HIL1A
Summary Electricity Connection

Daisy Hill Solar Farm

January 2021

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ABOUT ITP RENEWABLES

ITP Renewables (ITP) is a global leader in renewable energy engineering, strategy, construction, and energy sector analytics. Our technical and policy expertise spans the breadth of renewable energy, energy storage, energy efficiency and smart integration technologies. Our range of services cover the entire spectrum of the energy sector value chain, from technology assessment and market forecasting right through to project operations, maintenance and quality assurance.

We were established in 2003 and operate out of offices in Canberra (Head Office), Sydney, North Coast NSW, Adelaide and Auckland, New Zealand. We are part of the international ITPEnergised Group, one of the world's largest, most experienced and respected specialist engineering consultancies focussing on renewable energy, energy efficiency, and carbon markets. The Group has undertaken over 2,000 contracts in energy projects encompassing over 150 countries since it was formed in 1981.

Our regular clients include governments, energy utilities, financial institutions, international development donor agencies, project developers and investors, the R&D community, and private firms.

ABOUT THIS REPORT

This report was requested by the NSW WRRP as part of PPSSWES-26 – Carrathool – DA2020/017.

ABBREVIATIONS

AC	Alternating Current
AVR	Automatic Voltage Regulator
BSP	Bulk Supply Point
DC	Direct Current
EE	Essential Energy
EMT	Electromagnetic Transient
FI	Frequency Injection
HV	High Voltage
ITP	IT Power (Australia) Pty Ltd
kV	Kilovolt, equivalent to 103 volts
LDC	Line Drop Compensation
LV	Low Voltage
MVA	Megavolt-ampere, equivalent to 106 volt-amperes
MVAR	Megavolt-ampere reactive, equivalent to 106 volt-amperes reactive
MW	Megawatt, equivalent to 106 watts
OLTC	Onload Tap Changing / Changers
ONAN	Oil Natural Air Natural cooling method
p.u.	Per Unit
PF	Power Factor
PPC	Power Plant Controller
PSCAD	EMT simulation software from Manitoba HVDC
PV	Photovoltaic
RMU	Ring Main Unit HV Switch Gear
SINCAL	PSS SINCAL Software from Siemens PTI
SLD	Single line diagram
SP	Service Pack
SWER	Single Wire Earth Return
TQ	Technical Queries
Vk	Impedance Voltage
V1	Positive Sequence Voltage
Vn-LL	Nominal Line to Line Voltage
VRMS	Root mean square voltage

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1 INTRODUCTION

1.1 Project Background

ITP Renewables is proposing to construct 2 x 4.99MW solar farms located in Hillston, NSW. This report forms a part of the technical requirements of the grid connection application to Essential Energy (EE) but has been summarised for the purposes of a DA submission to outline the concept and provide the flowchart of process governed by EE.

1.1.1 Site Information

The new location of the POC is on pole CE9700469 west of the Solar Farm.

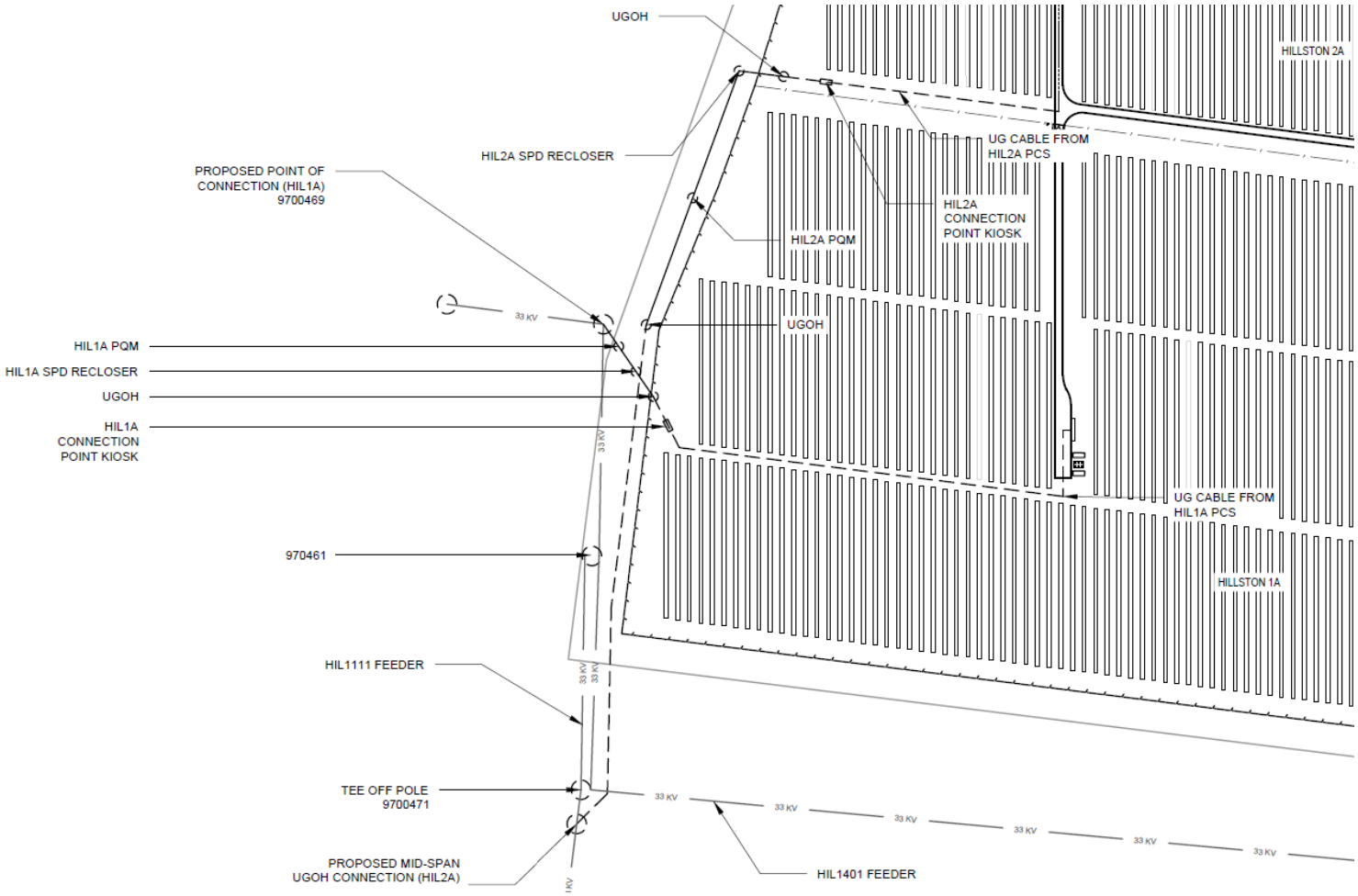

Figure 1: Proposed location of the solar farm with Essential Energy's 33 kV distribution feeder HIL1401 shown in yellow. Source: Essential Energy 2019

Table 1 Site Information

Parameter	Value
Lot / Dp	103/755189
Address	Racecourse Rd, Hillston NSW 2675
LGA	Carrathool Shire Council
Lat / Long	-33.51501, 145.53487
Elevation	122m

1.1.2 Connection Arrangement

The solar farm will be connected to the network as detailed in **Error! Reference source not found.**. Figure 2 and Figure 3 provide a high level a single line diagram representation of the connection arrangement into the existing network.

The solar farm will be connected to the electricity network of Essential Energy through overhead cables supported by steel/timber poles and traversing parts of the site through underground cables as per AS3000 and NSW Service and Installation Rules. Typical designs as per Figure 4 and 5.

Table 2 Network connection information

Parameter	Value
DNSP	Essential Energy
Supply Area	Darlington Point
Connection Voltage	33kV
Feeder Name	HIL 1401
Feeder Type	Distribution
Upstream Substation	Hillston 132/33kV Zone substation
Downstream Substation	N/A

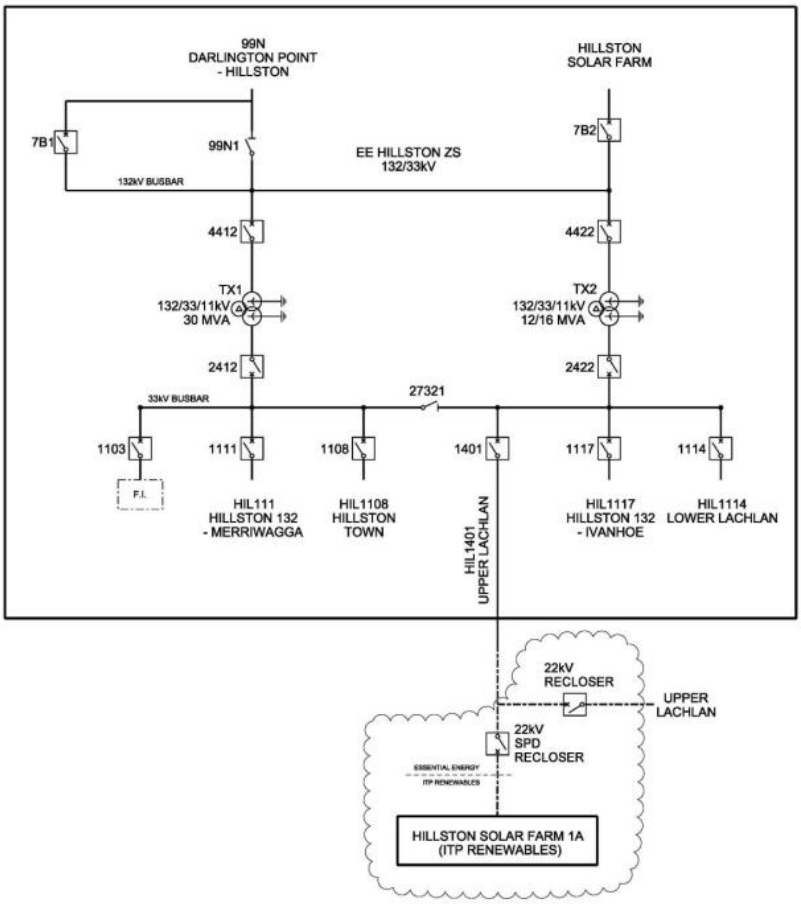

Figure 2: System Network Diagram showing the proposed Hillston 1A Solar Farm (source: Essential Energy, 2019)

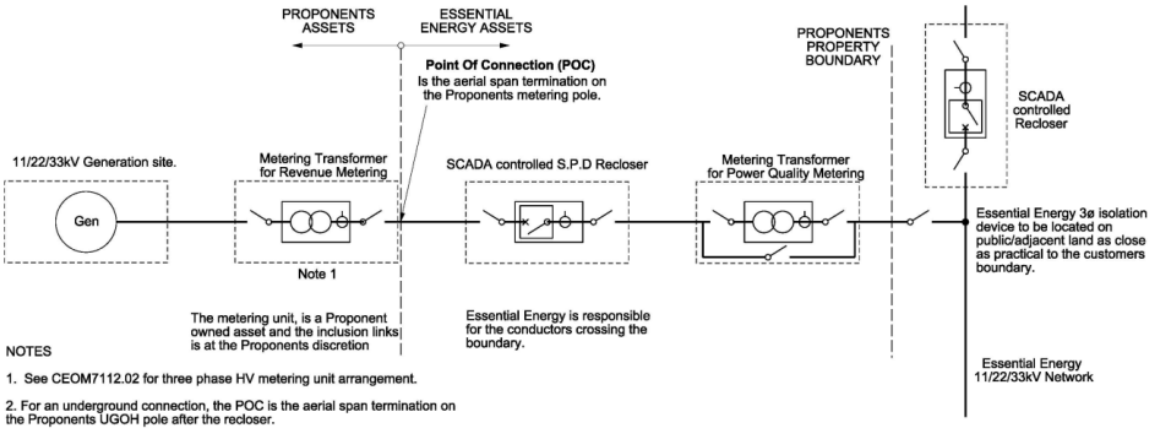

Figure 3: Connection point SLD (source: Essential Energy, 2019)

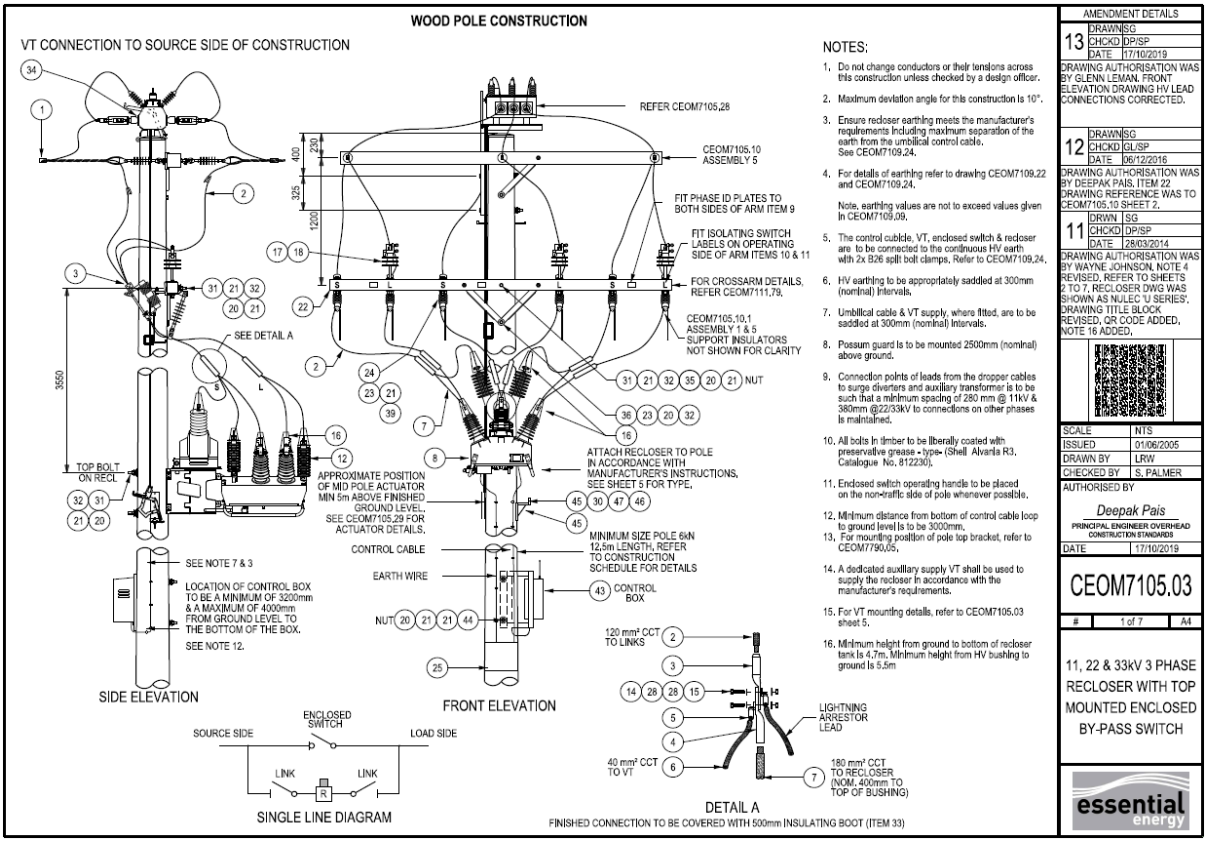

Figure 4 - Typical overhead HV switchgear and cabling on poles (source: Essential Energy, 2019)

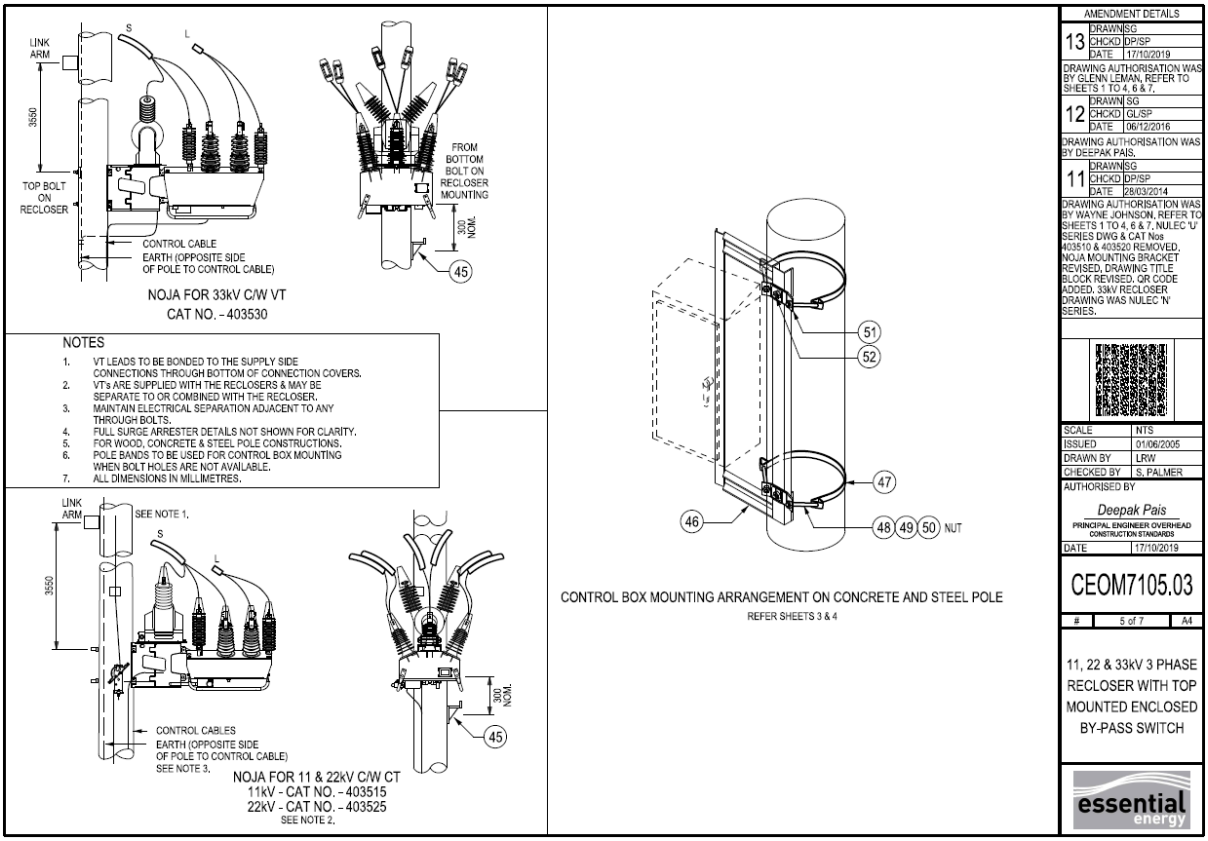

Figure 5: Typical overhead HV switchgear on poles (source: Essential Energy, 2019)

1.1.3 Proposed Generator

The solar farm will utilise photovoltaic modules to generate DC power which will be converted to 50Hz AC power by an inverter as detailed in Table 3. Figure 6 shows a single line diagram (SLD) of the proposed generator.

Table 3 Proposed generator key data

Parameter	Value
Generator Type	Asynchronous (Inverter based)
Rated power	2 x 4.998 MW[1]
Individual generating units	4 @ 2.499 MVA per unit
Inverter model	SMA SC-3000-EV (factory derated to 2.499MW)
Generator Voltage[2]	655V[4]
Step-Up Transformer	33/0.655/0.655 kV Dy11y11, ONAN, 5 MVA, 6.9% Vk

[1] The rated power is the sum of the nameplate ratings. The maximum apparent power at the point of connection will be slightly lower.
[4] This represents the voltage level at the terminals of each inverter.

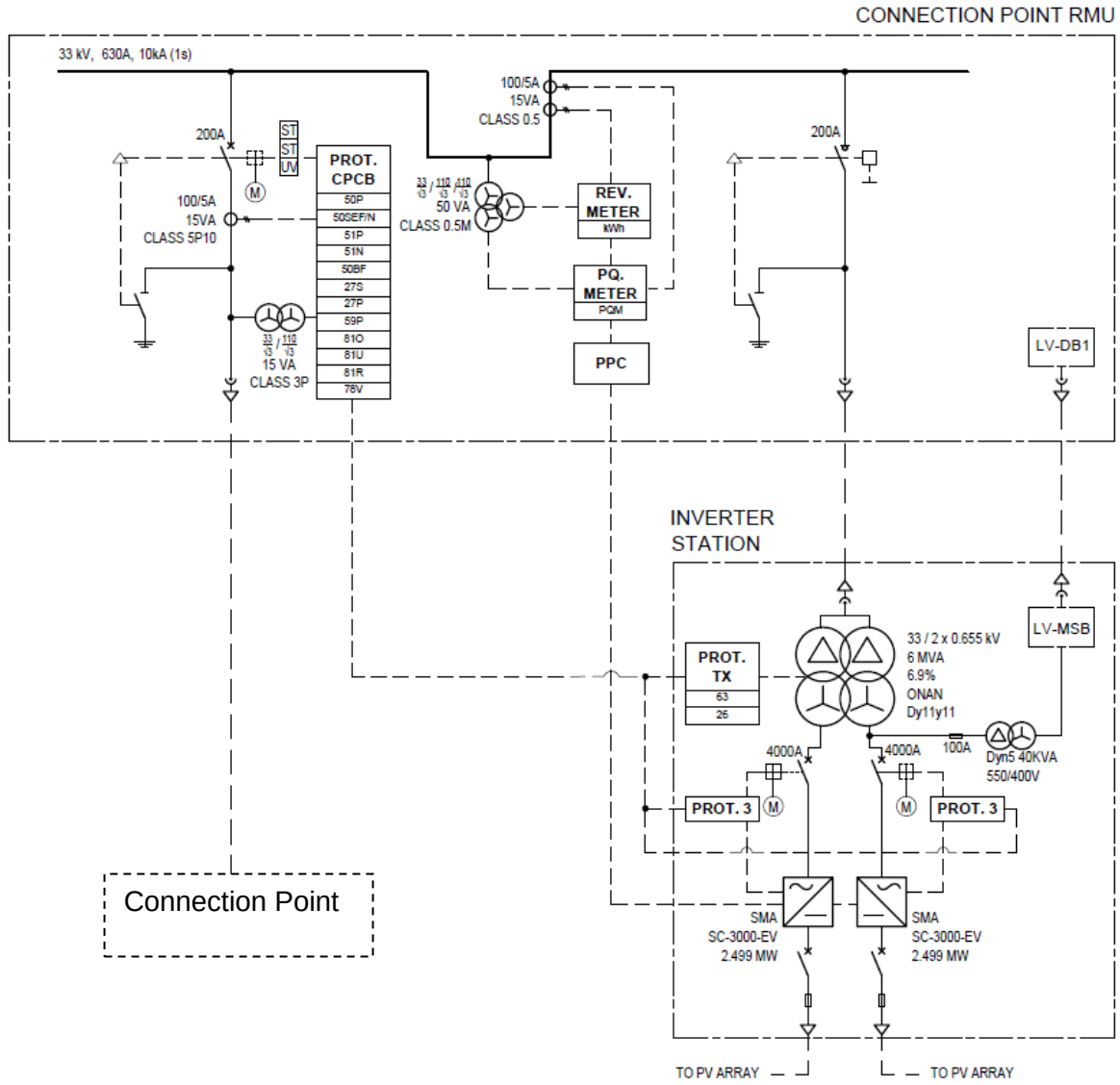

Figure 6: Proposed solar farm SLD

1.2 Study Execution Plan

The studies will be carried out in a sequential manner covering the following focus areas:

- Study 1: Steady State Grid Impact Assessment,
- Study 2: Dynamic system performance,
- Study 3: Power Quality Assessment,
- Study 4: Earthing Design Studies, and the
- Study 5: Protection coordination assessment.

ITP Development has (as of the date of this report) successfully received approval endorsements for each of the above studies as part of Essential Energy's grid connection process.

Details of each of the study components is considered commercial in confidence and proprietary in nature and hence will not be made available in the public domain.

ITP Development also does not consider the details of electrical engineering technical studies and analysis with Essential Energy a NSW planning criteria.

1.3 Intended Audience

Given the amount of necessary assumed knowledge, the intended audience for this report are the network planning and grid connection teams already affiliated with the proposed Daisy Hill Solar Farm, and those familiar with the nearby distribution and transmission system assets.

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