

Solar Farm Grid Connection

Preliminary Investigation

Prepared for Energy Farms Ltd

Prepared by Beca Limited

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Document Acceptance

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1 Introduction

Energy Farms Limited (EFL) are undertaking a programme of works to bring three solar farms online and connect them to the New Zealand electricity grid. Land has been acquired close to the Opunake, Wellsford and Marton substations and initial modelling suggests a potential total of approximately 240 MWp of electricity generation.

2 Opunake

2.1 Site overview

The proposed solar farm in the Taranaki area is located 5km North-West of the closest Transpower substation, Opunake (OPK) substation. Initial modelling has estimated a potential 80 MWp of generation from this solar farm and the land use to generate this is shown in the graphic below. The proposed connection voltage for this solar farm is 110 kV.

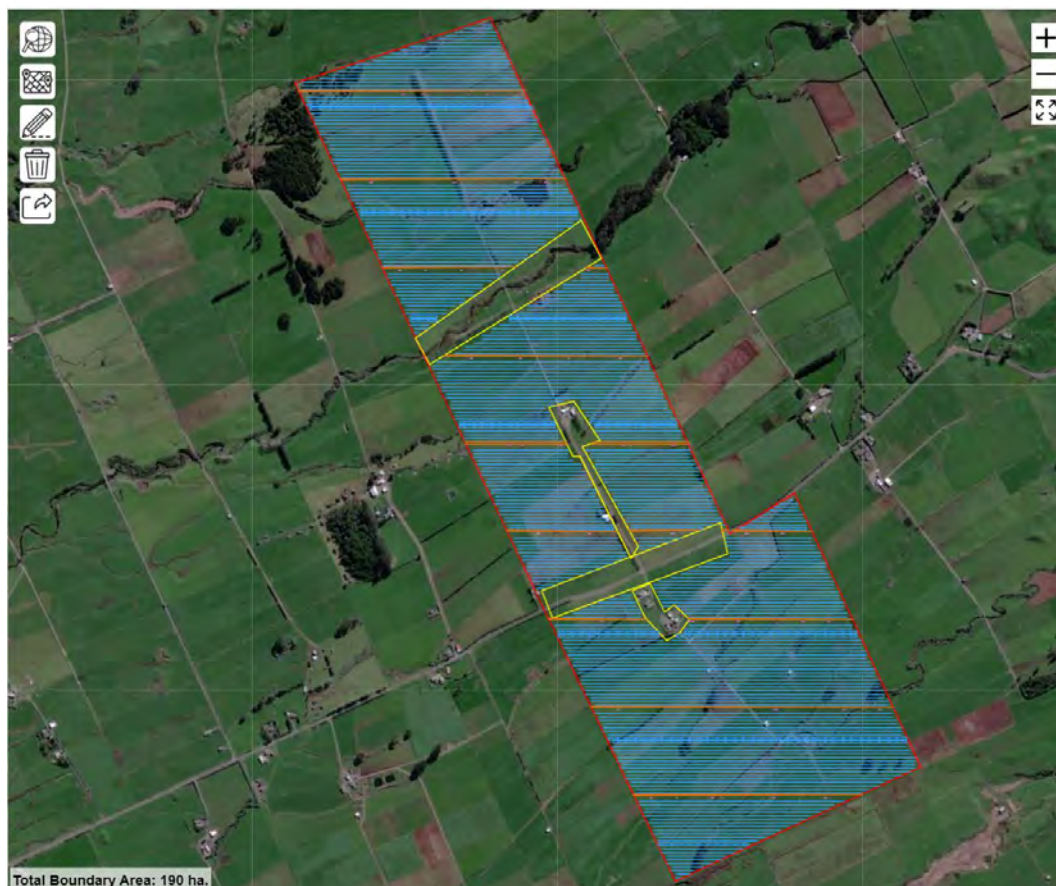


Figure 1 Opunake Solar Farm Overview

2.2 Transmission Network Topology

There are no 110 kV lines running near the proposed solar farm location, therefore a direct connection to Opunake substation, via a new 110 kV overhead line is required.

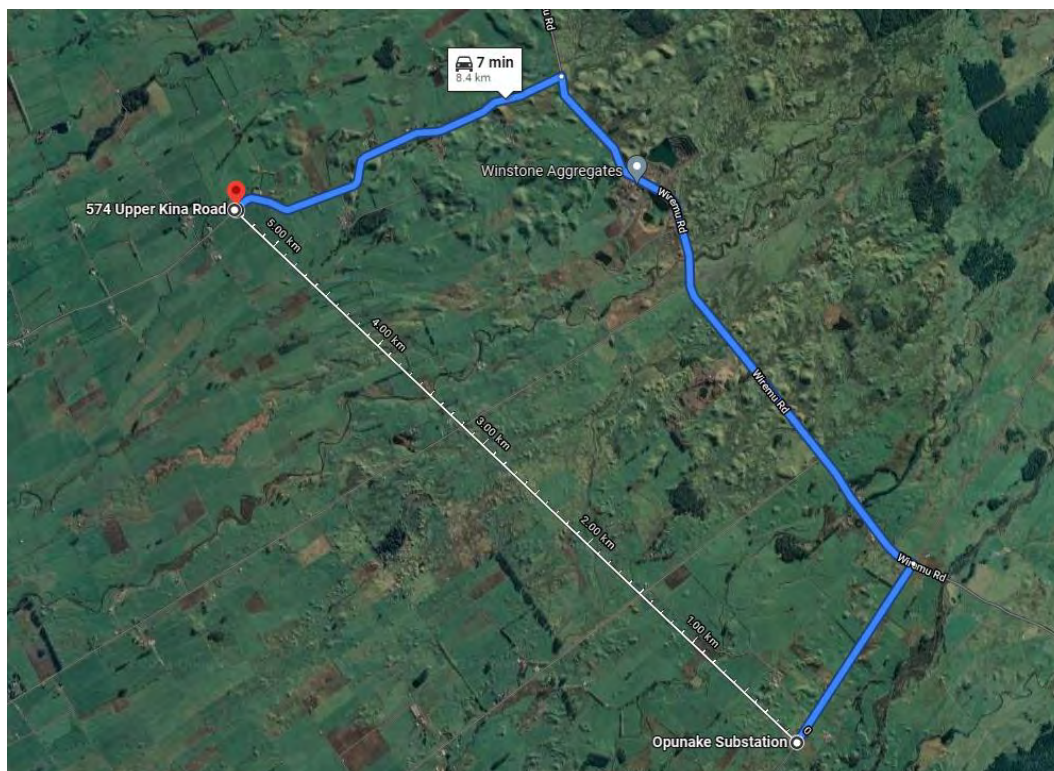


Figure 2 Opunake Transmission Line Route

Some key observations:

- Building the line across private land will provide the shortest distance but there are potential issues such as acquiring an easement and assessing environmental impacts that need to be considered.
- Building the line along the road reserve is another potential option, while the line will need to be longer and more costly to construct, pending discussion with the local council, the time frame to obtain an easement may be significantly less than the private land option.

2.3 Transpower Substation Upgrade Requirements

Opunake substation does not have a spare 110 kV bay hence an additional bay is required. Depending on the direction of the new line, the expansion can be done either on the West or East side of the substation as illustrated below. Option one is for the new line to be built over private land and option two is for the line to be built along the road reserve.

It is expected that a new CB would need to be installed either on the Kapuni – Stratford circuit 2 or Stratford circuit 1 depending on where the line will be connected to. The additional CB would be needed to provide adequate circuit protection with the new connection.



Figure 3 Opunake Proposed Switchyard Layout

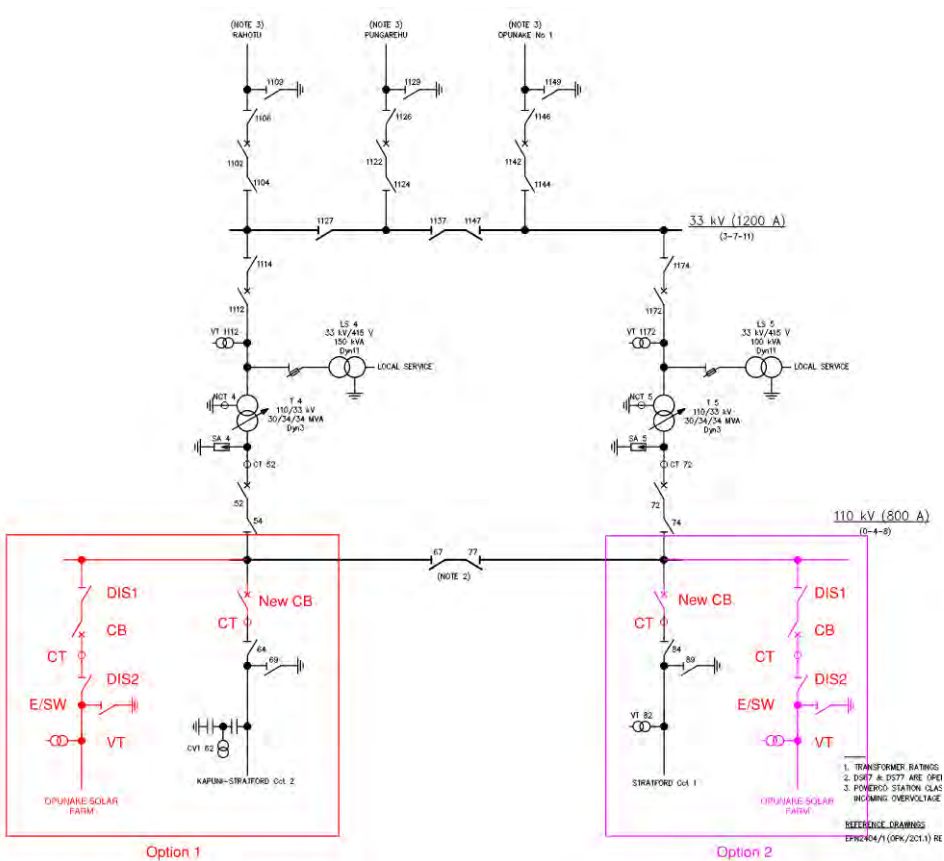


Figure 4 Opunake Proposed Single Line Diagram

3 Wellsford

3.1 Site overview

The proposed solar farm in the Wellsford area is located 3km South-East from the closest Transpower substation, Wellsford (WEL) substation. Initial modelling has estimated a potential 76 MWp of generation from this solar farm and the land use to generate this is shown in the graphic below. The proposed connection voltage for this solar farm is 110 kV.

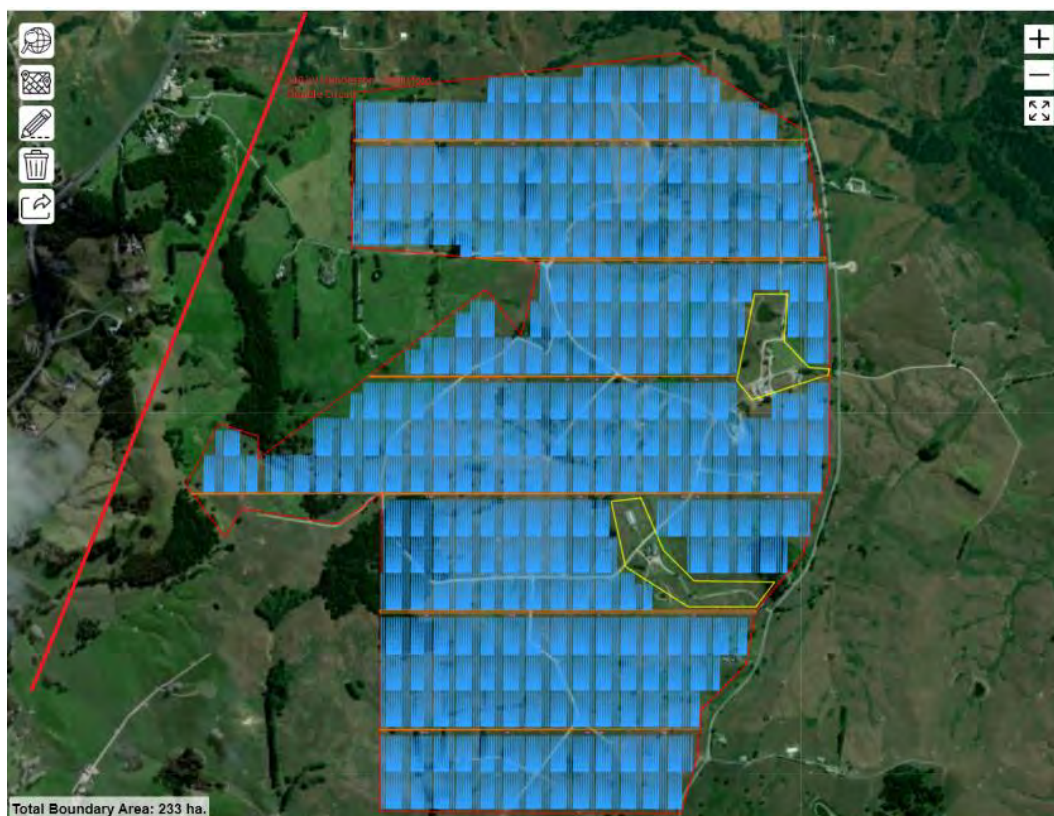


Figure 5 Wellsford Proposed Solar Farm Overview

3.2 Transmission Network Topology

The proposed solar farm location is close to the 110kV Henderson – Wellsford line, making a tee-off possible.



Figure 6 Wellsford Transmission Line Route

Based on its location, there are two possible grid connection options for the proposed Wellsford solar farm:

1. Tee off the connection from the Henderson - Wellsford circuit to the solar farm.
2. Direct connection from the solar farm to Wellsford substation.

Some key observations:

- The existing 110 kV Henderson – Wellsford line is very close to the proposed solar farm area, making it feasible to do the tee off connection to the solar farm.
- Option 1 is the preferred option since it doesn't need a new transmission line, less / no land easement is required, and less work is required at the Transpower substation.
- Option 2 poses an additional issue around uneven terrain and built-up areas between the solar farm and Wellsford substation.

3.3 Transpower Substation Upgrade Requirements

To accommodate the Option 1 connection, it is expected that two new CBs would need to be installed on the Maungatapere circuit and Henderson circuit to provide adequate circuit protection. Bay expansion is not required for this.

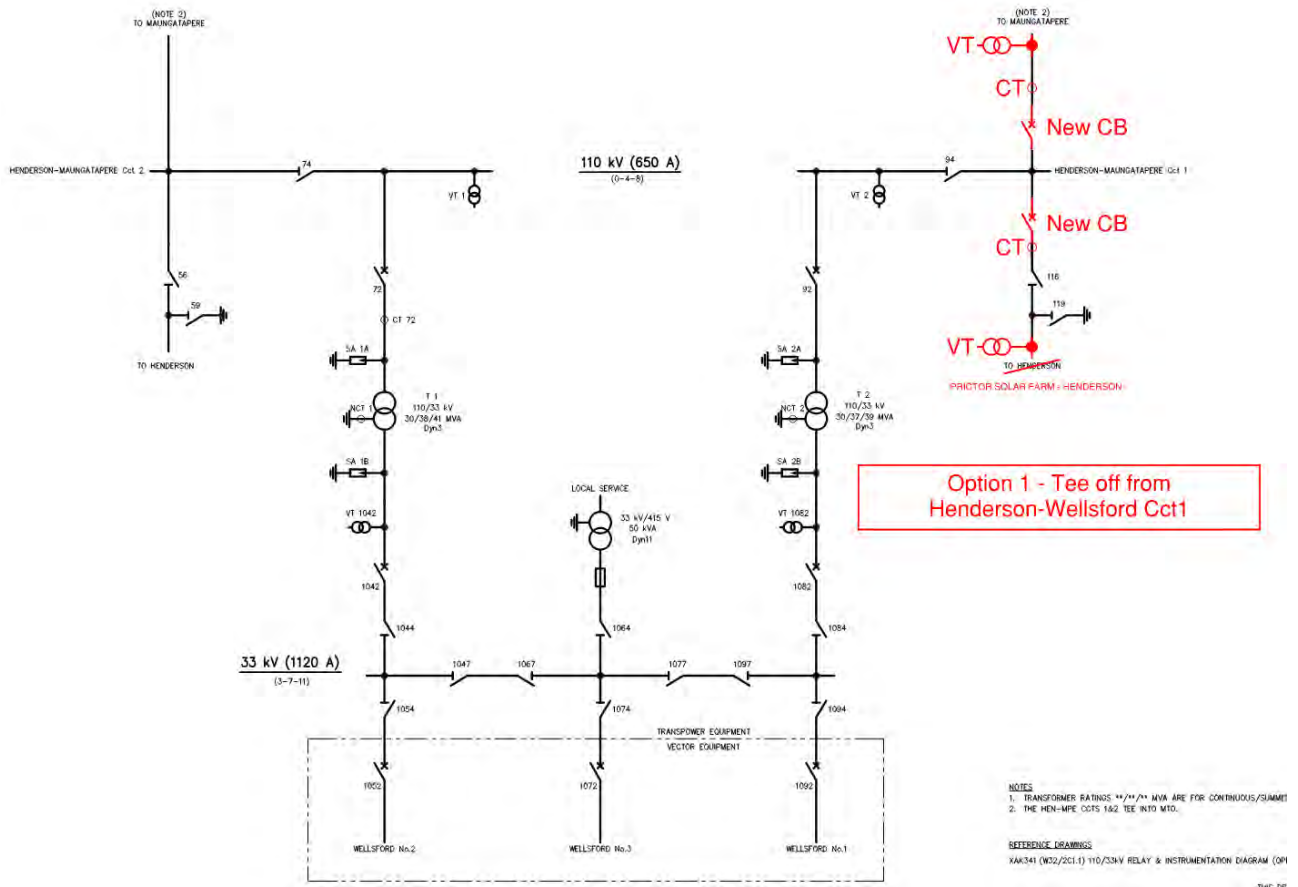


Figure 7 Wellsford Proposed Single Line Diagram (Option 1)

Tee off into circuit 1 is preferred as the circuit 1 bay has more space for the new circuit breakers to be installed.



Figure 8 Wellsford Proposed Switchyard Layout (Option 1)

On top of the new circuit breakers for the Maungatapere and Henderson circuits, Option 2 would require bay expansion at Wellsford substation as there is no spare 110 kV bay there. The expansion would be done next to Henderson-Maungatapere circuit 1.

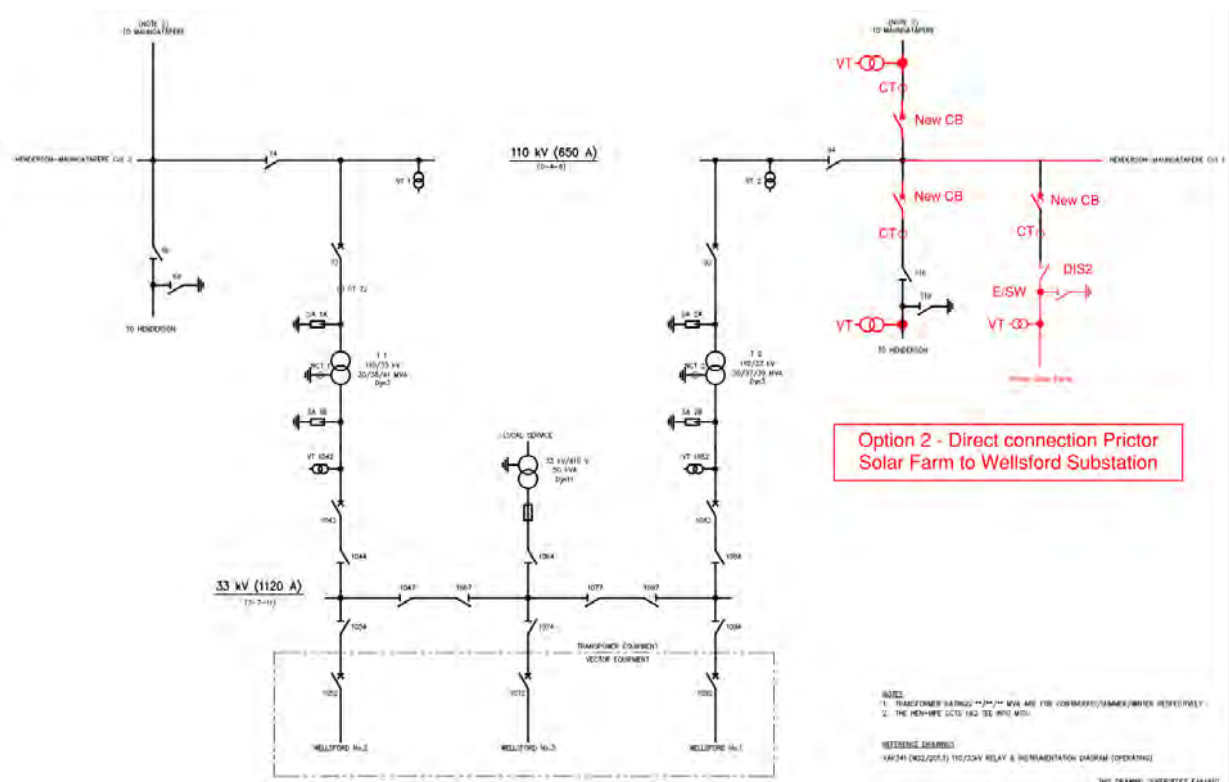


Figure 9 Wellsford Proposed Single Line Diagram (Option 2)

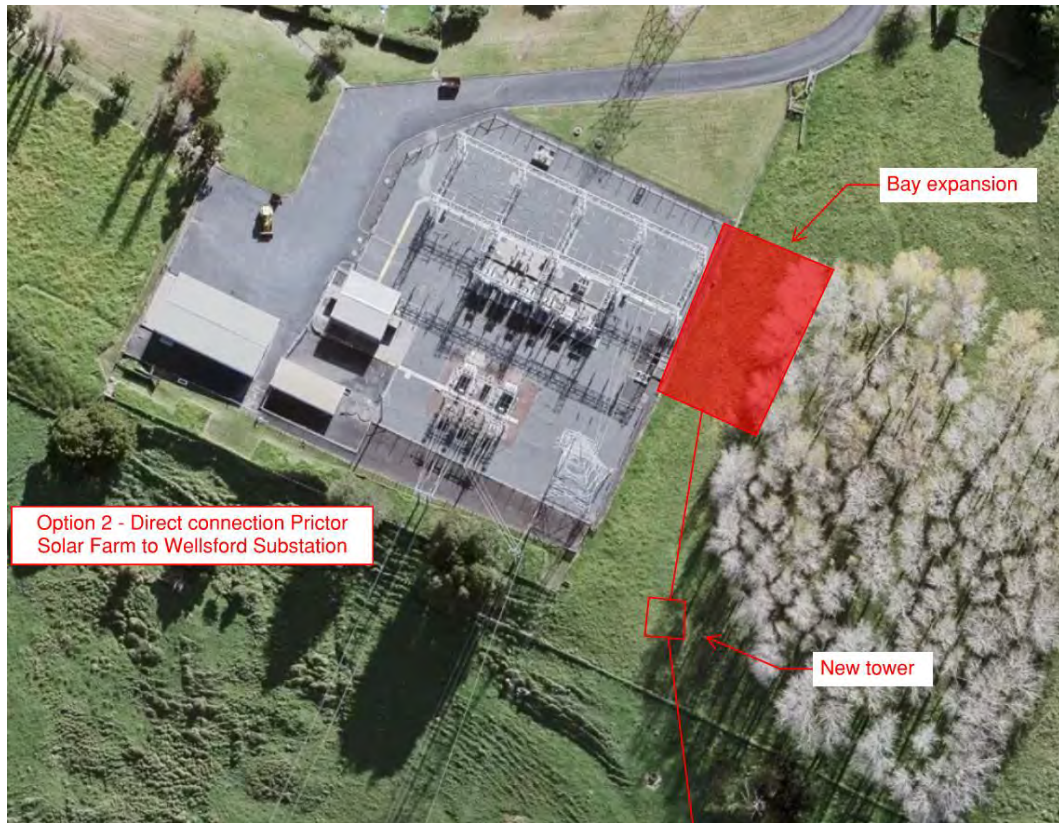


Figure 10 Wellsford Proposed Switchyard Layout (Option 2)

4 Marton

4.1 Site overview

The proposed solar farm is located 3.6km South-East from the Marton Substation with the Bunnythorpe-Wanganui double circuit going right through the solar farm area. Initial modelling has estimated a potential 80 MWp of generation from this solar farm and the land use to generate this is shown in the graphic below. The proposed connection voltage for this solar farm is 110 kV.

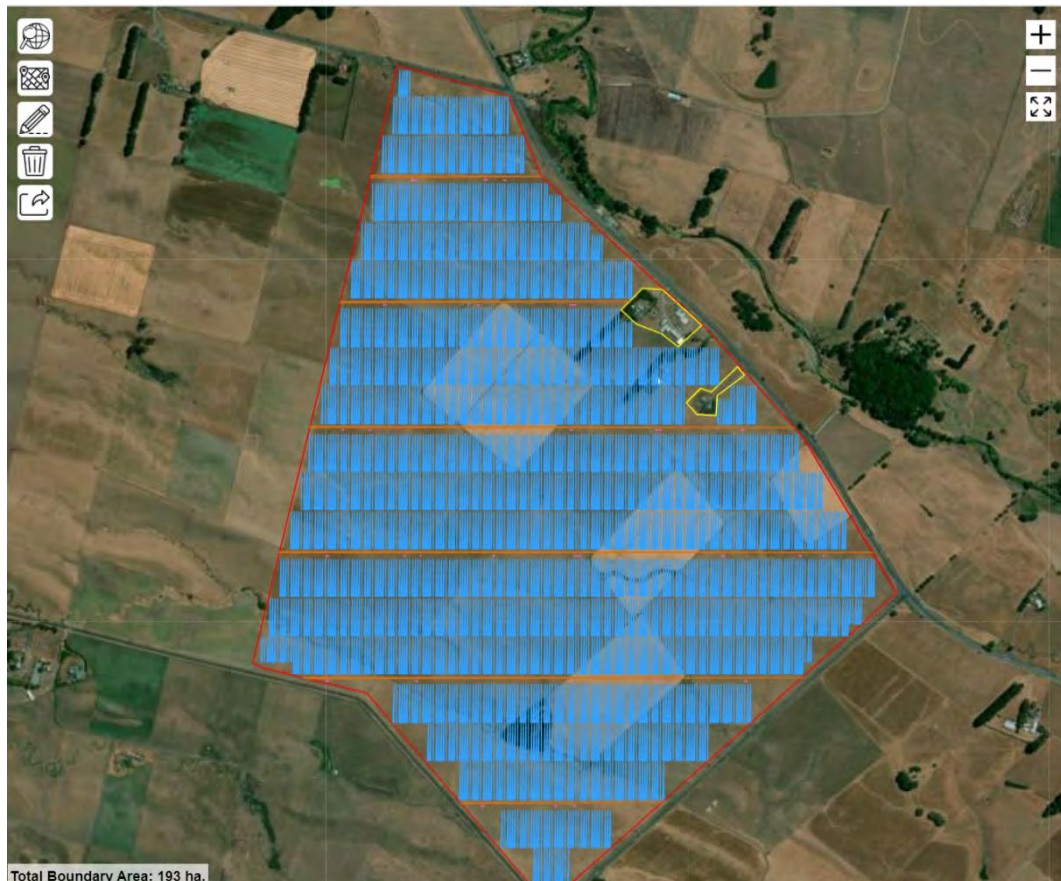


Figure 11 Marton Proposed Solar Farm Overview

4.2 Transmission Network Topology

There are three possible grid connection options for the proposed Marton solar farm:

1. Tee off the connection from Bunnythorpe - Wanganui circuit to the Marton solar farm.
2. A direct connection from the Marton solar farm to the Marton substation.
3. Connect the Marton solar farm in between Bunnythorpe - Wanganui circuit 1.



Figure 12 Marton Transmission Line Route

Some key observations:

- The existing 110 kV line runs through the solar farm area, making it relatively straightforward to do the tee-off connection (Option 1). All works can be done within the EFL-owned land which will reduce the complexity of the interconnection and there is no need for any land easement.
- Option 1 requires less work than Option 2 because it does not require a new transmission line, no land easement is required and less work is required at the Transpower end. This makes Option 1 a cheaper and simpler option compared to Option 2.
- Since the existing 110 kV line is going through the solar farm area another alternative is to cut the Bunnythorpe - Wanganui circuit 1 into the solar farm substation (Option 3). Therefore, avoiding the tee-off connection and improving the system reliability. Further study is required to determine the cost benefit from the improved reliability that Option 3 has to offer.

Further discussions between Transpower and EFL would be required for Option 3 with respect to asset ownership as it would make the Marton solar farm substation part of Transpower's 110kV system and requires modification to the existing 110 kV line.



Figure 13 Marton Transmission Line Route (Option 1)



Figure 14 Marton Transmission Line Route (Option 2)



Figure 15 Marton Transmission Line Route (Option 3)

4.3 Transpower Substation Upgrade Requirements

For Option 1 and Option 3, two new circuit breakers need to be added to the circuits going to Wanganui and Bunnythorpe to provide adequate protection. A little substation area expansion may be needed to place the new circuit breakers. Due to the way it is arranged, it is recommended to add Marton solar farm to Bunnythorpe – Wanganui circuit 1 instead of circuit 2 to avoid creating a 4-terminal line. Additionally, it is physically easier to add new circuit breakers at the circuit 1 bay.



Figure 16 Marton Proposed Switchyard Layout (Option 1 & 3)

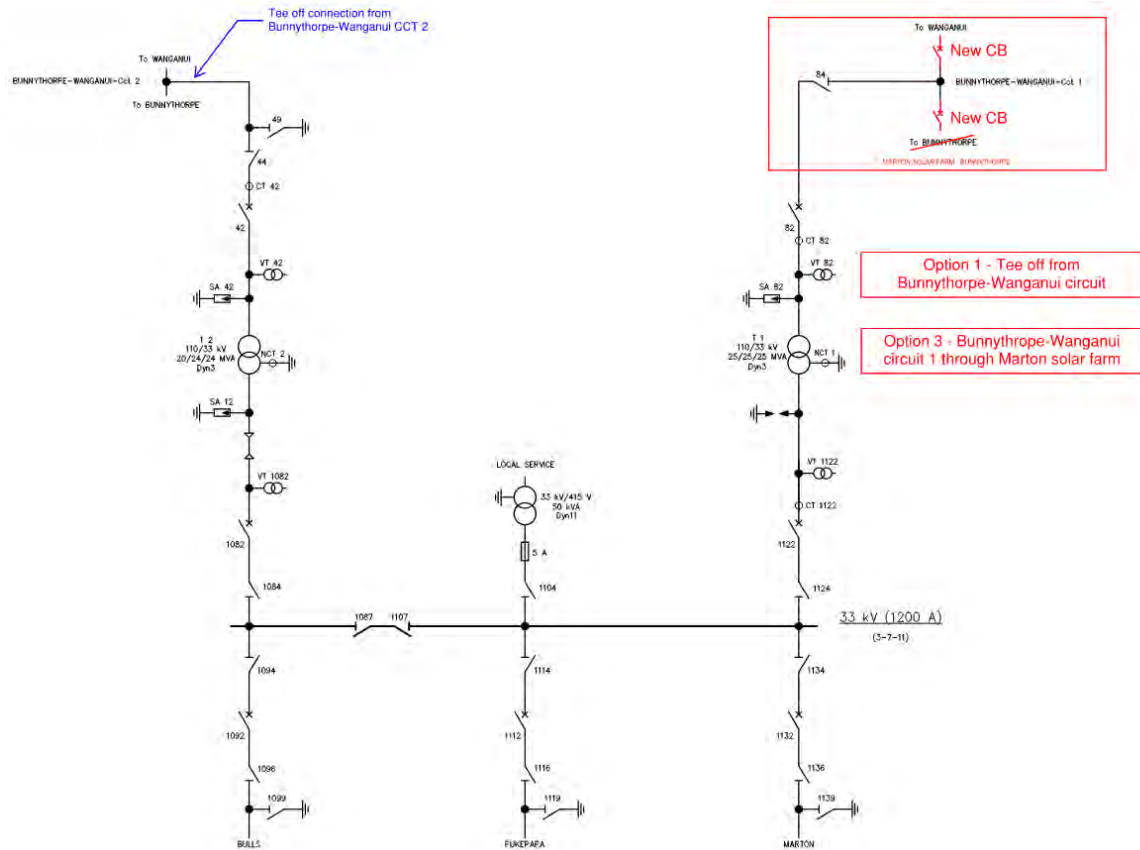


Figure 17 Marton Proposed Single Line Diagram (Options 1 & 3)

Option 2 requires the same work as Option 1 with the addition of a new bay expansion for the new line connection from the solar farm.

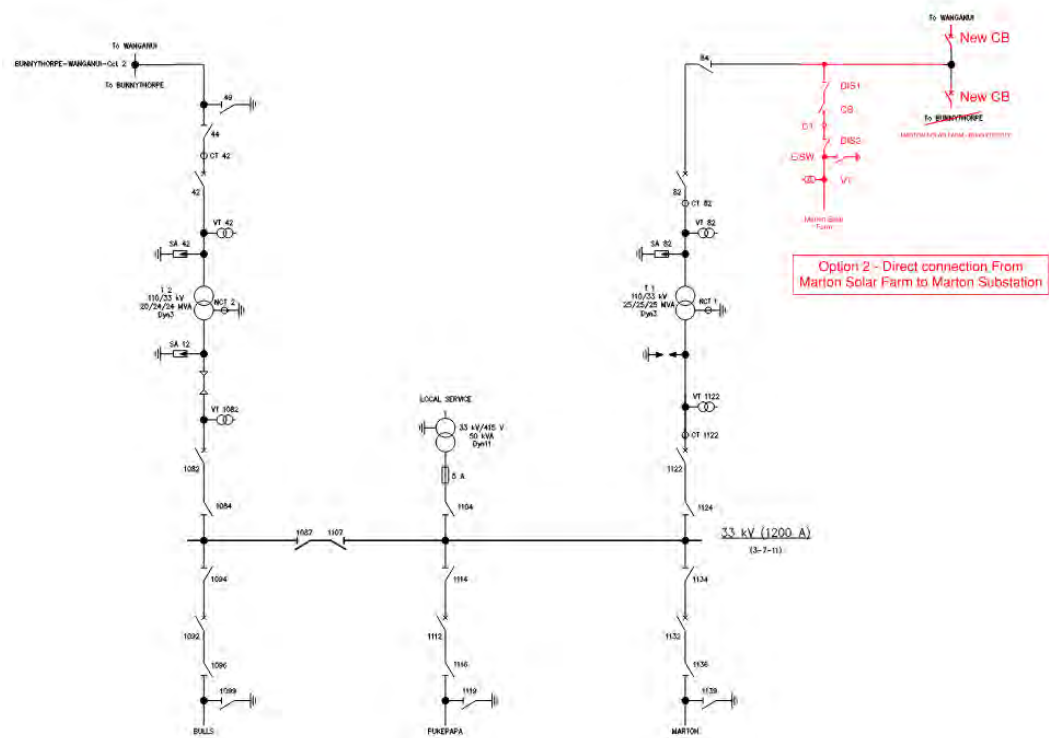


Figure 18 Marton Proposed Single Line Diagram (Option 2)



Figure 19 Marton Proposed Switchyard Layout (Option 2)