Feasibility Report

Lower Kaituna / Pongakawa

Client
Bay of Plenty Regional Council

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Response by

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A	Draft for Client Review	05/07/2024
B	Final Version	20/08/2024
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1. Introduction

BOPRC have commissioned Sunergise to assess the viability of selected areas of interest in the Pongakawa and Lower Kaituna regions for large scale ground mount PV arrays.

Figure 1 - Highlighted areas of interest for PV, with Pongakawa to the east and the Lower Kaituna to the West.

This assessment considers the viability of the overall area, checking for attributes that might rule out portions, or that might show portions to be the most preferable. It does not consider the real financial impacts of the effects, only points to where such impacts will be present and where there may be differences throughout the region.

2. Utility Scale PV Array - Overview

A typical Utility Scale PV array is greater than 1MW in generation capacity and installed on a metal frame that is mounted in a clear field.

Multiple installation configurations are available, primarily fixed tilt; a non-moving structure running east to west with panels tilted to the north, and single axis tracking; a structure with rows running north to south, with the rows rotating about their axis to follow the sun throughout the day.

A 1MW fixed tilt array will typically require 1Ha of land, while a 1MW tracking system will require 1.5Ha, but will generate more energy than the fixed system as it's panels face the sun more directly throughout the day.

Figure 2 - The Kapuni Solar Power Plant, a utility scale ground mount array installed by Sunergise, utilising a fixed tilt configuration.

Figure 3 - A ground mounted array in a single axis tracking configuration

A PV array generates DC electricity, which is then converted by a PV inverter to AC electricity of a desired voltage and frequency. Commonly inverters will supply power at the LV specification of the grid - in the case of New Zealand, 400V, 50Hz, 3 phase. To connect to the main distribution network, this must then be supplied to a transformer, which will convert it to the relevant distribution voltage (11kV, 33kV, etc.). This transformer is then connected to the electrical lines of the network operator – in this case, Powerco.

Mounting to the ground can be via screw or driven piles, or for an increased cost, concrete ballast system. Much of the decision making around foundation type is dictated by the ground conditions on site, and the viability of the site for tracking of machinery. Decisions around what mounting technology is used (tracker vs fixed tilt) considers terrain, wind and ground conditions.

3. Site Visit

A site visit was conducted on the 13th of June, attended by George van der Beek of Sunergise, and Jackson Efford and Santiago Bermeo of BOPRC.

The site at the end of Cutwater Road was visited, with a walk of the paddock from an eastern entrance, and a drive around the northern side as far as the pump station.

Following this, a visual inspection was made of all overhead lines and transformers within the regions of interest, as well as observations of the character of the land within the same region.

4. Assessment

The following section outlines the key considerations for ground mount PV installations, and their impact on the viability of solar in the area of interest.

Generation Considerations

The two primary factors that will affect the generation of a PV array are irradiance levels (sunshine hours) and temperature (electronics function better when cold).

Irradiance is affected by latitude, with much higher yearly irradiance totals found nearer the equator. Within the distances found in New Zealand; this typically has minimal impact. Of far more impact is weather. New Zealand's prime generation areas fall within the Mackenzie basin, southern Canterbury, and Nelson, all areas with high levels of sunshine hours.

Additionally, areas with lower temperatures throughout the day will result in the electronics in the PV modules operating more efficiently.

In the case of the coastal Bay of Plenty, as can be seen from Figure 4, it has high estimated generation levels, slightly higher than sites further inland. In fact, sites at nearby Edgecumbe have been selected by private developers as areas to install some of New Zealand's largest Solar Farms, due in part to the good generation possible.

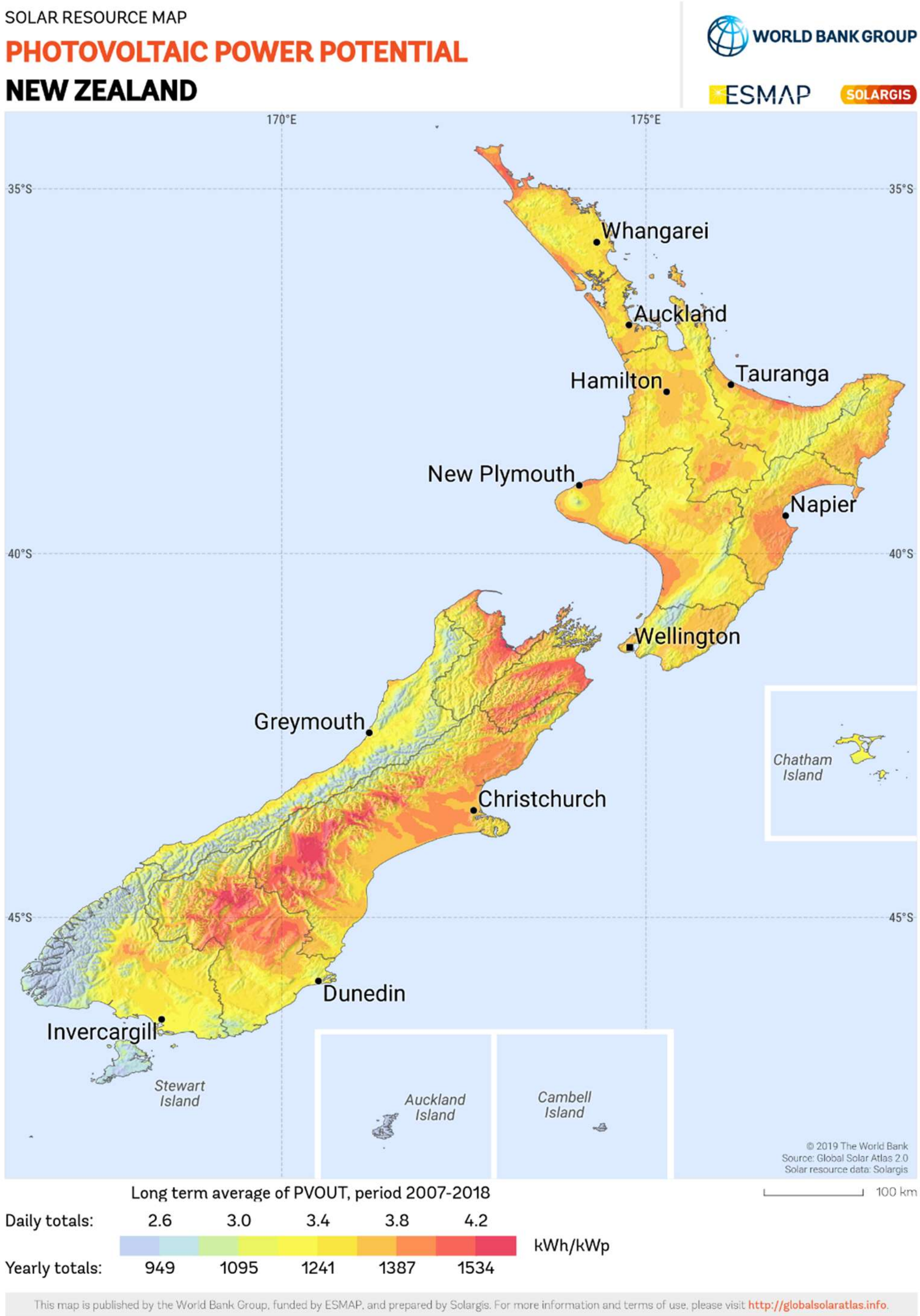

Figure 4 – Average array output map of New Zealand – kWh/kWp is a measure of how much energy is generated per unit of generation installed, so larger numbers are better.

Resource Consent Considerations

Glint & Glare

Large scale PV arrays require glint and glare assessments as part of the resource consent process. Where the reflected rays of the sun are determined to have an adverse effect on receptor locations, mitigation can be required. Primary receptor locations are airfields, houses and roads.

No large or small airfields or their approach flight paths are in or adjacent to the target region.

Houses that look down onto the array are typically the only area of concern when considering residential impact. As the few houses to the north of the areas of interest are at the same altitude as the array, (little to no impact is expected.

Large roads are primarily south of the target region, meaning they are outside of the angle of the reflected light with no glint & glare geometrically possible. The exception to this is for the far western portion of the Kaituna site, highlighted in Figure 4, which has the potential for glare in the evenings. This potential glare can be easily mitigated with planting shelterbelts. This will be a considered factor when evaluating viability.

Figure 5 - Region of Interest with area south of the highway highlighted in Red

Design/Installation Considerations

Network Connection

When considering site suitability, there are two main options for connection:

1. An existing transformer of sufficient capacity

or

2. A new connection with a new transformer

The first option is generally cheaper, as it eliminates the cost of a new transformer and establishing the connection.

In the case of the Pongakawa and Kaituna networks, during the site visit, all the network lines in the regions of interest were observed along their entire length, with the intention of noting any existing transformers of sufficient capacity for an array connection (>1MVA). Unfortunately, none were found with capacity greater than 200kVA. From our observation, as the region contains only broadly spaced residential/small commercial off takers, there are no locations with truly large power demands.

Figure 6 - Example of the small-scale transformers observed throughout the region

Therefore, any array will require a new transformer. As there is a reasonable fixed cost of connection, this will bias viability towards a larger array, better able to offset the fixed cost.

It should also be noted that connection to 33kV main lines is more costly and complex than connecting to 11kV distribution level lines, requiring a substation, and is therefore only viable for very large arrays (10MVA+). For this reason, consideration will only be given to 11kV lines in the region.

Network Capacity

Powerco owns and maintains the network that supports the areas of interest. 11kV overhead lines distribute power across the region, and a larger 33kV main line is present in the Kaituna area, following the line of the Motorway.

Figure 7 - Powerco Network map for the Lower Pongakawa & Kaituna Regions (Red - 11kV, Blue - 33kV)

Large PV arrays involve much higher levels of power than most non-industrial loads, and so can challenge the capacity of local lines. The line capacity available on the network is typically one of the most important factors defining the size of a PV array.

Powerco shares information on their network's capacity for distributed generation sources to allow for initial scoping. By determining the highest capacity line adjacent to each block of land they were divided into capacity categories for GIS analysis and overlay with other criteria.

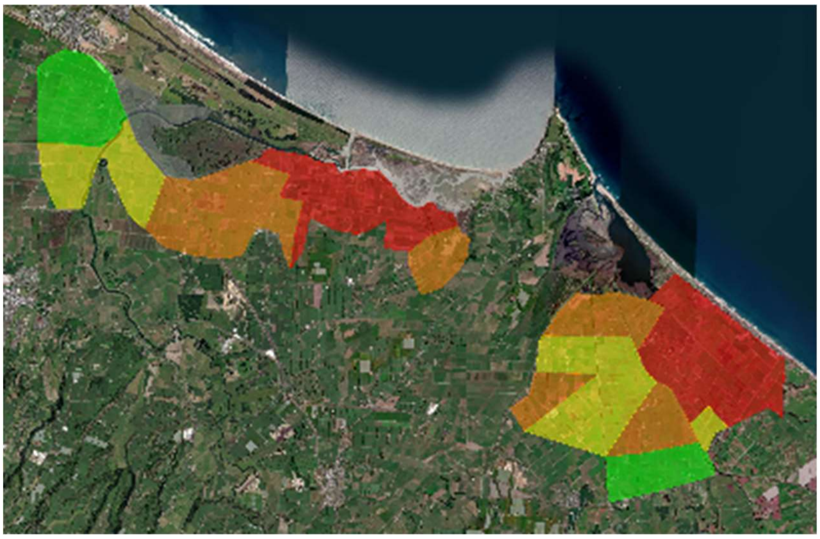

Figure 8 - Areas separated by line capacity. Green (3+MW), Yellow (2-3MW), Orange (1.5-2MW), Red (1-1.5MW), Grey (0-1MW)

The bulk of the regions have the capacity to support less than 2MVA of generation. Areas with highest capacity are labelled in green and yellow.

It should be noted that any generation added to the network will affect the ability of other branches to support their currently labelled loads.

Topography

Ground mount solar arrays are ideally constructed on land of consistent grade, with a low overall slope.

The entire area of interest features land with low overall grade, however drainage canals are real obstacles for array table installation. In particular, the ephemeral drains that cross the paddocks themselves have the potential to interfere depending on their depth and orientation.

Figure 9 - Satellite capture of land adjacent to McIntosh Road in Pongakawa

As can be seen in Figure 9 - Satellite capture of land adjacent to McIntosh Road in Pongakawa, the east-west drainage ditches are much more favourable for array tables, as they allow tables to fit in between the ditches without ever crossing them.

Overall, this is a non-critical issue, as it can be overcome by modification to the mounting structure, however this would incur increased cost.

In general, it appears that paddocks in the Lower-Kaituna region favour larger gaps between ditches, with some paddocks lacking any major ditches beyond those on the fence lines. For this reason, arrays on this region may see cost savings on installation.

Soil Conditions

Final pile design is based off geotechnical testing and – depending on array size – on site pile tests.

Geotech tests were available from neighbouring sites, which may give some indication as to the ground conditions encountered within the area of interest. The results of these tests showed ground conditions similar to other low lying coastal sites we have tested. Typically these sites require longer than standard piles in order to reach solid ground, and offer low lateral load handling, which may require a higher number of piles than typical of a system of similar design on ordinary ground.

The tests from areas in the Kaituna catchment showed evidence of testing refusal due to either buried rocks or trees. This could present an issue for a driven pile solution, as piles could refuse before reaching the required depth. Further investigation is required, and should the issue be present within the broader area, an alternative foundation may need to be considered, such as concrete ballast – another cost increase.

However, as the area is broadly homogeneous in character, there is no reason to favour any areas of the site on the basis of soil characteristics at this stage. Should the project progress further, a recommendation would be to conduct sample Geotech testing in a widely spaced grid over the whole area, with perhaps 6 tests in total, to assess the character of the region. In addition, the current tests available from neighbouring sites could be sent to mounting suppliers for initial investigation, as a way to steer any future testing.

Flooding

Large portions of the areas of interest are at or beneath sea level, with many pump stations used to prevent regular tidal inundation.

Where flooding is a risk, all PV modules, inverters and transformers must be above the expected maximum water level. Once array clearance is required to be greater than 1m above the ground, extra engineering requirements become necessary, and so installation price increases.

Flood mapping was made available for the Lower Kaituna region. For Pongakawa, an assumption was made to base flood risk purely on elevation given the lack of specific information.

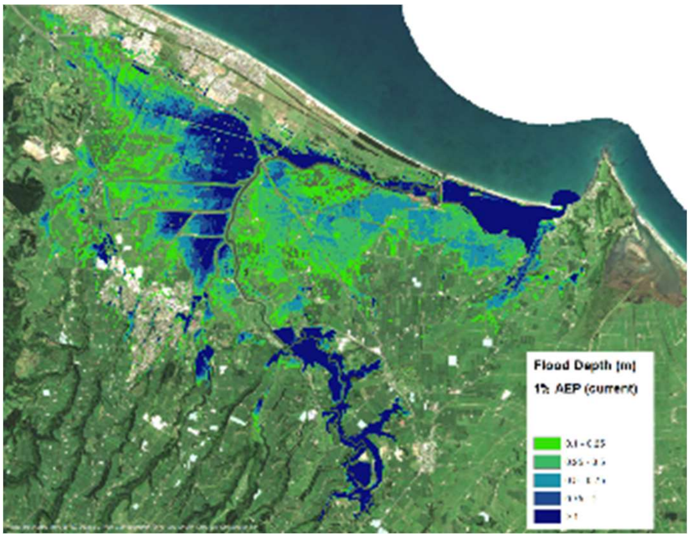

Figure 10 - Lower Kaituna Flood Map

Areas were weighted by degree of flood risk, with areas of >1m in particular heavily weighted against.

Trackability

Ground mount solar arrays require the use of small tracked piledrivers, and towing with large trailers. As such, ground conditions can have a substantial impact on site viability.

Ground conditions on the Cutwater Road site were acceptable for the required installation traffic, and as the lowest lying area in the region of interest, it has been assumed that this would represent the worst ground conditions in the region.

For this reason, no areas of particular concern were highlighted in relation to trackability.

Environmental effects

There is substantial salt content in the soil of both the Kaituna and Pongakawa areas, as evidenced by lack of growth in large patches observed at the Cutwater Road site.

Figure 11 - Bare patches of earth on the Cutwater Road site due to excessive salt content

This will influence pile design as mounting suppliers will need to ensure the structure has sufficient thickness of protective coating, usually hot dipped galv. In more extreme cases an epoxy coating may be required or where driven piles are unsuitable, concrete plinths can be utilised.

All PV arrays in New Zealand use either 306 or 316 stainless steel hardware, which will exhibit adequate corrosion resistance for this location.

There is potential for salinity to decrease towards the higher, more inland portions of the site, however as the elevation difference is relatively small this is not guaranteed. As was mentioned in the soil conditions section, sparse testing of the site would allow some indication of the potential difference across the region of interest.

No substantial shading effects are present in the region. The only issues observed were in the form of shelterbelts, which are easily modified following design.

Overall, in the absence of further information on salinity, minor weighting will be given to higher portions of the area of interest. No shading issues need be considered.

Long term Considerations

Typical ground mounted solar arrays require very little maintenance, particularly compared to other generation sources. Two primary maintenance requirements are cleaning of modules, and control of plant growth beneath the arrays.

Module cleaning

Modules self-clean during rain events due to their tilt, so manual cleaning is generally only required once or twice per year. Environmental factors can increase the frequency at which manual cleaning is required, typically when adjacent to:

- Industrial facilities that are sources of airborne particulates or contaminants (eg. Sawmill)
- Concentrated bird populations (eg. Refuse stations)
- Large seasonal pollen exposure (eg. Neighbouring forestry)

It is hard to estimate the effect of the environment on cleaning requirements without long term in-situ testing, however with the steep module tilt used for ground mounted arrays, self-cleaning is usually very effective.

No areas of particular concern were highlighted in the areas of interest.

Vegetation Management

In most regions it is necessary to in some way maintain the groundcover to prevent growth from obstructing the lower portions of the modules. A popular method typically involves allowing small numbers of stock to periodically graze in between the array tables, as they are more easily able to access beneath the arrays than mechanized methods.

This is not viable in this case, as sheep are unsuited to the wet ground conditions typical of the region. Cattle too are unsuitable, as their tendency to rub against the tables can cause damage to the glass modules. Young cattle, with their reduced height and weight, could be a compromise option worth investigating.

However, it is likely that mechanized mowing will be required and for this, sufficient space is left between table rows for access by road-sized vehicles.

If there is a desire for the land to have dual purpose, and to allow for production of silage/bailage in between array tables, extra space will be required between table rows to allow farm equipment to pass. This will result in a reduction in the quantity of generation installed per hectare, however this will be a site-specific consideration, and depend on the exact machinery to be used.

Figure 12 - Example for typical low ground cover, Cutwater Road left, State Highway 2 right

There appears to be no substantial difference in vegetation height across the region of interest, although as they are all currently grazed this may not truly reflect the unmanaged state of the paddocks.

Overall, vegetation management is the same across the region of interest and will have to be an important consideration no matter which area is selected.

5. Conclusions

For most attributes under consideration the Lower Kaituna and Pongakawa regions are broadly homogeneous, with only the following critical points for differentiation:

- Network capacity
- In field topographic variation
- Expected flood levels

Figure 13 - Pongakawa preferred location highlighted in green, Kaituna preferred location in purple

The most viable areas in each region according to these criteria are:

Pongakawa region preferred location (Green)

Immediately north of State Highway 2, between Wharere Road and Cutwater Road. The area has capacity for an array of up to 4MVA, installed on a ~4Ha parcel of land.

Primary factors are as follows:

- High network capacity (4MVA) adjacent to the land allowing a much larger array, better offsetting connection costs.
- Primarily east-west drainage ditches, which will allow for more efficient array configurations in fixed tilt configurations.
- Higher elevation compared to elsewhere in the Pongakawa area, reducing flood mitigation requirements and substantially reducing mounting cost.

Kaituna region preferred location (Purple)

Between the Eastern link and the Kaituna River, Northwest of Rangiuru.

The Kaituna Region was generally poorer than the Pongakawa region, with high capacity (>4MVA) lines only located in areas that have substantial flood risk under the current model. The selected location has capacity for a more moderate array than the Pongakawa area for this reason, despite some areas of the Kaituna having extremely high line capacity.

Primary factors are as follows:

- Moderate network capacity (2.5MVA) adjacent to the land allowing a much larger array, better offsetting connection costs.
- Better flood performance than other areas of the region, however the long-term flood risk would at a minimum require a higher than normal clearance for electrical equipment.
- Some glare mitigation may be required, however moderate height (<3m) planting should achieve this while not shading the array. A dedicated study would be needed during resource consent.

Consideration of the Cutwater Road site

In the case of the Cutwater Road section, there is line capacity for an array in the sub 2MW size. However, there is substantial risk of flood damage within the lifetime of the system, which will require substantial engineering and extra install costs to mitigate. Additionally, there are specific drainage channels on the Cutwater site that make array configurations difficult. Sunergise advises that when all factors are considered, it is not a suitable site for a long-term PV asset.

General Considerations

Wherever an array is located in the area of interest, the following points will need to be considered:

- Potentially poor ground conditions for foundations, which may result in increased cost of engineering and installation.
- Potentially high salt content in the soil, requiring more expensive materials.
- Considerations in the initial design around methods of vegetation management, requiring greater land area per unit of solar installed.

Next Steps

The next step we recommend is a financial feasibility study, encompassing the following factors:

- Identification of target energy offtaker and of sell rate of produced energy.
- Send current geotechnics from neighbouring sites to PV mounting suppliers for initial review.
- Geotech evaluation of broader area and submission of results to PV mounting suppliers for further review.
- Direct engagement with Powerco for detail on connection requirements/costs.
- Financial feasibility review, including concept level design.

6. Appendices

Appendix A - GIS Outputs