followed by Benmore at 540 MW and Clyde at 432 MW. Then in terms of demand, the Tiwai smelter is currently the biggest load in Aotearoa by a substantial margin at 572 MW and Lake Onslow’s pumping capacity could be almost double that.

6. Big market entries/exits can substantially change the supply/demand balance in the market, impact wholesale prices, and as a result alter the economics of different plants. For example, the potential exit of the Tiwai smelter causes a significant amount of uncertainty and impacted investments in the market (eg Harapaki Wind Farm). Note that impacts on the market have flow on effects to the Crown in terms of the revenue it receives from the state-owned energy companies (Genesis Energy, Mercury Energy and Meridian Energy).

7. Part of the industry’s uncertainty around NZ Battery is associated with how the NZ Battery would operate. Previous government led reserve energy schemes (eg Whirinaki Power Plant) have distorted the market and disrupted investment signals. These unintended outcomes have largely been attributed to the plant’s operating mandate, as government run plant was driven by different incentives compared to other profit-maximising market participants.

[6] Where MW indicates the generating capacity of the plant and TWh indicates the volume of storage

8. Providing clarity around the type of operating model the government would consider could help alleviate some of this uncertainty.

Operating an NZ Battery in the electricity market

9. Broadly there are two types of options for how a pumped hydro scheme at Lake Onslow could operate. This is broadly consistent for all pumped hydro options:

    a. the scheme could operate solely for dry year security of supply, generating only when a certain threshold is crossed (eg one of the security of supply risk curves), or

    b. the scheme could interact with the market on a continual basis, contributing generation when demand requires.

10. Operating the scheme solely for dry year security of supply should ensure there is reserve fuel available in a dry year. However, limiting its operation to prescribed periods also prevents it from contributing to system security through a broader range of issues, resulting in increased scarcity prices and/or industry generation investment costs. Moreover, as indicated above, reserve schemes with different incentives to the market are subject to gaming by other market participants and can distort market signals (such as signals to build new generation).

11. Operating the scheme solely for dry year security of supply also has implications for the revenue of the asset. If a pumped hydro scheme were to operate only in an emerging dry year, then the revenue it could generate through the market would be restricted to such events. Revenue would be negative or very low during wet years and high in dry years.

12. Note the scheme could also buy and sell hedges, which would help smooth its revenue profile across years, just as other market participants do.

13. Operating the scheme on a continual basis, in a similar manner to other hydro generators, means the asset can be used more efficiently. Our early thinking is that a model of this type would likely be the most viable, as it would enable the scheme to contribute to different kinds of issues over time (eg low wind events or other threats to security of supply beyond dry years).

14. In terms of revenue, if the scheme operated continually and used the value of holding on to water to determine its bids and offers, it could arbitrage the market on a regular basis – buying and pumping when prices are low and selling and generating when prices are high. This mode of operation would likely reduce overall market price volatility and average prices in the electricity market in the process.

15. As indicated above, a pumped hydro scheme at Lake Onslow would be large compared to the size of other market participants. If the scheme was operated by a single market participant, it would likely have considerable market power.

16. One potential way around this is a ‘virtual slicing’ model where multiple participants each operate a share of the scheme. The rights for these ‘slices’ could potentially be auctioned. A similar type of model is already used in the electricity industry to manage locational price risk (through Financial Transmission Rights). Another method would be to have a regulated methodology by which the NZ Battery makes day-to-day operational decisions.

17. The best way forward is likely to involve further industry engagement with a range of market participants about options for the operation of the scheme, with a focus on continual operation.

18. MBIE has run several initial briefings with Treasury, to start to assess issues such how much influence should government maintain in the operations of an asset like Lake Onslow.

19. Additionally, MBIE will continue to examine possible options for the NZ Battery Project to recover both its capital and operating costs and potentially allocate any net revenue. Options may include hedges, auctions, market arbitrage, and the electricity industry levy. Once we have a clearer picture of the revenue streams and of the options' costs, we will work with Treasury on the possible funding options, both private and public.

20. Finally, note that the NZ Battery Project team remains engaged in conversations about the Electricity Authority's upcoming paper on the Review of Competition in the Wholesale Market, as well as other work on market measures to support the transition.